ISSN 2219-9365

https://doi.org/10.31891/2219-9365-2024-79-23
UDC 004

MUSTAFAYEV Kamran
Institute of Control Systems
Ministry of Science and Education Republic of Azerbaijan
https://orcid.org/0009-0000-1762-7457
e-mail: k.mustafa91@bk.com

INFORMATION TECHNOLOGIES IN TRANSPORT

(Industry 4.0; digital transport corridors and platforms; modeling and simulation transport systems, etc.)

The aim of the article is to consider the significant importance of the use of information technology in modern society as the main technical tool for the development of transport systems. It also addresses the expansion of economic relations among countries and the acceleration of integrative processes, emphasizing the transportation system's role as a fundamental pillar of each country's national economy and sosio-economic essence of transport services.

In the rail transport it has been investigated using smart trains, smart locomotives and smart wagons in the connection of rail transport with other types of transport for safety of trains, transmission capacity of the lines, speed of shipping control and also increasing employee productivity through computer systems of automated control systems. It has been explored the importance of monitoring the level of service more smoothly and qualitatively with the mutual integration of these systems as well.

The novelty of the article the novelty of the article is that information technologies in transport are integrated into transport systems of the 4th Industrial revolution, researching the development of an intelligent management system for modeling digital transport corridors and platforms, and achieving optimization of traffic flow and traffic management of the application of intelligent transport. In conclusion, in the future, smart locomotives should be integrated with smart cars, they are local controls for all components of the car – braking equipment; electrical equipment, service equipment, etc. satellite technology should be used to locate moving objects and monitoring systems. These technologies should be used in conjunction with radio communication and radar sensing of railway facilities from satellites and determine their coordination. In the future, connected management should become the basis of a single transport complex for all transport sectors and all forwarders for operational monitoring and forecasting of situations for all mobile units and each link involved in the technological process. The application of intelligent transport will provide by predicting traffic flow and optimizing traffic management.

Key words: transportation system, national economy, productivity, monitoring, computer systems, train safety,

МУСТАФАЇВ Камран
Інститут систем управління Міністерство науки та освіти Республіки Азербайджан

ІНФОРМАЦІЙНІ ТЕХНОЛОГІЇ НА ТРАНСПОРТІ

(Індустрія 4.0; цифрові транспортні коридори та платформи; моделювання та моделювання транспортних систем і т.)

Мета статті розглядати значну важливість використання інформаційних технологій у суспільстві як основного технічного інструменту розвитку транспортних систем. У ньому також розглядаються питання розширення економічних зв'язків між країнами та прискорення інтеграційних процесів, наголошуючи на ролі транспортної системи як фундаментальної опори національної економіки кожної країни та соціально-економічної сутності транспортних послуг. На залізничному транспорті досліджувалося використання «розумних» поїздів, «розумних» локомотивів та «розумних» вагонів при з'єднанні залізничного транспорту з іншими видами транспорту для забезпечення безпеки поїздів, пропускної спроможності ліній, швидкості контролю перевезень, а також підвищення продуктивності праці працівників за допомогою комп'ютера. системи автоматизованих систем керування. Досліджено важливість більш плавного та якісного моніторингу рівня обслуговування при взаємній інтеграції цих систем. Новизна статті полягає в тому, що інформаційні технології на транспорті інтегровані в транспортні системи 4-ї промислової революції, досліджуються розробки інтелектуальної системи керування для моделювання цифрових транспортних коридорів та платформ, а також досягнення оптимізації транспортних потоків та керування дорожнім рухом із застосуванням інтелектуального транспорту. На закінчення зазначається, що у майбутньому «розумні» локомотиви мають бути інтегровані з «розумними» вагонами, вони є локальне управління всіма компонентами вагона – гальмівним устаткуванням; електрообладнання, сервісне обладнання і т. д. Для визначення розташування об'єктів, що рухаються, і систем моніторингу слід використовувати супутникові технології. Ці технології повинні використовуватися спільно з радіозв'язком та радіолокаційним зондуванням залізничних об'єктів із супутників та визначати їх координацію. В майбутньому пов'язане управління має стати основою єдиного транспортного комплексу для всіх транспортних галузей та всіх експедиторів для оперативного моніторингу та прогнозування ситуацій для всіх мобільних одиниць та кожної ланки, задіяної у технологічному процесі. Застосування інтелектуального транспорту забезпечить прогнозування транспортних потоків та оптимізацію керування дорожнім рухом.

Ключові слова: транспортна система, національна економіка, продуктивність, моніторинг, комп'ютерні системи, безпека поїздів

Information technology ("Information technologies" in English) - the term information is derived from the Latin word "informatio" and means reporting the object, event and fact, interpretation, explanation. The word technology formed from the combination of Greek word “techno” (mastery, skill) and “logos” (study, cognition). It expresses a body of knowledge about methods and means for carrying out production processes and those processes themselves.

Information technology is the process of receiving information (information product) about the state of the object, process and event which investigated using methods and means for data collection, transmission and processing.

Purpose in information technology

Purpose in information technology is information production for being analyzed by a human and making decision based on it. Information technology has passed several evolutionary stages determined by the creation of new technical means for the development of scientific and technical progress and information processing.

In modern society the main technical means of information processing technology is considered computers that affected seriously to the concept of development and use of technological processes and also quality of information. Application of computers in the information environment and use of telecommunication means brought to the new stage of development of information technology. So, new information technology stage has started.

The development of the transportation system plays a crucial role for the Republic of Azerbaijan.

Pic. 1. Highways intersections

Besides the infrastructures of state economy, such as energy, communication, education, and health care, the transport also plays an important role for achieving social, economic, foreign policy and other public priorities by ensuring initial demands of community life.

The dynamic development gained in all spheres of public life in our country in recent years increased significantly the geopolitical significance of our republic.

Along with all of these, important tasks such as active participation in socio-economic processes in the global economic space, effective access to foreign markets, and the forming of a competitive national industry have become a necessity.

The issues such as globalization, rapid integration and sustainable development etc. which are typical for modern era have also specific importance for our country.

The expansion of economic connections among the countries of the world and the acceleration of integrative processes have confirmed that the transport system is one of the main pillars of the national economy of each country.

Researchers who are engaged with clarification of the socio-economic nature of transport services proved that this system is an important condition for large-scale reproduction.

From this view, during the large-scale radical reforms in the economy, it is significant to formulate and implement a policy that takes into account the specifics of transport, its role in economic and social processes.

That`s why the sustainable development of the transport system requires a large amount of capital investment, the construction and reconstruction of a large number of major transport hubs.

Pic. 2. Crossing roads through the bridge over the river

Currently, along with all spheres of life in the country, special attention is paid to the systematic and comprehensive development of the road industry. Consequently, today the renewal and modernization of the road industry of our republic are expanding and construction programs aimed at increasing the strength and power of our state, improving the welfare of our people are successfully continuing.

During the last years, all planned infrastructure projects and social programs in Azerbaijan were completed successfully. İn addition, projects such as the reconstruction of the road sector, construction of new roads, an overhaul of existing roads, which are important areas of social infrastructure, have been successfully continued. Numerous overpasses, bridges, tunnels, underpasses and overpasses were built in the capital and regions.

Currently, Azerbaijan is implementing infrastructure projects to create the North-South and East-West international transport corridors. Work is underway to complete the following important projects to turn Azerbaijan into an international transport hub.

According to the report of the World Economic Forum, in terms of the state of roads, Azerbaijan ranking first in the CIS and has shown the highest result. Azerbaijan is ranked 10th on the Asian continent and 24th among 141 countries (2021).

Currently, in the liberated territories, work is underway to build road infrastructure.

"Zafar Yolu" (The “Road to Victory”) corridor extends from the Hajigabul-Minivan-Zangezur corridor to the city of Shusha that founded on November 16, 2020. The length of the road is 101 kilometers. Zangilan-Horadiz highway which is another important project and has great strategic importance, construction process continues. The total length of this road is 124 kilometers and consists of 4-6 lanes. The construction of the Hadrut-Jabrayil-Shukurbayli highway also started. The beginning of this road starts from Hadrut settlement of Khojavend region and passes through Shukurbayli village and Jabrayil region. The length of the road is 43 kilometers. One of the road infrastructure projects implemented in the liberated areas is the Barda-Agdam highway. This road starts from the city of Barda. The length of this road, called Barda-Agdam, is 44.5 kilometers. One of the road infrastructure projects implemented in the liberated areas is the Khudaferin-Gubadli-Lachin and Khanlig-Gubadli highways.

The length of the Khudaferin-Gubadli-Lachin highway will be 66 kilometers. This road will be separated from the Khanlig settlement and a new 17-kilometer highway will be built in Gubadli. The total length of the designed roads is 83 km.

In addition, the 29-kilometer-long Tartar-Chayli-Sugovushan-Talysh highway was restored.

Pic. 3. Transit transportation by rail transport

Railways are one of the important areas of the developed transport system in our country.

Currently, our republic, located in a favorable geographical area, is actively involved in the implementation of all international and regional projects.

In recent years, intensive work has been done to improve the railway transport system in terms of its expansion, modernization, and renewal of the railway with international standards. This process aimed to improve the country`s railway network. Therefore, Azerbaijan's active participation in the implementation of international and regional transport corridors, Baku-Tbilisi-Kars and North-South projects has also been ensured.

Pic. 4. Sea transport in international economic relations

It is impossible to imagine international economic relations without the participation of maritime transport. Comparing with other roads, maritime transport is the cheapest transport system.

In order to get advantages from maritime transport, investments are being made in a number of countries around the world. The Baku International Sea Trade Port started its operation in 2018. Along with port operations in Azerbaijan and abroad, the modernity and high carrying capacity of ships are some of the important contexts.

Currently, along with the transport fleet, Azerbaijan Caspian Shipping Company CJSC includes specialized fleet and ship repair plants. Our transport fleet consists of 51 ships, including 20 tankers, 13 ferries, 15 universal dry cargo ships, 2 Ro-Ro ships, as well as 1 technical ship and 1 floating workshop. The specialized fleet consists of 204 ships.

One of the important areas of the transport system is air transport. In the last years, 7 airports have been built or reconstructed in the country. Currently, there are six international airports (Baku, Nakhchivan, Ganja, Lankaran, Gabala, Zagatala) in the country. Yevlakh airport is a local airport in Azerbaijan. Currently, 3 more airports are planned to build in the liberated territories (Fuzuli, Zangilan and Lachin).

Automated control systems in railway transport

Automated system for operational control of transport was prepared to create and maintain a data model for forecasting and continuously planning of the transport process, operational work of road enterprises.

Automated control system sorting station, cargo station and container station – according to automated control systems for cargo yard, cargo station, container station - is designed for planning the entry of trains at the station, dispersing them, forming and dispatching trains, processing technological and train documents.

Information provides to maintain wagon model and organize information and information services for station employees, reduce idle time of trains and wagons, improve conditions of automated control systems in railway transport and increase labor productivity of station employees. Automated system for keeping exercuted movement schedule is an automated dispatcher control center - designed for centralized and operational management of the transport process in the railway network as a whole or seperately in the training ground.

Using network polygons, information boards, controlled computers, graphic color displays, etc. it provides improved conditions, productivity and transportation quality of staff equipped with collective and individual means that reflect the current state of the transportation process.

Automated control systems that regulate the movement of trains on a railway line.

Automated management systems in railway transport rely on the use of workstations with all automated systems and the use of automated workplaces related to transport process management and information provision. Operators of station technological centers, station attendants, locomotive and car warehouses, shunting dispatchers, as well as train dispatchers and other operational heads of traffic, engineering staff and each workstation is equipped with a special computing complex or computer center, personal computers and screens related to communication.

Passenger trains (except suburban trains) often pass sorting stations without stopping. So, stations where a lot of work is done with wagons and where technical routes, field trains, collecting and transmission trains are drawn up, sorted and destroyed based on the train layout plan are called sorting stations. Unemployed transit freight trains from sorting stations are accepted to special transit parks, but working transit freight trains, field, collector and transmission trains are accepted to the reception park.

Automated control systems in railway transport are sent from the station after locomotive crews or locomotives of transit trains are changed. After the technical and commercial inspection of the trains which arrive for sorting and preparation of the sorting sheet, they are sent to the hill and from here they are released on the tracks of the sorting park. After the train crew is fully assembled in the sorting park, it is transferred to the dispatch park. Here, after passing technical and commercial inspections again, the train locomotive takes this train to the destination station.

The functional composition of the set of applied tasks includes:

- processing of information about the train arriving at the station, the train being set up;
- information and reference system;
- analysis, accounting and report on operation of the station;
- planning of station works.

Automation of operational data entry for automated control systems is very complex in rail transport. Therefore, issuing a full sheet for the train to dispatched is limited by the process of manually adjusting the composition information based on the results of the natural extraction of car numbers.

In railway transport, automated control systems are introduced as part of the train, with carriage numbers coming from a keyboard via a teletype connected to a computer at the train's flat stations.

The computer-generated sort list is compared with a pre-made manual sort list in terms of filling accuracy and precision. In addition, the "machine" in the sorting list provides information on the control numbers of the head and tail wagons of each trailer, the total number of physical wagons directed to each joint venture track, clearly visible signs of conventional signs for trains. If necessary, re-purchase of sorting sheet for jobs is given on special request.

When automated control systems in rail transportation are transferred from joint venture to software with trains, the person on duty in the park informs the operator about the cancellation post and the operator writes down the numbers of the cars as when canceling the train at the station entrance.

After the train leaves the station, the operator in the departure park informs about the train numbers and departure time. Information about the actual departure of the train is compiled based on the their and received information and entered to the computer.

It can be accessed automated control systems through a telegraph station or an automatic telephone exchange in railway transport. Remote data processing and control of data transmission over communication channels is carried out by means of data processing, including computer interface devices with data transmission equipment, data transmission devices, signal conversion devices (modems), subscriber station equipment.

Automated railway traffic control systems cover all levels of railway management. At the same time, it makes up 72.2% of freight and 41.8% of passenger transport from all types of transport.

Railway transport provides 62.5% of all cargo transportation within the country. The railways of our country carry out more than half of the cargo turnover of the global railway network. There is an established operating system, a system of norms and rules based on technological processes related to planning of transport and operational activities, organization of vehicle flows, stations, schedules of operational trains of warehouses and other units, technical regulation and operational planning of operational works.

Automated control systems in railway transport consist of optimal planning and maintenance of railway network operation mode, ensuring the best use of transportation means, high economic indicators and labor productivity.

Various automated control in railway transport technologies

Automated control systems in railway transport are in a new stage of today's technical and economic development of Azerbaijan railways through smart passenger train. İn economics engineering and in technology scientific progress results are used.

In recent years, a large majority increase in volume of transportation by rail transport has been obtained with the application of modern and promising science workings related to the organization technologies, services, equipment, automated management systems and transportation process.

Today, new tecnologies are required for providing stable activity of industry in a market environment.

The automated railway control system was designed to organize all production activities based on the wide spread of methods of the centralized automated management and modern analysis, management, modeling, logistics and forecasting, as well as computer and information technologies on Russian railway lines. The system in all industry should integrate automated control systems into a single complex. System was designed to manage fixed schedule execution, safety of trains, capacity of lines and vehicles, to increase speed of shipping control and employees productivity. Here includes following basic intellectual levels of software-technical and organizational and technological means:

- dispatcher control;
- train safety and automated train control;
- intelligent train and management level of production and business activity of Railways in Azerbaijan.

The main functions of the system are:

- tain movement planning;
- conducting production and economic activities of Azerbaijan Railways in an automated mode;
- state of trains and state of technological processes in real time of automated control systems in railway transport;
- operational management in regular and emergency situations;
- operational diagnosis of the state of all technological processes and equipment;
- predicting risks and taking operational measures to eliminate them;
- to work when centralized management "Peregrine Falcon" cabin on emergency recovery is a risk.

Development of an intelligent management system

In the article, an attempt is made to develop a paradigm for the development of the intellectual management system of the transport-logistics complex by determining the breaks within the current socio-economic situation. This study is based on rigorous results presented in several sources. Digitalization of transport and logistics is one of the leading trends in the development of the industry. Today, despite the high level of economic volatility, the digital services market logistics sector is developing rapidly. Thus, in 2020, its volume was 89.4 billion rubles, and by the end of the decade it is expected to increase seven times to 627 billion rubles.

The expected effect of the digitization of the industry by 2030 involves a 20% increase in productivity. In Russia, in 2021, the Ministry of Transport developed a Digital Strategy, and high-level factors were revealed to increase the Transformation of the Transport Industry until 2030.

In relation to the employment effects of Industry 4.0, researchers point to two possible trends: massive technological unemployment in the future, and a shift of the workforce to new jobs with digital tasks and skills. The first approach is referred to in the literature as substitution-digitization, which forecasts the inevitability of massive technological unemployment due to the impact of new digital technologies and the loss of significant employment. The second alternative approach is called task-digitalization [1, pg.249–273].

Digitalization does not eliminate entire occupations but specific tasks within jobs, eliminating some jobs and creating new ones, thus increasing global employment figures. It is necessary to underline that both scenarios coincide with the emergence of losers and winners resulting from digitalization.

An important question for our future, then, is how well-prepared countries' education systems are to meet the significantly changing needs of the workforce as the contents of professions are transformed. Based on predictions, technological spending is expected to rise by 50% between 2015 and 2030, resulting in the creation of 20 to 50 million new jobs worldwide, which would also help to offset the effects of Industry 4.0. These would be new and novel high-end jobs, such as Big Data analysts and machine learning specialists [2, pg.448–456].

Operational connection with other modes of transport.

Automated control systems in rail transport include smart trains, smart locomotives and smart cars. The local computer network of a smart train connects all devices and systems in a train using a common data bus and controls locomotive and carriage equipment.

Locomotive equipment includes control systems of traction and auxiliary electrical circuits:

- ensuring traffic safety by performing optimal energy consumption functions and automatic control of schedule execution (car driver);
- diagnostic and data recording systems, digital communication systems; longitudinal dynamic force determination systems;
- distributed braking control systems;
- devices that determine the completeness of a train, etc.

It is an indisputable fact that Industry 4.0 is a broad concept and its content is constantly changing. Industry 4.0 encompasses a diversity of technologies, systems, and processes, and it aims to make manufacturing processes more flexible, autonomous and dynamic and to incorporate these into a network. It uses digital and cybernetic resources in production and industrial management environments.

Fundamentally, integrated manufacturing consists of 3D printing technologies, automation, and artificial intelligence. Intelligent manufacturing aggregates the Industrial Internet of Things (IIoT), cyber–physical systems (CPS) and virtual and augmented realities, and creates smarter and more adaptive processes through better use of production resources.

The definitions presented agree that Industry 4.0 will transform the entire corporate value chain, with impacts that will go beyond the organizational framework and have an impact on the global job market as well.

Industry 4.0 cannot be described in one word; however, the literature often uses the terms digitalization or digital transformation [3].

Today, Info Communication Technologies (ICT) is one of the most outstanding examples of this, but Industry 4.0 itself incorporates a wealth of smart technologies that, while not as far-reaching as the examples mentioned earlier, may prove essential to the development of companies.

Industry 4.0 has six main principles: virtualization (virtual replicas of physical tasks as digital data), interoperability (connecting machines via the internet, enabling them to communicate with each other, and with humans), decentralization (autonomous decisionmaking ability of interconnected systems), real-time capacity (simultaneous flow of information between systems, for better and quicker decision making), service orientation (the ability of the system to provide services and functions to stakeholders), and modularity (adaptation of systems to possible changes or errors, addition or replacement of operational modules) [4, pg.925–953].

Industrial revolutions cannot be separated from each other at a specific point in time; rather, the current industrial revolution is a continuation of the previous one. The dataSustainability 2021, 13, 7703 11 of 19 also show that the economic and financial crisis of 2008 had a significantly greater impact on employment than the fourth industrial revolution, which started in 2011. It is easy to see from global labor market data that crises can trigger or exacerbate different economic processes. Employment in the productive sectors (industry, agriculture) is likely to continue its downward trend in the coming decade, despite the conjuncture of the 2010s.

This change further reinforces the question of how labor that became redundant in the productive sectors can be reinstated in the future, and what absorption capacity the service sector has to offer to assimilate industrial labor surpluses. Nevertheless, we can assume that digitalization will have a number of positive effects on human life, especially on quality of life. In spite of all this, the number of jobs replaced by digitalization, and the economical and mental effects of this phenomenon, are also not negligible.

It is clear that the latest technological developments in digitalization solutions—cyber–physical systems, Big Data, Internet of Things, cloud computing and robotics—are having a negative impact on people's employment opportunities [5, pg.27–40].

The manufacturing sector, which is currently the industry most effected by digitalization, suffered a loss of 1.7 million jobs worldwide between 2010 and 2016. If this trend continues until 2030, as much as 20 million jobs could disappear, thanks to digitalization, which means an 8.5% loss of jobs in the sector. The effects of lost jobs will vary from country to country, but it will affect less educated workers and the poorer countries the most, meaning a twofold greater loss compared to richer countries.

References

1. Sánchez, A. L. Digitalization, Robotization, Work and Life: Cartographies, Debates and Practices. Cuad. Relac. Laborales 2019, 37 (2), Pages 249–273;

2. Forum, W. E. The Future of Jobs Report 2018; Centre for the New Economy and Society: Geneva, 2018;

3. Cerezo-Narváez, A.; Otero-Mateo, M.; Rodriguez-Pecci, F.; Pastor-Fernández, A. Digital Transformation of Demands in Industry 4.0: The Case of Offshore Platforms. Dyna 2018, 93 (4), Pages 448–456;

4. Manavalan, E.; Jayakrishna, K. An Overview of Internet of Things (IoT) Embedded Sustainable Supply Chain for Industry 4.0 Requirements. Calculation. Ind. Eng. 2019, 127, Pages 925–953;

5. Liu, Y.; Peng, Y.; Wang, B.; Yao, S.; Liu, Z. Review of Cyber-Physical Systems. IEEE/CAA J. Winter. 2017, 4 (1), Pages 27–40.