"Smart station"-a complex of automated control system

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Abstract. The present research paper considers the way of automation of control systems of life support processes and service delivery processes at the infrastructure facilities of the passenger complex, in a single information space, through digital platforms. This issue is relevant, as progress is at the stage of formation of the industrial revolution and the constant technological overturn. Digitization of boundaries, technologies, technical, technological, and organizational processes involved in providing services for passengers, in the work of station complexes, will allow effective management of engineering networks, minimizing gaps in the infrastructure and processes of transport systems. The work considers the transition from manual (personalized) labor at station complexes to an automated system as a whole, in the new construction or reconstruction, or commissioning of local digital facilities related to passenger services.

1 Introduction

As part of the implementation of the Development Strategy of the Russian Railways Holding Company for the period up to 2030, approved by the Russian Railways Board of Directors on December 23, 2013 No. 19, the Digital Railway project is being initiated. As part of this work, an innovative approach to organizing the work of station complexes, through a set of automated control systems such as "Smart Station" will be considered. For JSC "Russian Railways" digital railroad, and in particular "Smart Station", is the only balanced way of algorithmic relations between all participants of the transportation process (carrier, passenger, infrastructure), allowing to maximize the efficiency of infrastructure and technical means of the station [1,2]. This means that combining control and dispatching of such elements as passenger transportation, engineering equipment, services, correspondence, and diagnostics can be combined under the sign of "unmanned" technologies or minimize the transfer of information about the state of objects without human participation. The key aspect of this article is the allocation of a typical list of automated control systems of life support processes of the station complex, for functioning in a single information space.

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2 Scientific literature review

A similar issue was considered in the review works of such authors as Rublevskaya E. V., Shcherbakova A. V., and Ivanov A. A. published in 2018. The works considered the general approaches and mechanisms of change management, monitoring, and generalization of best practices. In the article of Perevertov V.P., Yurkov N.K. the system of smart development of JSC "Russian Railways" in combination with nanotechnology and smart manufacturing at JSC "Russian Railways" for the last 7 years is considered. The publications are limited to general provisions and are based on a superficial approach to the assessment of the parameters of innovation activity. [3-5].

The issue of information and communication technology management, through the Smart City strategy, and, in particular, at the infrastructure facilities of the passenger railroad complex, production systems, and lines, has also been considered in many foreign publications [6-17].

3 Materials and Methods

Today, the content, forms, and methods of providing mechanisms for information security, cross-functional interaction, and the organization of a barrier-free environment at infrastructure facilities are involved in the process of digital transformation. Production systems must consider people as part of system elements and integrate them into the digital field. The role of automated systems and devices should not be limited to a "resource," but should be expanded through the relationship between human resources and automation. Russian Railways is currently implementing the Digital Railway project, which aims to improve the efficiency of the Company's operations through the use of breakthrough information technologies [1]. The scale of JSC "Russian Railways", the geography of business, and the established production practices of the Company determine the focus of transformation at all levels of the business model of JSC "Russian Railways" (Fig. 1).

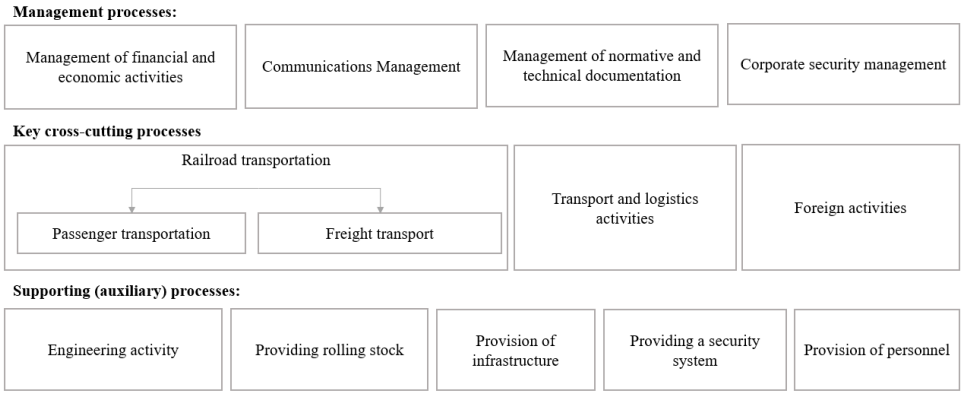

Fig. 1. Graphical representation of the business model of JSC "Russian Railways" (enlarged).

The fundamental difference between digital transformation and the Digital Railway project is that digital transformation considers a wide range of issues, covering all aspects and processes of production, while Digital Railway is a set of solvable applied tasks for process automation, for each type of company activity, including process optimization and re-engineering, work with innovation, improving the regulatory framework and changing corporate culture. In this article, we will consider a local fragment, namely the main end-to-end process of the company - passenger transportation, with a link to the infrastructure and

customer service system of passenger transportation, through the introduction of Smart Station technology.

Let us distinguish the main 3 stages of the transformation transition, aimed at gradual automation, internal production, and commercial activities, including station complexes.

1. The first step is to identify local places and systems that fall under automation;
2. The second is the unification of automated process control systems, in a single complex, and the future in a single control.
3. The final stage is the formation of territorial (geographic) clusters, with the function of unified economic management.

Already now we can talk about intermediate results (Fig. 2). At first approximation, we can see that in some processes of passenger transportation, automation is in a transitional or borderline state.

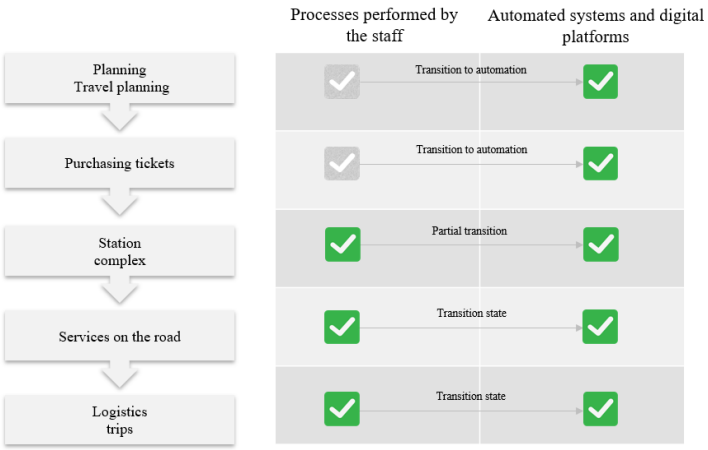

Fig. 2. Digital transformation of passenger transportation.

Even now, passenger trip planning and ticket purchase are carried out remotely via digital communications. In terms of the station complex, we note a partial transition, when the automation of processes is local. However, the unconditional beginning of the ongoing work on any of the activities will be the accumulation of a critical mass as a necessary condition for transition. And such a system is implemented through the project "Smart Station".

The object of the Smart Station technology implementation is the entire station complex, including the station building and adjacent infrastructure (platforms, platforms, underpasses, bridges, etc.). "Smart station" is a complex of systems (first of all, engineering systems) allowing to maximize the efficiency of the station infrastructure and technical facilities operation. Modernization of railway stations should be made taking into account their class, for large stations-full equipment, and small - the minimum necessary (Tab. 1).

Table 1. The regulatory base of station complexes and stopping points.

The criterions	**Services**
Station complex	Information, small architectural forms (MAF), canopy, waiting rooms, ticket service, toilets, etc.
Stopping points	Information, small architectural forms (MAF), canopy

It is worth noting that services for some facilities, may change in the direction of addition. It follows that the image of the service in the digital field should be created in such a way that it is universal, i.e., applicable to both large railway stations and bus stops.

As part of this work, the authors have identified and formulated three main conceptual components for automating the processes of implementing digital systems at infrastructure facilities: they are engineering networks, passenger services, and related services (Fig. 3). Each component, is possible to consider from the perspective of "unmanned" technologies, while it is necessary to understand how the development of digital products will be carried out, taking into account external priorities and the possibility of their potential use at a particular site. Of course, it is worth understanding that the goal itself is not the widespread and chaotic implementation of automated systems, but compliance with norms and established rules, within the boundaries of the process. First of all, the use of "unmanned" technologies will allow large railway stations and transport-transfer hubs (TTH) to optimize the number of staff, reducing certain processes from 40-60% of staff. For small stations, the task is slightly different - the formation of round-the-clock "mini-offices", with the function of essential services. When the automation of the work process has reached such a level that the passenger can receive the necessary range of services, without reference to the operating hours of waiting rooms, cash registers, luggage lockers, and other services.

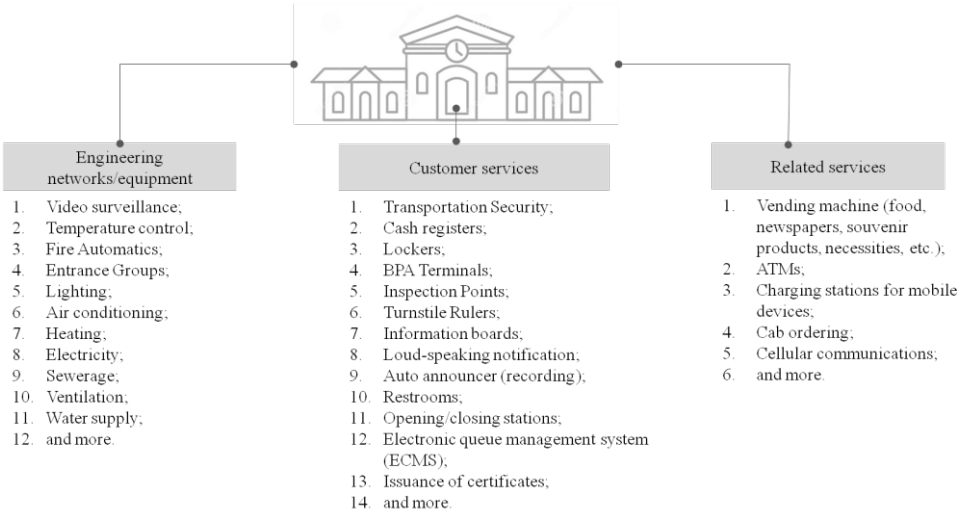

Fig. 3. Basic typology of technical, technological, and organizational processes of station complexes.

Currently, the Oktyabrskaya Directorate of Passenger Facilities – branch of JSC "Russian Railways" has equipped 68 "Smart stations" on the Oktyabrskaya railroad. The automatic system allows remote control of lighting, opening, and closing of waiting rooms. The passengers are connected to the dispatcher center, as well as visual dynamic information about the schedule of passenger trains. The temperature regime at the facility is monitored by the dispatcher. In terms of security, video surveillance with the possibility of downloading archive data is organized, as well as remote control of security and fire alarm systems (Tab. 2).

Table 2. Fragment of the results.

Stations	Services	% Automation
Station Staraya Russa	Management of the station complex remotely (opening/closing stations); video control of the safe location of passengers; information (feedback from the passenger); partial automation of life support processes, etc.	52%
Segezha station		43%

Thus, the obtained results reflect a fundamentally new type of assessment of the share of automation of the object. Staraya Russia station and Segezha station are small stations, where the average daily passenger traffic is small, about 40-50 people. But at the same time, the work being carried out is shaped in such a way as to minimize the servicing staff, making access to the station's services remote, with a small passenger traffic flow. The transition to these types of services makes it possible to monetize the existing potential of the station, while maintaining a basic set of services for the passenger, taking into account the specifics and needs of potential users. So part of several services at some station complexes will not be profitable, and only with a comprehensive approach, it is possible to position them as an independent automation product. At the same time, the nodal elements of customer services should be typified and ranked according to the class affiliation of station complexes and stops. To ensure the functioning of target indicators, the priority creation, and the development of the digital technological base of station complexes, through the construction of a unified system of activity with clear rules and algorithms of functioning for railroad facilities involved in passenger service.

4 Results and Discussion

The changing environment and the introduction of new requirements to the existing rail infrastructure related to transportation safety, passenger services, and additional services will require the creation of new transportation connections for passengers.

Thus, this project will reduce the overall or partial costs of operating costs by introducing the latest resource-saving and innovative technologies, as well as optimizing the use of human resources (Fig. 4). It is expected to increase revenues from auxiliary activities of railway stations by traducing the latest innovative technologies and optimizing the use of infrastructure facilities, including the optimization of the rental of railway station premises.

A prerequisite, regardless of the scale of the facility, remains the availability of feedback "passenger-company", as well as ensuring uninterrupted power supply, which is relevant in the transition to automation of processes.

Local elements of the transition to digital technology (queue congestion control, ticket-printing machine (BPA), screening frames and X-ray television installation, Face ID system

As for the tasks of passenger infrastructure operation, this digital platform "Smart Station" will ensure proactive work based on forecasting, calculation, and risk assessment, as digitization and process monitoring will exclude the human factor, especially if it is relevant to transport safety issues [18-21]. Even now, due to the implementation of digital technologies and local projects, the support of cross-selling activities for suburban and long-distance trains is noticeably increasing. So, the transition of ticket sales to digital platforms, for the period from 2016 to 2021 showed an increase in electronic tickets from 42% to 76% in long-distance trains. The issue of automation of feedback from passengers is developed separately, so at the station complexes, using information-help telephone service, sanitary and domestic issues are solved centrally. When a passenger makes a complaint (problem) on the hotline, within 30-40 minutes it is promptly eliminated. We use the so-called Heinrich

pyramid when analyzing the reliability of the data provided. Heinrich's theory for railroads states that one major incident (defect) has 29-30 cases with less serious consequences (technical failures, defects, micro downtime) and 300-330 minor incidents (violations in the maintenance of infrastructure facilities, omissions, errors, passenger complaints) that may go virtually unnoticed. At the same time, it is the transition to automation that makes it possible to influence multiple incidents, thereby minimizing the risks of defects in railway transport operations.

Fig. 4. Optimizing the use of human resources.

As a result, we must understand that the concept of a "Smart Station" includes a formed set of automated process control systems, when several processes are taken under unified economic management, especially it applies to small railway stations. Thus, having formalized and formulated the ideology, the project "Smart Station" with the use of new automation capabilities, both local and complex, with high probability we can talk about the multiplier effect in the framework of passenger transportation, as the transition to unmanned technology in one object, spreads and pulls up the surrounding elements of the system.

5 Conclusion

The results demonstrated in this article and the possible schemes for the provision of digital technology station complexes, with the possibility of wireless data transfer, necessary for the development of modern intelligent logistics and transport technologies, will justify the development directions (technological areas) of the program "Digital Railway", which provides for the creation of a single digital platform "Smart stations". These parameters and criteria provide necessary and sufficient conditions, as well as the elimination of possible obstacles and constraints, in the process of project implementation.

The creation of a unified environment of trust, between the passenger and transport market participants, will increase the level of connectivity of both passenger and freight

transport processes, with the possibility of scaling the mechanism of step-by-step implementation of current and future services in real-time, in the urban environment and industrial complex.

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