



EXPERT SYSTEM FOR THE FREIGHT COORDINATION BASED ON ARTIFICIAL INTELLIGENCE

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Abstract

With the rising of the Industry 4.0, new technologies are emerging that open new opportunities for the transformation of business. These technologies change the supply chains and promote new ways for business value creation (Arenkov, Tsenzharik, Vetrova, 2019). Intelligent solutions and systems based on artificial intelligence (AI) allow for automated management of information, while high level of automation in an organisation and sustainability that has been quickly gaining momentum are very important seeking not to lag behind the rapidly changing market. Many researchers have been trying to solve the transport route planning problem during the recent decades using various methods with different techniques. However, establishing the lowest price and the highest effectiveness is very complicated. One of the methodologies invoked for performing the operations of this type refers to the artificial intelligence machine learning system. A constantly changing dynamic structure of the supply chain poses numerous interesting challenges to effective system coordination. Many sectors earn high profits from AI-based solutions and automation of robotised processes in business attaining advanced results, from customers to companies and manufacturing enterprises. Transportation and logistics sector has also been increasingly seeking to introduce the innovations of these technologies in its processes. Automated logistics reflects the global trend of the logistics industry development, considering the rapid recent development of big data, internet of things, automated processes, and other technologies. Essentially, automation of intelligent logistics determines the effectiveness of logistics activities and service level growth (Li, 2018). Artificial intelligence is invoked in various industries, especially in automated production companies, to free up the human activities and to set a standard of advanced skills and techniques in business processes; it is also an excellent solution for the transportation and logistics sector (Lin, Shih, Yang, Lin, Kung, 2018). This research paper represents an attempt at examining the benefits of the supply chain management (SCM) service and its improvement conferred by automated decision-making and coordination. The paper discusses the conception of artificial intelligence and methods for its application as well as the benefits resulting from the application of these technologies in transport companies to improve the employee performance. Finally, a design of expert system for freight coordination is presented summarising the application of artificial intelligence, which can confer a competitive advantage to the company.

KEY WORDS: Artificial Intelligence; Business Process Automation; Logistics and Transportation.

JEL: L9; R40.

Introduction

The transportation and logistics sector has been changing and improving annually. The United States represent one of the largest developed markets in the world. Trucks are used in the US to transport more than 70% of freight. It is estimated that out of those, in 2021, full truckload (FTL) carriage market in the US will amount to more than US\$196 bill., whereas less-than-truckload (LTL) market – more than US\$80 bill. (Mazareanu, 2021). In recent years, the transportation and logistics sector has been constantly growing due to improving domestic transportation economy. These indicators show high income generation compared to any other sector in the US. Almost 6% of the population of this region are fully employed in transport companies, representing almost \$700 bill. annually. Considering the market size, we can assume that LTLs represent a sufficiently large market share. This suggests non-effectiveness of carrying less-than-fully loaded trailers. However, many companies of this sector still lag behind the innovations emerging in the world and are slower to join the digitalisation path due to high investment costs, thus diminishing their competitive ability. Seeing that logistics companies often provide their services remotely, various challenges are encountered: how to attain the maximum possible effectiveness, and how to improve the transport service processes meeting the client, employee and customer needs while maintaining the lowest costs.

Human resources in an organisation carry out a substantial share of processes that reduce the effectiveness of certain activities. Freight coordination is one of those. This is one of the activities that require significant human involvement. Generally, logistics companies provide sufficiently stable processes irrespective of the customer type; however, frequently, not all resources are effectively utilised. The reason for this is the fact that coordination encompasses orders of FTL and LTL. Automation of decision-making processes is one of the ways to accelerate the operations of the company and enhance the effectiveness (Juan, Mendez, Faulin, Armas, Grasman, 2016). Traditional tasks taking up the employee working time are becoming less-effective. Seeking to avoid this situation, organisations have the opportunity to introduce artificial intelligence solutions such as chat bots or decision support systems that stimulate smooth work in real time and reduce the time costs that would be sustained if employees did the work manually (Alpaydin, 2020). Digitalisation of activities also helps companies to avoid the bottleneck processes. This new technological stage introduces the internet of things, digital networks, and machine learning into the production environment and processes (Gunasekaran, 2016; Grossetete, 2020; Zhu, 2018). Using AI to automate these processes would help utilise the same resources more effectively, thus increasing the company's profit and the speed of carrying out the tasks. The purpose of the paper is to propose an artificial

intelligence-based expert system solution for freight coordination and to conduct a survey to justify the proposition. In order to attain this purpose, the following goals will be achieved: 1. To conduct a review of literature pertaining to the integration of artificial intelligence into operational processes; 2. To perform a case analysis of a logistics provider.

Theoretical solutions of logistics automation

In contemporary global economy, process digitalisation is becoming inseparable from the supply chain management (SCM). Transportation and logistics sector is no exception. Fierce competition forces organisations to employ new methods and to adapt under conditions of high uncertainty and risk. Automation of operations enables the companies to meet new requirements of their customers, enhance the supply chain effectiveness and prepare themselves for challenges. Lately, researchers started focusing on

organisational resilience that is necessary for maintaining competitiveness (Ralston, Blackhurst, 2020). It is therefore very important for the companies to be capable of identifying the prevalent risks, vulnerability level and possible mitigation methods for minor and major disturbances. Intelligent solutions and systems based on artificial intelligence allow for autonomous management of information – when seeking to go hand in hand with the rapidly changing market, high level of automation and sustainability are very important. A constantly changing dynamic structure of the supply chain poses numerous interesting challenges to effective system coordination. Hence, when analysing the theoretical aspects, a design of the freight coordination system is presented seeking to summarise the integration of artificial intelligence and present different ways of application that would help making the most appropriate decision (Fig. 1), reducing the time costs and, after taking all the limitations of the truck into account, selecting the most suitable freight.

As the process digitalisation increases, load planners

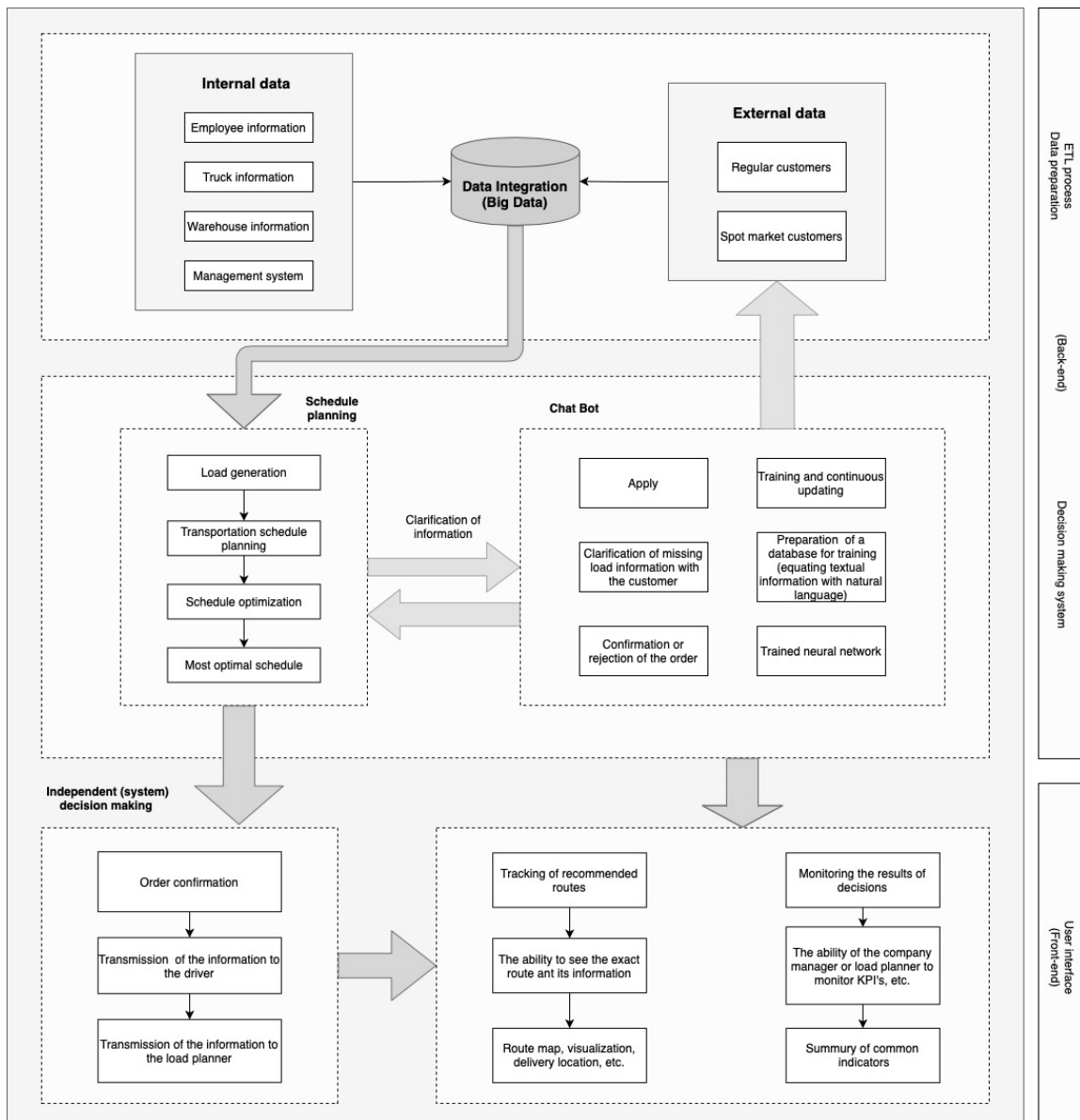


Fig. 1. Design of the expert system for freight coordination

are enabled to process more data during a limited period of time. The use of modern decision support systems is generally based on scientific, informative thinking and artificial intelligence approaches. This facilitates the visualisation of results and their presentation to the end user. Monitoring of traffic conditions, listing all the possible route options or calculation of prices are now all part of the everyday transport coordination. Hence, seeking for process automation, artificial intelligence is increasingly invoked to make the decisions faster, to avoid unexpected occurrences on the road, and to ensure effective transportation. Visualisation discusses the following steps:

- Information sharing technology that, as was observed, became a crucial success factor in SCM (Zhou, Benton, 2007). Sharing of information in the supply chain could be defined as the sharing of data, information, and knowledge by an organisation in the supply chain (Kembro, Naslund, 2014).
- Decision-making optimisation in the route planning. When modelling routes, logistics companies often encounter discrepancies and are forced to carry empty trailers. An incorrectly chosen decision might bring loss to an organisation. Decision support system has the possibility to access external and internal data and information of the database containing big data as well as to model different scenarios and to create graphic reports based on the user needs. According to the researchers, seeking to automate the solution of actual practical transport route planning problems, it is helpful to employ a decision support system that combines optimised solutions and simulation-based route schedules considering the truck limitations (Ocalir-Akunal, 2016). When searching for more than one solution, optimisation and DSS are the key two stages of the decision-making (Türkşen, 2015).
- Automation of intelligent processes. Essentially, automation of intelligent logistics determines the effectiveness of logistics operations and service level growth (Li, 2018). Artificial intelligence is invoked in various industries, especially in automated manufacturing companies while relieving the people from monotonous activities and seeking to set a standard of advanced skills and techniques in business processes; it is also an excellent solution for the transportation and logistics sector (Lin, Shih, Yang, Lin, Kung, 2018). Artificial intelligence is capable of learning from its errors, reasoning and even rectifying errors made. The most popular areas of artificial intelligence application can be observed in video, speech, and sense recognition applications. Various chat bots use the natural speech recognition function when providing services to customers online. Natural speech processing (NSP) is an integral tract of artificial intelligence and linguistics aimed at making computers understand statements or words written in the human languages (Khurana, Koli, Khatter, Singh, 2017). The key reason why NSP is so important for the future is that the system records certain information as input, processes it and presents a text or voice output in the natural language

understandable to the user. Considering the fact that the system has access to the big data and higher availability of the computational capacity, we can conclude that it is significantly more effective than a human being performing tasks of the same nature and creates higher added value in meeting the arising needs of the transportation systems (High, 2012), (Tizghadam, Khazaei, Moghaddam, Hassan, 2019).

Automated processes refer to a technology that actively collects data, transforms information and is capable of making decisions and controlling processes (Lee, Seen, 2004). Due to this reason, the design of the expert system for freight coordination proposes digitalising the operational processes by invoking artificial intelligence. After analysing the theoretical approaches and seeking to validate this system, the authors carried out a case study of UAB Unlimited Carrier. Actions are examined according to the current transportation services provided by the company and work processes.

Research and findings

Description of the selected case of logistics services provider

UAB Unlimited Carrier is a rapidly developing United States company operating in Lithuania. The company experiences great pressure to provide premium quality services at low costs. However, operational processes of the organisation, e.g. freight ordering, freight coordination, supervision of drivers, communication with the customers, route planning etc. become protracted due to the involvement of the human factor. In current freight coordination processes, employees experience numerous issues on a daily basis. The time it takes to find the freight and to compile a schedule, and activities of interacting with brokers for the purpose of specifying the information are based on a human factor that wastes a substantial portion of time and does not ensure the highest quality of processes. Their key object is artificial intelligence that is intended to be used for automation of the company's process solutions.

Methodology

According to the respondents, the selection process is made more difficult by the fact that in 70% of cases,

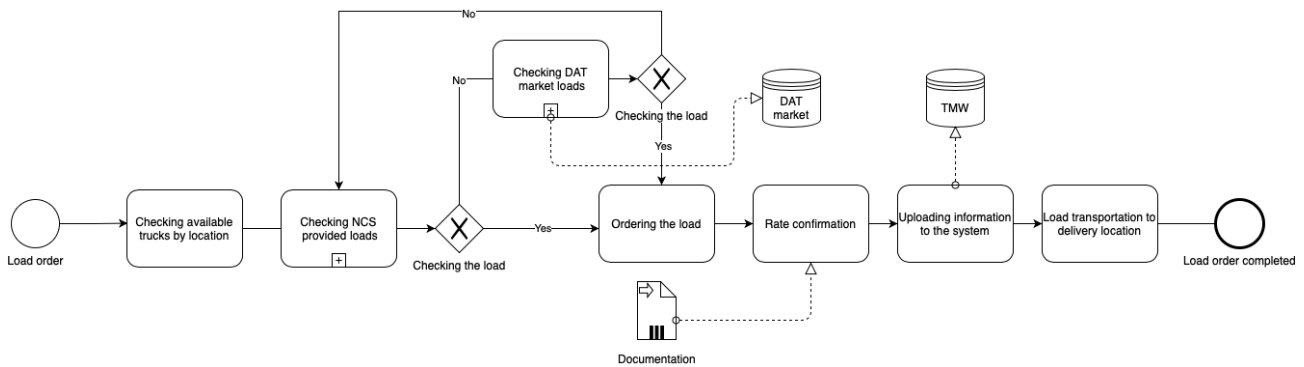


Fig. 2. Visualisation of the freight ordering process using BPMN

Seeking to ensure a higher degree of data provision, business process modelling notation (BPMN) visualisations are carried out based on the process documentation of UAB Unlimited Carrier. This is an observation-based method used to analyse the obtained secondary documents of the company, employees, their activities, service provision, and other processes. The process visualisation scheme analyses in more detail the proceeding of freight ordering starting with the identification of the driver's location to transmitting the order information to the driver. Clear steps are provided seeking to understand how the process operates and the decisions that must be made to order FTL and LTL freight as well as the sharing of information on the level of divisions and the entire organisation. Smooth and effective operations of the organisation help avoid unnecessary labour force resources, reduce the inaccuracies of the human factor and optimise the freight coordination (Fig. 2).

The second method used for the research was expert interview with the employees of UAB Unlimited Carrier conducted according to the aspects analysed in the theoretical part. Respondents included the employees from the human resources and quality control, accounting, information technologies, and transport coordination divisions. The main advantage in the collection of data of such type lies in diverse types of questions allowing the authors to find out various activities engaged in by the company and gain in-depth understanding of the business process functioning. When preparing for the interview, questions were divided into three categories: 1. Questions pertaining to business process analysis; 2. Questions on automation technologies; and 3. Questions pertaining to decision-making in the course of the process. The main objective of the semi-structured interview was to analyse the operational processes and propose suggestions for decision-making improvement in the organisation's processes. The course of the interview is presented in Fig. 3. The conducted interview showed that in the company, psychological factors play an important role. Load planners spend probably the most of their time searching for and ordering freight. This occurs due to the fact that freight is sought for each driver individually considering their location. Online cargo exchanges represent one of the options for searching for freight in real time.

brokers upload inaccurate information; the remaining 30% of cases represent brokers with whom the company has worked before. Nonetheless, an order cannot be finally confirmed until all the required information has been obtained. Thus, because of this, load planners waste significant time. Questions of the second part revealed that the applications used and listed by the respondents were not intelligent, interlinked or specially tailored to the organisation's content. As a result, the human factor manifests even more when attempting at linking all these applications into a whole. Planning occurs in real time, taking various factors into account; hence, acceleration of this process would enhance the process effectiveness. Questions of the third part associated with the decision-making showed that the company's employees would not be inclined to trust the decisions proposed by artificial intelligence entirely. Considering the fact that employees are bound by close interrelationships, the human factor in this case has the decisive role. The replies collected during the interview show that the majority of respondents were positive about the application of artificial intelligence in work processes. Possibility to revise the information to correct the inaccuracies using the chat bot would be helpful when sending emails. Using the generated voice messages to revise the information to correct the inaccuracies would be complicated due to additional questions arising in a conversation that would probably be impossible for the robots to answer. However, all the surveyed respondents concluded that, if possible, they would first start applying the artificial intelligence technologies to the freight planning and route optimisation.

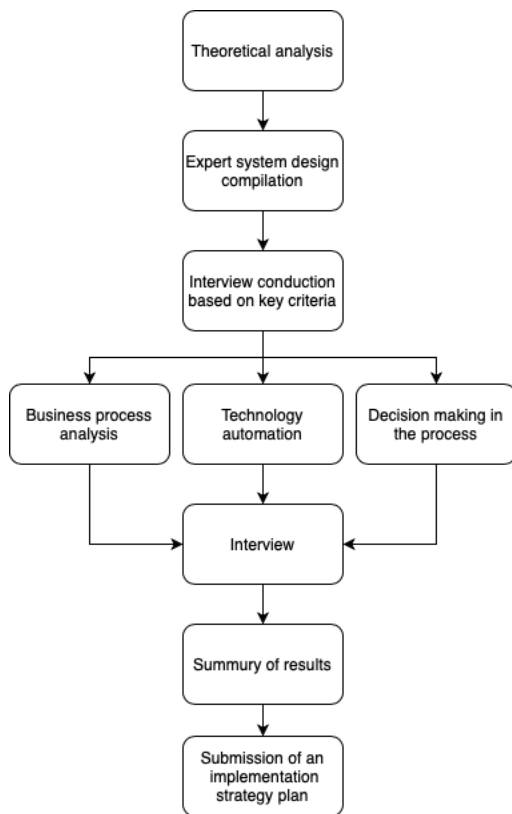


Fig. 3. Visualisation summing up the interview

Findings

Based on the conducted research, a recommendatory plan was drawn up for the improvement of organisation's processes. According to the authors, it is recommended to introduce the expert system for freight coordination in three stages. In the first stage, introduction and testing of the system should be started that would, invoking AI, select the freight according to the set criteria. Freight generated by the system would be prepared separately for each driver, thus ensuring individual requirements. In the course of the process, it is proposed to check which steps were justified and which ought to be eliminated. Thus, improving each time, the system would realise what is the ultimately expected result and how to distinguish it. Route optimisation is the second stage of introduction. Seeing that currently UAB Unlimited Carrier applies no route planning system, the driver decides which road to take and how to reach the destination. However, the likelihood of the driver choosing the shortest, most fuel-saving and most effective route is low. The authors contend that due to constantly increasing real-time demand and current pandemic situation the route optimisation and application of technologies are turning into an increasing advantage. Use of intelligent transport systems for company's route planning would help avoiding traffic jams on the roads, planning for bypasses of accidents in real time, estimating road charges and calculating the most cost-efficient route while avoiding the gas emissions to the air. After implementing a system of this type, the company would save fuel and costs. The third stage of introduction refers to the chat bot installation. Although the respondents stated that chat

robots would not be an effective form of communication with brokers and regular customers, according to the authors, as the technologies improve, interaction with machines based on artificial intelligence will gain popularity. Considering the fact that in transportation and logistics industry, human beings will always make the final decision, the constantly improving robots will also come in handy supporting the decisions. At present, many automated systems specialists are working on the improvement of the chat bot technology so that it is able to perceive emotions and distinguish the essence of the conversation. Taking into account the potential added value of this innovation, it is very important to start introducing it, albeit in small steps.

Conclusions

Based on the analysed data, we conclude that the processes of UAB Unlimited Carrier are not sufficiently automated and effective. The society is changing and developing rapidly; technologies are improving simultaneously. Seeking not to lag behind the competitors and to utilise innovations, companies must improve their operational processes. Seeing that the organisation expands each year, the managers should also take the application of new technologies into account, thus ensuring growth and improvement hand in hand with the transportation and logistics sector. Employees are forced to perform monotonous acts and to make the decisions wasting a substantial portion of their time. Hence, the main proposition is to improve the expert system for freight coordination by introducing artificial intelligence. While introducing this solution, it is necessary to ensure constant testing in order to avoid any risks or system failure by preventing excessively long freight order placement, selecting freight according to the set criteria, carrying out effective route planning and increasing customer satisfaction with the assistance of chat robots. Artificial intelligence and application of the required automated systems help accelerating the processes, eliminating redundant workforce, and increasing the profits with the same resources, thus ensuring the pay-off of the investment and implemented initiative in the future. Innovative technologies are now part of the rapidly developing world. Consequently, applying them increases awareness, helps becoming a leader among the competitors, ensures decision-making in real time, and reduces the risks. The performed survey allows concluding that the company's employees are positive about the application of automated systems and would be willing to embrace innovations of this type. An expert system design would ensure smooth sharing of data, precise route calculations and beneficial freight generation technology. Chat bots also have great prospects in the transportation and logistics sector seeking to simplify the processes of information revision. The constantly improving effectiveness of artificial intelligence application could improve the quality of transportation services in real time.

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