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A Typological Approach for Technological Innovation in Logistics in the Industry 4.0 Scenario

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***Abstract*— *This paper discusses the nature of logistics and their evolution based on technological innovation in industry 4.0 environment and seeks to relate to the future logistics transition models. It proposes a typology for logistics operations based on technological innovation in five dimensions. The objective is to show how this typological development can provide a useful approach for the integration of the various aspects of technology as a pillar of sustainability in a company operation*.
***Keywords*— Cyber-physical systems, Global logistics, Industry 4.0, Internet of things.**

I. INTRODUCTION

At a time in which the synchrony between production and consumption of products and services was overtaken by the geographic question, availability at different times and locations became preponderant along with information in time and space within the logistic chain.

Logistics therefore provides a connection between the subsequent stages of the supply chain consisting of links from the supply of the raw materials to the point of consumption of the final customers as well as the reverse flow of products, enabling the reuse of the materials or the components themselves (closed loop reverse chain).

However, this process is not necessarily performed by just one industry, but it encompasses a number of separate companies that are distributed to organizations that operate together across the business network.

Current supply chains are generally globalized and involve organizations that provide, produce, market, distribute and deliver logistics services around the world.

Thus, this paper seeks to analyze the way in which trade, production and logistics services have become a global business and its future transition based on technological innovation.

It also seeks to argue that, in the face of today's challenges, the need for a fundamental repositioning of the business model and the way in which production and logistics can be organized as well as the management of the corresponding information based on new technologies, which can contribute to the sustainability of operations in this constantly changing environment.

Zijm and Klumpp (2015) highlight the interconnection of three well-known development systems formed by social, ecological and economic sustainability (people, planet, profit) and other trends such as the individualization of the process (peer-to-peer, customization, and personalized services) and business automation/scanning (artificial intelligence, cyber-physical systems and the Internet of Things-IoT).

II. TYPOLOGIES

As noted by Doty and Glick (1994), typologies are a unique form of theory based on a set of ideal types. Typologies have proved to be very popular in research management with many well-known examples, such as those of Porter (1980, 1985), Miles and Snow (1978) and Mintzberg (1979, 1983). They are also popular in the field of research with well-known examples that are the ones that propose different types of services (Chase, 1978, 1981, Chase & Tansik, 1983).

In this way, the present work does not aim to develop a set of ideal types, but to suggest how typologies can help educators, researchers and managers interested in logistics operations, their management concepts, models and applications.

As such, this article follows the standards of Adam Jr. (1983) who in discussing organizational issues and methods notes that limiting any typology in production/operations where it does not provide an integrative theory for the discipline itself.

Therefore, the objective of this research is modest in typology, but it aims at bringing together the various aspects of logistics innovation in the industry 4.0 environment insofar as the propositions can be developed from the formation of the theory and then tested in the field (Adam Jr., 1983).

III. BUSINESS PROCESS DIGITALIZATION

For Demil and Lecocq (2010), a business model is a tool where it is up to companies to adapt to an innovation and suggest two different views according to research.

The first is a "static approach", where the business model within an industry is characterized by e-business. The other is called the "transformational approach" and requires progressive improvements to create internal consistency and/or to adapt to the environment. It includes technological innovations where they often require new business models in order to be successful in the market.

Therefore, Teece (2010) complements that the new business models can properly represent a form of innovation. This means that innovative companies should stand out not only in the development of products or technologies, but also to discover appropriate business model for innovation. In other words, Chesbrough (2010) argues that the innovation process and the business model are complementary to the success of a new product or service.

Digitalization has enabled the combination of these features and functions of industries and traditional products in a myriad of new paths.

COST (Cooperation in the Field of Science and Technology Research – Europe) stresses that the direct consequence of the digitalization of business processes in the instantaneous communication era is that the workflow of the production system can be installed in a location in a significantly profitable way.

It points to multiple implications in general, since both society and the production system must be rebuilt in this "Lego" world in which new forms of thinking are uncovered based on the distributed instantaneous communication system (relationship forums and virtual games).

In this way, new business models – many unexpectedly – will be invented. The most visible impact of the Digital Revolution is that of instant virtual communications around the world where distances are greatly reduced. Thus, the business life cycle, processes including products and services have also been increasingly shortened.

Therefore, flexibility has been the most appropriate new password – the flexibility of skills, technology itself, the labor market and trade regulations and agreements, and labor relations. At the corporate level, the digitalization of business processes is one of the factors that contribute to the operationalization of strategic efforts aimed at the innovation of processes at lower costs. Moreover, digitalization involves both the incorporation of new technologies into the organization as well as its integration with existing processes, forming a convergence between the product and its processes (Orlikowski, 1992, Roberts & Grabowski, 1996, Weick, 1990).

Prahalad and Ramakrishnan (2003) identified new competitive spaces for innovation that offer new opportunities for sustainable growth and value creation.

They presented competency spaces in addition to the company comprised of an extensive network including suppliers, business entities and partners and consumer communities. They remember that companies can differentiate themselves not only through the quality and cost of their products and services, but also through their ability to co-create unique experience environments with consumers, called the solutions space.

They emphasize innovation based on solutions beyond the physical product, resources and functions incorporated in hardware, but in knowledge accumulated by the company, that is, based on "soft knowledge". In this way, a vendor solution may involve responsibilities for one of the subsystems of a customer or for the entire business environment as a business portal highlighted in the Fig. 1.

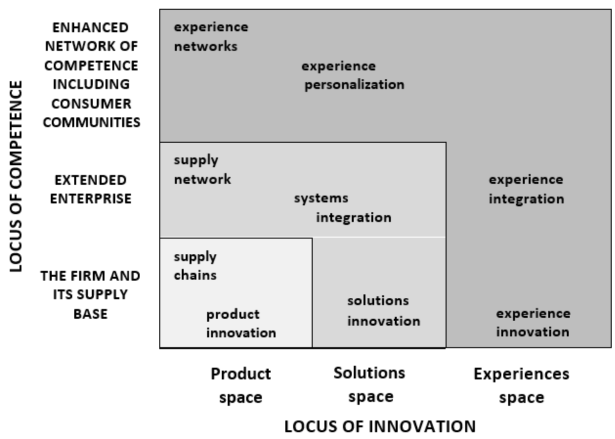

Fig. 1: New Competitive Space for Innovation. Source: Prahalad and Ramakrishnan (2003).

IV. INTERCONNECTION OF PROCESSES

Machines, devices, sensors and people are connected through IoT (Giusto, 2010) and IoP – Internet of People (Vilarinho, 2013) forming IoE – Internet of Everything (Santos & Villalonga, 2015).

Wireless technologies play a prominent role in the increasing interaction of business processes as they allow ubiquitous access to Internet. Objects and people interconnected via IoE are able to share information as the basis of collaboration to achieve common goals (Giusto, 2010). Schuh (2013) cites three types of collaboration

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within IoE: human-human; human-machine; and machine-machine collaboration.

In order to connect machines, devices, sensors and people to each other, it is of great importance to establish a standard communication that is common to all. These standards allow the flexible combination between modular machines from different suppliers (Zuehlke, 2010). This modularization enables industry-smart 4.0 plants to adapt to the fluctuating demands of the market or small batch of custom orders.

The convergence of industrial production and information and communication technology known as Industry 4.0 is currently one of the most frequent discussion topics among practitioners and academics in the area of operations (Drat & Horch, 2014).

The term Industry 4.0 was first used at the Hannover Fair in 2011 following the first Industrial Revolution by "Mechanization" as a result of the invention of the steam engine, the second with the "mass production" with the help of electricity and the third through the use of microelectronics and IT (Information Technology) (Dais, 2014).

The promoters of this idea as an association of representatives of business, politics and academy, supported the initiative as an approach to strengthen the competitiveness of the German economy (Kagermann, 2011).

Industry 4.0 is expected to improve the key industrial processes involved in manufacturing, engineering, the supply chain of materials and the management of the product and service life cycle.

Activated through communication between people, machines and resources, the fourth industrial revolution is characterized by a paradigm shift from centralized control to decentralized production processes.

As a result, intelligent products know the history of their own production, from their current state and destination, proactively guide the production processes by instructing the machines to perform the necessary tasks and drive the conveyor belts for shipping to the next stage of production (Kagermann, 2015).

The transformation of the digital industry into the Internet environment is undergoing intense progress, but artificial intelligence, the big data and total connectivity will bring about a complete transformation of the industry according to Almada-Lobo (2016); Schlechtendahl et al. (2015) by the following factors:

1. Digitalization of production – use of information systems for Production Planning and Management;
2. Automation systems for data collection directly from the production line and the use of the machines;
3. Automatic data exchange by connecting the factory floor to the global supply chain.

We are now contemplating the dawn of the fourth Industrial Revolution with the use of Cyber- Physical Systems (CPS) and Internet of Things (IoT) and Virtual Services.

The integration of cyber technologies that make Internet-enabled products facilitate innovative services to achieve, among other things, Internet-based diagnostics, maintenance and operation processes in a cost-effective and efficient manner.

In addition, it encourages the emergence of new business models, operational concepts and intelligent controls focusing on the user and their individual needs.

Lee (2008) identifies in the central objective of Industry 4.0 the emergence of digital factories that would be characterized by the connection and incorporation of the heterogeneous and autonomous devices.

A CPS consists of a control unit, usually one or more microcontrollers, which control sensors and actuators that are needed to interact with the real world, and to process the collected data. These embedded systems also require a Communication Interface for data exchange with embedded systems or a cloud.

Data exchange is the most important feature of a CPS, since data can be linked and assessed centrally. In other words, a CPS is an embedded system that is able to send and receive data over the network. CPS connected to the Internet is often referred to as the "Internet of Things". CPS tracks the inevitable trend of collecting and making information available everywhere in real time in the networked world. Embedded systems such as smartphones, automobiles and home appliances are the inseparable part of modern life and will be in the process of being remotely controlled.

This remote access to the process data can also be adopted for the very maintenance of these systems. The remote diagnosis information helps the service team in identifying the tool and spare part accurately and issuing requisition to the infrastructure with the help of the corresponding communication system. There are a number of existing and still applicable fields of application for CPS, such as medical equipment, driver safety and driver assistance, industrial process control and automation systems, power supply and the optimum use of renewable energies.

V. TRANSPARENCY OF INFORMATION

Activated by the growing number of interconnected objects and people (Lasi et al., 2014), the fusion of the physical and virtual world allows for a new form of information transparency (Kagermann, 2015). Through the connection between the data sensor and the model of digitalized plants, the virtual copy of the physical plants is created.

Thus, context sensitive information is indispensable among IoE actors to make appropriate decisions. Context systems perform tasks based on information from the physical and virtual world. Examples of information from the virtual world are electronic documents, drawings, and simulation models. While from the physical world we will have Information on the position or conditions of a production tool (Lucke et al., 2008).

To analyze the physical world, raw sensor data must be aggregated into other values and interpreted in the context of the information.

In order to create greater transparency, the results of data analysis should be incorporated into service systems accessible to all IoE participants (Gorecky, 2014). For critical processes real-time information is of paramount importance (Bauernhansl, 2014).

VI. DECENTRALIZED DECISION-MAKING

Decentralized decisions are based on the interconnection of objects and people, as well as the transparency of information inside and outside the premises of a production. The combination of decentralized and interconnected decision making allows simultaneous access to local and global information with full productivity (Malone, 1999).

IoE participants perform tasks as autonomously as possible. Only exceptionally, some interference or in the emergence of conflicting objectives, tasks are delegated to a higher level (Hompel & Otto, 2014).

From the technical point of view, the decision making is allowed by the CPS, which are automated systems capable of allowing the connection between the operations of physical reality with the Information and communication systems (Radhakisan & Gill, 2011, German National Academy of Science and Engineering, 2011, Lee, 2008).

Embedded computers, sensors and actuators allow the monitoring and control of the physical world autonomously (Lee, 2008).

These technological developments interact with each other, where each is characterized by its respective objectives and limitations. For example, when the aim is to reduce production costs, the limitations are also in terms of, for example, a reflection on wage costs.

The life cycles of commercial products tend to be shorter and shorter. At the same time, greater reuse of products, components, and materials can be observed, either through secondary (electronic) markets or in the so-called closed-loop supply chains (cradle-to-cradle, circular economy).

Mass customization is an important aspect of today's consumer markets fueled by sharp technological developments. The rapid advance of e-commerce is another feature of today's markets, and with mixed consequences, since on the one hand it reduces the number of links in the supply chain, but on the other hand, without proper regulation of the flows of goods or the reverse, it causes an increase in urban congestion and pollution.

Finally, we can mention the concept of sharing economy, that is, the notion that customers no longer buy a real product, but only the service that the product represents (eg cloud computing, music streaming, car sharing, among others). These phenomena will have a profound impact on the ecological footprint of mankind and on the design and planning of future supply chains.

VII. INNOVATION IN LOGISTICS

Current supply chains and logistics systems are global, partly due to scarce natural resources and not evenly distributed in terms of type and geographic location, but certainly also because of the differences in the cost of labor between emerging and mature economies.

According to Nakatani and Chuang (2005), logistics innovation began in the 1980s, initially with the introduction of the WMS and TMS systems, where logistics management became possible through the computerization of warehousing and transportation processes, the process of customs clearance and various processes related to the digitalization and the consequent systematization and integration of all foreign trade activity.

The emergence of outsourced logistics providers/operators is observed, aggregating all operations with the gradual adoption of handling, storage and management technologies towards the twenty-first century as shown in the Fig. 2.

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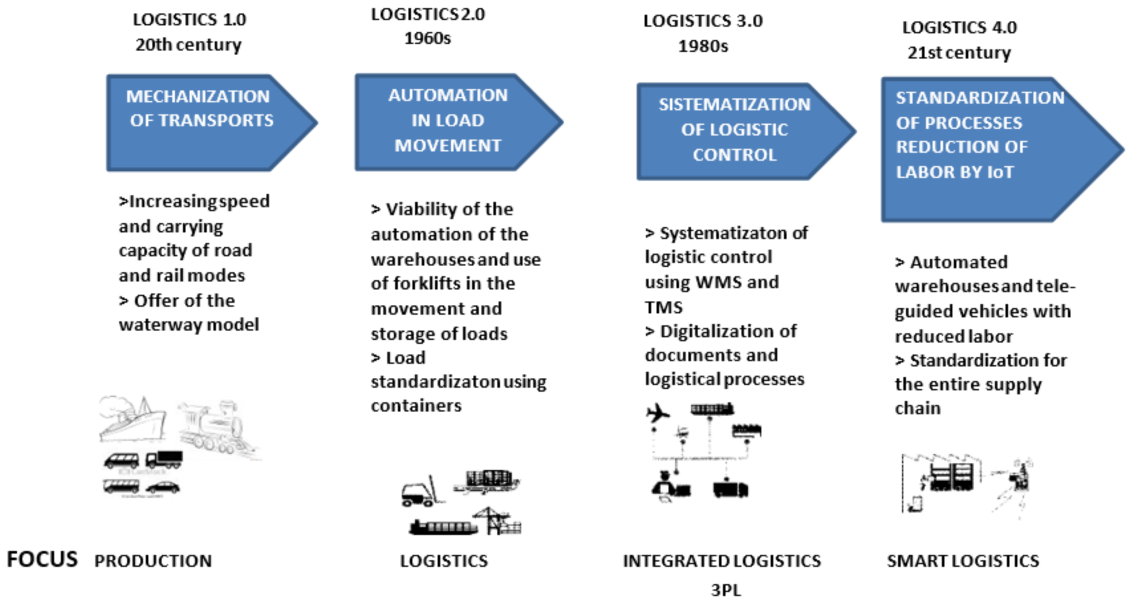

Fig. 2: Transition of Logistics by Innovation. Source: Logistics Systems (2017).

36 years after the first logistical theories, we can see in the 21st century the era of Logistics 4.0 with the evolution of IoT technology towards automation and complete standardization of logistics processes.

Radio Frequency Identification (RFID) is an identification technology used to track goods along the supply chain (Michael & McCathie, 2005).

RFID and sensors can work together as the main component of a ubiquitous system. RFID tags record the information that sensors collect from an object and its environment, and transfer it to a reader. With wireless sensor networks, objects such as products, parts, vehicles or machines become intelligent.

They issue alerts on any incidents that could cause damage such as dropping, abnormal temperature rise causing changes to perishable products, or any type of violation of security seals. With intelligent objects, all systems from equipment to the corporate level, tend to be restructured Systems become more responsive and accountable for any kind of problems that may arise.

RFID tags allow item, pallet or container-level control (Ustundag & Tanyas 2009). Singer (2003) identifies four important factors with the use of RFID technology: operational efficiency, accuracy, visibility, and security.

In fact, RFID tags can replace bar codes in the very near future (Kapoor et al., 2009) with advantages, as it does not require a direct line of sight between the label and the reader, thus allowing multiple and simultaneous reading through non-metallic materials and are resistant to ambient temperature and other external factors such as humidity. They can also be read and reprogrammed several times (Kärkkäinen, 2003).

In addition, battery-assisted RFID tags can monitor environmental variables such as temperatures and bacteria levels (Michael & McCathie, 2005).

The ultra-high-frequency RFID system (UHF RFID) allows the simultaneous reading of a large number of labels, increasing the volume of processing, integration with other systems and consequently increasing the productivity of the operation (Wu et al., 2006).

The world is currently experiencing the fourth Industrial Revolution in terms of cyber physical systems. These systems make up the automation that enable innovative features and access to the cyber world through networking dramatically changing our daily lives.

It requires organizations to understand how connected consumers can serve as a critical foundation for companies to identify sociodemographic and psychological views and factors that may influence their decision making regarding the use of connected products or services. Industry 4.0 organizations that have not yet taken action from conventional marketing for content marketing now have the opportunity to direct strategies towards the new business environment (Court, 2015; Rocco & Bush, 2016).

In this context, new business models, work processes and development methods that are currently unimaginable will bring about important changes in society and in people. In this way, family life, current processes of globalization, market structure and capital will tend to be redefined. However, Industry 4.0 simultaneously exhibits features that represent the challenges of developing cyber-physical systems, reliability, security, and data protection.

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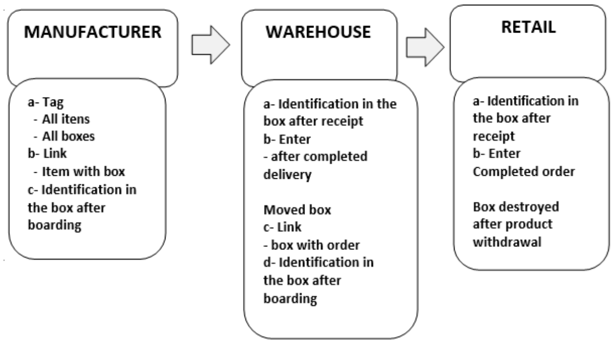

Fig. 3: RFID Scenario in SCM. Source: Nilgun et al. (2014).

An important factor is the dynamics of the profitability of operations. The main reason is the external factors, such as costs of specialized labor in the face of changes in the needs of users and customers, in the profile itself according to the change in the nature of the processes by technological innovation.

On the other hand, internal factors such as flexible leadership in the conduct of work adjusted to the reality of the environment and in the specificities of each project that requires perseverance, fighting spirit and courage for change.

Advanced technology provides an operation by the “efficiency” and “flexibility” in a friendly way in which people, robots, and artificial intelligence provide the extension of human boundaries according to the following chart.

In the next-generation business model, an integrated and interconnected system in the supply chain operation through robots, sensors and 3D printers in the process of storing, moving and tracking cargo and real-time information has been considered.

IoT can improve logistics and supply chain efficiency by providing detailed and up-to-date information in real time by mitigating the whip effect (Flugel & Gehrmann, 2009) by reducing unexpected occurrences and improving traceability of goods (Zhengxia & Laisheng, 2010).

However, to complete this scenario, it is necessary to get compliance in the process, regulation of operations, unification of standards, rules, procedures in the manufacturing and logistics industries, intellectual property rights, other issues such as finances, among others. By collaborative creation beyond manufacturing and logistics, it is believed to be necessary to create a new form of business to be competitive and become winners in the next generation.

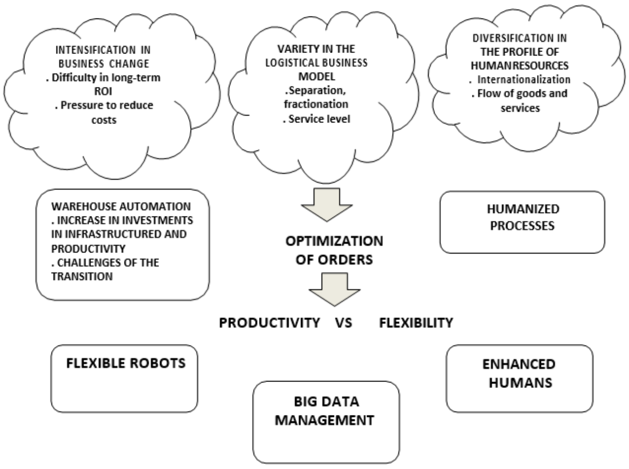

Fig. 4: Humanitarian Logistics: Compatibility of Efficiency and Flexibility with State-of-the-art Technology. Source: Adapted from Logistics Systems (2017).

In the moment the logistics environment is undergoing dramatic changes, the challenges that are unveiled in the field of supply chain management and logistics, the processes expand and diversify and require careful monitoring by the organizational managers.

It is observed as a result that future supply chains are global when necessary and local when possible. On the other hand, global supply chains will remain unavoidable in cases where food production conditions are only feasible in some regions of the world or when minerals are only locally available.

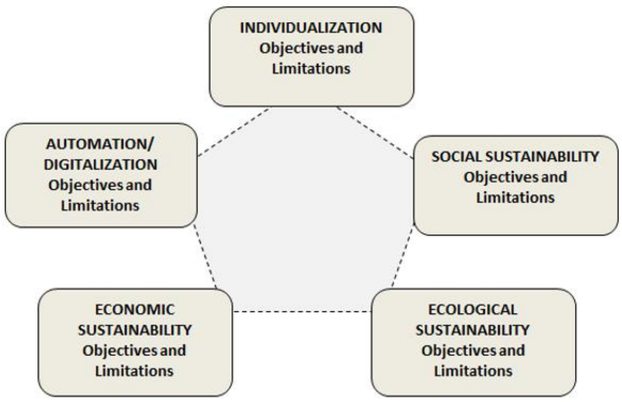

Fig. 5: Five Forces for the Future Logistics. Source: Zijm and Klumpp (2015).

They will also continue to exist where material processing consumes such an immense amount of energy that it is only sustainable in places where energy is plentiful and sustainable, such as geothermal energy, water power generation or long periods of intense sun.

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VIII. CONCLUSION

The purpose of this article was to evaluate the importance and influence of Industry 4.0 and the technologies connected to the Internet in the creation of added value for organizations and society. In fact, the fourth industrial revolution is happening and require each company and each individual a reflection and planning of what is expected or desired from the intelligent design of devices connected to the Internet. The present study represents an important theoretical contribution to the understanding of industry 4.0 and technologies connected to the Internet.

The fundamentals were based on literature review and the assumption that the IoT technology's business value is significantly higher than is reflected primarily by the number of devices that can be connected in cyberspace.

Technological innovation and intelligent information systems, as expected with the concept of physical Internet, depend heavily on the presence of a competent workforce. This brings a new level of interdependence to technological innovation – as well as new business models based on e-commerce, cloud computing and Industry 4.0 – and knowledge and competence of logistics and management personnel.

As the dynamics and changes in supply chains increase as described, a new form of competence will also gain more importance: Not the "concrete facts" of stored information and fixed concepts that are taught today can be valuable for business purposes, "soft facts" and skills such as adaptability (of mind – followed by the supply chain), flexibility and creativity can be announced in the future as the main competencies needed for logistics.

The purpose of this automation is to tailor products and services to individual customers, which will increase the added value for organizations and customers themselves (Kagermann, 2015, Yu et al., 2015). Therefore, IoT technology allows the creation of products, services and business models that promise gains for virtually all industries (Dutton, 2014).

Future research can contribute to refining the meaning of many of the concepts. In this area, issues such as logistics 4.0, and ways of measuring the contribution to the definition of the business model are essential attributes of this dynamic within the limits of a company's operations.

Much research is being done in the field of industry 4.0 together with its development, where this typology is largely multidisciplinary and offers opportunities for the researchers to develop approaches incorporating all areas of the typology matrix to examine what organizations are doing or need to do to become truly sustainable.

In this way, the use of typology could expand and modify the more restricted approaches currently in use.

As a limitation of the research, as Doty and Glick (1994) point out, the typology does not propose ideal types, as these would be an area for future research. Typological research usually aims to develop ideal types and give names to groups of organizations that emerge in this type of research.

REFERENCES

[1] Adam Jr., E.E. (1983). Towards a typology of production and operations management systems. Academy of Management Review, 1983.

[2] Almada-Lobo, F. (2016). The Industry 4.0 revolution and the future of manufacturing execution systems (MES). Journal of Innovation Management, pp. 16–21.

[3] Baheti, R., & Gill, H. (2011). Cyber-physical systems, The Impact of Control Technology, pp. 161-166.

[4] Bauernhansl T. (2014). Die vierte industrielle Revolution. Der Weg in ein wertschaffendes Produktionsparadigma, in: Bauernhansl, T., M. ten Hompel, and B. Vogel-Heuser, eds., Industrie 4.0 in Produktion, Automatisierung und Logistik, Springer, Wiesbaden, pp. 5–35.

[5] Chase, R. B. (1978). Where does the customer fit in a service operation? Harvard Business Review, pp. 137-142.

[6] Chase, R. B. (1981). The customer contact approach to services. Operations Research, pp. 698-706.

[7] Chase, R. B., & Tansik, D. A. (1983). The customer contact model for organizational design. Management Science, pp. 1037–1050.

[8] Chesbrough, H. (2010). Business model innovation: opportunities and barriers, Long Range Planning.

[9] Court, D. (2015). Getting big impact from big data. McKinsey Quarterly, pp. 217-234.

[10] Dais, S. (2014). Industrie 4.0 – Anstos, Vision, Vorgehen (Offense, vision, approach). In T. Bauernhansl, M. Hompel, & B. Vogel-Heuser (Eds.), Industrie 4.0 in Produktion, Automatisierung und Logistik. Anwendung, Technologien und Migration (Industry 4.0 in production, automation and logistics. Application, Roblek et al.technologies and migration) Wiesbaden, Germany.

[11] Demil, B., & Lecocq, X. (2010). Business Model Evolution: In Search of Dynamic Consistency. Long Range Planning, 43, 227-246.

[12] Doty, D. H., & Glick, W. H. (1994). Typologies as a unique form of theory building: Toward improved understanding and modeling. Academy of Management Review.

[13] Drath, R., & Horch, A. (2014). Industrie 4.0: Hit or Hype?, IEEE Industrial Electronics Magazine, pp. 230-251.

[14] Dutton, H. W. (2014). Putting things to work: Social and policy challenges for the Internet of things. Info, pp. 1-21.

[15] Eckhardt, J., & Rantala, J. (2012). The role of intelligent logistics centers in a multimodal and cost-effective transport system; Elsevier, pp. 612–621.

[16] Fescioglu-Unver, N., Choi, S. H., Sheen, D., & Kumara, S. (2014). RFID in production and service systems:

Technology, applications and issues, Springer Science+Business Media, New York, 2014.

[17] Flugel, C., & Gehrmann, V., Scientific Workshop, Intelligent objects for the Internet of things: Internet of things-Application of sensor networking logistic. In H. Gerhauser, J.

[18] German National Academy of Science and Engineering, 2011. Cyber-Physical Systems – Driving force for innovation in mobility, health, energy and production, Acatech Position Paper, December.

[19] Giusto, D., Iera A., Morabito G., & Atzori, A. (2010). Eds., The Internet of Things, Springer, New York.

[20] Gleissner, H., & Femerling, J. C. (2013). Logistics, Springer Texts in Business and Economics, Switzerland.

[21] Gorecky, D., Schmitt, M., Loskyll, M., & Zühlke, D. (2014). "Human-Machine-Interaction in the Industry 4.0 Era", 12th IEEE International Conference on Industrial Informatics (INDIN).

[22] Jazdi, N. (2014). Cyber Physical Systems in the Context of Industry 4.0, IEEE.

[23] Kagermann, H., Lukas, W., & Wahlster, W. (2011). Industrie 4.0: Mit dem Internet der Dinge auf dem Weg zur industriellen Revolution, VDI nachrichten 13.

[24] Kagermann, H., Wahlster, W., & Helbig J. (2013). Recommendations for implementing the strategic initiative Industrie 4.0: Final report of the Industrie 4.0 Working Group, Frankfurt.

[25] Kagermann, H. (2015). Change through digitization – Value creation in the age of Industry 4.0. In H. Albach, H. Meffert, A. Pinkwart, & R. Reichwald (Eds.), Management of permanent change, Wiesbaden, Germany.

[26] Kapoor, G., Zhou, W., & Piramuthu, S. (2009). Challenges associated with RFID tag implementations in supply chains. European Journal of Information Systems.

[27] Kärkkäinen, M. (2003). Increasing efficiency in the supply chain for short shelf life goods using RFID tagging. International Journal of Retail & Distribution Management.

[28] Lasi H., Fettke P., Kemper, G., & Feld, T., & Hoffmann, M. (2014). "Industry 4.0", Business & Information Systems Engineering.

[29] Lee, E. (2008). Cyber Physical Systems: Design Challenges, 11th IEEE Symposium on Object Oriented Real-Time Distributed Computing (ISORC).

[30] Lee, E. (2008). Cyber Physical Systems: Design Challenges, University of California, Berkeley Technical Report No. UCB/EECS, disponível em:http://www.eecs.berkeley.edu/Pubs/TechRpts/2008/EECS-2008-8.html.

[31] Logistics Systems (2017). Japan Industry Logistics Systems, Tokyo.

[32] Lu, X., Qu, Z., Li Q., & Hui, P. (2014). "Privacy Information Security Classification Study in Internet of Things", International Conference on Identification, Information and Knowledge in the Internet of Things.

[33] Lucke, D., Constantinescu, C., & Westkämper, E. (2008). Smart Factory - A Step towards the Next Generation of Manufacturing", in: Mitsuishi, M., K. Ueda, and F. Kimura, eds., Manufacturing Systems and Technologies for the New Frontier, the 41st CIRP conference on manufacturing systems, Tokyo.

[34] Malone, T. W. (1999). Is 'empowerment' just a fad? Control, decision-making, and information technology", BT Technol J Vol 17 No 4, pp. 141-144.

[35] Michael, K., & McCathie, M. (2005). The pros and cons of RFID in supply chain management. University of Wollongong. Research online. URL: http://ro.uow.edu.au/infopapers/105.

[36] Miles, R., & Snow, C. (1978). Organization strategy, structure, and process. New York: McGraw-Hill.

[37] Mintzberg, H. T. (1979). The structuring of organizations. Englewood Cliffs, Prentice-Hall, NJ.

[38] Mintzberg, H. T. (1983). Structure in fives: Designing effective organizations, Englewood Cliffs NJ: Prentice-Hall.

[39] Nakatani, K., & Chuang, T. (2005). The development of a datamart system at a public institution, Journal of Information Technology Case and Application Research.

[40] Orlikowski, W. (1992). The duality of technology: rethinking the concept of technology in organizations. Organ. Sci.

[41] Prahalad, C. K., & Ramakrishnan. V. (2003). The New Frontier of Experience Innovation, MIT Sloan Management Review.

[42] Roberts, K. H., & Grabowski, M. (1996). Organizations, technology, and structuring. In: Clegg, S.R., Hardy, C., Nord, W.R. (Eds.), Handbook of Organization Studies. Sage Publications, London.

[43] Rocco, R. A., & Busch, A. J. (2016), Exploring buyer-seller dyadic perceptions of technology and relationships: Implications for Sales 2.0. Journal of Research in Interactive Marketing.

[44] Santos, F. J. N., & Villalonga, S. G. (2015). Exploiting Local Clouds in the Internet of everything Environment, 23rd Euromicro International Conference on Parallel, Distributed, and Network-Based Processing.

[45] Schlechtendahl, J., Keinert, M., Kretschmer, F., Lechler, A., & Verl, A. (2015). Making existing production systems Industry 4.0, Production Engineering.

[46] Schuh, G., Potente, T., Wesch-Potente, C., & Hauptvogel, A. (2013). Sustainable increase of overhead productivity due to cyber-physical-systems, 11th Conference on Sustainable Manufacotring.

[47] Teece, D. J. (2010). Business models, business strategy and innovation, Long Range Planning.

[48] Ten Hompel, M., & Otto, B. (2014). "Technik für die wandlungsfähige Logistik. Industrie 4.0.", 23. Deutscher Materialfluss-Kongress.

[49] Ustundag, A., & Tanyas, M. (2009). The impacts of Radio Frequency Indentification (RFID) technology on supply chain costs, Transportation Research Part.

[50] Vilarinho, T., Farshchian, B. A., Floch J., & Mathisen B. M. (2013). A Communication Framework for the Internet of People and Things Based on the Concept of Activity Feeds in Social Computing, 9th International Conference on Intelligent Environments.

https://dx.doi.org/10.22161/ijaers.72.31 ISSN: 2349-6495(P) | 2456-1908(O)

[51] Weick, K. E. (1990). Technology as equivoque: sensemaking in new technologies. In: Goodman, P.S., Sprull, L. (Eds.), Technology and Organizations. Jossey-Bass, San Francisco.

[52] Wu, N. C., Nystrom, M. A., Lin, T. R., & Yu, H. C. (2006). Challenges to global RFID adoption. Technovation.

[53] Yu, J., Subramanian, N., Ning, K., & Edwards, D. (2015). Product delivery service provider selection and customer satisfaction in the era of Internet of things: A Chinese e-retailers' perspective. International Journal of Production Economics.

[54] Zhengxia, W., & Laisheng, X. (2010). Modern logistics monitoring platform based on the Internet of things. In R. Li e Y. Wu (Eds.), Proceedings of the international conference on intelligent computation technology and automation (ICICTA), IEEE, Changsha, China.

[55] Zijm, H., & Klumpp, M. (2015). Future Logistics: What to Expect, How to Adapt The Netherlands and FOM University of Applied Sciences, Essen, Germany.

[56] Zuehlke D. (2010). SmartFactory – Towards a factory-ofthings, Annual Reviews in Control, 2010.