

IT MAIN TRENDS AND CHALLENGES IN THE CORE BUSINESS AREA OF POLISH RAILWAY COMPANIES

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IT has a number of solutions that increase productivity while lowering costs allowing to improve the effectiveness of business. Using these solutions we can create new operational and commercial processes, including the relations with the environment adapting those processes to the needs of customers. Use of these solutions is a prerequisite for the digital transformation, which allows to obtain advantage over "old style" companies. The aim of the study is to present the necessary conditions and the concept of IT development for Polish railways, which will effectively take advantage of digital transformation for operators and infrastructure managers. This concept takes into account the needs and possibilities of public entities operating in Poland. Author pointed out the need for changes in the field of information technology and organization of railway companies.

Keywords: IT, digital transformation, management of core business, railway, current challenges

1. Introduction

IT is an essential element of every company. Its quality (functionality, availability, security) and total cost of ownership (TCO) can significantly influence the value of business and its competitive advantage. In the digital transformation IT significantly changes its position. IT is no longer a cost center, but becomes the main tool of core business. Companies like Amazon, Google, Apple and Facebook which intensively use information technology have gained a dominant position in

the global economy. Their activities include the sale and delivery of consumer goods and services (including payments), tourism, hotel, education, organization of travel, entertainment and other. In their case, we are dealing with a holistic shaping of operational and trade processes and relations with the environment, taking into account all the possibilities of digital technologies [3]. Usage of all IT capabilities is particularly important for companies with a network structure (like infrastructure management companies, carriers and other enterprises of the railway market).

The aim of this work is to propose the concept of IT development in the railway, in the light of current trends in IT, new ways of delivering services designed to meet the challenges faced by IT companies that support the infrastructure management companies and operators. The implementation of this concept would help to achieve the stage of Industry 4.0 in railway.

The second chapter presents the main IT challenges in different business areas which are infrastructure management, freight and passenger service. Also the main features of the new systems which should be characterized are presented. The third chapter presents chosen directions of IT technologies, which enable the correct implementation of these requirements and features. In conclusion, the author presents the proposed implementation process of the previously described challenges.

The most important systems implemented in the railway companies in the first decade of the twenty-first century are described in [6]. In large part these were the results of the project Operation and Management Information System (OMIS) launched in the 90s. In [5] are described the most important systems implemented at the beginning of the second decade of the twenty-first century in the largest companies and the inconsistency between IT operations and unjustified differentiation technologies, solutions and service providers. This diversity is visible in the individual companies, which introduced different technical solutions, which required different competencies from IT staff. PKP Informatyka's actions to eliminate certain IT services for these companies since 2013 were incomprehensible. They caused reduction of competence and reduced the quality of service and caused customer problems. System for the sale of tickets is particularly critical, because there is still no unified ticketing system for different carriers taking into account the different tariffs and promotions. The lack of such a system discourages people who consequently decide to use road transport. Worrying is also planned for mid-2017 resignation of the IT services for PKP Cargo, and reducing the scope of services for PKP PLK. Carriers and infrastructure management companies can independently carry out or order IT services (including using the latest technologies and models of service delivery), but it will not be economically justified because of the small volume of services. Enterprise-level selection of the provider also may not provide the security required of the whole services for the group of companies.

Table 1 presents the data of PKP Informatyka and Petrosoft.pl for the year 2015 [1]. Petrosoft.pl, is a company that supports Lotos Kolej and a few small carriers. The company recently completed an interesting system for the logistics freight.

Table 1. Business results of selected IT companies in 2015 [1]

Company	Position		Revenues from IT [K PLN]		Revenue growth [%]	Revenues from sales of IT services and products 2015 [%]			Financial result [K PLN]		Employment
	2015	2014	2015	2014	2015 / 2014	Services	Software	Hardware	2015	2014	2015
PKP Informatyka	96	73	83976	111771	-25	98,0	1,0	1,0	-5639	-6946	331
Petrosoft.pl	203	222	17513	11983	+46	28,5	16,8	54,7	1512	1026	59

PKP Informatyka lost market position, by more than twenty places and reduced revenues by 25%. The low share of sales of hardware and software indicates a shortage of competence, as sales of advanced products requires an appropriate manufacturer certificates. The high share of services shows the reduction of activity to maintain their own systems and software. In the case of transfer of the services to the PKP Cargo company, PKP Informatyka's situation will be worse. Petrosoft.pl shows a dynamic increase (46%), of which a large part in the sales of hardware and software. This requires competence, and shows that even on the freight market is possible dynamic growth of IT services and the rise in the ranking.

The rest of the work identified key challenges and actions needed to implement the digital transition or transformation of existing IT support for transport processes in the active development of operational processes and commercial relations with the environment that will fulfill all the needs of the business while maintaining security policies with minimal costs [3].

2. Current IT Challenges in Polish Railway Companies

In [6] and [5] the author presents an assessment of IT systems for the management of the most important railway companies after the first decade of the twenty-first century. In this article the author refers to the systems of enterprise management seen as a whole in terms of operational and commercial processes. The author does not deal with IT solutions closely associated with the rolling stock, telecommunications, motion control, presentation of passenger information. Management systems must work with these systems, acting for them as information source and recipient. This cooperation should be carried out by using the appropriate Application Programming Interface (API) or Service Oriented

Architecture (SOA). In the following sections, the author presents the most important features and functions of new management systems in the individual business areas.

2.1. Infrastructure and infrastructure management

2.1.1. Creating and managing timetables. The system must include:

- preparing data for the creation of the timetable, including the calculation of traction for all sections of the line, any different carriers trains with the possibility of determining driving times, enabling the realization of the necessary operational activities and minimizing energy consumption for traction
- service orders for access to infrastructure (train paths),
- creation and modification of the timetables based on the current needs, paths procurement in accordance with the capabilities of the carriers, planning costs of access to infrastructure
- timetable presentation for infrastructure manager's staff, systems operators, RTO and for the systems of carriers and their customers,
- presentation of data on infrastructure, timetables and services, taking into account the spatial location of infrastructure, trains and rail vehicles and points of service,
- sharing of data applications to customers and passengers taking into account the required access restrictions for the respective user groups,
- record the current operational work and the spatial presentation of the current traffic situation.

2.1.2. The investment project management at all stages: defining the needs of the feasibility studies, preparation of documentation and tender procedures, support of project implementation to the as-built documentation and the acceptance of infrastructure changes made as a result of project implementation.

2.1.3. Geographic Information System (GIS), including infrastructure and rolling stock information support and which is a necessary element of the two systems listed above. GIS offer information about the spatial position with respect to the linear structure of the railway lines (Line Reference System, LRS) for the purposes of infrastructure manager and accessible for the carriers and their customers in read only mode.

PKP PLK systems SKRJ and SILK may constitute the basis for the creation, development and modernization in terms of 2.1.1 and 2.1.3, while support for the implementation of investment processes at the largest railway infrastructure manager in Poland is insufficient. Microsoft EPM with a layer of data storage MS SQL Server and reporting based on SAP Business Objects BI platform, ETL (extract-transform-load) process built using SAP Data Services Module were implemented. The functionality of the system does not include the necessary set of management information so that it does not complies with all of the assumptions

and requires expansion and modernization including improved information exchange with the business environment.

The positive is that the majority of IT systems in PKP PLK is based on the Intel x86, Microsoft Windows and MS SQL Server. Only system SILK in the field of GIS technology uses Oracle Database with Spatial Option. This allows the use of converged infrastructure, used as a standard in the CC service delivery model.

2.2. Freight

2.2.1. Core business management information system covering the topics:

- commercial support for customers, and shipments (offers, contracts acquisition, calculation of receivables, settlements with customers, foreign infrastructure managers and carriers),
- operational support and tracking of the implementation of the services with events registration,
- delivery tracking and information sharing with employees, companies cooperating in the implementation of transport, customers using of individual channels of private information for individual entities.

2.2.2 The comprehensive fleet management including records of rail vehicles (locomotives and wagons) and the operational management of the rolling stock and operating activities, meeting the requirements RTO in terms of information. Freight existing systems support operational and commercial processes, but not shape them comprehensively, to take advantage of all the possibilities of information technology and to build relationships with the environment.

2.3. Passenger transportation

In terms of passenger traffic the most important challenges facing IT are:

2.3.1 Information system for clients including complete information about connections, tariffs, current promotions and the current situation in the delivery of services. It is advisable to link the system with the systems of other carriers to obtain information about connections with other public and private transport.

2.3.2 Selling tickets and presale system for all carriers between any stations, regardless of the route and the number of transfers and carriers, whose services will benefit passengers with the lowest price, taking into account all promotions and discounts and using any form of payment. It should be a subsystem of system (2.3.1), since the decision to purchase is the result of information. Due to the importance and complexity of the task it is presented as a separate challenge. The operator of the system must be independent from any of the carriers so that funds ran down regularly and quickly to all carriers participating on the system. The system should be available to passengers in the mobile version and in full version for cashiers and conductors. Carriers must be obliged that all of their services are available through the common system independently of any other sales channels.

2.3.3 Booking ticket system for all sections where it is necessary or possible. The system should be a subsystem of the previous one. It can be provided by another operator. The volume of trains with reservation of seats in Poland is limited and can be cost-effective use of outsourcing, because the system must support the reservations in all international connections.

In passenger transportation are required completely new IT solutions covering the entire market for passenger transport not only the railway.

2.4. The challenges for all IT systems of railway companies

All areas of activity require systems of new generation, giving a new quality by building relationships with the environment, business process automation and the use of all innovative technologies. These systems not only have to collect information about resources, procurement, planned activities and schedules as well as process and transmit this information to users and other systems, but also use optimization methods for planning service delivery with minimal total cost of their implementation. Optimizing the use of all the resources (personnel, rolling stock, infrastructure, and energy) is necessary due to the competition from other modes of transport. It is necessary to use solutions from science: math, graph theory and networks, management science, operations research, optimization theory, artificial intelligence, and economics. Previous solutions assisted processes, but did not optimize and shape them. They were not innovative enough to give a competitive advantage.

New systems need to retrieve information from the environment (customers, contractors, offices and software) and to implement processes in an automated and optimized way. The above-described approach to the role of IT in business is the essence of new solutions.

Other demands, which the author proposes to pay attention to:

2.4.1. Insufficient system integration and automation on of data recognition and processing. Independent and manual entered data about events into multiple systems introduce additional costs and potential errors.

2.4.2. Existing systems support various infrastructure facilities, trains or vehicles which are incompatible with the nature of business and services that are network. Necessary is the perception of events and processes as occurring in the network structure. Taking into account topology, spatial location and changes in time and space is essential.

2.4.3. Process optimization in terms of quality of services and costs. Most systems used to record events and control the correctness of the process only marginally supports the planning and decision-making. Cost optimization is necessary due to the intermodal competition both on the freight and passenger market. Necessary is intensive cooperation with the world of science and using more innovative solutions.

2.4.4. It is necessary to integrate systems due to the nature of the railway network and sharing infrastructure for various operators. The cooperation of these entities must be done by systems allowing for the use of win-win solutions (strategy win-win).

2.4.5. Systems should be created, operated and modified according to the results of customers' needs analysis (Big Data) in a manner adapted to their current preferences.

3. Current IT Trends as a Solution for Challenges

Virtualization and dissemination of broadband Internet access are the main techniques of Cloud Computing (CC), the fastest growing IT service delivery model. Services in the cloud are not only consolidated, virtualized, automated, remote accessed via the Internet, but also self-served and automatically ordered, implemented, measured and accounted for. Cloud computing is: the availability of on-demand, self-service as a result of process automation services and infrastructure management, access to services via the Internet, the pool of resources available for different services, flexibility and automatic measurement of the number and volume of services, "pay per use" fees.

Working in the cloud model is not only proceeding in line with the prevailing trend but an economic necessity [2]. IT departments of enterprises are at a crossroad. One path leads to agile cloud solutions and mobile applications, which are the driving force of innovation, development and cost reduction, the second is a dead end because of the lack of ability to compete. Rail transport competes in already worse conditions due to the relatively high cost of infrastructure. Incurring losses due to non-optimal organization of business and IT unjustified costs will worsen conditions of competition.

An important step to implementing modern data center for cloud computing is the Software Defined Infrastructure (SDI) including Software Defined Storage and Software Defined Network. Key features of such data center include intelligent, self-service, self-conscious, self-optimizing is just scaling up, self-repairing itself.

We have SDI in the cloud model Data Center, and on the user side computer workstations or mobile devices connected over by broadband Internet to the services. Mobile Internet enables complete mobility, continuous use of the services and the constant availability of the mobile personnel. Mobile network services enable availability of services in the cloud from any location available on the network regardless of processing location. This is another crucial trend – "mobility". Mobility is particularly important for the railway industry because of the nature of the business, which concerns the entire area covered by the service

and is based on the movement of people, goods and means of transport. The use of mobile devices, is a way to streamline and optimize business.

Extremely important is to use the possibilities of systems referred to as Big Data. Big Data techniques allow to obtain information about the various areas of activity, entities and events from different sources using different data structures or containing unstructured data from different periods of time. These techniques are necessary to analyze: customer needs, individual markets, the results of business activities of all market players and trends of changes on interesting markets.

Another trend is the Internet of Things (IoT). Computers connected to the Internet manage the objects in which they are installed and collect and transmit data to other systems or devices. Application of this trend is an opportunity to build intelligent rolling stock, Intelligent Transport Systems (ITS) and to support staff of railway companies in the most diverse activities. IoT is a field of the development of numerous innovations. Without innovation in railway companies it will be impossible to achieve performance improvements and maintain market share. IoT helps and it is the perfect support for the recognition of data. IoT is a chance to receive data fresher, more accurate and with fewer errors.

Another element is the integration of systems and data consistent with Service Oriented Architecture (SOA). Enterprises use different systems to support their business. There is the problem of data integration. Organization requires multiple systems able to cooperate with each other because they need from each other different information. These expectations meet the Enterprise Service Bus (ESB). Systems on railway, created from approx. 10 years use ESB solutions of different vendors. Older systems after modernization involving the creation of the API can also use this type of solution. Implementation of the chosen solution is needed to standardize communications between applications. Applications do not have to be connected directly, because ESB is the medium. The application does not need to be integrated with all other applications. Application is integrated with the bus in order to exchange data with other applications. These solutions allow to create a system compatible with the concept of SOA. Modification, extension, or appending successive elements of the system require less time and effort because it only require to integrate new applications with ESB based on any data exchange protocol. Systems and external applications can also be integrated through the ESB. ESB is also a way to integrate data between systems stationary and mobile.

IT operations of polish railway companies are not going in the right direction. For all cases of new IT solutions described in [5] the share of PKP Informatyka as a service provider decreased. There is therefore no consolidation of services from a single provider, the lack of standardization and consolidation of services within the PKP Group. PKP Group companies do not have a significant impact on the service providers due to dispersal of orders. Even if they were together, they use different technologies impossible to integrate into a single infrastructure [5]. The high level

of requirements of the industry reliability, security for of the IT service providers would be met easier and cheaper by concentrating all the services in one or several suppliers. Also the formal and legal requirements of services can be easier to provide and control in subsidiary company.

4. Conclusion

IT systems of all companies require modernization and integration to meet the needs of business. This is an opportunity to make the digital transition of those companies for which it provides a chance of survival after complete release of the railway market. Needed is the modernization and integration systems to various stakeholders working together in an automated way, being for each other both clients and the service providers. The main users and beneficiaries of the system should be customers. Development and dissemination of virtualization techniques to maintain high availability and performance allows to implement of the majority of IT systems in a standard, uniform hardware and software. Advantages of the opportunities offered by consolidation, virtualization, and automation give significant savings compared to legacy systems. The need for consolidation, virtualization and unification of information systems in the companies of the PKP group was recognized many years ago [4], but following actions proceeded too slowly. Consolidation, virtualization of systems, and automation of maintenance tasks allows cloud computing, which gives further cost savings by automating procedures, management systems and self-service. The biggest railway companies can afford implementation of private cloud. But the realization of one cloud will be more economical solution, which directly results from The Ten Laws of Clouconomics [7]. Smaller companies in group should benefit from the services specializing in Cloud Computing services provider. IT services for railway companies should be provided by a single entity. This entity should be dependent on the authority responsible for the organization of railway transport (eg. The Ministry of Infrastructure and Construction). To achieve economies of scale and to maintain the quality of services and market prices of the entity should also provide IT services to other companies. Modern information systems prepared for safe sharing of resources by different entities are available. If community, state, industry or interior legislation require separated infrastructure, the infrastructure for the relevant companies would be separated within a single data center.

PKP Group, despite the modernization of infrastructure, applications and the fact that they have a good, innovative solutions, acting in isolation, does not gain a competitive advantage. The companies incur unreasonable expenses caused by the lack of standardization, consolidation, smaller range of virtualization, automation and optimization of service and management. Gaining a competitive advantage requires the implementation of digital transformation. It is necessary to establish

a new entity, whose task would be to transform digital business by designing, implementing and delivering new systems, which offer complex support of the business processes from the recognizing and analysis of customer needs, by automatically placing orders, monitoring of the services until the automatic payment. Implementation of new systems using all the possibilities of digital technology with the optimization and automation of business processes would ensure the competitiveness of railway transport. It is necessary to change the overall relationship with the environment (customers, partners) by adapting to needs and automating, optimizing and self-service.

Creation of new entity is necessary because, due to technological and organizational progress, new ICT solutions must be cheaper for customers than the previous ones, and the entity maintaining existing services will not be materially interested in changing the price if it can adjust to the costs. So far, this was the cause of maintaining the old systems in spite of the economic calculus. The new entity should not take over full support of existing systems with the exception of network and data center. The mission of the new company, which should function as a digital company, has a range of activities include the following:

- ICT infrastructure: telecommunications and Internet connections,
- Data Center services including: cloud services (IaaS, PaaS, SaaS), web hosting and collocation,
- Design and development services - development of new systems according to the rules and requirements of the digital transformation,
- Implementation services for its own and third-party products.

In the next stage the range of services should be supplemented with full support for automated and optimized business processes. In this way, a shared service center (SSC) providing its customers with comprehensive outsourcing services: ICT services in the field of general activity (finance, accounting, human resources and payroll) and for the core business - supervision of business processes in the railway.

The operation of the new entity will therefore optimize service railway companies and other entities. Such shared services center would ensure the continuity of services while maintaining performance, the required level of security of systems and data while maintaining control over the entity responsible for providing the services. Such a center should also support private operators to the whole activity while complying with legal standards and requirements of the industry while keeping the competition rules. As a result, it will be necessary to maintain the standards, quality of services and prices, which will force the new entity to periodic modernization, the use of innovative solutions, the acquisition and maintenance of competence in terms of both infrastructure and applications to support business processes.

Implementation of these postulates in the author's opinion will use the possibilities of modern IT for the development of the railways and for implement Industry 4.0 in railway. Therefore, the aims of this work have been achieved.

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