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Smart Mobile Application for Short-Haul Cargo Transportation

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Abstract: Smart service systems have been dealing with various wicked social and cultural problems by providing diverse solutions for society. Cargo transportation is one of the most challenging issues in logistics; in this paper, we explore multiple stakeholders' information environments surrounding containerized cargo transportation by a design thinking approach. Throughout the analysis, the latent problems are summarized in the following two manners: (1) miscommunication with inefficient information flow among multiple stakeholders; and (2) a lack of resource management coordination among service providers. With these two identified problems, the objective of this work is to develop a prototype information and communication technology-based service application for both trucking companies and customers. This work makes two contributions. First, it methodologically proposes a customer-centered design approach for logistics management by adopting a design thinking approach. Second, it suggests a practical ICT-based solution for the mentioned problems.

Keywords: containerized truck transport; service science; smart service systems; design thinking; smart mobile application

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1. Introduction

Nowadays, there is an increasing emphasis on services in many business activities, and organizations have highlighted a customer-oriented approach to developing competitive service systems for better service quality and service innovations. Globalization, technological advances, developments in global economic trends, and Internet of Things (IoT) technologies have connected the world economically, technically, and socially and are transforming the ways of doing things [1]. Hence, the concept of 'service' has become crucial in design models, enterprise strategies, and decision-making processes [2]. The classical definition of a service as an 'intangible good' is no longer valid in itself, and services are more looked at now in terms of service science and management, which have led organizations to understand and manage their abilities to design, improve, and sustain service systems for business and social purposes.

The service science and business community recognize communication among multiple stakeholders as a critical issue in service performance since it has a significant impact on efficiency and competency [3,4]. However, in reality, many service systems still suffer from miscommunications and inefficient exchanges of information. According to Grabara et al. [5], a piece of information is not just abstract data that move between two stakeholders; it is rather a product that has a manufacturer and a recipient with many operations that can be performed on it, such as processing, storage, transmission, exchange, purchase, and sale.

This paper targets the service systems in Egypt in the sector of containerized cargo transportation, which is one of the most used international transportation modes. On land, trucks are the most common transportation mode used to move containers from or to a seaport. These trucks are usually owned by trucking companies or customers; they move through seaport container terminals to pick up or deliver containers. The total global containerized trade has grown by 9% in the last decade [6] and is expected to grow by 3.4% annually over the 2020–2024 period [7]. This growth requires more efficient management and scheduling methods to improve the performance of the whole service system. Since the use of information and communication technology (ICT)-based platforms in that context is still very limited in Egypt; this study tries to make use of a design thinking methodology as a solution-based approach to link an information system (IS) with this service system to transform it into a digital service system by using ICT artifacts. Hence, the main objective of service systems management in this work is to improve value co-creation under a win-win logic in some inter-related processes.

Two main research problems are highlighted in this work:

Research Problem 1: *Inefficient information flow within the service systems.*

In the era of big data, the IoT, and the increasing dynamicity and competition between companies, information flow management has become one of the most crucial factors in management in general. Despite the vast advances in ICT, which enable companies to improve their flexibility, responsiveness, and customer satisfaction, the lack of information exchange within service systems leads to considerable deficiencies in service quality. To this end, ICT can serve as the nervous system that enables information sharing in the service system by creating a suitable IT artifact that enables efficient information flow.

Research Problem 2: *The gap between design science and service science.*

Design science was initially developed in IS and is spreading to service research and operations management. The design focuses on understanding the system and creating artifacts that solve real-world problems [8]. In that sense, design science deals with creating new IS artifacts, and the identified IS artifacts require more knowledge of service science for effective managerial communications and decision-making among multiple stakeholders. However, the number of studies and applications that employ design science in service systems management is very limited [8]. Consequently, deploying the appropriate scientific approach to bridge this gap is essential to the development of an efficient customer-oriented service system.

To deal with these problems, this study focuses on IS concepts to improve the service in the container-trucking sector in Egypt with the following research questions:

Research Question 1: How can design thinking be used to redesign customer-driven processes in container-trucking companies to improve the performance of the service system?
Research Question 2: How can ICT artifacts be used to develop a collaborative tool for container-trucking companies to enhance resources management?
Research Question 3: What information is needed to be shared among the users, and what is the IS structure to be built?

This work aims to apply design thinking in understanding the root causes of the addressed problem and then develop a prototype information and communication technology-based service application for both trucking companies and customers. The results of the design thinking approach show that the main root causes are miscommunication, inefficient information flow, and lousy resource utilization. Based on the interviews with actual users, a customer-oriented design of a smartphone mobile-based application is developed to provide a reliable and interactive ICT-based tool for both trucking companies and customers. The paper makes two contributions; first, it presents a study on service systems and how to develop a smart service system based on a design thinking approach. Second, it proposes a smart ICT-based solution for business-to-business (B2B) and business-to-customer (B2C) problems for container-trucking companies in Egypt. The proposed solution is customer-centered and focuses on shared economy interactions.

The rest of the paper is organized as follows. In Section 2, a literature review is given about the use of IS and ICT applications in service systems. Section 3 describes the problem under study and Section 4 illustrates the design thinking methodology that is followed in this work. Section 5 illustrates the prototypes developed by the research team, and the results of the evaluation stage are given in Section 6. Finally, implications and conclusions are drawn in Section 7.

2. Literature Review on Service Systems

Using ICT in service systems has been receiving increased interest academically and practically. Since the 2000s, many scholars and practitioners have targeted the potential of using ICT to improve management service systems [9,10]. A service can be defined as the provision of assistance and/or expertise through a supplier-customer interaction to create and add value in business, education, health, government, and personal needs [11]. Services can also be regarded as a series of activities where some resources of different types (people, vehicles, machines, etc.) are used to have an interaction with the customers to find a solution to a problem or cover some needs [12]. Today, service systems are knowledge-based and customized depending on customer participation and interaction. Spohrer et al. [2] defined service systems as value-co-creation configurations of people, technology, value networks that connect internal and external service systems, and shared information.

As anticipated, enterprises and customers are involved in complex service systems, interacting together in the market to achieve the desired outcomes for both parties. There is a strong need for smart service systems based upon ICT to create some basis for systematic service innovation in complex business environments [13,14].

Many researchers have tried to take steps towards using ICT and IS methods to develop and manage smart service systems. Barratt [15] identified information exchange between different actors in a system as a significant element at the collaboration level. Barut et al. [16] proposed a measure for the degree of integration in a service system structure from an IS perspective. They emphasized the importance of such integration in both directions: suppliers and customers with several factors that influence the success of this implementation; social and organizational complexities are critical factors that sometimes lead to a failure in the IT implementation. Choy et al. [17] studied the status of using IT in logistics services in Hong Kong from a market-based view and a resource-based view for three technologies: ICT, logistics information systems, and business intelligence. One of their most important findings was that more money should be invested in having and managing new ICT infrastructure to deploy ICT solutions collaboratively in the service system.

The relationship with customers is an essential aspect of service systems. Payne and Frow [18] identified the information management process as one of five key cross-functional processes for customer relationship management (CRM). They argued that data and information should be used as a tool to understand customers, co-create value with them, and build consistent customer relationships. They suggested using the means of IT to achieve these goals by highlighting front-office applications that involve directly interfacing with customers. Ye and Wang [19] performed a study on 141 Chinese manufacturers to study the relationship between IT alignment, information sharing, and operational performance. They found that IT alignment is more beneficial for customer responsiveness, while information sharing is more useful for cost efficiency.

Prajogo and Olhager [20] showed that both information and material flow integration have significant effects on service system performance. They described two aspects of information exchange: the hard aspect (i.e., information infrastructure) and the soft aspect (i.e., building good communication and trust). Baihaqi and Sohal [21] showed that integrated ICT methods have a positive effect on the intensity of information sharing. They concluded that information sharing is essential but insufficient to improve the overall supply chain performance. Jonsson and Mattsson [22] argued that, in distribution networks, the value of information sharing is higher. Gonzalvez-Gallego et al. [23] collected data from 102 firms in Spain and Portugal and performed a hierarchical multiple regression analysis to test the effects of using ICT and IS integration in the service system. Based on their results, they suggested that firms should invest in ICTs to improve their external and internal performance. They also found that information sharing is very useful for suppliers and customers and will lead to stronger relationships and, hence, stronger performance and competitiveness.

Research on using web-based systems in service systems is relatively limited. Stefansson [24] highlighted the role of using the Internet in service systems, especially in small and medium-sized enterprises (SMEs); they stated that the advantages include reliability, a low cost, and accessibility, while the disadvantages include concerns about security and authentication. However, these concerns have been significantly reduced now with advanced security techniques. Helo et al. [25] presented web-based logistics management software that supports the modeling and analysis of supply-demand networks. They argued that such systems could increase the responsiveness and competitiveness of the supply chain service system. They also stated that the business environment is transforming from being production-centric to be information and customer-centric.

Service provider selection in service systems has recently received attention in academic research. Aguezzoul [26] identified eleven criteria for third-party logistics (3PL) selection; ISs form one of the main criteria, as they can be used to facilitate communication with customers, information sharing, security, and accessibility. Less research targets the use of IT in resource allocation and sharing among suppliers. Sanders [27] identified two patterns of ICT use: exploitation (improving the current methods); and exploration (finding new methods). They found that exploitation affects the operational coordination while exploration affects the strategic coordination. They suggested that suppliers should use both patterns to maximize the benefits of using IT in service systems.

From the literature review, smart service systems may be designed for wise and interacting management to enable easy reconfiguration and achieve higher satisfaction for all the involved participants. Hence, interaction is the core of smart service systems; meanwhile, interaction is a central issue in design science [15,28], and that is why this approach is well-suited for designing a smart service system. Smart service systems enable connections and interaction among all the involved parties within a service exchange and employ technological infrastructure that provides communication channels for B2B and B2C situations. Smart service systems have to deal with actors' behavior, expectations, needs, and actions to develop and configure smart supply chains.

3. Cargo Service Transportation Systems

Throughout its history, Egypt has been a strategic location from a logistics perspective. This is due to its unique geographic location that mediates Europe, Africa, and Asia, in addition to the strategic importance of the Suez Canal to world trade [29]. Containerized cargo transportation is a vital sector in Egypt; it is one of the fastest-growing business sectors. Yet, this business encounters many problems due to the increased demand for raw materials and semi-finished and finished products. Typically, imported containers are received at seaport container terminals (CTs) to be delivered by the trucking companies to the customers. In the opposite direction, exports are delivered to the CTs using fleets of road trucks that belong to trucking companies. Figure 1 depicts the containerized cargo basic supply chain. As the size of containerized cargo trade increases, the complexity of the decision problems increases in such a way that motivates researchers and practitioners in this business to develop innovative solutions to provide smart services. The focus in this study will be on the depots–customers link.

From an academic and practical perspective, there are three issues related to the containerized cargo transportation sector in Egypt. These problems can be classified according to the problem space in three categories: the customer-related problem, the organization-related problem, and the technology-related problem. The first problem is that customers experience long delays and waiting times to receive or deliver their containers through this chain. Secondly, for the organization-related problem, the service providers face a utilization problem for their resources that can have a negative effect on their profitability. Thirdly, for the technology-related problem, many transactions are still performed through traditional systems where much paperwork is done between customers and service providers (trucking companies and the seaport container terminal). This paper focuses on the previously mentioned problems in the inland container supply chain, i.e., where containerized cargo flows through several nodes to reach the designated container terminal.

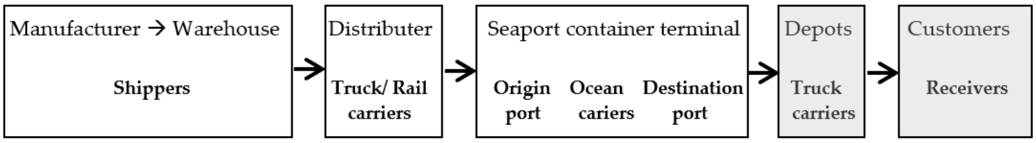


Figure 1. The typical supply chain for containerized cargo.

4. Methodology

To study the previously stated problems, a build-and-evaluate loop is adopted based on a design science research approach [30]. The design science community has sought to more deeply understand human aspects and values in synthesizing new features and functions of IT artifacts [31]. In this work, a design thinking approach is proposed as a research methodology to identify the main features and functions that can define a smart service transportation system in Egypt [30,32–34]. Based on the research gaps, our research objective is to develop an innovative ICT-based design application that can improve cargo transportation through better communication between different stakeholders. Drawing on this consideration, a design thinking approach was adopted as a design science methodology [35].

Using the design thinking approach, two main issues were elucidated. The first one is related to customers who need supporting tools to help them select a suitable trucking company and track their cargos. The other is related to trucking companies who want to increase their service performance and customer satisfaction and have better management of their resources in the most profitable way. On these two issues, a series of prototypes were synthesized: conceptual, procedural, behavioral, and appearance [36]. As a result, a web-based platform was developed as the design solution by the design thinking approach. The design solution went through usability testing by potential actual users, and their feedback and evaluations were reconfigured in modifying the features and functions [37]. Figure 2 illustrates the adapted design science approach that was followed in this work [30,33,36].

In the first stage, a set of problems were defined by understanding the actual stakeholders in the Egyptian cargo, technologies, and interactions in the given information environments of Egyptian cargo transportation service systems. After identifying the problems, a series of knowledge-sharing and creation processes were applied to elucidate latent issues and challenges for each problem to identify business opportunities from the design. The fundamental desires and needs from the information environments were then analyzed using qualitative and quantitative techniques.

To develop a smart service system as a design solution, a series of prototypes were developed reflecting on the business and multiple stakeholders' requirements. To satisfy the users' needs, several usability tests were conducted in the user-based build-and-evaluate cycle.

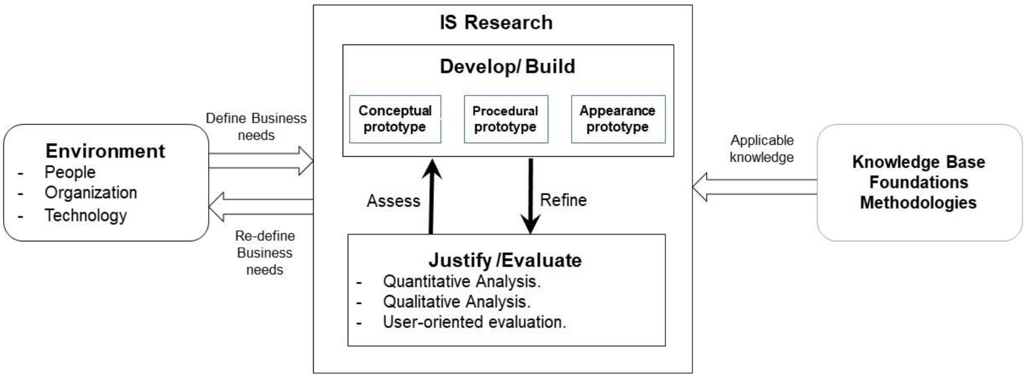


Figure 2. Methodology for developing the ICT-based application for cargo transportation.

4.1. Understanding the Ecosystem

To simulate the identified set of problems, a 3D model of the containerized cargo logistics was developed to visualize all the components and interactions among the engaged stakeholders. The typical procedure to deliver/receive containerized cargo is as follows: customers are informed of the expected arrival time of the vessel at the terminal, and, by that time, customers start searching for one or more trucking companies, contacting the company, negotiating the details of the delivery, and placing the order. Once the order is confirmed, the trucking company contacts the seaport to obtain an appointment to visit the terminal to deliver or pick up the container.

The main stakeholders are the customers (importers/exporters), the trucking companies, and the container terminals. Hence, there are two main types of interactions between the three stakeholders: the first interaction is between the customers and the trucking companies; the second interaction is between the trucking companies and the container terminals. By investigating these two types of interaction, it was concluded that the main problems are due to the first type of interaction for the following reasons: firstly, the delivery delays between customers and trucking companies can be estimated in days of transaction and order processing, while in the second type of interaction the delay is estimated by hours or even minutes due to the seaport's congestion, traffic, and container handling processes. Secondly, the transactions between the CTs and the trucking companies are performed under strict regulations and procedures in contrast with the transactions between the customers and the trucking companies, where more document work and communications are needed to perform the service. Hence, this work focuses on the first interaction loop of the trucking service problem related to the containerized cargo transportation performed by the trucking companies to serve the end customers. After defining the problem environment, including the stakeholders and related processes, an ideation process is adopted to identify the business needs according to the framework suggested by Hevner et al. [30,33].

4.2. Relevance/Business Needs

In this stage, an ideation process is performed through brainstorming activities to clearly set the problem statement and identify the root causes of the problem and the real business needs of the stakeholders. As illustrated earlier, the main obstacles that face the stakeholders are:

- Customers experience a long delay time in the transportation of containerized cargo from/to seaport container terminals.
- Trucking companies are poor at utilizing their resources (trucks and drivers).
- Both stakeholders still use conventional procedures to handle the delivery process.

After defining the problems clearly, the brainstorming activity is continued to dig deeper for the main root causes of the problems under consideration. The results of this activity were the main factors behind the abovementioned stakeholders' unfulfilled needs.

4.3. Causes and Factors

The ideation stage led to a deeper understanding of the problem's nature and its causes, and the affecting factors. It is important to identify and evaluate the relations between these causes and to define factors with the most dominant effect on the defined problems. For this endeavor, an insight matrix was used to visualize and analyze the correlation between the various causes and factors [38]. The insight matrix is a symmetric clustering matrix used to cluster entities based on their relations. To build the matrix, the research team interviewed fifty stakeholders in containerized cargo transportation. The objective of the interviews was to extract the key factors that affect on the short-haul cargo transportation that connects ports and customers by using trucks.

To understand how these different factors are related to one another, the team ran the list through a symmetric clustering matrix to score each relationship between factors on a scale from 0 to 3, with 0 indicating the weakest relationship and 3 indicating the strongest one. After scoring each relationship, the matrix was sorted to visualize the factors' clusters. Color coding was used by giving lighter shades for lower scores and darker shades for higher ones.

Figure 3 shows the originally developed matrix, and Figure 4 shows the matrix after sorting the problem items according to the strength of their correlation. As a result, information flow and communication between customers and trucking companies were found to have the most significant impact on the problem among all other factors.

	Truck Co. fleet size	Truck speed	Delivery schedule	Container location	Road traffic level	CT congestion	Truck no-shows	Other companies walk-ins	Trucks availability	Using appointment system	Information flow	Container terminal regulations	Communication among stakeholders	Driver availability	Appointment conflicts	Type of cargo	Customer Needs
Truck Co. fleet size	3	0	2	1	2	1	0	0	1	0	1	1	3	0	0	0	2
Truck speed	0	3	2	2	2	1	0	0	0	0	0	1	1	1	0	0	1
Delivery schedule	2	2	3	2	3	1	2	1	3	2	3	2	3	2	2	1	3
Container location	1	2	2	3	1	0	0	0	0	1	2	1	3	0	0	0	0
Road traffic level	2	2	3	1	3	0	1	2	1	0	1	0	2	1	0	0	2
CT congestion	1	1	1	0	0	3	0	2	1	2	2	2	3	1	2	1	1
Truck no-shows	0	0	2	0	1	0	3	0	2	1	3	2	3	3	2	0	1
Other companies walk-ins	0	0	1	0	2	2	0	3	0	3	3	2	3	0	3	0	1
Trucks availability	1	0	3	0	1	1	2	0	3	1	3	0	3	2	2	0	2
Using appointment system	0	0	2	1	0	2	1	3	1	3	3	3	3	0	3	1	2
Information flow	1	0	3	2	1	2	3	3	3	3	3	2	3	3	3	3	3
Container terminal regulations	1	1	2	1	0	2	2	2	0	3	2	3	2	0	1	2	2
Communication among stakeholders	3	1	3	3	2	3	3	3	3	3	3	2	3	3	3	3	3
Driver Availability	0	1	2	0	1	1	3	0	2	0	3	0	3	3	0	0	1
Appointment conflicts	0	0	2	0	0	2	2	3	2	3	3	1	3	0	3	0	2
Type of cargo	0	0	1	0	0	1	0	0	0	1	3	2	3	0	0	3	1
Customer Needs	2	1	3	0	2	1	1	1	2	2	3	2	3	1	2	1	3

Figure 3. Insight matrix before sorting based on the strength of the correlation between the factors.

	Road traffic level	Trucks availability	Driver availability	Truck Co. fleet size	Truck speed	Container location	Appointment conflicts	Delivery schedule	CT congestion	Truck no-shows	Other companies walk-ins	Information flow	Communication among stakeholders	Type of cargo	Customer Needs	Using appointment system	Container terminal regulations
Truck speed	2	0	1	0	3	2	0	2	1	0	0	0	1	0	1	0	1
Truck Co. fleet size	2	1	0	3	0	1	0	2	1	0	0	1	3	0	2	0	1
Road traffic level	3	1	1	2	2	1	0	3	0	1	2	1	2	0	2	0	0
Container location	1	0	0	1	2	3	0	2	0	0	0	2	3	0	0	1	1
CT congestion	0	1	1	1	1	0	2	1	3	0	2	2	3	1	1	2	2
Container terminal regulations	0	0	0	1	1	1	1	2	2	2	2	2	2	2	2	3	3
Delivery schedule	3	3	2	2	2	2	2	3	1	2	1	3	3	1	3	2	2
Truck no-shows	1	2	3	0	0	0	2	2	0	3	0	3	3	0	1	1	2
Other companies walk-ins	2	0	0	0	0	0	3	1	2	0	3	3	3	0	1	3	2
Trucks availability	1	3	2	1	0	0	2	3	1	2	0	3	3	0	2	1	0
Using appointment system	0	1	0	0	0	1	3	2	2	1	3	3	3	1	2	3	3
Information flow	1	3	3	1	0	2	3	3	2	3	3	3	3	3	3	3	2
Communication among stakeholders	2	3	3	3	1	3	3	3	3	3	3	3	3	3	3	3	2
Driver Availability	1	2	3	0	1	0	0	2	1	3	0	3	3	0	1	0	0
Appointment conflicts	0	2	0	0	0	0	3	2	2	2	3	3	3	0	2	3	1
Type of cargo	0	0	0	0	0	0	0	1	1	0	0	3	3	3	1	1	2
Customer Needs	2	2	1	2	1	0	2	3	1	1	1	3	3	1	3	2	2

Figure 4. Insight matrix after sorting to generate patterns (clusters) of factors.

5. Design Phases

After analyzing the problem and its causes, a customer-oriented solution was developed and evaluated. In this stage of design thinking, customers' needs were obtained by interviewing personas, who are representatives of the stakeholders [39,40]. The chosen persona from the customers expressed their real need to control their cargos, and confirmed that the communication between the stakeholders in this service sector in Egypt needs to be more organized. On the other hand, the persona from the trucking company complained about the uneven demand throughout the year, which led to inefficient management of resources. We made a list of the users' needs, and each need was used to define a function that users can use in the proposed ICT-based artifact. The artifact was developed by adopting a series of design phases, starting from the conceptual prototype and ending with the appearance prototype.

5.1. Conceptual Prototype

In design thinking, the conceptual prototype is the first phase of the design development [36]. Figure 5 illustrates the UML activity diagram for the system, where V2V denotes vehicle-to-vehicle and V2I denotes vehicle-to-infrastructure communication in intelligent transportation systems.

Table 1 illustrates the conceptual prototype. This prototype can increase customers' satisfaction by providing an effective tool to finish the transaction in a short time with higher information-sharing levels among all parties. Customers can use this system to make their transactions online and in a flexible way. On the other hand, it enables the trucking companies to increase the service quality and to reduce the transportation costs by improving the resources' utilization via getting the best use of information about the resource availability of other companies; this helps to build a collaboration based on a "sharing economy" in this business. The proposed ICT-based artifact is a web application that enables information sharing and communication as a smart transaction platform for customers and trucking companies.

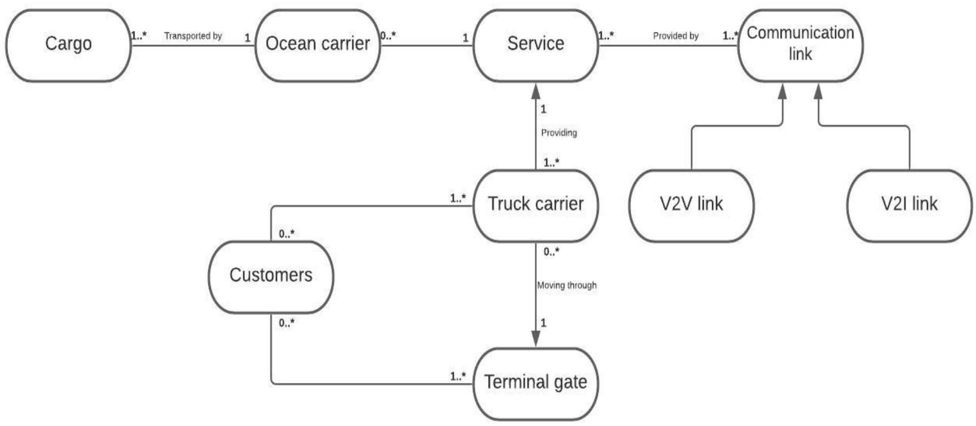


Figure 5. UML activity diagram for the system of cargo transportation (* denotes many).

Table 1. Conceptual prototype of the proposed system for cargo transportation.

What is it? A web app to gather and share information between customers and trucking companies and achieve online cargo transportation transactions.
How does it work? A database of trucking companies will be built. Customers can access the database through the website to select a service provider among many alternatives. Customers are able to make orders and track their cargos. Trucking companies are able to share information about their resources with other trucking companies.
Who are the users? Customers and trucking companies.
What are the targeted business needs? Reducing the cargo delays via easing information flow. Achieving better communication between customers and trucking companies. Building a collaboration platform for the companies. Increasing the resourse utilization for the trucking companies.

5.2. Procedural and Behavioral Prototypes

The IS architecture should be designed for smart service systems in a customized way that can differ from one organization to another. In this phase, a questionnaire and a survey were designed and used in a large Egyptian company for logistics services to identify their actual needs. After that, a preliminary information architecture of the system was developed (Figure 6). Customers can use the website to search for the companies that can transport their containers. Basic information about the companies will be provided, such as location, contact information, and fleet size and specification. The website offers many alternatives so that the customer can decide which company best fulfills his needs. Once the customer selects the appropriate company, he can make a reservation. The trucking company receives this reservation and assigns the truckers and drivers. Customers can track their cargo's status from the confirmation of the reservation to the delivery's completion at the destination.

Through the website, the trucking companies can offer their resources (trucks and/or drivers) to other companies to be shared when they are idle. Other trucking companies can find trucks or drivers to compensate for any lack in their resources.

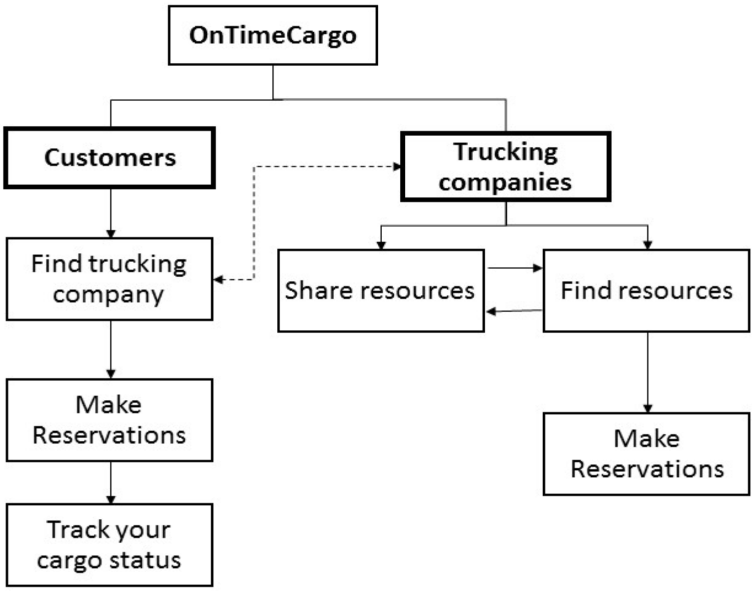
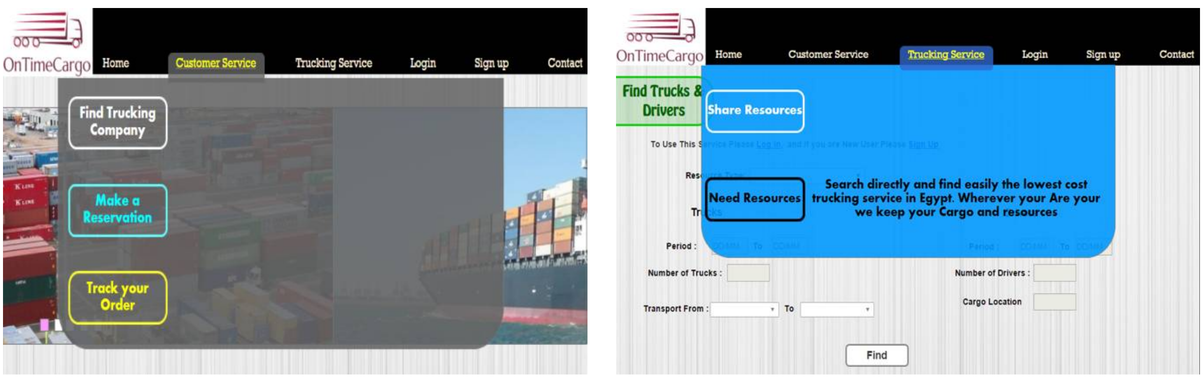


Figure 6. Information Architecture (IA) of the proposed system for cargo transportation.

5.3. Appearance Prototype

The final phase of the design is the appearance prototype [36]. Users can access the developed web application by using personal accounts. The web application provides services for customers and trucking companies. Customers can receive the service on three levels (Figure 6): searching for trucking companies, making a transportation order, and tracking their orders. The web application uses a search engine that asks the users to provide some key information before the search starts to provide suitable results. This key information, such as the location of the user, the cargo type, the required truck capacity and specifications, and the cargo's final destination, is the input for the data processor to find suitable results for the users.

The system provides a smart trucking service for the trucking companies as a solution to resource utilization problems. Trucking companies can now share their idle resources with other companies. The costs of hiring trucks or drivers are included to enable the comparison among different alternatives. If a trucking company has some shortage in its resources, this company can acquire resources from the shared ones. This service website is supposed to enhance the communication and interaction among stakeholders and is designed to be user-friendly. Figure 7 gives some real photos from the developed website.



(**a**) (**b**)

Figure 7. Appearance prototype of the proposed web-based system for cargo transportation; (**a**) Customer service menu; (**b**) Trucking service menu.

6. Evaluation Stage and Results

To evaluate the developed solution, a user-oriented activity was conducted, and the feedback was analyzed. This experiment gave the users the chance to interact with the developed website, and we then interviewed them to obtain their feedback. During the evaluation activities, the users used laptops and smartphones to try the services provided by the website. After that, we conducted a set of interviews to derive the impressions from users about the website's purpose from one side and the website's main features from another side. By analyzing the results, we found three main issues. Firstly, not both customers working with containerized cargo and customers working with un-containerized cargo experience the problems of miscommunication and information flow. This, in turn, widens the scope of the website to incorporate all cargo transportation services. Secondly, cargo transportation companies are experiencing the problem of empty trips where an empty truck may travel a very long distance without any load. This leads to a big increase in transportation costs due to the low number of value-added trips, and to a reduction in the percentage of resource utilization. This issue was considered during the improvement cycle of the developed prototype, where a smart feature was added to the newly developed application in order to consider cooperation among the trucking companies to share trips. Thirdly, most of the interviewed users showed their desire to use this service by using a mobile application rather than using the web application. This gives more technological flexibility and more opportunities for people to use the application anywhere. Figure 8 illustrates the newly improved IA for the developed application after considering users' feedback. It is illustrated that the users' needs are incorporated into the new design as smart features.

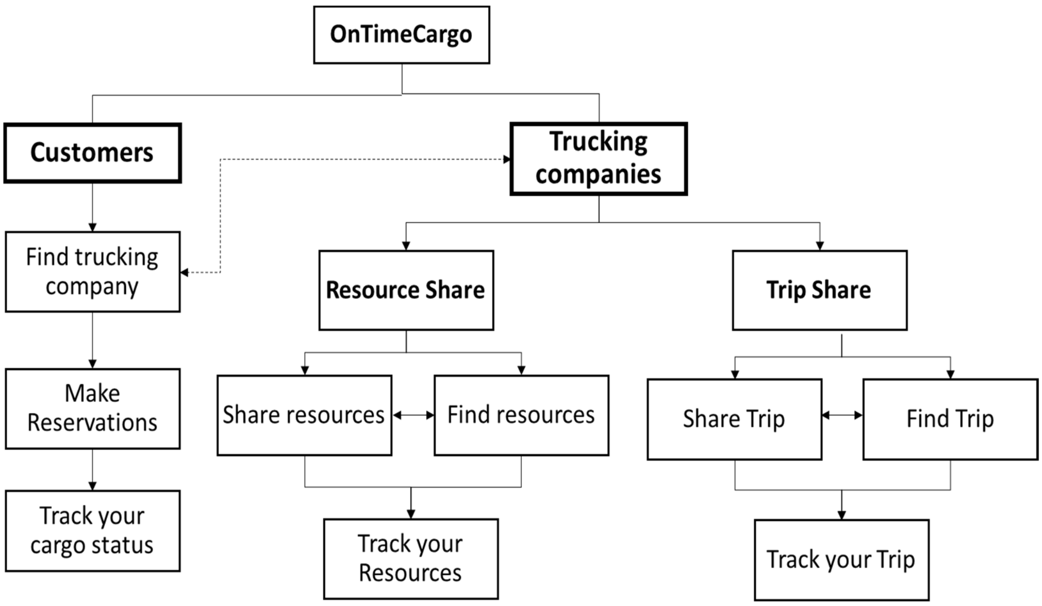


Figure 8. Improved information architecture (IA) after considering users' feedback.

The proposed solution was re-considered according to the above findings, and a user-oriented design for a smart information system was adopted. A prototype of a smartphone mobile-based application was developed to provide a reliable and interactive ICT-based tool for both trucking companies and customers. Figure 9 shows the application interface that provides a booking function for customers to enable them to select a suitable trucking company, reserve trucks online, and track their orders and cargo's status. The proposed application enables trucking companies to receive and manage orders and share their unutilized resources (trucks/drivers) with other companies. Another smart feature was added to the application where trucks with the same destination can share one or more trips. This smartphone application is expected to increase the satisfaction of customers and trucking companies.

Figure 9. Appearance prototype of the proposed smartphone-based system for cargo transportation.

7. Implications and Conclusions

Egypt is one of the most critical global logistics hubs. Accordingly, containerized cargo transportation is a significant sector in Egypt, yet it encounters many problems. For example, customers experience long waiting times to receive their cargos. Moreover, the service providers find difficulty maximizing the utilization of their resources and achieving more satisfaction for their customers. In this paper, a design thinking research approach is used to study these problems, and the results show that the root causes are miscommunication, inefficient information flow, and poor resource utilization. A solution was introduced by developing a web-based platform that enables both stakeholders and users to tackle these problems. To evaluate the developed solution, a customer-oriented activity was conducted, and the feedback was analyzed. It was found that the web-based application does not seem to be the most appropriate solution to be used in such a dynamic environment. As a result, a mobile-based application was developed to fit the users and fulfill their technological needs.

The proposed solution was re-considered according to the above findings, and a customer-oriented design for a smart information system was adopted. A prototype of a smartphone mobile-based application was developed to provide a reliable and interactive ICT-based tool for both trucking companies and customers. The application provides booking and tracking functions for customers and order-processing and resource-sharing functions for trucking companies. Another smart feature is added to the application where trucks with the same destination can share one or more trips.

From a service science perspective, it is concluded that the used thinking approach is effective for developing both information-based and technology-based service artifacts. In addition, design thinking is a customer-based build-and-evaluate process in which the customer is the main target. The developed prototype in the paper also introduces the new concept of service sharing, where users can share their resources (trucks/drivers) and orders (empty trips).

This work emphasizes that gaps between stakeholders in a service system can be filled by employing suitable ICT tools. The novelty of this work is that it integrates design thinking and ICT to create an innovative prototype that can be used practically in short-haul cargo transportation. Such prototypes can be a cornerstone in facilitating communication between different stakeholders and can be looked at as a design blueprint for using ICT in service systems for design and planning purposes. A possible extension of the solution proposed in this work may be in widening the problem's scope to include crowd shipping, in which parcels and passengers are co-transported along a trip that was intended to be made for another purpose [41].

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