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# ICT TOOLS IN FREIGHT TRANSPORT

## Summary of Policy Brief



The integration of information and communication technology (ICT) tools in freight transport has become a pivotal aspect of global logistics, given the rapid pace of industry evolution. In today's globalised market, real-time data exchange is of paramount importance. This policy brief offers an overview of the ICT tools employed in freight transport and assesses the challenges and benefits of implementing ICT tools in freight transport, as well as providing recommendations to overcome these challenges.



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# ICT tools



## Global Positioning System (GPS)

GPS is a space-based navigation system that uses GPS satellites to provide information regarding location and time [1].



## Geographic Information System (GIS)

GIS captures, analyses and presents data related to spatial elements. GIS integration in road freight transport yields improvements in planning, management, and execution and is virtually irreplaceable [1].



## Transportation Management System (TMS)

Transportation Management System (TMS) plays a pivotal role in advancing a more efficient, sustainable, and economical road freight transportation system. TMSs are designed to collect and process information related to transportation activities to perform the functions of flight planning, optimization, control, routing, carrier selection, and contractor selection [2].



## Electronic Data Interchange (EDI)

Electronic Data Interchange (EDI) enables movement of information between stakeholders (i.e., shippers, carriers, customers) with the rapid change and exchange of this information supporting any number of operational processes such as documentation, tracking and compliance management.



## Internet of Things (IoT) and Telematics

The redefinition of the industry through greater deployment of operational efficiency, safety, and real-time monitoring is made possible by the modulation of the Internet of Things (IoT) and telematics in road freight transport.



## Big Data and Analytics

Big data and analytics are transforming road freight transport (RFT), increasing efficiency, sustainability and decision-making ability. Vast data sources are integrated for better traffic modelling, demand forecasting and bottleneck identification for more optimized logistics operation as well as for customer satisfaction [3].



## Blockchain technology

Blockchain technology is shaking up road freight transport with an eye toward efficiency, transparency, and security with shipments. IoT makes it easy for real time tracking and management of the cargo, reducing costs and making the operation better [4], [5].

# ICT tools in freight transport



## Global Positioning System (GPS) and Geographic Information System (GIS)

GPS is a space-based navigation system that uses GPS satellites to provide information regarding location and time. GIS captures, analyses and presents data related to spatial elements. GIS integration in road freight transport yields improvements in planning, management, and execution and is virtually irreplaceable [1].

**Real time tracking:** The implementation of GPS and GIS technology within the transportation industry has been demonstrated to enhance customer satisfaction, safety, and performance. Such technology provides real-time traffic information, accurately estimates the time required for truck transportation, and predicts travel times, thereby facilitating efficient logistics transport [2], [3] [4].

**Reduced delays and costs and efficient route planning:** GPS data provides a basis for understanding the behaviour of urban freight vehicles, assessing optimal loading/unloading zones and reducing fuel consumption. GPS and GIS models aid transport policy makers in creating environmentally friendly systems, promoting sustainable practices and determining efficient logistics strategies [5], [6].

**Managing freight transport systems:** GPS models assess intermodal connectivity and efficiency of different modes transportation. GIS based decision support systems help policy makers analyse socio-economic and environmental factors [7].

## Transportation Management System (TMS)

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**Efficiency and cost reduction:** TMS improves the efficiency and reliability of road freight transport, reducing freight costs and streamlining operations [9]. It automates logistics processes, provides digital platforms for visibility and optimises freight management, driving regional economic growth [10], [11].

**Reliability and Risk Mitigation (RRM):** TMS increases reliability and reduces risk in road freight transport by adapting to the chaotic dynamics of urban traffic, ensuring on-time and safe delivery, and using digital twin technology for real-time monitoring and process adjustments [12], [13], [14], [15].

**User engagement data quality:** Road freight service quality is critical to optimising operations. Inaccurate data entry hinders the effectiveness of TMS. Methods such as Log Evaluation through Operation Sequence Distribution (LEOSD) improves data integrity. TMS applications improve transport coordination, safety standards and logistics management. Real-time monitoring tools improve reliability and performance [16], [17], [18].

## Electronic Data Interchange (EDI)

Electronic Data Interchange (EDI) enables movement of information between stakeholders (i.e., shippers, carriers, customers) with the rapid change and exchange of this information supporting any number of operational processes such as documentation, tracking and compliance management.

**EDI and traffic measures:** EDI optimises road freight transport, supporting traffic management, informed decision making and economic response. It captures truck movement data, integrates GPS and provides essential information on travel times and frequencies [19].

**Freight management digital platforms:** Digital platforms enhance freight management by providing visibility, optimisation and analytics, improving supply chain communication, reducing procedures, optimising resources and increasing transparency [20].

**Economic impacts:** EDI systems adapt freight transport activities to economic changes, maintaining performance and resilience in unstable markets. Combining EDI with digital platforms increases efficiency, market competitiveness and economic flexibility [21].



# ICT tools in freight transport



## Internet of Things (IoT) and Telematics

The redefinition of the industry through greater deployment of operational efficiency, safety, and real-time monitoring is made possible by the modulation of the Internet of Things (IoT) and telematics in road freight transport.

**Improved operational reliability:** The integration of IoT and telematics in freight transportation has the potential to enhance reliability, safety, and environmental support. This is achieved by optimising routes, reducing costs, and monitoring vehicle health in order to identify and address potential issues [22], [23], [24], [25].

**Improved safety measures:** IoT and telematics enhance safety by automatically detecting accidents, reducing response times, and providing valuable insights into driving behavior, thereby enhancing driver training and safety protocols [26], [27], [28].

**Environmental impact management:** Telematics and IoT enable better management of the environmental impact of road freight, reducing CO<sub>2</sub> emissions and contributing to a more reliable, safer and environmentally sustainable freight transport system [29].



## Big Data and Analytics

Big data and analytics are transforming road freight transport (RFT), increasing efficiency, sustainability and decision-making ability. Vast data sources are integrated for better traffic modelling, demand forecasting and bottleneck identification for more optimized logistics operation as well as for customer satisfaction [30].

**Traffic modelling, bottleneck identification and application of AI and data science:** Big data is used in RFT for traffic modelling, bottleneck detection, and AI and data science applications to improve supply chain efficiency and predict future trends [30], [31], [32].

**Customer satisfaction:** Big data and analytics enhance customer satisfaction in road freight transport by improving service quality, operational efficiency, and customer engagement. By integrating analytics, companies can monitor and improve service quality, reduce errors, and enhance customer retention [33], [34], [35].



## Blockchain technology

Blockchain technology is shaking up road freight transport with an eye toward efficiency, transparency, and security with shipments. IoT makes it easy for real time tracking and management of the cargo, reducing costs and making the operation better [36], [37].

**Improved traceability and transparency:** Blockchain technology integrates secure, decentralised systems with real-time data tracking for efficient road freight transport. It reduces fraud, improves accountability and automates processes. Smart contracts automate processes, promoting faster transactions and compliance [38], [39].

**Cost reduction and efficiency:** Blockchain technology increases supply chain transparency, security and efficiency in road freight transport, reducing costs and operational expenses by integrating with IoT for real-time freight tracking and management [38].

**Logistics providers' competitive advantage:** Blockchain technology increases transparency, traceability and operational efficiency in logistics, reducing costs, improving performance and enhancing cargo security, making it a key competitive advantage in the sector [40].

# Benefits of ICT tools in freight transport

## Operational efficiency

The utilisation of novel technology in logistics enables the efficient and cost-effective delivery of goods. In modern economies, the optimal level of inventory is required, as is a standardised logistics chain [41]. The use of ICT in freight transport has been shown to increase productivity, raise safety standards and improve network utilisation, which in turn leads to lower costs and an enhanced service value. It improves the readability and manageability of product logistics flows, enabling managers to identify potential problems and control delivery schedules [42], [43]. Mobile applications enhance communication in warehouses and distribution centres, allowing for greater flexibility and real-time inventory updates [44]. The implementation of ICT tools has a positive impact on operational efficiency and employee efficiency, which in turn enables optimised services to customers [45].



## Cost reduction

ICT tools are employed by the freight transport industry to enhance cost efficiencies and optimise logistics. These tools facilitate the streamlining of delivery schedules, the management of stock levels and enable real-time communication, thereby reducing transportation costs [41], [43]. ICT also assists in route optimisation, which in turn lowers fuel consumption and emissions [46]. AI can optimise delivery routes and assist logistics managers in cost-reduction strategies. These advancements contribute to economic efficiency and sustainability [47].



## Environmental impact

The utilisation of ICT tools has the potential to markedly reduce energy consumption and emissions in the context of freight transport, with a particular focus on CO<sub>2</sub> emissions. These tools can enhance operational effectiveness, reduce greenhouse gas emissions and improve environmental quality [48], [49]. Innovative technologies such as fleet platooning and renewable energy trucks have the capacity to mitigate environmental degradation, although initial costs may impact profitability [50]. A digital information space facilitates the tracking and control of transportation, thereby reducing negative ecological effects [51]. Effective ICT advancements promote sustainable growth in the freight transportation industry.



## Customer satisfaction

ICT tools play an essential role in freight transport, facilitating improvements in customer satisfaction through enhanced service efficiency, transparency, and communication. The implementation of Intelligent Transport Systems (ITS) has the potential to enhance logistics operations, thereby improving both delivery times and the customer experience. The utilisation of social media facilitates customer engagement and comprehension, thereby engendering a more responsive and customer-centric approach to freight services. The integration of ICT applications, such as e-payment and e-traceability, enhances customer satisfaction in e-logistics services, enabling real-time tracking and seamless transactions. The digital integration of contemporary freight transport optimises flexibility, productivity, and customer satisfaction [54]. Advanced algorithms in integrated network models reduce costs, meet service expectations, and improve customer satisfaction in e-logistics [52].



# Benefits of ICT tools in freight transport

## Operational efficiency



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## Environmental impact



The utilisation of ICT tools has the potential to markedly reduce energy consumption and emissions in the context of freight transport, with a particular focus on CO<sub>2</sub> emissions. Such tools enhance operational efficacy, vehicle utilisation, eco-driving conduct, and route selection. For example, the integration of telephone, internet, and mobile phone technologies has been demonstrated to reduce CO<sub>2</sub> emissions by 2.26% and 0.85%, respectively. The introduction of novel technologies such as fleet platooning and renewable energy trucks has the potential to reduce environmental detriment, although initial costs may affect profitability. A unified digital information space ensures constant tracking and control, thereby reducing negative ecological effects. Effective ICT advancements promote sustainable growth in the freight transportation industry.

## Cost reduction



ICT tools are employed by the freight transport industry to enhance cost efficiencies and optimise logistics. These tools facilitate the streamlining of delivery schedules, the management of stock levels and enable real-time communication, thereby reducing transportation costs. ICT also assists in route optimisation, which in turn lowers fuel consumption and emissions. Specialised tools such as FastTRUCK are designed to optimise transport planning, while AI is used to aid in route optimisation. These ICT advancements enable the industry to operate in a more economically efficient manner while meeting high standards of efficiency and sustainability.

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# Challenges of ICT tools in freight transport



## High initial cost

The freight transport sector is facing considerable challenges as a result of the high costs associated with investing in, implementing, managing and maintaining ICT tools [53]. These costs, in addition to the necessity for skilled personnel and the complexities of global supply chains, limit the adoption of these technologies [22], especially for smaller operators and new entrants. The transition from manual to advanced ICT infrastructures is further complicated by the need for real-time data sharing [54], [55]. The regulatory push for digital technologies, such as eFTI standards, further complicates the transition. To overcome these barriers, contingency strategies must be developed within the sector to adapt emerging ICT tools effectively.



## Data security and privacy

The freight transport sector is confronted with significant ICT challenges, primarily due to concerns regarding data security and the inherent complexity of data management. The current generation of wireless public services is characterised by a lack of guaranteed security, which has resulted in instances of data leakage and system failures [56]. The protection of privacy is of paramount importance, and the development of the IoT is essential to ensure its safeguarding. While integrated information systems, such as vehicular ad hoc networks, have the potential to enhance operational efficiency, they also present unique challenges in terms of privacy. It is, therefore, imperative that the industry develops effective strategies to safeguard data and prevent breaches during data sharing [57], [58].



## Compatibility issues

The utilisation of ICT tools in the freight transport industry encounters compatibility challenges, impeding the implementation of efficient traffic management and freight operations. The complex interconnection of freight management systems and ITS represents a significant obstacle, impeding the exchange of data and documentation across different modes of transportation [59], [60]. The advent of new technologies, including the IoT, blockchain, and big data, is vital for the advancement of dynamic city logistics and operational efficiency in freight transport [55]. However, ensuring compatibility and effective utilisation of diverse communication technologies are pivotal for their success [61]. Additionally, changes in regulatory measures and the emergence of innovative technologies present challenges, such as conflicts and incompatibilities in frameworks [48]. The integration of ITS and eFTI regulations emphasises the necessity for interoperability among diverse ICT platforms [62].



## Regulatory compliance

The implementation of ICT tools in road freight transport is constrained by regulatory challenges, largely due to the lack of flexibility inherent in existing solutions. The integration of Big Data and emerging technologies has the potential to enhance compliance and enforcement mechanisms; however, the current suite of tools is not aligned with industry requirements [63], [64]. The complex legal system and dispersed IT infrastructure also present challenges [62]. The advent of transport platforms introduces further regulatory complexity, necessitating a balanced approach to regulate these platforms effectively [65]. ICT tools should be designed with updated governance frameworks to facilitate compliance while maintaining innovation. Strategic approaches, collaboration between technology developers and policymakers, are necessary to facilitate the sector transition into a smooth digital one [63], [64].



## Skill gaps

The road freight transport sector in Europe is confronted with a significant deficit in the competencies of its workforce. In excess of 50% of the sector's 477 million employees lack the requisite modern ICT competencies, including digital skills [66]. This is a matter of particular concern in light of the growing trend of automation and data-driven processes [67], [68]. The lack of training in these competencies hinders operational efficiency [55]. The primary skill gaps are everyday, generational, and workforce skills [69]. In order to address these gaps, companies may wish to consider implementing strategies such as internalising skill development, encouraging employees to pursue advanced degrees, providing tuition assistance, engaging training specialists, hiring qualified new employees, and implementing a hybrid approach [70].

# Recommendations



## Security and Privacy

In the context of the digital age, the protection of personal data and privacy is of paramount importance. It is the responsibility of governments to establish policies and regulations for organisations, including specific protocols for the notification of data breaches and the implementation of corrective measures. The regular auditing and assessment of data security measures is essential for the maintenance of integrity. The collaboration of industry stakeholders and cybersecurity experts is crucial for the advancement of a secure digital future.



## Collaboration with stakeholders

- **Cybersecurity experts:** It is the responsibility of governments and cybersecurity experts to protect ICT users from data security and privacy risks. This can be achieved by implementing robust security protocols and enhancing public awareness. By fostering trust in digital systems, safeguarding economic interests and promoting a resilient freight ecosystem, this collaboration will lead to a more secure and resilient digital environment.
- **ICT providers:** It would be beneficial for governments to engage in collaboration with ICT providers in the freight transport industry. This would facilitate the provision of efficient tools, enable a deeper understanding of the challenges faced, and foster innovation. Such collaboration has the potential to enhance safety, sustainability, and environmental impact, while addressing data security and privacy concerns. Ultimately, this could result in the development of a more connected and efficient transportation system.
- **End users:** The efficiency of freight transport can be enhanced by governments through collaboration with end users and ICT providers. Such collaboration can facilitate the identification of trends and technologies, the creation of innovative solutions, and the fostering of a sustainable, safe, and technologically advanced transportation network.



## Increase capacity and awareness

Understanding ICT tools in freight transport is crucial for stakeholders and policymakers. Education programs, workshops, and advertising campaigns can help raise awareness, leading to cost savings, improved efficiency, and enhanced safety standards. This knowledge also aids in making informed decisions, promoting technological innovation, and ensuring the industry's resilience.



## Reducing emissions

To reduce emissions in the freight transport sector, governments should adopt comprehensive ICT policies, promote the utilisation of intelligent logistics platforms, facilitate real-time traffic monitoring capabilities, employ predictive analytics, implement AI-driven maintenance solutions, develop data-sharing frameworks, provide tax incentives, implement training programmes, adopt intelligent traffic management strategies, and promote electric vehicle routing.



## Reducing initial cost

Governments can reduce the initial costs of ICT tools in freight transport by introducing financial support mechanisms, forming public-private partnerships, and facilitating bulk procurement programmes. These strategies can assist logistics companies in overcoming the initial challenges associated with the adoption of new technologies, optimising operational efficiency, and reducing emissions, thereby driving economic and sustainability progress in the industry.

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