Shopfloor Logistics Management using RFID-enabled Big Data under Physical Internet

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Executive Summary

Physical Internet, in logistics, is a global system based on physical, digital, and operational interconnectivity by the using of encapsulation, interface, and protocols (B. Montreuil, 2012). The Initiative’s manifesto of Physical Internet is “Transforming the way physical objects are handled, moved, stored, realized, supplied, and used by applying concepts from Internet data transfer to real-world shipping processes, aiming to towards global logistics efficiency and sustainability.” (Ballot, Montreuil, & Thivierge, 2012; Benoit Montreuil, 2011). Current year, great attentions have been paid upon the Physical Internet due to the innovative and advanced concept of encapsulating goods in smart, sharing data in the Digital Internet, and shipping adaptively and efficiently. In the United States, National Science Foundation (NSF) funded a research project conducted by Center for Excellence in Logistics and Distribution (CELDi), aiming to establish a logistics system gain efficiency of the Physical Internet (Meller & Ellis, 2012). At the European level, the Modulushca project was to achieve the first genuine contribution to the development of interconnected logistics in close coordination with North American and international Physical Internet Initiative (Hakimi, Montreuil, Sarraj, Pan, & Ballot, 2012; Benoit Montreuil, Meller, & Ballot, 2013). In Asian Pacific area, an initiative project called AUTOM carried out in south of China to ease the cross boundary logistics between Hong Kong and Guangdong province in 2008 (Huang, Zhang, Chen, & Newman, 2008).

This paper is motivated by a real-life case from our collaborative industrial partner who has been using radio frequency identification (RFID) technology for supporting its shopfloor logistics management over 10 years. The company is Huaiji Dengyu Auto-Parts (Holding) Co., Ltd, which is specializing in producing engine valves with over 30 years history. There are around 1,000 RFID readers and 10,000 tags deployed on the manufacturing shopfloors. Thus, all the RFID identified resources are converted into smart manufacturing objects (SMOs) which are able to sense, interact, and execute in Physical Internet. Through adopting RFID technology in its shopfloor management, logistics within the entire manufacturing factories has been updated to a level that is accurate, real-time, and controllable (Dai et al., 2012).

Big Data, referring to a collection of datasets so large and complex that it is difficult to handle by using on-hand database management tools or traditional processing approaches, may be used for...
address the above challenges. Big Data usually contains datasets beyond the capacity of commonly used in software/tool to capture, curate, manage, and process the data under a tolerable elapsed time (Snijders, Matzat, & Reips, 2012). As the data floods faced by our digital daily life, Big Data has been widely studied from both academia and practitioners (Abbott, 2013; Bughin, Chui, & Manyika, 2010; Davis & Ratcliffe, 2012; Lynch, 2008; Manyika et al., 2011). Unfortunately, research on Physical Internet-based big data is scarcely reported that partially because both these fields are at its infancy.

This paper aims to fulfill the gaps by taking the application of RFID-enabled Big Data under Physical Internet for shopfloor logistics management as an example. Several research questions are concentrated upon:

- How can we establish a framework to process the RFID-enabled Big Data under Physical Internet so as to finally excavate significant knowledge to support shopfloor logistics management?
- What KPIs could be defined in the Physical Internet-based manufacturing shopfloor so as to examine the performance of various SMOs like logistics operators, machines and their workers?
- Based on the KPIs, what mechanisms or rules could be used to optimize the shopfloor logistics from the massive RFID-enabled Big Data under Physical Internet?

In order to answer these questions, this paper proposes a Big Data approach framework to address the RFID datasets from Physical Internet by using suitable models or algorithms to cleansing, compressing, classifying, and interpreting the RFID-enabled Big Data, defines some KPIs according to the practical concerns from both efficiency and quality aspects, as well as compares different rules used in the case company to work out the decent strategies given different situations or objective functions.

Several contributions from this paper are significant. Firstly, the creation of a RFID-enabled ubiquitous logistics environment in a real-life company under the concept of Physical Internet is realized. The creation integrates the practical applications and principles from Physical Internet so that the lessons from this case could be followed by other manufacturing companies who are contemplating to implement the RFID-enabled solutions. Secondly, a suitable framework is figured out to process the RFID-enabled shopfloor logistics Big Data. Different data structures, interpretation, data processing algorithms or models could be embedded into the framework so that it could be easily extended under different applications. Thirdly, under the Physical Internet-based shopfloor logistics management, some KPIs are defined to evaluate different manufacturing objects from the RFID-enabled Big Data. The findings are converted into managerial guidance which could be used for supporting logistics decision-makings in practice.