# USER PREFERENCES OF USAGE OF IOT (I4.0) FUNCTIONALITIES ON WMS MARKET, FUTURE TRENDS

Daniel Cisar[1]

*Summary: This research aims to deliver a useful snapshot of current offering of Internet of Things (i4.0; IoT) functionality into strategic warehouse management products (WMS) in the environment of logistics and 3PL services providers. It also aims to map current demand and customer expectations, as well as customer preferences on functionalities available. In result, this paper aims to bring thoughts on next development and trends.*

*Key words: Industry 4.0; Internet of Thins; Warehouse Management Systems; Supply Chain Management; Integration;*

## 1. INTRODUCTION

Market changes, intensified in previous couple of years due to technology and globalization as enablers of intense progress, reflected in the need of businesses to implement changes and improvements, responding to these market changes and increased customer requirements. Certain requirements could be addressed by modification of production proces by relocation of production facilities and services to off shore regions, but beyond certain point this was not efferctive (and in many cases not top quality solution) response to changed business environment.

Another type of response to such climate change was at hand when technology and its progress presented itself with IoT devices, automated and independent devices, enabled by Internet connection and able to provide real-time data to operational systém (ERP, WMS, CRM, …). This was opportunity for many businesses not only to focus on incremental proces improvements, but also to look into big data, artificial intelligence and to explore opportunities of complex automation enabling organization to benefit from real-time information and respond in split-second to event, or situation.

Industry 4.0 (also known as i4.0 or Internet of Things, or IoT) is very new and perspective industry. Although during the very brief search using database ProQuest (search string "Industry 4.0 supply chain management"), database returned over 63.000 relevant results, when using advanced filters (2010-2016; only conference papers, books, peer-reviewed papers, …) return was only 105 relevant results.

The i4.0 started its journey towards to wider scientific public mainly thanks to the strategic initiative of German government presented in 2001 and specified into details on

[1] Bc. Daniel Cisar, MBA, University of Economics, Faculty of Business Administration, Department of Logistics, nám. W. Churchilla 1938/4, 130 67 Praha 3, Tel: +420 775 484 846, E-mail: cisd00@vse.cz

Hannover fair in 2013, where the year 2021 was set as the year of this strategy implementation.

i4.0 is joined label for massive implementation of automated management systems together with relevant software, hardware, and process parts within production, logistics and other processes. It is not only about the implementation of passive sensors for data collection in relation to material, parts and shipment movement across warehouses within 3PL. i4.0 also covers technological parts of augmented reality, RFID parts, 3D printers, drone service implementation and many others.

Implementation of i4.0 functionalities is described in various contemporary scientific works from various angles and perspectives.

Basic, on the surface list of i4.0 characteristics and their use, opportunities for implementation of supply chain management is described in (1). Concept of i4.0 implementation opportunities is further elaborated in various works for instance as use cases for WMS solutions concerning the optimal placement allocation of products with respect to product and human safety in a sustainable system (2), supplier chain for retail fresh products (3), or as implementation in forest wood processing industry (4) or in agricultural industry (5).

Although most part of works, which fit search criteria is focused on technical side of implementation and technical and technological benefits of i4.0 for supply chain management, and for Warehouse Management Systems, there are some works focusing on business benefits and sustainable supply chain (6).

## 2. 3PL SERVICE SUPPLIERS / DEMAND-SIDE MARKET OVERVIEW – WMS SERVICES

The global market for logistics industry is served by several major 3PL Service providers who differ with regards to their footprint within the sector. Disregards if specific supplier reaches all corners of industry (air, ocean, land, rail, …) Warehouse Management System (in close integration with other IT solutions, eg. TMS – Transportation Management System, OMS – Order Management System, ERP, etc.) is a must-have. In any case, stand-alone WMS wouldn't do much of a good.

Warehouse Management System (WMS) is a software application that supports the day-to-day operations in a warehouse. WMS programs enable centralized management of tasks such as tracking inventory levels and stock locations. WMS systems may be standalone applications or part of an Enterprise Resource Planning (ERP) system.

Among benefits which successful WMS implementation brings are effective optimization of processes, efficient labor allocation, improved customer and supplier relationship, reduced operational expenses, better demand planning and balanced inventory, improved security and employee morale, transparency and visibility, and at last but not the least enabled continuos improvement.

WMS introduces number of strategical and tactical features as serial tracking, billing, crossdocking, forecasting, inventory and order management, warehouse map, wireless warehouse, workload and yard management, to name few.

Seamless and smooth integration of WMS into client's systems represents one side of business competition advantage equation. Another side is represented by WMS ability and available functions to interface, optimize and automate business and operation processes. (On the top of this, user experience and business intelligence is also perspective which needs to be considered.) What I also find an important angle is business strategy whether to employ multiple warehouse management systems to meet as many as technically possible customer expectations, or whether to „push" customers into one, preferably global warehouse management solution which not only can push logistics costs down, but also can provide global visibility and incredibly valuable management information (business intelligence, and information vital for continuous process improvement).

Among most of world's top 3PL service providers, there are several approaches to strategy as of how to approach WMS integrations. Following are seen most often:

- One global product providing multiple services on scalable levels – This approach supports global roll-out of one product which possesses ability to be scaled up to individual client's requirements and expectations (1). This approach as well provides the unique possibility to collect data in one centre to apply business intelligence above it and gain a benefit of big data analysis, and see trends, another way „hidden" developments and can respond to newly found business streams and development directions.
- Pre-approved WMS products as fit for integration – some logistics providers' scales one step up and propose certain products as pre-approved, fit for integration within their own business environment, applications, and software solutions. In most of the cases, these pre-approved products come from main software houses focusing on warehouse management systems and given their experience, they are very much ready for integration with client's in-house products or even aged application solutions (7).
- WMS in one package with ERP – Other 3PL service providers push for more complex integration packages from global, renowned providers while offering value-added service to clients when agreeing to proposed (solution design expertise, assistance with implementation, installation, and employee training (8).

## 3. WMS SOFTWARE DEVELOPMENT HOUSES / SUPPLY-SIDE MARKET OVERVIEW – WMS PRODUCTS

Warehouse management systems industry plays very significant role in cost efficiency of logistics and supply chain operations. Not only these systems are at heart of warehouse operations, but its technical ability, scalability, and readiness to integrate define competitive advantage for customers and possibilities to integrate new technologies in short and long-term future.

Because warehouse management product selection is significant investment in organizational life, many aspects and parameters must be considered. For purpose of this paper, I focused predominantly on functionality and ability to interface and integrate with new technologies.

According to market research performed by Zebra Technologies (9), in the outlook towards to 2020, outstanding business reasons for warehouse management product upgrade and technology innovation are necessity to move to full-featured WMS (83%) caused by business growth, push to low transportations costs (37%) and to fasten delivery times (36%). Among another reason, increasing number of warehouses and distribution centers (87%) and space expansion (71%) were mentioned. As for technology innovation segment, for 2020 strategy, almost 90% of participants expressed need to move from former, „pen and paper" based systems to mobile technology-based operations (mobile hand-held computers and tablets). Also, trend towards to „operations based on human senses" was very interesting. From these days, almost 75% managing operations using screen-only, vision is to move more than half (51%) to voice and screen based operations. Overall, more than 52% of interviews at least considers employing IoT technologies in technology expansion plans.

When considering a range of warehouse management products available on market globally, there is a wide scale of functionalities across the spectrum, but perhaps the most significant, ultimately enabling integration and use of IoT functionalities is the move of application architecture from rather old days, on-premise server installation to remote cloud-based architecture.

Apart from the cloud, off-premise based installations, products across the board offer very highly scalable, modular implementations based on customer requirements. And these requirements will vary depending on the industry, geographical location, necessity to integrate with other enterprise systems and solutions as well as expectations on data visibility (and consequently business and artificial intelligence) applied on the top of this solutions.

## 4. RESEARCH METHOD USED FOR DATA COLLECTION

The main challenge with research in this field is that, quite logically, strategic-size implementations of warehouse management systems and their technological extensions, interface like IoT segments are internal and confidential for both supply chain providers and for software vendors (bound by contractual terms with their clients).

For that reason, data gathered for this paper comes from two sources. From public, online resources combined with industrial and process knowledge. Also from limited response author was facing when approaching target group of respondents, primarily executives of 3PL suppliers in one part of research, in second part of research respondents were executives leading product development in software vendors and houses,

As already outlined, this research aims to map current functionality offer on WMS market in relation to IoT and automation and identify currently most preferred functionals and enhancements by customers, as well as to identify potential future trends. Given privacy and secrecy of such strategically important solutions, to really uncover details of those functions which really are in use of 3PL service providers or those which they really would use, when available, presents very challenging goal to achieve. For all reasons mentioned above, data gathering together with the attempt to collect data using questionnaires and semi-structured interviews utilized also publicly present information, including marketing materials, white papers and sales materials available online.

Analytical method used for data analysis was categorization of responses based role of respondent (to identify role within the organization), to identify and to answer research question What is thw customer preference of IoT functionality and also to understand reasons why certain technology might be prefered and prioritized comparing to others.

## 5. AREAS OF OVERLAP AND GAP

Research's initial goal was to map 3PL Service provided of Warehouse Management systems and to understand the utilization of currently available functionality.

Author's initial research for market leaders on both sides (Demand and Supply) thought of list of prospective contacts to reach to and involve in this research. Here are details on contacted and received responses from both sides, Demand and Supply.

**Demand (3PL Logistics Service Providers):**

We approached **45% of Top 25 Europe 2014 Supply Chain Organizations** (11 Organizations) where we contacted **in total of 41 professionals**.

We received (and followed up with interviews) with **12 professionals** (36% of contacted). Initial questionnaires and consequent interviews were discussing implementations of approximately **15 clients on regional scale**.

**Supply (WMS Software Development Houses):**

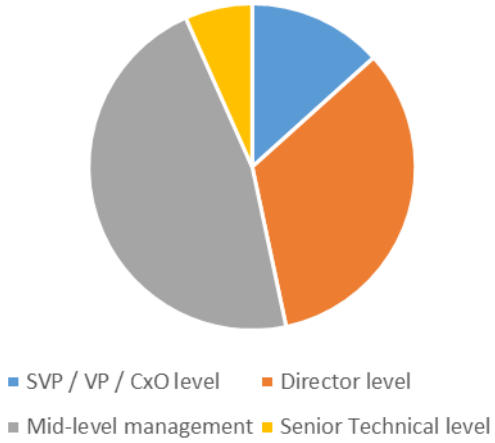
Our team approached **8 software houses organizations**, all with global foot-print. **In total, 31 professionals were approached** with initial questionnaire.

We received (and followed up with interview) responses from **16% of responded** (5 professionals).

Demographics of selected and contacted group of respondents was trying to cover the diverse array of seniority as you can see in Figure 1. Also, we tried to map diversity in seniority of counterparts in the respective organization, see Figure 2.

According to collected information from interviews and available publicly online, interviewed 3PL service providers are already now actively engaged and utilizing predominantly sort of most known and most mainstream IoT functionality, RFID tags and sensors, see Figure 3. Closely followed by NFC tags and involvement of robotics in process automation.

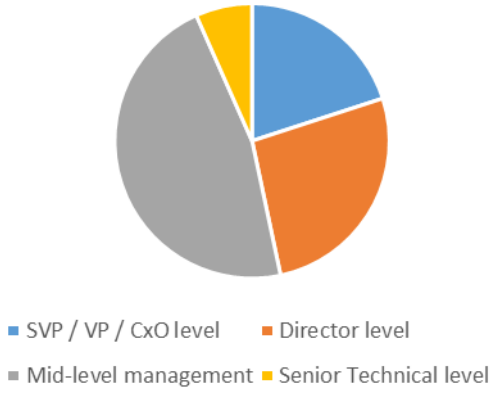
Data collected through these interviews also shows that most of the respondent's organizations plan to get involved in same, most mature, most mainstream IoT functionality, RFID tags and sensors, see Figure 4.




Source: Author

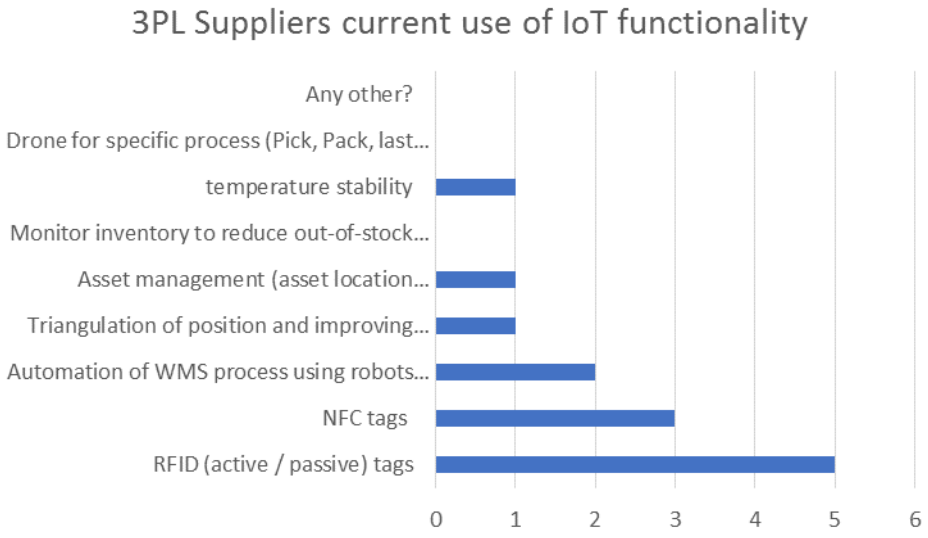
Fig. 1 - Participant's role within organization

F




Source: Author

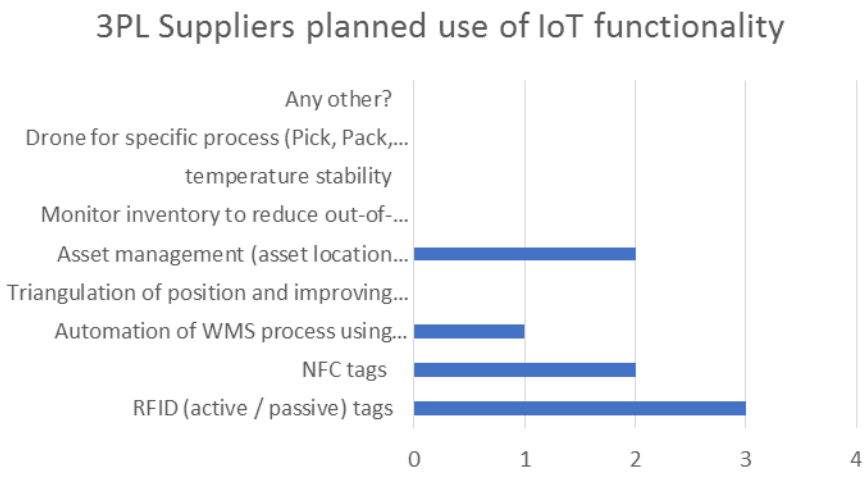
Fig. 2 - Participant's counterpart role within organization




Source: Author

Fig. 3 - Current 3PL Supplier utilization of IoT functionality

As can be seen from data collected as well as its interpretation in charts above, RFID is most used functionality. The reasons might not be only cost related, but also, historical and cultural. RFID technology in its modern form was patented (according to Wiki pedia) in 1983 and is with business for more than 30 years. Therefore, it is not that new and is not considered such major change and disruptor to business. Also, as mentioned previously, costs significantly decreased during these 30 years.




Source: Author

Fig. 4 - Planned 3PL Supplier utilization of IoT functionality

As for trend for upcoming period, based on outcome of our research, NFC is finding its way into multiple industries (eg. Retail banking as one for many), not just logistics and supply chain. Also as our research confirms, this technology is of an interest to both WMS software houses as suppliers as well as 3PL logistics providers as customers.

## 6. CONCLUSION

From collected data, we can see that although IoT industry is not only growing but is literally booming, although it is bringing significant value to the organization (as well as cost-optimization of processes and incredible possibilities for real-time information collection and business intelligence), it still faces hesitation from the customer side. Hesitation and uncertainty „what to do with it" might be main reasons for customers. 3PL suppliers not to go big on this newly created industry. The same also appears to be the reason for those, late comers, who opt for already verified functions and even though such latecomers want to innovate, they don't want to innovate „that much" yet.

As mentioned in previous chapters, this research was limited by multiple factors, and its aim certainly was not to explore all Industry 4.0 problematics in relation to warehouse management systems.

## 7. RECOMMENDATION / PROPOSITION FOR FOLLOW-UP RESEARCH

We focused to cover only part of topics and therefore we suggest continuing with research further on.

Since industry is growing at extensive rate, and there it is exciting and tremendous area to cover, author aims to cover following areas with follow up research:

- Robotizations of Warehouse Management Operations.
- Drone technology implementation into Warehouse Management Operations.
- Block chain penetration and potential benefits for Supply Chain Operations.
- Future trends for Industry 4.0.

## 8. ACKNOWLEDGEMENT

This paper is one of the research outputs of the project IGA VŠE F3/83/2017 financially supported by University of Economics Prague.

## REFERENCES

(1) *Panalpina Unveils JDA-WMS Ahead of Schedule*. (2015, November 12). Retrieved April 13, 2017, from http://airfreight-logistics.com/2015/11/12/panalpina-unveils-jda-wms-ahead-of-schedule/

(2) TRAB, S., BAJIC, E., ZOUINKHI, A., ABDELKRIM, M. N., CHEKIR, H., & LTAIEF, R. H. (2015). *Product allocation planning with safety compatibility constraints in IoT-based warehouse*. In D. E. Boubiche, F. Hidoussi, & H. T. Cruz (Eds.), *International Conference on Advanced Wireless Information and Communication Technologies (awict 2015)* (Vol. 73, pp. 290–297). Amsterdam: Elsevier Science Bv.

(3) PAN, F., & SHEN, F. (2011). *Fresh Produce Supply Chain Optimization of Our Country Based on the Internet of Things*. Management & Engineering, (4), 19–23.

(4) ZHAO, C., LI, X. S., & CHEN, J. S. (2011). *Study on the Application of Internet of Things in the Logistics in Forest Industry*. *Applied Mechanics and Materials*, *97–98*. https://doi.org/http://dx.doi.org.zdroje.vse.cz/10.4028/www.scientific.net/AMM.97-98.664

(5) LI, G., ZHOU, J., & YANG, T. (2015). *The Research of Supply Chain Information Management of Internet of Things about Agricultural Products Based on RFID and EPC*. In B. Cheng & W. Liang (Eds.), *Proceedings of the 3rd International Conference on Mechanical Engineering and Intelligent Systems (icmeis 2015)* (Vol. 26, pp. 833–836). Paris: Atlantis Press.

(6) SCHIEF, M., KUHN, C., ROESCH, P., & STOITSEV, T. (2011). *Enabling Business Process Integration of Iot-Events to the Benefit of Sustainable Logistics*. (J. Zhang, X. Li, Z. Zhang, & R. Zhang, Eds.). Setubal: Insticc-Inst Syst Technologies Information Control & Communication.

(7) *UPS: Warehouse Management Systems (WMS).* (n.d.). Retrieved April 13, 2017, from https://www.ups.com/content/us/en/resources/techsupport/alliances/application_wms.html

(8) *DB Schenker: your professional partner for warehouse management systems* | Schenker Deutschland AG. (n.d.). Retrieved April 13, 2017, from http://www.dbschenker.de/log-de-en/company/itcompetency/itInwarehouselogistics.html

(9) *Warehouse | Transportation & Logistics Solutions* | Zebra. (n.d.). Retrieved April 19, 2017, from http://www.zebra.com/us/en/solutions/transportation-logistics-solutions/warehouse.html