UNIVERSITY OF LJUBLJANA
SCHOOL OF ECONOMICS AND BUSINESS

MASTER'S THESIS

AN ANALYSIS OF INTERNET OF THINGS IMPLEMENTATION IN JORDANIAN LOGISTICS COMPANIES

Ljubljana, March 2021 DIA'A ALDEEN SHARAWI

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LIST OF ABBRAVATIONS

4G: Fourth Generation
AIDC: Automatic Identification and Data Capture
API: Application Program Interface
Auto ID: Automatic Identification
CEB: Certain Electronic Barcode

CEO: Chief Executive Officer
DDS: Data Distribution Service
DNS: Domain Name System
EDI: Electronic Data Interchange
EPC: Electronic Product Code
FQDN: Fully Qualified Domain Name
GDA: Global Distribution Alliance
GDB: Gross Domestic Product
GIS: Geographic Information System
GPC: Government-Private Cloud
GPS: Global Positioning System
GTIN: Global Trade Item Number
HTTP: Hypertext Transfer Protocol
IaaS: Infrastructure as a Service
ID: Identification
IoT: Internet of Things
IP: Internet Protocol
IR Sensor: Infrared Sensor
IT: Information Technology
JIT: Just-in-Time
M2M: Machine to Machine
MENA: Middle East and North Africa
MIM: Metal-insulator-metal
MQTT: Message Queue Telemetry Transport
NFC: Near Field Communication
ONS: Object Name Service
ONS: Object Name Service
PaaS: Platform as a Service
PML: Physical Markup Language
QoS: Quality of Service
RFID: Radio-frequency Identification
ROI: Return of Investment
RPA: Robotic Process Automation
SAS: Software as Services
SLAs: Service Levels Agreements
SOAP: Simple Object Access Protocol
SQL: Structured Query Language
UTA: User Training Acceptance
WIFI: Wireless Internet Free Internet
WSN: Wireless Sensor Networks

INTRODUCTION

Over the last decades, business strategy was directed to information technology strategy because of the importance of achieving and reshaping a business strategy, transforming business scope and business process. IT strategy as a functional level strategy essentially depends on business strategies like what is explained in many business research studies, such as the business value of IT, business process redesign, and IT outsourcing. (Bharadwaj, El Sawy, Pavlou & Venkatraman, 2013). Moreover, the transformation of digital business is disrupting business in different fields by removing the barriers between people, companies, and things. That gives them opportunities to introduce new services and products, and enhance efficiency. These improvements are happening in all fields, but they have common subjects, such as business model and process transformation, personalize customer/ citizen experiences, and workforce empowerment and innovation. (Schwertner, 2017).

Digital innovation includes changes in strategies, processes, services, and products, which drives the companies to draw new plans in their organizational logic. The importance of digital technology is increasing for companies, also the alignment between IT and business to achieve integration in information technology strategy and business strategy in a common digital business strategy. Digital transformation affects many fields inside a company, such as marketing, product development, IT, and human resources. All these fields need a common understanding to determine the priorities of digital transformation (Berghaus & Back, 2016). The digital transformation is complicated, costly, and big. It covers customers' and employees' participation efficiently, forming new corporation teams, imposing process improvements and innovation, and enhancing business model. The digital transformation has to present a tangible strategy for understanding and merging a change (Solis, 2016).

Most companies try to get new technology in their related work to execution, technology architecture, and appropriate service for their business when it is available in a market. The technology doesn't affect only a market, but also customers' and employees' behavior and expectation. The technology changes have alignment with the market changes, that works to enable competition (Solis, 2016). Also, increasing in sales, production, and innovations to create value. Moreover, creating new ways to interact with clients (Matt, Hess & Benlian, 2015).

Logistics Industry:

The logistics industry showed big development worldwide in last years, is one the main factor for economies. Logistics operations are important and have a big impact on trade and production. Logistics companies affect Companies and factories' raw materials purchase, process these raw materials in shipment, and clearance for the final client. In general, logistics indicates the flow process of the information from a source to product consumption, control, and plan in this process both in low cost and productive way via inventory and storage facilities. Logistics services include different types of services,

such as transportation, clearance, storage, insurance, inventory and stocks management, packaging, and customer relations management (Sezer & Abasiz, 2017).

In the 21st century, the logistics industry is considered one of the three most important fields besides gene technology and microbiology. Because of the far distance between the procurement point and the consumption. The logistics industry began to be considered as the main tool for competition, especially in developed countries (Sezer & Abasiz, 2017). The logistics industry has a considerable consequence on international trade between countries and economic alliances. Generally, the weak of the logistics industry and performance leads to handicap the international trade significantly and negatively impact the competition capability in any country. Poor infrastructure, rules, lack of transparency between different entities lead to weak logistics operations. Although the logistics sector contribution to the GDP in any economy (Hamed, 2019).

The logistics industry continues to improve its infrastructure and facilities, especially the information technology-based platforms. The international competition enhanced the quality role in the business world to keep its competition capability and handle increasing pressures and business integration with new and developed global markets. These pressure and challenges have placed renewed focus on quality improvement for a company to exist for a long time. Moreover, there is much evidence that the technology enhances and improves the logistics operations to enriched the job and increased job satisfaction (Brah & Lim, 2006).

Jordan's transportation and logistics field has a main role in Jordan's economy and contributes to 8.2% of GDP. It is growing at an annual rate of 6%. This sector employs nearly 8% of the Jordanian labor force, which leads to the offer of 126000 jobs. Jordan has 325 licensed transportation and logistics companies are currently working.

The quality of Jordan’s logistics infrastructure is globally recognized. Its telecommunications and electricity infrastructure ranks one of the best in the region, also air transport quality and connectivity. Jordan's focal point is air transport infrastructure, which has three main airports, two in Amman city and one in Aqaba city. The main Airport in Jordan is Queen Alia airport in Amman which won the 2014 Airport Council International Awards for the best and most improved airport in the Middle East and North Africa region (MENA). Jordan's Highway network covers more than 2700 kilometers and connects all Jordan's corners, jointly with nearly 1,900 km of secondary roads. Its logistics and trade procedures are considered very efficient, especially when comparing it with regional competitors. Jordan's government has lately improved and streamlined the custom clearance, enhanced the use of the electronic single window, and enhanced the Aqaba port infrastructure to optimize importing and exporting procedures. Jordan's government is dedicated to continuously improving its infrastructure and transportation networks with state-of-the-art technologies to enhance logistics operations and services such as tracking vehicles and importing and exporting procedures with custom clearance.

Background:

For logistics companies, the IoT is the future. By using IoT, the companies can capture an enormous amount of data in real-time and employ them to enhance the entire supply chain like storage, cargo management, and delivery. IoT implementation is reflected positively in data and supply chain accuracy, which leads to improving the logistic operations and open new business models in the future.

The internet of things is the name given to a wide network of things are correlated, such as vehicles and goods. These objects are fitted with sensors that can transfer an enormous amount of data to the related parties in real-time, which can help logistics companies to deal with problems before they emerge such as, crowding in cargo yards and handle with perishable goods. In this role, the IoT plays a key part in supply chain issues.

IoT contributes to decrease operational costs and enhance logistics operations. Also, open new markets and enhance new business models depend on enormous data, which makes IoT a valuable technology for logistics companies.

In this research work, I will highlight the IoT implementation at the logistics companies, and how the IoT affects their operations. Moreover, what is the challenges and opportunities are created when implementing the IoT at the logistics companies. Also, how cloud computing is implemented and the benefits of this implementation at the logistics companies. Then I will take a case study on the IoT implementation at the Jordanian logistics company " Aramex company".

Problem Purpose Statement:

The purpose of this master's thesis is to contribute a better understanding of how can the IoT is used by logistics companies in their operations. Moreover, how the IoT implementation gives them new opportunities to improve their services and open new markets.

With the growth of E-commerce and digital business in the last years, logistics companies have gained importance for their operations and services that play a main role in economic growth and E-commerce improvement globally. This growth and development increase the pressure on the logistics operation, which logistics companies have to handle with hundreds of thousands of parcels and shipments daily around the world. This development affects warehouse management, pickup, tracking and monitoring, delivery, and customs clearance efficiency. Due to the enormous data flow is dealt with by logistics companies daily. Moreover, logistics companies have to handle an enormous number of clients. Each one has his/her special requirements due to different products such as cold chain logistics, which requires accurate information in all stages of the shipment journey.

With all this growth and development, many logistics companies depend on paper for recording, guiding, and information is rarely shared even in the same company, which leads to poor logistics operations inside and outside the company, many information

loss, and poor customer services. On the other hand, many logistics companies have begun to enhance their performance by employing new technologies. Many of them started to improve their operational efficiency through the continuous implementation of information or automation technologies. The logistics companies have to adopt new information technologies to improve their operations and raise their capability in the E-commerce age.

One of the promising technology that can be implemented at logistics companies to face some difficulties and challenges is the Internet of things (IoT). IoT technology has the capability to determine various objects by using Auto-ID technologies such as RFID, GPS, and barcode, which facilitates the information capture in real-time and tracking a shipment, which leads to improving decision making, which will benefit the company.

Besides IoT implementation, another technology that can be implemented with IoT is cloud computing. The integration between cloud computing and IoT can compensate for IoT technological constraints such as storage, processing, and communication. Also, Cloud computing can provide efficient solutions to manage IoT services which will benefit logistics companies in their services and operations.

Research Objectives

The goal of this study is to provide an overview and analyze how the IoT affects logistics companies through implementing new technologies such as RFID and cloud computing. And how the Business process is changed through implementing these applications. Also, the opportunities and challenges facing the IoT implementation at the logistics companies.

In this research, I will use secondary and primary data to show the goals of this study. In the secondary data, I will choose to use scientific data from different sources such as literature published on different reports, books, articles, and Journals. Also popular data such as websites and magazines. And official data from government publications. To analyze the IoT and cloud implementation at logistics companies, also to find out the opportunities and the challenges that will face the companies regarding the IoT. In the primary data, I will follow a semi structured interviews approach with a Jordanian logistics company. By preparing some questions to find out the information about the IoT implementation, technologies, benefits, and challenges, that face them in their operations.

Research Questions

1. How can IoT, RFID, and cloud computing be implemented at logistics companies?
2. What are the benefits and challenges of IoT, RFID, and cloud computing implementation at logistics companies?

3. How can IoT affect Jordanian logistics companies?

1 INTERNET OF THINGS (IOT) IN LOGISTICS COMPANIES

Logistics is one of the main applications where IoT is considered an appropriate solution. Also, IoT is predicted to have a significant impact on logistics services (Xu, Yang & Yang, 2013). Logistics companies are facing many challenges with handling massive client requirements. Because of large difference of clients' requirements with different products. Such as some customers request cold chain logistics for some special products like flowers. Some customers require urgent logistics service as the emergency orders. Also, logistics companies deal with hundreds of thousands of products every day. It is important to create an efficient system to facilitate their works (Wu, Cheung, Lo, Zhong & Huang, 2020)

IoT may be a promising technology that may be integrated with logistics systems to face these challenges. IoT can determine different objects using Auto-Id techniques such as radio frequency identification (RFID) and barcodes. Then, the IoT can collect and capture the information from diverse objects, which achieves traceability and real-time visibility. With this information, logistics companies can take advanced decision-making such as logistics routing optimization (Wu, Cheung, Lo, Zhong & Huang, 2020). Moreover, as transportation systems develop and vehicles, with a growing level of networking, sensing, and communication capability, which enabling to interact with each other and facilitate logistics operations (Hopkins & Hawking, 2018).

1.1 Overview of Internet of Things

The next step of computing generation will be out a range of traditional desktops. In the Internet of things paradigm, many subjects will be connected with the network in different forms. Radiofrequency Identification (RFID) and sensor network technology will increase to meet new challenges, in a way to merge information and communication system invisibly in the environment around us. This generation outcome has huge amounts of data that should be processed, stored, and presented effectively, which can be interpreted easily. Cloud computing can provide the virtual infrastructure to merge storage devices, monitoring devices, analytical tools, client delivery, and visualization platform. Moreover, cloud computing offers will enable end-to-end service provisioning for users and businesses to access applications at any time in any place. Smart connection with existing network and context-aware is an integral part of using network resources in IoT. With improving WIFI and 4G, the development of information and communication have become everywhere. However, to see IoT, we have to exceed traditional mobile computing scenarios that use portable and smartphones and develop to connect existing daily things and embed intelligence in our environment. By understanding users and their devices' situation, software architecture, and communication network to transfer contextual information to relevant and analytical tools at IoT that pursue independent and smart behavior. By these

fundamentals, we can achieve a smart connection and context-aware. (Gubbi, Buyya, Marusic & Palaniswami, 2013).

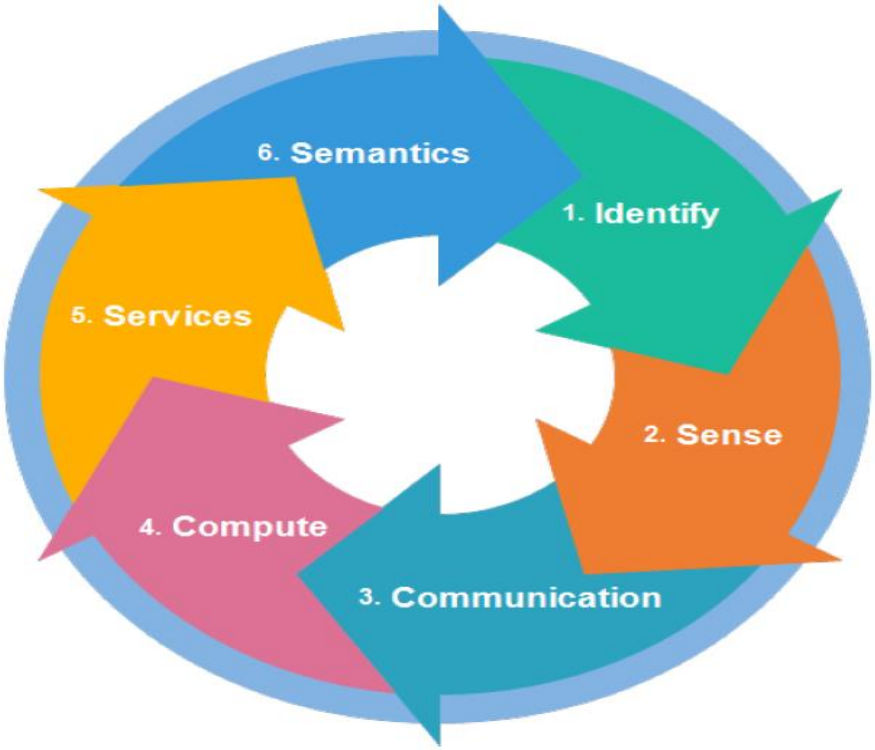
The internet of things is also called the internet of everything or the industrial internet. It is a new technology paradigm that envisions an interaction between devices and machines by a global network with each other. The IoT is known as one of the most important fields of future technology and has attention from a vast range of industries. The value of IoT can be achieved for companies when the connected devices can communicate with each other and merge with an inventory system, customer support, business analytics, and business intelligence. IoT is applied in many applications in our life, such as health care by using sensors to check human body temperature, heartbeat rate, and blood pressure. Also, in smart homes, because people use many devices like fridges, heaters, fans, and air condition. Other applications of IoT in animal tracking, smart robotics grippers, etc. (Burhan, Rehman, Khan & Kim, 2018). IoT affects available information in the supply chain and how the supply operates. It starts from receiving to a warehouse to delivery to customers, the IoT transforms a business process to be more accurate through real-time to flow items. (Lee & Lee, 2015). It achieves the goals of intelligent identification by locating, tracking, observing, and managing things. (Chen, Xu, Liu, Hu & Wang, 2014)

After technology development, the computing power of storage and battery capacities have become available at relatively lower cost and size. That leads to developing electronic devices to be able to determine and connect, which could be embedded in other systems, devices, and facilities. IoT should have the following three characteristics (Chen, Xu, Liu, Hu & Wang, 2014).

1. Comprehensive Perception: Using RFID, two-dimensional barcode, and sensors to get information about the object at any time and place. Information systems and communication can be invisibly merged with the environment around us. Sensor network allows people to interact with the real world remotely. It includes Identification technologies to determine objects and location identifications (Chen, Xu, Liu, Hu & Wang, 2014).
2. Reliable Transmission: Through a set of available radio networks, internet, and telecommunication, the information could be available at any time. Communication includes a variety of wireless and wired transmission technology, network, gateway technology, and switching technology. Moreover, IoT can create interaction between the digital world, the virtual world, the physical world, and society. Furthermore, Machine to machine (M2M) is the main technological execution for the network of things, which represents communications and connections between M2M and human to machine also mobile to a machine (Chen, Xu, Liu, Hu & Wang, 2014).
3. Intelligent Processing: Through IoT data collection from the database, many intelligent computing technologies, including cloud computing will be able to prop IoT data applications. This lets the network service provider handle millions or billions of messages immediately by cloud computing. So cloud computing will be encouraging for the Internet of things (Chen, Xu, Liu, Hu & Wang, 2014).

IoT offers many facilities and features for users to use them correctly, there are some elements needed to deliver the functionality of IoT.

Figure 1: The IoT elements



Source: (Burhan, Rehman, Khan & Kim, 2018)

1. Identification: Identification offers an obvious identity for every object inside a network. There are two processes for identification are Naming and addressing. Naming refers to the name of the object through the address. It is unique for every specific object. These both are very different from each other because two or more objects may have the same name but have a different address. (Burhan, Rehman, Khan & Kim, 2018). For example, a domain name system (DNS) is a good identification way that uniquely determines a host on the internet. It also reflects host property through a fully qualified domain name naming policy (FQDN). Moreover, it provides address map through DNS based on the success of DNS, object name service (ONS) is published to determine metadata and service associated with a certain electronic barcode (CEB). The suggestion of ONS indicates to a similar structure could apply to the object identification in IoT (Zhang et.al., 2014).

2. Sensing: The process of collecting information from an object is known as sensing. The information has been collected through sent to the storage media. There are many sensing devices to collect information from objects like RFID tags, actuators, smart sensors, and wearable sensing devices (Burhan, Rehman, Khan & Kim, 2018).

3. Communication: Communication is one of the main purposes of IoT. The devices are connected and communicated with each other. The devices send and receive messages, information, and files. Many technologies facilitate communication such as RFID, Near field communication (NFC), long term evolution, WIFI, and Bluetooth (Burhan, Rehman, Khan & Kim, 2018).
4. Computation: Computation is implemented on information that is collected by using sensors. It is utilized to remove undue information. Many essential systems and programs have been developed to perform processing in IoT applications. Regarding hardware platform, Rasperry Pi, Audrino, and Intel Galileo are used, and the operating system plays the main role to perform processing. There are many kinds, such as Android, tiny OS, and lite OS, etc. (Burhan, Rehman, Khan & Kim, 2018).
5. Service: IoT applications provide 4 types of services. The first one is an identity-related service. It uses to get an identity of objects that send the request. The second service is information collection from objects, the processing is implemented by aggregation service. The third service is collaborative services, the decisions are taken according to information are collected, then the appropriate responses are sent to devices. The last service is used to respond directly to devices without rigidity about place and time (Burhan, Rehman, Khan & Kim, 2018).
6. Semantics: It is the responsibility of IoT to facilitate user performance. It is the most important in IoT to achieve its responsibilities. It is like the brain of IoT. It gets all information and takes the best decision to send a response to the devices (Burhan, Rehman, Khan & Kim, 2018).

1.1.1 IoT Architecture

The number of things is increased significantly with the passage of time, and the current architecture with protocols have been adopted cannot handle with a big network of IoT, which caused to need new open architecture to process many security and quality of service issues also to support the current network applications by using open protocols. Without guarantee suitable privacy, IoT cannot be adopted by many. Therefore, data protection and privacy of users are the main challenges of IoT. For further development of IoT, a multi-layered security architecture is proposed. It is divided into six layers (Farooq, Waseem, Mazhar, Khairi & Kama, 2015).

1. Coding layer: is the basis of IoT, which identifies the objects. In this layer, each object is hired with a unique ID to facilitate object discrimination.
2. Perception layer: This is a device layer of IoT that gives physical meaning to every object. It has data sensors in many different shapes, such as RFID tags, IR sensors, or other sensor networks, which can sense the temperature, moisture, location, and speed, etc. (Farooq, Waseem, Mazhar, Khairi & Kamal, 2015). This layer processes data with a cooperative access point to get useful information then transfer it to the network layer through access devices (Duan, Chen & Xing, 2011).
3. Network Layer**:** The purpose of this layer is to receive useful information through digital signals forms from the perception layer and send them to the middleware

layer by transmission mediums such as WIFI, WIMAX, Bluetooth. (Farooq, Waseem, Mazhar, Khairi & Kamal, 2015)

4. Middleware Layer: At this layer processes information received from sensors devices, which consists of technologies such as cloud computing, Ubiquitous computing, which guarantee direct arrival to the database to store necessary information (Farooq, Waseem, Mazhar, Khairi & Kamal, 2015).
5. Application Layer: This layer realizes the IoT application for all industries. Based on processed data. These applications enhance IoT development, so this layer is very useful to wide development to IoT networks. (Farooq, Waseem, Mazhar, Khairi & Kamal, 2015). Moreover, it integrates all main functions for lower layers and provides limited services for all industries. It includes environment monitor applications, smart transportation, smart logistics services (Duan, Chen & Xing, 2011).
6. Business layer: This layer manages the IoT applications and services. Moreover, it is responsible for all researches related to IoT (Duan, Chen & Xing, 2011).

1.1.2 IoT Implementation in Jordan

In Jordan. the internet of things is still in the early phases of implementation and regulations. For organizing, IoT issues in Jordan are subjected as in almost the rest of the world according to the traditional regularity and statutory frameworks governing the Telecommunications sector. The most using of IoT technology in Jordan is in protection cameras in houses, health monitoring of patients, and smart homes. Also, in the transportation sector, such as parking, smart roads management, and logistics management. At the national level, the IoT is used in the national electricity management, floods, disaster monitoring management, firefighting, and smart cities (The Hashemite Kingdom of Jordan Telecommunications Regulatory Commission, 2017).

In Jordan, control and security services, smart home automation, tracking services, near field communication services (NFC), and health services are the main usages for the IoT. Jordan is characterized by a wide range of features for IoT implementation. In terms of spread telecommunication services and qualified young human resources. Jordan is ranked first in the middle east region, ahead of 12 countries, which qualifies it to provide IoT services (The Hashemite Kingdom of Jordan Telecommunications Regulatory Commission, 2017).

1.1.3 IoT Implementation Challenges in Jordan

There are points and challenges that have to be considered when implementing IoT in Jordan, as following:

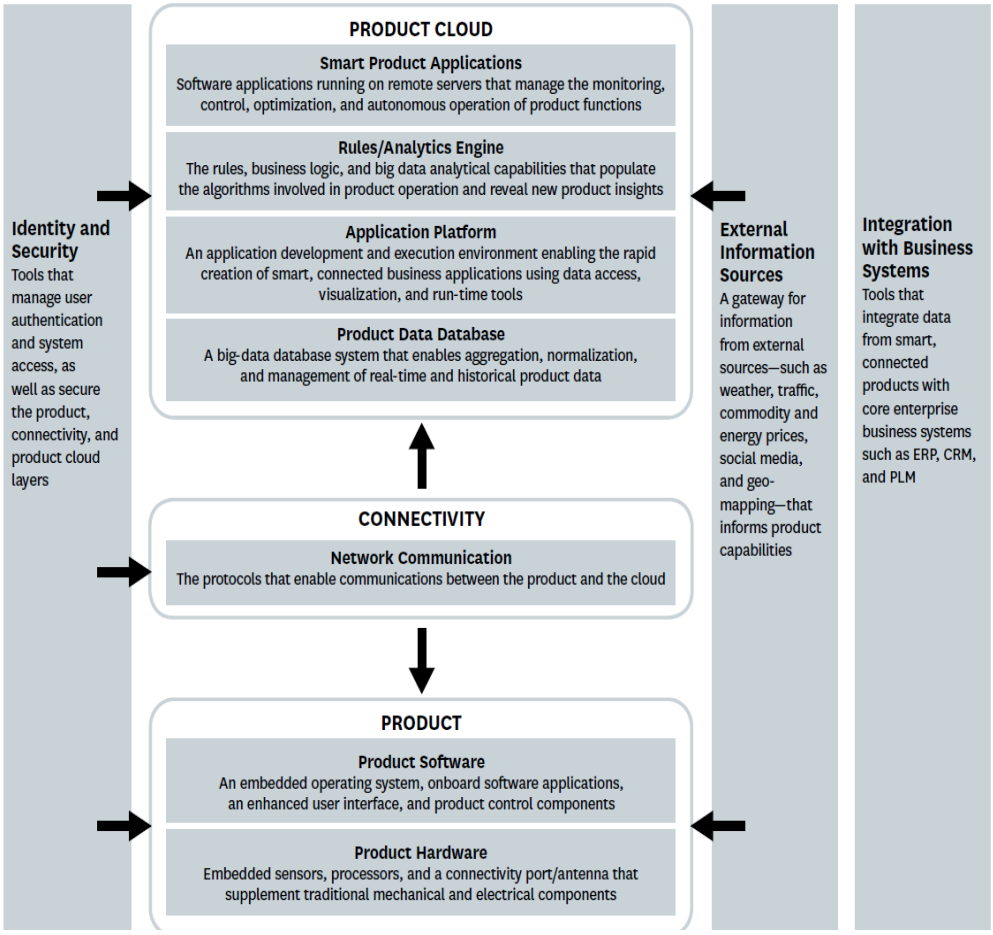
1. Traffic capacity: Relating to the ability to manage a certain amount of presented traffic per area unit in the busy hours.
2. Mobility/coverage: referring to the capability to provide the connection in any condition, on the go or stop, regardless of user location.
3. Network and device energy efficiency: relating to the power consumption in network infrastructure and wireless devices. Crucial factors that affect power efficiency are energy storage improvement, Solution System design, and energy technology improvement.
4. A massive number of devices: relating to the capability to handle a massive number of connected devices per area unit. While preventing the related control signaling overhead determines the user experience.
5. Reliability: relating to a capability to provide a level of given service with a high level. If a high level of reliability applied, the safety of life applications and critical mission applications can be supported
6. Latency: indicating the time that system needs to transfer data through its domain of responsibility. Moreover, it indicates sending and receiving data within an acceptable range.
7. Spectrum and bandwidth flexibility: referring to a system design flexibility to interact with different spectrum scenarios, also the capability to interact with higher frequencies and wider bandwidths in the future.
8. Achievable end-user data rate: referring to the highest level to the data rate a user normally experiences, like the perceived speed of the data connection.
9. The economic factor: indicating the user's capability to buy the IoT solutions, including enabled and connected devices. IoT implementation requires business and technical model innovation.
10. Interoperability and standardization: referring to multi-vendor device and technology coexistence (The Hashemite Kingdom of Jordan Telecommunications Regulatory Commission, 2017).

1.2 Requirements of IoT Implementation at Logistics Companies

IoT is a multibillion-dollar market that represents the integration between information systems and physical objects at companies. Therefore, the physical objects are got ready with specific technologies is called identification and data capture (AIDC), such as RFID tags, sensor tags, and telematics modular. These products acquired smart specification, including location, identification, sensing, communication, and logical functions, that facilitate IoT services in logistics. (Papert & Pflaum, 2017). The implementation of these services has three core elements, physical element, smart element, and communication element. They are highly complex and correlated with a high amount of cost. (Porter & Heppelmann, 2014). Firstly, there is a need for a physical element such as products, pallets, and containers. Then the realization of IoT service demands innovations to achieve integration between the physical component and existing information system (Mayordomo et.al., 2011). Briefly, the smart element enhances the physical element capabilities, and the connection element enhances the capabilities and value of the smart element. The outcome is the value creation for the object (Porter & Heppelmann, 2014).

Intelligent connected products require companies to build new technology infrastructure. they are consisting of multiple layers including, new hardware devices, software, connection, security tools, product cloud made up of software running on remote servers, a gateway for external information sources, and integration with the company business system. As shown in Figure 2 (Porter & Heppelmann, 2014).

Figure 2:Build new technology infrastructure



Source: Porter & Heppelmann (2014).

Logistics is one of the main applications that consider IoT an appropriate solution. There were some researches in IoT structure to implement specific new IoT technology, such as RFID, sensor network, and sensors in the logistics services area, leads to enhance tracking, monitoring of goods and vehicles in all supply chain in the company to improve a delivery process in terms of right goods and in time. The IoT implementation requires many steps to add value for logistics companies (Xu, Yang & Yang, 2013).

1. Comprehensive data sources: The logistics industry is witnessing a huge shift in services related to information about products and services. The demands and requirements are constantly changed in this field with the appearance of new innovations and technologies. The huge amount of data in real-time leads this field to demand new technology for data collection and analysis. Controlling in big data

leads to improve the analysis and visualization, which benefit the companies to improve daily operations and future innovations. The logistics companies need more technological and technical support to handle three elements, that are velocity, volume, and variety (Sivan, Johns, & Venugopa, 2014). Moreover, the logistics field handle with integrated supply chain through supply, warehousing, transportation, and delivery to the customer. The accuracy of collected data in real-time is the main key to the success of logistics processes. The deficiency of collected and shared data leads to the rupture and weakness of the efficiency and waste of resources. Usually, the information is collected from RFID is used from the beginning of the process of the receipt of the product to deliver to clients. Dynamic information is desired to observe and control the products in a changing environment and the status of products through the supply chain to ensure the efficient operation and quick response for the environment and expectations of the market. The continuous development of microelectronics and wireless communication makes it possible to deploy different wireless sensor networks besides the supply chain processes. That offers important products information to the IoT like what, when, where, and who (Xu, Yang & Yang, 2013).

2. Multiple users, multiple applications and multiple data sources: IoT supports many large distributed systems, such as thousands of distributed devices around a city to control products. The data are collected, aggregated, and distributed in multiple geographical areas by a smart grid consist of networked subsystems (Chiang & Zhang,2016). Logistics companies consist of multiple sites and multiple users in different geographical areas. That means the users prefer to reach multiple distributed information at the same time or squinty. Moreover, the distributed workflow between different organizations has different applications demanding to connect to multiple services in a network. So the design of IoT requires multiple functionalities of the application and feeding with multiple data sources. Furthermore, the companies have to be sure that their strategic information is flowing with a minimum delay and deformation. The minimum deformation demand that data sharing in the supply chain should be reliable and with minimum delay possibility because of the importance of information in real-time, with some need to send in time and others have a time scale. In this case, the design of IoT has a certain level of emergency mechanism to ensure a minimum level of losing information in any mistake happening. It also can reliably respond to multiple users' data requirements in a limited period (Xu, Yang & Yang, 2013).

3. Related Technology: IoT adoption has to take many aspects, such as technology, cost, patent, criteria, the return of investment, and infrastructure for logistics. Companies must consider many factors when making adoption decisions, such as technology, technology transfer, and compatibility (Tu, 2018). IoT adoption on some technologies such as RFID and WSN is not enough. The logistics and supply chain require a wide logistics information infrastructure. It is used to deploy related market information with logistics to avoid time loss. So, there is a need for efficient, low cost, and reliable infrastructure that takes in new different technologies. Moreover, it has to be implemented through logistics and supply chain to enable

efficient data sharing, that enables more accurate services to support logistics decision systems (Xu, Yang & Yang, 2013).

1.3 Development of Jordanian Logistics Companies Through IoT.

The IoT is considered one of the main tools in the logistics industry evolution (Ruan, Wu & Wu, 2012). The Internet of Things is an important part of logistics companies. It plays the main role in quality improvement and service implementation (Trappey et.al., 2017) Also, it focuses on improving the logistics system analysis capabilities and decision making through smart hardware (Wang, Lim, Zhan & Wang, 2020). Moreover, IoT makes the supply chain better through delivery tracking in real-time, data accuracy improvement that leads to enhance the ability to manage expectations faster. Standardization of technologies of IoT is important to reduce the entry barriers and improve interoperability (Tadejko, 2015).

In the last decade, many Jordanian logistics companies such as Aramex company designs Developers Solutions Center is made for any business model. It offers automated solutions without human interactions and many tools to manage shipments to facilitate delivery operations. Using these developed business models and electronic tools helps the company and clients to track shipments with all information (Aramex Jordan). I will explain that in detail in the Aramex chapter. The logistics industries got many changes, especially in IoT, that offer some features such as upstream and downstream to accelerate the promotion, and enhance the criteria to develop a unified technology, and other features. During this period, many modern logistics business models have appeared that helped the IoT development as following (Ruan, Wu & Wu, 2012).

Professional "IOT services providers" Spring up Everywhere: Because of the difficulties that face operations, technology, and online costs in the progress of IoT at the companies, which led to the IoT professional providers' appearance in the logistics field. They provide technical consultations, device leasing, software design, and other related services. The service provider may be RFID manufacturers and system integrators (Ruan, Wu & Wu, 2012).

Booming E-commerce Distribution and Logistics Industry Cluster: Logistics fields are important in e-commerce as considered one of the primary factors of production, including human, material, and machines. The development in e-commerce logistics depends on the information in real-time for logistics resources. These resources exchange information continuously when they interact with each other. E-commerce pushes logistics companies to improve their resources and services. Resources management focuses on e-commerce logistics in resource tracking, interaction, visibility, and interoperability. So those were the four most important types of resources, including man, material, and machines. The booming of IoT makes it possible to achieve accurate resource management (Chen, Trappey & Peruzzini, 2017). The E-commerce and internet of things have a natural fit. IoT brought the fast response, security, and support of goods and services to achieve efficiency in the supply chain, which makes up for the deficiencies of the current e-commerce improvement.

Moreover, the IoT cost is high. However, the characteristics of a large number of varieties of logistics business and Ecommerce cluster make the application has better performance through the cost (Ruan, Wu & Wu, 2012).

1.3.1 Jordanian Logistics Areas Improvement by IoT

The IoT has the capability to connect approximately anything through the internet and accelerate data-driven logistics services. Objects now can send, receive, store, and process information. IoT pledges many development processes at Jordanian logistics providers, which are part of international logistics companies' processes (DHL Jordan). The logistics providers deliver objects by transportation. distribution of the network widely and the quick distribution participation of information about states of devices lead to discover new kinds of sensors, and connection technology to improve this operation. By using IoT, the companies can accelerate the production, profitability, and operations by using tailor-made solutions that are designed especially for their process. The solutions in any company can connect all devices by a distributed network, and capture and share important information, that leading them to display real-time view for all operation, by benefiting from IoT opportunities. Logistics and transportation can significantly develop in many areas (Tadejko, 2015).

1. **End-to-end visibility**: Comprehensive visibility facilitates effective decisions making at the right time, and reduces delays by rapid disclosure on the problem (Tadejko, 2015).
2. **Warehouse and yard management**: IoT devices are designed to track inventory data, vehicles, and equipment. The companies can grant their physical assets a digital voice (Tadejko, 2015).
3. **Fleet management**: Companies can see their assets and enhance operations through portable scanners, computers, and RFID to keep their fleet movement (Tadejko, 2015).

1.3.2 Application of IoT in Jordanian Logistics Companies

The application of new technology provides new opportunities for companies to change the business model or for new companies to start with a new era of business. The new technology of IoT can add value in different ways at logistics companies (Wagenaar, 2012). Whereas the connected assets the most popular applications for IoT devices, as they have a longer life, higher value, and less mobility. initial use cases focused on big and expensive assets like tracking vehicles in fleet management. However, many big Jordanian logistics companies work to expand sensor usages to smaller and more complex assets to connect them with sent products (DHL Jordan) They enhance data analysis, exchange of information, mass storage, intelligent processing, etc. Merging the computing resources with IoT applications, mobile communication, and networks to achieve accurate, rapid, and comprehensive management. Also, achieve efficiency and services level improvement (Lu & Teng, 2012). Otherwise, to achieve IoT, there are some challenges that should be overcome. These challenges between applications, contextual, and technical. Moreover, the technology that depends on information and

data sending relates to its local cloud computing environment faces security and privacy issues. There are some fields of privacy need to be protected, data confidentiality and security have to be safeguarded. One of the important sides of IoT implementation is a huge number of devices connected with the internet. Each one exchanges data, which leads to big challenges in a store and interpretation of mass data reliably. Implementation such as Standardization and Interoperability, privacy and security, and big data (Tadejko, 2015).

The IoT include many technologies such as RFID, cloud computing, EDI, GPS, and other technologies.

Radio Frequency Identification (RFID): is non-contact automatic identification technology, which can determine a target automatically through RF frequency and get data without human interference. RFID can work with different adverse conditions, it supports a larger group of unique IDs than bar codes and can contain more information like product type, manufacturer, and temperature (Liu & Wang, 2009). RFID is vastly implemented in logistics companies. It is used to determine and track goods and vehicles. Where RFID can collect and track logistics resources information in unloading and loading missions, container location, shipment information, and customer order data such as volume, identity, and kind of goods (Ding, Jin, Li & Feng, 2020).

Global Positioning System (GPS) technology: is a navigation system connect with the satellite through the wireless communication system (Fan & Zhou, 2011). In logistics companies, the GPS devices provide accurate information for a company and customer about arrival time, delivery time, and vehicle and goods location, which improves scheduling fleet vehicle management (Hu, Chiu, Hsu & Chang ,2015). Moreover, it is utilized to track goods and assets in the external environment. Tracking is done through longitude and latitude, and goods information is displayed on the server (Yuvaraj & Sangeetha, 2016).

Geographical Information Systems (GIS): are a tool for consulting, analyzing, and editing data, maps, and location information. It is a computer system hardware and software that is utilized for analyzing, consulting, developing, manipulating, and storing to handle geographical information. So it is a system that handles with geographic information databases, it is commonly used in different fields such as scientific research, transportation and logistics, and urban planning. It facilitates the decision-makers the possibility of analysis, management, storage, and visualization of all geographical information (Sánchez-Lozano, Teruel-Solano, Soto-Elvira & Socorro García-Cascales, 2013). There are a lot of fields use GIS in logistics and transportation, such as commodity flow analysis, planning, and optimization of the locations of branches, clients, and suppliers, enhance the planning of tariff and delivery areas with the help of spatial information and workflows can be enhanced and decreased their costs (Gengeswari & Hamid, 2010).

Electronic Data Interchange (EDI): is an electronic exchange for standardized business documents between stakeholders with little or without human interference. It

could lead to enormous benefits when there is an integration with other business applications, also with trading partners (Gengeswari & Hamid, 2010). It improves the management of stock and optimal organization of deliveries through guide the business toward flexible management to respond to clients' needs. It enhances the relations between stakeholders through enhancing the effectiveness of transaction treatment and better coordination for information systems. Moreover, stakeholders realize the advantages of EDI through the reduction of errors related to traditional communication systems. The reduction of errors leads to enhance the quality of services, cost lowering, and cash flow (Jardini & Kyal, 2016).

Cloud computing: is a model for enabling convenient, on-demand network access to a common group of configurable computing resources such as network server, application, storage, and services. That can be quickly provisioned and issued with the lowest managerial efforts or service provider interaction (Dillon, Wu & Chang, 2010). It is the result of parallel computing, distributed computing, and grid computing, which divide the large calculating processing to many subprograms automatically through the network. A large amount of stored data in distributed computers work with processor resources so that the relevant calculation distribution in the distributed computer instead of the local computer (Lu & Teng, 2012). Cloud computing at logistics companies works to accelerate informatization at the company, reduce logistics costs, and enhance circulation effectiveness (Gao, Ma, Zhang & Lu, 2012).

The public information service platform is an innovative model in logistics information management. It depends on IoT technology and cloud computing, with strong data analysis, information exchange, smart processing, huge storage, and other features. It combines computing resources with RFID, QRcode, GPS, GIS, mobile communication, and network to achieve speed, accurate, comprehensive management, and enhance the service level in the logistics field (Lu & Teng, 2012).

IoT has many Principles of the Public Information Service Platform of Logistics. Starting from establishing a re-source center of large-scale cloud computing that depends on cloud computing architecture to fulfill data exchange and unified management in all companies, organizations, and institutions and guarantee all types of logistics information responses quickly. Then, using the internet of things technology by utilizing RFID, GPS, GIS technology, and high-speed internet to achieve updated information in real-time, enhance the smart management and operation, business efficiency, and logistics operation management. After that, establishing standardized working procedures by deploying all IoT and general software, etc. On the cloud computing center to improve data exchange. Employees can through a consolidated interface for standardized operation and management with a clear division of labor to improve their works and productivity. Also, this procedure contributes to monitor all logistics services by using the internet of things technology in time (Lu & Teng, 2012).

1.3.3 IoT Opportunities in Jordanian Logistics Companies

The application of IoT will establish a huge network of billions and trillions of things are connected. IoT is not disruptive evolution upon current technical, but it is a

comprehensive use for present technology, also it is a creation of new communication modes. Internet of things integrates between the physical and virtual world through combining concepts and different technical components, such as diffuse network, miniaturization of devices, mobiles, and ecosystem. In the internet of things, services, applications, network, middleware components, end nodes will be organized and used in new ways (Chen, Xu, Liu, Hu & Wang, 2014). Logistics is one of the fields that have been hugely affected by IoT, with the improvement of transportation systems and vehicles are provided with an increasing level of sensing, network, and communication capability (Hopkins & Hawking, 2018).

The Knowledge of IoT of logistics fields is significantly growing, and they are so closely connected to improve logistics missions such as an appropriate product in the right quantity at the right time at the right place in the appropriate situation at the right price (Hopkins & Hawking, 2018). Moreover, IoT helps Jordanian logistics companies to improve the use and protect the properties and assets. IoT sensors monitor and detect the facilities' usage, such as heat, and light, which leads to saving money and cost for facilities' owners. Also, it helps them to monitor the location, temperature, acceleration, shock, and damage in a full shipment journey (DHL Jordan). There are different ways for IoT can add value for logistics, such as:

1. Improve inventory management: The IoT can add value for inventory management by providing more information to enhance the positions of containers before shipments arrival. In this way, the shipment can be unloaded and loaded faster.

2. real-time supply chain management: Supply chain management enhances a process and collaboration with clients and other companies in the supply chain to achieve more value. Whereas the supply chain is already supported by various information technology solutions. However, the IoT can create value by providing additional information. Moreover, IoT can motivate all relevant stakeholders in the supply chain when makes any action in the company. In the normal process, information is passed just to one's who request the information instead of sharing the information between all partners in the supply chain. The new applications in IoT, such as RFID that enable us to record all correlated information to products and shipments like dates, warranty, places, after service details, and so on. That allowing real-time and enhance supply chain management.

3. Increased Logistic Transparency: IoT merges the cargo that is carried by a logistic operator with smart devices. The carry information around destination, identification, transport condition, etc. these have features for logistics companies. The smart items observe goods and send a prior warning if the conditions of goods are not ready for transport, so the carrier is warned, and the goods have a better condition to save them. This contributes to reducing the cost of the return, damaged goods, transportation costs because of a reshipment. Because the load offers information on the condition of the cargo transparently, the carrier can endure the responsibility of damaged goods. These benefits affect customer satisfaction through decreased damaged goods and provide detailed information about

shipments. Besides that, it is putting sensors on loads. The carrier itself can be smart also. The sensors can collect all kinds of information and provide the available information to the driver to enable better navigation and safety, which effects on driver positively to handle and respond to unexpected events.

4. Business Process Optimization: IoT can affect more efficiently the business process within the company. Through IoT application can implement and achieve the high-resolution management concept, that uses the information broadly in real-time and be available for the business process (Wagenaar, 2012). The high accuracy management confirms the transformation from the low accuracy management to a current environment. That we can embed almost everything in the business process, which leads to be more detailed results, and conflict detection, and inefficiencies in the business process. Also, the IoT use gives a chance to discover problems that have not been looked for at first, which creates new potentials to optimize the process. IoT transformed the business process to be decentralization of decision making. The smart objects are granted to be more level of freedom, which lead to increase the performance, capability, and the decentralization of decision making.

5. Resource Saving: As we explained before, IoT allows us to look at the business process with more details. The usage of the pattern of resources such as energy can be changed by automatic feedback systems and network-connected sensors such as smart energy meters (Wagenaar, 2012). Understanding the paperless filing form leads to enhance the fill efficiency and reduce the human mistakes (Fan & Zhou, 2011).

1.3.4 Challenges of IoT Implementation in Jordanian Logistics Companies

On the other hand, the IoT application at logistics companies has potential risks and challenges (Magruk, 2016). IoT provides many opportunities to the different fields and ends users, but at the same time, there are some challenges in criteria, technology architecture when merging the virtual and physical world (Chen, Xu, Liu, Hu & Wang, 2014). Moreover, these challenges are about contextual and technical applications in a world where everything is connected. The information and data are sent about their current environment to cloud computing, which leads to folding security and privacy. There are some areas where privacy needs protection to be their data more confidential and safe (Tadejko, 2015) Many Jordanian logistics companies face many challenges with increasing smart shipment. Whereas shipments need to across many borders through different transportation, the IoT devices have to accompany these shipments to meet physical and legal requirements with maintaining the digital connection to provide temperature, location, acceleration, damage, shock monitoring (DHL Jordan). following key challenges in IoT.

1. Deployment challenges: There are three types of cloud deployment models, public cloud, private community cloud, and hybrid cloud. Each model is suitable for each logistic company. The public cloud depends on sharing the concept of information and infrastructure are provided by a third-party service provider. The private cloud

depends on sharing limited information inside the organization. The hybrid cloud depends on both private and public clouds. Therefore, infrastructure selection is one of the main challenges (Chen, Chen & Hsu, 2014).

2. Security challenges: Security protocols are an important problem when it is related to IoT. There are some known criteria, such as the online trust alliance (OTA), which published trust criteria particularly for the internet of things devices, which demands best practices for data privacy and protection. This approach is a global initiative that offers instructions for device manufacturers and developers to improve security and privacy for connected devices and collected data (Tadejko, 2015). Most enterprise information contains clients' and employees' information, also private information and data have to be protected. Therefore, enterprises give big attention to information and data security, when they build private cloud computing. Preventive efforts include advanced security software to protect the information system, such as firewalls, advanced access control, and surveillance mechanisms (Chen, Chen & Hsu, 2014).

3. Business Process Challenges: At the IoT, there are many possibilities and suspicions in business models and applicable scenarios. Therefore, it is inefficient whence of business-technology alignment and will not be one solution for all possibilities. The IoT is not easy to implement and should be accurately looked to businesses to reduce risks (Chen, Xu, Liu, Hu & Wang, 2014). Moreover, there are many fears such as flexibility, the capability of carrying cost, and discontents, for example, RFID application on services or goods that have a low-profit margin, server farm building, and cloud computing infrastructure (Chen, Chen & Hsu, 2014).

4. Technical Challenge: IoT technology maybe is complex for some reasons. Firstly, there are some old heterogeneous architectures in the application and technologies of an existing network, for example. Different environments and applications need different networking technologies. Also, the specifications and ranges are different between mobiles, local wireless networks, and RFID from each other. Secondly, technology communications have to be low cost and reliable connectivity, including mobile and fixed connectivity, wireless communication, power line communication, and short-range wireless communication. Finally, there are many different applications need in nature to different solutions, to connect with suitable security solutions. (Chen, Xu, Liu, Hu & Wang, 2014). As we see, technical challenges to implement IoT in logistics companies require different competencies and systems, such as connect smart objects that network support it with an external network, data storage, data discovery, and data sharing (Tadejko, 2015).

5. IoT data collection challenges: Companies need to collect related data of their business, and this big challenge. Moreover, they need to filter excessive data and secure data from any attack. These operations need high efficient mechanisms including software an (Tadejko, 2015). The most common tools for data collection are devices with special sensors. The data collection process needs a special

protocol like Data Distribution Service (DDS), and Message Queue Telemetry Transport (MQTT) are the most common protocols. These protocols help devices to connect with real-time machine-to-machine networks. Message Queue Telemetry Transport collects data from different devices then put data through information technology infrastructure. Then data distribution service distributes data on the devices. IoT will deploy a large amount of data that needs processing and analysis in a real-time situation. Processing large amounts of data in real-time leads to an increased burden on data centers' work. That leads to increasing challenges for service providers, especially in security, capabilities, and analyses (Tsai, Lai, Chiang & Yang, 2014).

6. Architecture Challenge: IoT includes a wide range of technologies. It includes an increasing number of smart devices connected with sensors. According to the communication between these devices at any time and place to any related services, which are wireless, automatic, and ad hoc manner. Moreover, the services become more decentralized and complex. In IoT, data integration through different environments is hard and will be supported by operable components. Infrastructure solutions will request systems to data integration from different sources and determine related features, to explain data, and to show their relationships, to compare data with useful historical information, and to support decision making. Therefore, single reference architecture cannot be a schema for all applications. Diverse reference architecture has to coexist together in IoT. The architectures have to be open and following standards. They should not restrict users to use fixed and end to end solution. The architectures have to be flexible to handle some cases such as RFID, identification, smart objects, and smart devices (Chen, Xu, Liu, Hu & Wang, 2014).

2 RADIO FREQUENCY IDENTIFICATION IN LOGISTICS COMPANIES

Due to globalization, the logistics field has become a strategic factor in creating a competitive advantage in the supply chain at logistics companies to ensure the smooth flow of products, shipments, and information from starting points to the final process. Radiofrequency identification (RFID) is one of the recent innovations in the logistics industry, which helps to determine and monitor physical elements by using radiofrequency (Ramanathan, Ramanathan & Ko, 2014).

RFID application was started in the modern logistics field. Because of visible issues that face a current supply chain and logistics industry (Tan, 2008). RFID usage has attracted the logistics companies' attention by giving some potential for logistics services such as reduce labor hours, minimize damage, and reduce shrinkage in the supply chain. Moreover, there are other potential advantages represented in process efficiency enhancement, track and trace improvement, the accuracy of product control improvement, and inventory management improvement (Pålsson, 2007). One of the main factors to the success of RFID implementation in the company is the degree that enables the company to change its business process to take advantage of technology

most effectively. To get benefits from RFID, the company needs to redesign its business process or determine the innovative usages for the new technology (Langer, Forman, Kekre & Scheller-Wolf, 2007).

2.1 RFID Overview

Radiofrequency identification (RFID) is automatic technology that helps devices, machines, and computers to determine objects and record metadata, and control the individual target by radio waves. The RFID was issued in 1945 as a spy tool for the Soviet Union, which retransferred incident radio waves with audio information (Jia, Feng, Fan & Lei, 2012). In the last years, RFID technology moved from ambiguity to known applications that help to hurry up the handling of products and manufactured goods. RFID enables recognition from far distance opposite of barcode. It works without requires a sightline (Want, 2006). RFID composes of 1- RFID tags combined into or attached with any kind of object (Goods, tools, products, persons, etc.) 2-RFID reader can read the stored information and transmit them to a computer system. RFID can be deemed a kind of barcode, but there are some differences between them. In RFID, the data are not collected manually like a bar code that leads to working easier. Moreover, in the barcode, the operator should scan the items separately, but in the RFID reader can automatically receive data from the tags and can store more data and scan from farther distances than the barcode (Dolgui & Proth, 2008).

There are many types of RFID, but the highest levels of RFID can be divided into active and passive. Active tags need a power source; they are connected with powered infrastructure or use power stored in a battery. In the last status, a tag lifetime is determined through stored power. However, the batteries make the active tags unpractical in companies' operations, because of cost, size, and lifetime. Passive RFID of interest because the tags don't need battery or maintenance, and one of the features of the tags has infinity operational life and small size to fit a practical adhesive label. A passive tag consists of three parts: RFID chips, an antenna, and a substrate, for example of an active tags is GPS to determine the car if it is stolen (Want, 2006).

As we mentioned before, the RFID composes of a tag and reader. The reader generates and transmits the integration signal to the tag. The active tag operates its microchip from a battery and transfers a signal to the reader. A passive tag can be operated by the reader through magnetic induction or electromagnetic wave capture. Both of them can send enough power to passive tag to guarantee their operation. RFID system depends on frequencies between 100KHz - 30 kHz works by using magnetic induction. In otherwise, the RFID system depends on microwave frequencies 2.45 - 5.8 GHz works by using electromagnetic wave capture (Kumar, Reinitz, Simunovic, Sandeep & Franzon, 2009). Moreover, with the advancement of technology in RFID technology, there is a new generation in this technology is clipless RFID. It is used to determine ID, tracking, sensing, and security applications (Herrojo, Mata-Contreras, Paredes, Nunez, Ramon & Martinm, 2018). It has many advantages when compared with traditional

RFID, such as the better read range, the potential to read the tag in non-line-of-sight, also can add sensors to chip less RFID (Vena, Perret & Tedjini, 2011).

2.2 RFID Implementation in Logistics Companies

There is increased attention to RFID implementation at the logistics companies. It gives a comprehensive and accurate vision for inventory and warehouse data at all supply chain processes to enhance and improve the different operations at companies (RFID adoption and implementation in warehousing). The RFID implementation at the postal logistics companies attracted great attention in the last years, for what it carries of many potential opportunities to the companies such as decreasing labor hours, fewer damages, increasing the efficiency, improving the services because goods control, improving monitor and tracking of goods, improving inventory management (Pålsson, 2007). That helps postal managers to make decisions to enhance transportation costs and containers and posts transfer (Vaculk, Kolarovszki & Tengler, 2013).

RFID is implemented through two generic types. Firstly, a closed-loop to monitor, measure, and improve operations, for example, to monitor international mail services between hubs, by tags are put on parcels, that help to measure delivery time, which leading to determine the services issues to treat it reliably and confidentially (Vaculk, Kolarovszki & Tengler, 2013). Secondly, an open system can be implemented in the supply chain, but many challenges appeared, such as tags technology, and taking into consideration the technological requirements executions with several actors, the RFID should work with all actors. Moreover, RFID open system implementation has other challenges, such as the barriers between companies like cost and benefit-sharing, cooperation, information sharing, and technology transfers (Pålsson, 2007).
When implementing the RFID at the supply chain in logistics companies, some technologies have to be developed to identify objects and capture information about these objects such as (Angeles, 2005):

Electronic Product Code (EPC): The auto-identification concept rests on the use of an electronic product code. The RFID has the capability to provide accurate information about the object movement and location through minutes for management instead of hours or days. These are because the RFID tag has EPC, which can store electronic object codes, bit numbers whose format is based on serial current numbering schemes like the Global Trade Item Number (GTIN). Every RFID tag has a unique EPC That allows every element tracking that has RFID tag separately from other similar items. However, item tracking is one part of the equation. The RFID power comes from link EPC with element data (Radko & Schumacher, 2004).

Savant Enterprise Software: The savant middleware is a main component of EPC. It links the EPC tag reader and company applications. Also, it is the central nervous network in IoT network to manage, examine, and transmit data (Yang, Ling & Xia, 2013). Each of the savant nodes transmits information from the tags to another savant in the network. For example, a savant at port sends information to a savant at a warehouse that a shipment is coming at a specific time and date. The savant executes many of the main missions that support the network of readers, data smoothing, namely,

coordination, data storage, data forwarding, and task management. When the errors happen on a network system, as a result of tags are incorrectly read or condemned, the savant treats this situation by applying algorithms that use data smoothing technics to correct these errors. Also, savant was designed to delete duplicate codes, when two signals from two readers interfere after reading the same tag. Moreover, savant forwards only suitable information up and down the supply chain (Angeles, 2005).

Object Name Service: The ONS is a subset of the domain name system (DNS). It was designed to encode the EPC in a correct domain name syntactically, then use DNS infrastructure to inquire for further information. The main idea of ONS is network needs a system for matching the EPC with more detailed information that correlates with that code. This can be achieved by ONS, which works in a very similar way to DNS, which is a service that correlates an IP address with a domain name (Fabian, Günther & Spiekermann, 2005). When the reader reads the tags, the EPC code is transmitted to the near savant, which contacts the ONS on the local network or the internet to know more information about a certain object. The ONS will determine the suitable server that contains object information that savant is querying. The object information is restored by the savant then forward to the supply chain applications, which need this information. The companies participating in the supply chain need to improve the ONS server and maintain it to guarantee quick information recuperation. Thus the companies will store and maintain the ONS data from clients or suppliers on the local network instead of download it on the web (Angeles, 2005).

Physical Markup Language: The main mission for PML is a general simple language to describe physical objects to use them for remote monitoring and control in the physical environment, including warehouse management, automatic transaction, and supply chain monitoring. The PML has to encourage the rapid development of software tools and applications. Also, have to be simple as much as it can but comprehensive in everything (Brock, Milne & Lewis, 2001). Moreover, PML is purposed as an international standard to use through different industries for describing physical objects. For example, every kind of product is classified under the same kind of product and field. Furthermore, the PSL takes into consideration, the data Chang of objects that constantly change, such as container lateness and location. That will contribute the companies to provide more detailed information about objects and enable them to provide more dynamic data (Angeles, 2005).

2.3 Challenges of RFID Implementation in Logistics Companies

The implementation of RFID has many challenges. these include cost, applications, tools, the lack of standards and cooperation between stakeholders in the supply chain, and privacy and security (RFID adoption and implementation in warehousing) One of the main challenges that facing management when implement RFID is the Return of Investment (ROI)of RFID, and it happened the RFID use is necessary for business agents to enhance the cooperation. The calculation of cost and benefits will differ from company to another, and these companies will have to change the technology infrastructure and internal data when implementing the RFID (Angeles, 2005). Moreover, there are many challenges when implementing RFID at companies such as:

1 **Choose the right RFID technology**: It is important to choose the kind of RFID technology. It is a critical decision. The decision-makers have to consider the company needs when choosing RFID, 1- their company environment needs 2- their trading partners need 3- the industry needs which belong to it. The best choice is who has the greatest adoption potential in the market, which encourages consider industrial criteria. Also, the economic effect of vast technological adoption prefers to decrease the RFID applications and device prices (Angeles, 2005).

2 **Technological challenges**: The connection between reader and tags is exposed to electromagnetic overlap. Usually, transmission in RFID leads to collisions as tags and readers work at the same wireless channel, so the efficient anti-collision protocols lead to determine multi tags at the same time has importance for RFID application improvement. Many anti-collision protocols have been suggested to define RFID tags, such as query tree protocol (QT), binary tree protocol (BT), frame slotted ALOHA protocol (FSA), etc. (Jia, Feng, Fan & Lei, 2012).

3 **Security of RFID technology**: The information inside the RFID tag is at risk for changing, corruption, and cancelation, due to low processing and low memory. On the other hand, there are some active RFID readers and tags to enhance security through to use of encryption, challenge-response protocols, use of a password, and manipulation discovery technology. These devices have bigger memory and more processing power than passive counterparts. They are more expensive and don't need a battery. The tags wake up just when they receive a signal from the reader (Vaculk, Kolarovszki & Tengler, 2013).

4 **RFID data collection tool-backend communication attack:** Middleware and backend communication happens by using HTTP, SOAP, or JSM. There are two kinds of attacks that may affect the backend are MIM application layer attack and a TCP replay attack (Vaculk, Kolarovszki & Tengler, 2013).

5 **MIM application layer attack**: MIM attacks happen when someone monitors a system between a company and persons who communicate with them. When computers connect with a low level of networks, they cannot determine who exchanges data with. In MIM attacks, someone exposes the user identity to read the messages, and the attackers can reply to these messages to get more information. Also, application-layer attack targets application servers by making disorder in the operating system of the server and its applications, that leads to give the capability to the attacker to exceed the control elements and control in applications, network, and system, such as read, add, delete, and modify data or operating system, and send virus program to a network, etc. (Vaculk, Kolarovszki & Tengler, 2013).

6 **TCP Replay Attack**: When a hacker can get information from the wire, he can get information from the packets like password and authentication information. When the hacker extracts the information can return the captured data to the network and reoperate. Some level of authentication can help to stop the TCP reply attack (Vaculk, Kolarovszki & Tengler, 2013).

3 CLOUD COMPUTING IN LOGISTICS COMPANIES

Cloud computing provides operational benefits and effective international relations through the cooperation between cloud computing and logistics (Subramanian & Abdulrahman, 2017). The integrated logistics information system contributes to reduce costs and enhance business efficiency (An & Lee, 2015). Also, improve their services, achieve optimal planning, and reliable daily operation. Moreover, cloud computing solutions can facilitate the organization and execution of transportation, customs clearance, freight forwarding, warehousing, distribution, and shared work process (Subramanian, Abdulrahman & Zhou, 2014). Especially the logistics system has enormous information regarding business, client, and markets. And the logistics companies need to build a good relationship with clients, companies, government, transporters, and employees in warehouses, transportation, and all departments (Dixit & Chhabra, 2015).

The integration of cloud computing does not only provide the transportation and logistics services to be more efficient through optimal use, reduce mileage use, production improvement, and overheads reduction, but also it provides important features for clients such as integrated information and promotion, customers relationship management, and provide price offers through different channels. Cloud computing also enables transportation and logistics companies to integrate their services. That way, they reduce negative external factors such as environmental pollution (Subramanian, Abdulrahman & Zhou, 2014).

3.1 Cloud Computing Overview

The development of cloud computing in the last years created an improvement in computing history. Therefore, if cloud computing needs to achieve its target, it has to understand the various relevant issues from both sides of service providers and the consumers of technology. (Marston, Li, Bandyopadhyay, Zhang & Ghalsasi, 2011). Cloud computing has many definitions. Also, it is not a new concept, but it became a buzzword after web 2.0. It has connections with many different new technologies such as grid computing paradigm, cluster computing, utility computing, and distributed systems (Foster, Zhao, Raicu & Lu, 2008). Moreover, cloud computing is working on changing factories and enterprises working way. By offering dynamic and virtualized resources are provided as a service through the internet. It creates new opportunities for them (Xu, 2012).

Cloud computing able to access a variety of computing resources that are owned and managed by a third partner through the internet. The cloud consists of hardware, network, storage, interfaces, and services that provide the means which users can access through it to infrastructure, application, computing power, and services on demand (Arora, Parashar & Transforming, 2013). The distributed computing paradigm differs from traditional services such as it is enormously expandable. It can be encapsulated as

an abstract entity, that offers different levels of customer services out the cloud, it is driven by economies of scale, and the services can be delivered and configured dynamically (Foster, Zhao, Raicu & Lu, 2008).

Cloud computing converges between two majors in information technology. Firstly, IT efficiency, which uses the power of new computers efficiently through hardware and software resources that high ability to implement. Secondly, business agility, that information technology can be used as a competitive tool through quick deployment, intensive business analytics, and mobile interactive application that respond to users in real-time (Marston, Li, Bandyopadhyay, Zhang & Ghalsasi, 2011).

An increasing number of companies that use cloud computing are developed consistently. Which these companies realize the benefits and opportunities will be achieved by using information technology resources with the unlimited ability for development, and online payment for services, instead of classical operation in the workplace (Arnold, Oberlander & Schwarzbach, 2013). Moreover, cloud computing provides additional virtual storage for resources and superior abilities such as data processing, data storage, and management, which reflect the decrease costs, improve efficiency, and data sharing with the client, leads to get the information and use it easily (Wang, 2011).

3.2 Cloud Computing Implementation in Jordan

Governments around the world started to implement their cloud computing. Despite the differences and diversity of applications between the countries. However, this implementation will have positive effects on the social and economic aspects. Jordanian government believes the need to determine a clear direction and guidance for the cloud future in Jordan, to achieve specific targets in national policies to develop the digital infrastructure (The Hashemite Kingdom of Jordan Ministry of digital economy & entrepreneurship, 2020).

The increased adoption of cloud computing in Jordan by the government will encourage the companies' growth and facilitate their entry and competition in the global markets, which will quicken the local digital business growth and increase their contribution to Jordanian digital economy growth. The increasing usage of smart technologies that work on the cloud leads to enhance new digital services and provide them for partners and citizens in an innovative way by the government to improve public services. Moreover, it will enhance the digital transformation by enabling the government to design and manage functions that supported information technology with more innovation, flexibility, and saving costs by taking advantage of technology resources (The Hashemite Kingdom of Jordan Ministry of digital economy & entrepreneurship, 2020).

In line with the public policy for the information and communication sector in Jordan (ICPT) 2018, article NO,8 indicates to take advantage of the fourth industrial revolution

with the primary goal to develop a digital economy, which leads to economic development and increase the income and wealth for Jordanian individuals. Moreover, article NO.47 of that policy indicates to the government will use cloud services to expand owned storage capacity and improve data management and available application services in the cloud. Therefore, the Jordanian government through the Ministry of Digital Economy and Entrepreneurship issued the Jordanian cloud computing policy in cooperation with partners and stakeholders. To achieve the national goals and policies. Moreover, considering a cloud is one of the primary digital technologies for digital transformation (The Hashemite Kingdom of Jordan Ministry of digital economy & entrepreneurship, 2020).

Since 2014, the Jordanian government through the Ministry of Digital Economy and Entrepreneurship established and developed a government-private cloud (GPC). To provide various essential cloud services to government institutions represented in the following main service Categories: software as services (SAS), infrastructure as a service (IaaS), and platform as a service (PaaS). The ministry provides many services for them, such as Email as a service, database as a service, rapid software development as services, and other services. Moreover, servers hosting service to enable government institutions to host their servers in the government data center belongs to the ministry to benefit from secure infrastructure. Government institutions are responsible for server settings, applications, operating programs, updates, and security. Moreover, the Ministry constantly works to develop the infrastructure to serve the maximum possible number of government institutions (The Hashemite Kingdom of Jordan Ministry of digital economy & entrepreneurship, 2020).

About the local public cloud in Jordan, there are private local cloud providers, that can provide all kinds of cloud services. That cover primary cloud forms such as human resources systems, Email services, data archiving. Cloud service providers haven't been organized yet, and some criteria have to be written to organize cloud service providers for ensuring the quality services and users rights in private and public sectors also individuals (The Hashemite Kingdom of Jordan Ministry of digital economy & entrepreneurship, 2020).

The government mainly tries to develop and build an integrated cloud system for Jordanians to contribute to the development of digital economy growth by realizing the following goals (The Hashemite Kingdom of Jordan Ministry of digital economy & entrepreneurship, 2020).

1. Encouraging the government institutions to optimal usage of cloud services.
2. Continuing the government-private cloud development, keeping up with the latest technology, and ensuring the availability of the needed resources.
3. Ensuring protection of cloud users by establishing an organizing framework and determining the responsibilities, rules, and commitments to guarantee essential rights for users from cloud services providers.
4. Achieving fair competition between cloud services providers.

5. enhancing the local companies' growth, facilitating entering into global markets, and supporting the Jordanian cloud markets growth (The Hashemite Kingdom of Jordan Ministry of digital economy & entrepreneurship, 2020).

3.3 Cloud Computing Architecture in Logistics Companies

Cloud computing services are divided into four levels, application layer, platform layer, infrastructure layer, and virtualization layer. Each layer matches a subset of services. and the levels of cloud computing can be divided, and each level can complete users request separately (Wang, 2011). Cloud computing services are negotiated by clients and service providers in terms of service level agreement in logistics companies mainly used these services (Dixit & Chhabra, 2015).

1. **Software-as-a-Service (SAAS)**: provides applications and software for users. The resources can be arrived through clouds by using any connected device with the internet without installing licensed software. Organization control is limited to application configuration settings. (Dixit & Chhabra, 2015). Logistics companies in the information construction process usually develop the software through their own IT department. Most logistics companies have an IT department, which they are responsible for their process information development, but it is highly costly. Also, some companies go to professional software programmers' companies to get technical support. However, the purchased information software is rarely convenient for their needs. In SAAS, all logistics software providers can arrange the applicable software with intranets and servers. And meet clients' requirements through the internet. The clients can use web-based software to manage logistics activities by renting. That means small and medium logistics companies can benefit from relevant software, hardware, and maintenance services, which allow them to use and improve them by paying some fees (Wang, 2011).

2. **Platform as a Service (PaaS)**: provides the platform to deploy, develop, and implement software on the desired programming languages, and depends on company processes (Dixit & Chhabra, 2015). Moreover, to provide customers with a developed environment, server platform, developed applicable software, applicable servers, database, and experimentation. It integrates existing business that can be classified to applicable servers, business engine, business access, and open business platform. PaaS estimates basic service capabilities according to business needs. It provides business manipulation services and monitoring all resources in a platform and facilitates access to SaaS users. PaaS can be improved to data processing and knowing its appropriate rules to achieve intensive and in-depth use, to make data more comprehensive and accurate (Wang, 2011).

3. **Infrastructure as a Service (IaaS)**: indicates to entire IT infrastructures such as storage, servers, and network. Users can implement and control their applications without needing to control the cloud infrastructure (Dixit & Chhabra, 2015). It provides essential computing devices in a service form. Main devices are rented as services such as servers, storage, processors, and other forms. The users cannot

manage these devices, but they can play in system choice, space storage, and deployment (Wang, 2011).

Table 1: Service Models and Deployment Models of Cloud computing

Acronym	Expansion	Description
SaaS	Software as a Service	Providing application software as a shape of online service. For example Google Apps, Impel CRM, and Salesforce CRM
PaaS	Platform as a Service	Wide collection of infrastructure application services. Including business process management, integration, database services, and application platform. For example, Microsoft Windows Azure,Force.com, and Google App Engine.
IaaS	Infrastructure as a Service	Providing computer infrastructure as a service. Including software, network equipment, and data-center space. For example, Google Cloud Storage and Amazon's Elastic Compute Cloud

Source: An & Lee (2015).

Cloud computing also offers different operation modes, such as private cloud, public cloud, and hybrid cloud. These deployments depend on companies' business needs, security, cost, reliability, and performance (Dixit & Chhabra, 2015).

1. **Public cloud**: In this deployment, the resources are provided publicly on the internet (Dixit & Chhabra, 2015). At the logistics companies, it depends on the logistics services and logistics platform. the companies register and publish their logistics services in the public cloud logistics service platform, and the clients request a service through the cloud logistics platform. The logistics operations that depend on the public cloud can offer matching missions between supply and demand, transaction management, design and enhancement of logistics solutions, process observation, business cooperation, credit management, and other options. To integrate and enhance logistics services for customers that could be provided by third-party logistics services (Dillon, Wu & Chang, 2010).

2. **Private cloud**: The cloud infrastructure is operated inside a company and managed by the company or third party, whether if it is in the same location or not (Dillon, Wu & Chang, 2010). It is a development to build information infrastructure for logistics companies. Logistics companies apply and deploy the technology infrastructure for an information system according to cloud computing. They offer logistics resources and capabilities to execute operations and information management. So, the logistics service mode is different according to logistics companies and their private cloud. Generally, logistics companies that have essentially professional services are driven by customer logistics services. So

the service quality is power. This deployment implements in large logistics companies or third-party professional logistics services because it needs a lot of investment (Li, Zhang & Li, 2014).

3. **Hybrid clouds**: In this deployment, the organization data is distributed between public and private clouds. This mod has advantages in the logistics operation based on the public and private cloud, but this mode needs higher requests to the logistics companies. and it needs integration between private and public cloud

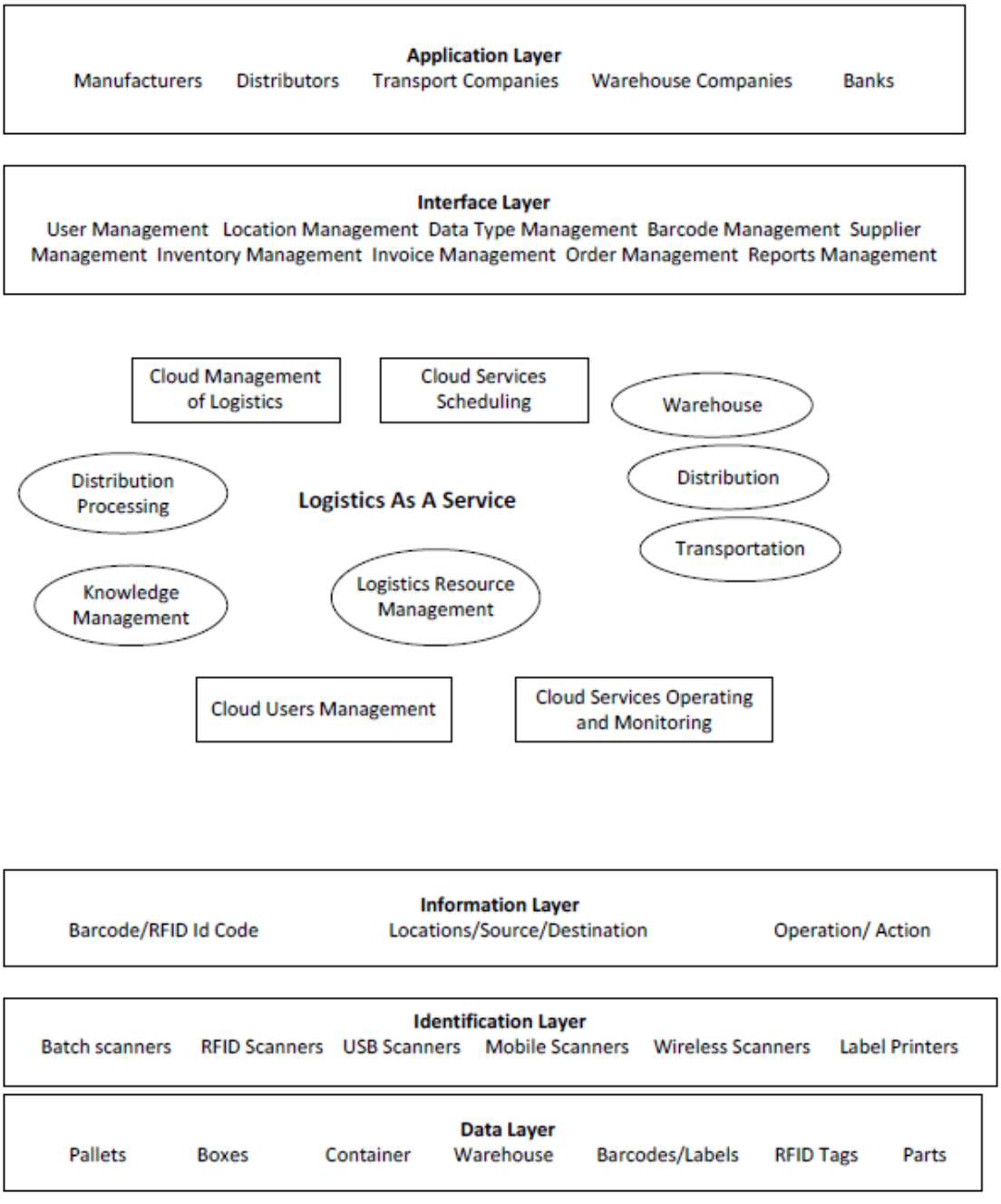
Table 2: Comparative Analysis of various operation Mode

No	Operation mode	Advantage	Weaknesses	Scope of Application
1	Logistics operation mode based on public cloud	Integrating Social logistics resources, Providing a variety of logistics services for customers	Operation of the business mode is more complex. Related to business reputation and information security	The area having good policy and credit environment
2	Logistics operation mode based on private cloud	Mode of operation is simple, driven by the order of Customer logistics service, Providing their own professional logistics services as the core.	The service offered is relatively single. enterprises need to heavily invest in the project	Applies to the large and comprehensive logistics enterprises or the professional third party logistics providers which have certain scale.
3	Logistics operation mode based on hybrid cloud	Have the advantage both Logistics operation mode based on public cloud and Logistics operation mode based on private cloud	To realize seamless integration between the logistics platform of private cloud owned by the core logistics enterprise and the logistics platform of public cloud	The area with a good policy environment and more mature market

Source: Li, Zhang & Li (2014).

Logistics cloud architecture including three main markets, the logistics service software market, the logistics products, and services market. The final web platform can be understood as a logistics solution gate in the figure 3 shows logistics cloud architecture (Niharika & Ritu, 2015):

Figure 3: The Cloud Architecture



Source: Niharika & Ritu (2015).

The main functions and roles at the different architecture layers are:

Data layer: In this layer, data is tracked. The data source could be anything such as boxes, pallets, barcodes, and RFID tags. Every data source has a unique identifier, such as a tag or barcode (Niharika & Ritu, 2015).

Identification layer: From barcode or tags are provided by the data layer. A layer is required to perform the user interface. The interface assists encode the application use

of barcode and implementation of a barcode pattern on a device. This is consisted of interfaces and hardware to get data, which can use different scanners to read tags and barcodes for shipment tracking (Niharika & Ritu, 2015).

Interface layer: The layer offers a user and application interface to access the information, data, and reports. All data captured is stored from the information layer according to its business requirements. Scanners can be programmed to provide various kinds of output files. The output file can be established according to customer requirements (Niharika & Ritu, 2015).

Application Layer: This layer defines the system application matching to the business field such as warehouse, banks, logistics, etc. (Niharika & Ritu, 2015).

3.4 Cloud Computing Implementation in Jordanian Logistics Companies

With continuing the applications based on cloud computing at many logistics companies in Jordan to disrupt traditional processes at supply chain management, the application program interface (APIs) is a basis for logistics services and data processing in real-time. It allows logistics providers to expand and integrate software services by using centralized cloud-based platforms. With the continued growth of the global supply chain management, the cloud-based segment will be stronger when logistics players begin to realize cloud reliability, cost efficiency, and scalability and directly benefit from using cloud service. This growth leads to increase logistics data exchange between parties in a supply chain. Well-designed APIs are necessary to provide shipments tracking, rate sourcing, cost calculation, and other logistics services at anytime and anywhere through web and mobile applications (DHL Jordan).

With different kinds of logistics companies' services, essential common logistics services can be designed and applied to an intelligent logistic system on the cloud computing platform (Yang, Mahmood, Zhou, Shafaq & Zahid, 2017).

When adopting cloud computing at logistics companies, there are many steps before implementation:

1. **Analyze existing IT environment**: The core business system is an important side that concerns companies. About logistics services in addition to the core business, these companies require more helps systems chain for daily procedures, including financial system, customer relationship management system, Email system, visual management system, human resources management system, decision support system, etc. With continuous development, logistics companies' advantages are not limited to financial management and customer relationship management just. They have to provide more power in core businesses like distribution, storage, and competitiveness enhancement. THE existing IT environment analysis can help the logistics company to know more about current new information technology. There

are software architecture analysis and hardware resources analysis that help to determine if IaaS will be used to get software and hardware resources or not (Li, Wang & Chen, 2012).

2. **Decide whether to move IT service to cloud platform**: Through analyzing the IT environment, you will know the core business structure of the companies and help systems. The core business system correlates with business operations, and it contains the essential data. So companies' requirements for stability and reliability of systems are compared highly with the core system, and it can give them to the third party for maintenance (Li, Wang & Chen, 2012).

3. **Achieve transfer of cloud service**: After when the company decides to adopt cloud computing, the transfer will happen. System transfer can be divided into two categories. The first one, the company already has an IT system like CRM have to move this system to the cloud computing platform. The second one, companies get the application through SaaS or PaaS. Both need integration and a flexible interface between the system inside the company and the cloud computing platform (Li, Wang & Chen, 2012).

The basic service platforms can access at the same time a huge amount, store, and analyze the huge amount of heterogeneous terminals. Moreover, it can provide a different kind of common applications to satisfy business requests, that including express delivery, dynamic task allocation for delivery staff, real-time query, distribution status tracking, and financial statement of the delivery charge. There are many technologies for building to achieve a smart logistics cloud platform (Yang, Mahmood, Zhou, Shafaq & Zahid, 2017).

1. High concurrent processing technique: The intelligent logistics cloud platform provides essential data services and application services for smart distribution that support millions of users and concurrent terminal access. A security platform can be stable to provide large-scale concurrent terminal access, data access, and the capability to call essential services through cloud computing to meet big concurrent processing and continuous credible operation. For the diversity of big data storage and access in logistics companies, data management of the relational database, distributed database cluster, and real-time database cluster will be used. According to cloud computing technology, distributed cluster architecture is the key to treat concurrent processing and system for credible operation. All nodes in cloud computing can serve independently. When a node fails in a cluster, it doesn't affect the normal operation of the other node. Also, it guarantees a continuous and stable operation. Moreover, any node can guarantee and provide external services independently. So the capability of the cloud cluster can be increased to deal with big concurrent demands, concurrent access, data access, and service call request through expanding the cluster scale (Yang, Mahmood, Zhou, Shafaq & Zahid, 2017).

2. Heterogeneous terminal data access: It is the interaction between the cloud computing system and sensor network layer, which has limited functions that can access a collection terminal and collect terminal state, send information, and provide a unified control interface for inside and outside. Moreover, data access services can provide other external data sharing, such as data services from meteorology, traffic, illegal information, information from the third party, and so on. There are many core modules in the data access service:

A. Kernel manager is an axis of the whole system. It is responsible for data source run time, release run time, data point observation operation and event, and normal operation process.
B. Data monitor is a main function in the system. It is responsible for calling external data sources depending on specific agreements, collecting external information, collecting information in the kernel manager, and data analysis service.
C. Data dissemination is responsible for data release is gathered by data monitor to external systems or releasing rest interface for an external system to access data.
D. Event manager is responsible for an event definition, such as system events, publishing events, data source events, and maintenance and timing events. The events operation and processing indicate to mail processing way, determine processing method, and implement an instruction approach.
E. Configuration tool is responsible for the design management tool, configuration model, data source configuration, data dissemination model, report model, event model, and settings.
F. Encapsulation and open technology: To decrease the complication in implementation, the business system and service functions can be built independently. Service functions can be enveloped through a web service interface by an applications engine. To enhance call interface to kinds of terminal capacity including, location alarm, vehicle control, task management, telephone announce, information collection, data processing, and terminal management. Through this technology, the business can be responded to accurately and quickly through the high-level application.
G. The technology of data storage and data mining service: Data service engine will achieve access to organized and unorganized data and cloud services that can guarantee the data processing efficiency and feasibility. The platform has to be designed by using a data service engine with the basic modules of data scheduling, data access, data mining, and data storage to deal with the huge amount of data in the smart logistics services (Yang, Mahmood, Zhou, Shafaq & Zahid, 2017).

The implementation of cloud computing at the Jordanian logistics companies generates new commercial opportunities, especially when merges with APIs such as delivery options, cargo rates in third parties web shops, logistics marketplace, and e-commerce platform. Logistics providers guarantee presence in the digital journey of clients searching to buy logistics services and products online. E-commerce sellers see coherent customer experiment requires clear shipping options, tracking, and last-mile delivery, all of these are seen as an added value for their brands. Managing smooth data

flow, financial, and products is very necessary for the whole experience (DHL Jordan). Moreover, the implementation of cloud computing in logistics companies has many benefits and enhancements:

1 Decreasing the cost on the company and the user. Increasing the flexibility to get logistics services information efficiently and in real-time (Niharika & Ritu, 2015).
2 Facilitating the modification and adaptability when adding new rules (Niharika & Ritu, 2015).
3 Enhancing the delivery time and be more accurate, decreasing the loss in warehousing, avoiding the emergency statuses at the last minute (Niharika & Ritu, 2015).
4 Making a balance between small firms and international firms through sharing the resources equally (Niharika & Ritu, 2015).
5 Enhancing information security due to rapid and massive data in business transactions (Niharika & Ritu, 2015).
6 Providing direct access to hardware, leading to speed up time for many businesses (Marston, Li, Bandyopadhyay, Zhang & Ghalsasi, 2011).
7 Decreasing the innovation limitation in IT and enhancing the logistical services (Marston, Li, Bandyopadhyay, Zhang & Ghalsasi, 2011).

4 IOT AND CLOUD COMPUTING INTEGRATION

Cloud computing and IoT are two different technologies, and both of them are very important and part of our life. They have seen rapid and independent development, and their characteristics are often integral, as the table shows (Botta, Donato, Persico & Pescapé, 2016). The integration between IoT and cloud computing leads to change in the system exploitation on both sides. On the other side, IoT may get benefits from storage and computation resources offered by cloud computing (Bhawiyuga, Kartikasari, Amron, Pratama & Habibi, 2019).

Table 3:Complementary aspects of Cloud and IoT.

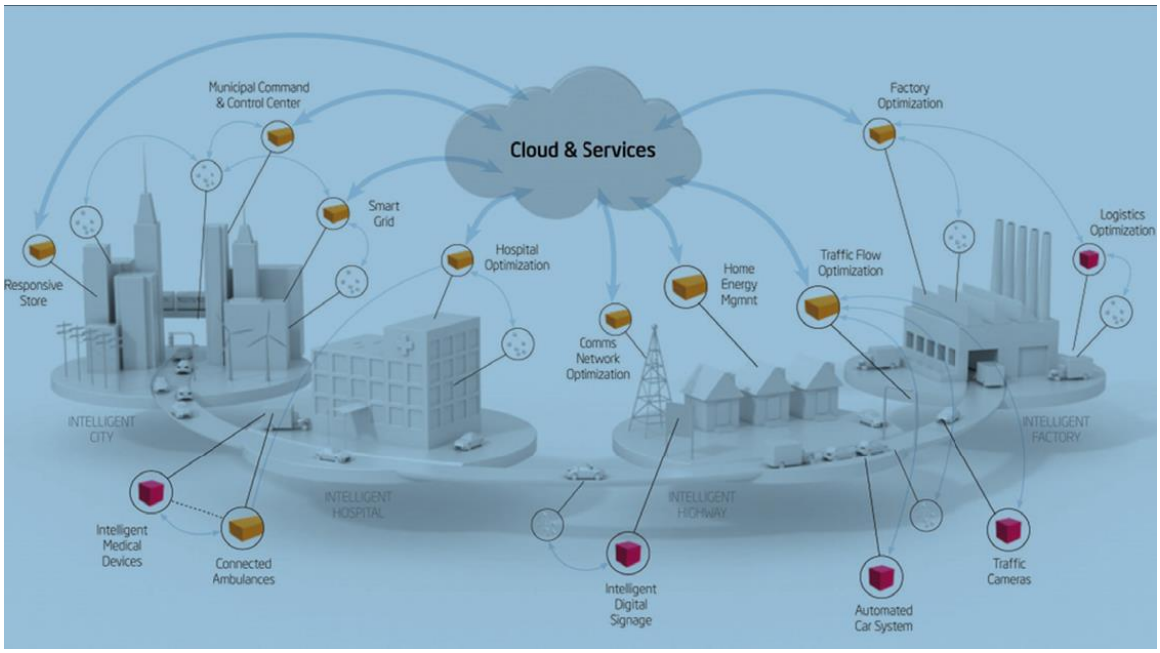
	IoT	Cloud
Displacement	Pervasive	Centralized
Reachability	Limited	Ubiquitous
Components	Real world things	Virtual resources
Computational capabilities	Limited	Virtually unlimited
Storage	Limited or none	Virtually unlimited
Role of the Internet	Point of convergence	Means for delivering services
Big data	Source	Means to manage

Source: Bhawiyuga, Kartikasari, Amron, Pratama & Habibi (2019) .

In general, IoT can benefit from unlimited cloud computing capabilities to compensate for its technological constraints such as storage, processing, and communication. Cloud computing can provide efficient solutions to manage IoT services and their composition to implement the applications and services that exploit things or data are produced by

them. On other hand, cloud computing can benefit from IoT by expanding its range to interact with real things in more dynamic and distributed, and provide more new services in many scenarios of our real-life. In many situations, the cloud can offer the intermediate layer between things and applications, which leads to a decrease in complexities and functionalities needful to applications implementation. That will lead to future application development, where information gathering, processing, transformation, which lead to creating new obstacles, especially in a multi-cloud environment hem (Botta, Donato, Persico & Pescapé, 2016). Despite its benefit, there are many challenges are generated by IoT and cloud computing integration including, network, communication, data management, and security. The first challenge is network communication which produces from the variety and variability of available networking protocols. For example, there are TCP-based protocols such as HTTP, MQTT, and AMQP, while on the other side, there exists a UDP-based protocol such as CoAP.The second challenge around the cloud system capability to emphasize that its IoT device match is a righteous partner (Bhawiyuga, Kartikasari, Amron, Pratama & Habibi, 2019).

Figure 4:Services made possible thanks to the Cloud IoT paradigm.



Source: Botta, Donato, Persico & Pescapé (2016).

The integration of cloud computing and IoT has introduced many applications in different fields. That affected daily users' life and companies. (Atlam, Alenezi, Alharthi, Walters & Wills, 2017). The IoT and cloud integration enhances new services change radically business models at logistics companies. It provides new scenarios and allows easily automated mechanisms for shipments flow from receiving to delivery. To meet its requirements are expressed in time, transport, and cost. Also, it improves tracking systems thanks to new technologies like GPS. CloudIoT is suggested to help traditional logistics systems to develop advanced systems. It can automatically with changes and complexities. Logistics resources are heterogeneous such as geographical distribution and self-governing zone. These make resource management and sharing more complex. Computer-supported software tools supporting the IoT adoption can face difficulties in dealing with complexities, uncertainties, and dynamics in their applications in new

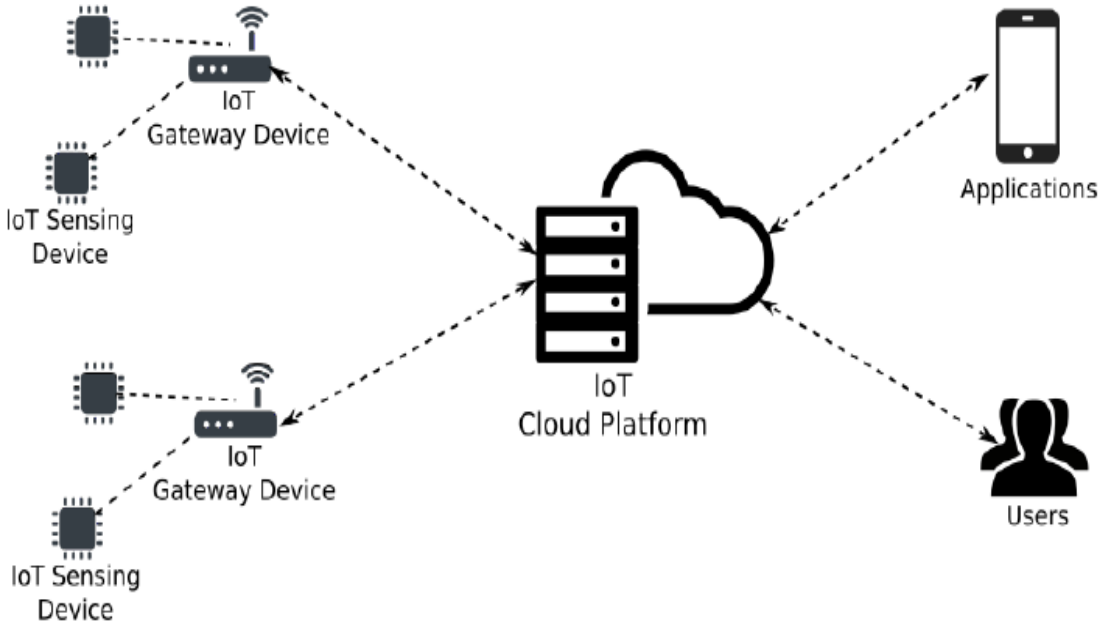
enterprises. Cloud adoption can help overcome the difficulties enabling complex decision-making systems, through automated algorithm can be enforced to restore information. By adopting a strong and modularized architecture, the cloud helps make a strong, flexible, and reliable system. Important challenges are correlated to resource heterogeneity, and solutions are researched in logistics virtualization and service selection (Botta, Donato, Persico & Pescapé, 2016).

4.1 System Design

Figure 5 explains the general environment of IoT systems uses three effective aspects are IoT sensing devices, IoT gateway devices, and IoT cloud platform. IoT device is used to determine both IoT sensing and gateway devices.

IoT sensing device has two roles for realizing contemporary circumstances of the surrounding environment via sensor involvement, also has a role for giving a specified response to the environment by adding actuator part in IoT device. The collected sensor data will be sent to the IoT gateway through a wireless connection such as Bluetooth Low Energy, WIFI, low power wide area network, or ZigBee. Upon the data is received, IoT gateway devices transmit the data to the IoT cloud platform via mobile or backbone network. Because of that, The IoT gateway must have the ability to communicate with local IoT sensing devices and the global IoT cloud platform. In the end, the sensor data are received through the IoT cloud platform and stored in its database system to process complex data. Also, access the data by users, and developed applications. In the opposite direction, the IoT cloud could receive a specific order from a user through an application programming interface (API) then send it to an IoT device via IoT gateway assistance.

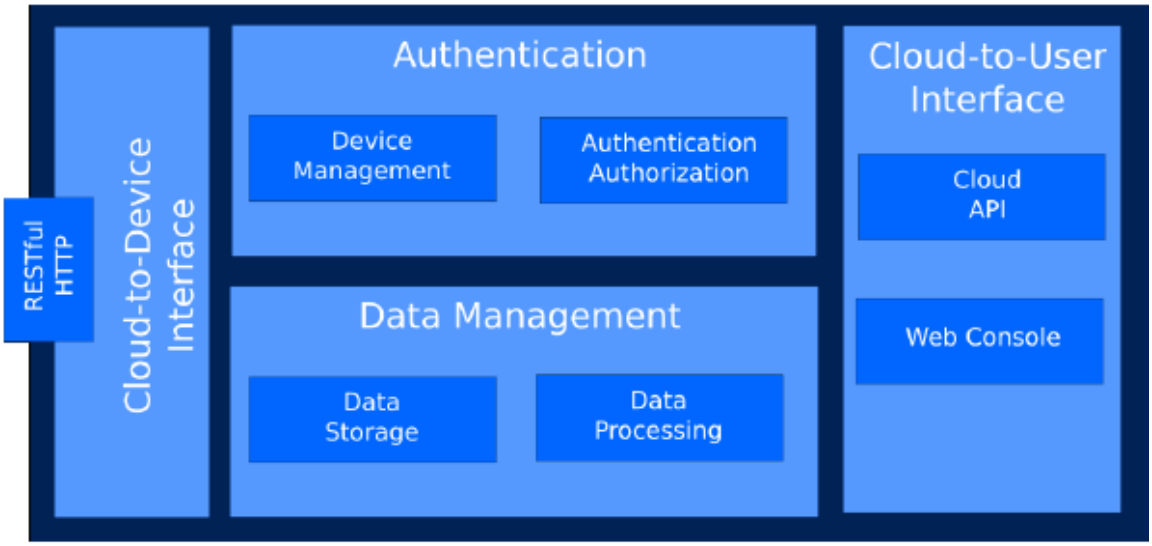
Figure 5: General environment of IoT based system



Source: Bhawiyuga, Kartikasari, Amron, Pratama & Habibi (2019).

The essential system building of IoT cloud platform has five primary components, as shown in figure 6. They are cloud-to-device interface authentication, data management, and cloud-to-user interface component. The cloud-to-device interface works as an endpoint of data transmission between the whole cloud system and IoT devices. Before the data transmission session, the communication interface connects with the authentication component to guarantee that the IoT gateway is legitimate before being granted to send sensor data to the cloud environment. Valid IoT gateway can be registered in the cloud system web console component. After that, the received sensor data has arrived in the cloud system then collected in the data storage component. Any stored data can be analyzed through data processing. The user can restore the collected data by API data access and web console (Bhawiyuga, Kartikasari, Amron, Pratama & Habibi, 2019).

Figure 6:Building block of proposed IoT cloud platform



Source: Bhawiyuga, Kartikasari, Amron, Pratama & Habibi (2019).

4.2 BENEFITS OF INTEGRATION IOT WITH CLOUD

Given that IoT has limited capabilities in storage and processing power. Also, it has to handle privacy, security, performance, and reliability. So for sure, the integration between IoT and cloud computing is the best solution to address most of these challenges. Cloud computing can benefit from IoT by extending its border by handling real-world objects in a more distributed and dynamic way and offering new services to billions of devices (Atlam, Alenezi, Alharthi, Walters & Wills, 2017). Besides, IoT and cloud integration provides ease of use and reduced cost for both application users and providers. Cloud computing facilitates the flow between IoT data collection and data processing and enables quick integration and setup for new things while maintaining reduced complex data processing and cost. That leading to do unprecedented complexity analyses, which offer means to reduce risks and increase revenue (Botta, Donato, Persico & Pescapé, 2016). The IoT and cloud computing integration benefits are discussed in the following section.

Communication: Application and data are important kinds of cloudIoT drivers in the communication category. Because of the cloudIoT paradigm and personal applications can be delivered everywhere through the IoT. Whereas automation can be applied to both data collection and distribution at a low cost. Cloud provides an efficient and cheap solution to track, manage and connect anything in any place and time, by using customized portals and merged applications. The high-speed network offers effective control and tracking for distant things with better coordination and communication to data in real-time (Botta, Donato, Persico & Pescapé, 2016). Despite cloud computing capability to develop and facilitate a connection between IoT, it still has weak points in certain areas, which leads to some problems appearing when big data are transferred from the internet to the cloud (Atlam, Alenezi, Alharthi, Walters & Wills, 2017).

Storage: IoT includes a huge amount of information sources, which produce a huge amount of unstructured and semi-structured data, which has characteristics such as big data (data size), variety (data types), and velocity (data generation frequency) (Botta, Donato, Persico & Pescapé, 2016). Cloud computing is considered one of the most effective costs, and proper solutions when it comes to handling big data were established by IoT. Furthermore, It offers new chances for data integration and collection, and sharing with a third party (Atlam, Alenezi, Alharthi, Walters & Wills. 2017).

Processing capabilities: One of the main characteristics of IoT is limited processing capabilities, which prevents complex data processing on site. The aggregated data is transferred to the nodes, which have high capabilities, which the aggregation and processing take place here. The Cloud offers unlimited virtual processing capabilities and an on-demand usage model. Predictive algorithms and decisions making can be merged in IoT to reduce the risks and increase the revenues at the lowest cost (Atlam, Alenezi, Alharthi, Walters & Willsm, 2017).

Scope: IoT adds more capabilities, people, things, and information are connected. Users around the world can enter the IoT. One of the networks generates billions of communications chances, which create new opportunities and risks also. CloudIoT model adoption enables new services and applications based on cloud extension through things, which enable the cloud to interact with different scenarios in real life (Botta, Donato, Persico & Pescapé, 2016).

New abilities: The IoT is characterized by the heterogeneity of its devices, technologies, and protocols. Then it is hard to achieve scalability, reliability, security, efficiency, and availability. The integration of IoT and cloud computing leads to solving most of these problems, also provides more other features such as ease of use and access at low cost (Atlam, Alenezi, Alharthi, Walters & Wills, 2017).

New Models: The integration of IoT and cloud generate new scenarios for smart application, things, and services. Some of the new scenarios are listed as follows.

Table 4:New Paradigms enabled by CloudIoT

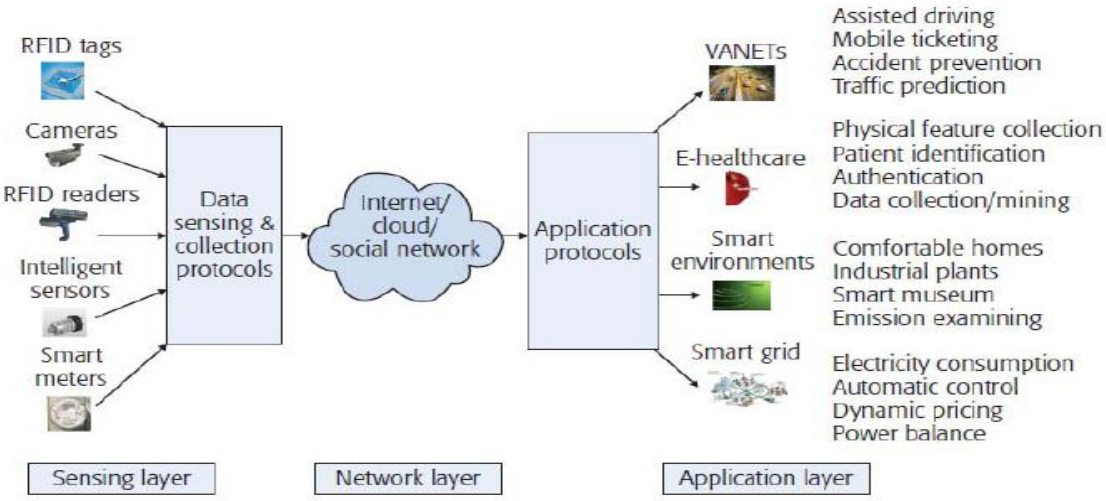
Acronym	Expansion	Description
SaaS	Sensing as a Service	allowing access to sensor data
EaaS	Ethernet as a Service	providing ubiquitous connectivity to control distant devices
SAaaS	Sensing and Actuation as a Service	providing control logics automatically
IPMaaS	Identity and Policy Management as a Service	providing access to identity and policy management
DBaaS	Database as a Service	providing database management anywhere
SEaaS	Sensor Event as a Service	Sending messaging services that are created by sensor events
SenaaS	Sensor as a Service	providing management for distant sensors
DaaS	Data as a Service	providing access anywhere to any type of data

Source: Botta, Donato, Persico & Pescapé (2016).

4.3 Cloud Based IoT Architecture

According to previous studies, IoT architecture is divided into three layers: application, perception, and network layer. Which assumes the network layer is a cloud layer. The perception layer is used to determine objects and collect data. That is collected from the surrounding environment. On other hand, the main target of the network layer is to transmit collected data to the cloud (internet). The application layer provides an interface to various services, which achieves the cloudIoT architecture. As shown in Figure 7 (Atlam, Alenezi, Alharthi, Walters & Wills, 2017).

Figure 7:Cloud-based IoT architecture



Source: Atlam, Alenezi, Alharthi, Walters & Wills (2017).

4.4 Challenges Facing Cloud-Based IOT Integration

We discussed how the cloud and IoT integration provides many benefits and enhances many applications in different fields in our lives. However, we saw that a complex cloudIoT scenario imposes many challenges in every application of importance (Botta, Donato, Persico & Pescapé, 2016). These challenges can prevent the successful integration between IoT and the cloud. These challenges are (Atlam, Alenezi, Alharthi, Walters & Wills, 2017):

Security and privacy: When IoT applications move toward the cloud, worries establish due to the shortage, such as the trust in the service providers, knowing about physical data location, and knowing about service levels agreements (SLAs). Due to that, new challenges demand special attention. Furthermore, public-key cryptography cannot be applied in all layers due to processing power constraints are forced by IoT. New challenges require special interests; for example, a distributed system is exposed to different possible attacks, such as session riding, SQL injection, side-channel, and cross-site scripting. Furthermore, Important security vulnerabilities, including session kidnapping and virtual machine fleeing, are also problems are (Atlam, Alenezi, Alharthi, Walters & Wills, 2017).

Heterogeneity: One of the significant challenges faced by IoT and cloud computing integration is related to the spacious heterogeneity of devices, platforms, operating systems, and services available and possibly used for improved and new applications (Stergiou, Psannis, Kim & Gupta, 2018). Cloud platforms face heterogeneity issues. For example, cloud services come with a proprietary interface, which leads to resource integration based on a specific service provider. Moreover, the heterogeneity challenge can be aggravated when the end-users adopt multi-cloud approaches. Subsequently, the services will rely on multi suppliers to enhance application flexibility and performance (Atlam, Alenezi, Alharthi, Walters & Wills, 2017).

IoT Services and applications usually are designed as secluded solutions, in Which all system components are tightly connected to the specific application context. For each

application or service, the service provider has to analyze requests, survey target scenarios, integrate heterogeneous subsystems, determine hardware and software environments, provide and develop computing infrastructure, and provide service maintenance. However, thanks to Cloud service delivery models, IoT and cloud integration have to facilitate IoT service delivery (Botta, Donato, Persico & Pescapé, 2016).

Performance: Usually, cloud and IoT integration provide limited performance and QoS requirements in different levels, such as storage, computation, and communication aspects, also on specific scenarios, meeting demands could not be easily achievable. Especially, gaining acceptable and stable network performance to reach the cloud is one of the challenges. Broadband growth is not keeping pace with computation and storage development (Botta, Donato, Persico & Pescapé, 2016). In many scenarios, services and data have to be provided with high efficiency. Because the timeliness could be affected by unexpected matters and real-time application are very sensitive to performance competence (Atlam, Alenezi, Alharthi, Walters & Wills, 2017).

Reliability: When cloud and IoT integration is adopted for critical applications, some reliability worries appear such as, in the context of smart mobility, especially when in vehicles movement and vehicular communication or networking is interrupted and unreliable. When applications are distributed in environment limited resources, there are several challenges related to device failure, or there are no devices that can reach it. On the other hand, cloud computing helps to overcome some of these challenges, for instance, the cloud enhances the device reliability by accepting to empty heavy tasks, which leads to improving the battery life or providing the potential of building a modularized architecture. Also, it offers uncertainties faces related to the data center or resource drain (Botta, Donato, Persico & Pescapé, 2016).

Large scale: CloudIoT allows the design of the new application to integrate and analyze information is coming from real-world devices. Some scenarios require the interaction between a large number of these devices. Usually, these devices are distributed through wide-area environments. A large scale of the system leads to hardly overcome typical challenges such as, storage, computational capability for more hard processing. Also, IoT distributed devices make monitoring more difficult, which needs to face communication problems (Botta, Donato, Persico & Pescapé, 2016).

Legal and social aspects: Legal aspects are important in new researches related to particular applications, for example, service providers have to understand different international legal regulations. On the other hand, users should give donations to contribute to data collection. In general, social sides are important for research and considered an interesting challenge (Atlam, Alenezi, Alharthi, Walters & Wills, 2017).

Big data: In the world, there are billions of IoT devices. It is important to give attention to transmission, access, storage, and big data processing are produced. Due to the constant development, the IoT will be the main source of big data. Also, the cloud will facilitate this data storage for a long period, and submitting it to complex analysis. Big data processing is considered an essential problem. Which application performance heavily adopts on data management services properties. Cloud computing faces challenges in big data processing. Moreover, data safety is a very important issue, not

only because of the effect of service quality but also because of security and privacy problems are related to external data (Atlam, Alenezi, Alharthi, Walters & Wills ,2017).

Sensor networks: Sensors network is the prime enabler of IoT. One of the technologies that will shape the world. It will provide the capability to measure, conclude, and understand environmental indicators from accurate environmental systems and natural resources. Newly developed technologies have made small devices more efficient, with lower power and cost available to use in large-scale and distant sensing applications. Moreover, smart mobile phones have limited power consumption and reliability. It includes many applications such as GPS, camera, microphone, and digital compass, which lead to providing different IoT applications. In this context, the timely processing of big and streaming sensor data, submit to energy, uncertainties, and network constraints, which are the main challenge. The cloud provides new chances for aggregating sensor data and availing the aggregates to get better relevancy and coverage, but it affects privacy and security. Moreover, being a shortage of mobility is a typical aspect of common IoT devices, the sensor mobility introduced via smartphones and available electronics represents a new challenge (Botta, Donato, Persico & Pescapé, 2016).

Monitoring: Monitoring is the main procedure in cloud computing. It relates to resource management, performance, security, capacity planning, service level agreements, and troubleshooting. IoT and cloud integrations have the same monitoring requirements approach for the cloud, even though there are some challenges related to velocity, variety, and volume of the IoT characteristics (Atlam, Alenezi, Alharthi, Walters & Wills, 2017).

Fog computing: Fog computing is an extension of cloud computing to the network edge. It was designed to support IoT applications characterized by the requirement for mobility and geographical distribution. Through storage, computing, and networks are resources to fog and cloud. Fog computing has specific characteristics such, edge location and location consciousness, which meant low transition, a big number of nodes, and geographical distribution not like a cloud. Support for mobility through wireless access, real-time interaction instead of collected process, cloud interaction support (Botta, Donato, Persico & Pescapé, 2016).

5 CASE STUDY: ARAMEX COMPANY

Aramex is a provider of comprehensive transportation and logistics solutions. It was established in 1982 as an express operator. After that, the company worked to transform itself into being a recognized international brand for its services. Its services include international and domestic express delivery, freight forwarding, integrated logistics solutions, consumer retail services and e-commerce solutions, information and document management solutions.

In 1997, Aramex became the first Arabic company its stocks are traded on the NASDAQ stock exchange. After five years, Aramex was owned to private ownership for a private sector and made international alliances to get stronger brand recognitions. In 2005 went public On the NASDAQ stock exchange. Today Aramex includes more

than 353 offices and 12300 employees who provide transportation and logistics solutions to wholesaler and retailer customers worldwide.

Aramex is a founding member and president of the global distribution alliance (GDA), which includes more than 40 leading express and logistics companies around the world. Everyone specializes in their region to cover the world in the same service, quality standards, and technology criteria. The network includes more than 12000 offices, 33000 vehicles, and 66000 employees serve different customers in 240 countries around the clock.

Aramex owns one of the largest land fleets in the Middle East, UK, and Ireland. New land fleets equipped with IoT technology such as GPS, temperature and humidity devices, and scheduled services, all work together to make their land freight smart and cost-effective alternative. Moreover, Aramex offers Air freight service, which provides global and cost-effective shipment solutions for all categories, through an extensive network in four continents. Aramex's professional team provides international services and local experience to guarantee full transit from door to door and custom clearance at any time. Their technology and offices network in the global help to total tracking and visibility of the customers' shipments from receiving to the final destination. Aramex has a fully integrated IT network that enables the full shipment tracking 24 hours, also provides updated shipping information by SMS or Email.

5.1 Aramex Services

5.1.1 International Express

Aramex offers international services for moving parcels and sensitive documents on the whole world from door to door, within the diversity of transit time options that meet customers' needs.

Aramex international express services offer real-time information tracking, delivery of shipment proof, request delivery notification through SMS or Email. Through its extensive network, Aramex guarantees to deliver your shipment on time and from door to door to any destination in the world. As follows are some of Aramex's international services.

Document express: Through their extensive network and competitive shipping prices, the company guarantees the delivery of your urgent documents on time.

Parcel Express: The company especially packages non-documents shipments, ships, and clears from customs to deliver on time to the customer in any location.

Express Inbound: In addition to exporting, Aramex allows importing from any destination in their network to the client door.

Cash on delivery: Upon delivery, Aramex collects the entire payment for a sold good on the client's behalf. Fees payment way and schedules are organized with the client on a case-by-case basis.

Return Service: this service is provided for retailers, who wish to add a free return service with the delivery of their goods, and for retailers' customers who return items to be repaired and then shipped back.

Cash Collect: Aramex provides customers the option to collect shipping charges from the sender, receiver, or a 3rd Party.

Customs clearance: Aramex provides a fast and efficient customs clearance, with different handling services for imported and exported goods clearance.

Insurance Coverage: In addition to their high responsibility. Aramex offers insurance against all risks that will happen to shipments.

5.1.2 Domestic Express

Aramex domestic express offers credible solutions for important parcels to be delivered on time and door to door inside a country or city. Aramex picks up and delivers the shipment during an agreed time, with the ability to track your shipment through the internet at any time.

5.1.3 Business Solutions Services:

Aramex offers different services to fit companies' business needs, including:

Inter-Branch Solutions: Aramex delivers and manages mail between branches regularly that meets a client's requirements.

Mass Mail Solutions: Aramex sends clients' ad hoc or regular mass mail, including invoices, marketing material, promotions, and invitations.

Financial Solutions: Aramex guarantees a secure delivery of credit cards for customers, ID investigation, get a delivery proof, and return it to the client.

Telecom solutions: Aramex stores sim cards and mobile phone for telecom operators, upon their notification, Aramex deliver to their clients' doors. In addition to mass mail service.

Cash on Delivery: Aramex guarantees fast delivery of clients' products and safe and reliable cash collection for sold goods.

Document Return: Aramex provides a document return service, which picks up the documents and delivers them to sign, then returns them to the client.

Customer clearance and door delivery: Aramex received your shipment from airports, ports, or client's warehouse, and it makes all clearance procedures and delivers to the client's customer door.

5.1.4 Aramex Logistics and Supply Chain Management

Aramex is a leading transportation and logistics field. It combines experience and the latest global technology and criteria to provide comprehensive solutions for clients' logistics and supply chain requirements.
Aramex comprehensive logistics and supply chain solutions work on product transfer, information, money between their clients' suppliers and customers. It covers all clients' supply chain stages from suppliers' inventory to final customer or retailer. It provides many services in logistics and supplies chain management such as:

Warehousing: Aramex provides warehousing service within supply chain management. It stores and manages clients' products at their logistics centers offering bonded or duty-paid options to meet customers' needs requirements in all industries. Supported with new technology, Aramex guarantees storage requirements and inventory management that need to offer direct real-time visibility at all levels to help companies to control their stock levels.

Facility Management: Aramex provides a storage and warehouse management service for the clients' stores. In case a client has its warehouse, Aramex provides advisements and management of the client's warehouse and inventory for decreasing cost, minimizing waste, creating better space usage, selecting the right equipment, and enhancing the service levels.

Distribution: Aramex provides delivery service for clients' products through their fleet of GPS-equipped trucks. That works on a massive land network providing comprehensive supply chain operations and providing visibility through shipment tracking.
IT Services: Aramex offers warehouse and inventory management through its warehouse management system. It is a new system that was improved by Aramex company. That helps on efficiency development and enhancement by providing management visibility and access to information through the internet and various automated reports.

5.1.5 Information Management

At Aramex company has service's name is info fort offers comprehensive and advanced information management solutions that support companies, government, and industries with their digital transformation journey. It transforms paper-centric and manual

practices into an automated, smart, and digital process. For this purpose, Aramex analyzes all data flows and information assets, forces paper out of the organization through off-site storage at Aramex's secure and specialized record management centers. Moreover, Aramex digitizes all documents, offers their advanced electronic documents and content management technology, allows clients to manage and create digital data and eliminate any need for paper. Integrate with the clients' IT infrastructure and data sources, provide tape vaulting and management or backup cloud replication solutions when needed.

Using Aramex workflow management technology, they can automate the manual process such as insurance claims, accounting payable, on-boarding process for banks, and more. The clients' data became easily accessible and more valuable. Info for business intelligence and analytics platform will help clients visualize, analyze data, extract corrective action.

5.1.6 General Recommendation

The Aramex company is a global logistics provider, is originated in Jordan where After the analysis of Jordanian logistics companies, I found out that Aramex is the most important and innovative Jordanian logistics company. Moreover, Aramex has progressed in technological development and digital transformation than other Jordanian logistics companies inside and outside Jordan, especially in the Middle East and North Africa, of which the founder is Jordanian. However, the Aramex company provides its services across the globe, which has more than 353 offices in 60 countries across the world. Since its establishment in 1982, It worked as a private company until 1997. After that, the company chose to go public on Nasdaq as the first Arab corporation to be registered on an American stock exchange. After that, the company was registered on Dubai Stock Exchange in 2005 (Alberti-Alhtaybat, Al Htaybat & Hutaibat, 2019).

Aramex always realizes that technology will bring a competitive advantage. Starting from cooperation with Airborne to create the FOCUS system is a mainframe-based in Washington. It enables the various partners and companies to track shipments across the world. The tracking ability system is very important for clients, which leaded Aramex company to improve its own system Info Axis in-house. The Internet evolution broke the cost barrier of the tracking and tracing systems are used by big courier companies. The Chief Technology Officer(CTO) in Aramex company mentioned that in the past, the technology hubs were in America, Singapore, and Ireland. However, Aramex was able to establish a superior system in-house by using Jordanian talents. Aramex continued to invest in technology to improve operational efficiency, to create a competitive advantage through cost reduction and customer satisfaction (Balakrishnan, 2015).

Aramex company has maintained its entrepreneurial character and outperforming, especially in Disruptive technological innovations, such as big data analytics, new applications, new hardware, which can connect the individuals with the company in

different situations. To manage their collective knowledge strongly through innovation and value creation. New innovations are embedded in their business models and an important for the company's business operations (Alberti-Alhtaybat, Al Htaybat & Hutaibat, 2019).

Its annual turnover in 2016 amounted to USD 1182 million, superior to the main international competitors DHL USD 67,381 million, UPS USD 60,906 million, and FedEx USD 50,385 million. Aramex company is the leader in technological implementation in its business operations, not only in Jordan also in the middle east. It endeavors to adopt the most innovative and emerging technologies in its operations. The top management studies the innovations and developments that will affect and threaten its competitive opportunities (Alberti-Alhtaybat, Al Htaybat & Hutaibat, 2019).

6 RESULTS, SUGGESTIONS, AND DISCUSSION

6.1 Results

Through this research, I established a conceptual model depending on the literature review. The model around IoT, RFID, and cloud computing implementation at logistics companies, and the benefits of this implementation. Also, I mentioned the challenges that face by the IoT, cloud computing implementation at the logistics companies. Moreover, how the integration of IoT and cloud computing leads to change in the system exploitation on both sides.

In addition to the theoretical framework, I did the interviews with Aramex company in Amman, Jordan. According to the IoT implementation in their company (Appendix 1). Which they apply two kinds of IoT technology in shipments tracking while in transfer and temperature and humidity tracking of shipments during its whole journey. Also, there are other technologies are used to help these two kinds of IoT technology as following.

1. Tracking of shipments while in transport

Aramex company has a tracking system through a mobile phone application. Every shipment has a barcode attached to a shipment or parcel. This barcode has all data such as tracking number, reception office, destination, receiving office, and delivery information in the company or delivery to the client, and all updated information directly is sent to the Aramex website.

Via the barcode, all data are updated step by step, and it is shown on the Aramex web account for clients and companies. Through this technology, the client can track his shipment and know all information such as location and estimated time for arriving.
The ground courier or employee scans every shipment step by step through the mobile phone. The company and client can track the ground courier through the mobile phone

application that has access to the GPS mobile, and both of them can know arriving estimated time. Moreover, through the mobile screen, the client can sign the receipt, and all this information is updated online and directly.

2. Temperature and humidity tracking of shipments during its full journey

In this technology, the clients and company can get information about the temperature and humidity for the shipment in warehouse and transport, which lead the company to open new fields with medicine companies, pharmacies, and food companies.

The company and the client can monitor the shipment's conditions through its transportation cycle. It depends on Bluetooth technology that provides real-time monitoring of shipment, including temperature, humidity, and pressure. That Lead them to analyze and archive data on the company's cloud.

This technology works by sticking a portable device on the container surface or pallets that you are shipping. The portable device sends the data through Bluetooth to the mobile hotspot. The sensor data is uploaded repeatedly to the company cloud, so that allows the company to take action when anything wrong with the temperature and humidity to protect the goods at right time, also the mobile information. Moreover, the portable device can provide the mean kinetic temperature in real-time. In case the portable device is disconnected and unable to communicate in real-time, the data is stored in the device and automatically transmits to the company cloud when connectivity resumption, so the company and client can monitor and check data even it was on the air flight or ocean.

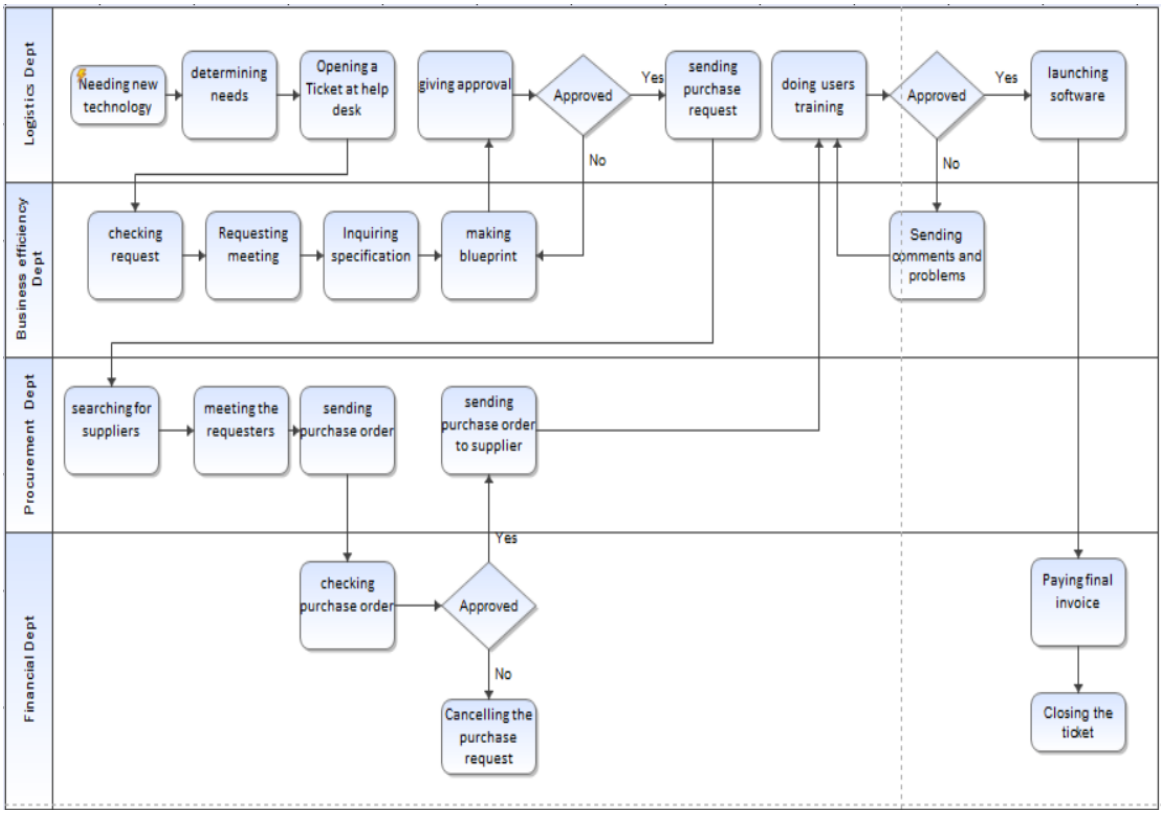
The Aramex company adopted these IoT technologies at their operations for many reasons as following.

1. To get accurate information about shipments, such as location and the shipment condition.
2. To improve customer services by giving them access to track their shipments and know the estimated time for delivery.
3. To improve coordination between the client and the company to avoid any misunderstanding or chaos between them according to correct shipment and delivery time.
4. To open new markets fields and exceed their competitors such as medicine companies and pharmacy, food companies.
5. To maintain and protect the shipment quality from any damage through the transfer, such as the temperature and humidity.
6. To improve the employees' control, especially in warehouses and ground couriers, to know all information about them, such as location and working hours.
7. To improve the inventory system such as the tracking and decrease the missing goods at the warehouse.
8. To improve logistics security through tracking the vehicles and shipment, and sense if the shipment has been sidetracked or opened, to decrease embezzlement.

Before implementing the IoT, the company has many processes and procedures to implement any new technology. They depend on a business efficiency department to

monitor current setups like customer satisfaction and current services and develop the current system like market research and find new technology.

Figure 8:IoT Business process mapping



Source: Own work.

As previous figure shows. When Aramex implemented the current IoT technology. The logistics department ordered to get these technologies, they determined the needs and reasons to get them. Through opening ticket on help desk system, which is the internal system inside the company between employees to connect with each other, and follow any case was opened quickly and accurately. The business efficiency department checked the request and requested a meeting with the logistics department to inquire about specifications, usages, and technics. Then they do a blueprint, which is used to automate the business process at the company and to provide a business process platform, it includes process capture, designing, enhancements, plans, and specifications to any new project. After that, they take approval for the blueprint from the logistics department, then sending the purchase request to the procurement department to find the best supplier and quotation with working with requesters because it has technical issues. Then sending the purchase order to the financial department to take approval, "the approval of purchase order depends on the cost if the cost is very high they have to take the approval from regional CEO" then the procurement department sends the purchase order to the supplier. Before Launching the software and devices, the requesters have to make a procedure is user training acceptance (UTA). In this procedure, the requesters do a test and take training on the system from the supplier

and business efficiency department to give feedback if they have any comment and confirmation before software launching.

Aramex company always wants to know from the clients the methods help improving its services by making evaluations from customers' standpoint and getting a deep understanding of the current network, services, and infrastructure to build future expectations and improvements. Leading to present strategic recommendations for clients' services improvements, cutting cost, and enhance the company's work and the supply chain inside and outside the company.

The company's Target from The IoT implementation to optimize the supply chain network, such as enhance shipment velocity, demand prediction accurately. It improves data analysis and artificial intelligence to provide accurate and trustworthy information. The company's cloud platform is operated by IoT devices to monitor and control shipments at a wide range. Moreover, the company provides many Application Programming interfaces (APIs) and tools to enhance the cooperation and enhance the services between the clients and the company through their application. These tools work in the background and real-time to provide and calculate accurate data.
Along with medicine companies' and pharmacies' business grows. This field opened new opportunities for the company, especially are facing an increase of complexity and growth in their supply chain. Many of them don't have a vision or capability to improve the logistics operations and their current supply chain. Aramex wants to offer its services in logistics fields to help them cost-saving and products transfer more safely, less complexity, and improve the service for them through direct delivery and open new markets.

At the IoT, there are many applications that can be implemented. Also, there are priorities of the various IoT application choice at the logistics companies. According to Aramex company, In the beginning, they were using the barcode scanner to capture data and follow the shipments, then improved this technology to be used by mobile phone. They developed the Aramex application on the mobile phone, where the employees in the supply chain can scan and capture data from the phone camera and update the data directly. Via this application, the employees can find all data about the shipment like the client name, phone, location, weight, and time for received and delivery.

They used GPS to track the cars, employees, and shipments. After that, they added new technology for their employees tracking through the same Aramex application on a mobile phone, in which the employee opens the GPS on his, her phone, which can the management tracks him/her. Then they would like to open new markets with medical companies, pharmacies, and food companies. They added new devices to measure the temperature and humidity for the shipments and determine the location. To provide accurate data and gaining customer confidence.

Aramex company doesn't use just IoT technology. Also, it uses some technologies besides the IoT, such as artificial intelligence, machine learning, and cloud computing,

to complete each other and improve logistics and warehouse operations. Artificial intelligence is a sequel to IoT from their standpoint, by AI can get data from the IoT and analyze it. Artificial intelligence has planning operations that help the company make sorting and priorities for loading and delivery by making particular algorithms and calculations.

IoT enables the company to collect the data such as barcodes, GPS, and temperature and humidity devices, which led them to build servers and established cloud computing to store big data. Moreover, IoT helps the company the location and the condition of shipments in carriage and warehouses in real-time.
They partnered up with a third-party company when implementing the IoT to enable them with the required hardware. In addition to facilitating technology integration for better performance between their hardware and software, with following and upgrading any problems or new updates. Moreover, the provided devices send data to a supplier site. The company fetches it through time by webhook or Robotic Process Automation (RPA) when data are available, or the company fetches from the supplier's API to withdraw data upon their request.

IoT Achieved many business values for the company in warehouses and logistics operations. Moreover, it enabled them to penetrate market segments that require features and capabilities of implemented IoT solutions and process improvement.

1. Warehouse management: attached barcode on the shipments provides all data about the shipment, also to know the inventory levels, spaces, and exported and imported shipments. Moreover, knowing the temperature and humidity in the warehouses by send alerts for any issue to the warehouse management.
2. Employees' efficiency: employees can connect through the Aramex application on a mobile phone, knowing their missions, and determining the process that can be enhanced, especially ground courier to track, monitor them, and improve their operations.
3. Assets Management: via connecting the vehicles and shipments with the system, which allows the managers to monitor all assets in real-time.
4. location and condition tracking: monitoring shipments provide accurate data about the shipment condition and location through different transportation, which improve the decision making and control
5. Delivery and pickup coordination: clients can track and monitor the ground courier. Who is coming to deliver or pick up the shipment through the Aramex web application, and know when the ground delivery driver will arrive at the location. This operation improves flexibility and customer service.
6. New markets: IoT technology allowed the company to cooperate with pharmacies and medical companies to ship their products safely and under monitoring throughout the whole journey, which leads to enhance the client's trust.

IoT platform contains many elements such as Device management through their supplier portal, Integration management to integrate existing on-prem services with IoT collected data, and Digital touchpoints covering dashboards, reporting, and tracking features.

However, there are many business issues were addressed with the IoT implementation as following.

1. between stakeholders' cooperation: The IoT implementation requires a cooperation between all departments, especially in logistics companies along a supply chain.
2. High cost: IoT implementation required to prepare network, buy devices, contract with a third-party company, and rent and buy servers, which lead to additional on the company.
3. Shipments tracking: Some locations face some tracking difficulties because of network communication failures or break down or some airplane instructions.
4. Asset management: The company needs more coordination to follow the retainable IoT devices are attached with shipments and return them to the main branch or distribute them.

6.2 Suggestions

Aramex company is a developed company in the technology field and has many services was built on technology and IoT, as I explained before in my thesis. Following my meetings with Aramex employees and understanding of how to exploit the IoT technology in their company. That leads me to suggest additional services need more researches, such as feasibility studies and return of investment in the IoT technology field.

Establishing smart mailboxes: One of the difficulties faces by logistics companies is the coordination between the pick-up and delivery time between a company and customer. which leads to waste of time, efforts, and money.

The smart mailbox will allow managing mailboxes from both sides a client and company. They will receive a notification when a parcel or letters are added to the mailbox through a specific application. That will be downloaded on their mobile phones.

It is working by sensors are placed inside the mailbox. These sensors send notifications for a ground courier to pick up the shipment from the mailbox in his area or skip the box if it is empty. At the same time, the sensors send notifications to the clients if they received any shipment. It is provided with a smart lock to enable both sides to open the mailbox safely.

Automatic replenishment and anticipatory shipping: One of the Aramex services is warehousing, in which Aramex stores and manages clients' products at their logistics centers. Also has facility management, which Aramex provides a storage and warehouse management service for the clients' stores.

Through these two services, Aramex has the capability to add an automatic replenishment and anticipatory shipping service to improving logistics efficiency, reducing delivery time, and avoiding stock-outs.

It is working by sensors are placed in retailers' stores to monitor inventory levels. When a retailer has low stock, an order is placed automatically to the Aramex company to deliver the request from its warehouses.

6.3 Discussion

IoT is a multibillion-dollar market that represents the integration between information systems and physical objects at companies. Therefore, the physical objects are processed with specific technologies is called identification and data captures (AIDC), such as RFID tags, sensor tags, and telematics modular. These products acquired smart specifications, including location, identification, sensing, communication, and logical functions. That facilitates IoT services in logistics. The IoT includes many technologies which can be implemented in logistics companies, such as RFID, GPS, GIS, and EDI. The implementation of these technologies has three core elements, physical element, smart element, and communication element. Before IoT implementation at the logistics companies requires many steps such as Comprehensive data sources, Related Technology, and Multiple users, applications, and data sources, which I explained in detail in chapter 2.6.

The IoT is considered one of the main tools for logistics industry development. It plays the main role in enhancing the quality and service implementations. Also, it enhances the capability of the logistics system analysis and decision making through smart hardware. Moreover, The IoT makes the supply chain better through delivery tracking in real-time, data accuracy improvement, which leads to improving the expectations management. Moreover, many factors helped IoT usage spread in logistics fields like professional IoT service providers' existence everywhere and Ecommerce development.

On the other hand, Cloud computing provides operational benefits and effective international relations through the cooperation between cloud computing and logistics. The integrated logistics information system contributes to reduce costs and enhance business efficiency. Also, it improves their services, achieves optimal planning and reliable daily operation. Moreover, cloud computing solutions can facilitate the organization and execution of transportation, customs clearance, freight forwarding, warehousing, distribution, and shared work process.

With different types of logistics companies' services, essential common logistics services can be designed and applied to an intelligent logistic system on the cloud computing platform. When adopting cloud computing at logistics companies, there are many steps before implementation, such as Analyzing an existing IT environment and Achieving transfer of cloud service.

With no enough scientific researches according to IoT implementation in Jordanian logistics companies, but we can find many international Jordanian logistics companies has many branches around the world also many global companies have affiliates in Jordan. Most of them implementing the IoT criteria to integrate their procedures, processes, and services with their affiliates around the world.

Many logistics companies in Jordan, such as Aramex company, designs Developers Solutions Center is made for any business model. It offers automated solutions without human interactions and many tools to manage shipments to facilitate delivery operations. Using these developed business models and electronic tools helps the company and clients to track shipments with all information. IoT Achieved many business values for the Jordanian logistics companies in warehouses and logistics operations. Moreover, it enabled them to penetrate market segments that require features and capabilities of implemented IoT solutions and process improvement like medical and pharmaceutical markets and working with online stores and markets.

CONCLUSION

The IoT has many impacts on every stage in logistics companies, from receiving to the delivery stage. It promotes supply chain visibility, Accurate information, customer service improvement, and delivery tracking, reflecting an increase in control and security. However, IoT faces many challenges in implementation, such as deployment challenges, Security challenges, Business Process Challenges, Technical challenges, IoT data collection challenges. This paper addressed these challenges at the logistics companies and necessary elements for delivering the IoT functionality. Moreover, it mentioned the industrial field providers for IoT services (hardware, software) and the existing IoT technologies such as RFID, GPS, GIS, and EDI. Furthermore, we mentioned cloud computing and how it provides operational benefits and effective international relations through encompassing it at logistics companies. It provides solutions that can facilitate the organization and execution of transportation, customs clearance, freight forwarding, warehousing, distribution, and shared work process, and the main steps have to do before cloud computing implementation at the logistics companies.

After that, we did meetings with Aramex company is a provider of comprehensive transportation and logistics solutions, to know the IoT implementation effects on their works. We discovered the IoT technology contributed to developing their work and open new markets. It improves the shipments tracking while in transport service and Temperature and humidity tracking of shipments during their whole journey. These opportunities led the company to open new markets and achieve many business values in warehouse and logistics operations management, such as warehouse management, employee efficiency, assets management, location and condition tracking, and delivery and pickup coordination.

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APPENDICES

Appendix 1: Povzetek (Summary in Slovene language)

IoT ima številne vplive na vse stopnje v logističnih podjetjih, od prejema do faze dostave. Spodbuja prepoznavnost dobavne verige, natančne informacije, izboljšanje storitve za stranke in sledenje dostavi, kar odraža večji nadzor in varnost. Vendar se IoT pri izvajanju sooča s številnimi izzivi, kot so izzivi uvajanja, varnostni izzivi, izzivi poslovnih procesov, tehnični izzivi ter izzivi zbiranja podatkov IoT. Ta članek obravnava te izzive v logističnih podjetjih in potrebne elemente za zagotavljanje funkcionalnosti IoT. Poleg tega omenja industrijske ponudnike storitev IoT (strojna oprema, programska oprema) in obstoječe IoT tehnologije, kot so RFID, GPS, GIS in EDI. Omenja tudi računalništvo v oblaku in kako zagotavlja operativne koristi in učinkovite mednarodne odnose, ki so zajeti v logističnih podjetjih. Ponuja rešitve, ki lahko olajšajo organizacijo in izvedbo prevoza, carinjenje, transport tovora, skladiščenje, distribucijo in skupni delovni process. Glavne korake je potrebno opraviti pred izvajanjem računalništva v oblaku v logističnih podjetjih.

Po tem smo se sestali s podjetjem Aramex, ki je ponudnik celovitih transportnih in logističnih rešitev, da bi spoznali učinke izvajanja IoT na njihova dela. Ugotovili smo, da je IoT tehnologija prispevala k razvoju njihovega dela in odpiranju novih trgov. Izboljša sledenje pošiljk med prevozom in sledenje temperature in vlažnosti pošiljk med celotnim potovanjem. Zaradi teh priložnosti je podjetje odprlo nove trge in doseglo številne poslovne cilje pri upravljanju skladišč in logističnih operacij, kot so upravljanje skladišč, učinkovitost zaposlenih, upravljanje premoženja, sledenje lokacije in stanja ter koordinacija dostave in prevzema.

Appendix 2: Interviews Questions

The questions were designed in a way to figure out the current IoT applications are used in Aramex company and the degree of reflection on its work.

The goal of the interview is to get information and analyze IoT implementation. Also, identification of opportunities and challenges arising from this implementation. Moreover, making some suggestions for future improvements in the IoT field.

Question No. 1
What are the main IoT applications do you have in your company?

Question No. 2
What are the justifications for IoT adoption?

Question No. 3
What were the procedures before implementing the IoT?

Question No. 4
How did you determine business requirements to IoT infrastructure, process, data to achieve your expectations?

Question No. 5
How did you determine the priorities of the various IoT application choice?

Question No. 6
Why did you decide to use IoT and not any other technology?

Question No. 7
Did you work with a third-party company such as a technology company? Why did you choose that "benefits and challenges"?

Question No. 8
What is the business value (reducing costs, improving quality, …) of IoT implementation?

Question No. 9
What are the main elements of your IoT platform?

Question No. 10
What business issues are you addressing with the IoT?

Appendix 3: List of Interviewed Persons

I interviewed two of Aramex's employees four times:

Name: Mr. Iyad Tabello
Mobile: +962 7 88334328
E-mail address: IyadT@aramex.com
Place of work: Aramex company, Amman,Jordan
Position at the work: Digital Transformation Manager

Name: Mr. Mahmoud Abugharbieh
Mobile: 00962 7 77777457
E-mail address: MahmoudG@aramex.com
Place of work: Aramex company, Amman,Jordan
Position at the work: Financial Manager

Appendix 4: Answers of the interviewees

What are the main IoT applications do you have in your company?

The Aramex company uses two kinds of IoT applications for shipments tracking while in transfer and temperature and humidity tracking of shipments during its whole journey. Also, there are other technologies are used to help these two kinds of IoT technology.

Tracking of shipments while in transport:

Aramex company has a tracking system through a mobile phone application. Every shipment has a barcode attached to a shipment or parcel. This barcode has all data such as tracking number, reception office, destination, receiving office, and delivery information in the company or delivery to the client, and all updated information directly is sent to the Aramex website.

Via the barcode, all data are updated step by step, and it is shown on the Aramex web account for clients and companies. Through this technology, the client can track his shipment and know all information such as location and estimated time for arriving.
The ground courier or employee scans every shipment step by step through the mobile phone. The company and client can track the ground courier through the mobile phone application that has access to the GPS mobile, and both of them can know arriving estimated time. Moreover, through the mobile screen, the client can sign the receipt, and all this information is updated online and directly.

Temperature and humidity tracking of shipments during its full journey

In this technology, the clients and company can get information about the temperature and humidity for the shipment in warehouse and transport, which lead the company to open new fields with medicine companies, pharmacies, and food companies.
The company and the client can monitor the shipment's conditions through its transportation cycle. It depends on Bluetooth technology that provides real-time monitoring of shipment, including temperature, humidity, and pressure. That Lead them to analyze and archive data on the company's cloud.
This technology works by sticking a portable device on the container surface or pallets that you are shipping. The portable device sends the data through Bluetooth to the mobile hotspot. The sensor data is uploaded repeatedly to the company cloud, so that allows the company to take action when anything wrong with the temperature and humidity to protect the goods at right time, also the mobile information. Moreover, the portable device can provide the mean kinetic temperature in real-time. In case the portable device is disconnected and unable to communicate in real-time, the data is stored in the device and automatically transmits to the company cloud when connectivity resumption, so the company and client can monitor and check data even it was on the air flight or ocean.

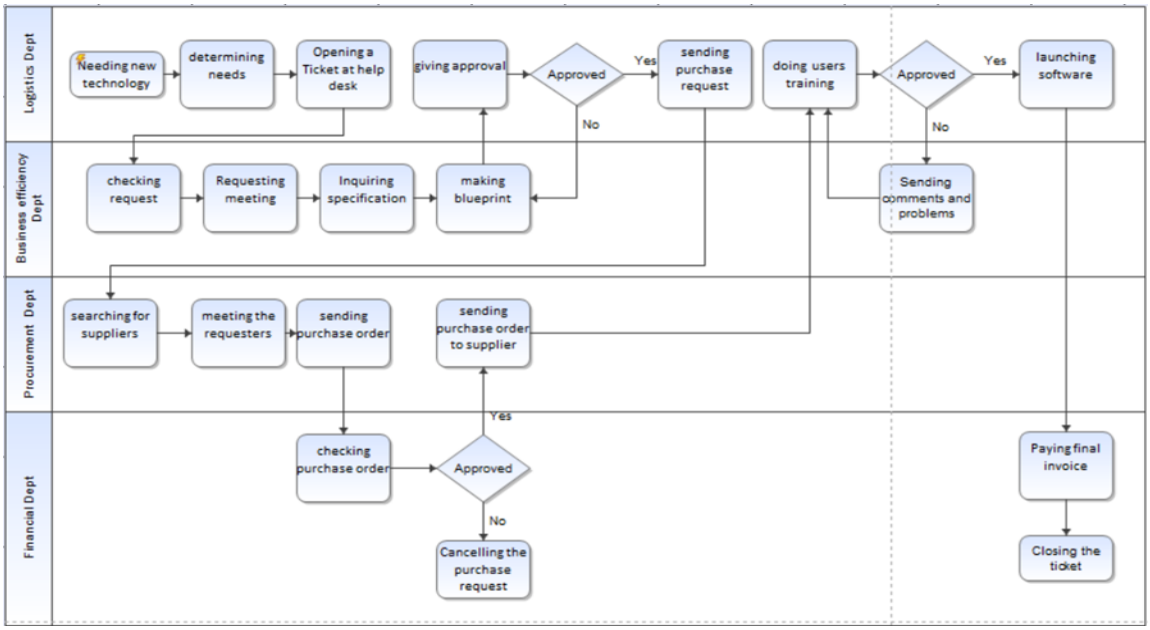
What are the justifications for IoT adoption?

1 To get accurate information about shipments, such as location and the shipment condition.
2 To improve customer services by giving them access to track their shipments and know the estimated time for delivery.
3 To improve coordination between the client and the company to avoid any misunderstanding or chaos between them according to correct shipment and delivery time.
4 To open new markets fields and exceed their competitors such as medicine companies and pharmacy, food companies.
5 To maintain and protect the shipment quality from any damage through the transfer, such as the temperature and humidity.
6 To improve the employees' control, especially in warehouses and ground couriers, to know all information about them, such as location and working hours.
7 To improve the inventory system such as the tracking and decrease the missing goods at the warehouse.
8 To improve logistics security through tracking the vehicles and shipment, and sense if the shipment has been sidetracked or opened, to decrease embezzlement.

What were the procedures before implementing the IoT?

At Aramex company has many processes and procedures to implement any new technology. They have a business efficiency department to monitor current setups like customer satisfaction and current services, and develop the current system like market research and find new technology.

Figure:IoT Business process mapping



Source: Own work.

When Aramex implemented the current IoT technology. The logistics department ordered to get these technologies, they determined the needs and reasons to get them. Through opening ticket on help desk system, which is the internal system inside the company between employees to connect with each other, and follow any case was opened quickly and accurately. The business efficiency department checked the request and requested a meeting with the logistics department to inquire about specifications, usages, and technics. Then they do a blueprint, which is used to automate the business process at the company and to provide a business process platform, it includes process capture, designing, enhancements, plans, and specifications to any new project. After that, they take approval for the blueprint from the logistics department, then sending the purchase request to the procurement department to find the best supplier and quotation with working with requesters because it has technical issues. Then sending the purchase order to the financial department to take approval, "the approval of purchase order depends on the cost if the cost is very high they have to take the approval from regional CEO" then the procurement department sends the purchase order to the supplier. Before Launching the software and devices, the requesters have to make a procedure is user training acceptance (UTA). In this procedure, the requesters do a test and take training on the system from the supplier and business efficiency department to give feedback if they have any comment and confirmation before software launching.

How did you determine business requirements to IoT infrastructure, process, data to achieve your expectations?

Aramex company always wants to know from the clients the methods of improving its services by making evaluations from customers' standpoint and getting a deep understanding of the current network, services, and infrastructure to build future expectations and improvements. Leading to present strategic recommendations for clients' services improvements, cutting cost, and enhance the company's work and the supply chain inside and outside the company.

Aramex company's Target from The IoT implementation to optimize supply chain network, such as enhance shipment velocity, prediction demand accurately. It improves data analysis and artificial intelligence to provide accurate and trustworthy information. The company's cloud platform is operated by IoT devices to monitor and control shipments at a wide range. Moreover, the company provides many Application Programming interfaces (APIs) and tools to enhance the cooperation and enhance the services between the clients and the company through their application. These tools work in the background and real-time to provide and calculate accurate data.

Along with medicine companies' and pharmacies' business grows. This field opened new opportunities for the company, especially are facing an increase of complexity and growth in their supply chain. Many of them don't have a vision or capability to improve the logistics operations and their current supply chain. Aramex wants to offer its services in logistics fields to help them cost-saving and products transfer more safely, less complexity, and improve the service for them through direct delivery and open new markets.

How did you determine the priorities of the various IoT application choice?

In the beginning, they were using the barcode scanner to capture data and follow the shipments, then improved this technology to be used by mobile phone. They developed the Aramex application on the mobile phone, where the employees in the supply chain can scan and capture data from the phone camera and update the data directly. Via this application, the employees can find all data about the shipment like the client name, phone, location, weight, and time for received and delivery.
They used GPS to track the cars, employees, and shipments. After that, they added new technology for their employees tracking through the same Aramex application on a mobile phone, in which the employee opens the GPS on his, her phone, which can the management tracks him/her.
Then they would like to open new markets with medical companies, pharmacies, and food companies. They added new devices to measure the temperature and humidity for the shipments and determine the location. To provide accurate data and gaining customer confidence.

Why did you decide to use IoT and not any other technology?

The Aramex company uses different technologies besides IoT, such as artificial intelligence, machine learning, and cloud computing, to complete each other and improve logistics and warehouse operations.
IoT enables the company to collect the data such as barcodes, GPS, and temperature and humidity devices, which led them to build servers and established cloud computing to store big data. Moreover, IoT helps the company the location and the condition of shipments in carriage and warehouses in real-time.

Artificial intelligence is a sequel to IoT from their standpoint, by AI can get data from the IoT and analyze it. Artificial intelligence has planning operations that help the company make sorting and priorities for loading and delivery by making particular algorithms and calculations.

Did you work with a third-party company such as a technology company? Why did you choose that "benefits and challenges"?

Yes, they partnered up with a third-party company to enable us with required hardware, in addition to facilitating technology integration for better performance between their hardware and software, with following and upgrading any problems or new updates. Moreover, the provided devices send data to a supplier site. The company fetches it through time by webhook or Robotic Process Automation (RPA) when data are available, or the company fetches from the supplier's API to withdraw data upon their request.

What is the business value (reducing costs, improving quality, …) of IoT implementation?

IoT Achieved many business values for the company in warehouses and logistics operations. Moreover, it enabled them to penetrate market segments that require features and capabilities of implemented IoT solutions and process improvement.

1 **Warehouse management**: attached barcode on the shipments provides all data about the shipment, also to know the inventory levels, spaces, and exported and imported shipments. Moreover, knowing the temperature and humidity in the warehouses by send alerts for any issue to the warehouse management.
2 **Employees' efficiency**: employees can connect through the Aramex application on a mobile phone, knowing their missions, and determining the process that can be enhanced, especially ground courier to track, monitor them, and improve their operations.
3 **Assets Management**: via connecting the vehicles and shipments with the system, which allows the managers to monitor all assets in real-time.
4 **location and condition tracking**: monitoring shipments provide accurate data about the shipment condition and location through different transportation, which improve the decision making and control
5 **Delivery and pickup coordination**: clients can track and monitor the ground courier. Who is coming to deliver or pick up the shipment through the Aramex web application, and know when the ground delivery driver will arrive at the location. This operation improves flexibility and customer service.
6 **New markets**: IoT technology allowed the company to cooperate with pharmacies and medical companies to ship their products safely and under monitoring throughout the whole journey, which leads to enhance the client's trust.

What are the main elements of your IoT platform?

1. Device management through their supplier portal
2. Integration management to integrate existing on-perm services with IoT collected data
3. Digital touchpoints covering dashboards, reporting, and tracking features

What business issues are you addressing with the IoT?

1 **between stakeholders cooperation**: The IoT implementation requires a cooperation between all departments, especially in logistics companies along a supply chain.
2 **High cost**: IoT implementation required to prepare network, buy devices, contract with a third-party company, and rent and buy servers, which lead to additional on the company.
3 **Shipments tracking**: Some locations face some tracking difficulties because of network communication failures or break down or some airplane instructions.
4 **Asset management**: The company needs more coordination to follow the retainable IoT devices are attached with shipments and return them to the main branch or distribute them.