Automation of the Configuration Process for a Transportation Management Application and the Creation of a Web Application with an Integration of an E-Learning Solution to Offer a New User Experience

by

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FOREWORD

The research presented in this Master is part of a partnership between a company that offers a transportation management application to its customers and the École de Technologie Supérieure. The goal of this partnership is to offer solutions for a list of problems the company is facing. To reach this goal, a team of each party has been formed to work together and carry out this project.

On the company side, the team has prepared the list of problems that this project need to address. Also, the company team prepared a version of the application for us to use during this project. On the side of ETS, Mr. Marc Paquet, thanks to his experience, helped to define the project aim and the areas that are needed to be tackled. During the development of the solution he offered Advice and remarks that helped shape the obtained result.

Meetings with the company team during the development of the solution helped to keep the project advancement in check. Discussing with the company team allowed us to see the project from real-world state perspective. The company point of view was always requested during this project to be sure that the proposed solution meet their needs and expectations. I was personally responsible for the automation of the personalization process of the transportation management application, choosing the technologies that has been used to develop the prototype, define the new user experience, develop the E-learning solution and finally provide a functional prototype.

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I would like to thank all the great friends I met at ETS who have contributed to the success of this Master. Special thanks to Manel for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this Master.

AUTOMATISATION DU PROCESSUS DE CONFIGURATION D'UNE APPLICATION DE GESTION DE TRANSPORT ET LA CRÉATION D'UNE APPLICATION WEB AVEC INTÉGRATION D'UNE SOLUTION E-LEARNING POUR OFFRIR UNE NOUVELLE EXPÉRIENCE UTILISATEUR

Wael JABALLAH

RÉSUMÉ

Le but de l'étude présentée dans ce mémoire est de fournir une solution adaptée d'une application de transport pour les petites entreprises et de remplacer le processus manuel de personnalisation et de création de fichier de configuration. En plus, le manque de connaissances des clients doit être adressé. L'objectif final de ce travail est d'améliorer l'aspect de la personnalisation de l'application, de résoudre le problème de déficit de connaissances et d'offrir une meilleure expérience avec l'application pour les petites entreprises. Dans cette étude, nous avons automatisé la personnalisation de l'application, mis en place une solution de E-learning et nous avons créé une nouvelle expérience utilisateur à l'aide de principes HCIs. Ce travail débute avec une étude sur l'apprentissage et la formation sur le web, suivi d'une étude détaillée de la solution E-learning proposée. Enfin, un prototype est élaboré pour illustrer la solution proposée et la nouvelle expérience utilisateur.

Mots clés: tournée de véhicules, application de gestion de transport, apprentissage en ligne, le model ADDIE, développement web

AUTOMATION OF THE CONFIGURATION PROCESS FOR A TRANSPORTATION MANAGEMENT APPLICATION AND THE CREATION OF A WEB APPLICATION WITH AN INTEGRATION OF AN E-LEARNING SOLUTION TO OFFER A NEW USER EXPERIENCE

Wael JABALLAH

ABSTRACT

The aim of this study is to provide a customized solution of a transportation management application for small business customers and to replace the manual process used for the creation of the configuration file and for the personalization of the application interface. Also, the customers knowledge gap related to the use of the application needs to be addressed. The final goal of this work is to ameliorate the personalization aspect of the application, solve the knowledge gap problem and offer small business customers a better experience with the transportation management application. In this study, we automatized the personalization process of the application, implemented an E-learning solution and created a new user experience using human computer interfaces principles. This study kicks off a review on E-learning and on web-based training, followed by a detailed study for the proposed E-learning solution. Finally, a prototype is developed to demonstrate the proposed solution and the new user experience.

Keywords: vehicle routing problem, transportation management application, E-learning, instructional design, ADDIE model, Web development

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LIST OF ABREVIATIONS

ETS	École de Technologie Supérieure
VRP	Vehicle Routing Problem
CVRP	Capacitated Vehicle Routing Problem
VRPTW	Vehicle Routing Problem with Time Windows
ID	Instructional Design
HCIs	Human Computer Interfaces
TMS	Transportation Management Application
TS	Tabu Search
ADDIE	Analyze, Design, Develop, Implement,
ASTD	American Society for Training and Development
ISPISD	Inter-Service Procedures for Instructional Systems Design

INTRODUCTION

In recent decades, logistics management has been the center of attention in both research and industry. In fact, logistics management reached various areas thanks to the trend of nationalization and globalization. For industries, logistics use management techniques to optimize production and distribution processes with the effort to not add any resources (Tseng *et al.*, 2005). The result is an efficient and competitive enterprise system. Transportation is indeed the key element in a logistic chain (Kumar & Shirisha, 2014) as the cost of transportation occupies one third of the total amount of logistics costs. Hence, the transportation problems has been largely studied to deliver efficient and effective solutions. A transportation problem can attack many domains such as pick up problems, delivery problems and people transportation. Each domain has its own specifications that need to be considered to get optimized results.

Given a vehicle fleet and a number of transportation request, the goal is to determine a set of vehicle routes to perform all or some transportation requests with the given vehicle fleet at minimum cost. This means, decide which vehicle serve which requests in which order so all vehicle routes can be executed. This type of problem, subsumed under the term Vehicle Routing Problem (VRP) (Irnich *et al.*, 2014). Many variants of VRP are studied by researchers and industries. The most studied version of the VRP is The Capacitated Vehicle Routing Problem (CVRP) which uses a homogeneous vehicle fleet. The Vehicle Routing Problem with Time Windows (VRPTW) is also very known family of VRP, it is an extension of CVRP in which the customer must be served in a specific time interval, called time window. Pickup-and-Delivery Problems (PDPs) is an important family of routing problems in which the transportation is done from different origins to different destinations. In recent years, there has been a steadily growing interest in Stochastic Vehicle Routing Problems (SVRPs). More recent works involve a growing line of research which involves environmental aspect, called green Vehicle routing.

Computer support is very important for the solution of VRP problems. Using it at the planning and the operational levels, yields substantial savings in the global transportation costs (Irnich *et al.*, 2014). The complexity attached to the constraints and the different variants of VRP makes the creation of a transportation management application, which is adaptable to each customer needs, a hard task to achieve.

Nowadays, more and more companies are targeting logistics management problems. The company we are cooperating with, offers a solution that allows its customers to manage their fleet and optimize their routes using a transportation management software in combination with their proprietary algorithm. The solution can be used for many sectors such as food distribution, technicians rounds, passengers transportation and materials collection. The major problem of the company application is that it works manually on the configuration files to adapt the application for the customers needs. Transportation management application is not easy to use. As a result, the customer needs long-term support and assistance. Actually, the company offers the support via phone calls or direct meetings, which is time consuming and raise the starting cost for customers. Moreover, this kind of support can cause communications problems between the company and its customers. This can be problematic and lead to the dissatisfaction of the customers despite of the good application performance. The aim of this work is to determine how we can improve the personalization process of the logistics management application of the company to make the application easy to use for small business customers and at the same time to solve the existing knowledge gap of the customer.

To reach these objectives, a study for the actual solution needs to be done first. The actual process used by the company needs to be observed and analyzed to define the main problems that must be addressed. After that, it will be important to take a look at the domain of human computer interfaces so we can have a prototype that respect and implement it principals. To be able to address the knowledge gap problem, a study for how to implement an E-learning solution

needs to be done. In our project, we will develop a prototype which allows the automation of the application personalization process. The prototype will offer a new user experience which is easier for the customer to use. In fact, the creation and optimization of the transportation model process by the customer will be updated to offer an intuitive usage and a simple input solution. The quality principles of human computer interfaces will be applied while creating the prototype. Finally, the developed prototype will offer the needed tools to fill the customers knowledge gap by offering an integrated E-learning solution.

The remainder of this thesis is structured as follows. Chapter 1, outlines literature review about vehicle routing problem, E-learning processes and existing web based training solutions. Chapter 2 describes our methodology to automate the configuration process for the transportation management application of the company, to implement a new user experience and to integrate a process of our E-learning solution. Finally, Chapter 3 outlines the different implementation steps of our prototype.

CHAPTER 1

LITERATURE REVIEW

1.1 Introduction

In this chapter we will start with a review of the Vehicle Routing Problem (VRP). Then, we will present a review for web-based training and E-learning solutions. To get familiar with E-learning paradigms, we will detail its approaches, components and formats. In the third part of this chapter, we will review the human computer interfaces principles. The fourth part is dedicated to the description of state-of-the-art instructional design models. Finally we will present a review of some technologies used to develop web applications.

1.2 Vehicle routing problem

The term Vehicle Routing Problem (VRP) regroup the problems in which given as set of transportation requests and a fleet of vehicles, the task is to determine a set of vehicle routes to perform the transportations requests with the given fleet of vehicle at a minimum cost (Irnich *et al.*, 2014). The VRP was introduced first in 1959 with the name of "truck dispatching problem" by Dantzig and Ramser. They worked on a real world problem which was the delivery of gasoline to gas station (Dantzig & Ramser, 1959). After five years, Clarke and Wright proposed an effective heuristic for the approximate solution of the VRP (Clarke & Wright, 1964). Since then, many research and papers have been published, presenting mathematical models and proposing exact and heuristic algorithms for the optimal and approximate solution of the different versions of the VRP.

1.2.1 The family of VRPs

The Capacitated Vehicle Routing Problem (CVRP) is the most studied version of the VRP. It uses a homogeneous vehicle fleet, which mean all the vehicle have the same capacity. The objective is to minimize the overall routing costs. The CVRP problems can be classified based

on the type of transportation requests. The Vehicle Routing Problem with Time Windows (VRPTW) is also a very known family of VRP. It is CVRP in which we introduce the time windows constraint. In fact, the customer must be served in a specific time interval. The early works on the VRPTW were case study oriented (Pullen & Webb, 1967). At that stage, the solution methods were based on simple heuristics. When the transportation is done from different origins to different destinations, the family of VRP is called Pickup-and-Delivery Problems (PDPs).

Over the past 58 years, many algorithms were developed to solve the VRP. In the following, we will present some exact and heuristic methods used to solve the VRPs.

1.2.2 Exact methods for the VRP

Exact algorithms are developed to find the optimal solution. Christofides & Eilon (1969) developed a branch-and-bound algorithm to solve exactly the VRP problem. The VRP can be formulated as dynamic program and solved optimally (Eilon *et al.*, 1971). Balinski & Quandt (1964) provided a set partitioning formulation of the VRP.

Exact algorithms provide the optimal solutions for the problem. But, in real-world applications, the settings of the instance may be large. In this case the computing time become high. This means that we need another approaches to solve the problem. Efficient heuristics are developed in this case.

1.2.3 Heuristics for the VRP

Many heuristics were developed to solve VRP problems. However, Heuristics cannot grant that the solution is optimal. Constructive heuristics are usually easy to implement and provide a starting solution to be improved. Clarke & Wright (1964) developed a fast and intuitive heuristic called the Clarke and Wright heuristic. Later, a parallel version of this heuristic was developed (Gendreau *et al.*, 2001). More complicated and more sophisticated heuristics were developed based on local search algorithms. Variable Neighborhood Search (VNS) was intro-

duced by Mladenovic and Hansen (Lourenço *et al.*, 2010). Gendreau *et al.* (1994) implemented the Tabu Search algorithm (TS). Other heuristics are based on population algorithms such as the genetic algorithm (GA). Prins (2004) implemented a GA to solve the problem.

Many approaches are used to measure the quality of the solution provided by the heuristic such as developing a lower bound for the problem or testing the performance of the heuristics with small instances in which we have an optimal solution.

1.3 E-learning and Web based training

In this section, we will detail E-learning and web based trainings as well as the targeted skills of such learning approaches.

1.3.1 E-learning

E-learning can be defined as "the use of computer network technology, primarily over an intranet or through the Internet, to deliver information and instruction to individuals" Welsh *et al.* (2003). It has been defined by ASTD as "a wide set of applications and processes, such as Web-based learning, computer-based learning, virtual classrooms, and digital collaboration. It includes the delivery of content via Internet, intranet/extranet (LAN/WAN), audio- and videotape, satellite broadcast, interactive TV, and CD-ROM" (Kaplan-Leiserson, 2002). Today, E-learning is considered as a very important tool for organizations. In fact, 95 of respondents to a 2003 survey by the American Society for Training and Development (ASTD) reported using some form of E-learning in their companies (Ellis, 2003). This is explained by the fact that E-learning can be as effective as traditional training at a lower cost. Delivery costs (including costs of web servers and technical support) are considerably lower than those for classroom facilities. Also, E-learning reaches a wider target audience by engaging learners who have difficulty attending conventional classroom training.

E-learning can offer effective instructional methods, such as practicing with associated feedback, combining collaboration activities with self-paced study, personalizing learning paths

based on learners needs and using simulation and games. Further, all learners receive the same quality of instruction because there is no dependence on a specific instructor.

Most of E-learning approaches in organizations are asynchronous, which means that instructor and learners do not have to be in the same place or even forced to respect a specific time. E-learning is available at any time for the learners. On the other hand, synchronous E-learning requires all the learners to be available at the same time in front of the instructor directly or online.

Implementing an E-learning solution is not an easy task. The learning environment becomes more complicated since it conducted using the Internet and World Wide Web. Many challenges need to be overcome. In fact, Derouin *et al.* (2005) confirms that, to be able to use E-learning at full potential, organizations need to overcome a challenging problem. The main problem is that learners drop out of distance learning courses.

1.3.1.1 Targeted Skills of E-learning

E-learning goal is to solve the lack of knowledge and skills. (Margaret, 2002) classified E-learning skill into three categories: cognitive skills, interpersonal skills and psycho-motor skills.

Cognitive skills: Include solving problem, applying rules, task requires manipulation of symbols and numbers. They can be taught using text, graphics, symbols and such instructional strategies as reading, writing answers, solving problems, completing exercises, execute steps in a process.

Interpersonal skills: Skills used by a person to interact with others properly. This kind of skills is involved in active listening, presenting, negotiating, etc.

Psycho-motor skills: Complex combination of physical movement and thought. This kind of skills is difficult to teach in a WBT Program.

Most E-learning courses are developed to build cognitive skills the cognitive domain is the most suitable for E-learning. Within it, thinking skills may require more interactive E-learning activities because those skills are learned better “by doing”.

1.3.1.2 E-learning approaches

There are two main E-learning approaches:

a. **Self-paced E-learning:** Also called Web-Based training. Course-ware is usually housed on a web server, easy to access by learners via Internet. Content is available for learners all the time, as result they can follow their own pace and define a specific program that answer their needs and interests. Based on the learning objectives the E-learning content is developed. It can be delivered using different elements such as text, audio and video, etc. A database can be created to track learners’ actions. E-learning providers do not have to schedule, manage or track learners through a process.

b. **Instructor-led E-learning:** Unlike self-paced E-learning, the course needs to be scheduled.

   To communicate and work as a team, learners and instructors can use many available tools such as emails discussion forums, chat, conference application, etc.

1.3.1.3 E-learning components

E-learning approaches can call different components. According to Ghirardini (2011) four components need to be considered, each play an important role in designing online courses: E-learning content, E-tutoring/E-coaching/E-mentoring, collaborative learning, virtual classroom.

1.3.1.3.1 E-learning content

E-learning contents must be developed based on the knowns learning objects. It can include:

- Simple learning resources: This kind of content do not allow the learners to interact with it such as documents, Power-point, video, audio. They are very valuable when used right, they need to be linked to specific objectives and well designed in a structured way.
- Interactive e-lessons: Is a linear sequence of screens which can include text, graphics, animations, audio, video and interactivity in the form of questions and feedback.
- Electronic simulations: it is about creating a learning environment that simulates the real word. This allows the learner to learn by doing. This kind of content respond in dynamic way to the learner behavior.
- Job aids: It provides just-in-time knowledge. Basically an immediate answer to specific questions. Technical glossaries and checklists are a few examples of simple job aids, some other complex system can also be developed.

1.3.1.3.2 E-tutoring, E-coaching, E-mentoring

Services which provide human and social dimensions can be offered to learners to support them through the learning experience. To support learning through the learning experience many services with human and social dimensions can be provided.

1.3.1.3.3 Collaborative learning

Collaborative activities involve a group of person. They can use discussions and knowledge-sharing or even work together on a project. Social software, such as chats, discussion forums and blogs, are used for online collaboration among learners.

1.3.1.3.4 Virtual classroom

A virtual classroom is the instructional method most similar to traditional classroom training, as it is led completely by an instructor. It is a real time learning also called synchronous learning. An appropriate technology must be in place for both learners and instructors.

1.3.1.4 E-learning Formats

Driscoll (2010) distinguish four E-learning formats. Two e-learning formats are designed for learners Who work alone and two other formats are designed for group work. The Table 1.1 highlights the main difference between the four formats.

Table 1.1 Summary of Key Differences Among E-learning Formats, taken from Driscoll (2010)

	Learning Unit		**Temporal**	
	Individual	**Group**	**Asynchronous**	**Synchronous**
Web/Computer-Based Training	X		X	
Web/Electronic Performance Support System	X		X	
Web/Virtual Asynchronous Classrooms		X	X	
Web/Virtual Synchronous Classrooms		X		X

1.3.2 Web based training

Horton (2000) defined web-based training as "*any purposeful, considered application of Web technologies to the task of educating a fellow human being*". He considers it, as depicted in Figure 1.1, as a result of the confluence of three social and technical developments: distance learning, computer-conveyed education, and Internet technologies. It started since 1890, when Sir Isaac Pitman used the mail to teach his shorthand system. By 1960 the University of Illinois and Control Data Corporation developed the PLATO (Programmed Logic for Automatic Teaching Operations) system. It allowed the sophisticated branching necessary for teaching complex subjects. The third development was born with the Internet, it allowed for more possibilities and surpassed the boundaries of politics and distances.

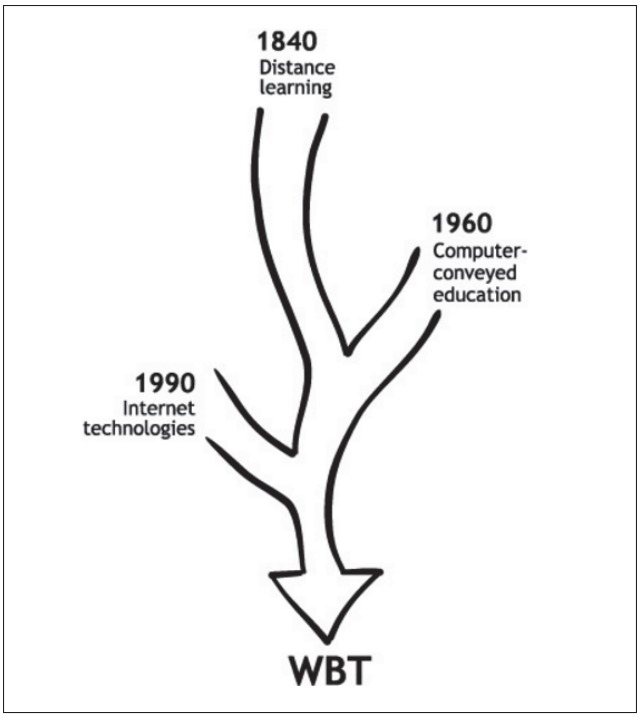


Figure 1.1 The three social and technical developments
Taken from Horton (2000)

1.3.3 Advantages

(Driscoll, 2010) listed many advantages for using WBT. He classifies them under strategic and tactical Advantages. The benefits are listed in the Table 1.2.

Table 1.2 Strategic and Tactical Advantages of WBT
Taken from Driscoll (2010)

Strategic	**Tactical**
Developing a global workforce	Reducing travel and related costs
Responding to shorter Product Development Cycles	Enabling learning any time and any Place
Adjusting the needs	Providing just in time learning
Increasing Productivity	Enabling delivery Independent of a platform
	Providing tools for tracking and records keeping
	Making update easy

1.3.3.1 Strategic reasons

Strategic is an adjective applied to things linked to the overall direction of enterprise.

- **Developing a Global Workforce**: Global workforce refers to the international labor pool of workers, it includes employers connected through a global system of networking and production. WBT offers a consistent and quality training which is available at any time for the users.
- **Responding to shorter Product Development Cycles**: Today products are known with the short development cycle. The development of new products or an update can be realized within 8 months. At this tempo, the training solution must be able to keep pace. WBT can offer the tools to face this problem.
- **Adjusting the needs**: Learning requirements and preferences of each learner tend to be different. WBT offers the flexibility and the needed adjustment for each learner. In fact, the learner can benefit from a training delivery methodology that can adjust to their hours and working style.
- **Increasing Productivity**: Increasing the learner skills and knowledge will improve the productivity. As result, he will complete the work faster with fewer errors.

1.3.3.2 Tactical reasons

These benefits meet important short-term needs:

- **Reducing travel and related costs**: web-based training allows cost saving. Costs can be related to meeting, travel. In fact, Wagner & Longmire (1999) confirm that company can save a good deal of money not only in the travel budget and in productivity but also in revision charges.
- **Enabling learning any time and any place**: one of the remarkable benefits of web-based training is that it can be done at any time, at any place.

- **Providing just in time learning**: unlike traditional way of training where the learners need to spend weeks going through content before they might need the training, using web-based training allow learners to take the needed training just before they need the content. Also, learners can get back at any moments to make a refresh and access the needed content.
- **Enabling delivery Independent of a platform**: using WBT allows to create a program that works on all systems (PCs, Macintoshes, Unix, Mobiles).
- **Providing tools for tracking and records keeping**: WBT offers tools to keep records that can be used to ameliorate the user experiencen and even ameliorate the training program.
- **Making update easy**: WBT programs are easy to update unlike training programs that delivered via CD-Roms.

1.3.4 Disadvantages

Even though the big advantages of Web-based training, there are a number of potential drawbacks to using it. In fact, Horton (2000) argue that this kind of training has costs, requires compromises, and poses serious risks. The same author believe that web-based training courses in education field require more time and effort to teach, to design and to take. In addition, Kroder *et al.* (1998) reported that Web-based training courses can take 20 to 40% more time and effort to understand by learners than traditional classroom courses. Special instructional design and course material are also required because of the physical absence of the instructor.

There is a common belief about the risk of loosing human contact with the increasing use of Web-based training (Kubala, 1998; Bostock, 1997; Horton, 2000). The loose of human-touch and face-to-face contact with the teacher and fellow classmates in web-based training courses may have a negative impact on social skills development.

Since the learning process is based on the available technologies, learners in web-based training courses may face some technical difficulties: connection problems, the server going down, the browser does not display the course correctly, etc. This can be frustrating and stressful for both

learners and instructors. As a result, less time will be dedicated to the subject matter of the course Wagner & Longmire (1999).

1.4 Human computer interfaces

(Kumar, 2011) define an interface as the medium through which, two objects can interact with each other. it is a part of an object exposed to the other object. When the first object is Human and the second object is Computer, the interface is called Human-computer interface. While working with the software, the user see the interface, it is the first contact with the system and for many users the interface represent the software.

(Kumar, 2011) illustrate in Figure 1.2 the human-computer interaction as two elements linked together with an interface. The two elements are the user and the computer.

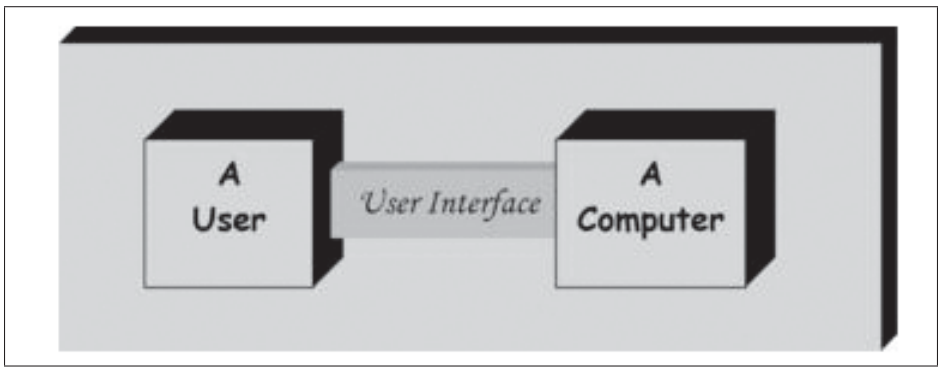


Figure 1.2 A Human-Machine Interaction
Taken from Kumar (2011)

The interface is used to simplify the tasks that a user need to execute, to allow the user to input data for processing, to present information to the user in an understandable way and to protect the computer from damage due to user interaction. Facing the complexity of systems, the design of interfaces is getting more intention. Since it is a key to allow the user to operate a complex system naturally and with ease.

The concept of the human–computer interfaces emerged from research in the field of Human–Computer Interaction (Macredie & Coughlan, 2004). Hartson define Human-computer interaction (HCI) as "a field of research and development, methodology, theory, and practice, with the objective of designing, constructing, and evaluating computer-based interactive systems so that people can use them efficiently, effectively, safely, and with satisfaction" Hartson (1998).

HCI studies the mechanism side, the human side and the relation between both. In the same aspect Faulkner described HCI as "the study of the relationships that exist between human users and the computer systems that they use in the performance of their various tasks" (Faulkner, 1998)

Creating effective interface for users is challenging and complex. For a user, the interface in the first contact with the system. It is the visible part of "designing an efficient user interface that is understandable by the end user and paramount to the usability quality of all successful software systems" (Otero, 2012). In a world were being first is getting more and more important, the company focus on the functional side of an application and forgot that visual designs have a major role in the success or failure of software systems. for instance, if a system or an application meet the functional requirements but is not usable it is distant to failure. The main goal of the user interface designer is to provide an interface that is easy to use and allow the user to reach his goal and complete the task rapidly and without unnecessary effort.

1.4.1 Quality Principles for HCIs

Many works have been done regarding the HCIs. As result, many authors developed quality principles for HCIs. The goal was always to provide guidance and a starting point for developers which when used allow the creation of a usable interface.

An interface may be acceptable to one user and unacceptable to another user, it is based on the user's point of view. the Principles HCIs specify basic qualities of a good interface. A designer who follow these principles increase the probability of acceptance by the user. The

quality principles are general and open, which mean that they can be applied to many software systems. In fact, they are essential for every interface, regardless of the software for which it is designed.

According to (Mack & Nielsen, 1994), when creating a user interface there are 10 heuristics to follow:

- **Simple and natural dialogue**: The dialogue that the user have with a computer should be simple and natural. In fact, it is important to avoid using the computer language when communicating with the users because they will not understand it.
- **Speak the Users' language**: You can use technical language or business language when it is the area of expertises of the users. As a developer, it is not recommended to speak your area of expertise or a computer language.
- **Minimize the Users' memory load**: People are bad are remembering stuff, when computer are very good at it. Many developers push the users to remember rather than the computer.
- **Contractive error messages**: Error messages with HEX code or a pointer to a memories. Two aspects must be present on an error message,why it occurs and what should be done to resolve it.
- **Support recall**: It is easier to recollect something from before than having to remember something from thin air. Giving choices is better than giving blank space.
- **Clearly marked Exits**: Never get the user into a corner where he can not get out.
- **Shortcuts**: It help the expert users without bothering the novice users. Usually the user does not discover shortcuts until he is ready to using them, then gradually he incorporates them into what he does. This helps providing a system that has to cater to a group of users with different levels of experience.
- **Feedback**: it is always important that user get informed about the status on the system. The user needs to always get informed when something wrong happens. Even when something

go right, the user needs to get informed. For instance, the user needs to get informed when an application is installed successfully, otherwise the user can't be sure.

- **Prevent Errors**: Anticipating where the errors may occurs and where the user may commit errors.
- **Consistency**: People tend to pull on what they have learned in the past. So it is important to make sure that what they learned in the past imply to the system.

On another study, (Shneiderman, 2005) confirms that there are three main principles that need to be respected:

- **Recognize the diversity**: one of the important aspect that a developer or a designer need to take in consideration in the diversity of the users. For instance, each use have his own background and knowledge, work in a specific environment with a specific set of terminology. The interface should respect the diversity of all users, otherwise, the system will only be usable for a group of users and unusable for the rest.
- **Use the eight golden rules of interface design**: The eight Golden rules are:
  a. **Strive for consistency**: In similar situations the sequences of actions need to be consistent and the terminology is identical. Use what the user know either from a previous version of a system or from other system because the first think they will try is what they learn in the past.
  b. **Enable frequent users to use shortcuts**: As the user became more familiar with the system, he will try to reduce the time to complete the tasks. shortcuts allow the user to complete a step directly and fast without going through some menu.
  c. **Offer informative feedback**: it is important to get feedback, for each operator action a feedback is needed, it could be a message, a change of a color or even a sound.
  d. **Design dialog to yield closure**: Sequences of actions should be organized, the beginning, the middle and the end should be clear for the users.

e. **Offer simple error handling**: the system should be able to detect the error and offer a simple and clear mechanisms to handle it.

f. **Permit easy reversal of actions**: after each action the user should be able to get back and undone it. This feature relieves anxiety. Along side with that being able to undone any action will encourage the user to explore the system.

g. **Support internal locus of control**: it is important for the user to feel in charge and in control of the system. Actions should be initiated by the users avoiding putting the user in the position of responders.

h. **Reduce short-term memory load**: information processing in short-term memory need to be limited. Placing the least amount of burden on user's memory will allow him to focus on the actions rather than trying to remember. The displays need to be simple.

- **Prevent Error**: it is always good to design the interface so that users cannot make serious errors. For instance, gray out menu items and buttons that are not appropriate, do not allow alphabetic characters in numeric entry fields.

Knowing the particularity of Interactive M&S software, Tuncer and Levent confirm that adopting the quality principles for the HCIs to M&S software is not enough. In the article (Ören & Yilmaz, 2005), they specify quality principles for the ergonomics of M&S software by taking into account the front-end and back-end functionalities of M&S software. M&S software model is depicted in Figure 1.3.

As result, four road categories with 21 interface quality principles are developed as shown in Table 1.3.

1.5 Instructional design

Many definition of instructional design are available in the literature. For instance, Allen define the instructional design as a process of arranging for learning to happen safely, certainly,

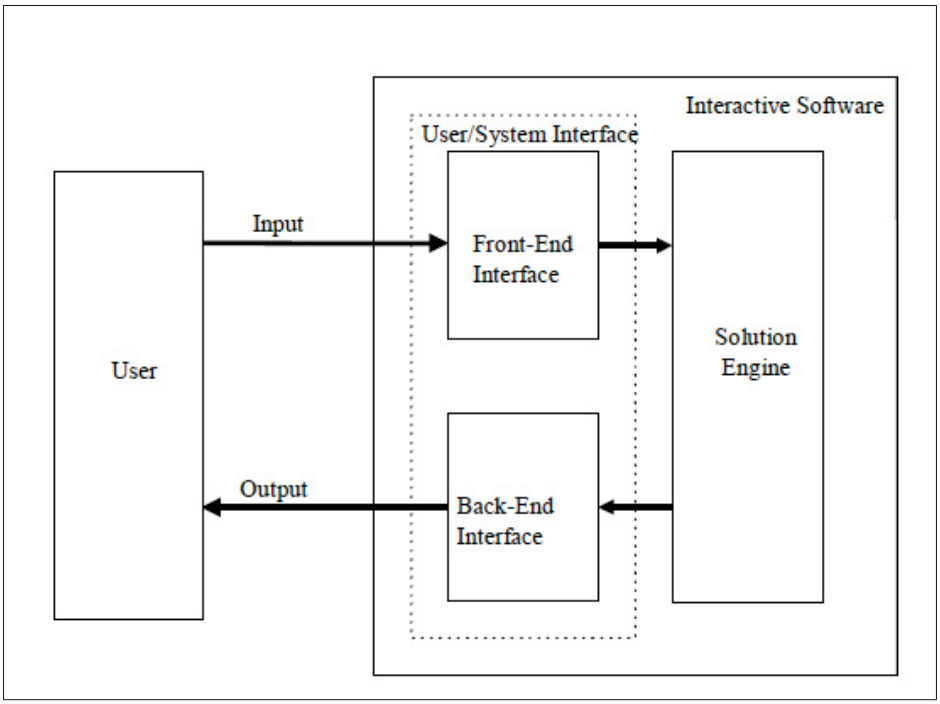


Figure 1.3 M&S software model
Taken from (Ören & Yilmaz, 2005)

thoroughly, and expeditiously (Allen, 2011). Gustafson and Branch define it as a system of procedures for developing education and training programs in a consistent and reliable fashion (Gustafson & Branch, 2002).

The origins of Instructional design can be traced back into 1965 with Silvern attempt to solve problems applying general systems theory. In his work he was interested in creating an effective and efficient military training by applying the general system theory. by 1970s the Instructional systems design methods starts to take place in industrial and commercial training. And by the end of the 1970s it become accepted as standard training methodology in many large organizations (Gustafson & Branch, 2002).

Instructional design models provide conceptual tools to visualize, direct, and manage processes for creating high-quality teaching and learning materials. For that, many models are developed. Two models are very popular. The first is the one created by Dick and Carey. The second is ADDIE model.

Table 1.3 Quality Principles for HCIs of M&S Software
Taken from (Ören & Yilmaz, 2005)

Categories	**Interface quality principles**
Usability	Least training Minimum memory load Simplicity Familiarity Separation of concerns Functionality
communicativeness	Restrained relationship with users Informativeness Perceptiveness Explanation ability Expressiveness Aesthetic and cultural acceptance
Reliability	access reliability Predictability Consistency Safety Build-in quality assurance
Evolvability	Adaptability Customizability Learning ability Maintainability Portability

1.5.1 Dick and Carey Instructional Model

Named for its developers, the Dick and Carey model (Figure 1.4) is widely known (Dick, Carey, and Carey, 2014). In fact, Carliner confirms that Dick and Carey model is the dominant model of design taught in academic instructional and educational technology programs (Carliner & Shank, 2016). Same as the ADDIE model, and to ensure alignment of learning objectives with the evaluation of success in achieving those objectives early in the development process, this model suggests creating the assessments before design and develop instructions (Biech, 2014).

Dick and Carey instructional design model consists of 10 steps.

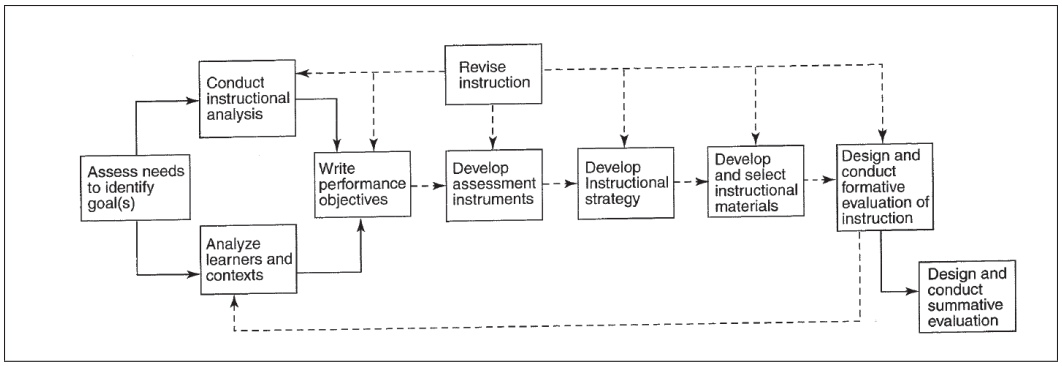


Figure 1.4 Dick and Carey instructional design model
Taken from (Dick, 1996)

a. Instructional Goals: In this step, instructional goals need to be clearly defined to know what is the learners need to learn.

b. Instructional Analysis: In this step, targeted skills that learners have to acquire during the learning process should be defined.

c. Entry Behaviors and Learner Characteristics: Assess which skills the learners have out of those previously determined as needed to understand the course.

d. Performance Objectives: In this step, specific goals and objectives of the learning process should be defined and clearly detailed.

e. Criterion-Referenced Test Items: This step is meant to help the learners understand what they have or have not mastered yet by fixing criteria for test items.

f. Instructional Strategy: In this step, lesson plan is outlined. All the planned activities should be clearly specified and scheduled.

g. Instructional Materials: In this step, all course materials should be prepared to guarantee better learning experience.

h. Formative Evaluation: The evaluation of the learning process is done in this step to get the satisfaction degree of learners.

i. Summative Evaluation: In this final step, the entire learning process should be revised and ask these questions: Did we create a better lesson plan than we had before? Did we spend too much time on one area?

Due to the importance of this model, many searchers worked on illustrating how to use it. For example, (Hirumi & Bermudez, 1996) illustrate how the use of Dick and Carey's (1990) instructional design model can guide the creation of innovative, interactive online courses.

Finally, (Willis, 1992) confirms that although instructional development models and processes may differ, they are based on the same structure and basic stages of analysis, design, development and evaluation.

1.5.2 ADDIE Model

ADDIE is an acronym for Analyze, Design, Develop, Implement, and Evaluate. It is a framework training e-Learning developers may use. As an instructional design methodologies, it describes guideline to builds effective training and performance support tools.

The origin of this model can be traced into the mid-1970s when the Center for Educational Technology at Florida State University worked with a branch of the U.S. Army and develop a model known as Inter-Service Procedures for Instructional Systems Design (IPISD). This model became the standard for how military training was to be developed. Branson illustrate this model as a five phases model which are: analyze, design, develop, implement, and control. Over the years, this model become more dynamic and interactive to reach the familiar version we know today. In fact, Grafinger (1988) presented the Figure 1.5 that illustrates the ADDIE Processes as we know it now Molenda (2003).

(Ghirardini, 2011) recommends the ADDIE model and provides a case study published by the food and agriculture organization of the united states. He shows all the needed step to succeed the using the model in Figure 1.6.

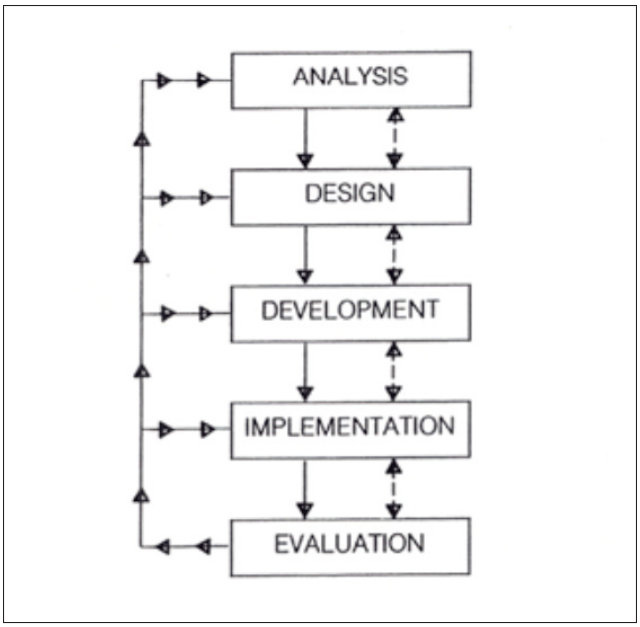


Figure 1.5 An ISD Model featuring the ADDIE Processes
Taken from (Molenda, 2003)

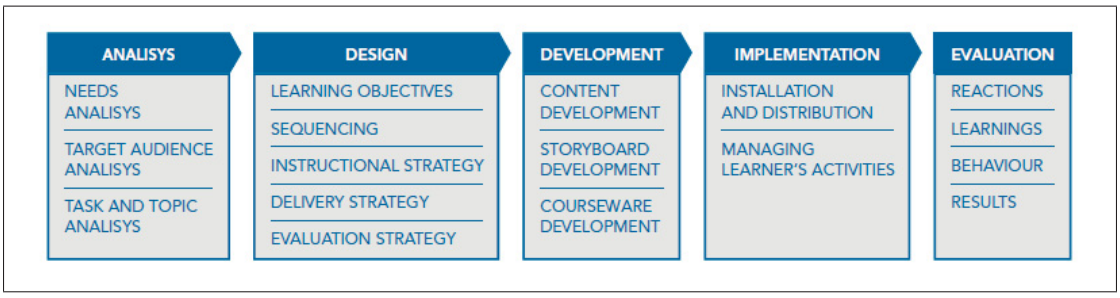


Figure 1.6 An ISD Model featuring the ADDIE Processes, taken from (Molenda, 2003)

Creating products using an ADDIE process remains one of today's most effective tools. It is one of the most common models used in instructional design field. This model helps to create an efficient, effective teaching design by applying the processes of the ADDIE model on any instructional product. Thanks to its flexibility, it can be adapted in education, private sector, training, and general learning events. The instructional product made using the ADDIE model is not limited to face to face environment and it can be used in online environment. It can be modified as well for individual or for group instruction.

1.5.2.1 Analyze phase

Before creating a plan or think about developing a solution, Addie model analysis phase must be conducted. It is the foundation for all other phases. The purpose of analyze phase is to analyze the audience or learners and gather as much information as possible. In fact, the information that instructional designers gather at this stage will be put to use throughout the system. To do that (Hodell, 2007) define five points that need to be determined in this phase:

- If a problem exists that can be appropriately addressed by training;
- What goals and objectives the training should address;
- What resources are available for the project;
- Who requires the training and their needs (population profiles);
- All additional data needed to successfully complete the project;

A-Needs analysis

This analysis goal is to confirm if a training is required to fill a gap in professional knowledge and skills. Also, to confirm if E-learning is the best solution to deliver the learning solution. To address this question, the first step is to validate the performance gap of the users or learners. Based on this gap and the opportunities that E-learning is offering, it is possible to decide whether E-learning is the needed solution or not.

B-Goal

A course goal may be defined as a broad statement of intent or desired accomplishment. It is define a path without presenting all the steps. One of the important steps is to define a clear general goal for the training.

After working on training programs, and having results that were not meeting the requested goals, (Mager & Peatt, 1962) worked on improving the training delivery. The author confirms that working on the goal is a very critical step.

C-Audience analysis

As known not all the learners have the same level of knowledge or skill. This must be taken in consideration to create an efficient learning environment. Otherwise the instructions will be inadequate for some learning compared to others. the collected information facilitates instructional design considerations such as instructional content, level of content, motivational needs, and instructional methods. Some of the factors that need to be analyzed are:

- Range of aptitudes;
- Previous background and experiences;
- Previous education Interests;
- Size of target audience;
- Demographics;
- Computer literacy;
- Network bandwidth;
- Available time;
- Lexical field;

D-Task Analysis

Task analysis is a method for describing the actions or behaviors that learner should learn to perform. It is a detailed analysis of actions and decisions that a person takes to perform a task. All the tasks should be described accurately and completely since these task descriptions or "statements" should be used to develop the instructional objectives which constitute the framework for instruction. In fact, during the task analysis, for each task the requirement to complete it should be specified. This includes identifying which tasks should be performed, under what conditions they are performed, and the standards of acceptable performance. Four steps can be considered to do the Task analysis.

a. **Identifying tasks:** in this step tasks that learners should learn need to be identified and well described.

b. **Classifying tasks:** tasks can be classified in two categories:
   - Procedural task: all task involves performing a procedure that could be considered as executing an ordered sequence of steps.
   - Principle-based task: all task require judgment or a decision. This decision can be made for different situations that can change every time.

c. **Breaking up the tasks:** each task after being well defined need to be broken up into steps or guidelines. In fact, if the task is a procedural task it should be broken into the steps that allow the learner to complete the job or the task. If the task is considered as principle-based task, guidelines should be applied that help the learners to improve their skills regarding the approaches that need to be taken or regarding the best decision among many possibilities.

d. **Identifying required knowledge and skills:** the question that need to be answered is what do learners need as skills to be able to complete the steps defined for each task. Based on the answer, each step or guideline will be associated with a list of required knowledge.

1.5.2.2 Design phase

Hodell (2015) defines the second phase as the blueprinting stage of instructional systems during which instructional designers create the blueprint for a project with all the specifications necessary to complete the project.

A-Learning objectives

After defining the goal and analyze the learners, learning objective must be specified. In fact, unlike the learning goal, learning objective must be more specific and provide more details.

We define what learners should be able to do when the instructions are finished. An objective need to:

- specify an observable measurable behavior. This should indicate the success in achieving the objectives.
- specify the level of accuracy that needs to be accomplish.
- specify conditions under which the performance will take place.

B-Sequencing

After defining the learning objectives, we need to know the best way to sequence them when structuring a course. There are many sequencing methods that can be used. The most known method is the prerequisite method. Based on the defined learning objectives, it starts by teaching the skills that seem to be prerequisites for other skills. Another method is the job-oriented method. Based in the taken action in real job environment, the content is organized in a way to follow that specific action. This method usually used when developing a perform course.

The result of sequencing is a course structure. Each element of the course is linked to a specific learning objective that aim to the attainment of the overall course coal.

C-Instructional strategy

At this point the instructional strategy need to be proposed. It is a combination of methods and techniques that helps learners to understand the course or topic. Three main instructional methods can be used:

- **Expository methods:** this method involve using an expert to explain a concept or provide information to the learner. it does not allow learner to make much of interaction with the instructor. The presented information must be clear and organized allowing learner to easy

understand concepts and make connection between them. The idea behind this method is to lay down the needed information to learners and avoid them going through unnecessary information and the waste of time if they try to find the information themselves.

- **Application methods:** this method is concentrated on the active process that learners use to perform a task.
- **Collaborative methods:** focus on the social dimension of learning. Learners can communicate between each other and share knowledge and even performs task together.

D-Delivery strategy

At this point, the delivery mode of the course need to be selected. When selecting delivery formats, several factors must be considered, including:

- **Learner-related factors:** some important factors can be considered about learners such as their comfort with delivery channel. For instance, audio conferencing can be frustrating for non-native language learners, in this case it is better to provide the course with method that allow learners to take more time understanding the instructions.
- **Technology aspects:** learners skill using technologies must be considered along with the new tendency. The access to network systems is important and can affect the delivery strategy since some activities require an Internet connection. Using mobile devices become an important factor that need to be considered when selecting the delivery strategy.
- **Organizational requirements:** this factor is associated with the company or the organization who prepare the E-learning solution. As know time and budget are constraints that need to be taken seriously since the start to be able to complete the project within the available limits. Developing a self-paced learning can require much time and resources.

1.5.2.3 Development phase

Development is the third phase of the ADDIE model, in this phase the training start to take shape using the constructed blueprint from the design phase.

A-Content development

The content need to be developed for self-paced E-learning solution. Unlike face to face training, it must be carefully designed to provide all the support needed by the learners. It must allow them to use the course independently with ease. For instance, a presentation must include all the explanations and examples which is not the case if the presentation is developed for face-to-face interaction, since the presenter can inform directly the learners. When developing the content many tips can be considered:

- Learning objectives: the content need to be based on the learning objectives and course plan.
- Obvious knowledge: no matter how some knowledge looks obvious to the instructor it needs to be included. It may not be known by the learners and can be a huge obstacle when starting the self paced learning.
- Examples: using a familiar example helps a lot learners to absorb the information and remember it when needed. In case the learners have different background it is likely to use variety of examples.
- Language: the content need to be simple and clean with small sentence with no jargon used. The personal pronouns can be used to involve the reader. The acronyms need to be always spelled at first in full. If possible, it is recommended to add them to the glossary.

B-Storyboard development

At this point, the storyboard is used to describes screen by screen what will happen in the final e-lesson. It allows to review the content along with the instructional technique that will be used. The typical structure for e-lesson is based on four parts:

- Learning objective (1 Screen): learning objectives should be presented in this screen. It should be described clearly.
- Introduction (1 to 3 Screens): by the end of this part, the learner should be able to understand the knowledge that he will gain and it benefits. This part usually used to motivate the learner.
- Content (4 to 25 Screens): the big part of the structure is reserved for the content itself which make up the core of the lesson. The goal as known is to allow the learner to gain new set of knowledge and skill.
- Summary (1 Screen): at the end of the e-lesson, a list of the important points in the lesson should be presented. The purpose behind the summary part is to help the learners memorize the important key points of the lesson.

C-Courseware development

Courseware development require the setup of the course interface which assemble all the course component, work on the animations and navigation, programming complex interactions. The result will be the final interactive E-lessons that will be tested.

1.5.2.4 Implementation phase

Implementation is the forth phase, it is the phase when the system is placed in service.

A-Installation and distribution

At this point, the action start. three major steps need to be considered :

- Training the instructors: the first step in the implementation phase is to prepare the instructors. In many cases the person who is training the learners is not the person who developed the course. As result it is very important to have an instructors comfortable with the material, assessment, course objectives, etc.
- Prepare learners: this step starts with a kickoff event, the purpose is to introduce the course goals and the agenda. It is important to prepare the learners for the courses and be sure that they have all the needed tools and knowledge to take the course. They also need to be aware about when and where the course will be available. Preparing the learners also require a pre-course learning activity. In fact, this could be a walk through the platform and the features available for the learners. This will get the learners familiar with the online platform. It is important that the pre-course leave a positive impression to motivate the users.
- Organizing the learning environment: the goal of this step is to be sure that all the tools needed by the instructor are available and the E-learning platform work as expected.

B-Managing learners activities

E-learning activities can be either synchronous or asynchronous. Synchronous activities take place in real time. It require the participants to be logged in at the same time. Some of the activities includes video and audio conference, live web-casting, sharing, etc. Unlike synchronous activities, Asynchronous activities are not a real time activities. The learner can pick any time he's comfortable with to access it. It does not require a scheduled time. Forum, e-mail, blog and web-casting are the most known form of asynchronous activities.

1.5.2.5 Evaluation phase

Evaluation is the last phase of ADDIE. Many aspect need to be evaluated such as the clarity, the impact of the solution, etc. Also, summative evaluation need to take place. The goal is to prove the worth of the instructions and the course after being completed by the learner. It is based on four main aspect: Reaction, learning, behavior and results

A-Reaction

Evaluating the reaction of the learners is the easiest evaluation in the summative evaluation. It means understanding how they react to the program and the courses. Usually, survey are used at the end of the course. Using this type of evaluation make it possible to ameliorate the program and the training and make it convenient comfortable and relevant to the learners.

B-Learning

The goal is to evaluate the achievement of learning after taking a training. This implies that learners increased their knowledge, developed skills or changed behavior after attending a course. Post-test such as Assignment and tests are used for the assessment. It is a must that the assessment on a level with learning objectives.

C-Behavior

Involves measuring the transfer of knowledge and attitudes outside the training frame. It's important to observe how learning impact the learner's behavior on real work environment, time is needed for this type of evaluation since learners need time to apply what they learned and use it in efficient way.

D-Results

This evaluation involve results and return of investment. The goal is to check how training effect the performance, the profit, the productivity and job satisfaction for learners.

1.6 Web application development

In this section we will review some web application development frameworks and concepts.

1.6.1 Database management system

One of the things that need to be considered when working on a web application is how to store the data. Computer software application called database management have been around for many years and provided reliable and performance storage capabilities.

A database management system (DBMS) organize the files to give more control over the data. It is possible for users to create, edit, update on database files. DBMS allow to save and retrieve data from the database files. Some of the benefits of using DMBS are:

- Concurrency: allowing users to access the same data base in the same time and preventing interfering with each other.
- Integrity: database structure and rules improve the integrity of the data.
- Backup and recovery: processes to backup the date and recover it to a valid state if a problem occurs.
- Security: there are components that limit access or actions right of users.

Traditional relational database technology like oracle, MySQL, etc. has some limitations that was responded by NoSQL databases (Tiwari, 2011). When compared against relational databases, NoSQL databases are more scalable and provide superior performance, and their data model addresses several shortcomings of the relational model.

(Vohra, 2015) confirm that the advantages of NoSQL include being able to handle:

- Large volumes of structured, semi-structured, and unstructured data;
- Agile sprints, quick iteration, and frequent code pushes;
- Object-oriented programming that is easy to use and flexible;
- Efficient, scale-out architecture instead of expensive, monolithic architecture;

Today, companies leverage NoSQL databases for a growing number of use cases. NoSQL databases also tend to be open-source and that means a relatively low-cost way of developing, implementing and sharing software.

1.6.2 Node.js Frameworks

Node.JS Technology was announced in 2009. JavaScript at that point was only used for the front end development for web applications. Unexpectedly, this technology wasn't designed to run in the browser as front end technologies. It was about running JavaScript in the server (Rauch, 2012). With this big change, Node.js frameworks today are shaping the future of web and application development technology. Frameworks like Express.js and Meteor.js are used to design a better website and mobile applications. This technology brings many advantages, it is very important to embrace the latest innovations brought into the development world by Node.js frameworks.

1.6.2.1 Meteor

Meteor is an open source platform for web, mobile, and desktop (Robinson *et al.*, 2015). Thanks to an integrated javaScript stack it allow to accomplish the needs in 1/10 code lines. One of the interresting thing in meteor is that apps can be build for any device. In fact, the same code will adapt with the used device. It can be used for simple application to the very complex ones such as Modern collaboration app with real-time sync and e-commece applications.

In his book (Weil, 2017), Arnaud said about Meteor. "I love tools that make me productive for common tasks while also allowing for greater power and customization when needed. Meteor does just that, providing simple ways to answer most requirements of today's applications." The author listed many reasons make writing an application using meteor faster than many other JavaScript environments.

- JavaScript code on the server and client, some of the code may be shared between the two;
- Native support for MongoDB collections;
- Most of the functionality a developer usually needs is provided as easy-to-install packages;

1.6.2.2 Hapi.js

Hapi.js is a powerful Node.js web framework for building application program interfaces (APIs) and other software applications. It started as a project called Sled late in 2010 at Yahoo (Nguyen, 2015).The framework has a robust plugin system alongside with many key features. It includes input validation, configuration-based functionality, error handling systems, account management. What makes Hapi unique is the fact that it enables developers to focus more on writing reusable application logic instead of spending time building infrastructure. The more development knowledge you have the better you can use it.

1.6.2.3 Express.js

Express.js is a web framework based on the core Node.js http module and connect components (Mardan, 2014). Express.js is one of the most essential Server-side web frameworks for Node.js. It offers a simple, performant, and unopinionated tool set for creating web application servers. What makes Express.js stand out from the other Node.js framework is that it allows the developers to reuse code elegantly, without the need to constantly writing the same code for similar tasks.

1.7 Conclusion

In this chapter, we presented literature review about vehicle routing problem, E-learning processes and existing web based training solutions. In the next chapter we will describe our methodology to automate the configuration process for the transportation management application of the company, to implement a new user experience and to integrate a process of our E-learning solution.

CHAPTER 2

METHODOLOGY

2.1 Introduction

In this chapter, we will start by presenting the actual transportation management application. It will describe the process the customer takes to optimize their transportation model. Then, we will discuss the problems the customers are facing while using the application. The research methodology will be detailed next. Five objectives will be defined. For each objective, we will define the steps that we will be taking to reach our goal.

2.2 Description of the actual transportation management application

The company offers a transportation management application for its customers. The current solution of the company is a desktop application based on client-server architecture. Figure 2.1 sketches the application architecture.

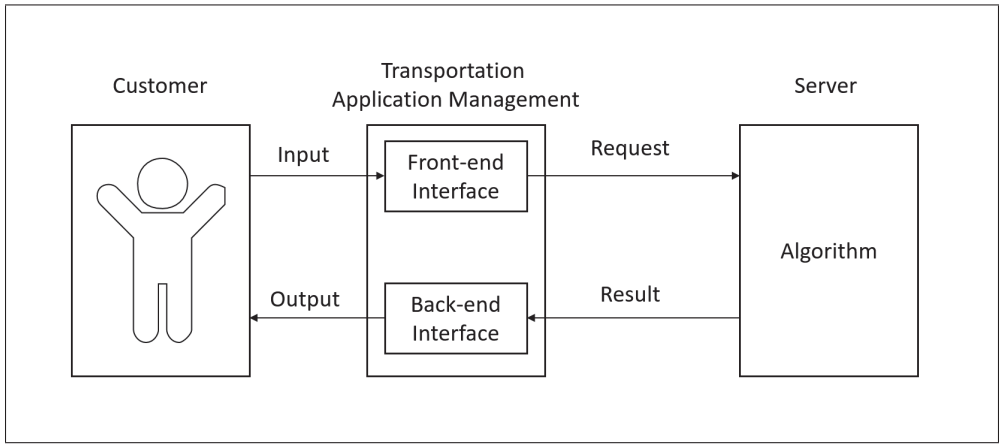


Figure 2.1 The process of creating the configuration files in the company

The input for the application is the customer model of transportation. This model includes vehicle data, client data, goods data and optimization parameters. When the customer wants

to optimize his model, a request is sent to the server. The company algorithm installed in the server side receives the data and optimizes the model. After that, the requested result is sent back to the client application.

The transportation management application needs a specific configuration file to be usable. A configuration file is a file that contains configuration information for an application and it is used to configure the parameters and initial settings. In fact, when an application is executed, it consults this specific file to get the settings and preferences that are needed to be used. The company uses the configuration file for two main reasons. The first reason is to define the customer type of service and some optimization settings. The second reason is to define the application appearance. Actually, for each customer, the company creates the configuration file manually based on the information the customer provide during meetings. After that, the company sends the configuration file to the customer so he can add it to the application installation folder on his machine. The company needs to keep in touch with the customer to be sure the application meets the customer expectation after adding the configuration file. It is s very important to be sure the configuration file is correctly set since it will affect all the customer experience with the application.

After the application is set, the customer add the data to the transportation management application. To do so, an file with a specific template is need. The customer imports the excel file filled with his personalized data to the application in order to optimize his model. The data is sent to the company server to process. The algorithm afterward optimizes the model, defines the optimal routes and sends the results to the client side application. The transportation management application shows a map and the input data in the top. The map in the right side provide the user with the suggested routes. The input data is loaded on the left side as shown in the picture. Below the input data and the map the result details are shown in a table.

2.3 Criticism of the current application

Four main problems are found in the actual solution. The first one deals with the configuration. The second problem involves the complexity of use of the application. The third problem is the lack of an E-learning module that facilitate the use of the application by the client and the last problem deals with the limited client support.

2.3.1 Manual configuration

Each customer needs the application to be configured to meet his needs as well as his unique model. This kind of support requires a lot of time since it is based basically on meetings. As a result, the starting cost become higher. To have a functional application, the configuration files need to be modified based on the customer specifications. This process must be done for each customer. This kind of process time consuming, disrupts the company and leads to the focus on supporting the customer rather on ameliorate the application. The diagram in Figure 2.2 shows the used process and illustrates the communication flow between the company and the client to just create the right configuration files.

After the long configuration process, the application displays many unnecessary information that overload the customer with complexity and alter his focus on what he needs. We talk here about the tabs available on the application. To edit the tabs two options are available. It is either to the company to edit the configuration files or it is up to the clients to edit it after starting the application if he knows how to do it. This leads again the communication issues between the company and its customers.

2.3.2 Complexity of use of the application

The transportation management application offer many functionalities. Small business customers don't need all of the proposed functionalities. The personalization of the application is not an easy task to do. As result, the customer receive data that he don't need but must deal with it. Adding data is not an easy process. The customer need to work with a specific file with

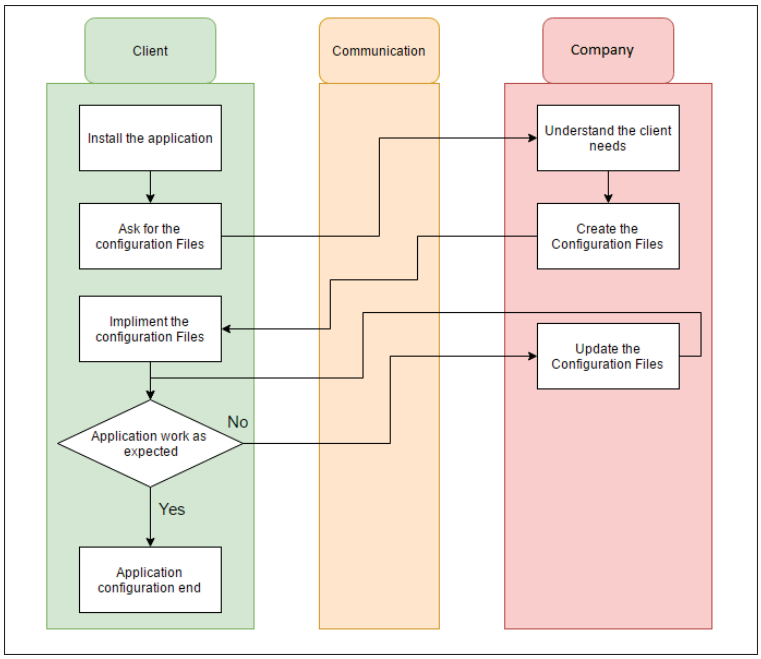


Figure 2.2 The process of creating the configuration file in the company

a predefined template. Also, having all the data (Input data, map, Transportation requests, etc) in the same interface add to the application complexity.

2.3.3 No application learning support

Actually, the only learning support provided by the company is a document that cover the bases of using the application. This document is not enough to answer all the customer answers. The company don't offer an effective and efficient learning experiences for the customers.

2.3.4 Limited clients support

Actually, a document is the only support provided to the clients. If the client is not enough the client must call or schedule a meeting. For the company this didn't work very well since sometimes a small issue can take much time to solve with the customer. Taking customer satisfaction become one of the key factors in the success of a business. It can even affect

the strategic business decision-making since it confirms if they are in line with the customer interests. For now, there is no option allowing the clients to send a feedback to the company.

2.4 Research methodology

In this section we will detail our research methodology that we used to solve our problem. It is depicted in Figure 2.3. Our research methodology consists of five main objectives. In a first stage, we need to have a complete comprehension of the current transportation management application of the company. Then, our second objective consists of the automation of the configuration of the transportation management application. Our third objective consist of the creation of a new user experience based on the analysis of HCIs techniques. Then, our fourth objective consists of the integration of an E-learning platform that offers the support as well as the necessary resources to the client for better understanding and use of all the application functionalities. Finally, the development and the implementation of the prototype will be done.

2.4.1 Objective 1: Comprehension of the company transportation management application

The goal is to get familiar with the transportation management application that the company offers to its customers and understand how the configuration file works. To reach this goal, two steps need to be done. The first step consists of analyzing all the available parameters and transportation constraints for the different type of service. The second step consists of analyzing the configuration file and get familiar with updating it manually to change the application configuration. Finally, a manual test of the possible changes in the configuration file will be done.

2.4.1.1 Application parameters analysis

First, we need to be aware of all the available parameters and constraints for each type of service. To do that, several experience with different sets of data should be done. The a table

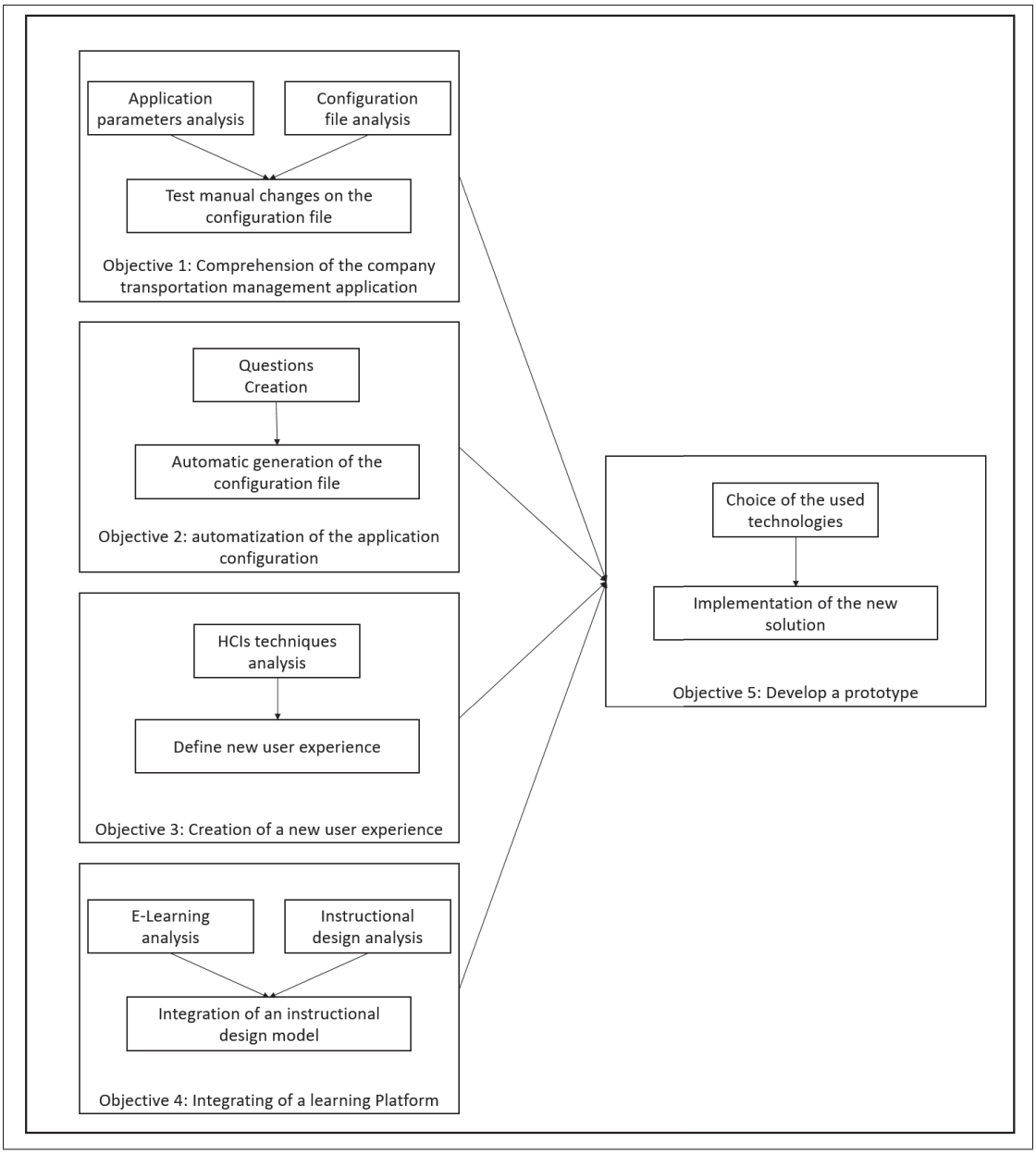


Figure 2.3 Research methodology

describing all available parameters and constraints for each type of service should be presented to have a better understanding of the application parameters.

2.4.1.2 Configuration file analysis

As explained previously, the configuration file contains configuration information of the transportation management application. We need to understand the code in the configuration file and the possible changes that can be made. A description for the configuration file need to be done.

2.4.1.3 Test manual changes on the configuration file

In this part manual changes on the configuration file should be done. The goal is to confirm that the application change based on the updated configuration file, and that the changes meet our expectations.

For example, regarding the list of items under the File menu it is possible to disable or show an item by changing the value from false to true. If we need to show the item *New Visit* the code line should be:

<BNouveauVisible>true</BNouveauVisible>

But if we need to disable the item from the menu the code line should change to:

<BNouveauVisible>false</BNouveauVisible>

Same goes for the tabs available for the requested transportations and the the optimized transportation solution. For example, It is possible to show the compartment tab by writing true in the code line shown bellow:

*<Column Name="gridColcompartment" Visible="**true**"Header=""></Column>*

To hide it, false need to be used instead of true:

*<Column Name="gridColcompartment" Visible="**false**"Header=""></Column>*

Figures 2.4 and 2.5 show the effect of this change on the transportation management application.

Départ	Nom	Quantite_C.	Compartiments	Incompatibilités	Compatibilité 2
2017-02-11 08:21	Collecte	1,2			
2017-02-11 08:23	Collecte	2,1			
2017-02-11 08:23	Collecte	3			
2017-02-11 08:46	Collecte	4,2			
2017-02-11 08:46	Collecte	5,4			
2017-02-11 09:01	Collecte	6,3			
2017-02-11 09:18	Collecte	7,2			

Figure 2.4 Compartment option is ON

Départ	Nom	Quantite_C.	Compatibilité 2
2017-02-11 08:21	Collecte	1,2	
2017-02-11 08:23	Collecte	2,1	
2017-02-11 08:23	Collecte	3	
2017-02-11 08:46	Collecte	4,2	
2017-02-11 08:46	Collecte	5,4	
2017-02-11 09:01	Collecte	6,3	
2017-02-11 09:18	Collecte	7,2	

Figure 2.5 Compartment option is OFF

The result of these tests will confirm our understanding of the code used in the configuration file and prepares the ground for the next objective which is the automation of the application configuration.

2.4.2 Objective 2: Automation of the application configuration

The goal is to automate the generation of the configuration file process. The idea is to develop a list of questions. After answering the questions, the configuration file will be generated automatically. The new process is shown in the Figure 2.6.

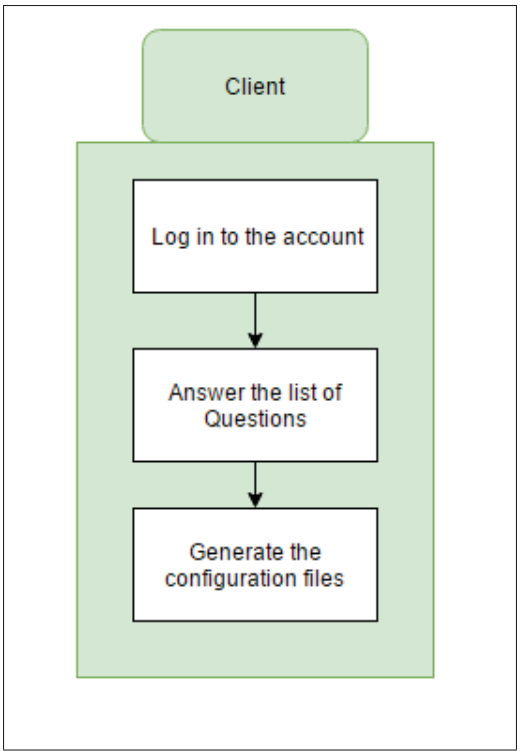


Figure 2.6 The process of creating the configuration files in the company

2.4.2.1 Questions creation

Creating the list of questions is an important step toward the automation of the transportation management application configuration. It consists of creating as fewer questions as possible, but enough to define all the needed parameters and constraints for the application. First, we will need to fix all the parameters and constraints that have to be available for all the customers, no matter the transportation model. Then, we will need to create a list of questions for each specific constraint or parameter that differs from customer to another.

2.4.2.2 Automatic generation of the configuration file

As discussed previously, the communication in the process of creating the configuration file cause much confusion and it is time consuming. The proposed solution to solve this problem

is to automate the process of the application configuration by allowing clients to create their own configuration file without the intervention of the company. To be able to generate a configuration file based on the customer answers we need first to create a specific version of the configuration file. This version will have variables instead of fixed values. When the customer answers the list of questions, values will be assigned to the variables.

2.4.3 Objective 3: Creation of new user experience

The goal is to create a new user experience for small business customers. The new experience must offer an intuitive and an easy usage of the application. To reach this goal, a study of state of art techniques about the human computer interfaces should be done before defining the new user experience.

2.4.3.1 HCIs principles analysis

In this step, we need to study the field of human-computer interface design. The principles of human compute interfaces need to be clearly defined and explained. The goal is to apply these principles into our application design.

2.4.3.2 Definition of new user experience

One of the issues we saw in the available application is that all the tasks are done in the same place. In fact, the user has to do many steps via the same interface and the results are also displayed at the same interface (e.g, data edition, entering the date, model configuration, etc.). This kind of design cause a problem to most users and create confusion. To create a better experience, we need to define a new process with a clear separation between main Tasks. The new process consists of three main blocks as shown in the Figure 2.7

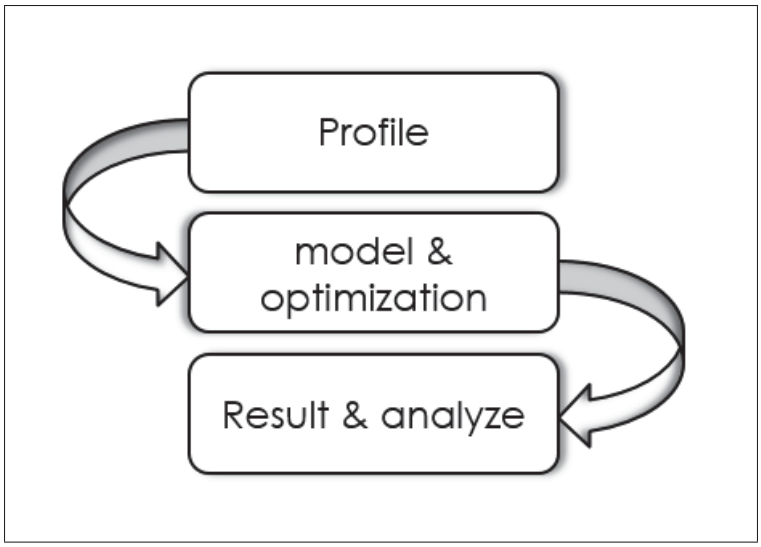


Figure 2.7 The three main blocks defining the new user experience

2.4.3.2.1 Profile

For the customer, the profile is the place where to find and update the relevant information. The name of the client alongside with the type of service he offers must be available. Going further, the profile will show the setting and the model parameters and constraints that the user picked while creating it, such as the usage of compartments and using time windows. Some parameters can be defined only one time and will be unchangeable for the customer, others can be updated anytime. To create a profile, the user needs to create an account and answer a list of questions. The process of creating the account is shown in the Figure 2.8.

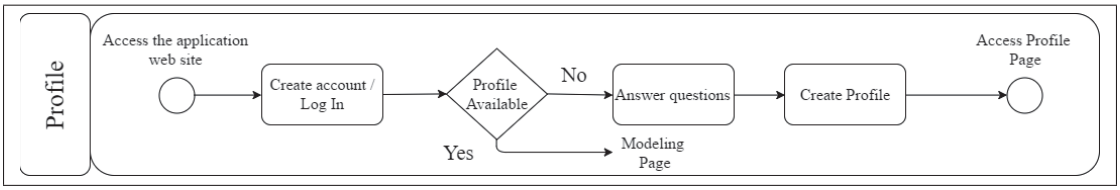


Figure 2.8 Profile's Tasks

2.4.3.2.2 Model & optimization

After setting up the profile, the customer will access the modeling page. This is where the data are submitted by the customer. Many tasks will be associated with the model and optimization block, as shown in Figure 2.9.

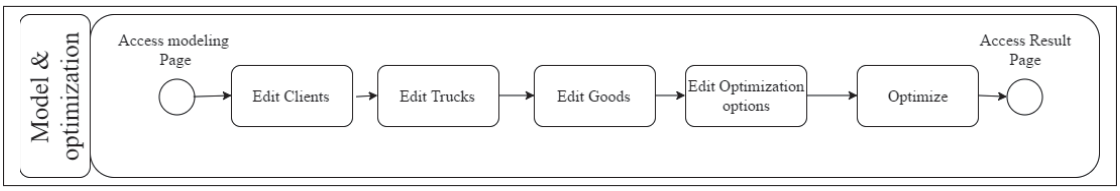


Figure 2.9 Model & optimization Tasks

To make the experience easy to handle by the customer, creating the model and optimization will be decomposed into four tasks. The first task is to add the clients data. The second task is to add vehicles data. The third task is to add the goods data. Finally, the optimization parameters will be chosen. After the optimization, the client is taken to the result page.

The Model & optimization process will be directly affected by the client profile. In fact, the data requested and field will be presented based on the answer the client provided. If the customer answer “NO” for the compartment question, the application will not show the compartment field and functionalities. If the customer answer “YES” the compartment field and functionalities will be shown and requested.

2.4.3.2.3 Result & analyze

Result & analyze task is depicted in Figure 2.10. After the optimization, the customer will be directed to the result page. In this page, the client will have access to the algorithm output. The result will be shown in a new page to allow the client to focus on it without the distraction of other useless information. The customer will have access to a map with the relevant information such as the position of the clients, the transportation visit order, etc. A table will provide details about the solution. Graphs will present data in a quick way, lift out the most important facts.

In addition, the customer will have access to two functionalities: "suggestion" and "compare". The first one, "suggestion", will provide recommendations based on the results. For example, if there is unbalanced use of vehicles the application will suggest updating the optimization settings. Then, "Compare" functionality will allow the customer to compare side by side two optimization results based on different settings.

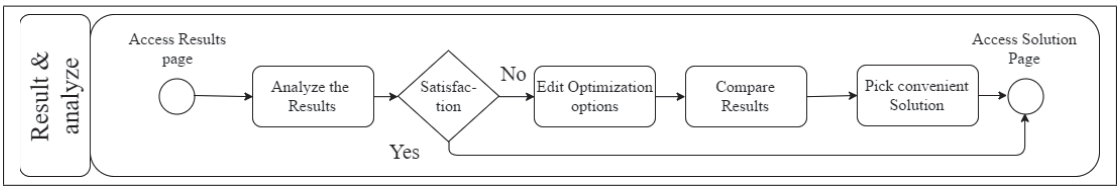


Figure 2.10 Result & analyze Tasks

2.4.4 Objective 4: Integrating of an E-learning platform

The goal is to provide the customers with an E-learning platform that will be integrated to the transportation management application. The E-learning solution offers the support and the necessary resources to use the application correctly and understand all the functionalities. To reach this goal two steps need to be done. The first step consists of analyzing the E-learning approaches. The second step consists of analyzing the instructional design approaches. Finally, an instructional model will be implemented and integrated to the prototype.

2.4.4.1 E-learning techniques analysis

The goal is to determine if the E-learning is a good solution for our problem or not. To do so we need to understand the web based training domain. Then, we need to focus on the E-learning and determine what skills the E-learning solutions can improve. After that, we need to determine the E-learning approaches, components and formats.

2.4.4.2 Instructional design approaches analysis

The goal is to use the Instructional design tool to offer effective and efficient learning experiences to the customers. We need at first to understand this tool approaches. Then, we need to find designed models that will guide us in the instructional design process.

2.4.4.3 Integration of an instructional design model

After understanding the instructional design domain and introducing some of it used models, we need to pick the right model for our case. After that, we need to use the chosen model to create an effective and efficient learning experiences for the customers.

2.4.5 Objective 5: Development of the prototype

The goal is to provide a prototype based on the previous steps. To reach this objective, the technologies that will be used should be carefully chosen to assure a better performance of our prototype. The final prototype should demonstrate the automatic generation of the configuration file, the new user experience and the integrated E-learning solution.

2.5 Conclusion

In this chapter we defined five objectives that need to be completed. We also, detailed the steps that need to be taken to achieve our goal. In the next chapter, we will start the development of the solution.

CHAPTER 3

DEVELOPMENT OF THE SOLUTION

3.1 Introduction

In this chapter we will detail the development process of our prototype. In fact, the proposed solution is a web application that offer a new process to use a transportation management application. It gives the client the possibility to create the configuration file. An E-learning solution is implemented using an instructional design model. A prototype is developed to illustrate the new user experience, including the new process and the Implementation of the E-learning solution.

3.2 Choice of technologies

Providing a web application for customers has a lot of benefits such as platform independence, so the application can run using any navigator on windows, Linux, Mac OS and mobile. To develop the prototype we used the database management NoSQL, the platform Meteor and the framework bootstrap.

3.3 Web application development

In this section we will detail and argue the different web technologies that we used to develop our prototype.

3.3.1 NoSQL

We chose to work with NOSQL databases since it just offers many advantages compared to SQL-based relational databases. The first advantage is scalability. In fact, NoSQL databases support horizontal scalability which allows adding capacity without the need to shut down the database. This allows an application to adjust when receiving data. The second advantage

is performance. Since we need to serve many users at the same time, we need a database that provides low latency and high availability. NoSQL just offer much better performance compared to SQL-based relational databases. The third advantage is the auto-failure handling. There is no need to worry about the server failure anymore. In fact, NoSQL databases typically handle server failure automatically.

3.3.2 Meteor

We chose to work with meteor since it offers many advantages. First, it is friendly to beginner developers. In fact, we only need to know one language which is javaScript to be able to develop the application. Meteor uses javascript on both server side (Node.js, Underscore) and client side (jQuery). What also make development easy to beginers is that the Same MongoDB interface is used on the client as well as the server.

While creating the application we thought about mobile users. We wanted to allow customers to access the application using mobile devices while providing an elegant experience, not just mirroring the application on smaller screen. Meteor, Unlike many other platform, can generate mobile applications from the same code-base already developed.

Using Meteor can save too much time while developing an application. The reactive programming model embedded in Meteor, allows creating applications using lesser JavaScript code. We used an integrated javaScript stack which allow a big save of time.

Another advantage is that Meteor integrate Bootstrap Which is an open source toolkit to develop the web application interfaces. In fact, this toolkit is considered as the most popular HTML, CSS, and JS framework in the world for building responsive, mobile-first projects on the web. Moreover, one of the biggest advantages of Bootstrap is the development speed. In fact, rather than coming from scratch, Bootstrap offers ready-made blocks of code that facilitate the web development process. Also, thanks to cross-browser compatibility of the toolkit and CSS-less functionality, many hours of coding can be saved. Added to that, the fluid grid layout

of Bootstrap are adjusted dynamically to the proper screen resolution. This makes desktop and mobile ready websites development more easier with Bootstrap.

Using these technologies we developed our prototype. Appendix presents the code used to add different elements of the application.

3.4 Generate the configuration file

As explained on the methodology, to be able to automate the creation of configuration file we created a specific file with all the variables we will be updating based on the customer answers. This file is saved on the server side. When the customer answer the list of questions, the variables receive the corresponding value. As a result, some variables will be defined based on the selection. For instance, if the client pick the service ”*Pickuponly*” the variable "#*Pickuponly*" on the configuration file will be set to true.

<PickUpOnly>#Pickuponly</PickUpOnly>

change to :

<PickUpOnly>true</PickUpOnly>

To create the list of questions:

a. Isolated the must have code lines (Group A). These code lines must be available no matter the model the customer want to implement. For example the code lines related to customer name, date, or quantity belong to group A.

b. Define the parameters that can vary based on the customer model (Group B). Parameters such as compartment, time windows belong to group B.

c. Identify the questions that cover all the items on Group B

Each client has his own transportation model. It can be a basic model or a complicated one that uses compartments and compatibilities to name few parameters. Showing many unnecessary information or tabs for a client is not good, since it will make the application hard to use. To personalize the application, a part of the questions will be used to personalize the tabs that will be shown for the customer. For example, if the client answers "no" for the availability of the compartment, this tab will not be shown for the client. After answering the list of questions shown in the Figure 3.1, the customer can download the new configuration files with the new values.

3.5 Application Components

To access the application, the customer need to visit the company website. We updated the website home page as shown in Figure 3.2 to provide information about the new application and it main features. The user can create an account or log in. If the user choose to log in, he will be taken to the model and optimization page. New users will have to register before having access to the application. A registration button is displayed to start the registration process.

3.5.1 Profile component

The customer can access his profile using a menu drop-down available on the right side of the navigation bar. When clicking on the drop-down the customer will have access to three options. The first one is to edit the profile, the second one is to change the password and the third is to sign out. When the user clicks on "Edit profile", the customer is taken to the profile page which contains two parts. The first part preserves the personal information of the customer: the name and the email address as shown in Figure 3.3.

The second part sown in the Figure 3.4 contains all the information that the application needs to work. It is based on the questions the customer answered when first used the application. The service type and the service specifications cannot be updated or changed since a customer is not allowed to use many types of services. Other answers can be updated so the application

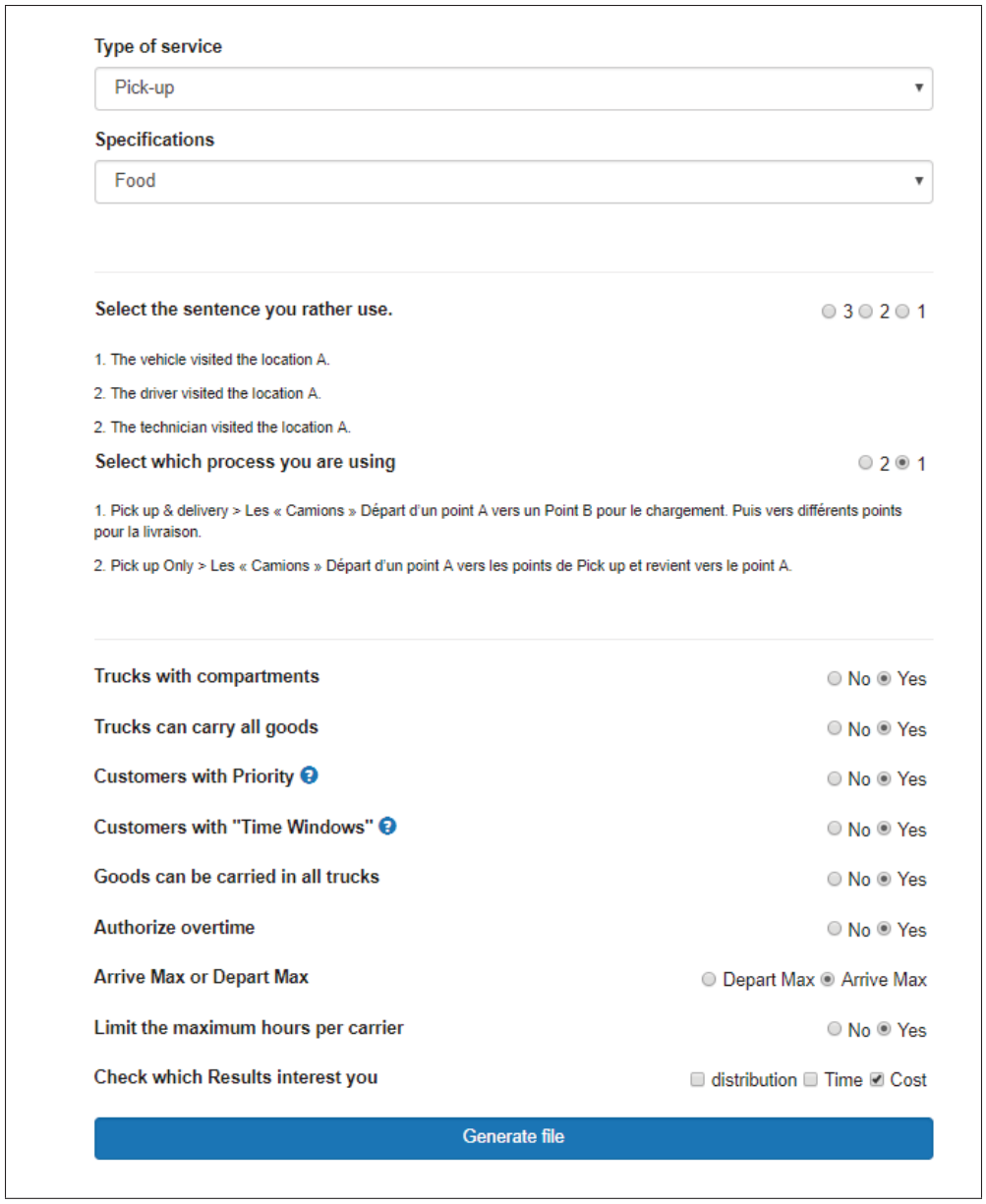


Figure 3.1 List of questions

can adapt to the changes which can occur on the customer model. Questions such as the use of compartments or the use of compatibilities can be changed any time. The unchanged parameters are gray out.

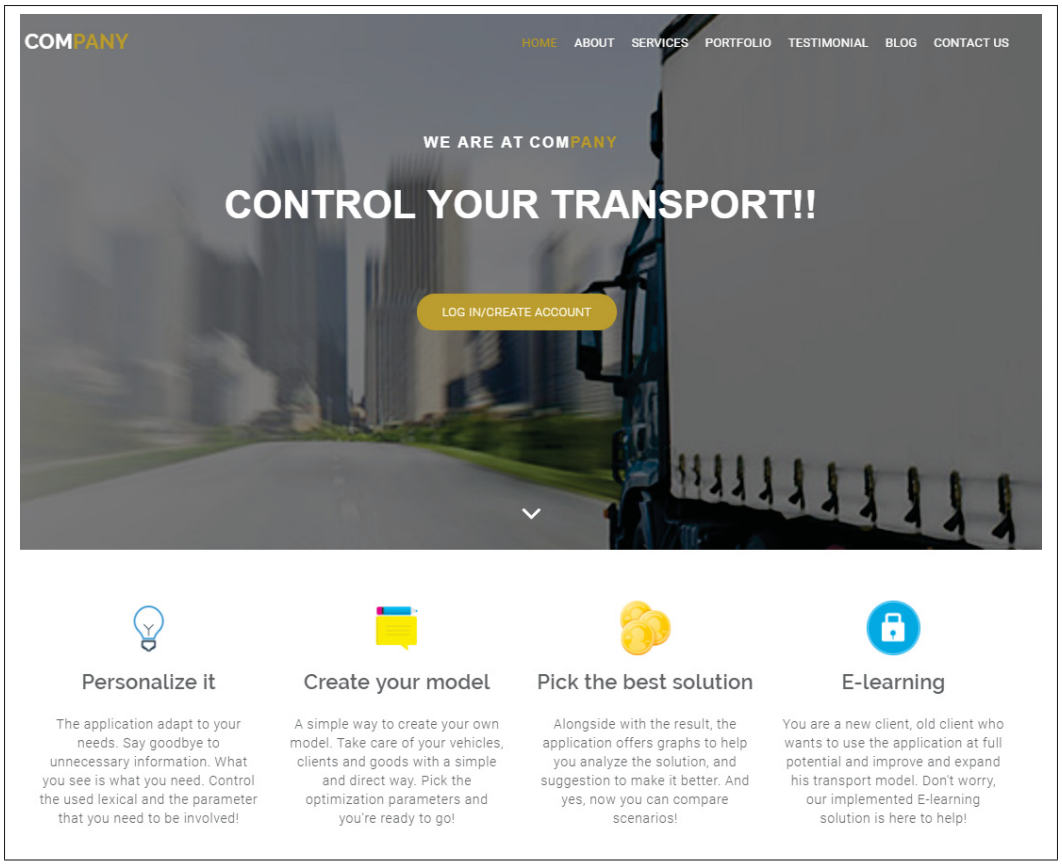


Figure 3.2 Home page

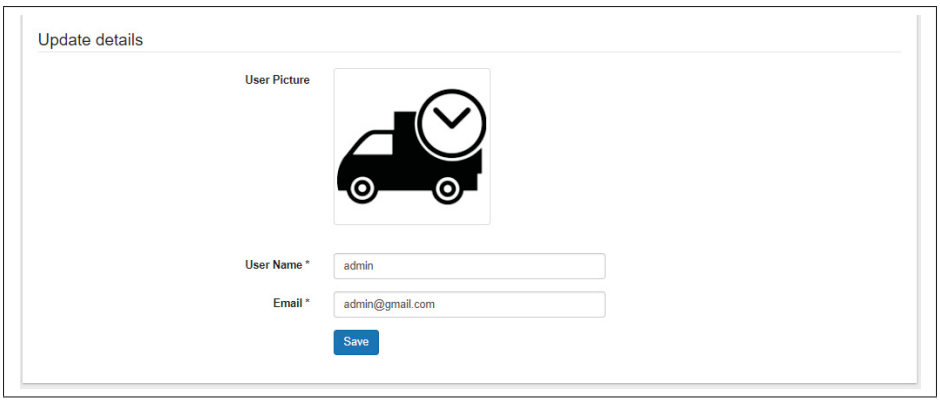


Figure 3.3 Update details

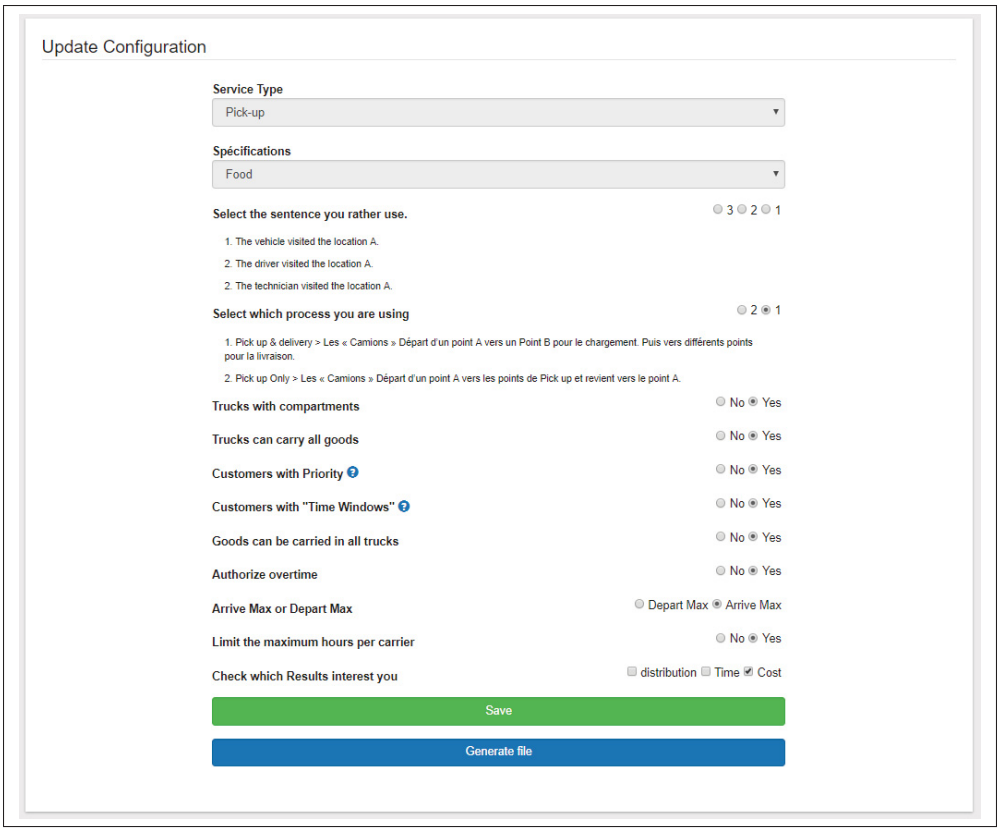


Figure 3.4 Update configuration

3.5.2 Model and optimization Component

While working on the design and the process, we kept in mind that the application need to be intuitive and easy to use. To implement that on the "Model and optimization" page, we used in-page tabs to create a different tab for each data category that need to be submitted. Tabs are generally best used to alternate between views within the same context. For the context of adding the model and optimization data we created four tabs, a specific tab for the vehicles data, for clients data, for goods data and for optimization parameters. The active tab is highlighted so customers can tell which tab is selected. The unselected tabs are clearly visible and readable to remind the user of the additional options.

When the customer access the model and optimization page, his goal is either to create the model or update it. Creating the model is usually one time task and it is done the first time the

customer uses the application. Updating the model requires most of the customers work which can be adding new data or modify existing one. The important objective is to make the access to the data as easy as possible and discard any distraction.

The first thing the customer will see on the page is the first tab associated to vehicles data. The tab will give the user access to a table that shows information about the used vehicles in the model. Figure 3.5 shows the first contact with the model and optimization page.The Vehicles tab is active by default.

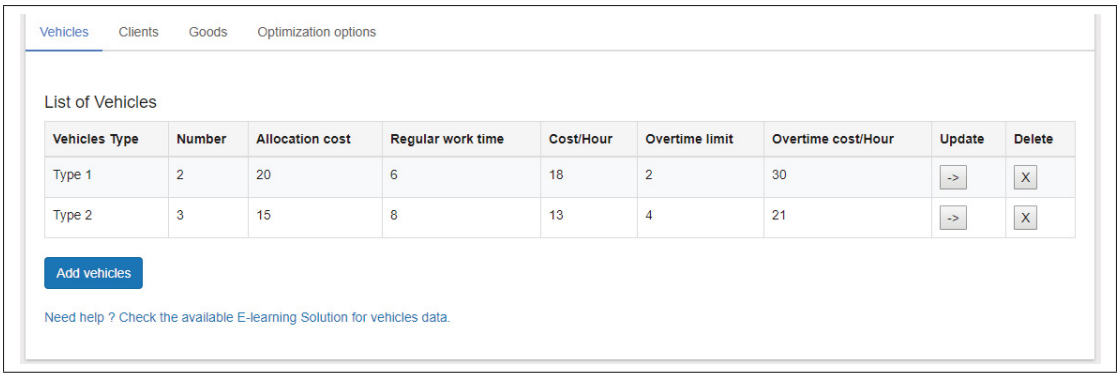


Figure 3.5 Vehicles tab

Right from the table, the user can delete a row or update it. Clicking on delete button will delete the entire row without any need to refresh the page. Clicking on update button will open a model in which the user can access the actual data and update it.

Adding data process is not shown, so the customer can edit or delete data with ease, without the distraction of this specific process. A button is available below the table to start adding data process. When the user clicks the form, the screen illustrated by Figure 3.6 will be shown below the table. No refresh or leaving the tab is needed. The customer will always have access to the actual data.

After adding the information, the customer click save. As result, the new data is added directly to the table without the need to refresh the page.

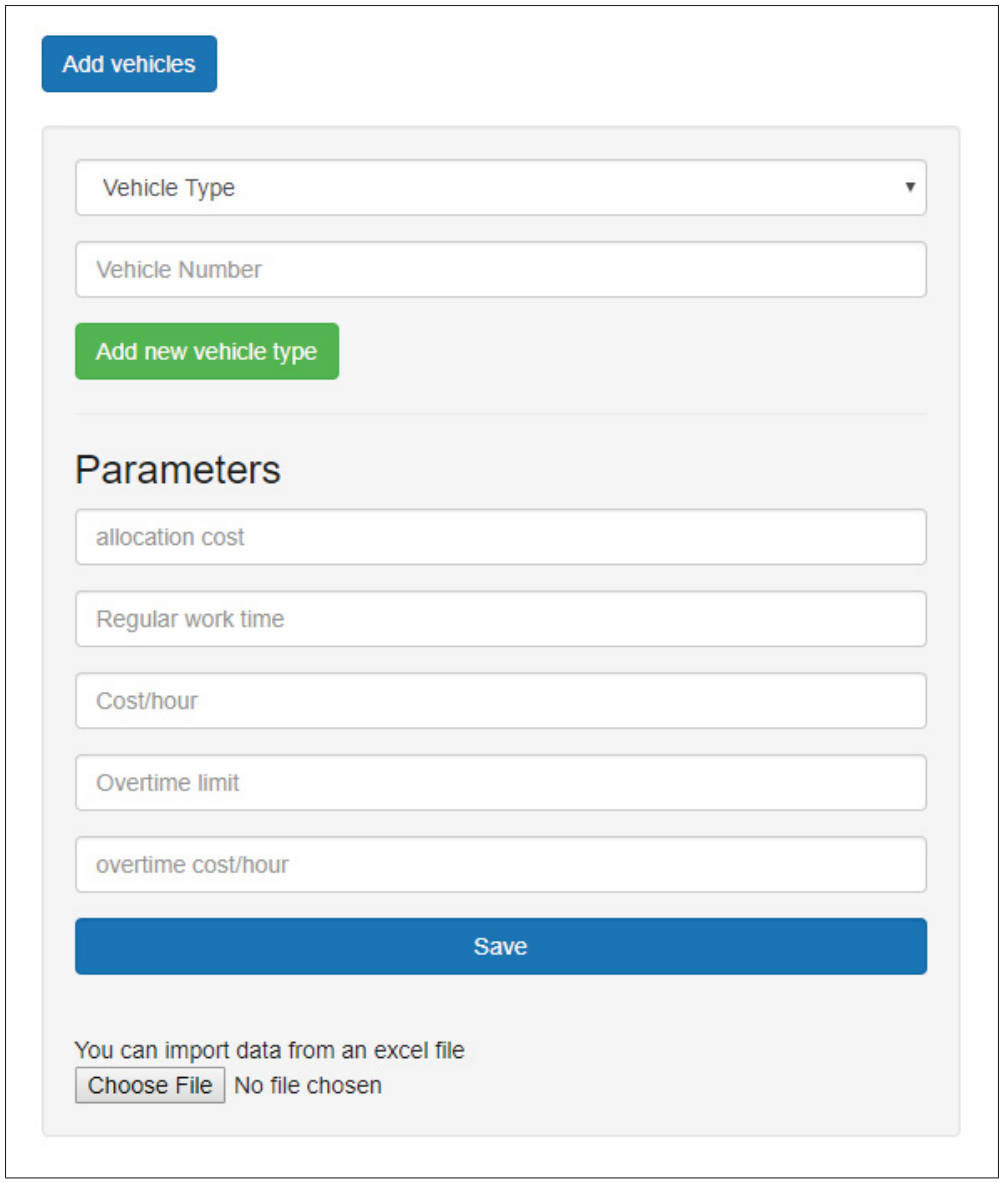


Figure 3.6 Add vehicles data

The old input method is still available for the customers, the application was designed to accept the Excel files which are used with the desktop application. The customer can upload the excel file to load the data into the application.

The same design is used for the clients tab and the goods tab as shown in Figure 3.7 and Figure 3.8. The last tab is the optimization option tab in which the customer can select an option for the optimization as shown in Figure 3.9.

Vehicles Clients Goods Optimization options

List of clients

Name	Address	unvisited cost	Visit duration	Quantity	Time windows
Client 1	Address 1	100	0.5	35	09:00 - 17:00
Client 2	Address 2	120	0.3	27	13:00 - 17:00
Client 3	Address 3	100	0.6	52	06:00 - 17:00

Add client

Figure 3.7 Clients tab

Vehicles Clients Goods Optimization options

List of goods

Name	Size	Weight	Compatibilities
Type 1	2x5x3	5	1-3-4
Type 2	2x2x3	3	2-4

Add good

Figure 3.8 Goods tab

Vehicles Clients Goods Optimization options

Select the optimization option

- Cost
- Time
- distribution

Optimiser

Figure 3.9 Optimization options tab

3.5.3 Result and analyze component

The result page, which is illustrated in Figure 3.10, loads a map with the clients positions and the route to take by each vehicle. Below the map a table is present to provide the needed information. To make the result clearer a list of graphs and charts are implemented so customers can grasp visually the important information so it is easy absorb and comprehend.

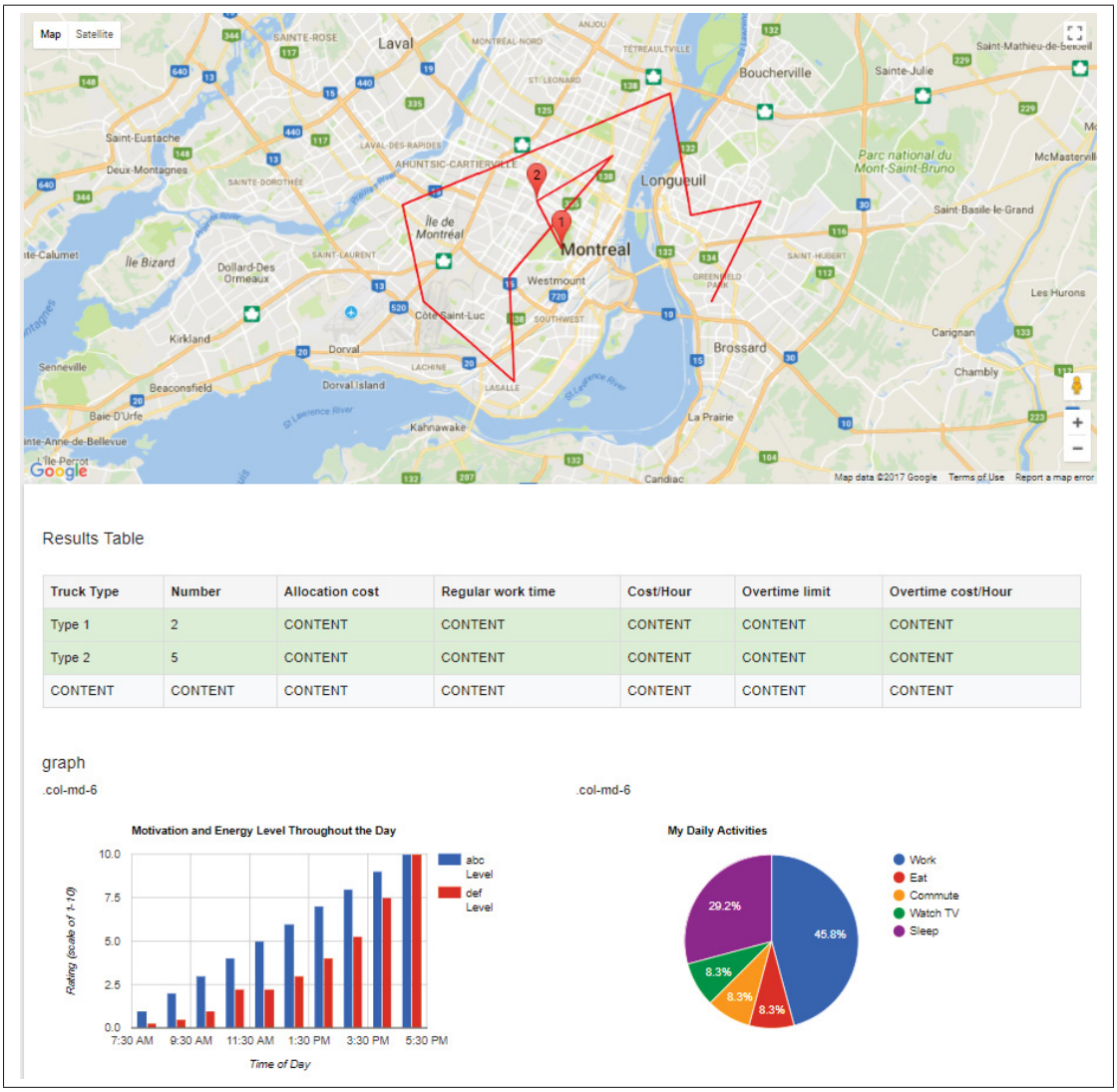


Figure 3.10 Result page

Based on the result, suggestions are offered to the customer. The last suggestion will offer the customer the possibility to compare results using different optimization's parameters. When click compare the customer will be taken to a new page as shown in Figure. The page is devised into two vertically. Each side will present the result of the optimization based on the selected parameters.

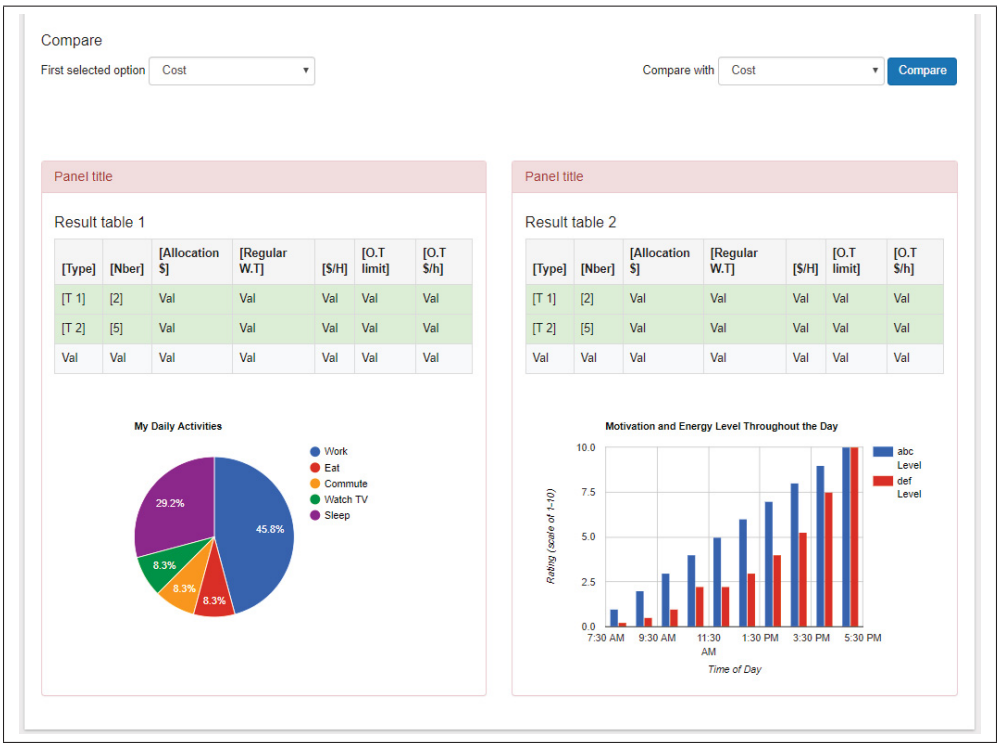


Figure 3.11 Compare page

3.6 E-learning implementation

For the E-learning implementation we choose to work with the ADDIE model. It represents a descriptive guideline for building effective training and performance support tools in five clear phases. Compared to Dick and Carey model, ADDIE model have a clear meaning and easy to understand. This step-by-step method occurs linearly with easy distinction in progression.

3.6.1 Implement an E-learning Solution: ADDIE model Integration

To reduce the knowledge gap and provide clients the needed tools an E-learning solution is implemented. The clients need to be able to complete the tasks with ease. Also, they need to understand and be able to ameliorate the solution when needed. One of the most used models in E-learning is the ADDIE model, this model will be used to develop and integrate the solution within the application.

As explained in the literature review chapter, the ADDIE is an acronym for Analyze, Design, Develop, Implement, and Evaluate. We need to go through these phases to implement this model. We will start with the analysis phase, which requires defining the goal, audience analysis and task analysis. Then, we need to complete the design phase. In this phase we will define the learning objectives, sequencing the course, define both instructional design and delivery strategy. For the development phase, we will provide the company detailed steps and guideline to complete the content development, storyboard development and courseware development. As for the fourth phase, we will implement the E-learning solution in our prototype. For the final phase, we will offer the company solution to be able to evaluate the E-learning solution and its effect on the customers.

3.6.1.1 Analyze

The analyze phase is the first phase in the ADDIE model. In this phase we worked on three parts. First, we analyzed the company problems and confirmed that the E-learning is the best solution. Second, we developed the audience analysis and third we detailed the steps of the task analysis.

A-Analysis

The course audience is composed of customers that work in good transportation field. The used application needs to be configured for each customer, it depends on his type of service and how

much parameters are needed to be involved. The company suffer from two big problems that can be resolved with implementing an E-learning solution:

- **Customer Knowledge**: Each customer has a set of skill and knowledge, that differ from one person to another. the company confirmed that its customer face many issues using the application.
- **Support**: For now, the company only provide direct support via meeting or calls. As known, when the number of customer increase, companies need more man power to answer all customer requests. Sometimes an easy fix for a problem can take an important amount of time to be understood by the customer.

With that we confirmed that a new process must take place. E- learning offers a solution that can solve most of the issues the company facing. Since it offers the needed resources and courses for the customer. Using an E-learning solution, the customers can learn how to use the application without the need to reach the company regarding each issue they face.

B-Audience

Analyzing the target audience is required to identify the different factors that may affect the course design. we defined the list of factors listed bellow.

- **Region or geographic area**: After years providing it services, the company reach many customers from many regions. To respond to customer need and preference the map should cover all the region and two languages must be available: English and French.
- **Type of service**: While all customer work on transportation, five types of services can be distinguished. As results it is possible to consider five groups of customers. Specific learning objectives are defined for each target audience group.
- **Customer knowledge**: Customers do not have the same level of knowledge about the use of the application in general or how to implement the model.

- **Available time**: Usually customers have a limited time available. Chunking the content into small units need to be considered.
- **Learning location**: : Home, office, etc. Customers need offline access.
- **Learning devices**: The application designed to be used on PC, phone or tablet. It is a must that the E-learning platform is compatible with all three devices.
- **Software capabilities**: Needed plug in, multimedia capabilities.

C-Tasks

Task analysis is a very important step. It allowed us to see clearly the task that the customer needs to complete to be able to use the application and achieve his goal. This step is the base that we used to define the required knowledge and the learning objectives in the next sections. To complete the task analysis, we completed four steps as shown in Figure 3.12.

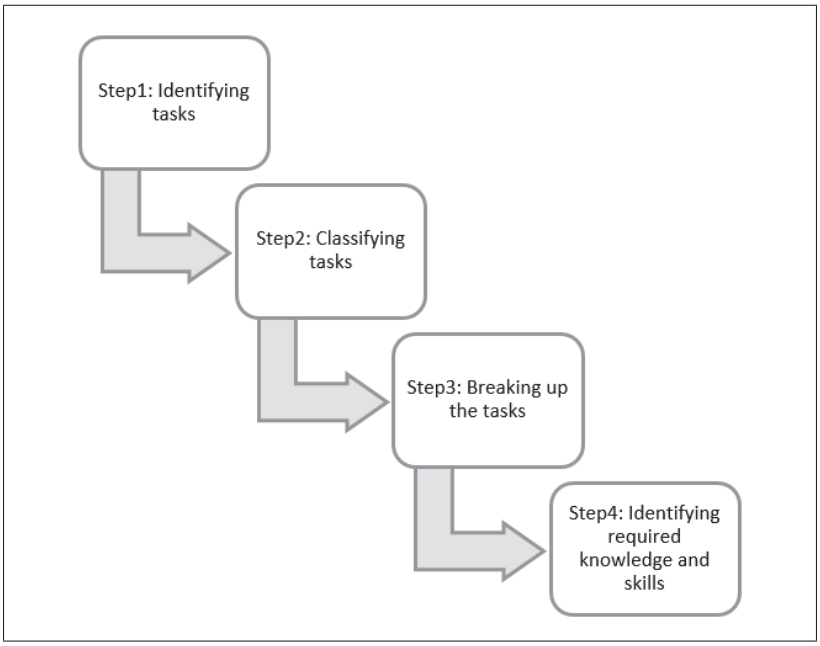


Figure 3.12 task analysis's steps

- Identifying tasks

  We defined three main tasks.

  a. Create the user profile

  b. Setup the model & optimize

  c. Analyze the results

- Classifying tasks

  As explained on the literature review, any task can be classified as procedural or principle-based. The first and second defined tasks are considered as procedural tasks. While the third defined task is considered as principle-based task.

- Breaking up the tasks

  Based on the classification of the task, a task can be broken into Steps or Guidelines. The result of this step is presented in Table 3.1.

Table 3.1 Breaking up the tasks

Tasks	**Steps or guidelines**
Create the user profile	- Create account / Log in - Identify Type of service and specification which affects the list of questions - Answer the list of questions
Setup the model & optimize	- Add vehicles data - Add Clients data - Add Goods data - Set optimization options
Analyze the results	- Understand the results - Criticize the result - Identify the Issue and Check the available suggestions. - Compare (Optional)

- Identifying required knowledge and skills

The fourth step on the task analysis is to determine the required knowledge and skills needed to be able to complete the task. The table 3.2 provide the required knowledge and skills we defined for the first step on the second Task.

Table 3.2 Identifying required knowledge for the first step on the second task

Tasks	**Steps or guidelines**	**Required knowledge**
Setup the model & optimize	- Add vehicles data	How to add a pre-defined type of vehicle How to create a new type of vehicle Difference between costs Available constraints

3.6.1.2 Design

Design is the second phase of the ADDIE model. It answers to how the need should be addressed. At first, we defined the learning objective. Then a sequencing method was selected for the courses. Finally, the instructional strategy and delivery strategy are selected.

A-Learning objectives

We used the task analysis Table 3.2 to define the learning objectives. We develop four learning objectives:

- Explain the concept of manipulating the vehicles data.
- Describe the involved parameters.
- Explain the concept of vehicles group.

Defining the learning objectives is very important since it will be used to develop the course content. Also, it will be used later for the evaluation step to see if the learning objective are met or not.

B-Sequencing

Many sequencing methods are available such as the prerequisite method, the job-oriented course method and the personal learning paths. We used personal learning paths. In fact, this course structure seems the most appropriate in our case. Using a modular approach, the course will be composed of many units and each unit will provide many sessions. The user can pick the session that suit him and reply to his learning needs without being forced to go through a specific path of sessions. This will allow the user to target the knowledge he needs to complete his task.

The outcome of sequencing is a course structure. Using the task analysis and the defined learning objective, we created three main courses: User Profile, model and optimization, result and analyze. Each course is composed of many Units. And each unit provides many sessions. Working on the second course, we created this structure, presented in Figure 3.13.

The previous work on the task analysis and learning objectives shaped the sequencing of the course. In fact, these steps felt simple when developing thanks to the ADDIE model organization. Without the previous work, we could never reach a well-organized course.

After defining the structure, we designed the course plan. The table 3.3 presents the plan detail we developed for the first unit of the second course.

C-Instructional strategy and Delivery strategy

As explained on the literature review, many instructional methods can be used to help learners understand the courses and meet the learning objectives. Three methods are available: expository methods, application methods and collaborative methods.

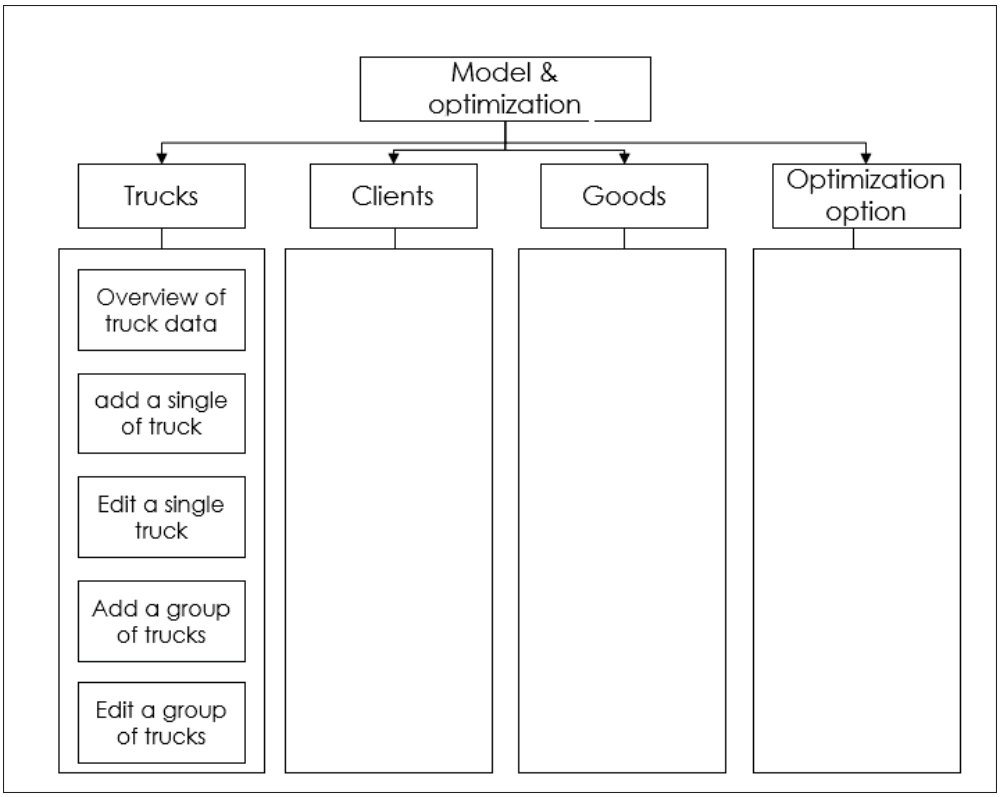


Figure 3.13 Structure of model and optimization course

The collaborative methods will not be used since confidentiality is a very important aspect for the customers and they are not willing to share information one to another. Also, the possibility to implement an interactive solution was discarded. An interactive solution is a time-consuming method which require experts to implement and it require a complex design. Both expository methods and application methods are welcome to be used to deliver the courses. Actually, we Used video as the main delivery format. In fact, Video is a simple delivery formats which is quick to develop for the company and easy to manage for the customer.

The Table 3.4 shows the expository methods and Application methods that can easily be added to the application.

Table 3.3 Course plan for the first unit of the second course

Model & optimization: Unit and lesson title	**Description**
Unit 1: truck	The unit illustrate how a customer can create the truck data and edit. Explain the difference between the concept of a single truck and the concept of a type of truck. It also provides basic concepts of manipulating the data regarding the used and available trucks. It explains the available parameters that can be associate with the truck.
Lesson1.0: Overview of truck data	This lesson review the main functionality and features available in the application linked to truck data.
Lesson 1.1: add a single truck	This lesson demonstrates how to add a single truck to the data and the parameter that need to be filled.
Lesson 1.2: Edit a single trucks	This lesson demonstrates how to edit the parameter for a truck
Lesson 1.3: add a group of trucks	This lesson demonstrates how to create a group of trucks and add it to the data. It explains how the group can be used after it's been created.
Lesson 1.4: Edit a group of trucks	This lesson demonstrates how to edit the parameter for a group of trucks.

3.6.1.3 Development

Development is the third step on the ADDIE model. Two aspects need to be developed. The first aspect is the Course. For that, will offered the company the guidelines and all the needed detail to develop an effective course. As presented in the literature review, it starts with the content development and end with the storyboard development. The second aspect is the design which involves the courseware development. For that, we presented the course interface and integrated the E-learning solution on our prototype.

Table 3.4 Expository methods and Application methods

	Method	**Delivery formats**
Expository methods	presentations case studies worked examples	Documents PPT presentations video lessons
Application methods	Job aids Guided research Project work	technical glossaries Online help e-mail blog audio and video conference shared documents

3.6.1.4 Implement

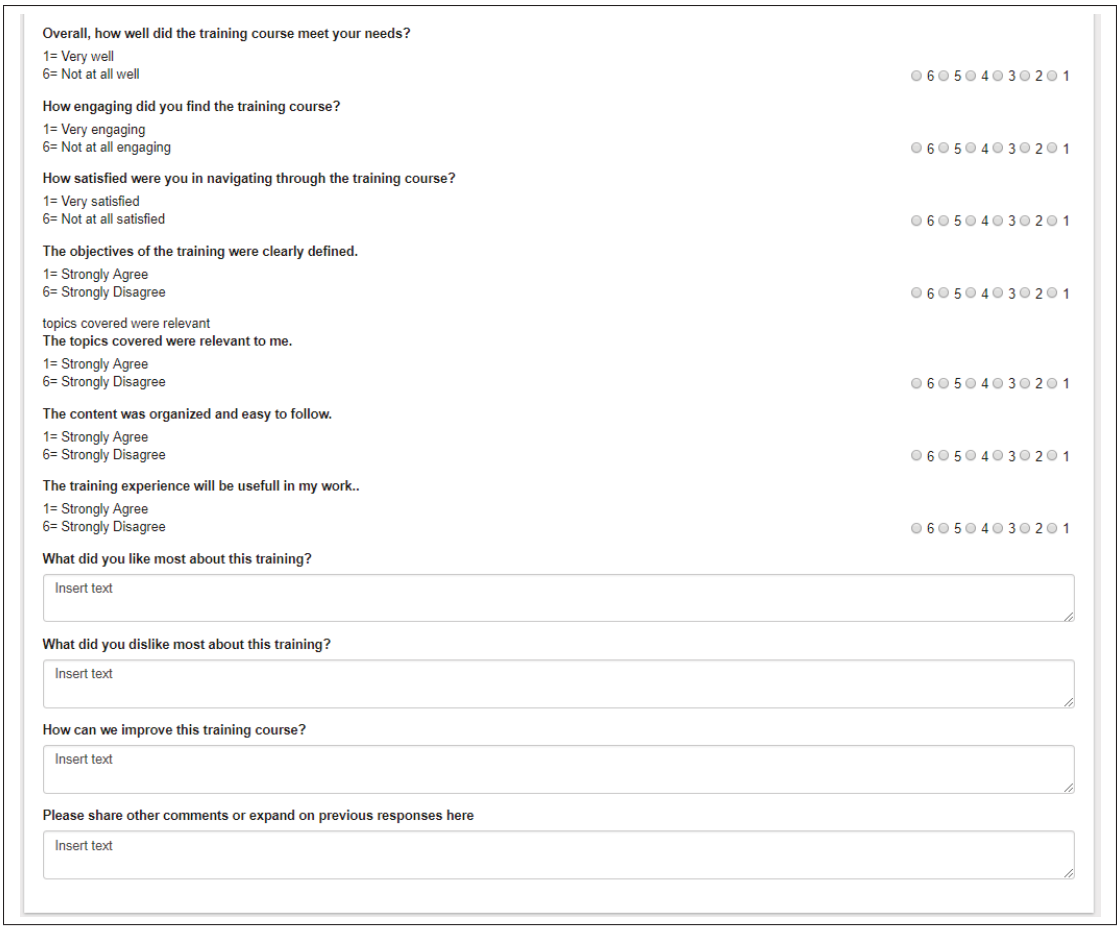
This step involve educating and training end users to use the final product. The system is placed in service in this phase. We provided the company with detailed guideline on the literature review.

3.6.1.5 Evaluate

The last stage of the ADDIE model is Evaluation. WE developed a survey (3.14) and integrated it to the application to collect feedback from the customers. Using this survey we understanding how the customers react to the program and the courses.

3.6.2 Integrate the E-learning into the web application

We dedicated a specific page for the E-learning solution. Two ways are available to access the E-learning content. The first is through the main navigation bar. The second through links available while using the application. For instance, the customer can access directly the lessons under the unit "Vehicles" which belong to the course "model and optimization" from the Vehicles tab when adding or updating the relevant information. Links to a specific learning



Overall, how well did the training course meet your needs?
1= Very well
6= Not at all well
6 5 4 3 2 1

How engaging did you find the training course?
1= Very engaging
6= Not at all engaging
6 5 4 3 2 1

How satisfied were you in navigating through the training course?
1= Very satisfied
6= Not at all satisfied
6 5 4 3 2 1

The objectives of the training were clearly defined.
1= Strongly Agree
6= Strongly Disagree
6 5 4 3 2 1

topics covered were relevant
The topics covered were relevant to me.
1= Strongly Agree
6= Strongly Disagree
6 5 4 3 2 1

The content was organized and easy to follow.
1= Strongly Agree
6= Strongly Disagree
6 5 4 3 2 1

The training experience will be usefull in my work..
1= Strongly Agree
6= Strongly Disagree
6 5 4 3 2 1

What did you like most about this training?
Insert text

What did you dislike most about this training?
Insert text

How can we improve this training course?
Insert text

Please share other comments or expand on previous responses here
Insert text

Figure 3.14 Survey page

content associated with the actual task in hand are powerful tools to allow an easy and a fast access to the needed E-learning resources.

We will use the sequencing defined on ... to create the E-learning process. The first page shows the three defined courses as shown in the Figure 3.15. The course title, number of units and objectives are pieced together under the same panel. This offer a visual distinction between the three courses.

For each course a button named "View units" is available. After picking the course, the customer click "view units" to have access to the available units. When clicked, a float panel on the right side will show and list the available units. Using the same principle used to group the courses' information, a panel will be used for the same purpose for each unit. As shown in

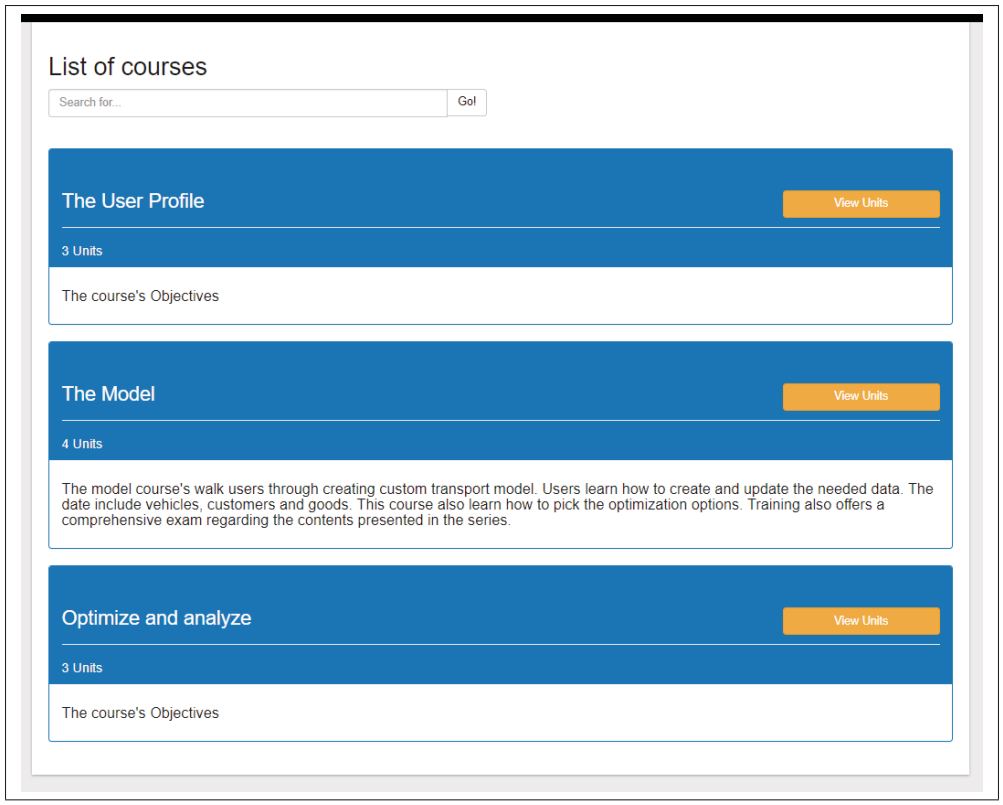


Figure 3.15 List of courses page

the Figure 3.16 a unit is panel have the unit title, a description of the unit is objectives and a progress bar that shows the percentage of the completed lessons under the unit.

Clicking on "View lessons" will take the user to the lessons page. Lessons page is decomposed into two parts. The left side shows a panel with all the lessons names, while the right side shows the content as shown in the Figure 3.17. The content is dynamic and change based on the selected lessons. Each lesson content offers the lesson name followed by the lesson objective which allows the customer to know what to expect from the lesson. The video is loaded below the lesson objective.

The user can access the next lesson or the previous lesson when available using the buttons below the Video. Next to each lesson name, a check mark is added. Its color change from gray which means the lesson is not viewed by the user to green after the user view the content.

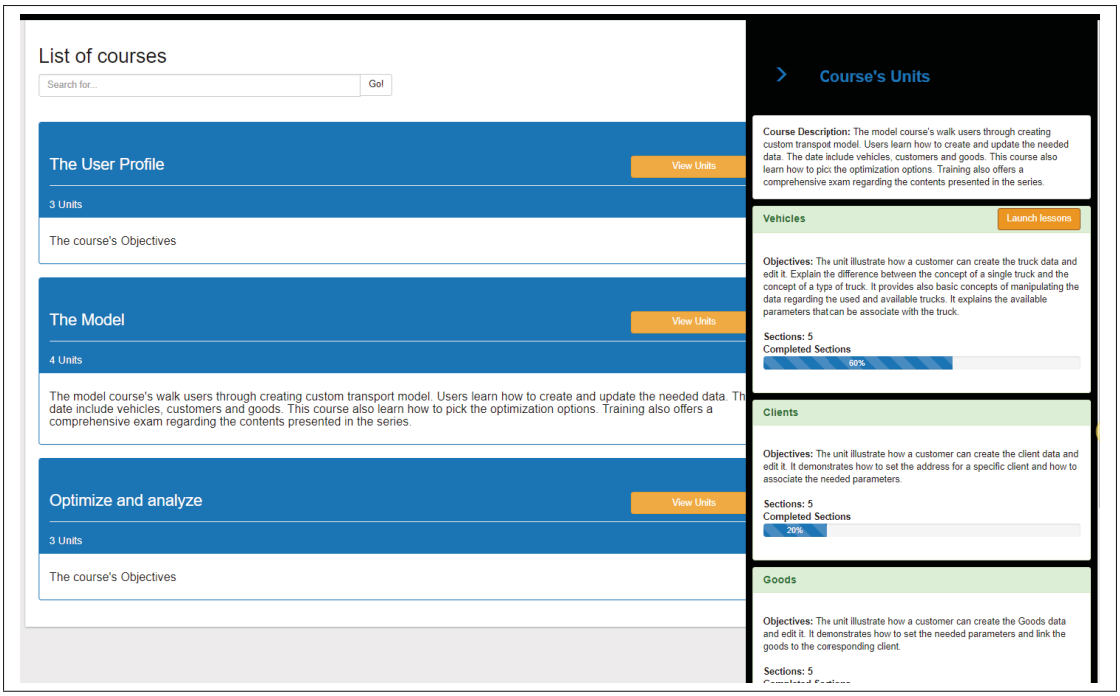


Figure 3.16 Panel of the course units

With each lesson, a survey is available for the customer to take. This will allow the company to collect a feedback about the course and build based on it.

At the end of the list of lessons, the user can take comprehensive exams. This will allow to test the knowledge of the customer after taking the course and confirm if the content respond to the E-learning objective.

3.7 Integration of Human computer interfaces principles

While developing the web application we kept in mind that we need to implement the HCIs principles since fallowing these principles increase the usability of an application.

- **Simple and natural dialogue**: the application offer a simple dialogue. the application also uses Tooltip to offer information when needed. A tooltip is a graphical user interface element, it appears when the user hover the pointer over an item as shown in the Figure 3.18

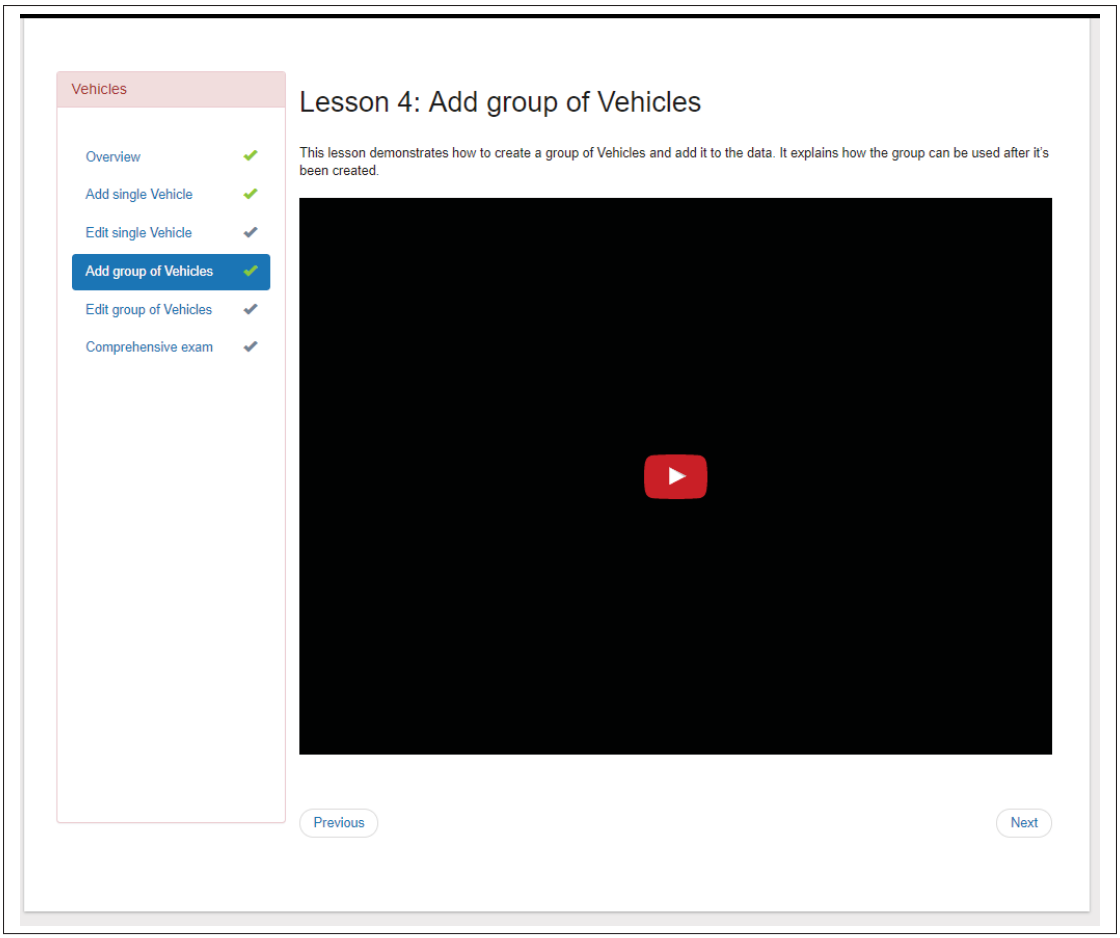


Figure 3.17 Lessons page

Figure 3.18 Survey page

- **Speak the Users' language**: The application only use technical language linked to the transportation field. It is the area of expertises of the company customers. We didn't use a computer language, or terms linked to other fields.

- **Minimize the Users memory load**: The customer can update the data of his model directly in the data table. No need to go to another page and try to remember the entered data or the other available data. All the data is available while editing.

- **Contractive error messages**: Actually, the error messages are not integrated into the application. But when the company create the error message, it should use this principle to provide an acceptable error message. A well constructed error message helps the customer solve the problem that caused the error.

- **Support recall**: Easier to recollect something from before then have to remember something from thin air. give choices better than giving blank space.

- **Clearly marked Exits**: The application always offers an exit solution. If a modal is open, a close button is always available. The customer can always use the navigation bar to go through the application pages.

- **Shortcuts**: This principle is applied through the windows known shortcuts. The application does not offer any special shortcuts to the users. The company can implement this principle to offer a faster way for expert users to get tasks done faster.

- **Feedback**: We created a survey, as shown in Figure 3.14 ,and integrated it to the application. While using the application the customer will have access to the survey link. This will allow the customer to send valuable comment and feedback to the company.

- **Prevent Errors**: An example of integrating this principle is the fact that when a customer tries to add the number of vehicle he can only fill the label with number to prevent the error of submitting a character instead of numbers.

- **Consistency**: To apply the consistency principle of human computer interfaces, the three tabs of data: vehicles data, for clients data, for goods data look and work the same way. Implementing this principle in this context will allow:

    - **Recognizability** : Tabs look the same, as result the customer will know what to look for and easily understand what he finds.

- **Predictability** : Tabs look the same, as result the customer can know what will happen and act based on it.
- **Empowerment**: Customer can rely on his past knowledge to achieve his goal.
- **Efficiency**: No need to spend time leaning new processes and worry about inconsistent features.

3.8 Conclusion

In this chapter we detailed the implementation process of our solution. It offers many advantages to the company and its customers. Customers can now configure their application without the need for the company assistance. This allows them to spend less time on configuring the application and reduce the number of meetings. The result is a reduced starting cost. The customers now have a direct access to the support and many available resources thanks to the implemented E-learning solution. The new process is friendly to use and avoided many of the available solution problems, such as the missing feedback while using the application. The company no longer spends time in creating manually the configuration file. This allows to focus on more valuable tasks. The application offers an easy-to-navigate graphical user interface and more intuitive user experience.

CONCLUSION AND RECOMMENDATIONS

The aim of this work is to solve the manual configuration aspect of a transportation management application, since it raises the starting cost for every project. We solve the complexity of the desktop application by creating a new user experience using a web solution. Finally, the aim of this work was to solve the customer knowledge gap related to the use of the application. To do so, we have automated the configuration process of a transportation management application. We provided a user-friendly application for small business customers and integrated an E-learning solution using an instructional design process.

After doing a literature review that allowed us to get familiar with the web-based training domain, E-learning solutions, some instructional design models, and an implementation of an ADDIE model took place. Based on this model and by walking through its different phases, we created an efficient and a user-friendly learning experience for the customers. This work confirmed that the ADDIE model is a general model that can be used effectively on many fields. Our literature review on the web application development technologies allowed us to create a functional prototype despite of our limited programing knowledge. We learned that there is no need to use different languages for front-end and back-end sides of a web application. Thanks to a NodeJS framework (meteorJS), we only used one language which allowed us to accelerate our work on the development of the application.

The limit of this work is that the development and implementation of an ADDIE model requires a team work. We have been able to develop many parts of this model. However, the development of the course content and the implementation of the solution requires the help of instructors. Regarding the parts we did not develop, we offered the company the needed details and guidelines to be able to complete it. Also, there is a limitation regarding the evaluation phase. In fact, many aspects of the evaluation phase can only be done after creating a complete product. As a result, only survey is integrated on our solution as evaluation method.

With the available work, the company has in hand a prototype that answers the requested requirements. First, the customer can create the configuration file without the need of the company support. The generation of the configuration file based on the customer answer is functional. Second, a new simpler experience for small business company is afforded. A user-friendly interface that implement the principles of human computer interfaces is provided. Finally, we implemented E-learning solution that offers very valuable resources for the customers.

As future work, for the automation process, it will be very interesting to add a dynamic aspect to the list of questions. That means, the list of questions can adapt directly after the customer select the type of service. For instance, if the customer select "Home service" as types of service there is no need to show the compartment question. Since the prototype can be used for usability testing, the future work can involve a usability testing with some selected customers. The goal is to get an idea about how the customers react to the new process and the new application. After receiving the customer feedback, the company can work on completing the development of the application with dynamic contents. For the integrated E-learning solution, the future work will consist of developing the content and add it to the application. Also, some research can involve integrating more methods for evaluation. For instance, if we know that the user clicked back or canceled many times on a specific part of the application, we can confirm that there is an issue in that part. It is also possible to calculate the number of clicks that the customer took to complete a task. Based on that, recommendation can be sent and improvement can take place.

Another future work that can be very interesting is the amelioration of the used vehicle routing algorithm. In fact, the actual used algorithm is using a single objective function which allows to minimize the cost. Using multi-objective algorithms can offer alternative solutions for the company customers.

APPENDIX I

1. HTML Form

For the configuration file, the user needs to answer some question. The form is developed using HTML, CSS and JavaScript. In the following we will present the components we used for the form.

a. **Dropdown list**: We use drop down list for the selection of the type of service and the specification of the selected type. We present an example to show how to create a dropdown list:

```
<form>
<select name="dropdownname">
  <option value="item1">item 1</option>
  <option value="item2">item 2</option>
  <option value="item3">item 3</option>
  <option value="item4">item 4</option>
</select>
</form>
```

b. **Radio button**:We use a radio buttons when the user needs to make one choice from multiple ones. We present an example to show how to create radio buttons.

```
<form>
  <input type="radio" name="Answer" value="Value1" checked> Value 1
  <input type="radio" name="Answer" value="Value2"> Value 2<br>
  <input type="radio" name="Answer" value="Value3"> Value 3
</form>
```

c. **Checkbox**: We use checkbox when the user needs to make one or multiple choices from multiple ones We present an example to show how to create a list of checkbox.

```
<form>
  <input type="checkbox" name="vehicle1" value="Value1"> Vehicle 1<br>
  <input type="checkbox" name="vehicle2" value="value2"> vehicle 2
</form>
```

d. **Submit button** : We use a submit button to submit the form. The code to do so is:

```
<form>
<input type="submit" value="Generate">
</form>
```

2. Data Base

The data is stored as documents in a binary representation called BSON (Binary JSON). Documents are analogous to columns in a relational database. Collections, on the other hand, are analogous to a table in a relational database where we store documents that shares a similar structure. For example, we present the user and the truck collections.

a. **User Model**: The user model contains the following attributes.

```
_Id
CreatedAt
Services
Username
Emails
Profile
```

Each user has a unique id, a unique username. The id in generated automatically by MongoDB. When a new user create a new account, we check if the username is already taken. If it is the case, an error message is displayed.

We keep the information about the time the account was created. Services field is for the authentication process. It stores both the password (crypted) and the login token. For

the authentication we use the accounts-password package. To install it we execute the command:

```
meteor add accounts-password
```

The Emails fields store the email account and a Boolean field to indicate if the email was verified. Finally, the "profile field" store the user data such as the picture URL.

We present an example for a user:


```
{
    "_id" : "XCiKxNf4rABqRN9fX",
    "createdAt" : ISODate("2017-05-06T10:39:52.973Z"),
    "services" : {
        "password" : {
            "bcrypt" : "$2a$10$IPqu8uk9PkMc./gs8IkDX.SsioAiONmgagmD
        },
        "resume" : {
            "loginTokens" : [
                {
                    "when" : ISODate("2017-05-06T10:39:52.999Z"),
                    "hashedToken" : "Lor4+Gz/SvkBzjcaHnEhbqh0xPq2rFq
                }
            ]
        }
    },
    "username" : "admin3",
    "emails" : [
        {
            "address" : "admin3@admin.com",
            "verified" : false
```

```
            }
        ],
        "profile" : {
            "picture" : picture url
        }
    }
```

b. **Truck model**: The truck model contains the following attributes.

```
_Id
CreatedAt
UserId
vehType
Number
Allocation
RegularTime
CostHour
OvertimeLimit
OvertimeCost
```

Each truck has a unique id, generated automatically by MongoDB. We keep the time of the creation of the truck and the user who create it. The data stored for the truck are:

- The truck type
- The number of trucks available
- The Capacity of the truck
- The regular time
- The hourly cost for using the truck
- The overtime limit allowed for the vehicle
- The hourly cost for the overtime

As an exemple:


```
{
    "_id" : f7vChHvEThLQMvPsJ,
    "userId" : "XCiKxNf4rABqRN9fX",
    "vehtype" : "Type 1",
    "number" : "1",
    "allocation" : "12",
    "regularTime" : "12",
    "costHour" : "12",
    "overtimeLimit" : "12",
    "overtimeCost" : "123",
    "createdAt" : ISODate("2017-09-24T17:12:20.450Z")
}
```

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