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Digitalization and critical infrastructure: The role of information technology in energy and autonomous transportation

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Abstract

Energy and transportation are the two largest contributors to carbon emissions globally. The study examines Digitalization and critical infrastructure: The Role of Information Technology in Energy and Autonomous Transportation. Using a mixed–methods approach 20 questionnaires were distributed to 20 energy and autonomous transportation companies to complete the survey. Collected data were subjected to analysis. The result shows disparity on the 4 Likert scale result obtained. Majority of the respondents strongly agreed (50%) that IoT and AI are crucial to the future of energy/ transportation development. Majority of the respondents (50%) also agreed that automation in the transportation industry has brought about enhancement. Conclusively, Digitalization in energy and autonomous transportation offers lots of benefits: an enhancement of road safety, the alleviation of traffic congestion, transportation enhancement and the optimization of urban mobility, ultimately culminating in an improved standard of living for urban inhabitants.

Keywords: Digitalization; Critical infrastructure; Information technology; Autonomous transportation

1. Introduction

Energy and transportation are the two largest contributors to carbon emissions globally. Under the strategic objectives of achieving "carbon peaking and neutrality," the low-carbon transformation of these sectors is imperative for China.

Digital technologies are revolutionizing various aspects of life, including the energy and transportation sectors. Digitalization, a key trend, offers promising solutions for reducing energy demand and carbon emissions. However, concerns remain about whether the energy savings from networked digital devices can offset the growing energy consumption of those devices. Despite these concerns, digital technologies hold significant potential to shape next-generation transportation systems through intelligent and sustainable design. A critical area of interest for both academia and industry is how digitalization can facilitate timely and cost-effective decarbonization. Digitalization encompasses sensing, transmission, and computation—specifically, data generation, transmission, storage, transformation, and application (data value creation). From a data value stream perspective, the generation of high-quality data is heavily dependent on advances in infrastructure, such as energy and transportation sensors. Furthermore, the development of 5G and 6G technologies enables the rapid transmission of data, meeting the demands for real-time processing in the big data era. With the support of more advanced mechanisms and algorithms, digitalization can unlock value in a range of applications, ultimately fostering industrial growth.

In the wake of the ever-growing imperative to optimize energy consumption and curtail the environmental footprint, the transport sector is transitioning into a pivotal sphere where digital innovation has the potential to usher in

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substantial beneficial transformations (Zharova and Shikorova, 2019). It is worth emphasizing that the efficiency of transport directly reverberates onto energy efficiency, thereby exercising a direct influence on sustainable mobility.

2. Methodology

The study developed a comprehensive methodology that included a thorough analysis of data and an extensive literature review to identify key trends in the digital transformation of the transport complex. In this study, a mixed–methods approach was used combining qualitative and quantitative methods. The period for the time horizon in this study is cross-sectional. In this study, the author used raw data in the form of questionnaires on Energy and Autonomous Transportation Company. The sampling technique used an intentional sampling method. The author distributes 20 questionnaires from 20 energy and autonomous transportation companies to complete the survey. For this study, surveys and questionnaires were used to gather data on socio- economic characteristics, current state of digitalization and benefits and challenges of digitalization. Descriptive statistics such as frequency distribution and percentage tables were used to analyze the objectives of the study.

3. Result and Discussion

Tale 1 Socio economic Characteristics

	Variables	**Frequency (N=20)**	**Percentage (%)**
Gender	Male	12	60.0
	Female	8	40.0
Education level			
	Technical degree	4	20.0
	B.S/B.A	4	20.0
	M.S/M.A	5	25.0
	PhD	7	35.0
Organization size	< 100 employees	4	20.0
	Medium, 100-500	12	60.0
	Large > 500	4	20.0
Professional Experience	Less than 2	5	25.0
	2-5 years	5	25.0
	5-10 years	8	40.0
	More than 10 years	2	10.0

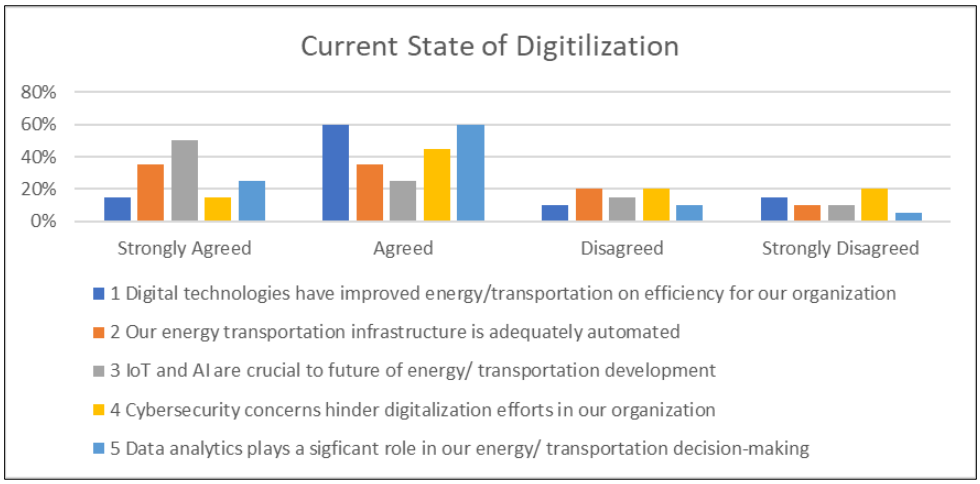

Figure 1 Current State of Digitalization

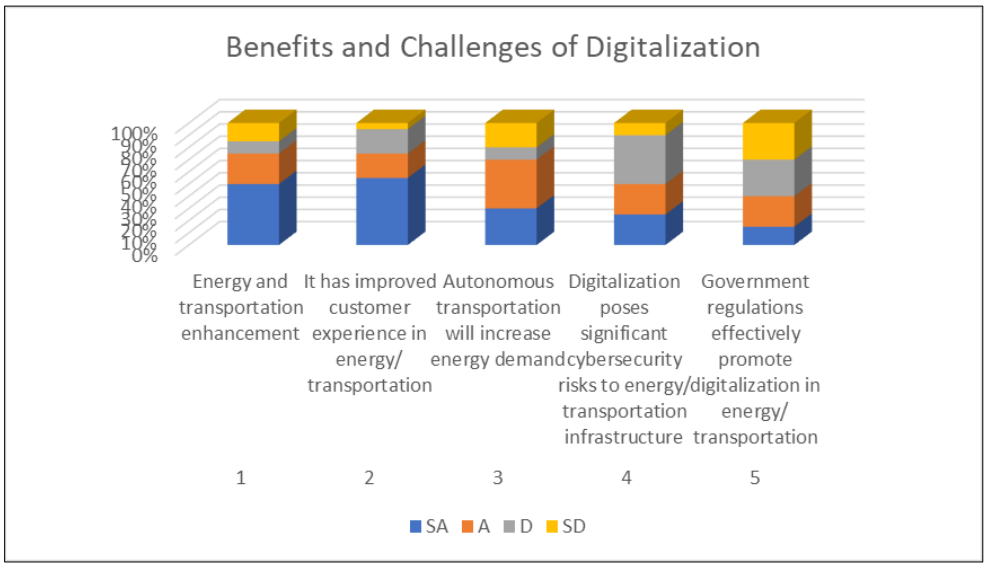

Figure 2 Benefits and challenges of digitalization

The result obtained in figure 1 shows that the majority of the respondents agreed that Digital technologies have improved energy/transportation efficiency for their respective organization. While 10% disagreed with this. Furthermore to the result obtained in figure 1. The result shows that 35% strongly agreed and agreed that energy transportation infrastructure is adequately automated. However, 10% disagree with this fact. Majority of the respondents in figure 1 strongly agreed (50%) that IoT and AI are crucial to the future of energy/ transportation development. The result obtained in this study aligns with that of Kodeli et *al.* (2016); Magomedov *et al.* (2020) where it was also observed that Digital transformation exerts its influence on transport logistics, cargo management, and port and rail infrastructure. By harnessing digital technologies, logistics processes can be streamlined, forecasts and management of cargo flow can be refined, thus yielding a more efficient utilization of resources and a reduction in costs. In addition to the result obtained in figure 1, cybersecurity is believed to hinder digitalization efforts. It should however be known that the utilization of digital technologies empowers the enhancement of route planning, the optimization of freight transportation, and the reduction of transport expenses. This fosters the judicious utilization of resources and the mitigation of adverse environmental impact. Nonetheless, cybersecurity emerges as a salient risk within the ambit of digitizing transport infrastructure. As the proliferation of interconnected devices and data exchanges intensifies, the susceptibility to cyber-attacks commensurately escalates. Violations of data and system security bear the potential for grave consequences, including accidents and the unauthorized disclosure of personal data (Khudy, 2020). The result obtained in figure 2 presents benefits and challenges associated with Energy and Autonomous Transportation. The result shows that majority of the respondents 50% strongly agreed that automation in the transportation industry has brought about enhancement. However, 10% of the respondents disagreed with this while 15% strongly agreed. Majority of the respondents based on the result obtained in figure 2.2 strongly agreed that there has been an enhancement in

energy/ transportation with the aid of digitalization. In the result, 20% of the respondents however agreed and disagreed respectively to this. The major challenge obtained in this study however shows that the Government is trying to effectively promote digitalization in energy/ transportation as 25% agreed to this and thus, didn't see it as a major challenge. However, 30% strongly disagreed and disagreed that the government isn't doing enough.

4. Conclusion

Digitalization in energy and autonomous transportation offers lots of benefits: an enhancement of road safety, the alleviation of traffic congestion, transportation enhancement and the optimization of urban mobility, ultimately culminating in an improved standard of living for urban inhabitants.

Recommendation

For policymakers, it is essential to design effective incentives and mechanisms for data sharing and trading that clearly demonstrate the benefits of collaborative digitization across the energy and transportation sectors. Simultaneously, ensuring data privacy, security, and rights requires regulations that are informed by technological advancements. By establishing balanced regulations, digitalization can be harnessed as a powerful tool for progress rather than a source of complications.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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