Autonomous Vehicles and Distributed Resources on Logistic Systems

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The autonomous vehicle (AV) is one of the emerging technologies of the new age that has the potential to restructure transportation infrastructure. AVs are able to sense their surroundings and move around with control and self-sufficiency. AVs can contribute towards reducing traffic congestion on the roads, improving the quality of life, and achieving the highest levels of traffic safety. Thus, this type of vehicle can be integrated into the logistics industry. Due to the presence of several AVs, selecting a standard and efficient AV for logistics planning is a great challenge. The selection of an AV depends on many conflicting and essential criteria.

logistic systems autonomous vehicles uncertainty logistics

1. Introduction

Nowadays, the transportation of products and people plays a crucial role in economic and everyday life concerns [1]. As a consequence, environmental repercussions are rising, and the sustainability of the ecosystem is in jeopardy. Government authorities and organizations are searching for novel methods of freight delivery that have high levels of efficiency, flexibility, dependability, and quality [2]. Logistics refers to the complete management process for resource movement, maintenance, and restoration [3]. Logistics management results in cost savings and increased benefits [4]. As a result of the streamlining of processes, businesses are able to handle an increase in sales to endpoints. Logistics management in a company is essential if it is to be successful. Effective logistics management seeks to boost operational performance, customer loyalty, and output. These instructions and methods are necessary to improve logistics and transportation system procedures. Due to air pollution, many academics are now concentrating on the long-term viability of all concerns, including industrial planning, the supply chain, logistics, and transportation [5].

A city is considered to be smart when its transportation system is sustainable and does not have an influence on the environmental sustainability of the surrounding area [6][7]. Transportation and logistics play a vital role in the current corporate environment, particularly with regard to the delivery of services and goods to their final destinations. In order to guarantee the effective management of logistics transportation and the protection of information, resources, energy, and the means of transportation, important management choices need to be made. The logistics environment is fragile and in desperate need of significant adjustments. In addition, the use of modern technology is required as a solution to a variety of social, economic, political, technical, and technological problems

[8]. In addition, the majority of accidents that take place in the transportation sector are often caused by a lack of technologically advanced equipment, and these accidents can cause environmental catastrophes.

Client services in the field of logistics are often described as the amount of time that elapses between two separate customer operations or purchase orders [9]. The level of value that a client receives from a product or service will, over time, be directly proportional to the quality of the customer service provided. The pleasure of one’s customers is an essential component of the transportation sector of a logistics business, especially in the logistics sector. In the field of industrial logistics, autonomous vehicles (AVs) are utilized to cut down on the amount of time wasted waiting for transportation. Trucks that operate on their own and never require the assistance of a human driver are known as AVs [10]. They integrate sensors and software for vehicle monitoring, navigation, and operation. The Internet of Things has the potential to link all computer systems to the Internet so that they may share and utilize additional value. The interconnection of AVs enables information to be shared between onboard sensors, cellphones carried by pedestrians and riders, sensors embedded in the road, and parking detectors [11]. The Internet of Things enables businesses to collect data remotely about the areas around their facilities, which makes it simpler to manage and get rid of unwelcome negative replies. The Internet of Things and improvements in mobile technology have a significant impact on the operations of businesses involved in transport and logistics.

There is a significant possibility that AVs will improve both the efficiency of transportation and the overall quality of life [12]. Recent advances in technology have allowed us to design automobiles that are more dependable and fuel-efficient. However, owing to ongoing safety concerns, the widespread use of AVs is still in its infancy [13]. The use of AVs is restricted in a number of nations as a result of legislation and regulations. It may be possible to increase the rate at which AVs are adopted by defining the criteria for assessing AVs and establishing a selection procedure that is complete. The development of full AVs has emerged as a significant topic of study in recent years. There has been an uptick in the number of research projects concentrating on the introduction of AVs. Particularly as a result of recent technological advancements, self-driving vehicles have grown more dependable and convenient. Despite this, there are still a lot of worries, particularly with respect to ethical and safety considerations. Various governments are working on formulating regulations and protocols in an effort to control the proliferation of AVs [13]. The difficulty of the assessment procedure is increased by the fact that the appraisal of AVs is fraught with hesitation and imprecision.

The transportation industry is undergoing profound transformations as a direct result of the implementation of Industry 4.0 and the digitization of the whole value chain [14][15]. The idea of the AV is a relatively new notion in the field of transportation. In a perfect world, an AV or self-driving car would be able to detect its surroundings and function independently of human input. To assume control of the vehicle at any point in time, a human passenger is not required in any way. In the last ten years, the AV industry has seen phenomenal expansion. Advanced computer systems and electric mobility are front runners in this endeavor. Software is executed by a self-driving car’s sensors, actuators, machine learning systems, and complicated and efficient algorithms. A person does not need to intervene in order for the car to travel from one location to another. As a result, the use of environmentally friendly technology may eliminate all forms of environmental harm. AVs are one of the newest solutions that have been developed to deal with the issue of traffic and accidents. These vehicles, which are equipped with electronic systems, have great performance and higher precision than human capabilities. Because of the rapid pace of technological advancement in AVs, the logistics industry is a natural fit for the deployment of AVs.

The deployment of AVs in the logistics industry may provide a beneficially competitive environment. The regulated environmental activities that are provided by logistics, such as distant sites and storerooms, make it a perfect working environment for AVs. Therefore, it is likely that the logistics industry will adopt this technology sooner than passenger transport [16]. The assessment of autonomous vehicles according to the many capabilities they possess may be seen as a form of multi-criteria decision-making (MCDM). When it comes to finding solutions to issues involving transportation decisions, the techniques of MCDM may provide an approach that is both more effective and more rational [17][18][19][20][21].

2. Autonomous Vehicles

In this part, studies related to AVs and some studies related to the logistics industry are presented. The idea of AVs has attracted the attention of researchers, academics, and those interested in the industry since its inception, which has provided an abundance of research related to this field [22]. The studies presented are not significantly related to logistics. Nevertheless, presenting a review of studies on autonomous vehicles highlights their benefits to the logistics industry. Kumar et al. [14] pointed out the obstacles that will be faced in the general adoption of AVs in developing nations. Their findings will assist decision-makers in policy development and AV producers in better comprehending the degree of relevance associated with each obstacle and the interrelationships between them. Raj et al. [23] conducted a study to investigate the different barriers to the adoption of AVs. Their study was presented in five stages to identify ten barriers to the adoption of AVs. Then, an MCDM approach was presented using the Grey-based Decision-Making Trial and Evaluation Laboratory (Grey–DEMATEL) method to search for these barriers and clarify the causal relationships between them. Abosuliman and Almagrabi [4] presented a very important research paper investigating the challenges of managing industrial logistics. They introduced the Internet of Things-assisted smart logistics transportation administrative approach in an industrial setting for establishing an optimum logistics strategy, increasing customer service, and lowering transportation costs. Gokasar et al. [24] investigated the available solutions to manage the congestion problem to improve traffic for the success of the AV driving system on public and open streets. Their approach adopted the Measuring Attractiveness by a Categorical-Based Evaluation Technique (MACBETH) method under a rough set to determine the most appropriate street traffic administration systems. Rahnamay Bonab et al. [1] presented a research paper to determine the optimal self-driving vehicle to be adopted by a modern transport system and in logistical planning. Their methodology adopted the Choquet integral (CI) method to conduct the study under a spherical fuzzy set (SFS) environment. Abdel-Basset et al. [17] developed a study on the risk assessment of self-driving vehicles using an MCDM approach. Their approach consisted of two methods of decision-making: the Analytic Hierarchy Process (AHP), Multi-Attributive Border Approximation Area Comparison (MABAC) and the Preference Ranking Organization Method for Enrichment Evaluations II (PROMETHEE II). In addition, the study was conducted in a neutrosophic environment.

3. T2NN Environment

Undoubtedly, the neutrosophic theory has attracted the attention of academics and researchers in the current period, especially the environment of T2NNs [25]. Simić et al. [26] offered a research paper for selecting the most appropriate route for transporting petroleum using an MCDM approach. Their approach consists of two decision-making methods: the indifference threshold-based attribute ratio analysis (ITARA) method and the evaluation based on distance from average solution (EDAS) method. Their study was conducted in a T2NN environment to address ambiguity and uncertainty. Görçün et al. [27] presented a study extending the version of the weighted aggregated sum product assessment (WASPAS) method under T2NNs based on the Bonferroni function (WASPAS'B) for selecting the suitable Ro–Ro vessel in the second-hand vessel market. Zolfani et al. [28] provided a paper for discussing and assessing the benefits and notability of the extended efficiency analysis technique with input and output satisficing (EATWIOS) technique based on type-2 neutrosophic fuzzy numbers (T2NFNs). Their methodology was applied using a case study in the container industry.

4. MEREC and CoCoSo Methods

In this part, some of the literature related to MEREC and CoCoSo decision-making methods are reviewed. Hezam et al. [29] presented a study researching alternative fuel vehicles to reduce fuel costs and reduce emissions. Their study relied on a decision-making approach to select the optimal alternative fuel vehicle for a private home health care provider in Chandigarh, India. Their approach combined the MEREC method, the ranking sum (RS), and the Double Normalization-based Multi-Aggregation (DNMA) based on an intuitionistic fuzzy approach. Rani et al. [30] introduced a paper for selecting the food waste treatment technology. Their approach applied the MEREC method and the additive ratio assessment (ARAS) method based on the Fermatean fuzzy set (FFS). Accordingly, the MEREC method was applied to prioritize criteria. Su et al. [31] pointed out the importance of achieving the sustainability of blockchain systems in the field of manufacturing. They adopted a decision-making approach composed of three methods: the entropy method, the rank sum (RS) method, and the CoCoSo method based on the Pythagorean fuzzy set to investigate the transformation of blockchain technology into a sustainable manufacturing model in the Industry 4.0 era. The CoCoSo method was applied to rank the candidate alternatives. Chen et al. [32] presented a study on occupational health and safety risks in order to increase productivity and competitiveness. Their approach adopted the CoCoSo method based on Fermatean fuzzy linguistic sets (FFLSs) to assess risk.

According to previous studies, the field of AV encourages researchers to conduct more studies. Despite this, there is a paucity of studies evaluating logistics and AVs. Also, the environment of T2NNs is a promising environment for conducting studies and dealing with certainty and the lack of ambiguity. In addition, the MEREC and CoCoSo methods are applied in many fields. Accordingly, a comprehensive decision-making approach, T2NN–MEREC–CoCoSo, was introduced to assess and rank logistic AVs to support the logistics industry.

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