Chapter 19
Big Data in Railway O&M:
A Dependability Approach

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ABSTRACT

Railway systems are complex with respect to technology and operations with the involvement of a wide range of human actors, organizations and technical solutions. For the operations and control of such complexity, a viable solution is to apply intelligent computerized systems, for instance, computerized traffic control systems for coordinating airline transportation, or advanced monitoring and diagnostic systems in vehicles. Moreover, transportation assets cannot compromise the safety of the passengers by only applying operation and maintenance activities. Indeed, safety is a more difficult goal to achieve using traditional maintenance strategies and computerized solutions come into the picture as the only option to deal with complex systems interacting among them and trying to balance the growth in technical complexity together with stable and acceptable dependability indexes. Big data analytics are expected to improve the overall performance of the railways supported by smart systems and Internet-based solutions. Operation and Maintenance will be application areas, where benefits will be visible as a consequence of big data policies due to diagnosis and prognosis capabilities provided to the whole network of processes. This chapter shows the possibilities of applying the big data concept in the railway transportation industry and the positive effects on technology and operations from a systems perspective.

INTRODUCTION

Industry 4.0 symbolizes a fourth generation of industrial activity as a result of the fourth industrial revolution characterized by smart systems and Internet-based solutions, Landscheidt et al. (2016). The first revolution took place in the 19th century, when production was mechanized. This meant that production was moved from the home or small workshops to large factory units and a new social class was born; the working class. The second revolution occurred in the last century when the production was electrified and parts and processes were standardized. The archetype of this revolution is Ford's assembly line. The digitization of production is usually called the third revolution marked by introduction of programmable logic controllers (PLC) in late 1960s.

The fourth industrial revolution relies on ICT evolution and data driven decision making processes by the means of big data. Two of the characteristic features of Industry 4.0 are computerization with the help of cyber-physical systems and intelligent factories that are based on the concept of "internet of things" (Amadi, 2010). Cyber-physical systems are integrated computer-based or digital components that monitor and control physical devices, also called embedded systems (Le, 2016). These systems communicate over a network usually based on internet technology, creating an "internet of things" (as opposed to social media that could be described as "internet of persons"). Combining these two concepts, we get a distributed network of embedded systems communicating with each other in an ad hoc and dynamic way. In today's competitive environment, there are unmistakable signs that human beings, organizations, cities, systems and so on are increasingly becoming interconnected, instrumented and intelligent.

The transportation sector and especially the railway have not ignored industry 4.0 and adapted most of the positive inputs, as has the aircraft industry (traditional driver of advanced O&M methodologies by the means of massive data capturing).

This is leading to improved quality of services, new savings, enhanced resource utilization and efficiency. This has also facilitated the development of the new services and business models based on the capability of industrial internet and the analytics capabilities provided by big data. Indeed, big data provides a foundation for the next generation of transportation technologies based on the use of advanced information logistics analytics to transform the current state of the art railway platforms into a network of collaborative communities seamlessly moving freight and passengers and delivering services in a planned way. It symbolizes the current trend of automation and data exchange in the transportation sector striving to adopt and adapt the new and emerging technologies to achieve new levels of effectiveness and efficiency.

Big data in railways include necessary stakeholders who instrument, interconnect and finally provide intelligence to the railway system. It means that the complete big data architecture will be comprised of cyber-physical systems, the Internet of things and cloud computing in order to have a real big data environment providing "smart railways". In fact, one of the application areas which created more expectations is a better operation and maintenance in the form of self-learning and smart systems that predict failure, make diagnoses, and trigger maintenance actions. These systems are already having high demands on data access and data quality and use multiple data sources to extract relevant information with further analytics, Lee et al. (2014). Several research projects have focused on the cyber-physical approach for developing intelligent O&M management systems for failure detection, diagnostics and prognostics, Kroll et al. (2014), Sankavaram et al. (2013) and Syed et al. (2012). So far, the main application area has been process and manufacturing industries, but it is pretty obvious that these services have a huge

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