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Factors affecting the adoption of technologies to improve fleet safety management

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Abstract

The study explore factors affecting the adoption of smart technologies in improving fleet safety within the logistics industry. There are limited studies in literature on factors that affect the adoption technologies to improve fleet safety in the logistic industry. The understanding of the factors is important for the success of the adoption of smart technologies fleet safety management. Therefore, this study aims to fill that gap. The study adopted a systematic literature review to explore the factors that affect the adoption of smart technologies fleet safety management. The Technological, Organizational and Environmental (TOE) framework was used explore the factors affect the adoption of smart technologies to improve fleet safety management. The study used quantitative content analysis to analyse data collected from published articles. The study results suggest that the technological factors and environmental factors were the most factors affecting the adoption of of smart technologies fleet safety management. The paper contributes to the body of knowledge on factors affecting the adoption of smart technologies to improve fleet safety management.

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1. Introduction

Logistics challenges occur and are prevalent in all industries and organisations. The fleet and vehicle industry is no different which has its current challenges [1]. Havenga [2] defined logistics as a major part of the supply chain process, which plans, implements and controls the flow and storage of goods effectively and efficiently. Furthermore, logistics consists of various activities and processes, which include procurement, inventory management, transportation and fleet management [2]. According to the Transport and logistics IRC [3] the upcoming problems the industry might face include the arrival of semi and fully automated vehicles, the usage of interconnected devices and the large amounts of data they will carry. A single accident or breakdown, for example, has the effect of delaying schedules, causing loss of cargo, increasing costs for the organisation and decreasing profits [3]. According to the National Safety Council [4], traffic safety issues are the leading cause of fatalities in which 1 in 103 persons die in a vehicle accident [4]. Furthermore, the situation has become difficult because congested roads, where vehicles are travelling at faster speeds [5].

Safety in logistics is becoming increasingly important in assuring an effective and efficient supply chain process. At a South African fleet management conference highlighted driver fatigue as a major source of accidents in South Africa [6]. Further problems about safety arise from various other aspects such as security threats, distractions, poor vehicle conditions and unsafe roads and infrastructures [7]. An emphasis on safety in fleet management is, therefore, a vital measure to undertake and can be seen as a strategic approach in improving the safety of the entire vehicle fleet to ensure smoother workflow and profitable operations [8]. Traditional methods of ensuring and managing safety within the operations of fleet management consist of areas such as providing driver training, developing safety policies and ensuring effective health and safety procedures [9]. Although there are many initiatives in place to improve safety, the literature suggests that the problem still exists. This study main research question is therefore: What are the factors affecting the adoption of technologies to improve fleet safety management in the logistics industry?

2. Literature review

As time has progressed over the course of history, technological advancement have made many available resources for use in different industries. Xu [10] defined industrial revolutions as technological advancements that have primary impact on the development of the world, its industries and economy. To this day, three industrial revolutions have occurred, which ultimately had the impact of contributing to the introduction of the fourth and latest industrial revolution. This revolution, commonly known as industry 4.0 has seen the emergence of digitalization, networked communication, machine learning and data analytics to name a few [11]. The development of Industry 4.0 seeks to integrate various technologies to improve and change the way business is conducted, its supply chain and the value delivered to customers in a way which is more efficient and effective [12].

With the development of these new digital technologies and systems within Industry 4.0, organisations and industries are digitizing their supply chains. Rouse [13] defined digital supply chain as a supply chain that uses IT-enabled processes, connectivity, system integration and web-enabled capabilities to improve efficiency, and profits while reducing risks and waste. Many industries, including supply chain and logistics companies, have begun implementing or digitalizing their supply chain operations [14]. DHL, a logistics company, for example, has started to integrate and utilize big data into its operations to reduce risks and have introduced data glasses for employees (for their picking process) which has resulted in a 25% increase in productivity [14]. The existing literature suggest that there are many opportunities available in digitalizing an organisation's supply chain through digital technologies of Industry 4.0.

2.1 Fleet Management

Valenti [15] defined Fleet management as the overall management of an organisation's transport and its related activities. It overlooks various aspects of the logistics area of organisations such as driver management, fuel management, safety management and vehicle purchasing and maintenance to name a few. The management role over fleets seeks to reduce costs and risks, improve efficiencies and ensure overall effective usage of resources [16]. In relation to this study, the focus would be around the management of safety in fleet operations for logistics companies.

Previous studies identified safety as a major concern in the logistics process, which involves areas around driver and vehicle safety, health issues and ensuring the safety of the cargo [16]. The management thereof, therefore, becomes an important aspect in ensuring effective and efficient delivery of goods to customers. The rapid development of technologies has provided organisations with new ways and methods to improve and ensure safety within their operations [17].

Fleet management around safety seeks to adopt various approaches, tools and techniques to different management areas around staff, such as driver management, vehicle management and health and safety management to name a few. These are examples of effective management areas used in managing safety without industry 4.0 technologies. Management of drivers may be one of the most important measures, which currently exist in ensuring safety within fleet operations. Managing drivers involve processes such as ensuring drivers are physically and mentally fit to drive and manage a vehicle [18]. The issue of driver fatigue as an example contributes to around 15-20% of all vehicle accidents [19]. Frone et al [20] defined fatigue as a state of being overly tired along with a lower mental and physical capacity to complete tasks. Fatigue management has therefore evolved to become an important measure for organisations to manage. Processes such as physical check-ups and planned driver-scheduling are therefore important to ensure drivers are in good shape to complete their activities and reduce any health and safety risks. The fatigue management is just a subset of various management areas in ensuring the safety of fleet operations. With the introduction of new digital technologies, companies would seek to incorporate the technologies into the management of fleets and its operations to improve safety.

2.2   Related Studies

Existing literature on the safety of logistics has a large focus on the issues pertaining to accidents and loss of cargo. Furthermore, the issues of safety around vehicles have been widely investigated where numerous amount of research focused on safety in terms of road accidents, road safety and numerous causes thereof over recent years. There is limited research on the adoption of technologies to improve safety of fleets in the logistic industry. In addition, various articles have identified potential benefits of supply chain technologies to improve fleet safety management in organisations [21].

2.3   Theoretical Framework

The study adopted the TOE framework to explore factors affecting the adoption technologies in fleet safety management in the logistic industry (Figure 1). The TOE framework consists of three main constructs technological, organisational and environmental contexts, which affects technology adoption in organisations [22,23]. The technological includes those factors that are both internal and external to the organisation [24]. The technology factors variables include cost, availability, security, complexity and relative advantage. The organizational factors of the TOE framework includes size, management, structure and resources of the organisation [22]. Finally, the last context of the TOE framework is the environmental context. The environmental include industry competitors, government regulations and service providers [24].
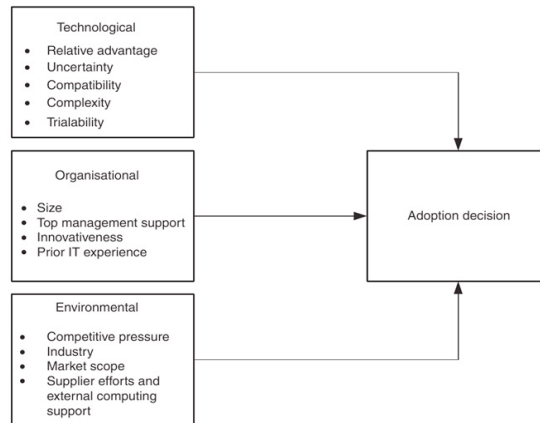
Figure 1: Generic TOE Framework (Source: Oliveira, et al [24])

3. Research Methodology

The study used a quantitative research approach to explore factors affecting the adoption technologies in fleet safety management in the logistic industry [25]. The study adopted a quantitative research method to gather and analyse the existing literature on the research area [26]. The study adopted a positivist philosophy, where the information collected is concentrated on the facts and observations, in this case through the analysis of secondary literature [27]. The study used a literature matrix to identify articles to be analysed. The matrix listed themes from existing research, meeting certain criteria in each articles [28]. The study reviewed existing literature on the topics of logistics companies, management of fleets, safety management, digital supply chain and digital technologies. The articles were systematically collected from online research platforms and publishing journals such as Google Scholar, BASE and ResearchGate. The exclusion criteria was used to select only articles published from 2013-2019. The study collected 63 through convenience sampling, involving a search for keywords in the above-mentioned platforms. Some of the keywords used in the search include digital technologies, fleet safety, TOE framework and technology adoption.

3.1   Research Methods

The study reviewed existing secondary literature and adopted a quantitative content analysis to gather data for the research. A content analysis may be defined as a research analysis method by which data may be collected and analysed in a "systematic" and "reliable" way, which would allow inferences and generalisations to be made [29]. The study followed key stages as presented by Siddaway [30], in doing a systematic literature review. The steps are, scoping, planning, searching, screening and eligibility [30].

3.2   Data Analysis

From the 63 articles obtained on the topic area, the data was analysed through the TOE framework, which consists of technological, organisational and environmental factors. Each article was synthesised to find the presence of each TOE framework variable within each article. Furthermore, the study converted the qualitative data into quantitative data through coding, in order to produce quantitative statistic results using SPSS software package.

4. Study Results

This section presents the results of analysed data from the collected published articles on factors affecting the adoption of technologies to improve fleet safety in logistic industry. The first sub-section presents the demographic results of the study and second sub-section frequencies of Technological, Organisational and Environmental factors affecting the adoption of technologies to improve fleet safety in logistic industry.

4.1 Demographic Results

This sub-section present the results of the analysed data from the published articles relating to the adoption of technologies to improve fleet safety management. The results show that most research were published Europe (33%) and North America 33%). Other region published articles were as follows: South America (3%), Asia 13%, Africa at 10% and Australia with 8% respectively. The results of the study suggest that most articles were published in 2018 (23%) with the rest of the years as follows: 2019 (8%), 2014 and 2017 with each at 11%. The results indicate that 59% were published between 2016 and 2019. The results show that quantitative method (67%) was the most preferred research methods used on the published articles, followed by qualitative methods (25%). The mixed method (8%) was the least used research method. A majority (87%) of the articles analysed made no use of frameworks in the research. The following framework were used in the remainder of the articles, TOE framework (13%) TAM model (3%) and DOI model (2%).

4.2 TOE Framework Results

The following sub-sections presents results of Technological, Organisational and Environmental from the 63 published articles analysed. The study analysed TOE framework factors that affect the adoption of technologies to improve fleet safety in logistic industry.

4.2.1 Technological Context

The figure 2 below show technological that affect the adoption of technologies to improve fleet safety in logistic industry. The technological factors include cost, security, relative advantage, complexity and availability. The results indicate that cost (74 %) had the highest percentage of the published articles on technological factors. The other variables of the technological construct were as follows complexity (44%), security (48%), relative advantage (62%) and finally, availability (59%).
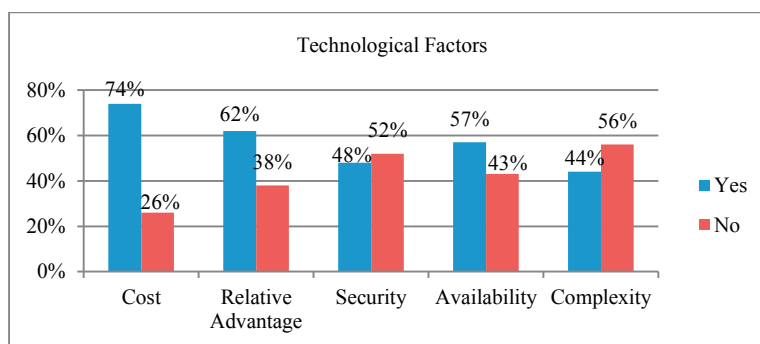

Figure 2: Technological Factors

4.2.2 Organisational Context

Figure 3 below, shows frequencies of organisational factors variables from the analysed data from published articles. The results indicate that management 63% had the highest percentage of the published articles on organisational factors. The other variables of the organisational construct were as follows organizational resources (59%), organizational size (16%), organizational structure (40%) and supply-chain strategy (41%). The results indicate that organizational size had the lowest percentage of the published articles on organisational factors.
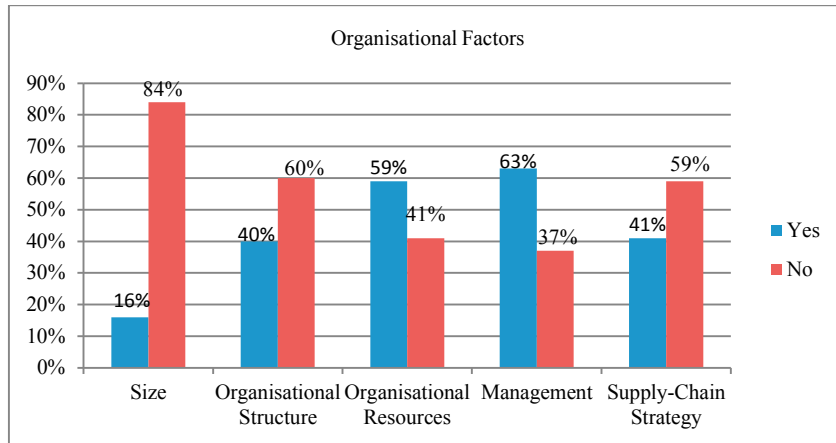
Figure 3**:** Organisational Factors

4.2.3   *Environmental Factors*

Figure 4 below, shows frequencies of environmental factors variables from the analysed data from published articles. The results indicate that trends 81% had the highest percentage of the published articles on environmental factors. The other variables of the environmental factors construct were as follows service providers (5%), regulations (38%), market structure (32%), competition (56%) and finally best practices (30%). The results indicate that organizational size had the lowest percentage of the published articles on organisational factors.
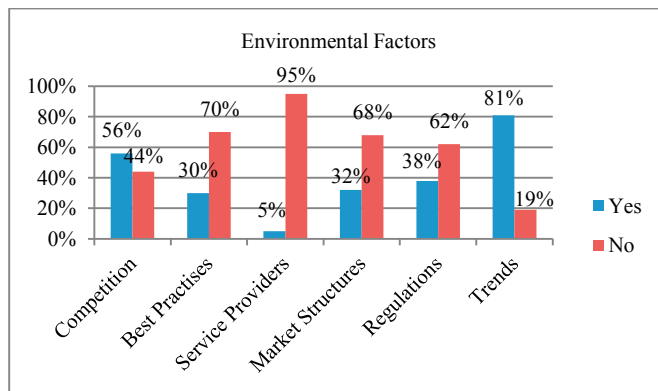

Figure 4: Environmental Factors

5. Discussion and conclusion

The study used a systematic literature review to explore factors affecting the adoption of technologies to improve fleet safety management in logistic industry. The results from the study show that most research were published Europe and North America and the least from South America. The results indicate that most of the published articles were between 2016 and 2019. The quantitative method was the most preferred research methods used on the published articles. A majority of the articles analysed made no use of frameworks in the research. The results indicate that cost had the highest percentage of the published articles on technological factors and complexity the least percentage. The results indicate that management had the highest percentage of the published articles and organizational size had the lowest percentage of the published articles on organisational factors. The results indicate that trends had the highest percentage of the published articles on environmental factors and service providers had the lowest percentage of the published articles on environmental factors.

As a conclusion, the study explored factors that affect the adoption of technologies to improve fleet safety management in logistic industry. The results indicate most of the technological factor were important adoption of technologies to improve fleet safety management in logistic industry. In addition, the results show that management and organisational resources were most popular organisational factors in the published articles. Finally yet importantly, trend and competition were the most popular environmental factors in the published articles. The study contributes to the body of knowledge on the adoption of technologies to improve fleet safety management in logistic industry. Despite the study's contribution, it had also some limitation. The study based on secondary data not empirical data. Future research may therefore focus on empirical studies using other research methods.

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