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Optimization (automation) of transportation and storage of finished product in industrial enterprises

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Abstract

Firms must recognize that competitive advantage can be gained through either lower product and/or service costs or commodity and/or service distinctiveness throughout terms of functionality and capabilities. A modern ecosystem necessitates not only the quality of a product, but also a timely reaction to a client request in terms of product availability and delivery. Logistics is now part of a broader concept known as supply chain management, which combines operations with intra-firm and firm-to-market communications systems, as well as a firm's technical team. Warehousing is considered an integral part of a company's logistics system, which acts within both the production of raw materials, elements at the point of origin, as well as finished products at the point of consumption (Min, 2015). Expecting to receive (materials, quality and variety guarantees of those components), prepackaging, putaway (sending materials from point of receipt to area of storage), cross docking (receiving bulk consignments, dividing them into smaller orders, packaging and shipping), and unitizing all were traditional storage of goods or storage capabilities (merchandise packaging in shipping containers, order accumulating by outbound carriers). Transportation of finished products and raw materials are also highly important to accomplish the logistics operations' performance.

The current study aims to investigate the major factors that lead to both warehousing and transportation operations' performance, while at the same time employs multi-criteria decision-making (MCDM) approach to optimize the decision-making in warehouse types and transport modes in the context of cement industry. In the next stage, technology acceptance model (TAM) is employed to justify firm employees' (managerial and operational levels) desire to use new technology in regards of automation of processes of sales/marketing-to-manufacturing-to-warehousing-to-deliveries. In analytical hierarchy process (AHP) part of the analysis, 8 experts are selected from local company in Azerbaijan, while in the TAM analysis, 15 employees are involved. The measurement model is analyzed and by using the Pearson correlation analysis, the significance of relations between TAM variables are identified. Finally, based on the results, key findings are discussed and recommendations are given.

Keywords: Transportation, warehousing, AHP method, TAM model

1. Introduction

Customer awareness towards the term ‘value’ has risen as a result of the recession in many markets, paired with new sources of competition. In today's world, ‘value’ refers not just to monetary worth – though that is undoubtedly an important factor in many purchasers’ purchasing decisions – but also to perceived advantages. Customers are increasingly seeking higher-value items at cheaper prices, and the new competitive imperative is to figure out how to do just that (Waters & Rinsler, 2014). Companies must understand that the competitive success or advantage could be achieved either through reduced costs of products and/or services provided, or through product and/or service differentiation in terms of functionality and features (Porter, 1985). These are also called perceived benefits, which may include tangible aspects of products. In proceeding years, product and service-related benefits were not solely based on the price of a product or service, but also customer’s cost of ordering, carrying inventory, and transaction-related costs. In this regard, better management of logistics and supply chain enable companies to gain competitive advantage, which leads to better product development practice, usage of information systems (IS) to manage transportation, warehousing, and optimization of products, as well as effective marketing planning. Henceforth, modern ecosystem demands not just the superiority of a product, but also quick response to a customer requirement in terms of availability and delivery of a product. Logistics, according to the Council of Logistics Management (1991), is “*a component of the supply chain process that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customer requirements.*” Johnson and Wood’s concept (quoted in Tilanus, 1997) interprets logistics, inbound logistics, materials management, physical distribution, and supply chain management as “*five crucial core words.*” Logistics involve the whole process of products or materials moving into and from a company. In the context of materials, materials are moved into a company from suppliers, where physical distribution is generally emphasized. It is particularly important in distributing end products to customers. Henceforth, logistics become a part of a wider concept, so-called supply chain management, which connects logistics with intra-firm and firm to market, as well as firm to customer communications network, as well engineering staff of a company (Tseng et al., 2005). The authors highlight that logistics would be unable to fully exploit its benefits without well-developed transportation infrastructure. Furthermore, a competent logistics transportation system may improve logistical efficiency, save operating costs, and improve service quality. Both the public and private sectors must work together to enhance transportation infrastructure. A well-functioning logistics system might boost the government and business competitiveness. In the past twenty years, cost ratio analysis of logistics items has shown that transportation accounts for the costly item (29.4%), which mainly includes transportation means, terminals, labor, container, transport corridors, and so on (Chang, 1998). Other costly items have been found as inventory (17.4%) and warehousing (17.0%). Under the least cost concept, the transportation system makes commodities and products transportable and delivers timely and regional efficacy to boost value-added. Transportation has an impact on the outcomes of logistical activities, as well as production and sales. The cost of transportation in the logistics system might be viewed as a market constraint. The value of transportation varies depending on the industry. Transportation costs occupy a very small part of sale for products with small volume, low weight, and high value, and thus are less regarded; transportation costs occupy a very large part of sale for big, heavy, and low-valued products, and thus are more regarded; transportation costs occupy a very large part of sale and affect profits more, and thus are more regarded. In the study of Santoso et al. (2021), and Bahagia (2018), the major elements of transportation costs have been identified as public and private land transportation, rail and water transportation, air transportation, and finally support services of transportation.

1.1. Role of transportation and storage in logistics and supply chain

Warehousing is considered an integral part of a company's logistics system, which acts both in the storage of raw materials, components at the point of origin, as well as finished products at the point of consumption (Min, 2015). Conventional warehousing or storage functions mainly included *receiving* (materials, quality and quantity assurance of those materials), *prepackaging*, *putaway* (sending materials from point of receipt to the area of storage), *cross docking* (bulk shipments receiving, dividing them into smaller orders, their packaging and shipping), and *unitizing* (merchandise packaging in shipping containers, order accumulating by outbound carriers). However, the rapid transformation of logistics system also affected warehousing functions with growing popularity of the principle of 'just-in-time'. This principle holds the idea that in particularly e-commerce environment, customer-oriented business practices with value-added service is taken into consideration, fast and error-free fulfillment of customer orders become a priority with paperless and automated transactions. Recent studies have also highlighted the importance of warehousing in supply chain system (Jaehrling, 2018; Banabakova et al., 2018). In practice, warehousing decision requires the selection of the most optimal type of warehouse in terms of flexibility and the cost. Scholars have classified warehouses into private, public, and third-party storages. Manzini (2012) also stated that supply chain firms in the modern world encounter warehousing issues due to the lack of estimating the effects of types of warehouses on a company performance. Notwithstanding the challenges in decision-making towards building effective warehousing and transportation mechanism for uninterruptedness of a material's receival by a company, the process of a material becoming a finished product and its on-time delivery to a customer, modern optimization techniques can allow companies to make good decision on an entire process. However, as modern supply chain is considered an integrated mechanism of physical flow of goods, planning of manufacturing, and distribution, the models of supply chain optimization has become a challenging mission. Technological development has put the supply chain into intelligent supply chain, where optimization at each stage has become utmost important.

1.2. Aim and objectives of research

Drawing from the discussion above, it can be emphasized that the major problem in supply chain and logistics system (from materials manufacturing to the delivery to customers) is making the right and good decision, particularly for storage of both materials and finished products, as well as their transportation to a company (materials) and to customers (finished product). And the reason is shown as rapid transformation to a more intelligent supply chain system, where decisions must be taken in a timely manner, while customers must be supplied with their requested products on time and in a cost-efficient way. In this regard, the current study aims to investigate on how to optimize the warehousing and transportation of a finished product, while at the end it tries to assess the organizational readiness to automation of the entire process. Henceforth, the objectives are:

- To identify the most optimal warehousing option(s) for safety, security and quality of storing finished products;
- To identify the most optimal transportation mode(s) for timely and safe distribution of finished products;
- To identify what are the determinants of automated system usage.

1.3. Methodological approach and contributions

The process of decision-making in operations is challenging. To achieve the overall goal of a company, managers or decision-makers need to understand how the decisions are made and which of the tools to use for the efficiency and effectiveness of decisions made. It also helps to overcome uncertainty. A good decision is an outcome of analytic decision-making, which relies on logical interrelationships, as well as data and alternatives (Heizer et al., 2016). According to the authors, a good decision-making process involves (1) clear definition of the problem and its influencing factors; (2) development of measurable and specific objectives; (3) development of a model of relationships; (4) evaluation of each alternative solutions to the problem; (5) selection of the best alternative; and finally (6) implementation and evaluation of the decision. This is what the researcher exactly employs in the current study, where the selection of the best transportation and storage solutions for the effective delivery of a finished product to customer.

The AHP, which is one of the MCDM methods, has been developed by Saaty (1980) and broadly used in solving different problems in decision-making process. It helps ranking the most critical alternatives (e.g., transportation modes or types of storages), which ultimately optimizes the decision-making for companies. The alternatives are compared based on pre-defined set of criteria, such as cost, time, quality, and others. Therefore, the researcher believes that the use of MCDM method is a good fit for the current study. Irrespective of the complexity of a particular decision, there are always alternatives out there. Alternative refers to a strategy or an action to be selected by manager or decision maker after its assessment.

The current thesis is structured as following: the next chapter introduces the literature review explaining the transportation and storage practices in the modern time, modes of transportation and types of storage that can potentially optimize the finished product storage and distribution to customers. Then, decision-making methods with particular emphasis on AHP is introduced and related studies with the same methodology are reviewed, while at the same time the results are discussed. In the next stage, AHP model for transportation and storage is built with potential set of criteria and alternatives. The next chapter introduces the methodology, selection of experts, how to treat the set of criteria and alternatives while approaching to the selected experts. Then, the results are analyzed, and the most optimal transportation and warehousing alternatives are selected in light of finished product. To further contribute to the theory, the TAM is tested with several respondents from a certain company to assess organizational readiness towards automation of transportation and warehousing process. Finally, the discussion section is provided, which discusses the main findings, gaps and potential recommendations.

2. Literature review

2.1. Warehousing as part of logistics and supply chain

One of the most important components of the entire supply chain process is the warehousing (Banabakova et al., 2018). When considering the globalization process and increasing demands of consumers, sometimes problems in transportation and warehousing, and their efficiencies are not extensively taken into account in the management process of supply chain (Olowa, 2018), which leads to the growth of the problems in the entire supply chain and become complicated to overcome. Henceforth, customer relationship management (CRM) becomes one of the top scopes of the logistics (see Fig. 1). According to Rushton et al. (2014), logistics is "*getting the right product in the right condition to the right customers in the right quantity at the right cost to the right location at the right time.*"

Figure 1: Logistics' major scopes

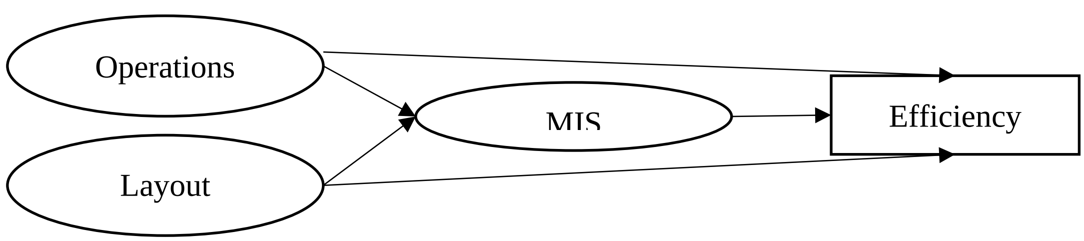
Logistics	**Warehousing**
	Transportation
	Import/export
	Packaging
	Handling of materials
	Management of inventory
	Management of order
	Logistics information systems (IS)
	Customer service

Regardless of all the scopes of the logistics being utmost important, previous scholars have emphasized that problems in the whole supply chain management have become serious, where transportation and warehousing are the most prominent issues (De Koster et al., 2007). Even several decades ago, the efficiency of warehousing has been linked to the competitive advantage of a company through which market situation of a company can be assessed by the warehousing approach (Tompkins, 1990). Why warehousing is highly important is because in the modern world customers can order products anytime and from any part of the world, while at the same time they expect their orders to be delivered on time without interruption and without loosing the quality (e.g., no damage). Henceforth, customer service assesses a company's capability to address customers' needs and requests, while at the same time the product delivery at a time required by customers. Nowadays, customer service management scope has entered to a new stage, which is formed by new technologies enabling real-time interaction with a customer to directly interact with them in order to understand their requests and concerns. In this regard, to keep up with the growing demands of customers across the world, as mentioned above, one of the main elements of logistics is warehouse and inventory management.

Inventory management (including planning and control) is concerned with planning (determining desired volume of items – raw materials of end products) and controlling (maintaining desired volume of either raw materials or end products). In addition, warehousing refers to receival, storage and shipment of materials or end products from and to locations of production or distribution. In the modern time, successful warehousing strategy could enhance a company's ability to efficiently store and deliver product, while at the same time to control effectiveness and safety issues. There are many components that help to assess the quality of warehousing, such as physical demands (e.g., size of warehouse, its layout) and others, such as technology and management approach to operations. Considering the traditional inventory and warehousing management, companies had to encounter serious problems, such as the cost due to excessive volume of inventory and risk of demand fluctuations in the markets. Therefore, it is vital to understand how warehousing management as a business strategy could be optimized to reduce costs and risks.

Jermsittiparsert et al. (2019) stated that although warehousing as part of supply chain has been extensively investigated before, the theory has not been well built with consideration of warehousing features, which could help to overcome warehousing challenges in the modern time. Therefore, the authors proposed two major attributes, namely operations and layout that contribute to the efficiency of warehousing. In addition, management information systems (MIS) had been treated as mediating variable, considering that data driven warehouse management could increase the efficiency (see Fig. 2).

Figure 2: Determinants of Warehousing efficiency



Source: Jermsittiparsert et al. (2019)

Warehouse layout decreases the production cycles, time to take care of materials, idles and so on. Other authors added that the selection of the most optimal warehouse layout is important as multiple factors could affect warehouse activities, including types of rack, dock area, and access to rack (Bartholdi & Hackman, 2008). On the other hand, warehouse layout must be standardized to overcome expenditures and administrative limitations. Other factors, such as labour, security, control and stock must be taken into account. If taken as part of a corporate strategy, warehouse size, location and capacities play significant roles. Warehousing can vary due to the types of product as well. For instance, storage of raw materials and end products might not be the same process. Layout of warehousing can also create different costs. Typical warehousing costs are characterized as:

- Building service costs – utilities, repair and maintenance, security and insurance;
- Labour costs – In case the warehouse is not fully automated, it may required additional labour, their salaries, training, operational health and safety (OHS), suits, and labour benefits;
- Equipment costs – fuel and spare parts, repair and maintenance, lease, and others;
- IT costs – building system to monitor and control warehouse operations;
- Structure and land costs – land lease or purchase.

Another attribute of the efficiency of warehousing – operations deal with the understanding of the procedure of request satisfaction. It includes the order processing from beginning to the end, recognizing both value-added and non-value-added elements, and time-consuming issues. Cagliano et al. (2011) emphasized that there are many elements of warehousing operations, such as capacity, taking care of raw materials or end products, speeding up receiving and sending products, and others. Jermsittiparsert et al. (2019) revealed that both warehouse layout and operations significantly increase the efficiency.

Warehousing strategy entails the types of warehousing. In literature, warehouses are classified based on different criteria, such as warehouse types by activities (consolidating, distribution, cross docking, reverse logistics, etc.). In other classification, warehouses are characterized based on ownership and layout/appearance. Moreover, warehouse classification is typically selected based on a company's business model, resources, and needs. In the current study, warehouses are classified as public, private and contract ownership types (see Table 1).

Table 1: Current study's classification of warehouses

Type of warehouses	Characterization	Advantages and disadvantages
Public warehouse	Warehouse that is leased by a private company to provide different service either for free or based on a contract. Services can include inspection of products, packaging and re-packaging. Public warehouses are mainly located on major roads, railways and other transportation centers for fact receival and shipment of products.	• Offers more than storing products • Provides multiple value-added functions (all aspects of packaging/re-packaging, reverse logistics, etc.) • Increases flexibility • Good for testing a product in new area though temporary storage • Does not provide predictability and control functions • Securing a space may not be available all the time • Leasing or rent costs may not be stable all the time
Private warehouse	A company-owner storage (company has full ownership on property, equipment and so on.)	• Provides full control on operations (continuous improvement of efficiency, customer service, risk response) • Can increase the value of warehouse as a real estate • Can act as a small office or production facility to reduce additional costs • Sometimes renting storage might be better than owning it • Some warehouses may not be flexible to accommodate new equipment or technology • There are always risks, such as theft, fire, labour injuries, environmental coincidences, etc.

Contract ownership warehouse	This warehouse is owned by a third party and leased to a single client.	• Costs and risks can be shared with owners and clients • Can help developing service and capabilities exceptional in the niche market • Can help to focus on developing own core competencies

Source: APICS (2017)

According to Coyle et al. (2013), major decision-making factors in private warehouses are throughput, market density, need for security, and customer service demands (see Table 2).

Table 2: Decision factors for public/contracted and private warehouses

Decision factor	**Private**	**Public/contracted**
Market density	High	Low
Throughput	High	Low
Demand attributes	Stable	Fluctuated
Physical control need	Yes	No
Need for security	High	Low
Customer service demand	High	Low
Multiple uses capacity	Yes	No

Besides the above-mentioned warehouse types, there is another classification, which includes specialized warehouse, automated warehouse, cold storage warehouse, bonded warehouse, and hazardous material warehouse. An example for **specialized warehouse** can be the storage of pharmaceutical products, considering that they are prone to contamination and possibility of theft. According to the World Health Organization (WHO), this type of warehouse must be supplied with ventilation, cooling and heating system, where cleaning supplies and other equipment must not have negative effect on products. In addition, dispatch and receival sites must be separate, products under control and with dangerous constituents must be kept in secure area. **Automated warehouse** is supplied with full technological capacities, where mechanical system controls the whole operations and provides special instructions to the personnel. In APICS Dictionary, 15th edition, it is characterized as a storage that performs loading and unloading functions automatically through computers. Automated warehouse is costly due to equipment and construction expenses, while it reduces labour cost, due to the fact that operations are handled automatically instead of manually. Another type is **cold storage warehouse**, which is designed for specific products that are vulnerable to high temperature and must be kept in frozen condition. This type of warehouse is also costly to build, while at the same time energy cost (air conditioning system) and extra equipment make it costly. Besides cold storage warehouse, there is a warehouse that must have specific temperature and humidity inside. It is also designed for special products (electronics, medicines, fresh goods, etc.). **Bonded warehouse** can be considered one of the flexible and beneficial warehouse types. Companies using this warehouse can manufacture, store and deliver products within the specific tax zones and are not subject to paying taxes. In a global scale, these zones are called free trade zones, which also applies to warehouses. Finally, **hazardous material warehouse** is aimed to handle products carefully that may have environmental effects, including radioactivity, toxicity, and explosive impact. There are special security requirements, such as air pressure system preventing emission out of the warehouse, drainage system, monitoring mechanism for air quality, alarm system, and of course specially trained staff with personal protective equipment.

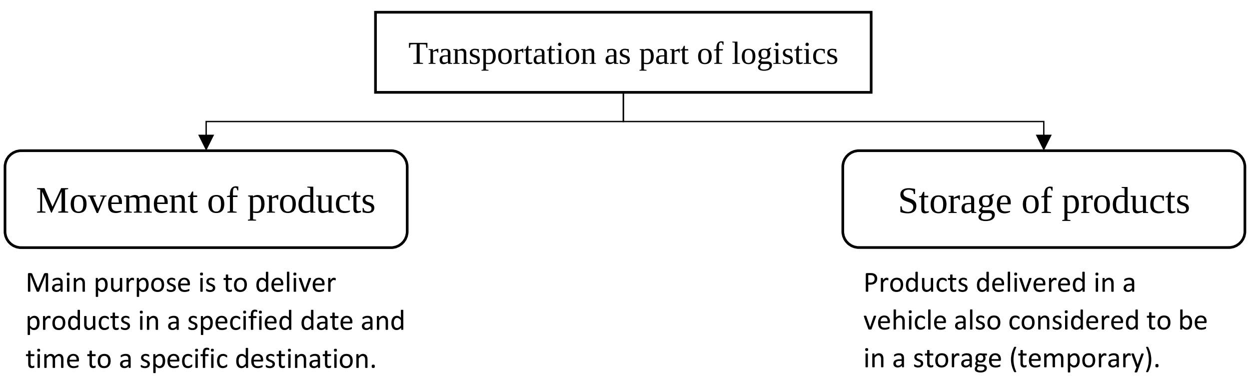
More accurate predictions, real-time issue identification and solutions, new segmentations, and fast reaction to consumer requests are all advantages of a data-driven supply chain (Meerkamp, 2018). Companies can develop an omni-channel strategy that allows customers to buy things in person or online. A number of services are supported by augmented reality-based systems, including picking components at a warehouse and delivering repair instructions to mobile devices. In the warehouse, augmented reality glasses can help with product selection and error-free collection. Although these technologies are still in their infancy, Tansan et al. (2016) predict that in the future, corporations will utilize augmented reality to give workers with real-time information to enhance decision-making and work operations. The benefits and drawbacks of various storage systems, such as volume utilization, effective use of height, convenience of order picking, product safety, worker safety, and stock control, should all be considered when choosing a storage system that is appropriate for product qualities and operations. In this study, a model for selecting warehouse rack systems was presented in order to satisfy the e-commerce industry's quick and precise delivery requirements, which still needs a development in Azerbaijan.

It must be emphasized that the advantages and disadvantages of storage systems should be evaluated in terms of volume and height utilization, ease of order picking, ensuring product safety, and stock control during the warehouse design process, while selecting the storage system that is suitable for the product specifications and processes. Therefore, prior to conducting AHP application, the qualities of storage systems are to be assessed, and those that are deemed inappropriate for the industrial finished products sector will be excluded. In addition to general benefits, parameters such as height-volume efficiency, product diversity, stock cycle speed can be considered, which are especially significant for warehouse management in the defined sector. After the pre-evaluation, AHP analysis is to be done on the storage systems that are deemed appropriate, with inclusion of selected attributes.

2.2. Transportation of finished products as part of logistics and supply chain

Transportation connects the components of supply chain and therefore it must be managed properly. According to the APICS (2016), transportation as part of the logistics accounts for 7 to 14% of final sales process, which depends on the industry. In literature, transportation emphases on two key processes of logistics system, namely the movement of products and storage of products (see Fig. 3).

Figure 3: Focus areas of transportation as part of logistics



Source: APICS (2016)

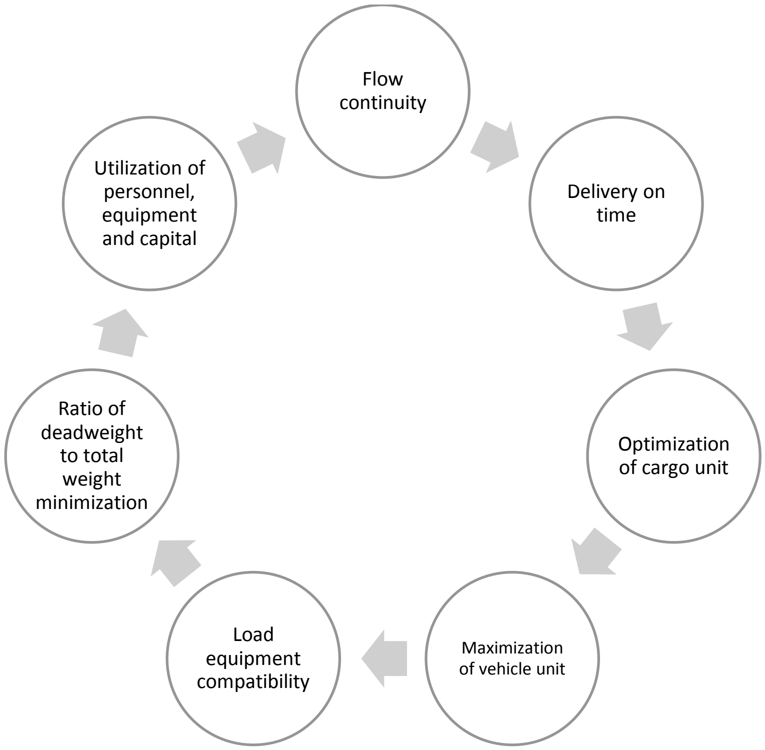
Regardless of the customer type (either business-to-business (B2B) or end users), they must be always satisfied with the products delivered to them. In this regard, transportation plays an indispensable role. Here, cost-effectiveness factors need to be taken into account. Because companies always seek for cost-effective means of transportation as it also affects the cost of products. When transportation cost is low, product cost also goes down and it leads to companies gain competitive advantage in a market.

The emergence of supply chain management from its transportation beginnings may be seen as a continuous extension of systems thinking and a reflection of the critical role that transportation plays in linking a company to its customer and supplier bases. In the pursuit of the intended objective, customer happiness, physical distribution management covered additional corporate processes and activities related with and impacted by transportation. Inventory, storage, order fulfillment, and packaging were among them. Materials management, which included these same movement-related activities on the supply side, was added to the system by logistics management. Finally, by combining the production and logistics systems, the area of supply chain management as we know it today was finished (Crum, 2015). Because of the scale of transportation expenses and their influence on supply chain costs and customer service, transportation will continue to play an important role in supply chain management. Transportation expenses are still the greatest component of total logistics costs, and they will always have an impact on a company's market reach. Indeed, a global economy is impossible to achieve without effective transportation. As warehousing has become a strategic standpoint in companies, transportation management in a proactive way is also highly critical for efficiency of operations, and therefore it must be considered in supply chain planning. According to the literature, major constraints in transportation management are as following:

- Increasing outsourcing. In case the manufacturing is done in offshore, transit time increases, and disruptions emerge in supply chain;
- Delivery with no defects. As customers demand products/deliveries to be defect-free, in case there are defects, then companies need to implement reverse logistics, receive products and replace with new ones;
- Constraints related to capacity. When demand for transportation exceeds the capacity for transportation, delays are unavoidable;
- Global cost structure in transportation. Considering the globalization, labour and fuel costs always change, and therefore companies must consider all these factors.

The effective transportation is comprised on multiple principles (APICS, 2016). These principles range from flow continuity to utilization of personnel, equipment, and capital to a maximum capacity (see Fig. 4).

Figure 4: Principles of effective transportation



Source: APICS (2016)

Notwithstanding the importance of transportation in logistics and supply chain system and its underlying principles, how to select the most optimal transportation mode tailored to certain products delivered by certain companies? It is obvious that transportation mode selection is both not quick and easy process. There are multiple factors, such as cost, capability, accessibility, security, and others that must be considered in transportation mode selection. In some cases, two or more transportation modes can be combined in a product delivery process. However, the most desired solution is a single transportation mode. Besides the above-mentioned factors, there can be also type of product to be delivered (had been mentioned in warehousing section), speed and time required to deliver a certain product, legality, and others. For instance, inconsequential products or materials (e.g., electronic component) are highly suitable for delivery through air or motor carrier mode of transportation, while heavy materials and/or products (e.g., lumber) are typically carried by rail and waterway. On the other hand, shape is considered another attribute in transportation mode selection.

In the study of Kumru and Kumru (2013), decision-making factors were defined as transportation cost, speed, safety, accessibility, reliability, eco-friendliness, and flexibility. The factors were tested against three transportation modes, namely, highway, railway, and combine transportation. The findings revealed that cost and speed of transportation are two major factors, and railway mode of transportation were the optimal selection. In another study, Berrado and Benabbou (2019) reviewed multi-criteria group decision making methods (MCGDM) in the context of transportation problem. It was suggested that one of the most critical strategic transportation decisions necessitate a high degree of participation from interested parties such as the Ministry of Transportation, local governments, transportation operators, private sponsors, country citizens, environmental organizations, and so on. Different competing factors, such as availability, dependability, delivery time, transportation cost, safety, and so on, must be addressed by the concerned decision makers. One of the most crucial strategic transportation decisions is to choose the most appropriate form of transportation. Since it involves several concerned stakeholders with distinct competing criteria, it is a complicated multi-criteria group decision-making problem. This research provides a review of the literature on the use of MCGDM approaches in transportation choices, specifically mode selection decisions. We were able to emphasize the necessity of using MCGDM approaches in the evaluation of transportation challenges while incorporating numerous interested stakeholders in the decision-making process because of this review. As stated above, there are multiple modes of transportation ranging from land (rail and road) to courier/express service. Table 3 presents the modes of transportation and their definitions.

Table 3: Modes of transportation

Mode of transportation	**Characterization**
Railroad	Products are moved to destination in containers and trailers pulled by locomotive. It is characterized with low variable (fuel and labour) and high fixed cost (rail yard, maintenance of terminal, etc.).
Road/Motorway	There are different carrier types, such as truck, van, motorcycle, bicycle, and so on. Compare to railroad transportation, here variable costs are high, and fixed costs (buying price of vehicle, highway, insurance, etc.) are low.
Air	Air transport is designed to freight carrying through cargo airplanes in a short period of time, and with e-tracking system.

	Cost structure is similar to road transportation. In addition, fixed costs include using airports and airways.
Waterway	Nowadays, freight carrying through water (sea, ocean) is accounted for 90% of global trade. It is particularly desirable due to the heavy freight loads. Cost structure is similar to road and air transport.
Pipeline	It is designed to mainly transport natural resources and raw materials, such as oil and gas, coal slurry and other chemicals. It is characterized with high fixed and low variable costs. Fixed costs mainly include terminal facility, while variable costs include maintenance of pipelines, litigation, and others
Intermodal	It is the combination of two or more transport modes depending on the demand and situation. In this transport mode, cost structure is combined.
Courier/express service	It is designed for delivering parcels, important documents and small items to either individual or business customers. This transport mode is characterized with high variable and low fixed costs.

Source: APICS (2016)

All features connected to the concerned mode of transportation must be examined while selecting the appropriate mode from the many modes previously outlined for usage on each component of the transportation network. Under certain circumstances, the appropriate method of transportation may appear clear, but a comparison based on a range of factors may be necessary (Tuzkaya et al. 2008). These factors can be subjective, but they vary a lot based on the qualities of the items being transported, as well as transportation parameters including distance, number of commodities, and other needs. Several studies have used the following qualitative factors in determining the most acceptable form of transportation: cost, reliability, availability, speed, and others (Majercak et al., 2018). However, multiple scholars have demonstrated that the transportation system entails several complicated processes and has a significant influence on a wide range of phenomena and social groupings. A thorough examination of the transportation system should consider technological, economic, social, and environmental factors, among others (Zak et al. 2011). As a result, choosing on the best mode of transportation necessitates the cooperation of a number of stakeholders interested in the transportation system’s efficiency, comfort, and effectiveness.

2.3. Studies related to the application of AHP method

A decision scenario in which more than one individual is involved is known as group decision making (GDM). These individuals have their own opinions and goals, are aware of a common problem, and are attempting to establish a consensus (Lu et al. 2007). According to (Saaty 2008), a choice made by a group of individuals has a lot more weight than one made by a single person, and GDM is a gift and chance to produce more impact via the collaboration of many brains. As a result, many real-life decision-making procedures necessitate group settings. Because of the rising relevance of group participation in decision making, group decision making has become a major study topic (Kabak, 2017). In an application to the current study, group refers to a set of experts who evaluate the pre-set criteria and alternatives in transportation and warehousing. To the date, a number of studies have used AHP, fuzzy AHP, analytic network process (ANP), and other methods to transportation mode decision-making. Such that, Hruska et al. (2021) investigated the three modes of transportation, namely rail, road and water in order to understand which of them are the optimal solution for the motor fuel distribution in a logistics chain. The findings revealed that transportation cost is the significant attribute to be considered in transportation, while at the same time, railway mode was selected the optimal solution by the experts. Wang et al. (2016) have used fuzzy AHP for transport mode selection in military logistics of Taiwan. Özfırat et al. (2017) have also used fuzzy AHP for transport mode selection in coal industry. Treadmills, truck sorts, suspension rail distributing systems, pipelines, and railroads are all examples of transportation systems. The open pit mine's transporting distance, hauling road orientation, quantity of coal resource, investment expenses, manufacturing capability, and unit manufacturing costs are all factors to consider while choosing one of these modes. Zak et al. (2015) have used AHP for assessing urban transportation solutions. Furthermore, in the Lagos State metropolis, (Odeyale et al. 2014) used the fuzzy AHP to determine the optimum mode of transportation. Nine choice parameters were used to assess seven transportation alternatives: low transport costs, low energy consumption, large capacity, improved safety, maximum comfort, ease of access, increased dependability, minimal number of intersections necessary, and shorter travel time. Various passengers' demands and perspectives were considered during the decision-making process. Table 4 summarizes some of the findings from previous studies.

Table 4: Findings from the related studies

Area of study	Methodology	Main findings	Reference
Assessing the mode of transport in the context of motor fuel distribution logistics	AHP	According to the results, cost of transportation is the most important factors in decision-making. In addition, rail transportation was selected the most optimal solution	Hruska et al. (2021)
Selecting the optimal pharmaceutical warehousing	AHP	Most important criterion was found infrastructural-physical condition of warehouse	Arslan (2020)
Selecting the cold storage warehousing	AHP	Accessibility and Security as two major criteria	Hassan et al. (2020)
Evaluating the transport routes for the aim of delivering oversize cargo	AHP	Results showed that among the criteria, smart selection of transport means is the most important factor	Wolnowska and Konicki (2019)
Selecting storage rack system in clothing e-commerce sector	AHP	In terms of criteria, load accessibility was found a major factor, while back-to-back rack system is the most optimal selection	Indap (2018)
Selecting the optimal distribution method for goods	AHP, decision making trial and evaluation laboratory method (DEMATEL)	As the most important criterion, positive environmental impact was selected	Kijewska et al. (2018)
Retail sector, selecting the warehousing site	AHP	Location was found the most important criterion	Durak et al. (2017)
Selecting the optimal transport for strategic goods	AHP	According to findings, air transport is the most optimal selection, while load capacity must be a priority	Ryczynski and

			Krawczyszyn (2016)
Selecting the transport mode for logistics firm	AHP	Cost was found the major criteria, while highway transportation is the most optimal means of transportation	Kumru and Kumru (2013)
Selecting the optimal transportation mean for mine planning	AHP	Findings revealed that among the criteria, specific cost of transportation is the most important element, while the analysis of transportation alternative showed that transportation system with 2 conveyor belts is the most optimal decision	Zoran et al. (2011)

Source: Author's own elaboration from various studies

Due to the presence of numerous decision makers with various competing parameters in the decision-making phase, there appears to be an increasing growth in the usage of MCDM approaches for picking the most appropriate mode of transportation. However, there are very few studies that take two major components of logistics and supply chain, namely transportation and warehousing as a single problem and applies decision-making method to find the interchange between them. In addition, there is almost no presence of any study using the above-mentioned approach and methodology in the context of Azerbaijan.

2.4. Automation of transportation and warehousing

There are several participants in the transportation and warehousing sector, including freight brokers, carriers, and shippers (Aituov & Kini, 2021). As previously described in the literature, the pandemic had an unprecedented impact on the worldwide transportation business (Ivanov, 2020). For example, as a result of COVID-19 pandemic, the quantity of worldwide marine exports fell by 20% in Q1 2020 compared to the same period in 2021. As a result, the importance of information systems in restoring the viability and resilience of the global supply chain is growing. In the transportation business, issues of inefficiency and transaction costs develop on a daily basis. Previous study indicates that intense competition in the transport industry inhibits information exchange and results in a lack of real-time data on sales forecast, vehicle availability, cargo volume and specifications (Baruffaldi et al. 2019). Major transportation firms, such as Fedex and Amazon, are expanding their digital infrastructure, but medium and small-sized freight forwarders have constraints in terms of IT budget, personnel, expertise, and technology awareness (Lee & Shin, 2020). While transportation businesses that would not invest in machine learning and big data beat rivals, a problem that periodically arises is how to optimize return on digital expenditures, analyze the impact of IT value before committed capital. Certain IT system benefits, particularly for storing procedures, are not immediately apparent at low trading volumes. Despite the fact that information systems facilitate the elimination of manual labor, actual data from previous study does not show productivity benefits despite expenditures in information technology.

The logistics business has a beneficial relationship with economic growth. E-commerce operation scale has expanded in recent years, from US$ 763.34 million in 2011 to US$ 1343.74 million in 2018. E-commerce is gradually has become the world's biggest market. The world of e-commerce, particularly in the logistics business, is now undergoing tremendous expansion (Hao et al., 2020). For instance, in the courier sector, items are received and delivered on a regular basis; consequently, speed and accuracy are essential needs in a warehousing application system. In practice, nevertheless, not all warehouses have easy access to the goods, therefore improving the warehousing ground space utilization rate is critical. Existing storage assets confront significant hurdles in terms of boosting utilization, enhancing scale efficiency, and lowering distribution cost. Throughout most situations, automated warehouse system is employed to solve such issues. Despite the fact that IT is frequently used in the logistics industry, warehouse advanced technologies are fairly recent. The Internet of Things (IoT) and smart factories play an important role in boosting information systems deployment, which adds to long-term corporate success (Afonasova, et al., 2019). Consumers are making regular journeys to offline businesses, which also are limited by physical opening and closing periods, as the Internet has gained popularity with the implementation of intelligent gadgets and e-commerce channels. Warehousing is an essential aspect of the distribution chain and helps to improve process efficiency. From 1980 to 2010, the logistics business grew at a 9.65 percent annual rate (Lan et al., 2020), and logistics expenses in the United States now account for around 8% of GDP, while shipping costs in Japan account for nearly 11% of GDP. Because of fast economic progress, meeting the need for logistics services is tough, and businesses must handle a wide range of client requests. Zhu and Kranemer (2005) developed an integrated model based on technological stage and dissemination. The technological preparedness condition, technological integration, company size, company scope, management hurdle, competitive edge, and managerial environment all affect technology, organizational, and environmental concerns. Jean et al. (2014) developed a new concept by combining the technology acceptance model with both the resource-based view (RBV) and contingency theories; their approach validates the causes and consequences of trans-boundary electronic cooperation and broadens the technology acceptance model's implications. Using the proposed model, Aboelmaged (2014) identified the elements influencing electronically maintenance technology in the manufacturing industry, such as fundamental technological resources, projected earnings, and electronic maintenance issues.

According to APICS (2016), warehouse automation refers to the utilization of electronic and mechanical tools for the completion of tasks in the context of storage, retrieval and movement of inventory and other resources. Automation allows for saving cost, security features and protecting human resources from environmental impacts. Warehouse automation includes information systems to control storage-related processes, where the objective is to employ suitable tools and devices efficiently, while at the same time enable employees to accomplish a specific task in short period of time, and finally ensure their health and safety. The following factors have driven the automation of warehousing process:

- Wider integration towards the supply chain, where stakeholders use information systems for communication and process coordination;
- Lean manufacturing principles' adoption that demand for better coordination and product flow control over warehouses;
- Enterprise process integration and control, which include transportation, warehousing and management of labour force.

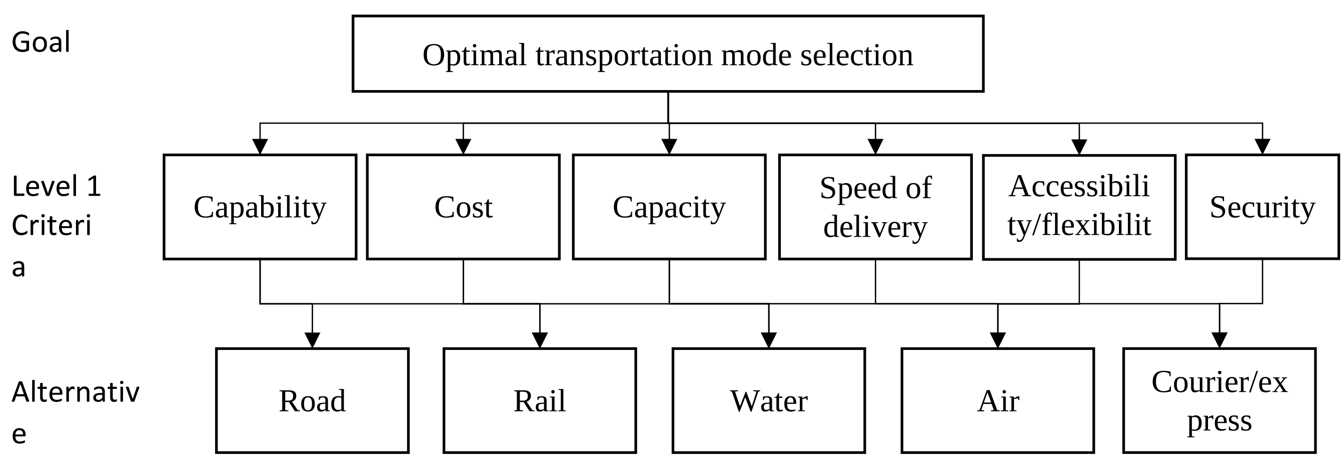
Overall, the IS system adoption enables transportation and warehousing companies to reduce costs (e.g., space and labour), while also expand customer service capabilities (e.g., rapid delivery time and minimum errors).

Davis et al. (1986) established the TAM model to gather and evaluate acceptability along with existing affecting elements. TAM depicts the relationships of multiple determinants for the acceptance of a technological solution. The perceived usefulness (PU) and perceived ease of use (PEOU) of a technology are basic components of this paradigm. If both of these characteristics are low, the behavioral intention (BI) to utilize this innovation is diminished, therefore implies the worker would most probably reject it. External factors impact both PU and PEOU, that are not explicitly identified in the initial version of this model. Warehousing management is often defined by basic procedures that commence with delivery reception, proceed with storage, and finish with selecting, packaging, and load/unloading. The next section delves deeper into the work items and personnel arrangements in warehousing logistics. The goal of this analysis is to identify particular individual determining elements for the adoption of innovative warehousing logistics technology. Drawing from the discussion above, the current research aims to test the organization readiness to automate the storage and transportation of finished products in the context of Azerbaijan. Moreover, PU and PEOU are taken as the major determinants of the BI to automate the process within an organization.

3. Methodology

In the context of transportation, the decision problem is considered the assessment of transportation modes offered by service providers, where the modes are employed from previous studies. In addition, the goal is the optimization of the selection of the best transportation mode to deliver a finished product as given in Figure 5.

Figure 5: AHP hierarchy of the most optimal transportation mode selection for finished product

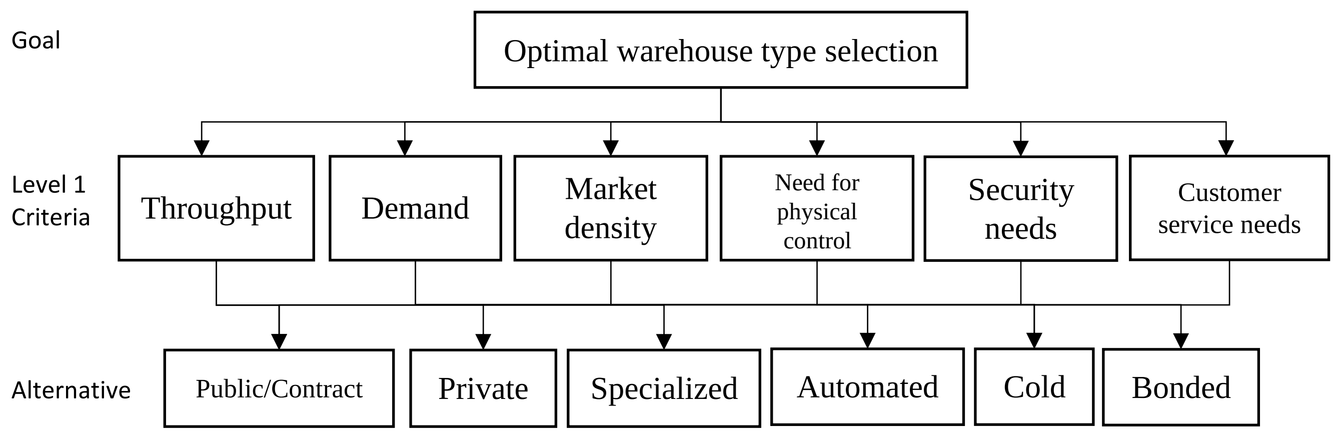


Note: The full list of the criteria (attributes) is given in the analysis part

Transportation modes are assessed against a set of criteria as shown in Figure 1. However, criteria can be extended further, based on the review of literature, such as environmental efficiency, damage, intermodal capability, reliability, and other factors.

In the context of storage, learning materials suggest two major classes of warehouses, namely private and public. Private warehouse is characterized as a "company-owned warehouse". However, other classification identifies warehouses in terms of their specialized features or services, namely automated, cold storage, bonded, hazardous materials warehouses, and so on. Therefore, the current thesis builds the AHP hierarchy of the selection of most optimal warehouse as in Figure 6.

Figure 6: AHP hierarchy of the most optimal warehouse type selection for finished product



The current study contributes to the theory and practice at the same time. In terms of theory, it must be noted that very few studies have focused on the optimization of entire process of supply chain and logistics. The current research takes the two most important stages of logistics, namely warehousing and transportation, as well as automation with consideration of a finished product. In addition, the use of MCDM method based on expert evaluations significantly contributes to a literature. In practice, decision makers and managers can use the same approach in decision-making towards any stage of logistics operations.

By using the measurement scale, which is based on a nine-point scale, the comparison between criteria and alternatives is made:

- *1=Equally important*
- *2=Equally important to somewhat important*
- *3=Somewhat important*
- *4=Somewhat important to moderately important*
- *5=Moderately important*
- *6=Moderately important to very important*

- *7=Very important*
- *8=Very important to extremely important*
- *9=Extremely important*

One of the major elements of the AHP process is the calculation of consistency ratio, defined as consistency index/random index. Random index is based on the number of criteria (*N*), while consistency index (*CI*) is based on the equation as shown formula 1 below:

$$CI = \frac{\lambda \max - N}{N - 1} \quad (1)$$

CI value must be smaller than or equal to 0.1 (*CI* ≤ 0.1), which is an indicator of consistency. For instance, in the context of warehousing, there are 7 criteria, showing that the corresponding value is 1.24 (see Table 5).

Table 5: R_i values corresponding the number of criteria/attributes

N	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
RI	*0*	*0*	*0.58*	*0.90*	*1.12*	*1.24*	*1.32*	*1.41*	*1.45*	*1.49*	*1.51*	*1.48*	*1.56*	*1.57*

Source: Saaty (1980)

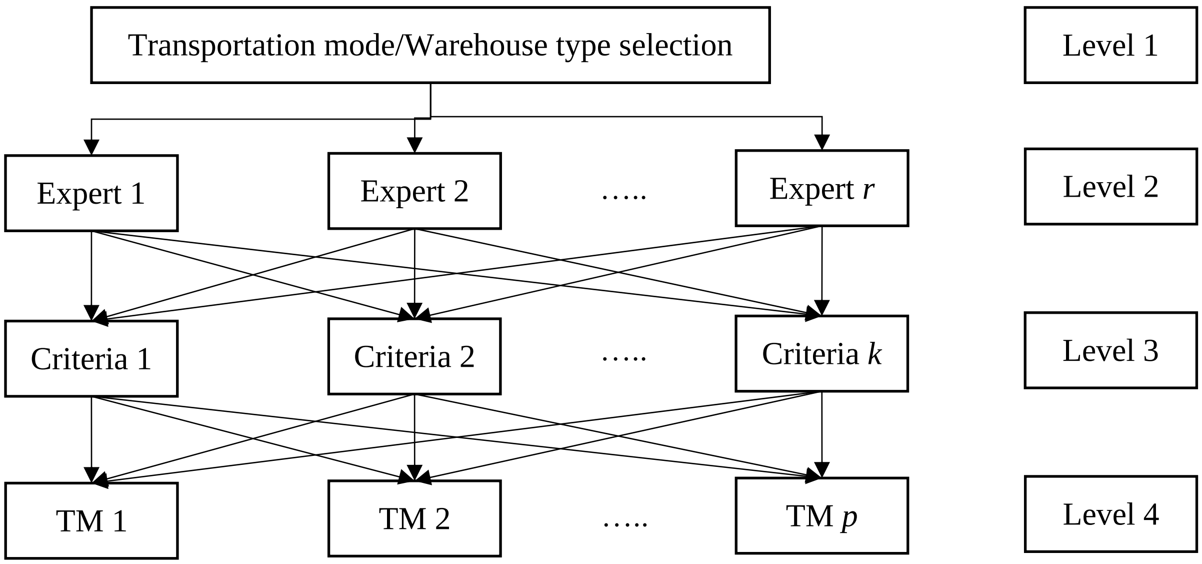
In the final step, consistency ratio is obtained through selecting the correct RI value from Table 5, and CI is divided by RI (see Formula 2):

$$CR = \frac{CI}{RI} \quad (2)$$

For instance, in the context of transportation, overall, 11 criteria are included and therefore, RI value is 1.51. It also applies to warehousing assessment.

As part of collecting data, initially, minimum seven, maximum twelve decision makers are approached, who are experts in both transportation and storage of finished products in an industrial context. Their preferences (comparisons) on each criterion are assessed based on the nine-scale assessment table. This process is repeated two times (transportation and storage). Decision makers' or so-called experts' assessment is depicted in Figure 7. It must be added that the AHP approach helps to simplify and speed up the natural decision-making process by providing a framework for successful logistic decision-making in complicated scenarios.

Figure 7: Decision hierarchy to solve a problem – role of experts (r = total number of experts, k = total number of criteria, p = total number of alternatives)



3.1. Selection of the most important factor and optimal transportation mode

In the first stage, based on the AHP hierarchy as given in Figure 5, the current study established a pair-wise comparative matrix, which was followed by the assessment of the weights of pre-set criteria in association with the selection of the optimal transportation mode. The list of criteria was extended and pre-set as following (Overall, 11 criteria were set):

- Capability (CAP) (Volume of multiple types products, which can be delivered)
- Cost (COS) (Charging prices for shipments)
- Capacity (CAPC) (One-time carriage volume)
- Speed of delivery (SPE) (time from pickup to delivery)
- Accessibility/flexibility (ACC) (Availability at any time in origin country and destinations)
- Security (SEC) (Level of security while carrying products)
- Liability issue (e.g., risk of damage, theft, unexpected accidents, etc.) (LIA)
- Fleet design for any specific needs (FLED) (as temporary storage)
- Durability (DUR) (Robustness to risks)
- Environmental efficiency (ENV) (eco-friendliness)
- Intermodal capability (INT) (Easy to connect with other modes)

The current research approached to overall 8 experts within Azerbaijan. The experts were introduced the comparison matrix in order to get acknowledged with the method of assessing each criterion against each other in a comparative way (see Table 6).

Table 6: Illustrative example of AHP comparison matrix

	9	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
CAP							+											COS
CAP						+												CAPC
CAP						+												SPE
CAP								+										ACC
CAP								+										SEC
CAP									+									LIA
CAP										+								FLED
CAP				+														DUR
CAP								+										ENV
CAP									+									INT

Note: This example is only given for the comparison of CAP attribute with other attributes

Experts were asked to put the "+" sign where relevant. For instance, in the first comparison of the example, if CAP attribute is given 3, it means that it is somewhat important compared to COS attribute. In the 7th row, if FLED is given 2, meaning that it is between equally important to somewhat important compared to CAP.

3.1.1. Determining the criteria weights for transportation

By using the AHP comparison matrix in Table 6, the matrix with the scores given by the experts is converted into standardized matrix by using the geometric mean method, which is mathematical process of AHP. Moreover, the standardized matrix is obtained as following:

$$(3) \qquad Matrix\ A = \begin{vmatrix} \mathbf{1} & 2.276 & 3.177 & 0.935 & 2.847 & 1.984 & 1.189 & 0.697 & 0.588 & 0.841 & 1.423 \\ 0.439 & \mathbf{1} & 3.266 & 2.586 & 1.586 & 1.889 & 0.951 & 0.347 & 0.351 & 1.414 & 0.652 \\ 0.315 & 0.306 & \mathbf{1} & 1.807 & 3.330 & 1.565 & 1.364 & 1.631 & 4.027 & 2.013 & 0.758 \\ 1.070 & 0.387 & 0.553 & \mathbf{1} & 1.769 & 0.811 & 0.789 & 0.651 & 1.855 & 1.070 & 1.740 \\ 0.351 & 0.631 & 0.300 & 0.565 & \mathbf{1} & 1.682 & 0.557 & 0.719 & 0.605 & 1.037 & 1.682 \\ 0.504 & 0.529 & 0.639 & 1.233 & 0.595 & \mathbf{1} & 1.542 & 0.475 & 0.663 & 0.744 & 0.625 \\ 0.841 & 1.052 & 0.733 & 1.268 & 1.795 & 0.648 & \mathbf{1} & 0.657 & 1.834 & 2.627 & 2.583 \\ 1.435 & 2.885 & 0.613 & 1.537 & 1.391 & 2.104 & 1.522 & \mathbf{1} & 1.189 & 2.495 & 3.011 \\ 1.701 & 2.847 & 0.248 & 0.539 & 1.654 & 1.507 & 0.545 & 0.841 & \mathbf{1} & 2.030 & 1.291 \\ 1.189 & 0.707 & 0.497 & 0.935 & 0.965 & 1.344 & 0.381 & 0.401 & 0.493 & \mathbf{1} & 1.338 \\ 0.703 & 1.534 & 1.319 & 0.575 & 0.595 & 1.601 & 0.387 & 0.332 & 0.775 & 0.747 & \mathbf{1} \end{vmatrix}$$

This matrix in Formula 3 is followed by normalization of pairwise comparison of weights given by the experts (see Formula 4):

(4) $$a_{ij}^{*} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}}$$

Normalized matrix is obtained as following:

$$(5)\ Matrix\ A = \begin{vmatrix} \mathbf{0.105} & 0.161 & 0.257 & 0.072 & 0.162 & 0.123 & 0.116 & 0.090 & 0.044 & 0.052 & 0.088 \\ 0.046 & 0.071 & 0.265 & 0.199 & 0.090 & 0.117 & 0.093 & 0.045 & 0.026 & 0.088 & 0.040 \\ 0.033 & 0.022 & 0.081 & 0.139 & 0.190 & 0.097 & 0.133 & 0.210 & 0.301 & 0.126 & 0.047 \\ 0.112 & 0.027 & 0.045 & 0.077 & 0.101 & 0.050 & 0.077 & 0.084 & 0.139 & 0.067 & 0.108 \\ 0.037 & 0.045 & 0.024 & 0.044 & \mathbf{0.057} & 0.104 & 0.054 & 0.093 & 0.045 & 0.065 & 0.104 \\ 0.053 & 0.037 & 0.052 & 0.095 & 0.034 & \mathbf{0.062} & 0.151 & 0.061 & 0.050 & 0.046 & 0.039 \\ 0.088 & 0.074 & 0.059 & 0.098 & 0.102 & 0.040 & \mathbf{0.098} & 0.085 & 0.137 & 0.164 & 0.160 \\ 0.150 & 0.204 & 0.050 & 0.118 & 0.079 & 0.130 & 0.149 & \mathbf{0.129} & 0.089 & 0.156 & 0.187 \\ 0.178 & 0.201 & 0.020 & 0.042 & 0.094 & 0.093 & 0.545 & 0.109 & \mathbf{0.075} & 0.127 & 0.080 \\ 0.125 & 0.050 & 0.040 & 0.072 & 0.055 & 0.083 & 0.381 & 0.052 & 0.037 & 0.062 & 0.083 \\ 0.074 & 0.108 & 0.107 & 0.044 & 0.034 & 0.099 & 0.038 & 0.043 & 0.058 & 0.047 & \mathbf{0.062} \end{vmatrix}$$

In the next step, estimation of the weight for each criterion is obtained through the following formula:

(6) $$W_i = \frac{\sum_{j=1}^{n} a_{ij}}{n}$$

The below examples are related to CAP and INT criteria. The rest of the criteria weights are given in Table 7.

(7) $$W1_{CAP} = \frac{0.105 + 0.161 + 0.257 + 0.072 + 0.162 + 0.123 + 0.116 + 0.090 + 0.044 + 0.052 + 0.088}{11} = 0.116$$

(8) $$W11_{INT} = \frac{0.074 + 0.108 + 0.107 + 0.044 + 0.034 + 0.099 + 0.038 + 0.043 + 0.058 + 0.047 + 0.062}{11} = 0.065$$

As a result of the analysis, the priority of weights representing the goal (optimal transportation mode selection) is demonstrated in Table 7. The expert evaluation regarding the assessment of the most important factor in transportation revealed that fleet design for any specific needs. In transportation context, it is also referred as temporary storage. It has also been emphasized in the literature review section that some products might be vulnerable to decay and losing quality (e.g., medicines, vegetables, fruits, etc.). In this case, containers transported to other destinations must be supplied with different equipment, technology, such as air-conditioning system to be able to delivery product securely to clients. In addition, the evaluation of factors also showed that capacity, so-called one-time carriage volume, is the second top priority. Even if it applies to the vulnerable products, a container or a mode of transportation must be able to take as much volume as it can. In this case, risks will be reduced (in case the availability of the number of containers). For instance, if a manufacturer can only deliver 1 ton of a medical supply in one-time carriage, and another 1 ton is waiting due to unavailability of carriers, it could create a risk. However, if the manufacturer is able to deliver 2 tons of medical suppliers at a time, it would be both less risky and less costly. Finally, capability of a mode of transport to delivery multiple types of products at a time is considered a great advantage.

Table 7: Criteria composite priority of weights for transportation attributes

Criteria	Definition	Local weight	Criteria Ranking
CAP	**Capability**	**0.116**	**3**
COS	Cost	0.098	5
CAPC	**Capacity**	**0.125**	**2**
SPE	Speed of delivery	0.081	7
ACC	Accessibility/Flexibility	0.061	11
SEC	Security	0.062	10
LIA	Liability issue	0.101	4
FLED	**Fleet design**	**0.131**	**1**
DUR	Durability	0.097	6
ENV	Environmental efficiency	0.063	9
INT	Intermodal capability	0.065	8
λmax = 12.540, C.I = 0.054, C.R = 0.106			

Finally, the assessment of the transportation mode revealed that the most optimal mode is air transportation, followed by road transportation (see Table 8).

According to APICS (2016), air transport is the top performer in terms of the following subjects:

- Speed of delivery – very fast
- Damage – very low
- Reliability – high
- Intermodal capability – high
- Courier/express – very high

However, it lacks cost (very high), capacity (very low), and capability (limited). Considering the advantages, it can be emphasized that rail carriage can be the optimal solution for companies, particularly in the context of finished products. For instance, a railway carrier is connected to the warehouses and major highways in a country and its intermodal capability allows for the delivery of finished products without losing time. In addition, it is good that products are less likely to get damaged due to the fast transportation and reliability factors. In combination with the factors related to the cement industry, the following takeaways can be inferred:

- Cement is mainly transported by rail and road in the country;
- It is transported by boat over long distances;
- Special purpose (oil well cement) - cement used in oil rigs can be transported by plane. The main reason is the high cost of these cements;
- Couriers can deliver a small amount of bag cement within a country;
- Features of cement products: dusty, heavy - cheap material, type of packaging: pile (bulk), bag and big-bag.

Henceforth, the finding from the expert evaluation is adjacent with the literature.

Table 8: Composite priority of weights for transportation modes

Alternative	Definition	Local weight	Alternative Ranking
Road	**Van, truck, car, motorcycle carriage**	**0.215**	**2**
Rail	**Containers and trailers pulled by locomotive**	**0.247**	**1**
Water	Freight carrying through water (sea, ocean)	0.202	3
Air	Freight carrying through cargo airplanes	0.175	4
Courier	parcels, important documents, small items	0.161	5
λmax = 5.123, C.I = 0.031, C.R = 0.027			

Road transportation is selected as the second optimal solution for carriage of finished products. In comparison with air transport, it is characterized with not limited capability, moderate to high cost, fast delivery, very high accessibility/flexibility, high reliability, very high intermodal capability, and courier service. As literature suggests, road transportation plays a vital role in both social and economic life of developing and industrialized countries. It is no coincidence that this transportation mode was selected the second priority by the experts in Azerbaijan too. Considering that the size of the country is small, factories are located near the major roads and hubs. Therefore, it is easy and affordable to use this transport mode to carry finished products to any point within the country. In addition, the airports and seaports in Azerbaijan have been well connected to the roads. For instance, Baku International Seaport is located near the highway, which is a major part of the Silk way. The highway connects Asia to Europe and goes through the country. Products both made in Azerbaijan and of other countries of origin can easily unloaded from ships in the Baku International Seaport and loaded to trucks. The same applies to Baku International Airport. Even if taking other countries cases, truck delivery is beneficial. Such that, English Channel allows tunnel transfer of truck deliveries, which eliminates any barrier (e.g., ocean or mountains). As trucking sector is labour-intensive, it is always under advancement process, such as controlling driver and delivery schedules, automated billing system, and progressing in intermodal system.

3.2. Selection of the most important factor and optimal warehouse type

In the second stage, based on the AHP hierarch as given in Figure 6, the current study established the second pair-wise comparative matrix, which was followed by the assessment of the weights of pre-set criteria in association with the selection of the optimal warehouse type. The list of criteria is determined as following:

- Throughput (THR) (Volume of products that can be stored)
- Demand (DEM) (Level of desire to use a specific storage type)
- Market density (MD) (demand-offer ratio in the market of a specific product)
- Need for physical control (PC) (Depending on the size and nature of storage, level of control)
- Security need (SN) (To what extent the specific storage is safe)
- Customer service need (CSN) (To what products customers have higher interest, and depending on that, selection of a specific storage)
- Multiple use (MU) (either multiple types of products can be stored, or multiple users can use)

Coyle et al. (2013) compared public and private/contract-based warehouses in regards of the above-mentioned factors. The findings showed that private warehouse is featured with high throughput, market density, need for security and customer service needs, whereas public/contract-based warehouse are not as reliable as private warehouse. Literature suggests ten steps of the process of warehouse designing:

- Understanding the business requirements and barriers for design
- Understand what data is needed and how to obtain it
- Planning process based on the throughput

- Describing the requirements for all activities related to warehousing
- Selecting appropriate equipment
- Formulating external and internal layout
- Assessing what information systems are needed for operations
- Estimating cost (CAPEX and OPEX)
- Assessing the design in comparison with demand and barriers
- Implement the design

Based on the above factors, it is highly required to assess which of the factors must be priority in the context of Azerbaijan.

The current research approached to the same 8 experts in Azerbaijan. The experts were introduced the comparison matrix of warehouse selection factors in order to make comparisons between each criterion.

3.2.1. Determining the criteria weights for warehousing

As a result of the analysis, the priority of weights representing the goal (optimal transportation mode selection) is demonstrated in Table 9. The expert evaluation regarding the assessment of the most important factor in transportation revealed that market density is the most important factor in selecting a warehouse. The second priority in decision-making is throughput, followed by the need for security.

Table 9: Criteria composite priority of weights for warehousing attributes

Criteria	Definition	Local weight	Ranking
THR	**Volume of products that can be stored**	**0.159**	**2**
	Level of desire to use a specific storage type	0.126	
DEM			5
MD	**The market of a specific product**	**0.224**	**1**
PC	The level of physical control capacity	0.135	4
SN	**Safety features of a storage**	**0.151**	**3**
CSN	Ability to meet customer service needs	0.119	6
MU	Multiple products or multiple users	0.086	7
λmax = 7.391, C.I = 0065, C.R = 0.049			

Why safety is one of the vital issues in warehouse selection process? Storages are acknowledged as hazard risky spaces or workplaces. According to the APICS (2016), major risks are overexertion, including damages in the processes of carrying, lifting, pulling and pushing of items, while at the same time slippery ground, bending, falling of items, collapse of shelves in cases of drop. These occurrences may lead to fire, explosion and spread of hazardous chemicals or materials to the entire area. The main safety measures include improved safety practices of employees, obligation (both legal and ethical) to the rules and the commitment of warehouse management to protecting employees from diseases and injuries. Although developed countries have well-established occupational health and safety (OHS) policies that set roles and responsibilities of all employees, in developing and industrialized economies it is still in development stage. The Government of Azerbaijan has also started to implement OHS laws and policies mainly from early 2010s. The amendment to the law, namely "*Compulsory Insurance in Case of Loos of Occupational Capacity as a Result of Occupational Accidents and Occupational Diseases*"[1] contains of the rights and duties of the insured, beneficiary party, and insurer. In addition, the decree of occupational capacity loss is assessed. According to Abdulazizov (2020), safe work is a profitable business. Investing in the skills of the workforce allows increase the volume and improve the quality of products and directly increase the competitiveness of the enterprise. It is believed that the past practice of compensation for work in harmful and dangerous conditions is already outdated and unproductive, while preventive investments in safety increase productivity. In 2018, in Azerbaijan, in the conditions that did not meet sanitary and hygienic standards, the share of employees working was accounted for 12.9% in industry, 3.7% in the construction sector 11.2% in transport and warehousing, and 4.3% in ICT. In 2005, the number of people died and disabled as a result of accidents at work amounted to 189 people, and in 2018 this figure rose by 10 persons and amounted to 199 people. Therefore, in selecting the most optimal warehouse type, the safety features must be taken into consideration.

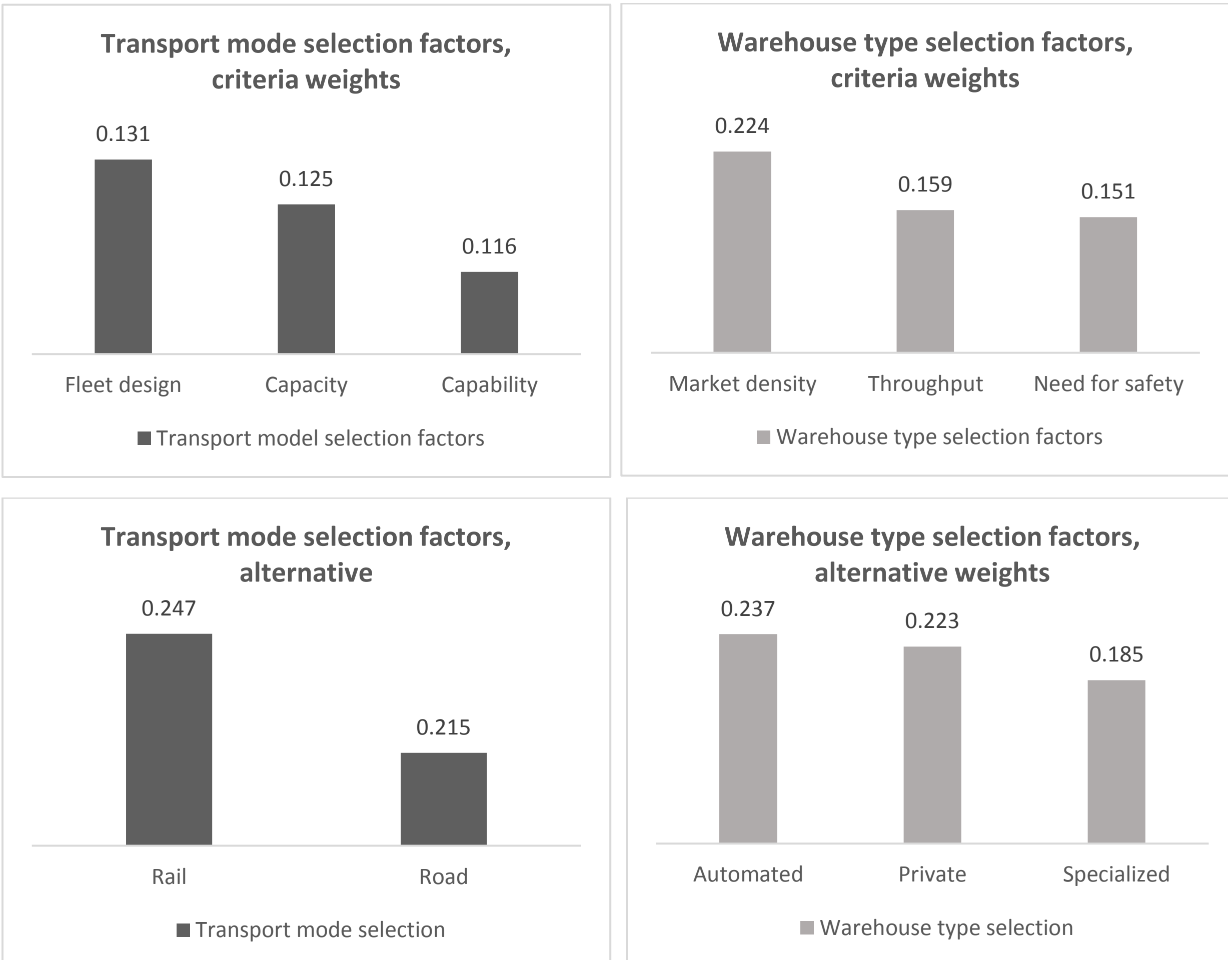
[1] https://www.ilo.org/dyn/natlex/natlex4.detail?p_lang=en&p_isn=106750&p_country=AZE&p_classification=14

Table 10: Composite priority of weights for warehouse type

Alternative	Definition	Local weight	Ranking
Public/contract	Rented or leased warehouse by a company	0.109	6
Private	Warehouse owned by a company	**0.223**	**2**
Specialized	Designed to meet the needs of a specific types of products	**0.185**	**3**
Automated	Warehouse that employs technology for performing warehousing operations	**0.237**	**1**
Cold	Warehouse that accommodates products vulnerable to high temperature	0.112	5
Bonded	Warehouse allowing companies to manufacture, storing and sending products between tax zones by not paying tax	0.134	4
λmax = 6.578, C.I = 0094, C.R = 0.071			

From Table 10, it is revealed that the most optimal warehouse type by the experts is automated warehouse (0.237), followed by private (0.223), and specialized (0.185) warehouses. As it is mentioned in the demographics section, for the selected company it is the target to make all the operations in an automated manner from putting sales orders to processing to the delivery process. Therefore, the finding supports that automated warehouse would significantly contribute to timeliness of order processing, product selection and others. In addition, experts emphasized that private warehouse could be highly beneficial due to the reason that sometimes, public warehouses may not be available as many companies are willing to rent them. If it is a case, then the company may fail to meet customer demands in storing requested products in warehouses. Therefore, it must be considered in the decision-making and planning process. Finally, specialized warehouse ranks third, which can be explained to the extent that each company's product is specific in terms of its nature, size, storing conditions, and so on. As mentioned above, some products, such as pharmaceutical products are vulnerable to contamination and theft. Considering that the major industry in the context of this study is cement and cement products, specialized warehouses can be important, as its ventilation, cooling and heating system, special occupational and health, and safety measures must be specific to these products.

Figure 8: Decision factors in transportation mode and warehouse type selection



3.3. TAM model

Since automation requires an organizational change with inclusion of employees' and major decision makers' attitudes and intentions towards the change, the current thesis tests the automation as "intention of companies to automate transportation and storage of a finished product". To do so, TAM is applied. The original TAM model is depicted in Figure 3.

The TAM has mostly been used to discover the characteristics that influence a decision to adopt a new system, such as computer self-efficacy, social fluency, perceived enjoyment, computer anxiety, and experience. The TAM's primary goal is to describe an individual's attitude toward technology adoption. External influences influence the TAM's primary variables, PEOU and PU, which influence an individual's negative or positive attitudes toward technology usage. According to Alsabawy et al. (2016), PU is a crucial component in determining the acceptability and success of adapting a certain system, and there is a paucity of evidence about the influence of IT infrastructure services on the usefulness of system. Attitude also determines BI's attitude about technology usage, which leads to actual utilization. Previous research has verified the TAM's validity and relevance in predicting technological adoption behavior (Abdullah, Ward, & Ahmed, 2016; Al-Gahtani, 2016). The TAM is also a robust model, according to King and He (2006). The TAM model has been employed in almost all sectors to date.

This idea explains how customers accommodate new and use a new technology. According to the concept, when a customer is offered a new form of innovation, various factors influence how and when they use it. This incorporates its obvious convenience and perceived usefulness. Different aspects like as customers, competitors, monetary elements, or outside influences from vendors are not 10 included in the TAM (van Akkeren & Harker, 2003). TAM encompasses a well-established causal sequence of real conduct convictions, aim, and inclination. Social therapists created this based on the anticipated activity theory. Davis' analysis identifies two critical components: seen efficiency and seen graciousness. These views shape people's attitudes about adopting a certain system. The attitude sets off the intents that result in real system utilization and user aspirations to use. TAM is commonly used in various technology research and has been shown to support to the formulation of a forecast of an individual's technology adoption. Customers are currently not only pleased with on-time distribution at the lowest possible cost, but customer e-business has been launched to fill this gap, which has elevated the levels of expectations to an unanticipated degree, and consumers now want the same equivalent services in their business endeavors. In this setting, sophisticated business processes can be carried out, demonstrating the capacity to effectively manage a distribution network and handle many details swiftly and precisely. Manual procedures cannot be used to complete tasks effectively. Global organizations demand integrated technological solutions in order to generate one of most appropriate market possibilities.

Figure 9: TAM model towards the intention to automate transportation and storage

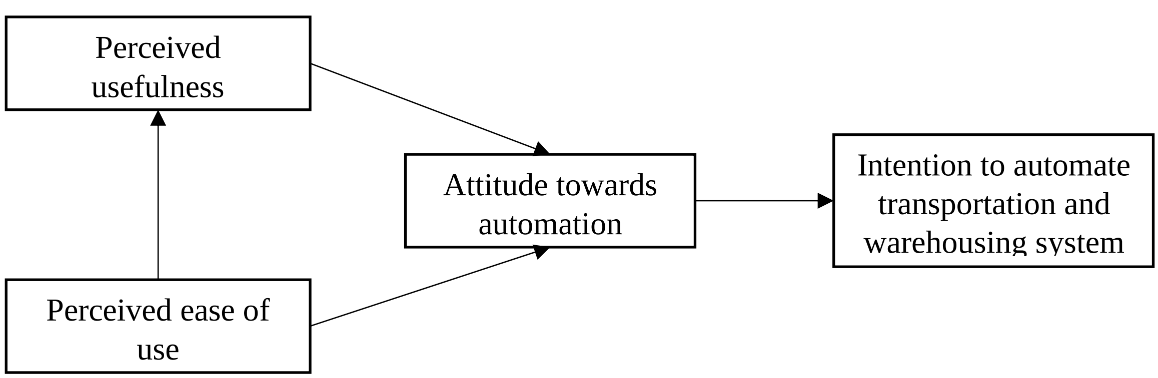


Table 11: TAM application areas

Areas	Sources
E-learning	Chang et al. (2017)
Internet banking system	Nasri and Charfeddine (2012)
Mobile internet	Son et al. (2012)
Clinical information system	Melas et al. (2011)
Health information system	Pai and Huang (2011)
Use of Internet	Lee and Kim (2009)
Business simulation game	Tao et al. (2009)
Electronic mail system	Serenko (2008)

The data will be collected based on the convenience sampling technique, where the companies of decision makers approached through AHP process will be selected and their employees will be surveyed. The data will be analyzed by using the structural equation modelling (SEM) by applying measurement model testing with inclusion of reliability and validity test.

3.4. Quantitative Research

3.4.1. Sampling Process

Purposive sampling is used in this study. The key rationale for selecting this type of non-probability sampling is because the researcher intends to target primarily industrial products provider firm and its managerial level, operational decision-maker employees who play a substantial role in the firm's transportation and logistics, warehousing operations. Several channels and techniques are used to reach out to the research population. As a result, the researcher has already established contacts and presented the research concept. Questionnaire forms are made available both online and in paper copy. Henceforth, face-to-face surveying technique is used with the main target group.

The data collecting procedure is divided into three parts. First, an academic supervisor administers and approves a questionnaire comprising of construct scales and questions. This is also helpful in establishing the research's content validity. Second, a pilot survey is carried out. A pilot survey allows researchers to fine-tune minor flaws and make required adjustments. The last stage involves collecting forms, whether online or hardcopies, and entering raw data into a database. Raw data is processed and evaluated using statistical methods.

3.4.2. Operationalization of TAM model

The TAM is the easiest and best model which is based mostly on theory of planned behavior, and it focuses primarily on the potential influence of belief factors on real information technology use. In line with the operationalization of the TAM variables according to Davis et al. (1989), namely PU, PEOU, Attitude (ATT), and intention (INT), PU is referred as the "*degree of recognition that the technology utilization is associated with improvement of that technology user's performance*". PEOU is referred as the "*degree of technology utilization being easy for the user of that technology*". ATT refers to the "*technology user's feelings (positive or negative, in favor or against) about the technology*". Finally, INT refers to "*what extent the user of the technology intends to actually use it – prediction of behavior*". The items representing the TAM variables have been given in Appendix A.

3.4.3. Data Analysis Approach

The quantitative data gathered is statistically examined and interpreted in order to offer exact responses to the study topics. The SEM approach is used to analyze statistical data. The key reason for utilizing SEM is that it ensures robust findings for confirming the conceptual model in the basis of theoretical propositions. SEM analysis is carried out using Excel software, which allows finding reliability and validity scores, as well as the relations between TAM model variables. This statistical tool is simple to use in terms of gathering data and visualizing it.

The results of data analysis are divided into three stages. To begin, the demographic characteristics of respondents are presented in appropriate tables and figures. Second, descriptive statistics are collected (mean scores and standard deviations). Third, measurement model analysis is done to ensure the research's data dependability and validity. Cronbach's alpha for each variable is tested for internal consistency throughout the reliability test. A variable having a lower dependability value (below the cut-off point) gets eliminated. The cut-off locations are discussed further in the measuring mode section. Following that, Confirmatory Factor Analysis is performed to clean the data and confirm that no irrelevant items are included in the subsequent analysis. Finally, discriminant validity is used with Pearson correlations to estimate the strength of relations between the TAM variables.

The structural model testing has not been done either through the SEM modeling or regression analysis due to the fact that the number of respondents is lower than the threshold level. According to previous scholars, the respondent size being 100-150 is a minimum requirement in the SEM analysis (Anderson & Gerbing, 1988; Tinsley & Tinsley, 1987). In the context of regression analysis, Green (1991) emphasized that 50 respondents are minimum, and as number of variables increase, sample size must increase as well.

4. Analysis Process

4.1. Demographics of Respondents

The demographic analysis addressed five questions to the company that produces cement products. The company sells products both to local and international markets. Main commercial department plays an important role in organizing marketing and sales operations, including the exporting procedures. In addition, the sales and marketing department analyzes global market demands, customer preferences, give feedback to manufacturing unit in order to contribute to the decision-making process. There is still no automated system that forecasts sales, communication of requests to manufacturing unit, stock preparation and finally delivery, stock check and order preparation operations in place. Communication is conducted through a human factor. As it was mentioned in literature section, timely response to customer requests and deliveries are utmost important. Moreover, sales department is willing to make the entire process automated, put its sales forecasts and requests in the system, forward to manufacturing units in a weekly or monthly basis. Adding that, logistics department is also willing not to wait when human decision makers will inform them how many products, how much volume, to where and when will be delivered. The department also wants to take all data from the system and conduct its operations uninterruptedly.

The questions included the gender, age, work experience in the sector, position in the current company, annual revenue of the company and the size of the company. The results revealed that 60% of respondents are males, while their female counterparts constitute 40%. In addition, the majority of them belong to middle age group of 36-40 (47%), followed by relatively young employees (27%). Most of them are in the sector for 7 to 9 years (46%), which means that the responses the research received in the assessment of the TAM model are considered to be reliable. The majority of the respondents are logistics operators (33%) and operations managers (20%) within the company. They were purposefully selected as they are directly related to the topic and could help accurately assessing the readiness of the company to adopt automation technology in its operations. Another fact to disclose about the company is that it employs 200 to 250 employees and its annual revenue is up to 120 mln AZN. Henceforth, the company is big enough and diverse in terms of employment and operations size. The details are given in Table 12.

Table 12: Demographic analysis of the surveyed company

Demographic indicators	**Frequency**	**Percentage**
Gender		
Male	9	60%
Female	6	40%
Age		
25-30 years old	2	13%
31-35 years old	4	27%
36-40 years old	7	47%
Over 40 years old	2	13%
Years of experience in the sector		
1-3 years	1	7%
4-6 years	3	20%
7-9 years	7	46%
More than 9 years	4	27%
Position in the company		
Operations manager	3	20%
Senior manager	1	7%
Logistics manager	2	13%
Logistics operator	5	33%
Product manager	1	7%
Other	3	20%
Annual revenue of the company	100-150 mln AZN	
Company size	200-250 employees	

4.2. Descriptive analysis

The descriptive analysis contains an assessment of the mean scores and standard deviations of each of the variables of the TAM model, as well as their underlying components (items). During the data analysis process, in total three items were removed due to the incompleteness of survey questionnaire filled out by the respondents. Those items are PU-4, ATT-3, and ATT-3.

The results of descriptive analysis show that PU-3, namely "*The use of automated system can enhance my effectiveness in decision-making in operations*" has the highest mean score (M=5.400), which means that the respondents are aware to some extent that the use of automated system for logistics and transportation operations can enhance the decision-making process and employees' contribution to the overall process. Overall, PU has also the highest mean score (M=5.067). Henceforth, usefulness of the system is considered an important factor. Because, employees think that even if the learning of operating the system is complicated, they can learn it if proper training is given to them. Therefore, PEOU has the lowest mean score (M=2.867). The details are given in Table 13.

Table 13: Results of the descriptive analysis

Variable	Item	Mean score	Standard deviation
PU		**5.067**	**1.306**
	PU-1	4.667	
	PU-2	5.133	
	PU-3	5.400	
PEOU		**2.867**	**1.395**
	PEOU-1	3.133	
	PEOU-2	2.867	
	PEOU-3	2.600	
ATT		**3.400**	**1.713**
	ATT-1	3.600	
	ATT-2	3.200	
INT		**2.933**	**1.935**
	INT-1	3.000	
	INT-2	2.867	

4.3. Reliability and Validity Check

As indicated by Hair et al. (2010), measurement model testing begins with an assessment of reliability, which is defined as how constant the measurement items and constructs are (2010).

Additionally, Cronbach's alpha (α) was used to evaluate dependability (Nunnally, 1978). As stated previously, the dependability assessment was based on the four cut-off values suggested by Hinton et al (2004). These points are (1) low reliability – lower than 0.50, (2) medium reliability – between 0.50 and 0.70, (3) good reliability – between 0.70 and 0.90, and (4) excellent reliability – over 0.90 levels.

The results through the analysis in Excel software show that the Cronbach alpha values fall within medium reliability (0.523~0.669). In details, PEOU variable shows the highest reliability value (0.669), followed by PU variable (0.633). The details are given in Table 14.

Table 14: Measurement model results

Variable	**Item**	**Cronbach alpha value**
PU	PU-1 PU-2 PU-3	0.633
PEOU	PEOU-1 PEOU-2 PEOU-3	0.669
ATT	ATT-1 ATT-2	0.523
INT	INT-1 INT-2	0.543

The validity test is then carried out in the next stage. The validity test is carried out through discriminant validity, so-called correlation analysis. In this analysis, validity is explained to the extent that variables or factors that are theoretically related to each other can or cannot be correlated to each other (Hubley, 2014). Henceforth, the discriminant validity analysis testifies whether the variables must be discriminated from each other or to what extent they empower each other in explaining a certain behavior. In the current analysis, it is found that within the TAM context, PEOU and PU has the highest correlation (0.450**), followed by INT and PEOU

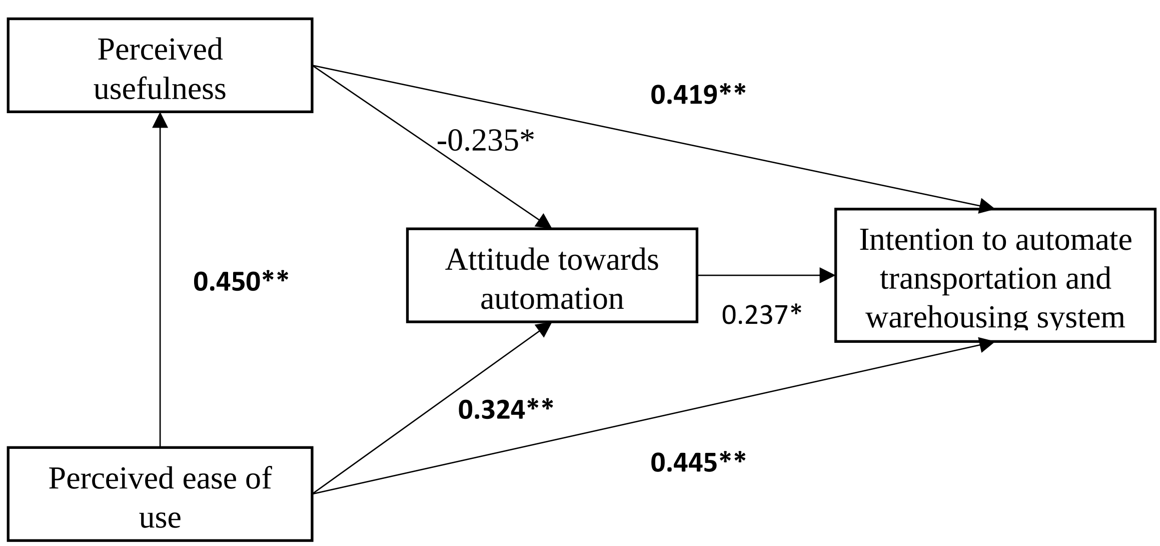
(0.445**), and INT and PU (0.419**). The findings can be explained to the extent that ease of use and usefulness of an automated system together empower employee's intention to use it when it is provided to them. Attitude is highly correlated with ease of use, while negatively correlated with usefulness. One reason for this can the initial experience that in the beginning employees might think that the system usage will be difficult to use, but when it comes to the actual behavior, they also take into consideration the usefulness of the system. The correlation value between intention and attitude also explains this connection (0.237*). Moreover, attitude and intention must be treated differently. The details are given in Table 15.

Table 15: Discriminant validity results (Correlation analysis)

Variable	**PU**	**PEOU**	**ATT**	**INT**
PU	**1**			
PEOU	**0.450****	**1**		
ATT	-0.235*	**0.324****	**1**	
INT	**0.419****	**0.445****	0.237*	**1**

The results of the correlation analysis are given in Figure 10. The analysis also reveals the relations of PU with INT (0.419), and PEOU with INT (0.445), as they are found to be highly significant.

Figure 10: Relations between TAM model variables (highly significant, * slightly significantly)**



4.4. Discussion of Findings

A major point of agreement among operators is how to get things into the hands of customers as quickly as possible. The next trend is the integration of logistics and e-business. Networking businesses typically collaborate with logistics sectors in attempt to acquire a more advantageous position and develop a complimentary and reliant connection. The unification may result in fewer intermediate operations. The producers might deliver the goods to the terminal clients right away. This might cut costs while also increase the effectiveness with which sources are managed. Furthermore, because the enterprises will not have to bear the expenditures of inventory and warehousing, they are becoming revolutionized sectors with cheap costs, increased efficiency, and division of specialty. Customers, for example, might obtain requested products from convenience shops.

In the current study, the cement industry is investigated. As the subject of the study the company sells to both domestic and foreign markets. The major commercial department is responsible for managing marketing and business operations, especially exporting processes. Furthermore, the marketing and sales team studies worldwide market requirements, customer preferences, and provides input to the production unit to aid in decision-making. There still is no autonomous system in place that estimates sales, communicates demands to production units, prepares inventory for shipment, and ultimately performs stock check and order preparation processes. Communication is carried out by the use of a human factor. As stated in the literature section, prompt responses to client requests and delivery are critical.

An AHP analysis with the assessment conducted among eight experts identified that in the context of transportation attributes, marketplace density is the most essential issue in picking a warehouse. Throughput is the second most important consideration in selection, followed by the necessity for security. Safety was selected as an important consideration in the warehousing selection procedure, because storage facilities are recognized as hazard-prone areas or workplaces. Main dangers include overexertion, which includes impairments in the operations of carrying, lifting, pulling, and pushing objects, as well as slippery terrain, bending, falling of items, and shelf disintegration in situations of drop. These instances may result in a fire, an explosion, or the spreading of dangerous substances throughout the region. Product lifecycle is an important element to take into consideration. It contains of stages from development to decline (APICS, 2016). Transportation of the products are highly necessary in introduction to maturity stages. Because, in introduction stage, customer become aware about a certain product even if the interest is low in the beginning, and it then starts to grow gradually. In growth stage, customers' requests increase, which starts to create both opportunities and challenges for manufacturers. Opportunities arise because companies can sell many products and earn money. Challenges arise because companies must comply with customer demands in a timely manner, while at the same time they must supply customers with high-quality products. This is when product reliability and success is proved in local and global markets. This is when transportation and inventory must be integrated comprehensively. If they are successfully managed, then delays will be minimized, and sometimes "make to stock" approach will work for companies. The pile product is stored in silos, it is recommended to store in a large bag and bag, mainly in closed warehouses.

Cement as a product is conservative in nature, although it is suitable for optimization and automation in production equipment. Rail transportation in Azerbaijan is more expensive than transport, although in international practice the railway is cheaper. Customers prefer to get cement directly from the machine in their warehouses and silos. Due to the small capacity of warehouses and silos, orders are preferred on a daily basis.

In the context of transportation modes, the current study revealed that road transportation is chosen as the second most successful option for transporting completed goods. When compared to railway transport, it has not restricted capabilities, a moderate to high cost, rapid delivery, very high interoperability, high dependability, very high intermodal capability, and courier service. According to the literature, road transport is very important in both the economic and social lives of emerging and developed countries. It is no surprise that this method of transportation was also chosen as the second priority by Azerbaijani experts. Given the country's location, manufacturers are concentrated around key highways and transportation centers. As a result, it is simple and inexpensive to employ this mode of transportation to deliver finished goods to any location inside the country.

When it comes to warehousing, both in growth and maturity stages, warehouse type selection is utmost necessary. The study's warehouse attributes and warehouse types have been adopted from APICS (2016) and other former studies. In an AHP process, experts found that the most significant aspect in transportation is fleet layout for any unique demands. It is also known as temporary storage in the transportation environment. It was also stressed in the literature study part that some items may be susceptible to deterioration and loss of quality (e.g., medicines, vegetables, fruits, etc.). In this situation, containers being carried to other locations must be outfitted with specialized equipment and technology, such as a ventilation system, in order to deliver products safely to clients. Furthermore, the factor evaluation revealed that capacity, also known as one-time transport volume, is the second highest priority. And finally, in warehouse type selection contest, according to experts, the most optimal warehousing type is an automated warehouse, private and specialized warehouses. As stated in the demographics section, the selected company's goal is to automate all activities from selling order entry through processing and distribution. As a result, the findings support the notion that an automated storage would considerably improve order management, product offerings, and other aspects. Furthermore, experts underlined that a private warehouse might be quite helpful because public warehouses are not always accessible because so many enterprises want to hire them.

In an entire logistics management process, communication and information sharing is considered a vital factor. When market demand and actual sales data are forecasted punctually, and shared with relative departments within a company, supply and manufacturing units will be able to match market demands more effectively. It will help companies reduce costs, while manage warehouses effectively and at the same time warehouses will have more space. In addition, sometimes customers may have customization requests, which will require manufacturers to immediately communicate it to decision makers and manufacturing units and to double check their warehouse management and transportation/delivery capacities. Henceforth, companies might have several risks to overcome, such as supply and demand risk, processing risk, financial and environmental risks, and others.

According to the TAM analysis results, the strongest correlation is identified between PEOU and PU, accompanied by INT and PEOU, and INT and PU. The findings are interpreted in terms of how the simplicity of use and utility of an automated process combine empower employees' desire to utilize it when it is made available to them. Attitude is positively connected with ease of use but adversely correlated with usefulness. One explanation for this is that employees may believe that the system would be difficult to use at first, but when it comes to actual conduct, they also evaluate the system's utility.

The logistics process is based on the procurement of goods at the most reasonable price, in the shortest amount of time, and with the best value quality percentage for any organization, private or public (Khataie & Bulkak, 2013). There must be value for money in the money invested in the delivery process, requiring the necessity for procurement systems, particularly in this modern technology era. Logistics network optimization aims to meet the needs of customers by developing plans, regulating and implementing them, and moving products and services from their place of origin to its final.

5. Conclusion

The current study, attempted to investigate the optimal decision-making in the context of transportation and warehousing operations. It applied a quantitative research method to initially employ AHP multi-criteria decision-making tool. To do that, literature review was conducted based on previous studies as well as study materials. Both important factors to optimize warehousing and transportation operations, as well as the optimal warehouse types and transportation modes were assessed. Overall, 8 experts were included in the current study. The results revealed that the most important factor in transportation revealed that fleet design for any specific needs. In transportation context, it is also referred as temporary storage. It has also been emphasized in the literature review section that some products might be vulnerable to decay and losing quality (e.g., medicines, vegetables, fruits, etc.). In this case, containers transported to other destinations must be supplied with different equipment, technology, such as air-conditioning system to be able to delivery product securely to clients. In addition, the evaluation of factors also showed that capacity, so-called one-time carriage volume, is the second top priority. Even if it applies to the vulnerable products, a container or a mode of transportation must be able to take as much volume as it can. In this case, risks will be reduced. In cement industry, products might also be vulnerable to external risks and conditions. Considering the advantages, it can be emphasized that air carriage can be the optimal solution for companies, particularly in the context of finished products. Road transportation is selected as the second optimal solution for carriage of finished products. In comparison with air transport, it is characterized with not limited capability, moderate to high cost, fast delivery, very high accessibility/flexibility, high reliability, very high intermodal capability, and courier service.

The expert evaluation regarding the assessment of the most important factor in transportation revealed that market density is the most important factor in selecting a warehouse. The second priority in decision-making is throughput, followed by the need for security. it is also revealed that the most optimal warehouse type by the experts is automated warehouse, followed by private, and specialized warehouses. As it is mentioned in the demographics section, for the selected company it is the target to make all the operations in an automated manner from putting sales orders to processing to the delivery process. Therefore, the finding supports that automated warehouse would significantly contribute to timeliness of order processing, product selection and others.

The TAM model analysis supports the idea that regardless of the sector, companies are highly interested in new technology adoption. In the context of transportation, the optimal control program can help with route planning by developing more efficient itineraries and improving utilization. It might also do this by broadening the sphere of responsibility and improving and centralizing the strategic planning. The incorporation of real-time data into the optimization technique, as well as the usage of technology to retain customers, operators, and administration informed, improves service visibility and staff happiness. Outbound or household moves, for example, can be integrated, as can transportation between several depots. Moreover, optimization tools allow a company to manage the distribution network in a broader sense instead of focusing just on logistics.

Additionally, Leading companies around the world have used logistics to convert expenses into value, boosting an enterprise's resilience in a volatile and dynamic international market. Many businesses have made a paradigm shift by perceiving logistics as an advantage rather than a variable cost. It has been accomplished by utilizing transportation to increase the consumer's delivering services level; access both regional and international emerging industries quicker than previously; and expedite the pace with which new goods are launched. At the global scale, logistics related infrastructure such as transport facilities, forms of transportation, interconnection, and information processing, as well as storage facilities, play an important role in the general movement of goods generated in the agricultural, production, and mining sectors.

Perceived usefulness and Behavioral Intention to use of the internet were highly connected perceptual characteristics. As a consequence, according to the study model assessed in the measurement model, Internet access that is directly impacted by intention will be linked to environmental/situational conditions.

The findings give some rationale for the company expenditure in Internet technology in order to enhance ICT acceptance and spread, and hence Internet use in warehousing and transportation operations. Some of the predecessors of Internet usage discovered in this study may aid other companies in lobbying and advocating for external support support of a tax regime that benefits the industry, as well as the availability of high price priced bandwidth requirements for institutions. Governments and policymakers must distribute their limited human and financial resources more wisely, which will ultimately stimulate private sector to make transition to high technology usage. For instance, assisting companies that use technologies in their operations can be considered sustainable businesses and therefore can be given incentives.

5.1. Limitation and Future Research Direction

One of the limitations of the current research is that in the analysis of transportation modes, it did not consider sub-types of transportation modes. Such that, railcars have multiple types: (1) Boxcar; (2) Hopper car; (3) Tank car; (4) Flatcar; (5) Refrigerated car; (6) Gondola car, and so on. The same applies to other modes of transportation too. Henceforth, it would be recommended for the future research to take these sub-types into consideration, particularly those that investigating the hazardous and vulnerable products. Assessing the specific sub-types with consideration of more attributes would help companies to make punctual decisions in specific situations. In addition, other methodological approaches, such as TOPSIS method can be employed to make second-level selection of the alternative in light of the transport mode sub-types.

Second, the majority of employees in our assessment included managers and decision-makers in key operations who do not really have much exposure to ICTs or a strong knowledge of macro or environmental issues relevant to Internet sector support. As a result, the findings of the study on the link between behavior intent to use the Internet and contextual variables may not fully reflect the perspectives of management. Third, rather than two ways, all responses in the questionnaire distributed were phrased in one direction. Future studies should explore these study limits at the design phase, so that study may be improved and therefore achieve more accuracy.

List of Appendices

Appendix A. Survey questionnaire with TAM model variables

Variable	**7-point Likert scale**						
Perceived Usefulness (PU) PU-1. The use of automated system can help me accomplish my work tasks more quickly than before PU-2. The use automated system can improve my task performance PU-3. The use of automated system can enhance my effectiveness in decision-making in operations	1	2	3	4	5	6	7
Perceived Ease of Use (PEOU) PEOU-1. Learning how to use automated system can be easy for me PEOU-2. I think automated system is easy in doing what I want it to do PEOU-3. My interaction with automated system can be easy and clear in performing the task	1	2	3	4	5	6	7
Attitude (ATT) ATT-1. I am positive about the use of automated system ATT-2. I think it is a must technology to contribute to the efficiency and effectiveness of operations	1	2	3	4	5	6	7
Intention (INT) INT-1. If I am given access to automated system, I would definitely use it INT-2. I plan to ask the company to use automated system of operational efficiency	1	2	3	4	5	6	7

Source: Hwang et al. (2014); Davis et al. (1989); Venkatesh and Davis (2000)

Appendix Ba. Expert evaluation of transportation criteria through AHP

B	C	D	E	F	G	H	I	J	K
	Exp1	**Exp2**	**Exp3**	**Exp4**	**Exp5**	**Exp6**	**Exp7**	**Exp8**	**Geomean**
CAP-COS	6	5	2	2	1	2	3	1	**2.276**
CAP-CAPC	6	4	3	3	2	3	4	2	**3.177**
CAP-SPE	7	6	0.500	0.500	0.333	0.500	1	0.333	**0.935**
CAP-ACC	5	2	3	3	2	3	4	2	**2.847**
CAP-SEC	5	2	2	2	1	2	3	1	**1.984**
CAP-LIA	6	0.333	0.500	0.500	2	3	4	0.333	**1.189**
CAP-FLED	0.333	0.333	0.250	1	3	1	2	0.333	**0.697**
CAP-DUR	0.143	0.200	0.250	1	3	1	2	0.333	**0.588**
CAP-ENV	0.167	0.500	0.500	0.500	2	3	2	1	**0.841**
CAP-INT	0.2	7	1	1	3	2	1	2	**1.423**
COS-CAPC	2	6	6	3	2	3	2	5	**3.266**
COS-SPE	1	5	5	2	0.333	6.000	5	4	**2.586**
COS-ACC	1	1	2	2	0.333	6.000	5	1	**1.586**
COS-SEC	3	3	3	3	2	1	0.500	2	**1.889**
COS-LIA	3	2	2	2	0.333	0.250	0.333	1	**0.951**
COS-FLED	0.5	0.333	0.200	1	0.250	0.200	0.500	0.250	**0.347**
COS-DUR	0.25	0.25	0.250	2	0.333	0.200	0.333	0.333	**0.351**
COS-ENV	0.333	1	1	4	4	4	3	0.500	**1.414**
COS-INT	0.333	0.500	5	0.500	0.250	0.250	0.250	5	**0.652**
CAPC-SPE	4	2	4	0.333	0.333	2	4	4	**1.807**
CAPC-ACC	5	2.000	6	6	2	1	3	7	**3.330**
CAPC-SEC	6	1.000	2	2	0.500	0.500	2	3	**1.565**
CAPC-LIA	6	0.500	1	1	0.333	2	3	2	**1.364**
CAPC-FLED	5	5.000	4	3	1	1	0.500	0.333	**1.631**
CAPC-DUR	3	5.000	6	4	4	4	3	4	**4.027**
CAPC-ENV	3	4.000	5	3	1	1	0.500	3	**2.013**
CAPC-INT	7	6.000	0.500	0.500	0.250	0.333	0.250	0.500	**0.758**
SPE-ACC	9	2.000	2	2	0.333	2.000	1	2	**1.769**
SPE-SEC	9	1.000	1	1	0.250	0.333	0.250	1	**0.811**
SPE-LIA	8	0.250	0.250	0.200	1	1	0.500	3	**0.789**
SPE-FLED	0.143	0.250	0.250	0.200	1	3	2	3	**0.651**
SPE-DUR	0.167	6.000	7	4	1	1	1	5	**1.855**
SPE-ENV	0.143	5.000	6	3	0.500	0.200	0.333	4	**1.070**
SPE-INT	7	5.000	6	3	0.500	0.200	0.333	4	**1.740**
ACC-SEC	2	4.000	4	1	1	1	1	2	**1.682**
ACC-LIA	1	1.000	1	0.250	0.333	0.333	0.333	1	**0.557**
ACC-FLED	1	0.143	1	1	1	2	0.250	1	**0.719**
ACC-DUR	1	0.143	1	0.250	1.000	2	0.250	1	**0.605**
ACC-ENV	0.500	0.167	2	2	2	3	0.333	2	**1.037**

Exp2 | Exp3 | Exp4 | Exp5 | Exp6 | Exp7 | Exp8

Appendix Bb. Normalization of criteria weights and ranking of most important criteria

B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
															Geomean		1.769
	CAP	COS	CAPC	SPE	ACC	SEC	LIA	FLED	DUR	ENV	INT				2.276		0.811
CAP	1	2.276	3.177	0.935	2.847	1.984	1.189	0.697	0.588	0.841	1.423				3.177		0.789
COS	0.4394	1	3.266	2.586	1.586	1.889	0.951	0.347	0.351	1.414	0.652				0.935		0.651
CAPC	0.3148	0.3061	1	1.807	3.330	1.565	1.364	1.631	4.027	2.013	0.758				2.847		1.855
SPE	1.0697	0.3867	0.5533	1	1.769	0.811	0.789	0.651	1.855	1.070	1.740				1.984		1.070
ACC	0.3512	0.6306	0.3003	0.5652	1	1.682	0.557	0.719	0.605	1.037	1.682				1.189		1.740
SEC	0.504	0.5294	0.6389	1.2327	0.5946	1	1.542	0.475	0.663	0.744	0.625				0.697		1.682
LIA	0.8409	1.052	0.733	1.2676	1.7955	0.6484	1	0.657	1.834	2.627	2.583				0.588		0.557
FLED	1.4352	2.8851	0.6132	1.5368	1.3908	2.104	1.522	1	1.189	2.495	3.011				0.841		0.719
DUR	1.7007	2.8473	0.2483	0.5392	1.654	1.5075	0.5453	0.8409	1	2.030	1.291				1.423		0.605
ENV	1.1892	0.7071	0.4967	0.9348	0.9647	1.3443	0.3807	0.4009	0.4927	1	1.338				3.266		1.037
INT	0.7028	1.5344	1.3187	0.5747	0.5946	1.6012	0.3871	0.3322	0.7746	0.7473	1				2.586		1.682
SUM	**9.548**	**14.155**	**12.346**	**12.979**	**17.526**	**16.136**	**10.227**	**7.75**	**13.379**	**16.017**	**16.103**				1.586		1.542
															1.889		0.475
															0.951		0.663
	CAP	COS	CAPC	SPE	ACC	SEC	LIA	FLED	DUR	ENV	INT	**Weight**	**Ranking**		0.347		0.744
CAP	0.105	0.161	0.257	0.072	0.162	0.123	0.116	0.090	0.044	0.052	0.088	**0.116**	**3**		0.351		0.625
COS	0.046	0.071	0.265	0.199	0.090	0.117	0.093	0.045	0.026	0.088	0.040	**0.098**	**5**		1.414		0.657
CAPC	0.033	0.022	0.081	0.139	0.190	0.097	0.133	0.210	0.301	0.126	0.047	**0.125**	**2**		0.652		1.834
SPE	0.112	0.027	0.045	0.077	0.101	0.050	0.077	0.084	0.139	0.067	0.108	**0.081**	**7**		1.807		2.627
ACC	0.037	0.045	0.024	0.044	0.057	0.104	0.054	0.093	0.045	0.065	0.104	**0.061**	**11**		3.330		2.583
SEC	0.053	0.037	0.052	0.095	0.034	0.062	0.151	0.061	0.050	0.046	0.039	**0.062**	**10**		1.565		1.189
LIA	0.088	0.074	0.059	0.098	0.102	0.040	0.098	0.085	0.137	0.164	0.160	**0.101**	**4**		1.364		2.495
FLED	0.150	0.204	0.050	0.118	0.079	0.130	0.149	0.129	0.089	0.156	0.187	**0.131**	**1**		1.631		3.011
DUR	0.178	0.201	0.020	0.042	0.094	0.093	0.053	0.109	0.075	0.127	0.080	**0.097**	**6**		4.027		2.030
ENV	0.125	0.050	0.040	0.072	0.055	0.083	0.037	0.052	0.037	0.062	0.083	**0.063**	**9**		2.013		1.291
INT	0.074	0.108	0.107	0.044	0.034	0.099	0.038	0.043	0.058	0.047	0.062	**0.065**	**8**		0.758		1.338

B	C	D	E	F	G	H
CAP	1.5232	13.18			**Lambda**	12.538
COS	1.2878	13.108			**CI**	0.1538
CAPC	1.5578	12.422			**CR**	0.1018
SPE	0.9958	12.35				
ACC	0.7347	12.025				
SEC	0.7576	12.259				
LIA	1.2438	12.369				
FLED	1.6184	12.351				
DUR	1.2199	12.515				
ENV	0.7755	12.25				
INT	0.8491	13.088				

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