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Thème

La Technologie de « Track and Trace » pour la Visibilité et la Transparence de la Logistique

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Thesis

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Theme

Track and Trace Technology for Logistics Visibility and Transparency

بسم الله الرحمن الرحيم

I dedicate this work to

my father for his sacrifices

to my mother for her care and encouragement

to my two sisters and brother

to my friends of Tlemcen

and last but not least

to my teachers who put their heart for our education.

Manal KHELIL CHERFI

I dedicate this work, the fruit of my years of study

to my parents, their patience, their unconditional love, they were the

ones to help me become the man I am

my gratitude for all my friends and teachers in Tlemcen, they were my

second family, they helped me a lot grow and have new vision of the

world.

a special thanks to EasyRelay team for all their contribution in our

work.

Hicham Allalou

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TABLE OF ELEMENTS:

ABSTRACT AND KEYWORDS:

ملخص:
الهدف من هذا العمل هو جعل الرؤية والشفافية ممكنتين في لوجستيات التجارة الإلكترونية لشركة من خلال اقتراح تنفيذ تقنيات التتبع والتعقب، مسبوقة أولاً بـ: تكوين نظام تقسيم الجزائر العاصمة باستخدام نهج بحث العمليات، وثانيًا بـ: اعتماد "مشكلة البائع المتجول مع التحديد الزمني" من أجل تحسين جولة رجل التسليم ودمجها في تطبيق الهاتف المحمول الخاص به، مع عرض إمكانية تعقب وتتبع الطرود.
الكلمات الرئيسية: التعقب، التتبع، المسار، الرؤية، الشفافية، التكنولوجيا، الخدمات اللوجستية، تقسيم المناطق، التحسين، الإعداد، الإدماج.

Abstract:

The objective of this work is to make visibility and transparency possible in Easy Relay's e-commerce logistics, by proposing track and trace technologies implementation, preceded with firstly: Algiers zoning system's configuration using operations research approach, and secondly: adopting "Traveling Salesman Problem with Time Window" methods for delivery man's tour's optimization and integration within his mobile application, while showcasing traceability and tracking of purchases.

Keywords: trace, track, visibility, transparency, technology, logistics, zoning, TSPTW, optimization, configuration, integration.

Résumé :

L'objectif de ce travail est de rendre possible la visibilité et la transparence de la logistique e-commerce d'Easy Relay, en proposant la mise en œuvre des technologies de suivi et de traçabilité, précédée d'une part par: une configuration du système de zonage d'Alger par l'approche de recherche opérationnelle, et d'autre part: l'adoption des méthodes de «problème du voyageur de commerce avec fenêtres de temps» , pour l'optimisation et l'intégration de la tournée du livreur dans son application mobile, tout en mettant en valeur la traçabilité et le suivi des colis.

Mots clés: trace, track, visibilité, transparence, technologie, logistique, zonage, TSPTW, optimisation, configuration, intégration.

ABBREVIATIONS:

ICT: Information and Communication Technology
AI: Artificial Intelligence
SC: Supply chain
SCM: Supply Chain Management
LM: Logistics Management
3PL: Third-Party Logistics
ER: Easy Relay
B2B: Business-to-Business
B2C: Business-to-Customer
DC: Distribution Center
DCR: Retail Distribution Center
COD: Cash on delivery
CLM: Council of Logistics Management
UGCAA: Union Générale des Commerçants et Artisans Algériens
TSP: Traveling Salesman Problem
TSPTW: Traveling Salesman Problem with Time Window
ERP: Enterprise Resource Planning
RFID: Radio Frequency Identification
QRCode: Quick Response Code
WMS: Warehouse Management System
TMS: Transportation Management System
NFC: Near Field Communication
GPS: Global Positioning System
5G: fifth Generation
Wi-Fi: Wireless Fidelity
GSMP: General Switch Management Protocol
EDI: Electronic Data Interchange
HTTP: Hypertext Transfer Protocol
XML: Extensible Markup Language
UMTS: Universal Mobile Telecommunications System
OLAP: Online Analytical Processing
WLAN: Wireless Local Area Network
GPRS: General Packet Radio Service
FTP: File Transfer Protocol
LTE: Local Terminal Emulator
GIS: geographic information system

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General Introduction:

In 1991, Internet got opened to the public, offering connectivity to its users, and creating the opportunity of shopping and selling online, since then ecommerce led to technological evolution especially Information and Communication Technology (ICT) and Artificial Intelligence (AI) development until today, impacting the economic growth in all its facets while creating new challenges in the market.

With the increasing competition, customer's satisfaction became first priority and a key success to e-commerce business owners. Successful logistics management leads to successful customer experience.

However, Logistics providers need to do their best in order to assure sustainable Business-to-Business (B2B) relationships with e-merchants, they need to develop their processes simultaneously with technological development, to offer package tracking option, return management service, payment at the door possibility, cash collection and management, personalized packaging, and flexible delivery to home, to work, and to relay points. These whole services cannot happen successfully without a well-studied logistics.

Easy Relay, is one of logistics providers in the Algerian market, that works to cover e-commerce businesses' logistics, and do delivery to their customers, its vision is to always develop its services by developing its technologies.

For this matter, the question is: how to develop its delivery process and efficiency, how to ensure a better customer experience and what are the adequate technologies to adopt?

In order to answer these questions, this present work consists of analyzing easy relay's market, its previous deliveries, and customers' centralization. Secondly, working on a zoning system's configuration of Algiers since it presents 19% of the whole deliveries in the country. Thirdly, optimizing and visualizing delivery agents' tour planning taking into consideration time constraint. Finally, Integrating Track and trace technologies for better visibility and transparency of logistics to both e-sellers, and end-customers.

The first chapter will be a study of what already exists: e-commerce reality in the world generally and in Algeria particularly, a presentation of the facilitator company, where we have done this project's internship, its services, delivery methods and added value, and finally its supply chain's management and processes.

The second Chapter will be a bibliographical study that aims to define the key components of our study: Supply Chain (SC), Supply Chain Management (SCM), Logistics, Logistics Management, E-commerce logistics and outsourcing to 3PL providers. Finally, "Trace and Track" as an important technology to ensure visibility and transparency for 3PL providers and logistics firms.

Chapter Three will be about: entreprise's orders analysis, adopted tools, languages, and methods, to configurate zoning system of algiers, optimize and visualize delivery tour's planing and integrating track and trace technologies.

Finally, chapter four will be interpreting and showcasing obtained solutions.

Chapter One:

Case

Study

I.1. Introduction:

The electronic commerce (E-commerce) industry has grown sustainably in Algeria, driven by increasing internet usage and diverse electronic commerce platforms that unable their clients to do shopping where they are, offering them all kinds of products, even the products that cannot be found in the market.

The moment a customer buys something online, the enthusiasm to receive it begins, if he/she does not receive his/her order within two days the enthusiasm will be lost, and here comes the challenge of logistics providers, who are very important factors to ensure a good or a bad customer experience of purchasing online.

This chapter consists of three main research points, the first one is a global study of E-commerce and its challenges in Algeria, the second sections is an introduction to the facilitator company where the research has been done, and finally the third section is an explanation of the existing, present supply chain of the logistics' firm.

I.2. Section 1 : E-commerce Reality

E-commerce refers to the electronic execution of all transactions supporting commerce among buyers, sellers and third-party intermediaries, such as financial institutions (Le & Koh, 2002) [1]. In this section we will be talking first about the evolution of E-commerce in the world, and how is this notion becoming a new trend to Algerian customers, and finally we will be revealing its challenges that are preventing it from developing in higher rate, unlike the other countries.

I.2.1. E-commerce in the world:

n the beginning of 2019, Global e-commerce sales amounted to more than 3.5 trillion dollars worldwide proving ecommerce is an increasingly lucrative option for businesses. Of global retail sales, 14.1 % came from online purchases. That is more than one in every five dollars spent (22 percent) on purchasing from the internet. Over the next few years, it is expected to increase and take a larger piece of the retail pie. By 2023, it is estimated that total retail sales will hit more than $6.5 trillion [2].
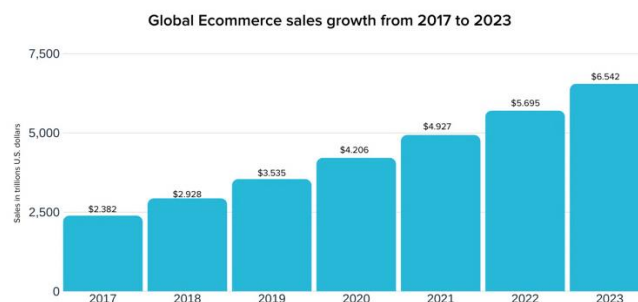
Figure I.2-1: Global Ecommerce sales 2017-2023 (sources: Oberlo)

The figure I.2-1 Presents Ecommerce sales evolution in the world from 2017 to early 2023

I.2.2.E-commerce Impact :

E-commerce appeared back in 1991, when internet became accessible to public users, Amazon was the first in the US to introduce shopping from the internet, and since then it is developing leading with its development new technologies, innovations, and thousands of businesses entering each year the online market. E-commerce had and still has impact on the following:

- **Market Structure:** E-commerce affects the structure of markets that it brings us closer to access to the market of full competition, whether goods or services, knowing that nowadays the economic growth depends not only on the increase in the supply of goods and services, but on how to take advantage of all these factors to achieve the highest possible revenue, as the closer the market to full competition, the more it can be achieved

- **Economic Growth:** E-commerce affects economic variables and growth rates. It leads to higher wages, higher standards of living for individuals, structuring markets and expanding marketing, increasing sales and exports and thus increasing production and growth rates;

- **Technology development:** E-commerce uses modern technologies in dealings and trading, it increases the level of management and organization within the institution and the development of its productivity activities by providing the right climate for the increase of efficiency via supporting the computer and software industries, the technological industry and other associated industries, such as electronic storage media, networks and communications, which are the infrastructure for e-commerce;

- **Exports:** E-commerce helps to increase foreign trade, especially exports, by eliminating geographical distances, facilitating access to global markets, making business deals easily and quickly without any administrative or commercial restrictions, responding to changes in consumer demand, marketing local products in these markets, and increasing the exports of these countries. All in All, e-commerce is increasing trade in services between countries. This sector accounts for 60% of the world's total production;

- **Investment:** E-commerce creates new investment opportunities, especially in the ICT (Information and Communication Technologies) sector, because they play an important role in the infrastructure of e-commerce. The spread of e-commerce requires increasing production in this sector and directing capital to invest in it to develop the infrastructure of e-commerce and then increase the investment in ICT sector which works to support the national economy;

- **Work's strength:** Most of the developing and developed countries suffer from unemployment problems and the lack of jobs, e-commerce can bring advantages to the national economy of the state in the field of employment, first by setting up small and medium-sized businesses and connecting them to the international markets at the lowest investment costs, especially the trade in services, for example freelance. Second, e-commerce offers career opportunities in several areas related to e-commerce applications, such as specialists in e-commerce sites, employees, administrators and technicians in e-shops, as well as providing jobs in the ICT sector in which the e-commerce depends on of the engineers of Networks and software needed for e-commerce applications and others [3].

I.2.2.1.   E-commerce and the Arab States:

E-commerce in the Arab countries suffers from weak marketing. If we compare the size of e-shopping in the Arab countries with what is spent on advertising in international sites, it is weak. However, it is required from large Arab trade institutions and banks and business men and those who are interested in the trade to keep up with the development of commercial transactions.

So that e-commerce is a fundamental basis in its domestic, global and future business strategy. Although Arab countries are cautious and hesitant towards electronic commerce, unlike other countries, they are moving strongly to achieve giant steps towards economic growth.

We reach the conclusion that e-commerce helps to reduce the unemployment problem by providing new jobs, especially in the field of information and communications technology and the knowledge industry, and facilitates free individual businesses and small businesses, work at home, increase employment opportunities for the disabled , and increase work opportunities for woman at home without having to work outside, but it requires specialized and trained technical personnel capable of handling with its applications [4].

I.2.3.Ecommerce in Algeria :

In 2020, According to JUMIA's website statistics, top leader of Ecommerce in Algeria, there are more than 1,500,000 Visitor to the website per month, Up to 1000 order per day and 1,000,000 Subscription [5]. Buying and selling through internet in Algeria is increasing remarkably, although it is a new notion to Algerian customers, this notion became a trend, due to:

- Increasing trust towards virtual markets

- Payment after purchase (for most of the cases)
- The possibility of exchange or return back
- The influence of Marketing
- The diversity of products

The Algerian individual became oriented to buying online not only from different ecommerce platforms like websites and mobile applications, but also from social networks like Instagram and Facebook.

I.2.4.E-Commerce Challenges in Algeria :

Algeria is the tenth largest country in the world by land area and has a population of more than 43,8 million, with 25,428,159 (58% of the population) internet users (Dec/2019 according to internet world stats) [6], the development of e-commerce and building an effective platform for it presents a real opportunity for the country to become a member of the information society and make e-commerce one of its main, vital sectors. A study, done by Samira Chaabna & Hu Wang, 2015, shows that the factors that prevent e-commerce development in Algeria are:

- Lack of a reliable and secured backbone, in terms of a widely accessible and fully interconnected high-speed network that will guarantee the availability of bandwidth sufficient for the requirements of e-commerce;

- Lack of a comprehensive regulatory framework that supports and controls the adoption of e-commerce in the country and clearly defines and protects the rights of all parties;

- Lack of highly skilled professionals;

- The limited use of credit cards due to the lack of existing culture and awareness of the usage of credit cards, as well as the lack of trust in electronic means, coupled with an insecure financial platform;

- Unreliability and inefficiency of logistics infrastructure [1].

I.2.5.COVID-19 and E-commerce industry:

In the fight against COVID-19, the enforcement of social distancing, lockdowns and other measures in response to the COVID-19, has led to the restriction of all economic activities that require physical contact, the national market is currently experiencing an unprecedented decrease since independence, according to UGCAA, commercial activities have fallen by 80% since the start of the spread of the pandemic, the remaining 20% has been limited to necessary commercial activities,

such as, fruits and vegetables, food products in addition to communication and telephone services. However, this pandemic has pushed consumers to opt for online shopping through mobile applications, websites and social network, not only consumers but also providers, to think of a relevant solution to run their business and step up to virtual commerce.

Algeria is experiencing the new trend, the electronic trend, which remained the only choice to run business during the lockdown, we can notice these past months a huge conversion rate to e-commerce due to the pandemic, many start-ups took the opportunity, the advantage, and got launched to offer services online such as buying goods, doing different kinds of delivery like food delivery, medicine deliver…etc.

This whole project is fruit of a study that was enabled by a company called "Easy Relay" (ER) that offers logistics services to e-commerce platforms and e-tailers (electronic stores or electronic sellers), and that what the next section will be highlighting "the facilitator company".

I.3. Section 02: Presentation of Easy Relay Company

"Require Delivery of Confidence" That is the slogan that entitles Easy Relay. In this section we will be introducing a logistics firm called "Easy Relay" where we had our study and practical internship facilitated for the realization of this project. We will be first talking about its creation and its mission, and then we will highlight its services, moving to its delivery methods and modes of collection, and finally the added value, that it offers to its partners and customers.

I.3.1. Easy Relay Creation:

It was First Started in 2012 as MAD DZ CONSULTING, a consulting firm, specialized in developing companies' performance through its activities of providing and installing information systems, data processing, and logistics.

After three years, the company decided to limit its activities and focus on E-commerce logistics only, and here came the creation of "Easy Relay" which was only an idea in 2015.

Easy Relay started its   activities at the end of 2016, as a SARL, since then it did not stop developing and progressing, it gained its customers confidence, and it is until today working on developing its own process and managerial tools.

Easy Relay offers, in addition to home delivery, a flexible relay delivery and return service.

I.3.2.Easy Relay's Mission:

Its mission is to develop long-term trusted partnerships with traders, local businesses and Marketplaces (web platforms based on virtual shops) such as Jumia and OuedKniss, thanks to the ecosystem that it has set up and which enables all stakeholders to the chain, sellers, deliverers and end customers.

I.3.2.1. How Does it Carry Its Mission?

Easy Relay develops its own platform and mobile application to better reach and serve its partners and end-customers. The Easy Relay platform links partners to their end-customers through:

- A simplified logistics follow-up service for all the links in the chain (storage, packaging, shipping and delivery);

- A payment tracking service facilitating the monitoring of all transactions with end-customers and collection with their partners;

- The Easy Relay Mobile Application to plan and deliver orders to ensure optimal delivery and feedback in real time [7].

It also ensures a good delivery experience to its customers by assigning highly qualified couriers and drivers thanks to the continuous training that it has and which allows them to provide a unique and professional experience to its partners and its end customers.

I.3.3.Delivery Service in Easy Relay:

Since the launch of Easy Relay, the company offers delivery to its partners such as e-sellers (who sell through internet), via social network (Facebook and Instagram), E-commerce platforms and marketplaces, whether they have a physical shop or not, it is not important as long as they pursue their business on internet, Easy Relay manages only orders done through internet. Besides delivery Easy Relay offers related services such as:

- **Storage:** Easy Relay stores e-tailers products when they are ordered and entered to its hub, also when they are returned, it delivers for each an identification sticker, containing item's information;

- **Return's Management:** when a customer is not satisfied of his/her received order (if the end customer did not answer to receive his product or it can be not the same product he ordered or simply it did not meet his/her

expectation), there is the possibility that the order get returned to the hub of ER until it is redirected to the e-tailer or the end-customer again;

- **Confirmation Service:** Easy Relay before investing any effort on its operations, it contacts the concerned person to confirm it, after that it decides to execute the operation, delay it or cancel it;

- **After Sales Service:** after sales services has always been a factor of quality for customer's satisfaction, ER does after sales service only for its e-tailers who request it for their clients;

- **Online advertising:** ER depends for this digital era, digital marketing through social network such as Facebook to support its both customers, the e-tailers and end-customers;

- **Cash collection and management:** when the order is delivered, the payment is collected; after it is collected, it is given to its seller (e-tailer), that is for the case of cash at delivery [7].

I.3.4. Delivery Methods:

Easy Relay's service adapts to each Business with its specificities and offers two delivery methods:

- **At Work:** Especially for clients who do not have flexible working hours, they cannot leave work to receive their purchase at home, Easy Relay makes it possible, by delivering their orders to them in their working place.

- **At home:** for customers who require Speed and Punctuality.

I.3.5. Delivery Modes of Collection:

The most common method of payment is payment upon delivery of the package. "Cash on delivery", but the seller can require his client to send him a part of the payment beforehand, and the company collect the rest when the order arrives to the client. As he can organize a total payment before delivery, the choice is up to the seller and his client, to sum up we distinguish three kinds of payment:

- Full payment before delivery: to optimize cashflow or to minimize risk. Payment before shipment can be requested from the end customer;
- Advance payment before delivery: this may just represent delivery costs or include part of the product price;

- Payment after delivery: to boost sales, with loyal customers or high potential prospects, payment after delivery gives confidence to the customer and facilitates the act of purchasing [7]

I.3.6. Added Value of Easy Relay:

The first added value lies in Easy Relay's structure, legally and legality speaking, it has what it takes to work transparently, from billing, contracts, and insurance. Another plus is the stability that it is in delivery rate, or in delivery planning, which offers sellers the possibility of making estimates when buying or managing their stocks. Without forgetting tracing possibility, the sellers can follow the status of their orders, in real time, if they are delivered or cancelled or postponed, they can directly integrate the orders on a platform that has been studied or via API's from their e-commerce websites.

In this section, we got to know what is Easy relay, its history, its mission, what does it do, and how does it do it, what are its services and how does it cover them. The next section will tackle deeper its logistics processes.

I.4. Section Three: ER Logistics Process

Easy Relay depends on its logistics three main processes, The pick-up process of orders from e-sellers, the dispatch process of orders, the right order for the right person, and finally the delivery process. In the following, we will be explaining each with details and illustrations

I.4.1. Pick-up Process:

It is the process where Easy Relay sends the pickup agent to the sellers to: either recover the new ordered packages, return or exchange unwanted packages, or give back the payment of the successfully achieved deliveries. This operation is scheduled two times per week (Monday and Thursday). The figure down below illustrates the pick-up process that happens between two factors: the e-seller and logistics service (ER), the modelling is done with CAMUNDA MODELER software. **(Figure I.4-1)**
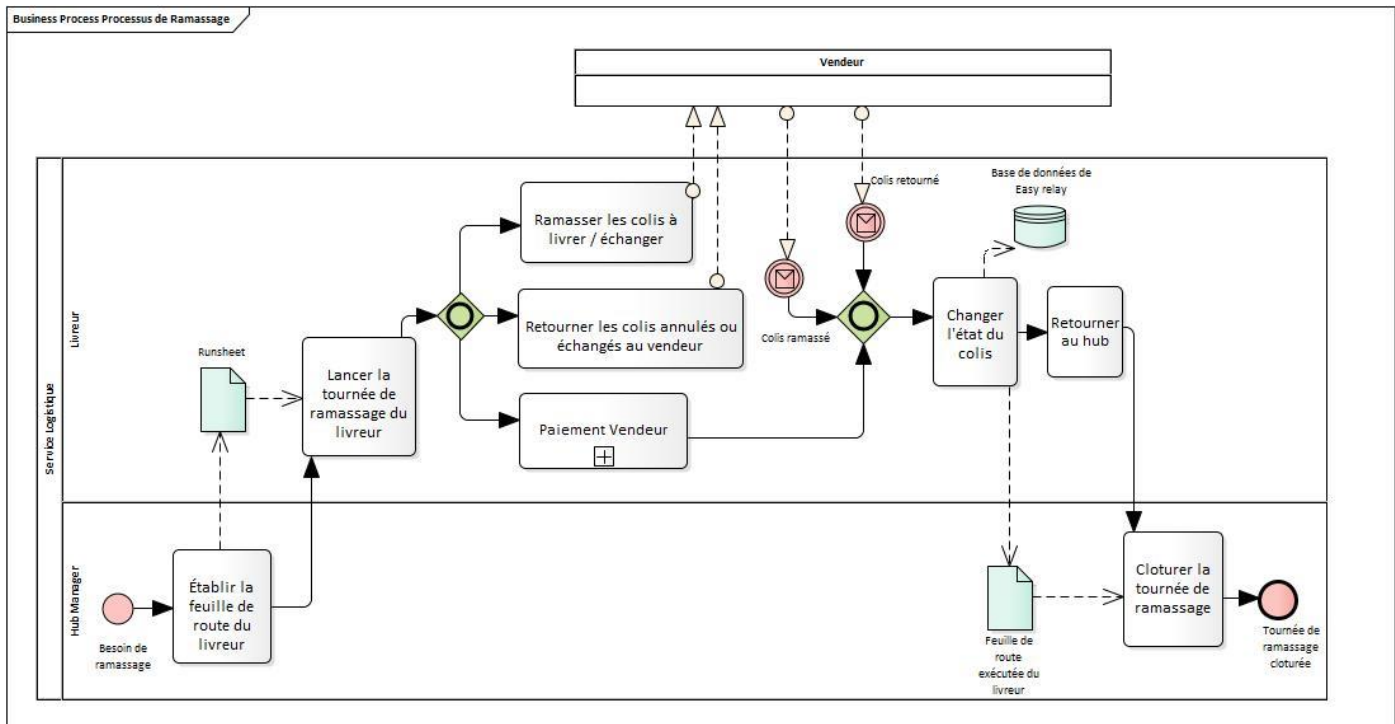
Figure I.4-1 Pick-up Process' Model (Source: Easy Relay Docs)

It all starts once the e-seller receives the client's order, it is automatically synchronized to Easy Relay's platform through the API, the e-seller prints the order's sheet and tape it into the package, the state is updated into "vendeur" (seller) in the platform, which indicates that the package is ready for the pick-up.

The process starts when the need to pick-up is expressed, The Hub Manager establishes a roadmap for the delivery man. Details of the roadmap are stored in a Runsheet.

The delivery agent receives the updated Runsheet and starts a pickup tour. The pick-up tour consists of three sub-operations:

- **Exchange or Return**: The orders that client wants to return to be replaced (exchanged), in order to receive a product of the same or greater value, will be delivered back by the e-seller.

- **Seller Payment**: if the seller has already previous completed deliveries, the pickup agent will check with him through the mobile application the total, and then he will be given his payment.

- **Recover ordered/exchange Packages**: the delivery man carries the validation details of the product, that are written in the purchased order, through mobile application, then picks up the order. His/her state in the platform will be updated from "vendeur" into "Livreur vers hub" (on the road to the hub)

Once the tour ends the agent will go to the hub and hand over the packages, the state of the orders will be updated into "hub state".

I.4.2.Dispatch Process :

Once the picking-up process is completed, and the orders are finally in the hub, the dispatch for their destination starts, the orders first are stored into bins indicating Wilaya they will be delivered to, and then the process starts. The figure 3-2, down below, illustrates the scan and dispatch process of orders done by CAMUNDA MODELER software
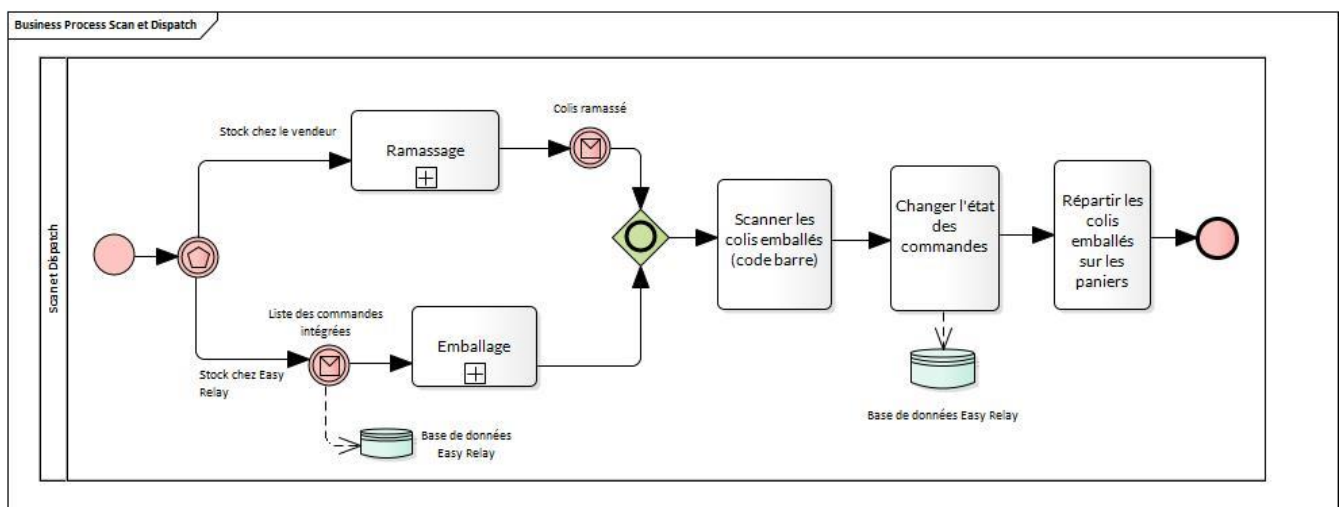
Figure I.4-2 Scan and Dispatch Process' Model (Source: Easy Relay Docs)

The dispatching process depends on the type of the e-seller, and there are two types of e-sellers: the ones that they do their own storage (they pack their own products) and the ones whom Easy Relay does the storage and the packaging for them. For the first type of e-sellers, the packages are scanned, after the pick-up, to change their state on the platform from "livreur vers hub" (delivery man to hub) to the "hub" state, after scanning, they are distributed in bins in the storing room, according to the destination.

For the second type of e-seller, Easy-Relay should already has a buffer stock of these products inside its warehouse (stock considered in the "vendeur" (seller) state on the Easy-Relay platform), the seller informs Easy-Relay of new customer orders, or they get fetched from the seller platform through the API, Depending on the number of orders and the priority, an agent prepares the packages and then changes their states from "vendeur" (seller) state into "hub" , they are distributed in bins in the storage room, according to the destination. These bins will be delivered affected to a delivery man.

Once the delivery man receives the packages. The delivery tour starts, the State of the product will be changed into "livreur vers client" (delivery man to client).

I.4.3.Delivery Process :

Once the dispatch process ends and bins are full or reach a minimum amount that ensures the profitability of the tour, the delivery agent receive the call to deliver. The figure I.4-3 down below illustrates delivery process, done by CAMUNDA MODLER software.
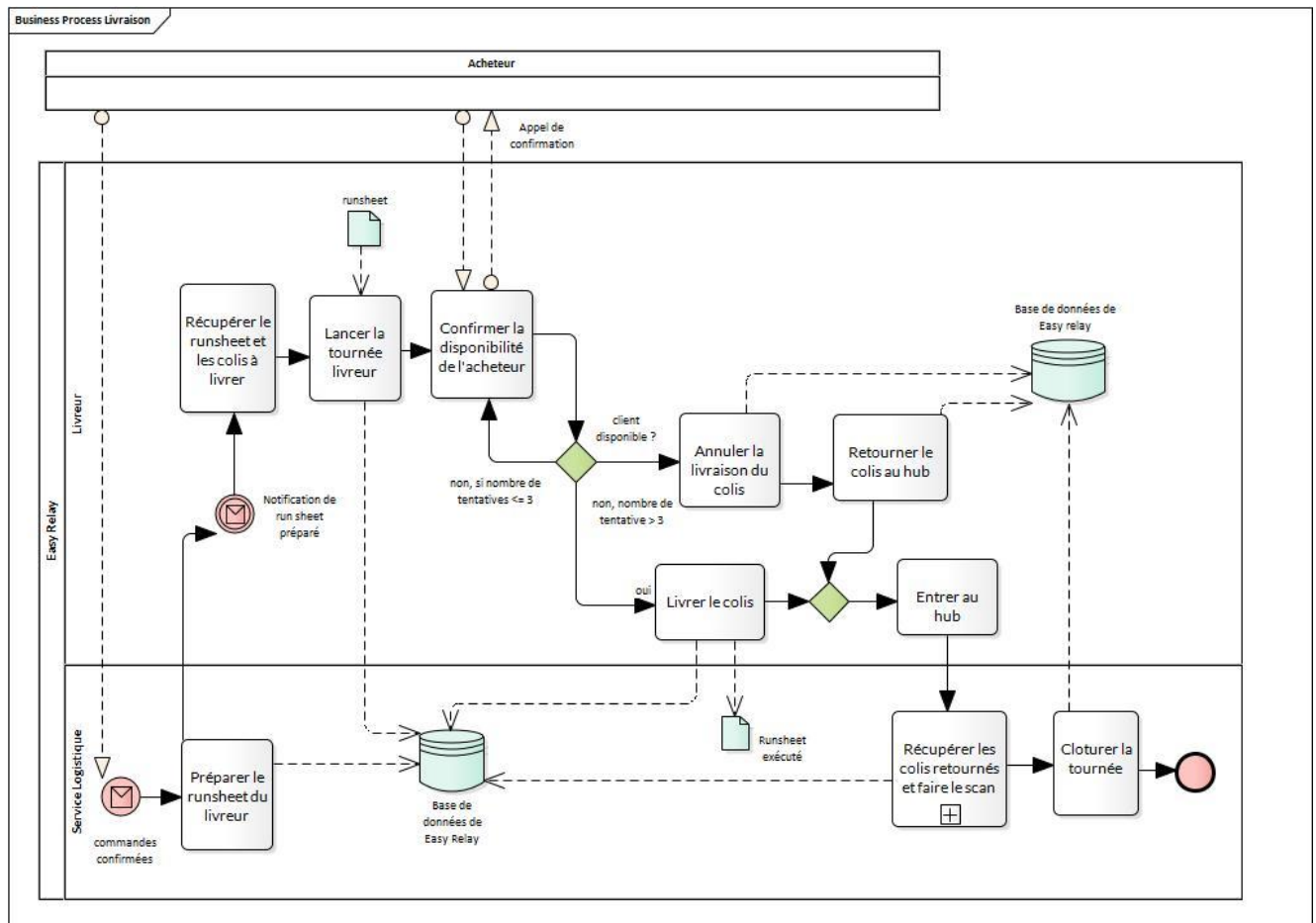
Figure I.4-3 Delivery Process Model

When orders are confirmed and collected from the hub by the delivery man, their state will be updated from "hub" to "livreur vers client" (delivery man to client) and here starts his tour.

Easy Relay services cover thirty-one wilayas (almost all wilayas except the ones of the south). The coverage is assured by a pre-determined tour, in which a tour can cover various wilayas, as it can cover a region (zone) in one wilaya (the case of Algiers). Depending on the number and the size of the orders, the frequency of delivery is determined: either daily, in zones with a large number of orders per day, or scheduled in an optimal way for zones with medium amount of orders. Noting that each zone is entrusted to one delivery man.

When the package is received by the customer, the delivery man validates directly on the application, that the package is delivered, the state turns into "livré" (delivered).

In case the package has not been delivered, its state changes in the platform and becomes either "annulé par le client" (cancelled by the client), or "N ème tentative" (N-th attempt). The order is automatically cancelled when it reaches the third attempt and it turns into "échec" (failure) state.

In this section we understood ER's logistics and processes in details, of pick-up, dispatch and delivery, the next chapter will get to know management strategies that ER takes in its logistics operations.

I.5. Section Four : ER Logistics Management Strategies

Any delivery chain cannot be possible without planning resources, the physical, the financial and the human resources, all together if planned and well-organized, a good efficiency and productivity in assured. In this section we will be talking about two main strategies, allocating hubs and zoning.

I.5.1. Hub :

A hub is a physical logistics structure where several logistics flows (mainly products or individuals) are routed with the aim of being sorted, organized, managed and redirected.

For Easy relay, its hubs, are the places where the pick-up comes to, and the delivery departs from, they are where orders are stored, managed, dispatched and packaged (for some e-sellers). The location of logistics hubs is also considered to be a strategic and long-term decision, especially due to the large amount of capital invested and the length of time that facilities will be available. Having a hub is very important for logistics optimization that is why Easy Relay has five hubs, in Tlemcen, Oran, Setif, Annaba and Algiers. Since our study was done in the hub of Algiers, it is so important for us to mention it, as it processes a considerable amount of orders every day (more than any other hub), also because the pick-up and the delivery are quite complex when it comes to their routing's optimization. The figure I.5-1 down below presents ER's Hubs in the map, done by Tableau Application.

Hubs in Algeria
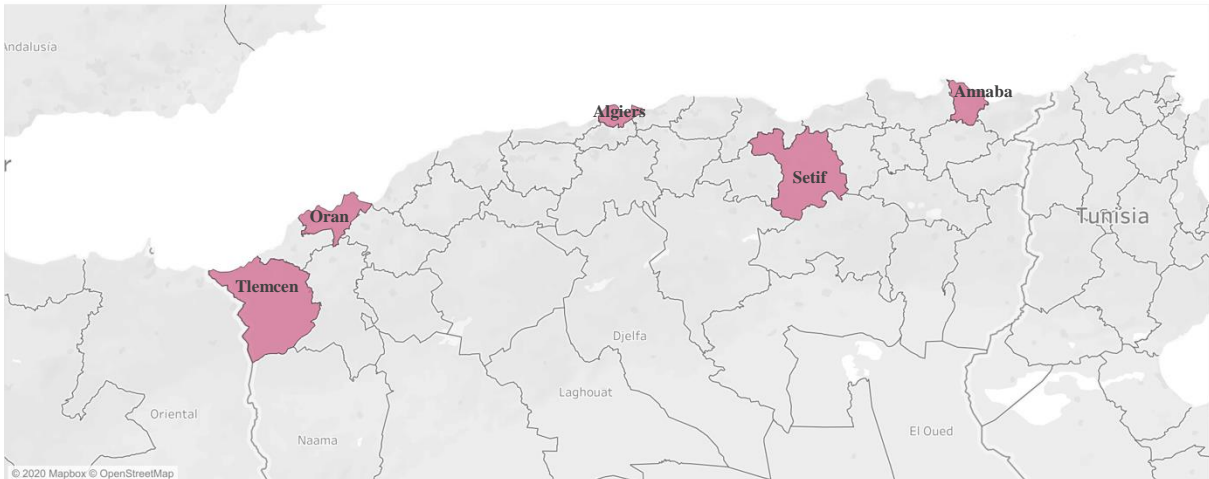
Figure I.5-1 ER's Hubs in Algeria location

I.5.2.Zoning :

In a big country like Algeria, with an area of 2,381,741 square kilometers, the delivery operation is complicated, every region has its own characteristics, covering the maximum of regions, is a challenge itself, therefore Easy Relay depends on zoning principle, it relies on dividing the country into zones, each zone presents a group of cities/towns/states, in a way to optimize the delivery cost and tour. This system of zoning is constructed according to geographical positions and area (nearest neighbors) and also the number of orders that needs to be balanced between all zones.

Our Study concentrates on the zone of Algiers:

- It presents 19% of the company's orders which makes of it the top delivery destination, and has the highest number of orders for the past six months, from November 2019 to April 2020 as it shows the **(figure I.5-2)**
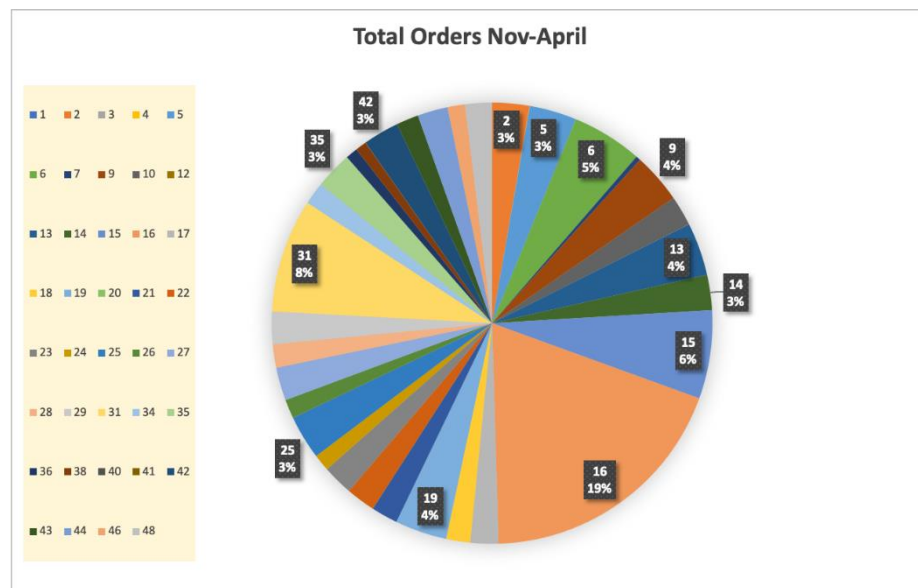
Figure I.5-2 Total Number of Orders per state from November 2019 to April 2020

- It is the most crowded and populated state in Algeria, with fifty-seven important towns, where the town with the least number of orders, has more orders than some states.

I.5.3.Algiers Division :

Algiers is divided into twelve zones: East1, East2, East3, East4, Center1, Center2, Center3, Center4, Center5, Center6, West1 and finally West2. Each zone presents a sector and groups towns "communes". The division is done in a way that all towns in the sector share borders (they are geographically neighbors) also each of these sectors are balanced in the amount of orders, in case one zone has more orders than another, then the division changes. The table 4-1 down below presents Algiers division, and towns forming each zone (sector):

Table I.5-1: Algiers Division (Source: Easy Relay Docs)

Sector (zone)	Town's name	Sector	Town's name
Est1	Oued Smar	**Centre 2**	El Harrach
	Dar El Beida		Les Eucalyptus
	Bab Ezzouar		Baraki
	Mohammadia		Sidi Moussa
Est2	Bourouba	**Centre 1**	El Biar
	Ain naadja		Cheraga
	Birkhadem		Beni Messous
	Djasr Kasentina		Bouzareah

	Saoula		Oued Koriche
Centre 3	Draria	**Centre 5**	Bir Mourad Rais
	Dely Ibrahim		El Madania
	El Achour		Hamma Anassers
	Ouled Fayet		Hydra
	Ben Aknoun		El Mouradia
Ouest 1	Rais Hamidou	**ouest 2**	Khracia
	Bologhine Ibn Ziri		Birtouta
	Ain Benian		Souidania
	Staoueli		Tassala El Merdja
	Zeralda		Ouled Chebel
	Bains Romains		Douera
	Mahelma		Rahmania
Centre 6	Alger Centre		Baba Hassen
	Casbah	**Centre 4**	Kouba
	Bab El Oued		Hussein Dey
	Sidi Mhamed		El Magharia
Est 3	Rouiba	**Est 4**	Bordj El Bahri
	Reghaia		Ain Taya
	Haraoua		Marsa
			Bordj El Kiffan

I.5.4. Delivery Cost :

Delivery cost is variable from province (wilaya) to another, it depends on:

- How many orders are there in one province: The more orders we have in a province the more meaningful the delivery tour is. If there is for example one order in Adrar within the whole week, then the delivery process will be costlier then the delivery income.

- How close the province is to the hub: the closer the hub is to its customers the less miles are to be crossed to deliver that order.

Easy relay is not responsible on providing vehicles to the delivery agents, the delivery agents need to have their own vehicles of scooters or cars. Also, Easy relay is not the one to cover delivery cost (fuel, gas) the delivery agents are the ones who take care of the vehicle's cost of maintenance and service.

I.5.5.Delivery Tour :

Each delivery tour is assigned to one delivery men, and each delivery tour is to be done within maximum 48 hours, in working days, and from 8:00 to 20:00 while it is up to the delivery man to decide when and what time and how to do his delivery.

Delivery tour in Algiers is considered the same as sector (zone), means one tour is to cover all towns in one and only one sector (zone).

Each customer is considered as a point in the sector means, he/she is presented with his/her town to be visited.

We saw in this section what are strategies that ER adopts in order to carry out its mission, and how does it manage its processes.

I.6. Conclusion:

This chapter was a general study of existent, we studied E-commerce reality globally and locally, and the facilitator company's logistics, we have seen what ER is about, how does it carry its mission and operations, what are its logistics processes and what are its adopted strategies in order to maintain its SC management and performance, After this study we will discuss the state of the art of the E-commerce supply chain and the latest technologies in the domain.

Chapter Two:

State of the Art

II.1. introduction:

This Chapter is a bibliographical study that aims to define the key points that clarify and push to better understanding our study. We will be discussing and differentiating, in the first section, the fundamental basics of Supply Chain (SC), Supply Chain Management (SCM), Logistics, Logistics Management and finally the difference between Supply chain management and logistics management. Moving to the second section which will cover E-commerce logistics and SC evolution, how does E-commerce logistics work in both forward and reverse direction, and finally the importance of outsourcing logistics to 3PL providers. Finally, we will get in our main project's subject in the third section, where we will talk about the different notions of traceability, tracking, and "Trace and Track" as an important technology to ensure visibility and transparency for 3PL providers and logistics firms.

II.2. Section One: Supply Chain Management and Logistics Management

This first section is divided into five main points, the first one will define Supply chain's meaning, what are its material, information and financial flows, and finally, what does reverse chain mean. Going then to the second point, which highlights Supply chain management (SCM) meaning, moving to the third and the fourth points, logistics and logistics management, and concluding at the end with the differences between supply chain management and logistics management.

II.2.1. Supply Chain:

(called sometimes the value chain or demand chain). The concept of "supply chain" is generally referred to the alignment of firms that bring products or services to market (Lambert, Stock and Ellram, 1998). The supply chain includes manufacturer, suppliers, transporters, warehouses, wholesalers, retailers, other intermediaries and even customers themselves. Any product traded on the consumer goods market, in its evolution from raw material to finished product [8].

- Supply chain operations require managerial processes that span across functional areas within individual firms and link trading partners and customers across organizational boundaries[8].
- Supply chain strategy is a kind of channel arrangement based on acknowledged dependency and relationship management [9].
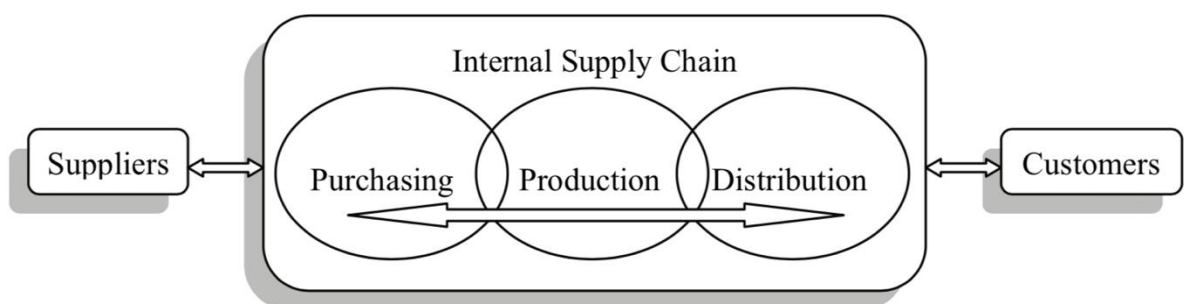
Figure II.2-1: An illustration of a company's supply chain (Chen & Paulraj, 2004)

Ayers (2001) suggest that a supply chain is: "Life cycle processes comprising physical, information, financial, and knowledge (information) flows, whose purpose is to satisfy end-user requirements with products and services from multiple linked suppliers". According to this definition, the supply chain encompasses processes that cover a broad range of activities including sourcing, manufacturing, transporting, and selling physical products and services. Life cycle refers to both the market life cycle and the usage life cycle and these are not the same for durable goods and services. Therefore, product support after the sale becomes an important supply chain component [9].

II.2.1.1. Supply Chain's Flow:

An integrated supply chain model can generally contain three interrelated flows (Waller,2003):

- Material flows which has itself three different stages of purchasing, transformation and distribution;
- Informational flows such as electronic data exchange or website linkages;
- the financial flow which include the payment to suppliers and subcontractors for the goods and services and the payment by the customer to retailer for the final product [8].

II.2.1.2. The Reverse Chain:

The flows direction in the supply chain is not only forward, from first supplier to final customer. Goods can flow back up the supply chain for different reasons such as service or repair, remanufacturing, recycling or disposal. The reverse chain can play an important role in areas such as customer satisfaction, recycling and environmental protection. Reverse logistics refers to a set of programs or competencies aimed at moving products in the reverse direction in the supply chain (i.e., from consumer to producer) and related activities may include handling product returns, recycling, reuse of materials, waste disposal, refurbishing or remanufacturing (Moise, 2008, p.198) [8].

II.2.2. Supply chain Management:

It is defined as the integration of activities along the supply chain linking customer orders, distributor orders, inventorial orders, manufacturer orders, supplier orders and ultimately related cash flows. According to the Council of Supply Chain Management Professionals (CSCMP): "Supply Chain Management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities." The examination of definitions, key and derived concepts resulted in the identification of four major criteria: management activities; logistics activities, objective and components. The table down below shows within each criteria, the most significant key and derived concepts and it presents definition of SCM related to each criteria.

Table II.2-1 The four major criteria of Supply Chain Management concept (Mihai Felea1 & Irina Albăstroiu, 2013)

Criteria	Concepts	Definition
1. Management activities	*Key Concepts*: planning, organizing, implementing, motivating, controlling *Derived Concepts:* goods, services, efficiency	SCM consist in planning organizing, implementing, motivating and controlling efficiently of all the activities involved in movement of goods and services from the first supplier to the ultimate customer.
2. Logistics activities	*Key Concepts*: transportation, processing, storage *Derived Concepts:* raw materials, work-in-process inventory, finished goods	SCM includes transportation, processing and storage of raw materials, work-in-process inventory and finished goods from initial extraction stage to the final customer.
3. Objectives	*Key Concepts*: value, customer requirements, trust, competitive advantage, relationships *Derived Concepts:* sustainable, long term	SCM include a number of value-added processes designed to satisfy customer requirements, to establish a long term relationships, to build the trust among the supply chain partners and to achieve a sustainable competitive advantage.
4. Components	*Key Concepts*: suppliers, manufacturers, warehouses, stores *Derived Concepts:* products, services	SCM encompasses suppliers, manufacturers, warehouses, stores and other intermediaries that are involved in the movement of products and services from point-of-origin to point-of-consumption.

II.2.3. Logistics:

Logistics is the ancient art of calculation and reasoning that exists over 5000 years, both in economics and military art and science, the most well-known logistics achievements in ancient time are the pyramids in Egypt and the Great Wall in China, to name a few. Logistics is the process that creates value by timing and positioning inventory; it is the combination of firm's orders management, its inventory, transportation policy, warehousing, materials handling, and packaging as integrated throughout a facility network. [10]

Integrated logistics serves to link and synchronize the overall supply chain as one giant continuous process and it is essential for effective supply chain connectivity. According to David Simchi-Levi (2000) logistics system (network, chain) is a group of applied approaches linking suppliers, producers, warehouses, shopping outlets in an effective way for the purpose that goods and services are to be produced (delivered) and distributed in right quantity, right place, at right time in order to minimize cost in the whole system in a response to the needs of customers in terms of their expected level of service [9].

II.2.4. Logistics Management:

Logistics management, as has been defined by CLM (Council of Logistics Management), refers to the process of planning, implementing and controlling the efficient, effective flow and storage of goods, services and related information from the point of origin to the point of consumption for the purpose of conforming to the customer requirements and expectations. [11]

II.2.5. Supply Chain Management and Logistics Management:

Supply chain management is a new concept of management that has gained its popularity since 1980 and the logistics management has been perceived as organization's traditional business or non-business activity since ancient time [9]. Analyzing definitions and essence of both logistics management and supply chain management leads us to many schools of thought related to the issue on relationship between those fields as presented in the following figure II.2-2:

- Logistics management is a part of supply chain management;
- Supply chain management is a part of logistics management;
- Supply chain management is strongly and strictly identified with logistics management and vice versa;
- Supply chain management and logistics management have something in common and something of their own [12]
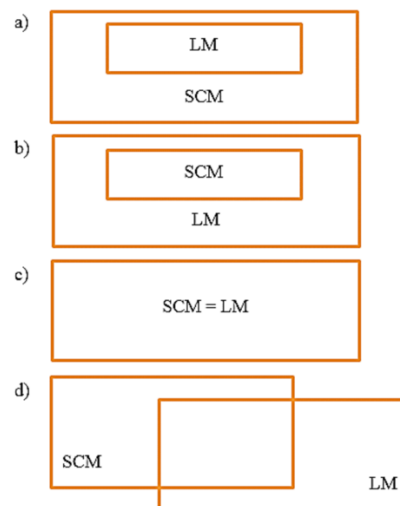
Figure II.2-2: Supply Chain Management and Logistics Management (source: Own Development)

From our point of view and in our strong belief, logistics management is part of the supply chain management and supply chain management encompasses all logistics activities of the firms, their partners they cooperate with, the synergy effect of those activities and more [9].

In the next section we will clarify how supply chain and logistics developed in E-commerce and how did E-commerce contribute for that.

II.3. Section two: Ecommerce Logistics

This second section is divided into five points, in the first one we will demonstrate the evolution of traditional SC and logistics, into E-commerce SC and logistics back in 2000, moving to the second point where we will explain how does logistics in E-commerce work in both forward and backward direction, then jumping to point three, where we will discuss e-commerce logistics evolution and change, from multi-channel to omni-channel. In the end, we will talk about the importance of logistics' outsourcing of small and medium e-commerce business to 3PL (third-party) providers, and what are 3PL benefits to e-tailers.

II.3.1. E-logistics:

The terms electronic logistics, e-logistics, internet-enabled logistics or e-business (e-commerce) logistics have been loosely used in both academia and practice. Some consider e-logistics as a supportive delivery process for fulfilling online e-commerce orders (Joseph, Laura and Srinivas, 2004). Others believe that e-logistics implies the use of information and communication technology (ICT) to support the provision and execution of a broad range of logistics activities (Daly and Cui, 2003; Gunasekaran, Ngai and Cheng, 2007). While the former narrowly defines the e-logistics utility in an online business to customer (B2C) or business to business (B2B) setting, the latter offers a broader concept focusing on utilizing ICT to manage information and information flows in supply chains or supply networks [13].

Can be defined as an essential component of electronic commerce aimed at controlling the entire chain which can be divided as follows:

• Reception and packaging of products;
• Storage;
• Preparation of the order;
• Price charged by carriers [14].

All these steps must be carried out with tracking tools (order tracking), the goal is to make accessible to customers all this information so that they can know the status in real time of their orders.

II.3.2. Logistics and Supply Chain Evolution to E-commerce:

The new e-commerce technologies have the potential to offer greater efficiencies and transparency and have led to significant changes within supply

chains, with alternative ways of doing business, improved visibility and changes to distribution channels, including new intermediaries. From a distribution property perspective, the evolution of logistics and supply chain has passed through various phases and very broadly in the timeline as follows (JLL, 2013) [15] **(see figure II.3-1)**.

Most retail stores were replenished by direct deliveries from wholesalers and suppliers in the 1970s. The distribution centers (DC) emerged and retailers started to centralize store deliveries through new DCs that they controlled in the 1980s. Global sourcing took off in the 1990s, with many retailers developing import centers to receive and process mostly containerized imports. From around 2000, e-commerce began to rapidly expand with Internet-only (pure-play) retailers leading the way in establishing giant e-fulfillment distribution networks. In 2000, the business concepts like information sharing driving the extensive and intensive cooperation, collaborative warehousing, collaborative urban (city) as well as non-urban distribution are merged and implemented in logistics and supply chain operations (Capgemini, 2008) [15].
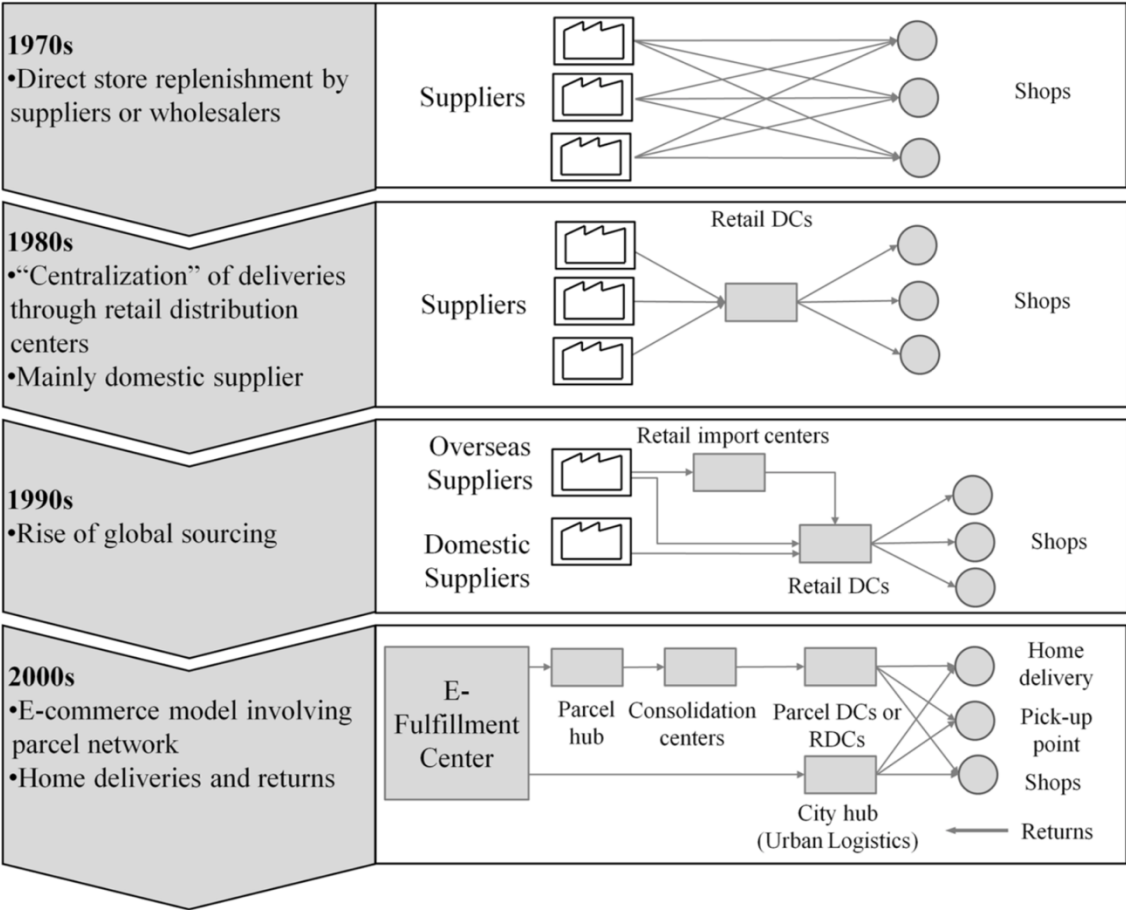
Figure II.3-1: Evolution of logistics and supply chain (JLL, 2013)

II.3.3. E-commerce Logistics Workflow:

E-commerce logistics functions in two directions:

- Forward Direction: Distribution and delivery of goods to buyers;
- Reverse Direction: Exchanging or replacement of defective, damaged or wrong shipments [16].

II.3.3.1. Working in the Forward Direction:

- Receiving the order on an eCommerce store, marketplace…etc;
- Providing a payment option;
- Preparing inventory;
- Packaging the item;
- Preparing its invoice;
- Dispatching the order;
- Handing over the parcel to the courier company [16].

For an E-commerce company, logistics in the forward direction involves receiving an online order, arranging for the item the packaging, preparing its invoice, arranging the payment, dispatching, and delivering the item to the customer's doorstep. The time between receiving the order and its distribution depends on the availability of the material and location of the consignee. For specific locations, a separate delivery charge could be applicable [16].

From the time of dispatch until delivery of a consignment, it is the responsibility of the seller to notify the exact location of a shipment to its respective consignee through tracking SMS or email notifications [16].

Payment collection is essential for any E-commerce business owner, analogous to a retailer. An online retail company should have multiple payment options for better customer experience such as debit/ credit cards, bank transfers, and COD (cash on delivery). In a country like Algeria where buyers are more comfortable with dealing in physical money, COD option is of utmost significance [16].

II.3.3.2. Working in Reverse Direction:

In spite of the best efforts the possibilities of incorrect or damaged orders cannot be ruled out. In such situations an efficient reverse logistics is essential. It is the responsibility of logistics to take back these defective or damaged materials and replace them with proper order that satisfies the customer within a reasonable time. A hassle-free exchange or replacement process goes a long way in building trust between the buyer and an E-commerce company [16].

II.3.4. Logistics Evolution in Ecommerce:

E- commerce logistics is the use of web-based technologies to support the material acquisition, warehousing, and transportation processes. It enables distribution to couple routing optimization with inventory-tracking information [15].

In developed economies, e-commerce logistics represents the latest big driver of change in logistics and physical distribution network and SCM, which have evolved substantially over the past forty years or so [17]. Currently, it remains the case that as e-commerce continues to grow, since low prices and convenience were the driving forces for e-commerce.

However, today e-commerce retailers (also known as e-tailers) are catering to every kind of shopping experience, service and product. Presently, it remains the case that as the gross revenue earned from e-commerce is increasing year on year from nascence to critical mass, most transport service providers (TSP) or retailers, particularly multi- and omni-channel retailers, are only starting to realize what this will bring to their retail logistics and physical distribution network infrastructures and what role they can have [15].

Now the e-commerce challenge has shifting to finding a way of synchronizing and standardizing the business processes to achieve real time access and insight of the inventory movement. As predicted, retailers in developed markets are experiencing to shift from multi-channel retail to omni-channel retail [15] as it shows the figure II.3-2:
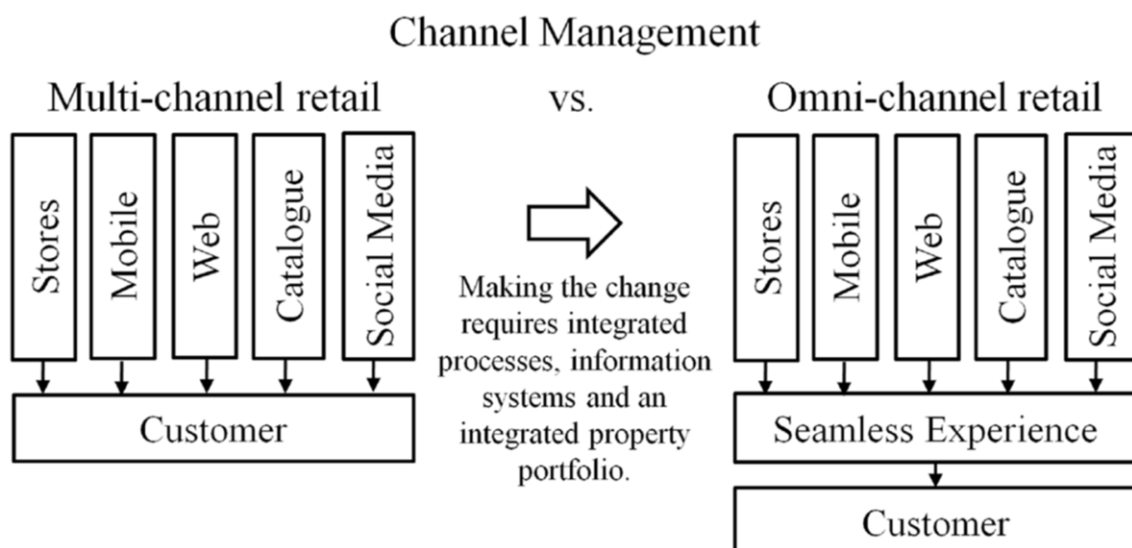
Figure II.3-2: Logistics change in E-commerce

- **Multi-Channel:** Customers interacts with retailers across the independently man- aged channels (e.g. social media, web and emails). Retailers with this

approach are adopting two or more channels to engage their customers, however, they are not necessarily focused on delivering a seamless/ consistent message across multiple touch- point. Furthermore, these programs do not necessarily factor in optimizing customer experience based on different devices (e.g. smartphones, tablets and laptops) [15].

- **Omni-Channel:** This business is diligent to ensure that customers receive the same experience and message through different channels and devices involved within their interactions with the retailer (Kourimsky & van den Berk, 2014). Thus, omni-channel has seamless integration with company software systems like ERP, WMS, warehouse control system, distributed order management (Hobkirk, 2016). Typically, omni-channel customers require their orders to be delivered within either same day or next day to their location of choice, whether the order is distributed to their home or can be picked up in a store or another location, moreover this type of customers expect to be informed of every step and any delays which may occur along the delivery process. Similarly, retailers have a holistic view into inventory in omni-channel environment, allowing them to fulfil orders from any location or ship inventory to other locations where inventory is needed or sells better. Omni-channel DCs share a common inventory pool and seamlessly combine both e-commerce and traditional store distribution channels in order to meet demand regardless of which channel it comes from, whether customers are shopping online from a desktop or mobile device, by telephone or offline in a brick and mortar store. Basically, the goal of omni-channel is to give retailers an end- to-end view based on aggregated information from suppliers to customers, orders, and inventory [15].

For a small E-commerce business, outsourcing logistics is a very fundamental solution for costs optimization and delivery risk management.

II.3.5. Outsourcing Logistics:

Outsourcing the business, is a practice of hiring a party outside a company to perform services and create goods that traditionally were performed in-house by the company's own employees and staff. Currently, the most promising form of business outsourcing is logistics outsourcing. The logistics outsourcing is one kind of enterprises' developing strategy pattern which is developed quickly at present, logistics and supply chain management is the backbone of an E-commerce, and for certain owners, outsourcing logistics services to a professional logistics company, the third-party logistics (3PL) companies, can be great solution, in order to:

- concentrate resources;
- save management costs;
- enhance core competitive power;
- handle risks management [18].

The outsourcing of logistics activities has become a common practice by many companies especially for Ecommerce companies, which implies an efficient choice of the Third-Party Logistics (3PLs) providers.

II.3.6. Third-Party Logistics (3PL):

One way to streamline ecommerce supply chain, warehousing and distribution included, is by outsourcing logistics to a third-party logistics (3PL) provider [19].

Third-party logistics was propelled first in US; later on, European nations put it on to successfully deal with an organization's coordination exercises, re-appropriating the capacity and purchasing the administrations[20].

3PL suppliers without their very own advantages are called lead coordination suppliers that have preferred the standpoint that they have particular industry ability combined with low overhead expenses, yet they bring down arranging power. Working with a 3PL allows the automation and management all of e-commerce logistics processes through one partner, including warehousing, inventory management, order fulfillment, and more [20].

II.3.7. Benefits of 3PL:
Here are some of the benefits of outsourcing ecommerce warehousing and fulfillment to a 3PL:

- **Ecommerce Integration:** Many 3PLs integrate directly with major ecommerce platforms (by implementing for example an API). The moment an order is placed on Ecommerce platform, the details are sent to a 3PL's warehouse or fulfillment centre. Then, the order is picked, packed, and delivered to the customer from the warehouse;

- **Ship easily on major marketplaces:** In addition to ecommerce platforms, some 3PLs also integrate with major online marketplaces. For example: If you sell on JUMIA, or Ouedknis, you can automatically sync your orders and inventory. This is especially useful if you sell on multiple platforms — store, manage, and track your inventory all through one provider and software;

- **Order tracking:** Once 3PL ships an order, tracking info is pushed back to ecommerce store and shared with the customer. This helps the customers to keep track on their orders from the moment they place it until it arrives on their doorstep;

- **Inventory management:** a 3PL can take inventory management off the seller's plate. This includes tracking inventory levels, ordering and restocking inventory, and forecasting future demand;

  Many 3PL firms offer inventory management software to streamline and automate the process. Good inventory management software allows sellers to prepare for various levels of demand and sales by monitoring trends and historical patterns.

- **Scale with e-seller's growth:** As online store grows and order volume increases, e-sellers will need more space to store their inventory and more staff to manage ecommerce fulfillment. Working with a 3PL ensures that they have room to grow — literally and figuratively;

- **Faster order fulfillment:** Customers want their orders delivered fast and free wherever they shop online. If the customer is shipping from home or a rural fulfillment center, fast shipping can be expensive [19].

  Choosing a 3PL with multiple warehouse locations can make a huge difference in the ability to ship orders quickly and affordably. By storing inventory in distribution centers closer to more customers, orders have less distance, making shipping faster and more affordable[21].

Logistics outsourcing Provides services for e-commerce, and e-commerce provides platforms for logistics outsourcing, the two sides complement each other for common development.

But how can logistics firms ensure visibility and transparency within their different operations and process, a Trace and Track is a fundamental technology solution for that.

II.4. Section Three: Track and Trace as a Technology for SC Visibility and Transparency

Tracking and tracing of orders is nowadays a necessity to 3PL firms. This section will be divided into six main points, we will first talk about traceability, its types and its different directions, and then tracking as a mean to define real time location of an item, moving to the third points which define trace and track as a one word, and its importance for SC visibility and transparency.

II.4.1. Logistics 4.0:

Basics of Industry 4.0 are the availability of relevant information in real-time by networking of all elements which are involved in the creation of value, the ability to deduce optimal value-added processes from the information/data at any time and

the realization of an information-integrated value-added process. The term "Logistics 4.0" brands the specific application of Industry 4.0 in the area of logistics. Logistics means the management of the flow of people, animals and goods between an origin and the point of consumption to fulfil the requirements of the customer. Traditional operations are e. g. collection, transportation, storage and distribution. Relevant technologies of Logistics 4.0 are, e. g. identification, mobile communication, localization, electronic data interchange, data analysis methods, data analytics processing and actuating elements [22].

II.4.2. Technologies and Basics of Logistics 4.0:

A new development like Logistics 4.0 is often induced by new technologies and basics and their application in a specific area.

Table II.4-1 shows some important technologies and basics of Logistics 4.0 in form of a morphological box gives an idea of the solution space of new solutions of Logistics 4.0. Please note that it includes the facts of Logistics 4.0 and not of Logistics 3.0 or former developments. It differs into identification, localization, electronic data interchange, sensor technology (also part of Logistics 3.0), varying terminals, cooperative technologies, architecture paradigm, architecture model, data analysis methods and data analytics processing [22].

Table II.4-1: Some important basics and technologies of Logistics 4.0 (source: E-logistics: an introduction)

Basics/Technology	Characteristics				
Identification	Smart card	Bar code/ QR	RFID	Sensor Technology	Biometrics
Localization	Georeference point based	5G	UMTS/LTE GSM/GPRS	Wi-Fi WLAN	Satelite based
Electronic data interchange	Electronic data processing medium	EDI	XML	Internet	Telematics
Data interchange technology	Fiber optic cable	Wi-Fi WLAN	Mesh Network	4G/5G	Bluetooth Zigbee LPWAN
Sensor Technology	Physical Properties	Chemical properties			
Terminals	Smartphones	Tablets	Special handheld units	On-board computer	
Cooperative technology	Physical Properties	Chemical properties			
Architecture paradigm	centralized	Decentralized, agent based	Decentralized Distributed Ledger (Block Chain)		
Architecture	Network	Hardware (server, cloud, storage)	Software (operating system, open source)	Database	

Data Analysis Methods	Descriptive	Inferential (point and interval estimate)	Explorative (big data)	Regression, casual analysis	
Data Analytics processing	Data access	OLAP	Data Mining		
Data Processing	Local	Cloud Computing	Edge Computing		

II.4.3. Traceability Overview:

- **Traceability as a general meaning:** is the capability to verify the history, location, or application of an item by means of documented recorded identification [23].

- **Traceability in supply chain:** seeks to know where and in what condition the product is in.

- **Traceability in logistics:** is defined as the process of determining the location of goods which are delivered from an origin to a destination.

- **Tracing (Logistics Traceability):** Thus, the term of logistics traceability is related to the order-delivery processes and can be understood as an ability to retrace steps and events, referring to logistical activities such as transportation, distribution or warehousing [24].

II.4.4. Types of Traceability:

When it comes to understanding the traceability of a product moving through the supply chain, we can talk about four main areas according to origin or meaning.

Traceability according to origin we distinguish between:

- **Process or internal traceability:** which refers to being able to obtain the trace that a product leaves behind through all the internal processes of a company, with its manipulations, its composition, the machinery used, its shift, temperature, batch…etc;

- **External traceability:** which is to be able to externalise the data of the internal trace and add some more indications (breakage of the packaging, change in the temperature chain…) In order to obtain the traceability of the product, it is necessary to record the indications left by the product while it is moving along the chain (either in the normal or inverse direction) [25].

Depending on the direction, we can find the following differentiation:

- **Backward traceability:** which refers to the reception of products from suppliers. At this stage, records are the key to tracking the movement of products to their origin;

- **Traceability forward**: is that of the products prepared for dispatch and the immediate customer to whom they are delivered. It covers what and to whom the products are delivered [25].

II.4.5. Tracking Overview:

Tracking (logistic traceability) is the ability to find the history, use or location of an entity by means of recorded identifications.It is a matter of tracking the product geographically and in real time, it therefore makes it possible to locate the products, to determine the destinations and origins [14].

Tracking consists of the determination of the ongoing location of items during their way through the supply chain. Tracking only, as a single information, is narrowed to "the identity of the entity at the checkpoint, the location of the checkpoint, and the time of arrival of the entity" (Kärkkäinen et al., 2004). Extended information may refer to the following fields:

- Environment of an item (e.g. temperature, humidity, process flow);
- Product information (e.g. ingredients, composition);
- And changes of the product state (e.g. detailed history of maintenance) [24].

However, this extended information could improve management decisions only if the Track and Trace technology is integrated with other enterprise's systems like ERP, SCM, WMS or TMS. Tracking and tracing system itself provides information, but does not analyze it [26].

II.4.6. Track and Trace:

According to van Twillert (1999) "tracking and tracing may be subdivided into a tracking part and a forward and backward traceability. The tracking part consists of the determination of the ongoing location of items during their way through the supply chain. The forward traceability part refers to the determination of the location of items in the supply chain, which were produced together. Backward tracing is used to determine the source of the problem of a defective item". All in All, Tracking and tracing, is usually associated with logistics as the process of determining the location of goods which are delivered from an origin to a destination [24].

II.4.6.1.   Track and Trace Importance:

E-commerce is developing, the market's high demand is increasing simultaneously with consumers orders, the 3PL companies are facing real challenges of managing all the supply chain process, of pick-up the orders(sellers), storing all the collected items in the warehouse, ensuring their availability, selecting the items of the order, packaging them, and finally delivering them to the right client at the right time ensuring the right amount of money is paid, all of this process is not easy for one order, what about a hundred order per day, here comes the importance of implementing a track and trace technology in delivery companies as:

- It ensures that ordered items in E-commerce websites and marketplaces are available
- It gives the possibility to the company to manage its data, in order to be able to analyse it for decision making
- It gives the possibility to the company to track the location of the delivered orders during their delivery cycle
- It avoids customer dissatisfaction that can be due to unwanted received product
- It makes it easy for 3PL service company to define easily the source of problems due to loss

But most of all, it ensures visibility and transparency of its supply chain.

II.4.6.2.   Track and Trace Technologies:

The ability to track and trace movements of supplies and products through the transportation system has evolved significantly in recent years, thanks to new technologies, their increasing reach across the globe, and falling prices. Radio frequency identification (RFID) and Bluetooth technologies are being used to inventory and track movement of items indoors, such as inside factories and warehouses. 3D printers generate readable sensor tags that can be attached to cargo and capture temperature and humidity conditions. Global system for mobile communication (GSM) and satellite tracking are used in maritime transport, and ship sensors monitor engine performance. Much of this is due to increases in the battery life of small tracking devices, which can now retain power for as long as five years through intelligent algorithms that shut down the device when the sensor is idle [27].

II.4.6.3.   Track and Trace Techniques :

Trace and track technologies play a very important role in supply chain's process automation and optimization, while Tracking and tracing solutions ensure greater transparency in the transport cycle. With the support of innovative elements (i.e. barcodes, RFID tags or NFC chips) and devices (barcodes readers, RFID or NFC antennas, GPS modules) all the stakeholders involved in a supply chain receive the accurate and up to date information about where their vehicles, containers, packaging and goods are at any particular moment, the **table II.4-2** down-below is a resume of some trace and track techniques [14]:

Table II.4-2: T&T techniques, how do they function, pros and cons (source: e-logistics lecture)

Technique (what?)	How?	Advantage	Disadvantage
Barcode: represents the codification of information relating to a product, this representation is optimized so that it can be read by an optical reader	A barcode reader, no matter which model always follows three steps when using it: • The reading itself • Interpretation: the mini calculator of the device • transpose bit streams into an ASCII array. • Data transmission: they are always connected to electronic devices to receive the decoded information	• Fast and reliable reading • Remove manual typing errors • Low cost	• They can only be read on contact with a reader • Limited information storage
EDI: is a structured transmission of data between companies by electronic means (IT tools)	• FTP, Email, HTTP • Information: In order for partners to use EDI together, it is necessary to agree on a common "information standard": EDIFACT (standard valid worldwide, updated regularly by assemblies at the UN), and also:VDA - GALIA - SWIFT - XML - ANSI X.12 - EANCOM - ODETTE ... • EDI software: It consists of connectors and a translator. The translator is the heart of EDI software, its role is to convert data (messages) from an internal company format to a standard EDI message, and also to convert standard EDI messages received from the partner into an internal format: SAP - ORACLE - IFS - Navision – Brain • Communication : Once the data (messages) are converted from an internal format to a standard information format using EDI software, they must be transferred to the intended recipient of the information.	• The main advantages of EDI are speed and reliability Studies have shown that EDI costs, in the worst case scenario, a third of the cost of the paper process Paper transactions that used to take 5 days, it can be completed in less than an hour • Fast error-free document processing largely avoids repeat order work, stock-out and canceled invoices • Up to 50% savings in terms of human resources • Real-time visibility of transactions. this will allows to react and make a decision quickly facing market and customer demands and this offers companies the ability to adopt their strategies demand-driven, not supply-driven	• A little expensive for SMEs (small and medium sized entreprise)
RFID: is a radio frequency identification system that allows information to be written, stored and reread on electronic labels integrated into the products to be traced. This system consists of an electronic chip equipped with an antenna (the RFID tag) and a reader. It is a technology developed to ensure easier tracking of goods	• RFID tag (or transponder or tag): It is equipped with a chip connected to an antenna. The antenna allows the chip to transmit information (serial number, weight, etc.) which can be read using a transceiver reader. • RFID reader: Once the information has been transmitted, the reader only has to convert the radio waves into data and these can be read by RFID software. • RFID software: or RFID middleware, is the brain of RFID chain, it transforms the raw data sent by the RFID	• Helps fight theft • Easy inventory • Allows to trace the rays • Better quality -> less manual entry • Better visibility on the supply chain	• Sometimes the price of the RFID tag is more expensive then the product itself, in other cases it represents in average 10% of the price of the product

during their movement in logistics processes The purpose of the American EPC (electronic product code) system is to standardize the code. Each object is identified by a serial number: the EPC code	chip into comprehensible information RFID software is necessary to process the information contained in the RFID chips and integrate this information into the company's databases		• Ethical problem of respect for privacy, (consumer tracking)
GPS: (Global Positioning System) allows you to locate an object exactly in time and in space according to the geographic coordinates longitude, latitude and height	/	/	/

II.4.7. Supply Chain Transparency:

Supply chain transparency is rapidly becoming a priority as many enterprises realize the advantages of having and sharing certain information with trading partners and consumers. By increasing supply chain transparency, companies can connect with consumers, build trust, achieve better visibility to all parties of the supply chain to drive improvements, and react faster and more effective when problems occur.

Transparency is defined by what data you are going to be transparent about, to whom, and how often, or when. Any company pursuing visibility needs to consider transparency upfront. Supply chain transparency refers to the strategy of how to disclose supply chain and sourcing information to stakeholders [28].

- **Who:** Who needs to have visibility and access to supply chain information, and for what purposes? Examples can include internal stakeholders, suppliers at multiple tiers, clients, and consumers;

- **What:** What information is being shared, and in what format? Is it a supplier list or a map? Does it include multiple tiers? What information needs to be included?

- **When:** How often will the information be shared and updated? There is pressure on companies today for information to be closer to real-time, but achieving this is a challenge [29].

Increasing transparency is an effective way of demonstrating sustainability efforts and openness to stakeholders [29].

II.4.8. Supply Chain Visibility:

Supply chain visibility (SCV) is the trackability or traceability of product orders and physical product delivery from the seller source to their destination. This includes logistics activities and transport as well as the state of events and milestones that take place before and during delivery [29].

The objective of SCV is to enhance and empower the supply chain by making information easily accessible to each and every stakeholder, including customers. The integration of SCV tools or systems enables different supply chain divisions in an organization to acquire real-time and precise information regarding stock, orders, and deliveries in their incoming and outgoing networks" [30].

In 2014, Jeff Dobbs, Global Sector Chair, Diversified Industrials and a partner with KPMG, said, "obtaining real-time visibility across all tiers in the supply chain can significantly increase speed to market, reduce capital expenditures and manage risk"[31].

Chain visibility depends on the creation of an effective "track and trace" (T&T) system that allows players to determine the status of any given shipment of goods at any point in its travels, by any transport mode. Transport data and status information will be captured from enterprise resource planning systems as well as from carriers, either through direct connections or via third-party portals. GPS technology will enable companies to check exact shipment locations, while field sensors monitor environmental conditions such as temperature and humidity, and even provide remote theft protection. But because data is arriving from many different sources — suppliers, transporters, warehouses, distributors — quality and interoperability of the data is critical, and still a significant technological barrier that a wide range of companies are working on [28].

The command center for these remote-sensing activities is the control room or logistics visibility platform, akin to a traffic control tower. The great virtue of the control room is that it can provide executives and senior managers with a fully transparent view of the company's supply chain, and thus support the many decisions that have to be made to keep the flow of parts and products going [27].

Top reasons why supply chain visibility is more important than ever:

- **Rising complexity of SCM:** Today many organizations function on a global scale and use numerous modes of logistics to serve their customers. Having a good supply chain visibility is indispensable to track the supplier network activity precisely and accomplish SCM. But even though your firm may not have to deal with the global demand and supply, there is a good chance for your supply chain to become widespread and complex. Proper communication and the skills to make rapid and informed decisions could be a challenge. In this case, the best solution to increase supply chain visibility may be to

capitalize in a cloud technology that is capable of managing big data or to work with a logistics company that focuses in transportation management;

- **Meeting customer demand:** The customers of today have more choices than ever before. This puts them at the right to demand more. Modern customers expect shorter cycle times and will be less tolerant of mistakes and late deliveries. To meet such high demands, firms need a transparent, more effective supply chain, and a better flow of data and information;

- **Compliance with regulatory demands:** Supply chain visibility tools help firms trace the continuously changing landscape of government regulations and compliance. This is particularly useful for organizations who function on a global scale when it comes to handling the complexity of trade agreements and government tariffs. Additionally, companies can better predict and respond to new regulations in the industry and in terms of transportation used [32].

II.4.9. Between Supply Chain Transparency and Supply Chain Visibility:

The terms "visibility" and "transparency" are frequently used interchangeably. In general, however, the term visibility focuses more on B2B data sharing within the supply chain to make it more efficient. Better visibility and more timely data sharing enabled by B2B connectivity and data flows allow companies to collaborate more effectively around processing transactions and resolving problems. Visibility also helps them manage orders, shipments, and inventory as well as plan and manage transportation [33].

Transparency often refers to the disclosure of information to trading partners, shareholders, customers, consumers, and regulatory bodies. This benefits all parties in the supply chain, but targets consumers and end users of an enterprise's product [33].

A useful way to look at the differences is to consider supply chain visibility as factual as opposed to normative. It's the data that you have concerning the functioning of the supply chain from supply through to demand at each node and the movements between them [33].

Transparency is normative; it's data plus a commitment to openness and data sharing with parties within the supply chain and outside of it, such as with customers, prospects, stockholders and regulatory agencies [33].

In short, the two are intertwined; you can't commit to sharing data that you don't have visibility into. We might say that visibility is about supply chain insight and running the supply chain more efficiently, while transparency involves supply

chain oversight, having accountability, and ensuring that quality, safety, and ethical standards are met [33].

II.4.9.1. Benefits of Supply Chain Visibility and Transparency:

- **Lowered risk:** Visibility into the supply chain helps companies identify problems and risks early so they can address them before they erupt into major and expensive crises. Having clear standards and accountability helps ensure that someone is responsible and motivated to monitor and enforce such standards;

- Threats can come in many forms, including weather, labor disputes, contaminated products, and counterfeits, all of which can lead to lost sales, damaged reputations, and fines. Increased visibility into and scrutiny of the supply chain reduces these risks and makes handling problems more manageable;

- **Improved efficiency:** Better data ensures all trading partners are aware of conditions throughout the supply chain. It also allows all parties to make decisions based on real-time data and current conditions as well as anticipate and respond to delays and disruptions quickly;

- **Increased trust:** Data sharing and standards concerning quality, safety, and ethical conduct inspire trust in companies doing business together and lead to higher consumer trust when companies willingly share and explain relevant materials, sources, and procedures that go into making and delivering their products;

- **Improved cooperation:** With good data, roles, and accountability, all trading partners can respond more effectively and work together when disruptions occur. The risk of substandard or contaminated products is much lower, but if it happens and a recall is necessary, trading partners can collaborate to quickly and effectively identify and remove substandard products from the supply chain and manage the recalled products [33].

II.4.9.2. How to Achieve Supply Chain Visibility and Transparency:

Enterprises must shift their technology, transitioning from enterprise-centric technology built on the point-to-point integration paradigm and instead connecting to a real-time platform that embraces its entire ecosystem of business partners, so data can be shared in real time with all parties. Newer approaches such as real-time networks provide both the data for better visibility and the tools to enhance transparency and accountability across the supply chain. One of the technologies that needs to be implemented for SC visibility and transparency is Trace and Track technology[33] .

II.5. Conclusion:

E-commerce development did not only create new businesses and new SC processes, it also increased competition, gave birth to new customer needs and pushed the 3PL providers to prove themselves as qualified firms for B2B (business to business) partnerships, and the constraints to be chosen as potential logistics provider; developing IT tools is fundamental to help the internal and the external trace and track possibility for different SC partners, If tracking is the ability to determine the current state of a product in the real time, tracing means the ability to remember the past states and the origins of the product as well, both as a technology implemented for better SC visibility and transparency. following this we will go into more pratical applications in ER , we will have a general overview of the selles analyses , further more we will progress into the the main problematique of this thesis .

Chapter Three:
Analysis and
Methodology

III.1.   Introduction :

This chapter will be divided into three complementary parts, in order to build a comprehensive methodology for clear solution and results. First of all, we will be going by all the phases of data processing, after that we will analyze it, visualize it and highlight the problematic. In the second and the third section, we will model our problem and explain our proposal of track and trace technologies integration for better visibility and transparency.

III.2.   Section One : Orders Analysis

"Torture the data, and it will confess to anything" (Ronald Coase). Data is a set of qualitative and quantitative values, registered through observation to explain a case or a person or an object, in order to extract information that can be useful for future prediction and decision making. Most of work mistakes made in many domains are not due to lack of performance but they are due to lack of knowledge of the information, that is why knowing our data is important as it presents fifty percent of the solution. Can the solution be trusted if the data is not trusted? That is what will we clear-out in this section.

III.2.1. Data Requirement Gathering :

First thing first is not data collection, but knowing data that we need to collect. In order to determine the required data, we proceeded from the general to the specific by asking and answering some questions, the sheet down-below for main questions that define our needs **(table III.2-1)**

Table III.2-1: Data requirement gathering sheet

ID	Questions	Answer	Comment
1	What is our mission?	Delivery	Ensure E-commerce orders delivery
2	What are, our SC's, participating individuals/parties?	Logistics department, Delivery men, E-seller, End-customer	The key factors that ensure our mission
3	How many delivered provinces (wilaya)?	38	Except the ones in the south of the country
4	How many delivery men do we have?	Not defined	Not fixed, always changeable: between provinces (wilaya) and inside one province

5	What is the capacity of a delivery man?	Not defined	20 on average/delivery man

What does each of our SC's participating individuals look for:

- **Logistics department:** Increase number of clients (income), decrease the number of delivery men (expenses), ensure clients' satisfaction and loyalty (delivery on time, aftersales support, professionalism of delivery men)

- **Delivery men:** more orders for more income, efficiency (deliver fast to be able to deliver more), optimize distances and time

- **The e-tailer (e-seller):** ensure client's satisfaction, on-time delivery, reduced delivery cost

- **The end-consumer:** reduced delivery cost, fast delivery, service quality

From above we came up with the conclusion that the best answer to all our questions above and the data we need to study is the orders history with its details that:

- Customer enters when ordering
- Logistician enters when processing the order

III.2.2. Data Collection :

Data collection is the process of gathering information from different sources, it enables an organization or a person to answer several questions and predict future probabilities and trends, it can be extracted from surveys and interviews. In "Easy Relay" the database is generated from the server, while every order's operation done, is synchronised and registered with all its information in the database. For our study, we were provided by the organization with orders history of the last six months – from November 2019 until April 2020 – in Excel format, more than 10.000 rows and 70 columns for each monthly sheet.

III.2.3. Data Pre-processing:

In real world, data can be inconsistent, incomplete or noisy, that is due to:

- Data entry, data transmission, data collection
- Discrepancy in naming conventions
- Duplicated records

- Incomplete data
- Contradictions in data

Preparing data before using it is as important as the solution is:

III.2.3.1. Data cleansing :

or data cleaning is the process of detecting, correcting, removing corrupt or inaccurate registrations from a record set, table, or database. Cleaning data is essential to obtain coherent useful results. In our study we proceeded, using excel software, as the following:

- **Fill in missing values:** missing values can happen due to equipment malfunction, deleted due to inconsistency or misunderstanding, or not considered important at time of data gathering, in our dataset there were:

  o 19 empty variables (columns) for information privacy such as customers emails…etc, we had to omit these columns since we do not really need them

  o 10 variables (columns) replaced with "0" such as dimensions of the package, they can be considered not important.

  o There were many cells not filled, generally when a case did not happen for example id_return, reason of return, reason of cancelation

  o There was a city (commune) that we could not find its geographical coordinates it presented 2.37% from the total orders, we neglected it

- **Smooth out noisy data:** noisy data can be data with a large additional meaningless information as it can be corrupted data that the system cannot understand or interpret correctly, in our study we had:

  o Corrupted data such as addresses, they were not written properly like the address format **(figure III.2-1)**, some were missing information, some written incorrectly (different languages, not mentioning the district, door number…), this was categorical data that we cannot predict nor correct.

number[,]thoroughfare type[ ]Thoroughfare name
postal code[ ]SETTLEMENT

Figure III.2-1: Address Format

- **Remove irrelevant data:** Out of seventy columns (variables) we omitted twenty-nine (mentioned above), we had to omit more insignificant data variables that have no use only taking memory space, at the end we were left with eight variables: id (delivery order's identification code) , commune

(town number), date_rammasage (pick-up date), id_retour (return identification code), last_etat_liv_date (last state of delivered order date), nb_tentative(number of delivery attempts), wilaya (province)

- **Correct inconsistencies:** inconsistencies are incoherent data, we found in our dataset, the dates of pick-up were after the date of delivery accomplishment, this mistake was due to the automatic selection of pick-up dates, since they are predefined before as Sunday, Tuesday and Thursday. Also, in addresses there were some containing phone number instead of the address and some others, wilaya (province).

We can distinguish in our dataset, the categorical and the numerical records, for the categorical one's case, they were impossible to be corrected especially the addresses, so in our present work we will use the information depending on "commune" (town) instead of addresses to obtain more reliable results, as towns data was defined with "commune number" with known available geographical coordinates of longitude and latitude.

III.2.4. Data Analysis and Visualization:

Data analysis and data visualization are what define business intelligence. After the data has been gathered, cleaned and organized, analyzing and inspecting it comes, in order to create reports and dashboards to gain business insight, and this latter cannot happen without visualizing it into different graphic representations (statistical graphics, plots, information graphics), to extract information, and conclusions supporting decision-making and future predictions.

III.2.1.1.   Number of orders in Algeria:

- **Analysis 01:** We notice that February was the peak in the last six months from November 2019 to April 2020, after it comes January, at the other hand, November was the poorest, unexpectedly march and April (COVID-19 lockdown) did not witness a very high increase in orders, unlike the other Ecommerce industries in other countries. The graph down below **(figure III.2-2)** done with Excel software, shows the delivery rate for each month per each province (wilaya)

- **Interpretation:**
    ⇒ Number of orders increases and decreases from month to month and from season to season
    ⇒ COVID-19 at its beginnings did not have great impact on Algerian consumers, because Algerians do not really have the culture of buying online
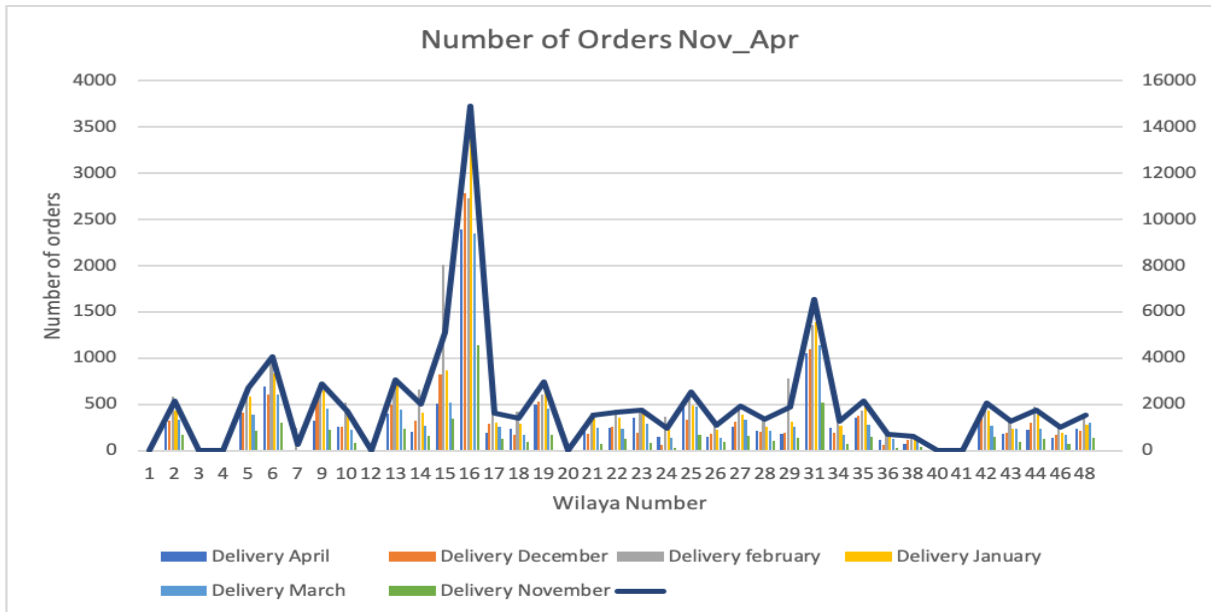
Figure III.2-2: Number of orders of each month (November-April) per wilaya

- **Analysis 02:** We notice that the peak is Algiers-16 with a huge difference in number of orders (19%) of the total delivery, to come after it oran-31 (8%), Tizi Ouzou-15 (6%), Bejaia-06 (5%), Setif-19, Tlemcen-13, Blida-9 (4%). The **figure III.2-3** down below shows the first delivery contributing provinces (wilayas) for the total six months (Nov-Apr) done with Excel software

- **Interpretation:** It can be due to many factors:
    - ⟹ Number of sellers in these provinces is higher than others
    - ⟹ Company's visibility and marketing campaigns in these provinces
    - ⟹ B2B partnerships
    - ⟹ Accessibility due to hubs in all of Algiers, Oran, Tlemcen And Setif
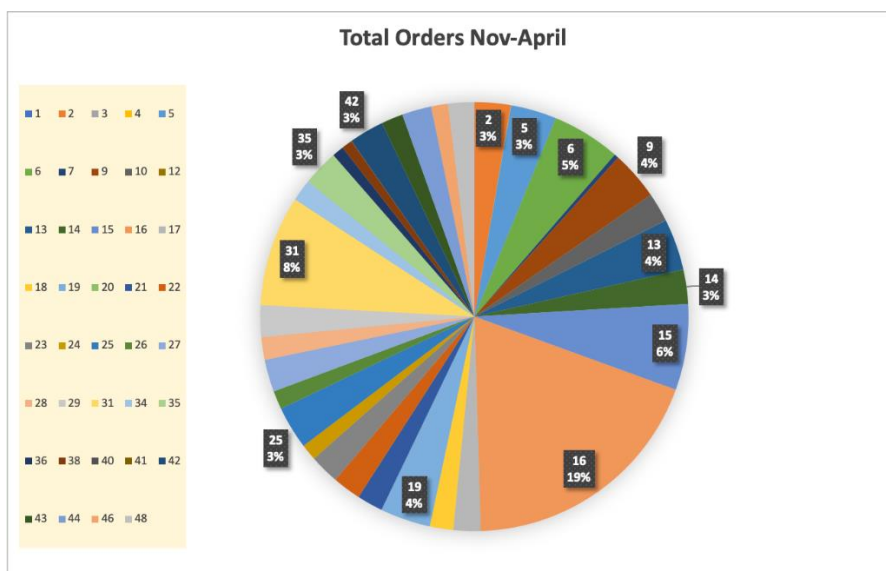
Figure III.2-3: Delivery contribution of provinces from November'19 to April'20

III.2.1.2.   Orders in Algiers :

As Algiers is the top contributing province to the company with the biggest orders rate in Algeria, analyzing its collected data is important:

- **Analysis 01:** The map down below **(figure III.2-4)** shows how orders are distributed in Algiers towns, the intense colour of red means increased number of orders, we can notice that number of orders is different from town to town, as we can notice that some towns are close to each other with high number of orders, and some others are distant with few numbers of orders.

- **Interpretation:** Generally, those with high rate of orders are the towns with high population
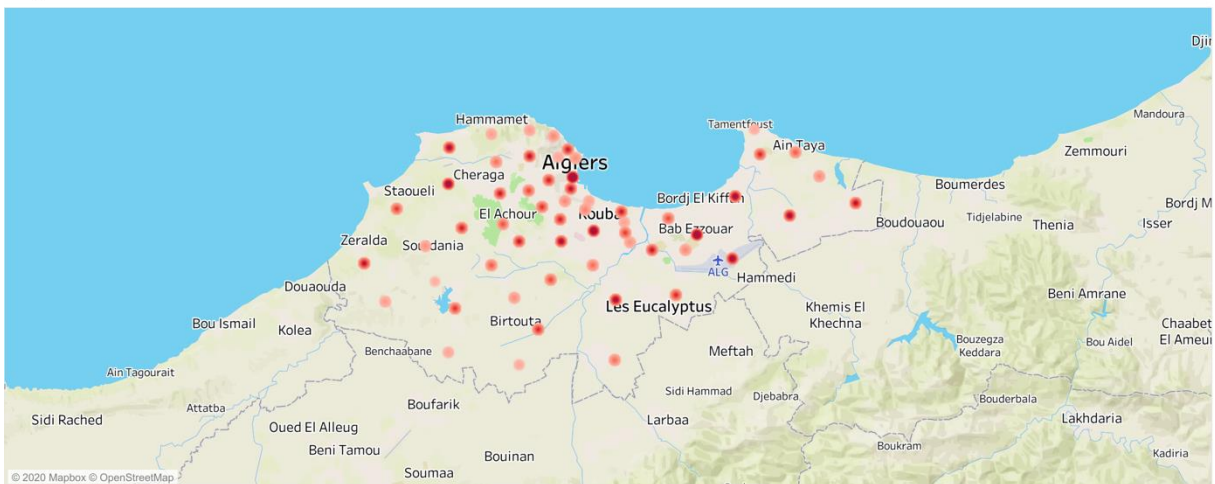
Figure III.2-4: Map of Distributed Orders par Town in Algiers

- **Analysis02:** As Algiers is divided into twelve zones **(see Table I.5-1),** we notice that the number of orders is almost the same in some zones and it is different in others (sometimes with huge difference), therefore deliveries are not balanced **(figure III.2-5)**

- **Interpretation:** This difference is due to the inefficiency of zones division, while all zones need to be equal for delivery balance and optimization
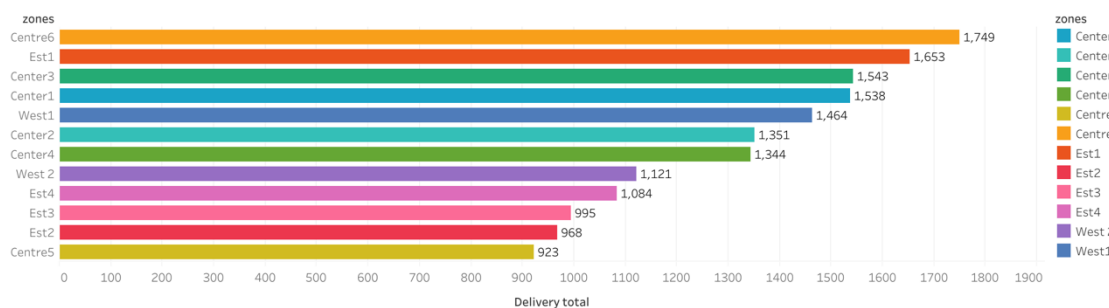
Figure III.2-5: Number of orders in Algiers per zone (sector)

III.2.3. Statement of the Problem:

After analyzing the orders, and in order to make our study meaningful, we came up with the decision of focusing our study on Algiers, as it presents 19% of the total orders of the country which means, hundreds of orders to be managed and satisfied monthly in one province between 57 city, while many constraints and challenges enter into consideration.

In order to satisfy the experience of all participating parties (logistics managers, delivery agents, customers) in the delivery chain, while ensuing visibility transparency consistency and efficiency of operations, we propose a whole delivery process optimization with integrated technologies, this solution consists of:

- A new balanced, optimized division of Algiers (zoning system configuration);
- Integration of routing planning to the delivery agent's mobile application;
- Integration of T&T technologies for tracking and tracing packages within delivery.

Proposing a new zoning system, while each sector presented by a delivery tour, is balanced and equal to all the other sectors, this latter prevents unmeaningful tours, tours with poor delivery and income, at the other hand, tours with exaggerated noisy surcharge that surpasses the capacity of the delivery agent who can fall in delays.

When the zoning is optimized, optimizing tour's planning is complementary to the previous process, while providing the delivery agent the possibility to have real time access to his tour: planned to be fast and meets time window. This planning is to be integrated to his delivery's mobile application.

At the end, real time tracking option of the package to customers (e-seller and the buyer), and tracing ability to the firm all this, provided by T&T technologies choice and integration.

From this section, and as we have seen before, data analysis is a whole process, it does not only help in the coming work's execution but it also helps in defining our needs and expectations.

The coming section will be about modeling the zoning problem.

III.3.   Section Two : Zoning Configuration Methodology

In this section, we will be defining first the purpose of this work, then our method of zones' division P-median, the mathematical model of the problem, different constraints taken into consideration, the objective function and the solution generation tool.

III.3.1. Purpose :

The purpose of zoning system's configuration is to ensure that all zones (sectors), are equivalent or almost equivalent in number of orders in a given period of time while all towns (communes) in one zone are closest possible to it, the aim of balancing is to make the delivery tour efficient e.g. instead of travelling 3 distant towns delivering 3 packages only, the delivery man can travel 6 nearby towns delivering 6 packages.

This division solution does not only optimize the delivery process, but it optimizes the number of delivery men needed by the company too.

III.3.2. Introduction to the Problem :

The problem is about dividing wilaya of Algiers into zones, the division concept is to make delivery process easier and faster, each zone presents a sector for a delivery tour, each delivery tour has the maximum capacity of packages to be delivered: 20. The number of zones P is to be chosen relatively to both the number of orders and the number of delivery men available (which are both variable in time).

A zone consists of towns (communes), knowing that wilaya of Algiers contains 57 city, means automatically the number of zones "P" needs to be less than 57 when choosing it.

Each zone needs to contain not less than one town. These towns need to be as closest as possible to the zone, therefore to each other. Their total number of orders to be delivered in a tour do not surpass 20 packages.
Each town is presented by its clients, and clients present the quantity of orders in a town.

In this solution we will not take into consideration delivery cost (as explained before, the company does not cover delivery cost). It is then ***capacitated and cost-free location-allocation problem solved with P-median method***. We need to locate (choose) out of 57 potential points (commune) P zone, and then allocate each town presented by client to one and only one zone, depending on number of orders (clients) and distance travelled.
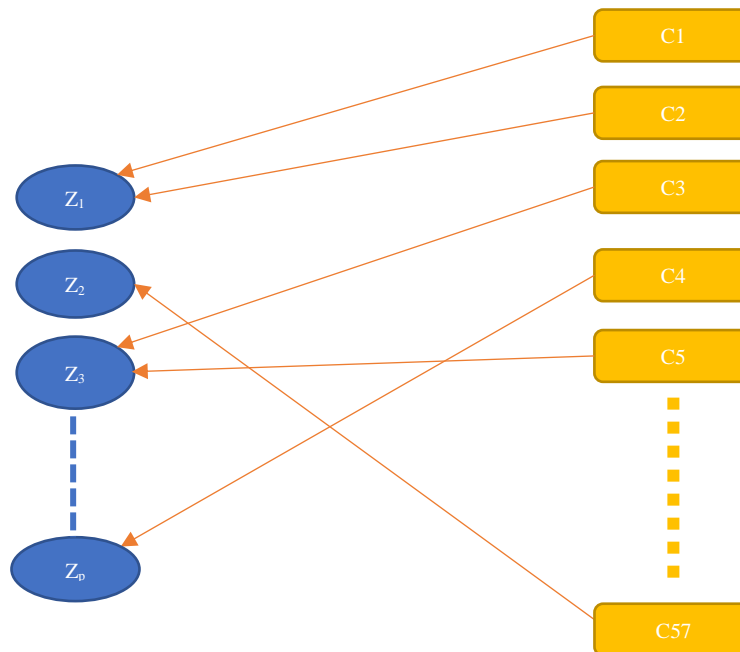
Figure III.3-1: Example of location-allocation of 57 city (clients) to P zones (sectors)

So, the objective function is to minimize the distances between the client (presented with town) and the zone he will be affected to while respecting our constraints.

III.3.3. Mathematical Model Based on P-Median Problem:

Multi-Facility Location Problems: are one of NP-hard operations research methods, it is about the simultaneous research of localization of many sites (problem of localization/allocation). In 1909, Weber wondered about the best location to give to a given industry (a given product). He bases his thinking on transport costs. This problem gave rise to the P-median problem which seeks, for a given number of P installations, to minimize the sum of the distances separating the installations selected for customers[34]. The p-median problem is one of several classical location problems which also include the capacitated and incapacitated facility location problems[35].

III.3.3.1.   Mathematical Model:

Our mathematical model is based on data that we have, Decision variables that we need, Objective function to optimize and different constraints to consider.

Data:
i : zone index
j : client index
O_j : number of orders of client j
D_{ij} : Distance between client j and zone i

K_i: Maximum Number of orders in a tour to zone i (the capacity of delivery man)
The distances were calculated according to real roads between each town.

Decision Variables:

- X_i: localization variable of zone i
- Y_{ij}: allocation variable of client j to zone i

$$X_i = \begin{cases} 1 & if\ zone\ i\ is\ chosen \\ 0 & Else \end{cases}$$

$$Y_{ij} = \begin{cases} 1\ if\ client\ j\ is\ affected\ to\ zone\ i \\ 0 \qquad\qquad\qquad\qquad Else \end{cases}$$

Objective function:

$$s = \ min \sum_{i=1}^{i=57} \sum_{j=1}^{j=57} Dij * Yij$$

Constraints:

$\sum_{i=1}^{i=57} Xi = P$: the total number of zones i to be localized is equal to P (number of zones)

$\sum_{i=1}^{i=57} Yij = 1 \quad \forall\ j$: the town j presented by client is allocated to one and only one zone i

$\sum_{j=1}^{j=57} O_j * Y_{ij} \leq K_i * X_i \quad \forall\ i = 1.....P$: no matter the zone i, number of orders j to be covered in zone i does not surpass the capacity of the tour i

$Yij \leq Xi \qquad \forall\ i,j$: if zone i is not chosen client j cannot be allocated to that zone, and if zone i is chosen, client j can be affected to it as he can be not affected to it

$Yij, Xi \in \{0,1\} \quad \forall\ i,j$: the decision variables Y_{ij} and X_i are binary variables taking the value of 1 or 0

III.3.3.2.   Generation of Results with LINGO:

LINGO is a comprehensive tool designed to make building and solving mathematical optimization models easier and more efficient. LINGO provides a completely integrated package that includes a powerful language for expressing optimization models, a full-featured environment for building and editing problems, and a set of fast built-in solvers capable of efficiently solving most classes of optimization models[36].

In the presented work, we used LINGO version 18.0.56 with commercial license usage **(figure III.3-2)**:
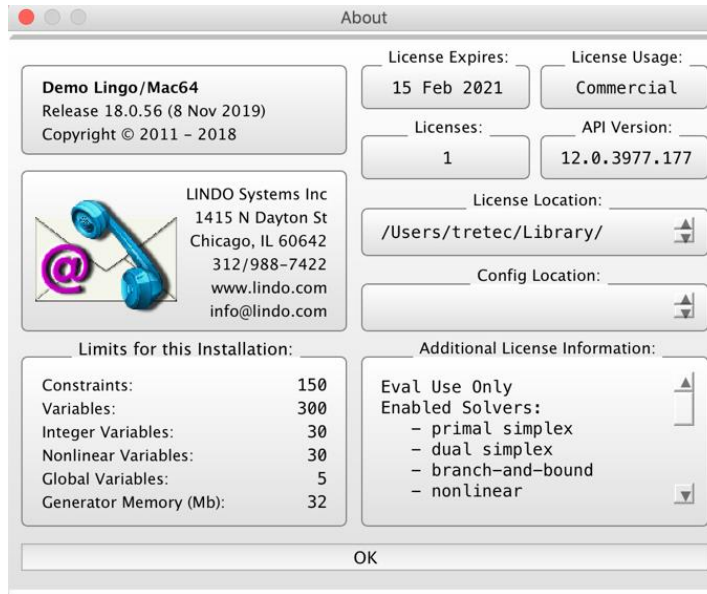
Figure III.3-2: LINGO 18.0.56 Features

In this section, we explained what is the P-median problem and how does it help us solve our problem of zoning system's configuration and optimization, in order to allocated towns presented by clients to zones localized simultaneously. In the next section we will see tour's planning solved with TSPTW problem resolution method.

III.4. Section Three: Traveling Salesman Problem with Time Window

Supply chain's visibility is an important success factor in the delivery operations, by planning the delivery tour before the due time we are giving an advance push to customer's satisfactions.

Customer will be informed about the reception's expected time of his/her purchases, same goes for the delivery man being given an optimal delivery plan can help him reduce the delivery cost and provide him with a decision-making aid.

In the spirit, we propose an algorithm for travelling salesman problem (TSP) with time window constraint (TSPTW) and dynamic approach, being connected to the company database, and a spatial database of the Algerian road network in order to get the exact distances.

The TSPTW consists of finding the minimum time of a tour in a set of locations where each location is visited only once. Noting that: all tours must start from the hub respecting the delivery man working hours, and each location (client) must be visited within its own time window.

The delivery man can arrive early but that imposes a waiting time, since the delivery costs are constant: the same to all the operations, the service time will be considered constant since no costs are paid for it.

In order to result more transparency and efficiency in the delivery, we have created a module that calculates the approximate delivery time to the run sheet.

III.4.1. Technologies :

The module is made of an application web client/server based on php/PostgreSQL as a server language, we have chosen so because the enterprise's back office uses php and backend, furthermore the PostgreSQL is used to get access to the routing library of Pgrouting that allows us to use spatial databases of map to store Algeria's OpenStreetMap routing map, to calculate distances based on roads. The client's side was coded in JS. In order to make a request to the server in the same way, we can use the server side as a rest API to be integrated in the mobile app. Finally, for the visual We use leafletJS to get access to the map, bootstrap and html for the markup (**Figure III.4-1).**
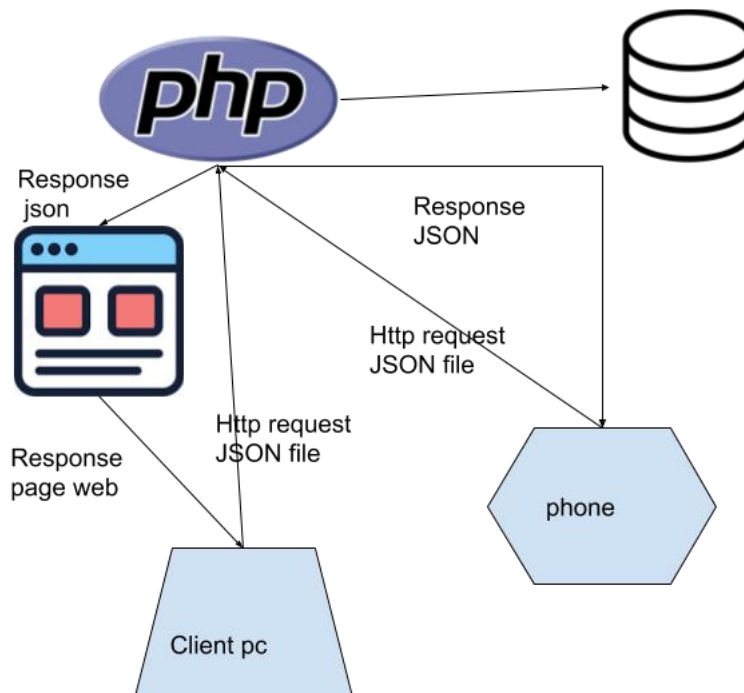
Figure III.4-1: The architecture of Technology implemented

The main utility of the module:

- Using real life distances,
- Result the optimal road tours in the map

III.4.2. Advantages :

- Since the modules works as call API thought sending JSON files as information it could be integrated with any kind of application web, mobile, pc
- Provide a possibility to use map with the gis databases integration

III.4.3. Limitations :

The road traffic, but it can be solved by collecting information about traffic hours, and then adding this constraint as penalty to multiplicate in the time used to pass the road, it must be used in a server, in order to provide access to multiple users.

III.4.4. Programming Languages and development Tools:

The used language and tools for reformulating the problem are:

III.4.4.1. PHP :
Hypertext Preprocessor also known as PHP is an open-source server-side scripting language.
PHP is mainly used to build interactive website, alongside databases :web pages interact with the users via input or queries[4]

Figure III.4-2 PHP Logo

III.4.4.2.   HTML
Hypertext Markup Language (**HTML**) is the standard markup language for documents designed to be displayed in a web browser.
Web browsers receive HTML documents from a web server or from local storage and render the documents into multimedia web pages[5].

Figure III.4-3 HTML logo

III.4.4.3.   Leaflet

Figure III.4-4 Leaflet logo

Leaflet is the leading open-source JavaScript library for web mapping applications interactive maps, Leaflet allows developers without a GIS background to very easily display tiled web maps hosted on a public server[6].

III.4.4.4. **Postgres***:*

PostgreSQL is a relational and object-based database management system [7] . It is a free tool available under the terms of a BSD type license.
The Main features of PostgreSQL:

- PostgreSQL can store more data types than traditional simple types integers, characters, etc. User can create types, functions, use type inheritance, etc. l'héritage de type, etc.

- PostgreSQL works on various hardware platforms and under different operating systems.

- PostgreSQL is widely recognized for its stable behavior, similar to Oracle. But also for its extended programming possibilities, directly in the database engine, via PL / pgSQL.

III.4.4.5.   PostGIS :

PostG8S is an open source software program that adds support for geographic objects to the PostgreSQL object-relational database[8]

Figure III.4-5 PostGis Logo

III.4.4.6.   pgRouting :

pgRouting is a PostGIS geospatial database extension to provide geospatial routing functionality (figure III.4-7).

pgRouting library contains following features:

- All Pairs Shortest Path, Johnson's Algorithm;
- All Pairs Shortest Path, Floyd-Warshall Algorithm:
- Shortest Path A*.
- Bi-directional Dijkstra Shortest Path.
- Bi-directional A* Shortest Path.
- Shortest Path Dijkstra [9]

Driving Distance:

- K-Shortest Path, Multiple Alternative Paths
- K-Dijkstra, One to Many Shortest Path
- Turn Restriction Shortest Path (TRSP)

Figure III.4-6 pgRouting logo

50
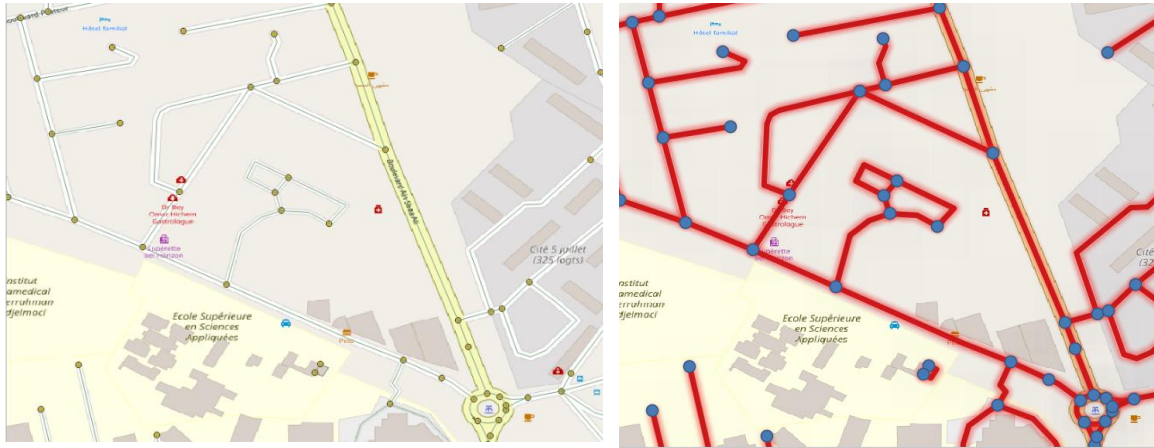
Figure III.4-7 : Roads map example

Figure III.4-8 OSM LOGO

III.4.4.7.OSM

"OpenStreetMap (OSM) is dedicated to creating and providing geographic data, such as street

maps, worldwide, for free. Most maps considered "free" actually have legal or technical restrictions on their use. OpenStreetMap is an adequate data source for pgRouting, because it has no technical restrictions in terms of processing the data. Data availability still varies from country to country, but the worldwide coverage is improving day by day.

OpenStreetMap uses a topological data structure [9]:

- Nodes are points with a geographic position.
- Ways are lists of nodes, representing a polyline or polygon.
- Relations are groups of nodes, ways and other relations which can be assigned certain properties.

Properties can be assigned to nodes, ways or relations and consist of name = value pairs.

III.4.4.8. PhpStorm :

PhpStorm is a commercial, IDE (integrated development environment) for PHP owned by JetBrains.,PhpStorm provides an editor for PHP, HTML and JavaScript with on-the-fly code analysis, error prevention and automated refactorings for PHP and JavaScript code[8]

Figure III.4-9 PHPSTORM Logo

III.4.4.9. XAMPP :

XAMPP is a free and open-source cross-platform web server solution, it's works on the most common operating devices.

Figure III.4-10 XAMPP Logo

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III.4.5. TRAVELLING SALESMAN PROBLEM WITH TIME WINDOWS ALGORITHM :

TSPTW (input : matrices_des_point_de_livraison)

A- build graphe of ways between points

B- initiate the solution matrix: depart point (hub) and remove it from
matrices_des_point_de_livraison
initiate impossible_to_delivery_array as empty array
initiate wasted time =0
 time now= the earlier time of starting from the hub
C- @foreach point in matrices_des_point_de_livraison

 C1- define last known place from the solutions array (LKP)

 C2- @foreach point in matrices_des_point_de_livraison

 C-2-1   Calculate the distance from the LKP to point
    Initiate a matrix early_late_mat of the earlier time and the later time of arrival
    If later time > time now
    Remove this point from early_late_mat   and added it to the
impossible_to_delivery_array
        @endforeach

D-From the early_late_mat get the smallest earliest times
(If there are many earliest times the result will be an array)

E-From the early_late_mat get the smallest lates times
(If there are many latest times the result will be an array)

F-@ Select the intersection between   D and E

G-@If the intersection exist

G1- From E select the closest to the LKP
     Assign the point into the solutions array
    @endif G

H- @else
Select the closest point to the LKP
    Assign the point into the solutions array
     @end else H
Update Wasted time
Update time now
Remove this point from early_late_mat

@end foreach C

In this section, we have defined our tour's planning as TSPTW, we explained the different tools used to help us generate a solution, also the algorithm's steps to follow while building our code.

The next section will be about our value-adding T&T technology's integration for better visibility and transparency of delivery operations.

III.5.   Section four: Routing and Track and trace technology's integration

Track and trace systems are often used in logistics mostly by shipping companies in order to prevent risks related to missing or losing items, offloading and delays.

This project is about implementing Track and trace technologies for a better visibility and transparency of the delivery, and it cannot be very helpful to the company if the delivery tour planning of delivery company is not optimized, therefore the presented work of section two was to make the integration of track and trace technologies meaningful.

In this section we will talk about both routing planning display on mobile application, and integration of T&T technology system.

III.5.1. Routing Planning's Integration to Mobile Application:

Easy Relay has developed a mobile application, for its delivery agents, to facilitate orders' logistics, our presented work in section two can be integrated to it, so that the mobile application displays real-time delivery tour of the delivery agent using internet network, we will explain it briefly:

1) Logging-in: Before starting the tour, the delivery agent logs-in

2) After he logs-in, he clicks on the menu, the menu appears like in **(figure III.5-1)**

- **Vendeur (seller):** Used to process transactions relating to sellers (Payment, Returns, Pickup)
- **Livraison (delivery):** Only visible for deliverers who make Easy-Relay deliveries, At the click, a sub-list is displayed, for what is to be Delivered, Exchanged and Recovered + Cancelled + Validated
- **Etat de caisse (Checkout):** Allows delivery agent to close the checkout, and return the money after the various operations.
- **Paiement Livreur(Delivery Person Payment):** Allows delivery agents to know if the payment is ready, by how much and for which tours.
- **Planning:** One week schedule for everything related to delivery people: Collection, closure, payment and training ..
- **Historique (history):** Allows deliverers to review the history of deliveries
- **Contacts:** Gives access to telephone numbers
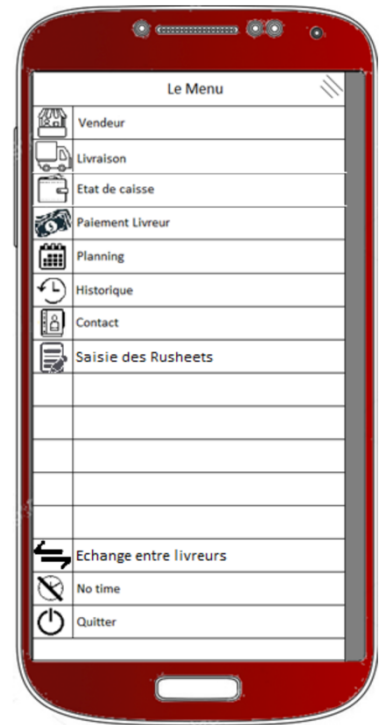
Figure III.5-1: Principle Menu (source: ER)

- **Saisie des Runsheets (Entering Runsheets):** Allows delivery man to enter Jumia Runhssets
- **Echnage entre Livreurs (Exchange between delivery men):** Allows delivery man to exchange parcels between deliverers in the same sector (zone)
- **No time:** Allows the delivery agent to report that there are deliveries that they could not meet due to lack of time
- **Quitter (log-out):** leave the app

3) The delivery man clicks on "livraison", it appears as in figure III.5-2:

To deliver Page: The page consists of two ribbons and blocks with the number of commands:

- The first ribbon indicates the title of the page and the button that allows access to the menu,
- The second ribbon contains:
  1. The number of packages to be delivered
  2. A Filter per Wilaya (Displays only the wilayas that concern this delivery man and only appears if there is more than one Wilaya)
- 3. A filter by Municipality (Only displays the towns that concern the delivery person)
- 4. A search mode filter with three options:
  a- Customer name   b- Package ID.
  c- Raise or not
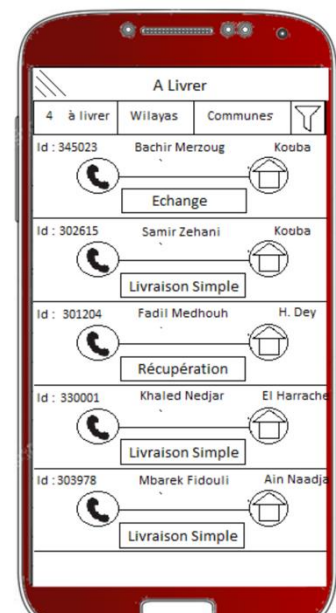
Figure III.5-2: To deliver page (source: ER)

The blocks indicate:

- The order id
- The name of the client
- The name of the town.
- Telephone icon: turns green if the customer is already called - The Home icon: Turns green if the customer has already been delivered (So GPS coordinates recorded).
- Box: Contains the type of operation to be performed by the delivery person:
  - A simple delivery.
  - An exchange
  - A recovery of a package.
- The colour of the block does not change if there is a raise. (Client not reachable or to postpone the appointment …)
- Parcel recovery cannot be at the same time as an exchange or a delivery, two different operations and two different id.

4) The delivery man clicks on commune if he has a delivery tour in Algiers, and the proposed window is as follows (**figure III.5-3):**

When he clicks on "Ma tournée" (My tour):
  - If all orders are in one zone (sector), then only one tour appears
  - Else all tours appear

5) He clicks on the one he wants to start with, and it is displayed on the map, indicating the first order to deliver, the second…the last, taking into consideration possible roads and giving estimated time to finish each order's delivery (details in chapter four)
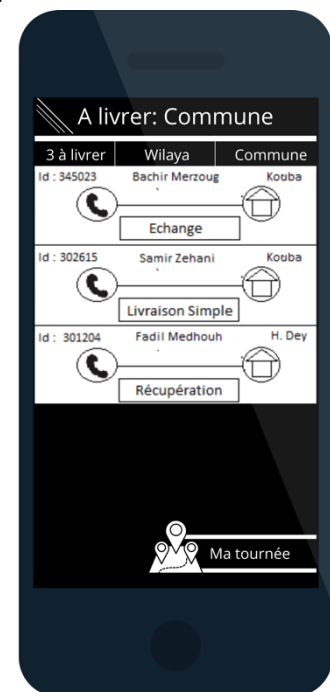
Figure III.5-3: To deliver in town page

III.5.2. Track and trace technologies' integration:

What happens when orders leave the hub until they arrive to the end-customer, is gloomy, having control and visibility on the operation can help to prevent many risks, integrating track and trace technologies in delivery process is a solution to provide:

- Real-time status (traceability) of the order to all parties: the seller to make sure that his/her product is delivered or not yet, and the company to ensure that the order will meet the deadline or not

- Localization and time optimization (tracking): for both delivery man provided with tour planning and needed time (max-min) to deliver one purchase, and the end customer to get ready to receive his/her purchase.

When the delivery man starts his tour, the buyer gets notified of the estimated time of his/her delivery to be at his/her door, he/she makes sure that he/she needs to be present and prepare the payment in order to prevent any wasting of time.

Technically talking, the tracking system will be a connection between the information systems and physical flow of goods in logistics' network. When ordering a product, we assure a real-time delivery notification for the stockholder to know the relevant information of the delivery, in case of a delay or any kind of problems.

III.5.3. The Choice of Technology:

The technology used in the tracking and tracing system is almost a cost-free solution, once the material is installed there will be no need to get any new material except for expending or maintenance, we propose that the turnover boxes **(figure III.5-4)** that the delivery man uses to gather his packages, is to be equipped with an *RFID tag* **(figure III.5-5)**, with *RFID readers* being installed in the company and in the delivery vehicles.

- Each turnover box equipped with an RFID tag is of unique serial number of identifications.
- Also, before, those items of each order, get in the system they are to be given a unique identification code. The purpose of codification of a product: is to identify each product unique when exchanging the information between counterparty of the chain.

Figure III.5-4: turnover box
(source: google)
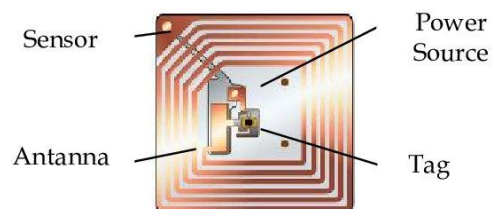
Figure III.5-5: The component of an RFID tag (source: researchgate)

III.5.4. Purchase's Codification :

The choice of identification technologies for tracking and tracing include the use of barcode and RFID, where the information system uses proprietary tracking

numbers. The methods for tracking the orders are done via a web interface where the coded item travel from seller to end-customer, via different node in the supply chain.   The arrival on each point trigger an update to the information system for the trace and tracking.

III.5.5. Track and Trace Network Architecture:

We propose the following track and trace network architecture **(figure III.5-6):**
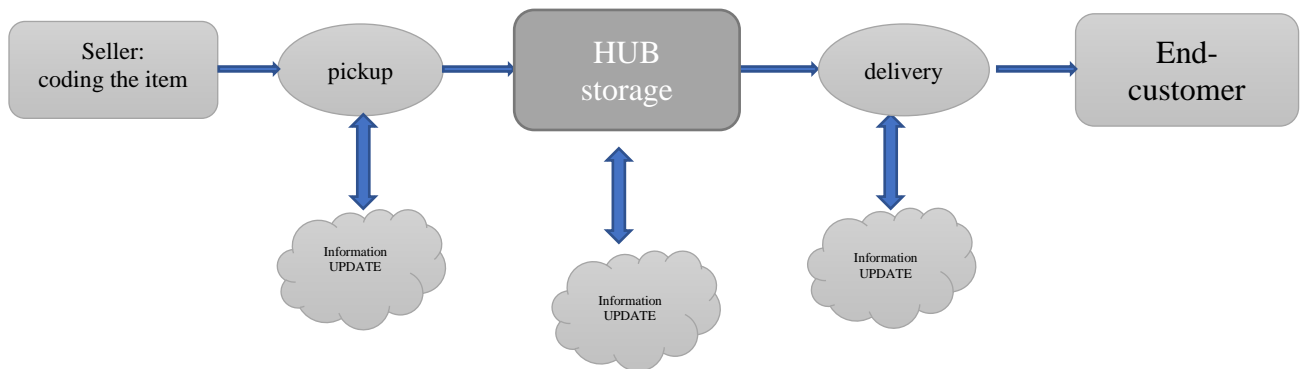
Figure III.5-6: Basic T&T Network Architecture

While the tracking process happens as the architecture that follows **(figure III.5-7)**:
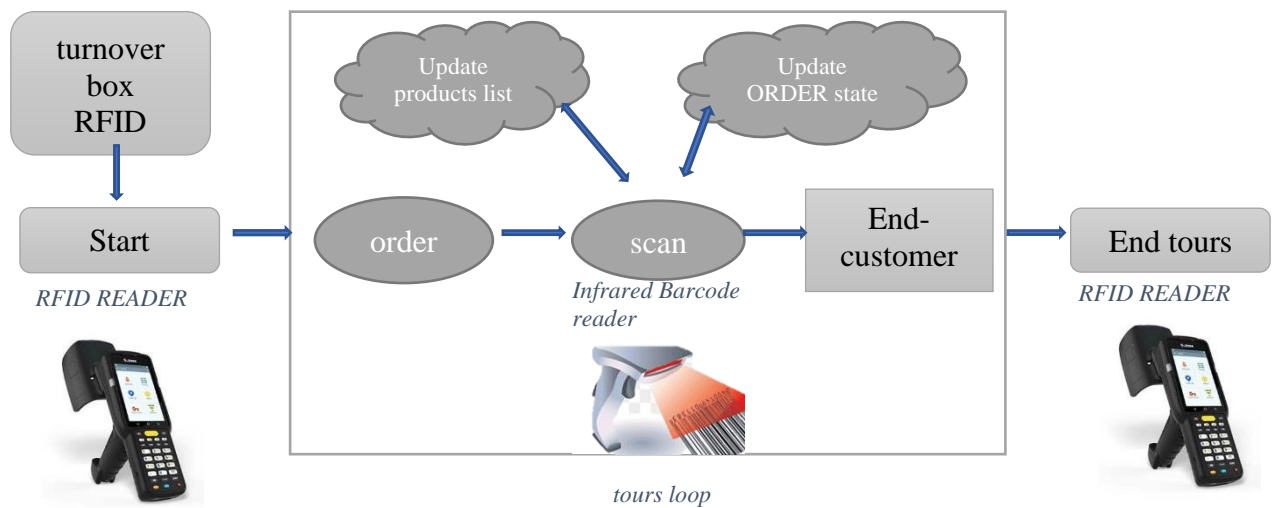
Figure III.5-7: T&T Process Architecture

Trace and track is based on two reading tools infrared code reader, and RFID scanner **(see previous figure III.5-7)**, the first one is for scanning the products to return a query of the full history of the tracked item such as name, designations, delivery information's, item price etc. After being introduced in the system, the item will be stored in a turnover box alongside with other items, and once the box is scanned by the already installed RFID antenna (in the vehicle, the hub), an update of the status of the products inside will be done automatically, when unloading any

item from the box the bar code of the item will be scanned and the item will be removed from the location box in the information system.

III.5.6. Trace and Track Software :

In order to ensure the best experience to the client, the visibility and transparency during the parchment are very important. A trace and track software in business activities, throughout the delivery process, aim is not only to maximize the efficiency of the delivery and the collection process, but also to allow the furls provide far better customer experience, giving the client the exact position, offering a more accurate estimated time of arrival, and even more, giving the client a full history of the parchment life cycle. Most of the tracking and tracing software are real time web-based systems, that users can access via internet from any device in a web browser **(figure III.5-8).**

Figure III.5-8: Tracking a purchase online

III.5.7. Trace and Track Devices :

There are various devices used in the tracking and tracing devices:

- Tracing: They record vibrations and socks during transportation, capture temperature and humidity.
- Tracking: localization devices that use the ground positioning system (GPS), for tracking the transported items.

Due to the type of products easy relay deals with, there is only the need to implement and use (GPS) in vehicles, with the installation of RFID antenna to identify the transported boxes, while each box is equipped with an RFID chips

III.5.8. Trace and Track Architecture :
The following figure III.5-9, visualizes the functionalities of working:
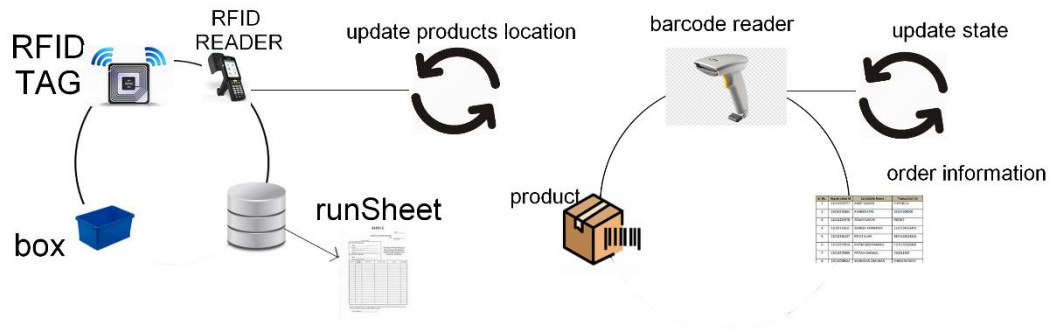
Figure III.5-9: T&T Integration Architecture

The hub and all the delivery vehicles are equipped with an RFID reader with full access to the database to fetch the runSheets, Once the box gets in or out one of the positions the RFID reader will fetch the Runsheet and update the state of all the products inside the box. When making the delivery the delivery agent uses the phone as the barcode reader, to get either the information of the product or to change its state when the delivery is done.

This section explained how the T&T technology can be integrated in the delivery process, and within the mobile application.

III.6.   Conclusion:

After seeing in this chapter step by step, going through data analysis first, the methodologies and theoretical solution to our problematic of zoning system's configuration, delivery tours planning and optimization using different IT tools, the added option to mobile's application in order to visualize the delivery tour's planning, and finally track and trace technologies we want to integrate and their implementation's architecture, now in the next chapter, we will see the practical side of this work, solutions of our problems, their integration and their interpretation.

Chapter Four:

Solution and interpretation

IV.1.   Introduction :

After that we have seen the methodology and tools used to solve our problems: of zoning, also of TSPTW for tours planning and finally the T&T technology implementation, now we move to practice. This chapter will be about the practical resolution of our problem, we will showcase the results of the previous work, while interpreting and explaining them.
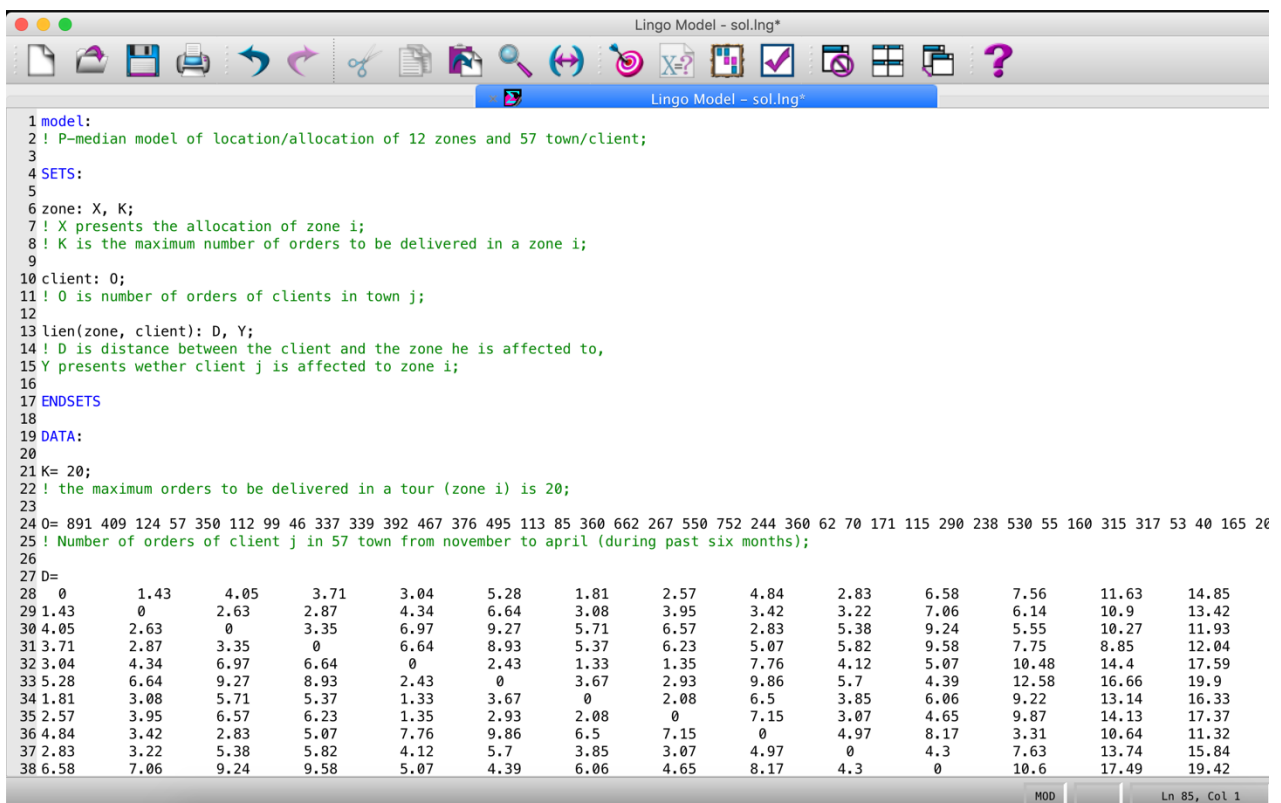
IV.2.   Section One : Zones division Configuration

Easy relay divided Algiers into twelve zones, each zone or as they call it sector, gathers many towns, while this concept of division is good for delivery and pick-up tours' organization, it is not well optimized. For this matter, we proposed a mathematical model for its optimization based on capacitated P-median problem solving.

IV.2.1. LINGO Model :

We interpreted our mathematical model in LINGO18.0, in order to obtain results of allocation of towns, also in order to know what are our zones (clusters).

The model in LINGO is as follows **(figure IV.2-5)**:


```
1 model:
2 ! P-median model of location/allocation of 12 zones and 57 town/client;
3
4 SETS:
5
6 zone: X, K;
7 ! X presents the allocation of zone i;
8 ! K is the maximum number of orders to be delivered in a zone i;
9
10 client: O;
11 ! O is number of orders of clients in town j;
12
13 lien(zone, client): D, Y;
14 ! D is distance between the client and the zone he is affected to,
15 Y presents wether client j is affected to zone i;
16
17 ENDSETS
18
19 DATA:
20
21 K= 20;
22 ! the maximum orders to be delivered in a tour (zone i) is 20;
23
24 O= 891 409 124 57 350 112 99 46 337 339 392 467 376 495 113 85 360 662 267 550 752 244 360 62 70 171 115 290 238 530 55 160 315 317 53 40 165 20
25 ! Number of orders of client j in 57 town from november to april (during past six months);
26
27 D=
28   0       1.43    4.05    3.71    3.04    5.28    1.81    2.57    4.84    2.83    6.58    7.56    11.63   14.85
29 1.43      0       2.63    2.87    4.34    6.64    3.08    3.95    3.42    3.22    7.06    6.14    10.9    13.42
30 4.05      2.63    0       3.35    6.97    9.27    5.71    6.57    2.83    5.38    9.24    5.55    10.27   11.93
31 3.71      2.87    3.35    0       6.64    8.93    5.37    6.23    5.07    5.82    9.58    7.75    8.85    12.04
32 3.04      4.34    6.97    6.64    0       2.43    1.33    1.35    7.76    4.12    5.07    10.48   14.4    17.59
33 5.28      6.64    9.27    8.93    2.43    0       3.67    2.93    9.86    5.7     4.39    12.58   16.66   19.9
34 1.81      3.08    5.71    5.37    1.33    3.67    0       2.08    6.5     3.85    6.06    9.22    13.14   16.33
35 2.57      3.95    6.57    6.23    1.35    2.93    2.08    0       7.15    3.07    4.65    9.87    14.13   17.37
36 4.84      3.42    2.83    5.07    7.76    9.86    6.5     7.15    0       4.97    8.17    3.31    10.64   11.32
37 2.83      3.22    5.38    5.82    4.12    5.7     3.85    3.07    4.97    0       4.3     7.63    13.74   15.84
38 6.58      7.06    9.24    9.58    5.07    4.39    6.06    4.65    8.17    4.3     0       10.6    17.49   19.42
```

```
39 7.56      6.14      5.55      7.75      10.48     12.58     9.22      9.87      3.31      7.63      10.6      0         10.81     9.57
40 11.63     10.9      10.27     8.85      14.4      16.66     13.14     14.13     10.64     13.74     17.49     10.81     0         7.48
41 14.85     13.42     11.93     12.04     17.59     19.9      16.33     17.37     11.32     15.84     19.42     9.57      7.48      0
42 14.28     13.5      12.94     11.51     17.01     19.37     15.8      16.8      14.24     16.41     20.15     14.43     5.06      10.69
43 9.62      8.27      6.75      6.8       12.36     14.91     11.09     12.13     7.7       11.02     14.93     7.99      4.06      7.94
44 6.35      5.53      4.89      3.47      9.02      11.33     8.02      8.86      6.75      8.47      12.22     8.05      5.45      10.49
45 6.94      5.52      4         4.51      9.86      12.16     8.6       9.46      3.83      7.63      11.46     4.69      7.69      8.73
46 8.66      7.36      5.96      5.78      11.34     13.65     10.07     11.17     7.04      10.23     14.15     7.57      5.18      8.85
47 16.88     16.09     15.54     14.25     19.68     22.08     18.55     19.39     17.06     19        22.85     17.23     8.35      12.49
48 14.15     13.36     12.81     11.52     17.04     19.28     15.78     16.83     14.67     16.37     20.04     15.21     6.13      12.09
49 4.9       5.19      6.99      7.89      6.02      7.59      5.78      4.96      5.1       2.28      3.62      7.54      15.54     16.35
50 8.12      8.04      9.69      10.74     8.76      9.93      8.88      7.72      7.27      5.59      5.74      9.42      17.8      18.23
51 11.18     12.06     14.27     14.56     9.31      8.64      10.3      8.89      13.4      9.37      5.24      15.84     22.48     24.41
52 9.66      10.52     12.75     13.03     6.92      5.72      8.12      7.37      11.88     7.96      3.71      14.31     20.96     22.88
53 10.83     9.4       8.36      8.5       13.74     15.84     12.48     13.13     6.55      10.89     14.59     4.6       7.78      5.43
54 3.21      1.85      2.37      3.5       6.19      8.23      4.93      5.52      1.92      3.03      6.86      4.64      11.53     12.5
55 4.37      3.75      5         6.45      7.34      8.9       6.15      6.27      2.87      3.31      5.52      5.19      13.19     13.88
56 12.85     11.96     11.41     10.19     15.18     17.49     13.92     15.03     13.36     14.78     18.53     13.92     5.05      11.67
57 17.85     17.2      16.65     15.55     20.58     23.29     19.25     20.43     18.5      20.18     24.16     19.32     10.51     17.12
58 7.35      6.38      5.42      4.47      10.03     12.33     8.76      9.89      7.13      9.48      13.22     8.1       5.3       9.82
59 8.43      8.9       10.87     11.42     9.04      8.43      9.18      8         9.79      5.93      4.03      12.22     19.33     20.91
60 17.75     16.54     15.02     14.88     20.4      22.74     19.13     20.18     14.38     18.54     22.74     14.42     6.39      7.42
61 19.85     18.43     17.84     19.08     22.84     24.87     21.51     22.16     15.41     19.92     22.49     12.87     17        11.58
62 23.08     22.47     21.92     24.13     25.68     26.97     24.87     24.63     19.66     21.95     22.64     16.91     23.07     18.41
63 22.09     20.66     20.07     21.94     25.01     27.1      23.74     24.39     17.81     21.52     23.29     15.06     19.87     14.19
64 20.85     19.43     17.91     18.05     23.6      25.93     22.33     23.37     17.33     21.49     25.25     15.56     12.68     6.93
65 25.91     25.26     24.75     23.61     28.58     30.88     27.31     28.42     26.57     28.17     31.92     27.39     18.57     25.19
66 22.26     21.62     21.06     19.96     24.93     27.24     23.66     24.78     22.92     24.52     28.27     23.74     14.93     21.54
67 24.83     24.18     23.63     22.57     27.49     29.8      26.23     27.34     25.48     27.09     30.84     26.3      17.49     24.11
68 27.72     27.08     26.52     25.42     30.38     32.69     29.15     30.23     28.41     29.97     33.72     29.22     20.38     27
69 22.31     21.51     20.97     19.68     25.1      27.29     23.72     24.82     22.82     24.42     28.17     23.4      14.48     20.78
70 29.26     28.47     27.92     26.63     31.93     34.24     30.79     31.77     29.77     31.38     35.13     30.35     21.43     27.73
71 14.66     15.13     17.08     17.64     13.48     12.81     14.47     13.06     15.76     12.15     9.4       18.01     25.57     26.71
72 18.65     18.95     19.9      20.95     19.42     19.77     19.4      18.24     18.13     16.03     15.43     19.68     28.07     27.93
73 24.05     23.62     25.26     26.33     24.87     25.71     24.99     23.83     22.76     21.44     21.35     24.91     33.29     31.47
74 28.08     27.65     29.29     30.36     29.2      30.49     28.96     28.14     26.63     25.46     26.15     25.18     34.36     29.87
75 19.61     19.18     20.82     21.89     20.73     22.02     20.49     19.67     18.17     17        17.68     16.31     25.89     21.4
76 18.32     17.89     19.53     20.6      19.44     20.63     19.2      18.38     17.03     15.95     16.23     16.93     27.02     23.9
                                                                                                               MOD            Ln 85, Col 1
77 12.96     13.48     15.17     15.96     13.58     13.96     13.72     12.53     12.7      10.46     9.62      14.84     23.23     23.66
78 13.29     12.86     14.5      15.56     14.41     15.7      14.17     13.35     12        10.67     11.36     12.85     22.53     20
79 9.52      9.18      10.34     11.84     10.64     11.96     10.4      9.58      7.6       6.9       7.64      8.49      18.04     17
80 8.76      8.15      9.13      10.81     11.72     13.3      10.55     10.67     6.18      7.71      9.47      5.91      16.18     14.33
81 20.09     19.48     19.11     21.31     23.05     23.98     21.87     21.63     16.84     19.04     19.64     14.1      23.18     18.69
82 13.2      12.58     13.44     15.24     16.16     17.73     14.98     15.1      10.61     12.14     13.31     8.75      19.02     15.9
83 15.51     14.23     13.64     15.85     18.47     20.05     17.3      17.42     11.38     14.46     16.14     8.63      17.24     12.75
84 12.52     11.1      10.51     12.71     15.46     17.53     14.18     14.83     8.24      12.42     14.57     5.5       12.53     8.03
85
86 ! Distance matrix 57x57 between 57 towns presented by clients j;
87
88 ENDDATA
89
90 min = @sum(lien(i, j): D(i, j)*Y(i, j));
91 ! the objective function;
92 s= min;
93
94 @for(lien(i, j): Y(i, j)<=X(i));
95 ! First constraint: explained previously;
96
97 @for(zone(i): @sum(client(j): O(j)*Y(i, j)) <= K(i)*X(i));
98 ! Second Constraint: explained previously;
99
100 @for(client(j): @sum(zone(i): Y(i, j))=1);
101 ! Third Constraint: explained previously;
102
103 @sum(zone(i): X(i))=12;
104 ! When Choosing the number of zones 12;
105
106 @for(zone(i): @bin(X(i)));
107 ! The variable needs to be binary;
108
109 @for(lien(i, j): @bin(Y(i, j)));
110 ! The variable needs to be binary;
111
112 END
                                                                                                               MOD            Ln 85, Col 1
```

Figure IV.2-1: Building the model in LINGO18.0 (Screenshots)

IV.2.2. Execution of the model:

After finishing the model, and verifying all the possible syntax mistakes, the execution of the results, using solver was as follows **(figure IV.2-2):**
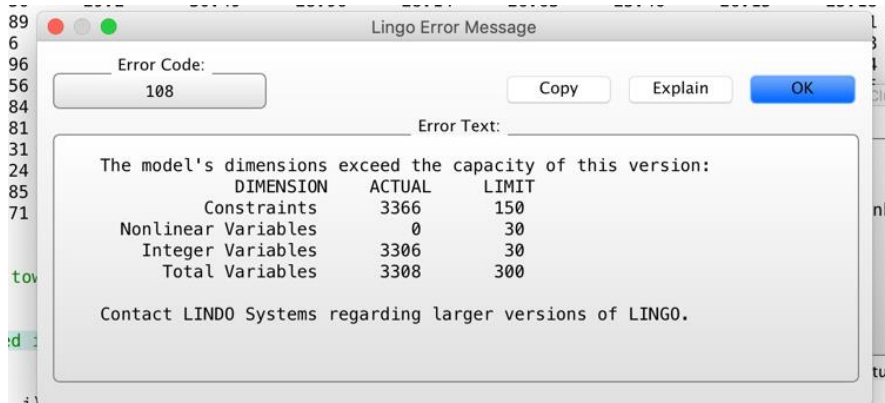
Figure IV.2-2: Model's execution

IV.2.3. Interpretation:

The model is: a Mixed integer linear problem MILP since the objective function and constraints are linear, and not all its variables are discrete.

The model could not be executed to give us results, because its dimensions exceeded the capacity of its version, we had:

- 3366 constraint while the limit was 150
- 3306 integer variable while the limit was 30
- 3308 total variables while the limit was 300

That was mostly due to our big matrix of distances between towns 57x57, we thought of dividing the problem into 3 models:

- One model for Algiers_Est
- One for Algiers_Center
- One for Algiers_West

But it stays, the same problem of exceeded dimensions, and if we divide those three models, into six other models, then the solution will have no meaning, we will not achieve our goal of a good optimization.

In order to obtain results, we need the extended version, since its integer variable limit is unlimited unlike the other versions **(figure IV.2-3).**

The limits for the various versions of LINGO are:

Version	Total Variables	Integer Variables	Nonlinear Variables	Global Variables	Constraints
Demo/Web	300	30	30	5	150
Solver Suite	500	50	50	5	250
Super	2,000	200	200	10	1,000
Hyper	8,000	800	800	20	4,000
Industrial	32,000	3,200	3,200	50	16,000
Extended	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited

Figure IV.2-3: Limits of LINGO versions

In this section, we have seen our P-median mathematical model built in LINGO Software specialized for operations research and optimization problems, unfortunately we could not obtain results due to the limited version that we have, also due to the dimension of our problem.

The next section we will see the application of planning tour's problem into a TSPTW using tools and algorithm explained previously in chapter three.

IV.3. Section Two: Tours' Planning and Vizualization:

In this section, we will be introducing our code for tour's planning optimization based on real roads distances, we will then showcase how the delivery man gets his delivery tour in the mobile application, and finally the traceability and tracking of packages.

IV.3.1. Tours Planning integration and Vizualization:

After planning delivery tours, this planning needs to be displayed in the mobile application that delivery man uses when doing his delivery tour. It happens as follows:
1) **Select orders:** In the main page the user has access to all orders assigned to him waiting for delivery, he will select orders he wants to deliver and only when selecting the minimal numbers of orders, the select validation button appear.

2) When validating the user will go to the next step **(figure IV.3-2).**
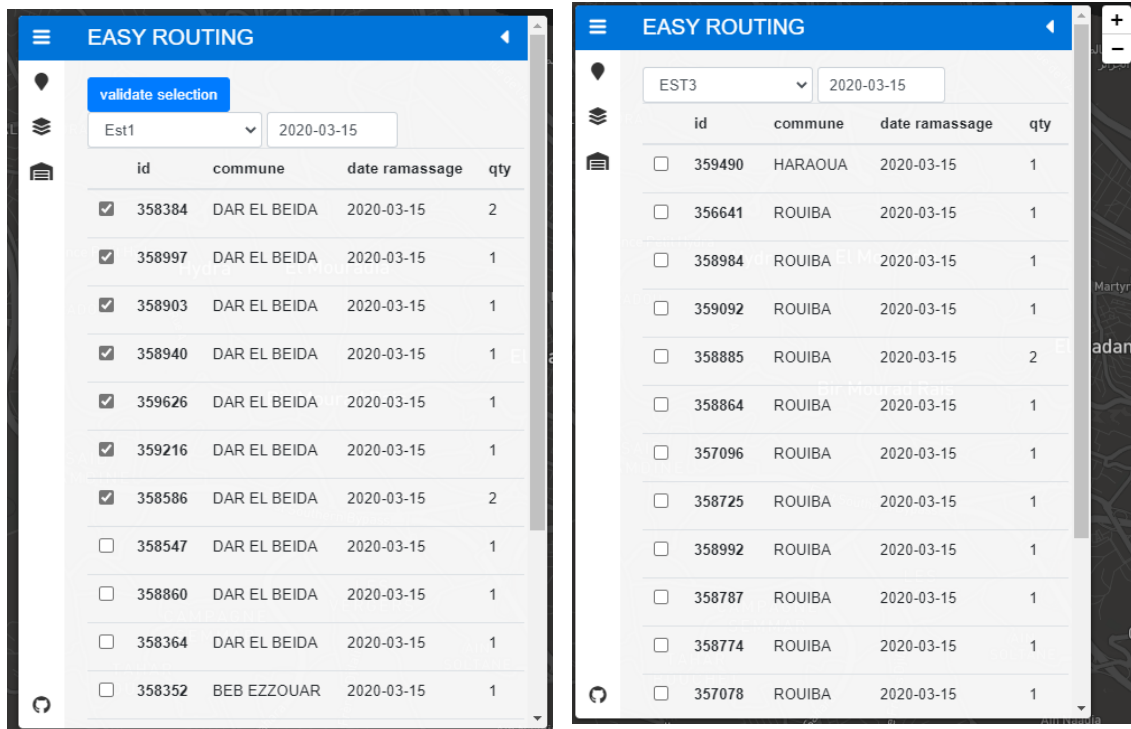
Figure IV.3-1: Checking and validating the packages to be delivered

3) Now the user have selected the list of orders to deliver, he is given access to input the interval of time of the availability of the clients, normally it is inserted in the database when the order has been confirmed , but due to the unpredictable changes of the availability of the clients, its confirmed before by a phone call to the client to validate.
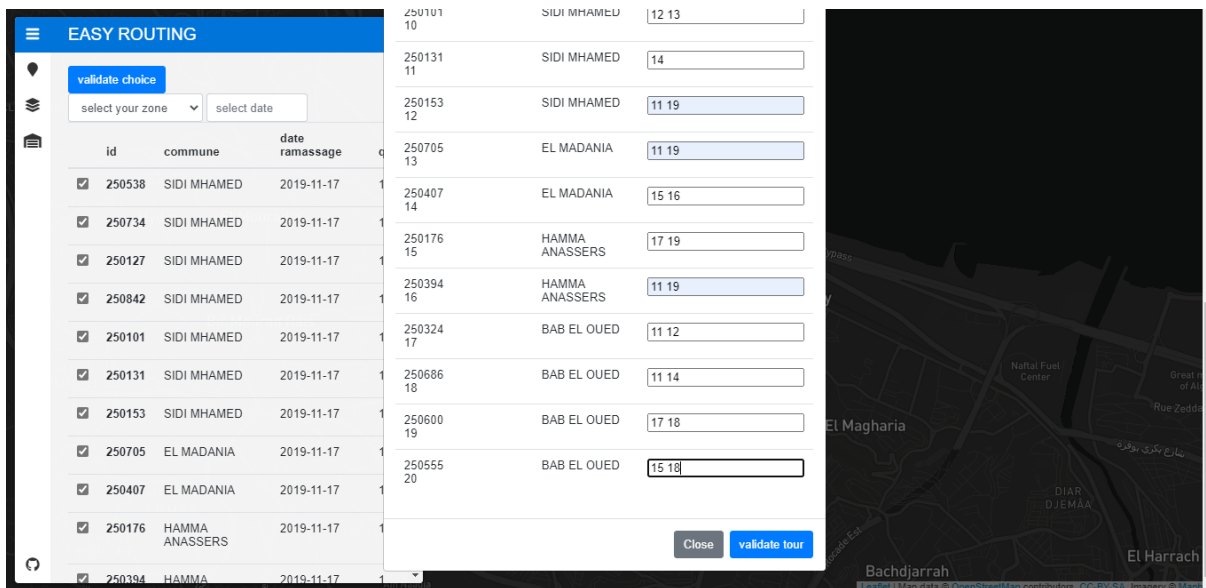
Figure IV.3-2: Inserting the timing of client's availability

64

4) Finally, when clicking on validating the tour, the user will be given the visualization of optimal result of tour's planning, to see the possibility of doing this tour, or reassign some jobs to others **(figure IV.3-4)**.
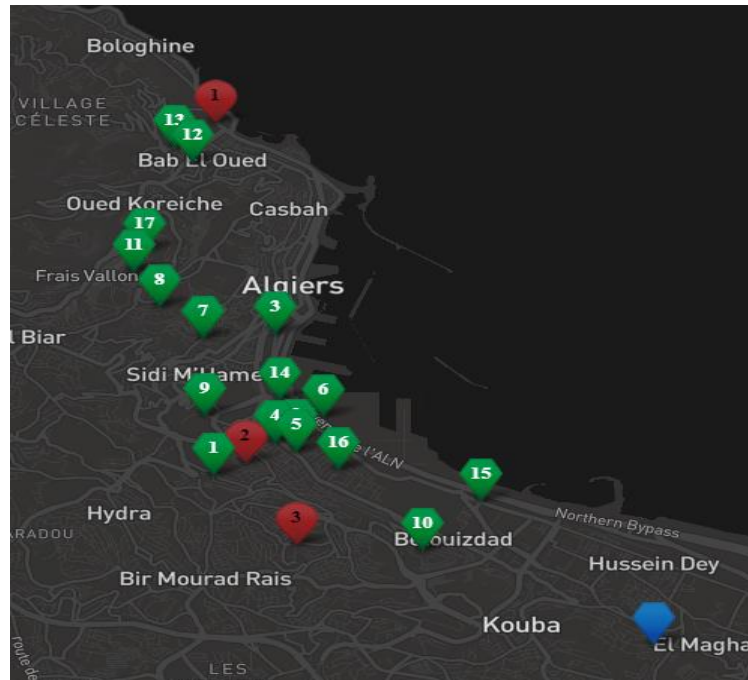
Figure IV.3-3: Visualized tour planning on mobile app

- Blue spot: Easy relay hub
- Green spots: feasible deliveries
- Red spots: impossible to delivery

Being bounded by the time window constraint, the delivery man must respect the time, so the modules will calculate the estimated arrival time and it is up to the delivery man to decide whether the delivery can be done or not, else it will be handled by another delivery man.

IV.3.2. Order's Visibility and traceability :

The user can view any order's information while for:

1) **Feasible Deliveries (in green):** when he clicks on any green spot, he will get to see the relative important information concerns the delivery and the package **(figure IV.3-5)**
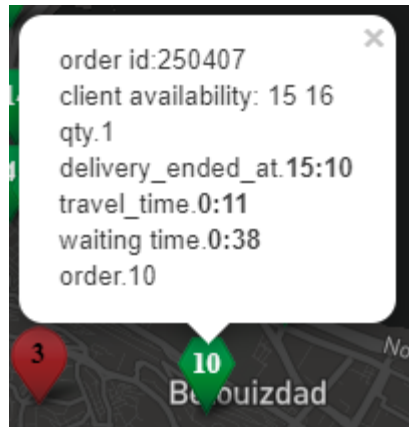
Figure IV.3-4: Feasible Delivery information

- Noting that the wasted time is due to the waiting time before the delivery

2) **Infeasible Deliveries (red spots):** The algorithm will calculate the estimated arrival time within the time window params and it will decide whether the order can be delivered or not, else it will be reassigned.
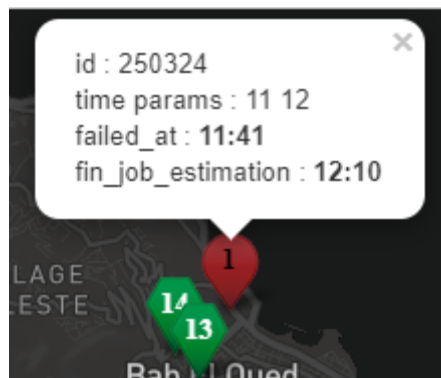
Figure IV.3-5: Infeasible delivery information

IV.4.   Conclusion:

This section was about generated solution of delivery tour's planning, its visualization and its interpretation while making traceability and tracking of the order possible.

GENERAL CONCLUSION:

The purpose of this study was to answer the company's need of developping its visibility and transparency of logistics while optimizing its delivery process.

In order to do so, we firstly treated the company's data related to delivey history, after that we presnted that data into analytical graphs, we chose Algiers as our focus of study since it presented 19% of total deliveries.

Based on that, we studied delivery process in algiers and we found out that the number of orders is not equivalent, not balanced between zones, which means unoptimized delivery tours and resources, so we suggested a configuration method to the system of zoning of Algiers. After that, we suggested delivery tour's planning and optimization integrated in delivery man's mobile application, as a tool to: facilitate the delivery process to the delivery man, and make the treacability and tracking possible when integrating T&T chosen technologies.

This study was based on six months data, between november 2019 and april 2020, we noticed that the given data was not very reliable when talking about timing precision and dates of operations, therefore we could not mesure key performance indicators based on time.

Due to the COVID-19 pandemic the lockdown and time, we could not persue physically our internship in the company, those conditions prevented us from digging deeper in the topic like making a study of returns, of costs, and of performance, and trying other solutions to obtain results of zoning.

At the end, this experience was enriching, we had the opportunity to work with a competitive team, learn about the black box of e-commerce logistics, apply our knowledge acquired during the past years, and learn from the different challenges that faced us.

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Annexes

Annex A: Algiers Towns' geographical locations, ID and code

commune_id	commune0	commune_name	wilaya_id	wilaya_name	nature	code	Latitude	longitude
554	1601	ALGER	16	ALGER	CHEF-LIEU-WILAYA	16	3.057561	36.768204
555	1602	SIDI MHAMED	16	ALGER	COMMUNE	16	3.055362	36.75862
556	1603	EL MADANIA	16	ALGER	COMMUNE	16	3.070128	36.741499
557	1604	HAMMA ANASSERS	16	ALGER	COMMUNE-COTIERE	16	3.074201	36.748849
558	1605	BAB EL OUED	16	ALGER	COMMUNE-COTIERE	16	3.052797	36.791276
559	1606	BOLOGHINE IBN ZIRI	16	ALGER	COMMUNE-COTIERE	16	3.037246	36.802765
560	1607	CASBAH	16	ALGER	COMMUNE-COTIERE	16	3.060581	36.784318
561	1608	OUED KORICHE	16	ALGER	COMMUNE	16	3.042759	36.784945
562	1609	BIR MOURAD RAIS	16	ALGER	COMMUNE	16	3.044486	36.733664
563	1610	EL BIAR	16	ALGER	COMMUNE	16	3.032346	36.76627
564	1611	BOUZAREAH	16	ALGER	COMMUNE	16	3.01278	36.786333
565	1612	BIR KHADEM	16	ALGER	COMMUNE	16	3.045695	36.714931
566	1613	EL HARRACH	16	ALGER	COMMUNE	16	3.139949	36.708265
567	1614	BARAKI	16	ALGER	COMMUNE	16	3.101522	36.666218
568	1615	OUED SMAR	16	ALGER	COMMUNE	16	3.174755	36.707639
569	1616	BOUROUBA	16	ALGER	COMMUNE	16	3.11717	36.714131
570	1617	HUSSEIN DEY	16	ALGER	COMMUNE-COTIERE	16	3.107808	36.739475
571	1618	KOUBA	16	ALGER	COMMUNE	16	3.078794	36.723921
572	1619	BACH DJERRAH	16	ALGER	COMMUNE	16	3.112233	36.722563
573	1620	DAR EL BEIDA	16	ALGER	COMMUNE	16	3.22343	36.700801
574	1621	BEB EZZOUAR	16	ALGER	COMMUNE	16	3.186633	36.720369
575	1622	BEN AKNOUN	16	ALGER	COMMUNE	16	3.011581	36.757474
576	1623	DELY BRAHIM	16	ALGER	COMMUNE	16	2.981306	36.754937
577	1624	BAINS ROMAINS	16	ALGER	COMMUNE-COTIERE	16	2.972831	36.804217
578	1625	RAIS HAMIDOU	16	ALGER	COMMUNE-COTIERE	16	3.012824	36.807762
579	1626	DJISR KSENTINA	16	ALGER	COMMUNE	16	3.07779	36.694915
580	1627	EL MOURADIA	16	ALGER	COMMUNE	16	3.049326	36.74875
581	1628	HYDRA	16	ALGER	COMMUNE	16	3.025041	36.743692
582	1629	MOHAMMADIA	16	ALGER	COMMUNE-COTIERE	16	3.156808	36.734011
583	1630	BORDJ EL KIFFAN	16	ALGER	COMMUNE-COTIERE	16	3.22638	36.752662
584	1631	EL MAGHARIA	16	ALGER	COMMUNE	16	3.110925	36.731153
585	1632	BENI MESSOUS	16	ALGER	COMMUNE	16	2.977787	36.781115
586	1633	LES EUCALYPTUS	16	ALGER	COMMUNE	16	3.164263	36.670155
587	1634	BIRTOUTA	16	ALGER	COMMUNE	16	3.02153	36.641887
588	1635	TASSALA EL MERDJA	16	ALGER	COMMUNE	16	2.927728	36.622315
589	1636	OULED CHEBEL	16	ALGER	COMMUNE	16	3.001516	36.612564
590	1637	SIDI MOUSSA	16	ALGER	COMMUNE	16	3.100929	36.616687
591	1638	AIN TAYA	16	ALGER	COMMUNE-COTIERE	16	3.288549	36.789185
592	1639	BORDJ EL BAHRI	16	ALGER	COMMUNE-COTIERE	16	3.251931	36.787836
593	1640	EL MARSA	16	ALGER	COMMUNE-COTIERE	16	3.24612	36.808447
594	1641	HARAOUA	16	ALGER	COMMUNE-COTIERE	16	3.314036	36.769641
595	1642	ROUIBA	16	ALGER	COMMUNE	16	3.282725	36.736702
596	1643	REGHAIA	16	ALGER	COMMUNE-COTIERE	16	3.351382	36.746829
597	1644	AIN BENIAN	16	ALGER	COMMUNE-COTIERE	16	2.929042	36.792938
598	1645	STAOUELI	16	ALGER	COMMUNE-COTIERE	16	2.874437	36.74236
599	1646	ZERALDA	16	ALGER	COMMUNE-COTIERE	16	2.840879	36.697121
600	1647	MAHELMA	16	ALGER	COMMUNE	16	2.862132	36.66504
601	1648	RAHMANIA	16	ALGER	COMMUNE	16	2.914042	36.68132
602	1649	SOUIDANIA	16	ALGER	COMMUNE	16	2.904404	36.710914
603	1650	CHERAGA	16	ALGER	COMMUNE-COTIERE	16	2.928525	36.763201
604	1651	OULED FAYET	16	ALGER	COMMUNE	16	2.941963	36.726103
605	1652	EL ACHOUR	16	ALGER	COMMUNE	16	2.984424	36.729111
606	1653	DRARIA	16	ALGER	COMMUNE	16	3.002098	36.714872
607	1654	DOUERA	16	ALGER	COMMUNE	16	2.935233	36.659017
608	1655	BABA HASSEN	16	ALGER	COMMUNE	16	2.972644	36.695477
609	1656	KHRAISSIA	16	ALGER	COMMUNE	16	2.996831	36.668496
610	1657	SAOULA	16	ALGER	COMMUNE	16	3.0343	36.683472

Annex B: Results of distances matrix between Algiers Communes

x	1655	1657	1626	1612	1642	1630	1611	1632	1614	1623	1618	1628	1609	1624
1655	0	8.29	12.64	8.75	31.57	27.48	13.31	12.44	15.9	8.4	12.9	8.83	10.61	16.23
1657	8.29	0	6.92	5.5	25.45	21.36	14.57	15.58	8.03	11.22	9.65	9.19	8.24	19.81
1626	12.64	6.92	0	4.6	19.93	15.84	14.59	16.09	5.43	13.32	5.07	9.05	6.55	19.7
1612	8.75	5.5	4.6	0	23.4	19.32	10.6	12.22	9.57	9.42	4.69	5.19	3.31	15.84
1642	31.57	25.45	19.93	23.4	0	7.58	28.17	30.02	20.78	29.53	19.79	24.99	22.82	33.33
1630	27.48	21.36	15.84	19.32	7.58	0	24.16	25.7	17.12	25.01	15.68	20.74	18.5	28.84
1611	13.31	14.57	14.59	10.6	28.17	24.16	0	4.03	19.42	5.74	11.46	5.52	8.17	5.24
1632	12.44	15.58	16.09	12.22	30.02	25.7	4.03	0	20.91	4.53	13.1	7.14	9.79	6.28
1614	15.9	8.03	5.43	9.57	20.78	17.12	19.42	20.91	0	18.23	8.73	13.88	11.32	24.41
1623	8.4	11.22	13.32	9.42	29.53	25.01	5.74	4.53	18.23	0	10.97	5.11	7.27	10.04
1618	12.9	9.65	5.07	4.69	19.79	15.68	11.46	13.1	8.73	10.97	0	6.38	3.83	16.55
1628	8.83	9.19	9.05	5.19	24.99	20.74	5.52	7.14	13.88	5.11	6.38	0	2.87	10.75
1609	10.61	8.24	6.55	3.31	22.82	18.5	8.17	9.79	11.32	7.27	3.83	2.87	0	13.4
1624	16.23	19.81	19.7	15.84	33.33	28.84	5.24	6.28	24.41	10.04	16.55	10.75	13.4	0
1625	17.02	18.28	18.28	14.31	31.64	27.32	3.71	7.5	22.88	9.3	15.03	9.23	11.88	5.65
1605	16.16	15.46	13.74	10.48	25.1	20.58	5.07	9.04	17.59	8.76	9.86	7.34	7.76	9.31
1650	10.37	16.6	18.71	14.84	34.55	30.24	9.62	5.94	23.66	5.46	16.4	10.55	12.7	9.18
1610	12.14	12.42	10.89	7.63	24.42	20.18	4.3	5.93	15.84	5.59	7.63	3.31	4.97	9.37
1620	25.5	18.51	14.11	17.23	8.51	7.36	22.85	24.6	12.49	23.93	14.06	19.57	17.06	27.74
1601	13.2	12.52	10.83	7.56	22.31	17.85	6.58	8.43	14.85	8.12	6.94	4.37	4.84	11.18
1651	5.11	12.4	16.75	12.85	34.16	29.83	11.36	9.34	20	6.23	15.69	9.61	12	13.06
1649	9.01	16.47	20.65	16.93	39.18	34.86	16.23	12.55	23.9	10.94	20.73	14.67	17.03	16.34
1654	7.24	11.08	17.57	14.1	36.1	32.02	19.64	18.39	18.69	14.51	18.24	15.72	16.84	22.22
1648	8.13	13.79	20.2	16.31	39.12	34.73	17.68	15.61	21.4	12.55	20.45	15.94	18.17	19.39
1656	4.96	5.14	11.63	8.63	30.16	26.08	16.14	16.72	12.75	12.24	12.78	11.15	11.38	21.04
1634	12.93	8.92	11.48	12.87	30.01	25.93	22.49	24.11	11.58	20.09	15.65	17.07	15.41	27.72
1635	10.24	13.42	17.29	16.91	35.82	31.74	22.64	21.48	18.41	17.5	21.06	18.72	19.66	25.27
1636	12.14	11.56	14.35	15.06	32.88	28.82	23.29	23.77	14.19	19.3	18.52	18.2	17.81	28.43
1621	23.37	17.25	11.9	15.21	9.26	6.51	20.04	21.87	12.09	21.42	11.57	16.99	14.67	25.01
1615	22.57	16.08	11.11	14.43	11.5	8.6	20.15	22.1	10.69	21.41	10.77	16.79	14.24	25.17
1619	15.78	11.44	5.92	7.57	16.85	12.75	14.15	15.8	8.85	14.18	3.69	9.59	7.04	19.12
1616	16.03	10.52	5	7.99	15.71	11.62	14.93	16.58	7.94	14.84	4.18	10.25	7.7	19.92
1641	37.36	31.24	25.72	29.22	6.94	10.51	33.72	35.57	27	34.88	25.56	30.54	28.41	38.71
1643	38.52	32.4	26.88	30.35	7.01	14.35	35.13	36.97	27.73	36.29	26.72	31.94	29.77	40.11
1640	34.47	28.35	22.84	26.3	11.12	7.64	30.84	32.68	24.11	31.99	22.7	27.65	25.48	36.03
1638	35.55	29.44	23.92	27.39	6.03	8.71	31.92	33.77	25.19	33.07	23.75	28.74	26.57	36.98
1639	31.95	25.79	20.27	23.74	8.6	5.07	28.27	30.12	21.54	29.49	20.11	25.27	22.92	33.26
1608	15.1	14.83	13.13	9.87	24.82	20.43	4.65	8	17.37	7.72	9.46	6.27	7.15	8.89
1613	19.02	12.53	7.78	10.81	14.48	10.51	17.49	19.33	7.48	17.8	7.69	13.19	10.64	22.48
1633	22.63	14.89	11.26	14.42	17.71	14.85	22.74	23.92	7.42	21.41	11.94	16.93	14.38	27.46
1637	18.79	12.79	11.43	15.56	25.85	22.99	25.25	26.87	6.93	24.01	14.73	19.88	17.33	30.41
1622	10.3	11.48	11.4	7.54	26.47	22.36	3.62	5.24	16.35	3.31	8.75	2.52	5.1	8.86
1652	7.39	9.51	12.35	8.49	30.33	26.02	7.64	7.92	17	3.39	11.21	5.43	7.6	12.86
1653	4.48	6.3	9.81	5.91	28.73	24.6	9.47	10.05	14.33	5.59	9.54	4.4	6.18	14.71
1617	16.27	13.07	7.12	8.05	16.27	12.08	12.22	14.06	10.49	13.37	4.07	9.06	6.75	17.21
1631	16.31	12.55	6.53	8.1	16.49	12.3	13.22	15.06	9.82	14.13	4.01	9.45	7.13	18.21
1627	11.74	9.6	7.91	4.64	22.33	18.01	6.86	8.5	12.5	7.32	4.65	2.91	1.92	11.95
1604	15.24	12.71	8.5	7.75	19.68	15.55	9.58	11.42	12.04	10.74	4.51	6.45	5.07	14.56
1603	13.44	10.51	8.36	5.55	20.97	16.65	9.24	10.87	11.93	9.69	4	5	2.83	14.27
1607	14.98	14.18	12.48	9.22	23.72	19.25	6.06	9.18	16.33	8.88	8.6	6.15	6.5	10.3
1602	12.58	11.1	9.4	6.14	21.51	17.2	7.06	8.9	13.42	8.04	5.52	3.75	3.42	12.06
1606	17.73	17.53	15.84	12.58	27.29	23.29	4.39	8.43	19.9	9.93	12.16	8.9	9.86	8.64
1644	14.69	19.67	21.76	18.01	36.27	31.93	9.4	7.62	26.71	8.51	19.31	13.35	15.76	4.41
1645	13.04	20.32	23.54	19.68	39.81	35.21	15.43	11.74	27.93	10.9	21.23	15.15	18.13	13.17
1646	17.79	23.87	29.1	24.91	44.91	40.62	21.35	17.66	31.47	16.47	26.46	20.38	22.76	20.3
1647	16.38	22.26	28.75	25.18	47.29	43.2	26.15	23.74	29.87	21.02	29.42	24.4	26.63	26.43
1629	22.05	15.91	10.39	13.92	10.39	6.13	18.53	20.37	11.67	19.69	10.23	15.35	13.36	23.52

1625	1605	1650	1610	1620	1601	1651	1649	1654	1648	1656	1634	1635	1636	1621
17.02	16.16	10.37	12.14	25.5	13.2	5.11	9.01	7.24	8.13	4.96	12.93	10.24	12.14	23.37
18.28	15.46	16.6	12.42	18.51	12.52	12.4	16.47	11.08	13.79	5.14	8.92	13.42	11.56	17.25
18.28	13.74	18.71	10.89	14.11	10.83	16.75	20.65	17.57	20.2	11.63	11.48	17.29	14.35	11.9
14.31	10.48	14.84	7.63	17.23	7.56	12.85	16.93	14.1	16.31	8.63	12.87	16.91	15.06	15.21
31.64	25.1	34.55	24.42	8.51	22.31	34.16	39.18	36.1	39.12	30.16	30.01	35.82	32.88	9.26
27.32	20.58	30.24	20.18	7.36	17.85	29.83	34.86	32.02	34.73	26.08	25.93	31.74	28.82	6.51
3.71	5.07	9.62	4.3	22.85	6.58	11.36	16.23	19.64	17.68	16.14	22.49	22.64	23.29	20.04
7.5	9.04	5.94	5.93	24.6	8.43	9.34	12.55	18.39	15.61	16.72	24.11	21.48	23.77	21.87
22.88	17.59	23.66	15.84	12.49	14.85	20	23.9	18.69	21.4	12.75	11.58	18.41	14.19	12.09
9.3	8.76	5.46	5.59	23.93	8.12	6.23	10.94	14.51	12.55	12.24	20.09	17.5	19.3	21.42
15.03	9.86	16.4	7.63	14.06	6.94	15.69	20.73	18.24	20.45	12.78	15.65	21.06	18.52	11.57
9.23	7.34	10.55	3.31	19.57	4.37	9.61	14.67	15.72	15.94	11.15	17.07	18.72	18.2	16.99
11.88	7.76	12.7	4.97	17.06	4.84	12	17.03	16.84	18.17	11.38	15.41	19.66	17.81	14.67
5.65	9.31	9.18	9.37	27.74	11.18	13.06	16.34	22.22	19.39	21.04	27.72	25.27	28.43	25.01
0	6.92	12.94	7.96	26.22	9.66	15.08	19.58	23.35	21.39	19.85	26.2	26.35	26.9	23.74
6.92	0	13.58	4.12	19.68	3.04	14.41	19.44	23.05	20.73	18.47	22.84	25.68	25.01	17.04
12.94	13.58	0	10.46	29.38	12.96	6.23	8.67	16	13.53	15.03	23.01	19.18	22.22	26.4
7.96	4.12	10.46	0	19	2.83	10.67	15.95	19.04	17	14.46	19.92	21.95	21.52	16.37
26.22	19.68	29.38	19	0	16.88	29.03	33.45	28.74	31.45	22.81	22.74	28.47	25.61	3.35
9.66	3.04	12.96	2.83	16.88	0	13.29	18.32	20.09	19.61	15.51	19.85	23.08	22.09	14.15
15.08	14.41	6.23	10.67	29.03	13.29	0	7.05	11.06	9.05	9.92	17.89	14.14	17.1	26
19.58	19.44	8.67	15.95	33.45	18.32	7.05	0	10.81	6.63	13.12	20.29	13.81	19.5	31.03
23.35	23.05	16	19.04	28.74	20.09	11.06	10.81	0	7.81	7.74	14.29	3.25	12.19	27.91
21.39	20.73	13.53	17	31.45	19.61	9.05	6.63	7.81	0	10.45	17.29	9	16.5	30.62
19.85	18.47	15.03	14.46	22.81	15.51	9.92	13.12	7.74	10.45	0	8.98	10.08	8.18	22.2
26.2	22.84	23.01	19.92	22.74	19.85	17.89	20.29	14.29	17.29	8.98	0	11.67	5.14	21.82
26.35	25.68	19.18	21.95	28.47	23.08	14.14	13.81	3.25	9	10.08	11.67	0	9.29	27.63
26.9	25.01	22.22	21.52	25.61	22.09	17.1	19.5	12.19	16.5	8.18	5.14	9.29	0	24.68
23.74	17.04	26.4	16.37	3.35	14.15	26	31.03	27.91	30.62	22.2	21.82	27.63	24.68	0
23.72	17.01	26.53	16.41	4.44	14.28	26.12	30.58	26.73	29.44	20.8	20.94	26.46	23.81	2.55
17.6	11.34	19.61	10.23	11.13	8.66	18.9	23.94	21.12	23.33	15.66	16	21.98	18.87	8.64
18.39	12.36	20.27	11.02	10	9.62	19.57	24.03	21.37	23.58	15.24	15.08	21.07	17.95	7.51
37.16	30.38	40.17	29.97	15.31	27.72	39.77	44.73	41.97	44.6	35.95	35.8	41.61	38.67	16.04
38.59	31.93	41.51	31.38	15.44	29.26	41.1	46.23	43.22	45.76	37.11	36.96	42.94	39.83	16.18
34.35	27.49	37.52	27.09	14.15	24.83	37.01	41.84	39	41.71	33.07	32.91	38.72	35.78	13.55
35.36	28.58	38.5	28.17	14.4	25.91	38.09	42.93	40.09	42.8	34.15	34	39.81	37.04	14.58
31.94	24.93	34.65	24.52	11.58	22.26	34.24	39.28	36.44	39.46	30.5	30.35	36.16	33.22	10.94
7.37	1.35	12.53	3.07	19.39	2.57	13.35	18.38	21.63	19.67	17.42	22.16	24.63	24.39	16.83
20.96	14.4	23.23	13.74	8.35	11.63	22.53	27.02	23.18	25.89	17.24	17	23.07	19.87	6.13
25.94	20.4	26.84	18.54	9.42	17.75	26.14	30.63	25.54	28.25	19.11	16.33	23.76	18.94	8.8
28.89	23.6	28.87	21.49	17.56	20.85	23.75	26	21.68	23.95	14.72	11.48	19.68	14.09	17.16
7.33	6.02	8.75	2.28	21.15	4.9	8.39	13.42	16.67	14.71	13.13	19.42	19.67	20.19	18.34
11.34	10.64	8.78	6.9	24.46	9.52	7.1	12.14	14.28	13.43	10.29	18.07	17.28	17.27	22.18
13.18	11.72	10.96	7.71	22.61	8.76	12.47	11.37	12.03	6.88	14.73	14.36	13.94	20.58	
15.68	9.02	18.6	8.47	10.84	6.35	18.19	23.22	21.61	23.82	16.15	17.63	23.44	20.5	8.07
16.69	10.03	19.56	9.48	11.06	7.35	18.94	23.97	21.66	23.87	16.2	16.96	22.95	19.83	8.29
10.43	6.19	12.75	3.03	16.9	3.21	12.13	17.16	18.2	18.45	12.74	16.93	21.02	19.17	14.17
13.03	6.64	15.96	5.82	14.25	3.71	15.56	20.6	21.31	21.89	15.85	19.08	24.13	21.94	11.52
12.75	6.97	15.17	5.38	15.54	4.05	14.5	19.53	19.11	20.82	13.64	17.84	21.92	20.07	12.81
8.12	1.33	13.72	3.85	18.55	1.81	14.17	19.2	21.87	20.49	17.3	21.51	24.87	23.74	15.78
10.52	4.34	13.48	3.22	16.09	1.43	12.86	17.89	19.48	19.18	14.23	18.43	22.47	20.66	13.36
5.72	2.43	13.96	5.7	22.08	5.28	15.7	20.63	23.98	22.02	20.05	24.87	26.97	27.1	19.28
9.59	13.48	6.8	12.15	30.83	14.66	11.52	10.64	14.63	20.64	17.86	19.54	27.48	23.74	26.68	28.09
18.66	19.42	7.21	16.03	34.11	18.65	9.04	8.8	18.57	13.37	17.84	25.81	19.99	25.06	31.38
24.66	24.87	13.12	21.44	39.49	24.05	14.22	11.17	16.61	10.07	20.52	27.37	15.74	25.02	36.93
29.86	29.2	19.2	25.46	39.92	28.08	17.52	13.25	15.3	8.47	18.92	25.76	14.13	23.42	39.09
22	15.18	24.91	14.78	4.97	12.85	24.5	29.53	26.56	29.27	20.63	20.47	26.29	23.34	2.24

1615	1619	1616	1641	1643	1640	1638	1639	1608	1613	1633	1637	1622	1652
22.57	15.78	16.03	37.36	38.52	34.47	35.55	31.95	15.1	19.02	22.63	18.79	10.3	7.39
16.08	11.44	10.52	31.24	32.4	28.35	29.44	25.79	14.83	12.53	14.89	12.79	11.48	9.51
11.11	5.92	5	25.72	26.88	22.84	23.92	20.27	13.13	7.78	11.26	11.43	11.4	12.35
14.43	7.57	7.99	29.22	30.35	26.3	27.39	23.74	9.87	10.81	14.42	15.56	7.54	8.49
11.5	16.85	15.71	6.94	7.01	11.12	6.03	8.6	24.82	14.48	17.71	25.85	26.47	30.33
8.6	12.75	11.62	10.51	14.35	7.64	8.71	5.07	20.43	10.51	14.85	22.99	22.36	26.02
20.15	14.15	14.93	33.72	35.13	30.84	31.92	28.27	4.65	17.49	22.74	25.25	3.62	7.64
22.1	15.8	16.58	35.57	36.97	32.68	33.77	30.12	8	19.33	23.92	26.87	5.24	7.92
10.69	8.85	7.94	27	27.73	24.11	25.19	21.54	17.37	7.48	7.42	6.93	16.35	17
21.41	14.18	14.84	34.88	36.29	31.99	33.07	29.49	7.72	17.8	21.41	24.01	3.31	3.39
10.77	3.69	4.18	25.56	26.72	22.7	23.75	20.11	9.46	7.69	11.94	14.73	8.75	11.21
16.79	9.59	10.25	30.54	31.94	27.65	28.74	25.27	6.27	13.19	16.93	19.88	2.52	5.43
14.24	7.04	7.7	28.41	29.77	25.48	26.57	22.92	7.15	10.64	14.38	17.33	5.1	7.6
25.17	19.12	19.92	38.71	40.11	36.03	36.98	33.26	8.89	22.48	27.46	30.41	8.86	12.86
23.72	17.6	18.39	37.16	38.59	34.35	35.36	31.94	7.37	20.96	25.94	28.89	7.33	11.34
17.01	11.34	12.36	30.38	31.93	27.49	28.58	24.93	1.35	14.4	20.4	23.6	6.02	10.64
26.53	19.61	20.27	40.17	41.51	37.52	38.5	34.65	12.53	23.23	26.84	28.87	8.75	8.78
16.41	10.23	11.02	29.97	31.38	27.09	28.17	24.52	3.07	13.74	18.54	21.49	2.28	6.9
4.44	11.13	10	15.31	15.44	14.15	14.4	11.58	19.39	8.35	9.42	17.56	21.15	24.46
14.28	8.66	9.62	27.72	29.26	24.83	25.91	22.26	2.57	11.63	17.75	20.85	4.9	9.52
26.12	18.9	19.57	39.77	41.1	37.01	38.09	34.24	13.35	22.53	26.14	23.75	8.39	7.1
30.58	23.94	24.03	44.73	46.23	41.84	42.93	39.28	18.38	27.02	30.63	26	13.42	12.14
26.73	21.12	21.37	41.97	43.22	39	40.09	36.44	21.63	23.18	25.54	21.68	16.67	14.28
29.44	23.33	23.58	44.6	45.76	41.71	42.8	39.46	19.67	25.89	28.25	23.95	14.71	13.43
20.8	15.66	15.24	35.95	37.11	33.07	34.15	30.5	17.42	17.24	19.11	14.72	13.13	10.29
20.94	16	15.08	35.8	36.96	32.91	34	30.35	22.16	17	16.33	11.48	19.42	18.07
26.46	21.98	21.07	41.61	42.94	38.72	39.81	36.16	24.63	23.07	23.76	19.68	19.67	17.28
23.81	18.87	17.95	38.67	39.83	35.78	37.04	33.22	24.39	19.87	18.94	14.09	20.19	17.27
2.55	8.64	7.51	16.04	16.18	13.55	14.58	10.94	16.83	6.13	8.8	17.16	18.34	22.18
0	7.84	6.72	18.31	18.44	15.59	16.68	13.03	16.8	5.06	7.4	15.76	18.44	21.67
7.84	0	2.06	22.63	23.8	19.74	20.82	17.17	11.17	5.18	10.7	14.86	11.76	14.43
6.72	2.06	0	21.5	22.67	18.62	19.7	16.05	12.13	4.06	9.35	13.94	12.55	15.15
18.31	22.63	21.5	0	4.68	9.27	4.18	7.77	30.23	20.38	24.53	32.67	32.02	36.07
18.44	23.8	22.67	4.68	0	13.68	8.59	11.69	31.77	21.43	24.63	32.8	33.42	37.29
15.59	19.74	18.62	9.27	13.68	0	5.2	2.8	27.34	17.49	21.85	29.98	29.32	33
16.68	20.82	19.7	4.18	8.59	5.2	0	4.27	28.42	18.57	22.92	31.06	30.22	34.08
13.03	17.17	16.05	7.77	11.69	2.8	4.27	0	24.78	14.93	19.28	27.41	26.57	30.63
16.8	11.17	12.13	30.23	31.77	27.34	28.42	24.78	0	14.13	20.18	23.37	4.96	9.58
5.06	5.18	4.06	20.38	21.43	17.49	18.57	14.93	14.13	0	6.39	12.68	15.54	18.04
7.4	10.7	9.35	24.53	24.63	21.85	22.92	19.28	20.18	6.39	0	8.48	19.24	22.03
15.76	14.86	13.94	32.67	32.8	29.98	31.06	27.41	23.37	12.68	8.48	0	22.18	22.3
18.44	11.76	12.55	32.02	33.42	29.32	30.22	26.57	4.96	15.54	19.24	22.18	0	4.62
21.67	14.43	15.15	36.07	37.29	33	34.08	30.63	9.58	18.04	22.03	22.3	4.62	0
19.74	12.75	13.19	34.3	35.68	31.41	32.49	28.91	10.67	16.18	19.97	19.09	6.46	3.55
8.04	2.64	4.39	21.95	23.22	19.06	20.14	16.49	8.86	5.45	11.41	16.49	10.52	14.21
7.95	1.65	3.4	22.18	23.44	19.28	20.37	16.73	9.89	5.3	11.25	15.82	11.27	14.52
14.19	7.29	8.08	27.87	29.28	24.98	26.07	22.42	5.52	11.53	15.56	18.5	4.46	8.34
11.51	5.78	6.8	25.42	26.63	22.57	23.61	19.96	6.23	8.85	14.88	18.05	7.89	11.84
12.94	5.96	6.75	26.52	27.92	23.63	24.75	21.06	6.57	10.27	15.02	17.91	6.99	10.34
15.8	10.07	11.09	29.15	30.79	26.23	27.31	23.66	2.08	13.14	19.13	22.33	5.78	10.4
13.5	7.36	8.27	27.08	28.47	24.18	25.26	21.62	3.95	10.9	16.54	19.43	5.19	9.18
19.37	13.65	14.91	32.69	34.24	29.8	30.88	27.24	2.93	16.66	22.74	25.93	7.59	11.96
28.22	22.01	22.79	42	43.4	38.91	40.29	36.34	13.06	25.57	29.89	32.46	11.36	11.83
31.5	24.44	25.11	45.08	46.58	42.19	43.28	39.94	18.24	28.07	31.67	30.99	13.75	13.1
36.88	29.67	30.33	50.76	52.11	47.58	48.66	45.01	23.83	33.29	36.9	34.46	19.16	18.32
37.91	31.8	32.05	53.07	54.23	50.18	51.27	47.62	28.14	34.36	36.72	32.42	23.18	21.9
3.45	7.3	6.17	16	17.34	13.13	14.2	10.56	15.03	5.05	9.71	17.54	16.83	20.69

1653	1617	1631	1627	1604	1603	1607	1602	1606	1644	1645	1646	1647	1629
4.48	16.27	16.31	11.74	15.24	13.44	14.98	12.58	17.73	14.69	13.04	17.79	16.38	22.05
6.3	13.07	12.55	9.6	12.71	10.51	14.18	11.1	17.53	19.67	20.32	23.87	22.26	15.91
9.81	7.12	6.53	7.91	8.5	8.36	12.48	9.4	15.84	21.76	23.54	29.1	28.75	10.39
5.91	8.05	8.1	4.64	7.75	5.55	9.22	6.14	12.58	18.01	19.68	24.91	25.18	13.92
28.73	16.27	16.49	22.33	19.68	20.97	23.72	21.51	27.29	36.27	39.81	44.91	47.29	10.39
24.6	12.08	12.3	18.01	15.55	16.65	19.25	17.2	23.29	31.93	35.21	40.62	43.2	6.13
9.47	12.22	13.22	6.86	9.58	9.24	6.06	7.06	4.39	9.4	15.43	21.35	26.15	18.53
10.05	14.06	15.06	8.5	11.42	10.87	9.18	8.9	8.43	7.62	11.74	17.66	23.74	20.37
14.33	10.49	9.82	12.5	12.04	11.93	16.33	13.42	19.9	26.71	27.93	31.47	29.87	11.67
5.59	13.37	14.13	7.32	10.74	9.69	8.88	8.04	9.93	8.51	10.9	16.47	21.02	19.69
9.54	4.07	4.01	4.65	4.51	4	8.6	5.52	12.16	19.31	21.23	26.46	29.42	10.23
4.4	9.06	9.45	2.91	6.45	5	6.15	3.75	8.9	13.35	15.15	20.38	24.4	15.35
6.18	6.75	7.13	1.92	5.07	2.83	6.5	3.42	9.86	15.76	18.13	22.76	26.63	13.36
14.71	17.21	18.21	11.95	14.56	14.27	10.3	12.06	8.64	4.41	13.17	20.3	26.43	23.52
13.18	15.68	16.69	10.43	13.03	12.75	8.12	10.52	5.72	9.59	18.66	24.66	29.86	22
11.72	9.02	10.03	6.19	6.64	6.97	1.33	4.34	2.43	13.48	19.42	24.87	29.2	15.18
10.96	18.6	19.56	12.75	15.96	15.17	13.72	13.48	13.96	6.8	7.21	13.12	19.2	24.91
7.71	8.47	9.48	3.03	5.82	5.38	3.85	3.22	5.7	12.15	16.03	21.44	25.46	14.78
22.61	10.84	11.06	16.9	14.25	15.54	18.55	16.09	22.08	30.83	34.11	39.49	39.92	4.97
8.76	6.35	7.35	3.21	3.71	4.05	1.81	1.43	5.28	14.66	18.65	24.05	28.08	12.85
8.75	18.19	18.94	12.13	15.56	14.5	14.17	12.86	15.7	11.52	9.04	14.22	17.52	24.5
12.47	23.22	23.97	17.16	20.6	19.53	19.2	17.89	20.63	14.63	8.8	11.17	13.25	29.53
11.37	21.61	21.66	18.2	21.31	19.11	21.87	19.48	23.98	20.64	18.57	16.61	15.3	26.56
12.03	23.82	23.87	18.45	21.89	20.82	20.49	19.18	22.02	17.86	13.37	10.07	8.47	29.27
6.88	16.15	16.2	12.74	15.85	13.64	17.3	14.23	20.05	19.54	17.84	20.52	20.63	20.63
14.73	17.63	16.96	16.93	19.08	17.84	21.51	18.43	24.87	27.48	25.81	27.37	25.76	20.47
14.36	23.44	22.95	21.02	24.13	21.92	24.87	22.47	26.97	23.74	19.99	15.74	14.13	26.29
13.94	20.5	19.83	19.17	21.94	20.07	23.74	20.66	27.1	26.68	25.06	25.02	23.42	23.34
20.58	8.07	8.29	14.17	11.52	12.81	15.78	13.36	19.28	28.09	31.38	36.93	39.09	2.24
19.74	8.04	7.95	14.19	11.51	12.94	15.8	13.5	19.37	28.22	31.5	36.88	37.91	3.45
12.75	2.64	1.65	7.29	5.78	5.96	10.07	7.36	13.65	22.01	24.44	29.67	31.8	7.3
13.19	4.39	3.4	8.08	6.8	6.75	11.09	8.27	14.91	22.79	25.11	30.33	32.05	6.17
34.3	21.95	22.18	27.87	25.42	26.52	29.15	27.08	32.69	42	45.08	50.76	53.07	16
35.68	23.22	23.44	29.28	26.63	27.92	30.79	28.47	34.24	43.4	46.58	52.11	54.23	17.34
31.41	19.06	19.28	24.98	22.57	23.63	26.23	24.18	29.8	38.91	42.19	47.58	50.18	13.13
32.49	20.14	20.37	26.07	23.61	24.75	27.31	25.26	30.88	40.29	43.28	48.66	51.27	14.2
28.91	16.49	16.73	22.42	19.96	21.06	23.66	21.62	27.24	36.34	39.94	45.01	47.62	10.56
10.67	8.86	9.89	5.52	6.23	6.57	2.08	3.95	2.93	13.06	18.24	23.83	28.14	15.03
16.18	5.45	5.3	11.53	8.85	10.27	13.14	10.9	16.66	25.57	28.07	33.29	34.36	5.05
19.97	11.41	11.25	15.56	14.88	15.02	19.13	16.54	22.74	29.89	31.67	36.9	36.72	9.71
19.09	16.49	15.82	18.5	18.05	17.91	22.33	19.43	25.93	32.46	30.99	34.46	32.42	17.54
6.46	10.52	11.27	4.46	7.89	6.99	5.78	5.19	7.59	11.36	13.75	19.16	23.18	16.83
3.55	14.21	14.52	8.34	11.84	10.34	10.4	9.18	11.96	11.83	13.1	18.32	21.9	20.69
0	12.55	12.83	7.31	10.81	9.13	10.55	8.15	13.3	14.03	15.29	20.51	20.5	19.16
12.55	0	1.33	6.15	3.47	4.89	8.02	5.53	11.33	20.29	23.73	29.5	32.29	6.64
12.83	1.33	0	6.81	4.47	5.42	8.76	6.38	12.33	21.29	24.33	29.7	32.34	6.93
7.31	6.15	6.81	0	3.5	2.37	4.93	1.85	8.23	14.71	18.18	22.89	26.92	12.86
10.81	3.47	4.47	3.5	0	3.35	5.37	2.87	8.93	17.64	20.95	26.33	30.36	10.19
9.13	4.89	5.42	2.37	3.35	0	5.71	2.63	9.27	17.08	19.9	25.26	29.29	11.41
10.55	8.02	8.76	4.93	5.37	5.71	0	3.08	3.67	14.47	19.4	24.99	28.96	13.92
8.15	5.53	6.38	1.85	2.87	2.63	3.08	0	6.64	15.13	18.95	23.62	27.65	11.96
13.3	11.33	12.33	8.23	8.93	9.27	3.67	6.64	0	12.81	19.77	25.71	30.49	17.49
14.03	20.29	21.29	14.71	17.64	17.08	14.47	15.13	12.81	0	8.81	15.9	22.03	26.6
15.29	23.73	24.33	18.18	20.95	19.9	19.4	18.95	19.77	8.81	0	7.36	13.65	29.89
20.51	29.5	29.7	22.89	26.33	25.26	24.99	23.62	25.71	15.9	7.36	0	7.92	35.26
20.5	32.29	32.34	26.92	30.36	29.29	28.96	27.65	30.49	22.03	13.65	7.92	0	37.74
19.16	6.64	6.93	12.86	10.19	11.41	13.92	11.96	17.49	26.6	29.89	35.26	37.74	0