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Enabling Sustainable Freight Air Transport in the Adriatic Region through Development of ICT Platform

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1 ABSTRACT

Freight transport in the Adriatic area suffers from persistent organizational, operational and service barriers and the negative impacts of road transport. Multimodal interventions could reduce CO2 emissions and other impacts, including air and noise pollution, and road congestion. Integrated sustainable solutions can act to improve traffic flow and logistics, and management of goods and tourism supply. Multimodal optimization of road-sea combined transport can be augmented to include air modal share on existing and new routes for sensitive freight with emphasis on yearlong operations.

This paper adresses the need to improve and extend the availability of passenger routes to allow the potential for mixed cargo in the Adriatic with a case study in Italy-Greece transport. Such plans are hampered by the overlong (up to 15 hours) duration of air trips, which could reduce product quality within a few hours after harvest. Fast shipment and delivery of affordable fresh products, such as mozzarella and strawberries is essential, and would benefit from nonused passenger cargo. Fresh products could use available hold space, guaranteeing lower-than-conventional shipping time at affordable price.

The new service would establish new shipping options for fresh products, empowering Italian and Greek local producers. The service will be enabled through an integrated ICT platform that was developed to offer user access (e.g. to information on departure time, load space availability, goods allowed for transportation), and facilitate creation of new market opportunities for fresh producers.

The platform supports the identification of demand and supply (by creating accounts as seller or buyer) and the booking of transport. The platform end user (seller or buyer) can find the proper passenger carrier for shipping fresh products to the airport of origin. Platform design includes Operational (OR) and Non-Operational (NOR) requirements. For assuring traceability and location information, static and dynamic RFID tags and portable RFID readers, as well as GPS devices and/or tracking smartphones and supporting infrastructure were included.

Keywords: sustainable freight transport, fresh products, ICT platfom, air transport, demand and supply

2 INTRODUCTION

2.1 Freight transportation

The current boost in the world economy is partly due to developments and innovations in the transportation sector (Agbo et al., 2017). Freight transportation has been identified as a major contributor to the negative impacts arising from all logistics and industrial activities (Agbo et al., 2017). In view of this, researchers and individual organizations are putting up efforts in finding solutions to the problem. The introduction of multimodal, intermodal and co-modal freight transportation network systems was thought to be means by which the high cost and environmental pollutions from the freight transport sector could be reduced. The efforts can provide partial solutions to the undesirable consequences from the freight transportation sector. However, there exists more to be done, especially regarding reducing the pollutions from the road freight transport sector and this is a major concern to all governments globally. This has consequently led to national and international regulations and policies regarding industrial activities and their pollutions levels (McKinnon, 2016). Industries and researchers are finding better alternatives and strategies to avoid sanctions with regards to environmental and other sustainability issues (Agbo et al., 2017). Achieving economic, social and environmental sustainability is only possible through the integration of the various transportation modes. Interestingly, each transport mode has its own advantage comparatively.

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2.2 ICT based transport applications

The term “Information and Communications Technologies (ICT)” is often used ina broad sense to delineate a set of heterogeneous telecommunication and information technologies that allow for electronic communication, data collection and processing in distribution networks (Black and Geenhuizen, 2006). The extant literature offers different taxonomies regarding ICT adoption in practices. For instance, there have been studies where ICT has been classified into basic and advanced but the criteria for such categorization where not specified (Evangelista et al., 2010). Furthermore, both the works of Marchet et al. (2009) and Perego et al.(2011) classified transport-related technologies into four main types from a commercial“ company” perspective:

(1) transport management applications;

(2) supply chain execution applications;

(3) field force automation applications; and

(4) fleet and freight management applications.

Although offering useful insights, such categories present some overlaps. For instance some supply chain execution applications will have a module designed for transport management, a real-time tracking function in a field force automation application may well be part of a fleet and freight management application.

It is recognised that information and communication technology (ICT) functions like the nerve system of a multimodal transport chain and brings multiple benefits toorganisations by providing real-time visibility, efficient data exchange, and better flexibilityto react to unexpected changes during shipment (Prajogo and Olhager, 2012).Recent developments in the field of ICT such as cloud computing, social networking andwireless communication have further revolutionised the ways information is shared andsupply chains are structured.

2.3 Logistics of Fresh Produce

The development of fresh food e-commerce has provided comfort and convenience for consumers’ daily lives and has modified cold chain management drastically (Ruan and Shi, 2016). However, as foodborne diseases can have a wide influence and reach epidemic speeds of transmission (Gibson et al, 2019), monitoring and managing risks associated with the logistics of fresh produce must be addressed to ensure food safety (Nakandala, 2017). As fresh products are characterized by their short shelf life and perishability, the continued development of fresh food e-commerce also brings new opportunities and challenges to global sustainable development. To reduce produce losses incurred during transport and storage, certain logistic and technological requirements must be met, such as an otherwise controlled atmosphere and this has led to a rise in related costs (Ishangulyyev, et al., 2019).

As fresh products are perishable, their transit time must be strictly controlled. Many scholars have aimed to optimize the scheduling of fresh produce logistics. Cai et al. investigated the effects of freshness-keeping efforts on the supply chain of fresh products and characterized optimal producers’ wholesale price and distributors’ order quantity in decentralized and centralized systems. Blackburn et al. examined supply chain design strategies for perishable products by considering a product’s marginal value of time. Bogataj et al. studied the effects of time, distance, and temperature in a cold supply chain. Based on fresh produce characteristics, carbon-trading behavior, and external environmental factors (e.g., emergency events, weather), scholars have established transportation scheduling models and proposed optimal scheduling and pricing strategies (Mohammed and Wang, 2017).

Food supply chain challenges and opportunities are inherently complex. Each of these involves different levels of social and economic engagement and is characterized by multiple interactions and feedback loops (Nesheim et al., 2015). To cope with the rapidly growing population and the ever-increasing demand for high-quality fresh food, a more advanced transportation system for fresh food delivery is needed, particularly in urban areas (Hsu and Chen, 2014).

3 FRESH WAYS PLATFORM

3.1 FRESH WAYS concept

THE FRESH WAYS project addressed the need to improve and extend the availability of Puglia-Greece routes covered by passengers' airlines. It can be estimated that to reach internal Greek locations from Puglia region by ship, the travel time (port to port) goes from about 7 hours to more than 15 hours, to which it has to be added the time to reach internal destinations. Moreover, some destinations are very hard to reach in adequate time preserving quality of products, as fresh products have to be consumed even a few hours after their harvest in order to fully preserve their organoleptic characteristics. Fast shipment and delivery of fresh products, such as mozzarella on the Italian side and strawberries on the Greek side is essential but, at the same time, the products have to be affordable for the consumers.

On the other hand, airplanes on existing passenger airlines often travel with not fully or not at all used luggage space. In that case, fresh products can be loaded in the hold, utilizing the free luggage space and guaranteeing shipping times lower than when conventional methods are used. When an airplane starts its journey from Italy, there will be "offer" from the Italian side and "demand" from the Greek side. The roles are reversed when the airplane returns to Italy carrying Greek products.

The FRESH WAYS was designed to enhance the supply chain, but to also facilitate the creation of new opportunities in the market between the two countries. This action was accomplished through the development of an ICT platform that enabled the user access to the service (e.g. departure time, load space availability, goods allowed for transportation) and further allowing the execution of pilot actions.

3.2 Platform Demand and Supply

A new service that facilitates the shipment of fresh products between Italy and Greece was established in the FRESH WAYS project. This service empowers Italian local producers to effectively export and transfer their products with fresh value to Greek enterprises and empowers Greek local producers to effectively export and transfer their products with fresh value to Italian enterprises. More specifically, the service was enabled through an integrated ICT platform.

The services of the platform support the identification of demand and supply and the booking of the transport. These services are accomplished in four steps (figure 1). At first, the local producer is able to create a "producer account" and the enterprises will create a "consumer account." Every time that the producer has available products and wants to export them, he can use his account in order to record this offer as a "package" in the platform, providing within this package all the information related to the products and the time window that the products are available for transport. As a next step, the initial matching between supply (producer) and demand (consumer) is taking place, the producer is able to book the airline shipment of the fresh products via the platform, taking into account the agreed time window (day-and-time) of shipment. More specifically, the producer is able to declare his need of shipping his products using his account in the platform again, in order to book some hold space in the airline. Furthermore, the producer can decide on the way to transfer his products from the origin to the "airport-origin". He may choose to transfer his products on his own or to identify the optimal shipper via the platform. In the second case and given the required freight's time arrival at the airport, the producer will declare his need for shipment from his origin to the airport. Finally, the producer is able to book the shipment of his freight from the "airport-destination" to the final destination, where the consumer can finally receive the products.

Additionally, as an option to the end user (seller or buyer), the platform user is able to find the proper carrier for shipping his fresh products to the airport of origin in case the user cannot make the transfer themselves. Similarly, following the arrival of the products to the airport of destination, the user can identify the best carrier to reach the final destination. The core architecture focuses on matching demand and supply for freight transport before and after products are transported by passenger airlines and there are customized matching criteria that optimize the results from the proposed matching for the users.

More specifically, in order for the platform to exhibit traceability features and provide location information to the users, special equipment was used by the involved parties of the supply chain. The necessary equipment involves static and dynamic RFID tags and portable RFID readers, as well as GPS devices and/or smartphones with tracking capability and the supporting infrastructure. If the user selects one of the carriers proposed by the platform, the carrier is able to pick up the freight, place on it an RFID tag, and read the tag

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with the portable RFID reader, thus recording the initial location of the shipment. The carrier can also activate the GPS device or smartphone for tracking his location consistently until arrival at the desired node/hub (e.g. airport) of origin, and for updating the platform accessed by the user. Then, the airport authorities that are equipped with compatible portable RFID readers are able to confirm the products' arrival.

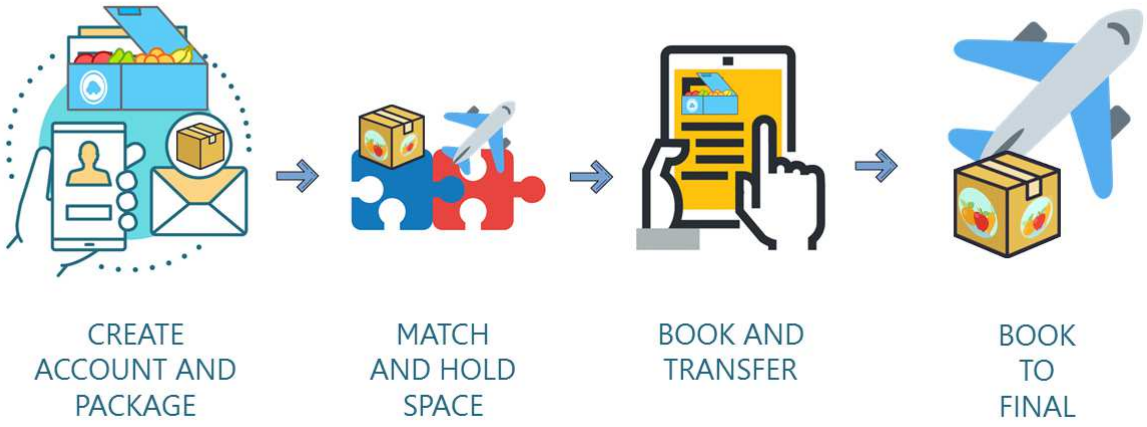

Fig. 1: Four Steps of the ICT Platform Demand and Supply

Customer Requirements
1 The platform must be able to register each client.
a. This will make the customer's future purchases easier. At first login it needs to enter its details in the user registration form.
b. Also, this way the manager has the information of each customer and it will be easier and faster for him to send the products.
2 After completing the form, each customer will be able to log in to the platform and be able to view and purchase any products they wish.
3 After completing the form, each customer will be able to log in to the platform and be able to add to the basket the products they wish to purchase.
4 Quick Product Search:
c. by type
d. by name.
5 Each client user can log out after visiting the platform.
6 The administrator should be able to add a new product to the platform.
7 The data is available - stored in a database on the computer.
8 The platform should be as fast as possible and run on windows.
9 The system can be installed on multiple computers.
10 The data can only be viewed by the administrator from the database with a special code.
11 Software function to be user friendly.
12 The products should be registered in such a way that the inventory manager can be informed daily.
13 Have a password containing digits and usernames.
14 Buttons have icons for convenience.
15 Automatically disconnect from the cart after 5second after ordering.
16 Each user has their own password.
17 The system should isolate and display errors without shutting down. If an error occurs, the system will try to correct it, otherwise the program maintainer will correct it.
18 The user tab contains e-mail, password, address, city, telephone.
19 Have product categories and specific products.
20 Details under the products.
21 Have a newsletter to better inform users.
22 If the customer does not make a connection the customer will not be able to place an order.
23 In case the customer adds a product to the cart:
a. be able to go back and add others and be able to delete products,
b. to add / remove products by selecting pieces,
c. change the price in this case,
d. the cart can be renewed,
e. empty cart,
f. and continue
24 The platform can change language.
25 Enable real-time chat
26 Be able to communicate with the platform administrator
27 Have a help desk

Table 1: Customer Requirements of the ICT platform

4 REQUIREMENTS ANALYSIS

For determining the system requirements, a study is carried out on the needs and requirements of the user and the data are mainly acquired from the feasibility study developed in the FRESH WAYS project. After all the use cases have been formulated and checked as well as the potential problems that may arise, a plan is

created for the design and implementation of the project. A key ingredient for a successful information system in any organization is for it to be user-friendly so, if it is easy to use, customers without special technological know-how can use it.

The recording of requirements is helpful for both those implementing it and for users completing the work requested by the client. Requirements are divided into Operational (OR) and Non-Operational (NOR). Operational requirements are those that describe what the system should do while non-Operational requirements are those that describe the properties that a system should have, for example usability, security, performance, legality and privacy. In order to better organize and serve the customers of a shop of local traditional and organic products it is necessary to implement an electronic platform with the following characteristics as described in Table 1, 2 and 3.

Operational Requirements
1 The platform must be able to register each client.
2 This will make the customer's future purchases easier. At first login it needs to enter its details in the user registration form.
3 In this way, the administrator has the information of each customer and it will be easier and faster for him to send the products.
4 After completing the form, each customer will be able to log in to the platform and be able to view and purchase any products they wish.
5 After completing the form, each customer will be able to log in to the platform and be able to add to the basket the products they wish to purchase.
6 Quick Product Search:
a. by type
b. by name.
7 After each visit to the platform, each client can log out.
8 The administrator should be able to add a new product to the platform.
9 The data can be stored in a database on the computer.
10 The platform should be as fast as possible and run on windows.
11 The system can be installed on many computers.
12 Data can only be viewed by the administrator from the database with a special code.
13 Software-friendly operation with help feature.
14 The products should be registered in such a way that the administrator can be aware of the stock on a daily basis.
15 Automatically disconnect from the cart 5second after ordering.
16 The system should isolate and display errors without shutting down. If an error occurs, the system will try to correct it, otherwise the program maintainer will correct it.
17 The user tab contains e-mail, password, address, city, telephone.
18 Have product categories and specific products.
19 Details of the products below.
20 Have a newsletter to better inform users.
21 If the customer does not make a connection, the customer cannot place an order.
22 In case the customer adds a product to the cart:
a. be able to go back and add others and be able to delete products,
b. add / remove products with item selection, and change the price in this case,
c. the cart can be renewed,
d. empty cart,
e. and continue
23 Enable real-time chat
24 Be able to communicate with the platform administrator

Table 2: Operational Requirements of the ICT platform

Non-Operational Requirements
1 The program should be as fast as possible and run on windows. (Efficiency)
2 It will work on many computers and will be administrator controlled. (Auditability)
3 Each user has their own password and username. (Security)
4 Buttons have icons for convenience. (Usability)
5 Have a password containing digits and usernames. (Security)
6 Will be able to move to any P/C regardless of hardware. (Portability)
7 Must have a help desk (Usability)

Table 3: Non-Operational Requirements of the ICT platform

5 ICT PLATFORM BASIC DESIGN- USE CASE DIAGRAMS

Users of the application are divided into Administrators and Standard Users. A single user can act as both a Buyer Role and a Seller Role. The Use Case Diagrams below show in detail all the actions that users of the application can take depending on the role they play. Note that the following use case diagram describes only the users that will transport their own products to the airport and back.

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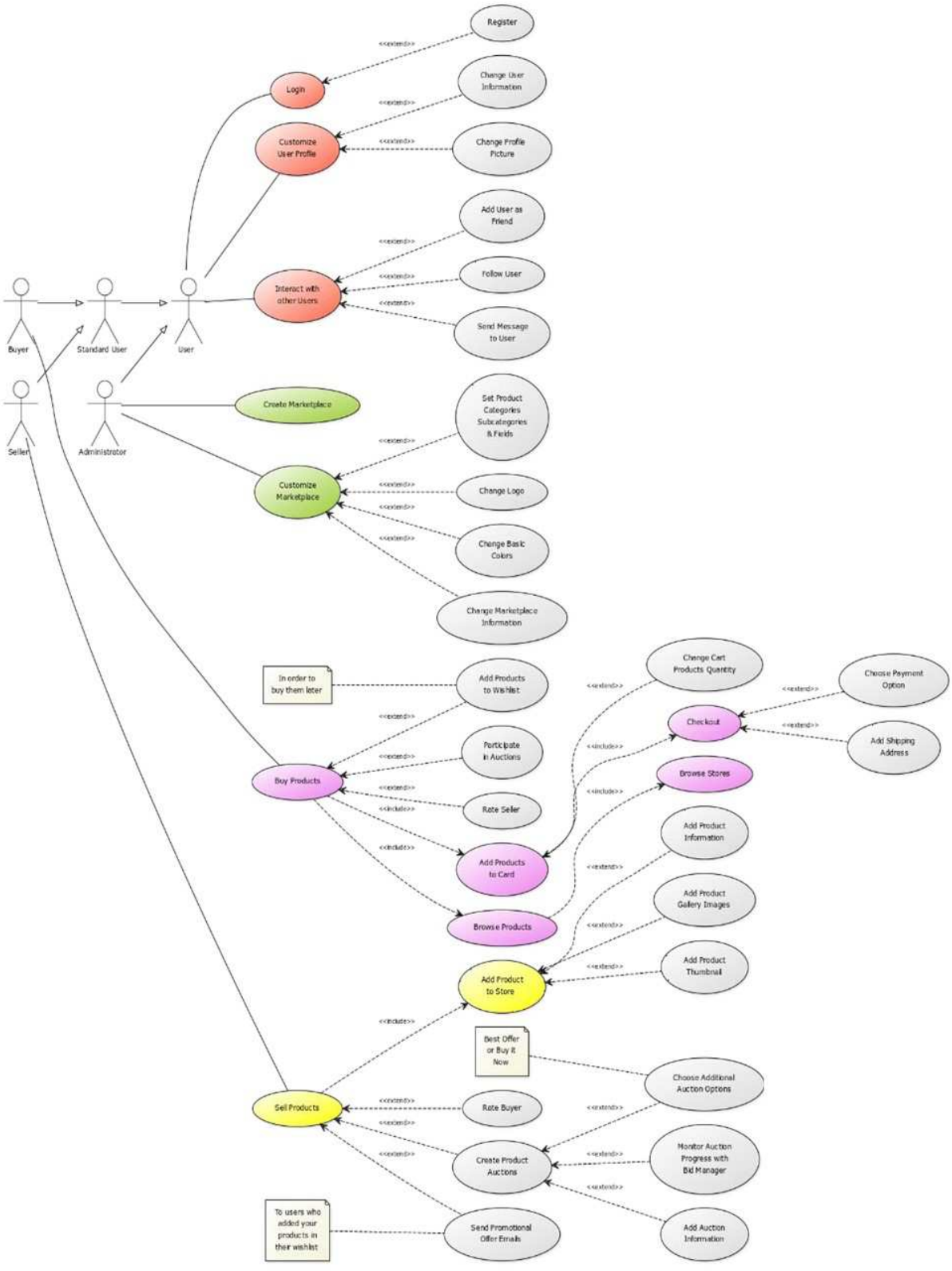

Fig. 2: Overall Application of ICT Platform User Chart (Overview)

6 CONCLUSION

Considering that the current freight transport system in the Adriatic area suffers the persistence of organizational, operational and service-related barriers, FRESH WAYS platform improves these services through its multimodal interventions, thus decreasing the negative impacts of road transport. Behavioral change of stakeholders and increase of their knowledge in green transport policies, relevant mentoring and

funding opportunities, sustainable freight transport and logistics and sustainable connectivity alternatives in Adriatic region through innovative educational approaches can play an important role.

Furthermore, the definition of the digital platform is a fundamental step to guarantee efficient data management, demand/offer matching and logistics, scalability, and traceability. In that regard, some requirements to be satisfied within the management of the whole FRESH WAYS process. The relation between some relevant aspects of some potential mid-term/long-term factors of this process and platform have to be noted in order to understand the impact of the technology enabling the design and implementation process on the macro environment.

Regarding data management, it has to be noted that the appropriate management of data can give an accurate and dynamic representation of demand and supply of fresh products. This issue is also recognised as a fundamental scope of action by the European Commission. Data management through a suitable ICT platform can be used to improve the users' experience and adapt business strategies, in order to foster existing market between the Project Regions and creating new opportunities. However, it is noted that current international policies (e.g. the EU Regulation 2016/679 on General Data Protection Regulation - GDPR) dictate that particular care is paid to data management and related responsibilities.

The scalability is also considered and important factor, since a flexible design of the digital architecture making use of the most recent solutions for access to microservices is a fundamental prerequisite for future extensions and for the inclusion of new services in future phases of the FRESH WAYS project. Furthermore the sustainability is also an important factor, since new technologies to enhance sustainable air transport such as biofuels, electrofuels and e-planes may be expected from progresses coming from on-going research. The FRESH WAYS project and the platform that was developed may offer intermediate steps toward sustainable air transport through the optimization of current resources. This can be implemented with current technology in order to increase the efficiency of air transport in the Adriatic Region with respect to carbon emissions.

The platform, that was created and put into operation, can be adopted and used multimodaly by different countries across the European Union, with minimal operations needed to be done in order to implement trading actions. Moreover, the project encourages related research and technology transfer to other EU countries that intend to innovate on the logistics sector intermodal and multimodal. By adopting innovative logistic technologies more and more small businesses of the agriculture sector could have additional competitive advantages, such as consistency of delivery time, safetyas well as low freight cost. Future studies could expand the scope of the research to include different transportation scerarios and needs to provide further insight.

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