RESEARCH ON AN INTELLIGENT LOGISTICS CONTROL SYSTEM WITH A FOCUS ON MONITORING THE HYGIENIC SAFETY OF THE LOGISTICS CHAIN

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Abstract. The main objective of the paper is to scientifically elaborate the idea of a methodology for ensuring the safety of transported goods in terms of antiviral and antibacterial protection. The output is a description in the field of transport with the possibility of applying the knowledge also in the aerospace industry. The core of the paper is formed by the description of an intelligent logistics control system with a focus on monitoring the hygienic safety of the logistics chain is a challenge to solve the current problem of ensuring the stability and infection-free transport of goods, primarily needed for production and consumer. Using advanced digital numerical simulations of logistics processes throughout the life cycle of the supply-customer chain and will fit into the issues outlined in the Industry 4.0 strategy. The prerequisite is the constant requirement for stability and infection-free or to ensure the continuity of the supply of goods also in the future to react to the arrival of different epidemiological situations. The need for an intelligent logistics management system is based on the changing actual requirements of hygiene measures, which are determined differently for each region. It is possible to respond to the situation with an intelligent solution tailored to the chosen carrier.

Keywords: COVID-19, critical infrastructure, essential components, government regulation

1. INTRODUCTION

At the beginning of the COVID-19 epidemic, the public impression was that this crisis would be short-lived, at worst a few days, weeks. However, positive cases were increasing, and the world was closing in on itself. Life came to a standstill. The economy came to a standstill. Transport stopped. The essential components of society had to continue to function. Critical infrastructure employees kept the country running. The spread of the disease was contained by carriers through a variety of measures. The main measures were taken from government regulations. Several European carriers had almost unified requirements for passengers in their vehicles. The setting of measures was in line with the governments' regulations to ensure and provide the highest level of elimination of the infection of passengers and service personnel in the means of transport [1][2].

2. BASELINE SITUATION FOR THE IMPLEMENTATION OF THE SUBMITTED PROJECT

On a global scale, the pandemic has been steadily manifesting itself, resulting in disruptions of connections and warehouse links, but also cancellations of flights and transport. This disruption is not only due to the possible contamination of goods and their surfaces, but also due to the loss of manpower. Because of the loss of people from the process and the lack of digitization and insufficient autonomous interconnection providing track & trace technology, the digitization of logistics activities and its appropriate adaptation to local needs would stimulate the expansion and greater competitiveness of smaller companies from less developed regions operating in the market of providers in the transport industry [3]

Technical solutions are therefore being sought intensively in each area and procedures are being coordinated, not only for digitization but especially for disinfection methods and strict health and safety measures. Some companies such as DHL are testing "smart" warehouses in three European locations" [4][5]. German logistics giant DHL has announced that it is working with networking giant Cisco and start-up Conduce to create "smart warehouses" in Germany, the Netherlands and Poland. They are currently testing in these three locations, Cisco's Wi-Fi-based infrastructure technology in collaboration with Conduce's operational data visualization platform, which aims to present data collected via IoT to logistics managers in the simplest possible way. Amazon uses many different shipping services to deliver packages, so they implemented UV light-emitting robots in the warehouse areas [6]. These are sanitizing robots developed by Siemens and Aucma and equipped with NX software. These robots have been implemented from design to sample production in a short time and are now involved in the fight against corona virus and other viruses in hospitals and warehouses. Large transportation logistics companies not only have their own freight forwarding companies, but also hire smaller companies to provide freight forwarding activities on a large scale. They also expect these companies to perform activities such as tracking the goods, the transport route along which the goods are moving, etc. However, so far, they have not included the necessary innovative approach of implementing the application of bio-cleanliness in the route of the goods being transported. The necessary knowledge arising from the risk of spreading a pathogen (virus) when the whole of humanity is subject to disinfection and testing [7]. Protection is also needed in the event of human failure in industry, transport and not only in the actual biological protection. The newly developed procedures could form the basis of new principles, guidelines and requirements and their implementation in OSH according to § 21 of Act No. 124/2006 Coll. which would form new standards with biological pathogens [8]. However, the constantly changing conditions of virus spread have one thing in common - appropriate disinfection = risk elimination. Even a small improvement can help us in the pandemic period. Whereas reinfection can also occur in workers who are vaccinated but have a weaker immune response, as indicated by NCZI statistics when approximately 20% of vaccinated workers test positive. It remains the case that if someone tests positive, they must undergo quarantine. This shortfall in staff results in the possibility of the previous worker's agenda being poorly or incorrectly handled, caused precisely by a breakdown in the chain of logistics and in the human-machine ecosystem. [9]

3. DEGREE OF ORIGINALITY AND INNOVATION

World is in its second year of constant struggle with an unprecedented global pandemic. In the early days of the pandemic, the world hoped that it was only a matter of a few weeks at most months. As a result of the outbreak and the quarantine measures, the transport of goods suffered major disruptions, resulting in delays or non-delivery of needed goods for secondary processing or distribution to processors or customers [10]. The chosen solutions to the research problem are based on the continuous innovation of software support products (SIEMENS PLM) and customized functionality solutions based on the sophisticated integrity of the individual components of the database system option. The information obtained from the interoperability of real processes is the input base for the application of simulation methods and their subsequent optimization in the form of iteration cycles. The application transfers the information in the form of innovations into real practice and enables the whole society to achieve higher added value in the national economy, also by creating an intelligent industry of the future as one of the pillars of the development of the Slovak economy with a significant impact on society in the future period. The degree of originality and innovation is based on the international needs to ensure the efficiency and stability of logistics processes in the current epidemiological situation (shortages of goods caused by the failure of components necessary to produce products, production interruptions, etc.). Ensuring the hygienic cleanliness and infection-free nature of the international flow of goods is also now coming to the fore. Reacting to changes in actual parameters, identifying critical points in the logistics chain and reacting immediately is a matter of using the appropriate methods and tools.

Conventional methods used so far are becoming ineffective or even insufficient due to scientific and technological developments and increasing demands on reliability, time flexibility, operability, validity and changing pandemic measures.

Different pandemic measures apply within each country, whether they concern cleaning, disinfection, or quarantine measures. In the advanced period of the pandemic, a high rate of vaccination with 3 doses of the so-called booster has been reported by the NCZI to be 20% reinfection or infection with COVID-19 virus. We believe that the appropriate placement of the right disinfection will eliminate the risk of reinfection and help to reduce or even prevent the spread of COVID-19 virus. The application of optimization methods, approaches with individualization of functionalities solved on the IRLS interface, can be considered as one of the starting points to address this issue in logistics However, common optimization approaches based on constant algorithms show signs of unreliability and poor performance [11].

This fact is compounded by the fact that with the advent of Industry 4.0 principles, the volume of requirements for the implementation of optimization measures within individual sets of logistics and transport processes is increasing. Because of this fact, it is necessary to search for new and progressive approaches that are sufficiently powerful, valid and applicable within logistics and transport processes. In particular, this involves the use of a combination of experimental methods and simulation-optimization calculations in order to create uniform interconnected structures in the future, the result base of which will be directed towards the provision of valid information. The integration of advanced digital simulations and IRLS fits fully into the Industry 4.0 field [12]. The implementation of the project is appropriate and important because Industry 4.0 according to the adopted strategy of the Ministry of Economy of the Slovak Republic should be considered as a national priority, because Industry 4.0 transforms the Slovak industry and is a prerequisite for increasing the competitive advantage of our industry. This transformation should be priority oriented and j to the less developed regions of the Slovak Republic, so that the distribution of the added value of the Slovak GDP is balanced also in the eastern territory of the Slovak Republic.

The partial results of this activity will also be the input data base. Subsequent overall optimization will be carried out continuously as an optimization of iteration cycles of the digital model carried out by simulations and by comparison with real measurements from the laboratory environment. The method of implementation of this activity will consist of the following steps: 1. Analysis and analysis of primary data from existing logistics processes. Subsequent thorough analysis of the provided underlying data. In parallel, an initial concept design of the digital model will be developed, which will be complemented by the results of real measurements. Based on the above, an evaluation and assessment of all input data will be carried out. A digital model of the internal logistics system will be created using the SIEMENS PLM software platform (specifically its Plant Simulation technology module), replicating the actual state of its processes related to the transport of goods. The Plant Simulation application enables simulation and optimization of production and logistics systems and their processes. Using this software, it is possible to optimize [13]:

- material flow,
- resource utilization and logistics for all levels of planning in the company,
- applications from global distributors through local warehouses and intermediate warehouses to the final consumers of goods.

Through the developed concept of simulated processes in a digital model, which will also be a source of input, by being able to create a methodological basis for the application of the basic processes of the IRLS. The client is able to plan logistics and human resources on a weekly basis, but also to react operationally if necessary, during individual changes or critical control points (Hazard Analysis and Critical Control Points), based on the structure of the transported goods, legislative conditions, pandemic restrictions and the resulting transport requirements. If it is necessary to increase the capacity above the normal standard within the transport plan for the transport of goods, the client is able to operatively plan the renting of additional transport fleet. The application will set up the required number of vehicles and the necessary service personnel after inputting the input data [14].

The added value of the created solution is also other important functionalities of the planning system, which will be gradually developed and added to the system during its processing. The results of the partial solution of these customization functions will result in a more efficient operation, which, in addition to streamlining the operation of the plants, also represents a significant cost saving [15]. The design of the software architecture is based on the definition and structure of an individual solution tailored to the customer, which meets the technical and operational requirements of the goods transporter throughout the entire period of tracking and recording the current epidemiological situation at the point of movement of goods. The concept of software architecture is provided by a database system (DBS) inheriting a set of interrelated data obtained from freely accessible data of information portals such as NCZI, ÚZIS ČR. Input attributes should be continuously updated based on daily information covering the full range of relevant measures of the respective measures. This architecture optimizes the processes involving the resulting decisions and their reactions on safety, performance and transport efficiency. These decisions ultimately affect the quality of the optimized application for ensuring the stability of the transportation of goods logistics systems to ensure they are infection free [16].

The concept of the Innovative Modular Integrated Architecture is based on the assumption of integration and its applicability based on two methods:

1. The method of situational management, which is an integration platform of systems and algorithms of the database system for the collection of data from individual measurements of selected logistics points, the adjustment of the ergonomics of the workplace, as well as the refinement of the locations of the individual sectors, the analysis of the and its hygiene risks and control points

2. The method of analysis of hygiene risks and control points, which will consist of the following steps [17]:

- Identification, risk analysis
- Determination of critical control points
- Determination of control point limits.
- Monitoring procedures
- Development of draft corrective actions

The proposed methods will serve to minimize the risk of COVID 19 disease transmission and will be verified by feedback as multiparametric systems within the framework of integrated safety, which are part of the HACCP (Hazard Analysis and Critical Control Points) logic [18]. This approach will allow the manipulation of selected parameters, which will be chosen according to the above procedures, so as to effectively influence the resulting risk deployment in applications and their systems to collect, analyse and evaluate all available data from the warehouse premises monitoring system but also the actual operation in vehicles as well as looking for correlations in the measured data in order to develop predictive models and algorithms for the behaviour or development of model situations. In connection with the intelligent diagnostic system, the implementation of a complex collection and management of information from the goods location tracking data is addressed. The administration centre will implement a system for collecting data from individual measurements of selected logistics routes, refining the locations of individual collection sectors by evaluating them and recording dynamic data. At the same time, this platform is ready for the implementation of the registration of work environment risks. The functionality of the system is achieved by a web and mobile PHP dynamic system and its application to different types of hardware platforms [19].

Table 1. Timeline of goods transportation

Basic info			store area m2
Number of staff per shift	Risk of contact during the work	Contamination risk	100
6	0,05	1	0,9
	Contamination risk	7,64E-03	
present number of sick Slovakia		20000	
number of infected per 100k (Slovakia		363,636	
risk of contact with infected person		3,64E-03	
present number foreign country		40000	
number of infected per 100k (unload country)		400	
risk of contact with infected person		0,004	
transmission risk		0,04123636364	
load	disinfected goods from quarantine (1)	4	
	Disinfected (2)		
	only in quarantine 24h (3)		
	directly from store (4)		
use only if quarantine was applied			
quarantine time	96h (1)	4	
	72h (2)		
	48h (3)		
	24h (4)		
disinfection of goods	ozone (1)	4	
	dry fog (2)		
	UV-C (3)		
	none		
disinfection of loading area	YES (1)	4	
	NO (4)		
	risk value	3,010299957	

The risk of contamination of the goods during transport is negligible because there is no opening of the transport compartment and therefore no contamination of the surface of the transported goods (table 1). In the event of opening of the hold, the pandemic situation in the country where the hold was opened and thus possible contamination of the surface of the goods being transported will be considered. Such an opening may occur at customs controls, border controls or road checks to ensure that refugees or migrants from other countries are not being transported. the place of loading and the place of unloading of the goods are important for assessing the risk of contamination. This is where goods are handled and where contamination of the surface of the goods may occur.

Identify hazardous raw materials and foods for the presence of alimentary pathogens and toxic substances, determine whether raw materials and foods can support the growth of microorganisms, identify possible sources of hazards and points of contamination or entry into the food chain, determine the likelihood that microorganisms in food will survive or proliferate during food handling, assess the severity and risk of hazards and the health significance.

4. CONCLUSION

From the tests known and performed so far, the pathogen of the virus is transmitted by droplet infection. However, this does not mean that it must be a direct route of infection. It can also be a secondary infection where a virus that is ultimately neither alive nor dead can enter the host's body in another way. It is a well-known fact in the laboratories that the virus can hit the host even after several hours of surface contamination from a previous host or an infected person. In this case the value of the risk transmission is 0,7. In the used scale it means low risk.

For this reason, it is necessary to find out how the fight against invisible disease will continue in the coming periods. Establishing a scheme to assess the risk of disease transmission in a maintenance environment is demonstrably necessary. As well as OHS in the workplace, biohazard risk assessment needs to be put into practice for maintenance and work not directly related to biohazard material or environments. The COVID 19 pandemic has taught us that fighting a small enemy that cannot be seen but is dangerous to health and life must be approached differently. Different scientific disciplines should work together, whose knowledge will be translated into application outputs and will help to defend and protect health and life in the future, so that there are no major maintenance failures and thus no disruption to tourism.

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