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By: SAMY IBRAHIM

TOPIC

Decision Support System
Case: Multi-modal Transport System

Defended publicly on:/06/2014 by the jury consisted of:

| | | |
|----------------------|----------------------|-------------|
| Mr. | University of M'sila | President. |
| Mr. Ibrahimi Mahmoud | University of M'sila | Supervisor. |
| Mr. | University of M'sila | Examiner. |

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To the great parents before being great professors

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Dedication

Thanks to ALLAH in the first and last place.

Our fathers and mothers are among Allah's greatest gifts to us, let's honor them with respect, love and appreciation and let us not forget them in our prayers.

To my great mother "**FATIHA**" may ALLAH bless her soul and To my great father **SAMI** who have helped, supported, encouraged, advised and sacrificed a lot for me to be a good man, thank you about everything.

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SUMMARY

| | |
|---------------------------|---|
| General introduction..... | 1 |
|---------------------------|---|

First chapter

| | |
|---|----|
| 1. Introduction..... | 3 |
| 2. Reasons for using decision support systems..... | 3 |
| 3. Decision support systems definition..... | 4 |
| 4. Components of decisional support system..... | 4 |
| 4.1 Database management system (DBMS) | 4 |
| 4.2 Model-base management system (MBMS)..... | 4 |
| 4.3 Dialog generation and management system (DGMS)..... | 5 |
| 5. Characteristics of decisional support system..... | 5 |
| 6. Capabilities of Decision Support System..... | 6 |
| 7. Decision support system advantages..... | 7 |
| 8. Decision support system Disadvantages..... | 8 |
| 9. Fields of applying DSS in our life..... | 11 |
| 10. The importance of transport in our live..... | 11 |
| 11. The development of the transport system..... | 11 |
| 12. Reasons for preferring transport on driving..... | 12 |
| 13. The definition of the multi-modal transport system..... | 13 |
| 14. The reason for using multi-modal transport system..... | 13 |
| 15. The advantages of multi-modal transport system..... | 14 |
| 15.1 Minimizes time loss at trans-shipment points..... | 14 |
| 15.2 Provides faster transit of goods..... | 15 |
| 15.3 Reduces burden of documentation and formalities..... | 15 |
| 15.4 Saves cost..... | 15 |
| 15.5 Establishes only one agency to deal with..... | 15 |

| | |
|---|----|
| 15.6 Reduces cost of exports..... | 15 |
| 16. Forms of multimodal transport operations..... | 16 |
| 16.1 Land-Sea-Land..... | 16 |
| 16.2 Road/Air/Road..... | 17 |
| 16.3 Sea/Air/Sea..... | 17 |
| 16.4 Rail/road/inland waterways/sea..... | 17 |
| 16.5 Ro-Ro (Roll-on/Roll-off)..... | 18 |
| 16.6 L.A.S.H. (Lighter Abroad Ship)..... | 18 |
| 16.7 Piggyback..... | 18 |
| 16.8 Sea train..... | 19 |
| 17. Conclusion..... | 20 |

Second chapter

| | |
|--|----|
| 1. Introduction | 21 |
| 2. Problem Description | 21 |
| 3. Graph Representation | 23 |
| 4. Transfer Graph Model Definitions | 24 |
| 4.1 Multi-Modal Graph Definition | 24 |
| 4.2 Multimodal path | 25 |
| 4.3 Time-dependent multimodal network | 25 |
| 4.4 Time-dependent cost..... | 25 |
| 4.5 Shortest Path Problem, SPP | 26 |
| 5. Transfer Graph | 26 |
| 6. Relevant Graph..... | 26 |
| 6.1 Full path | 26 |
| 6.2 Relevant head paths | 26 |
| 6.3 Relevant intermediate paths..... | 27 |
| 6.4 Relevant tail paths..... | 27 |
| 7. Solving the Transfer Graph | 27 |
| 8. Approaches to Compute Pre-calculations..... | 28 |

| | |
|---|----|
| 8.1 Computing Pre-calculations with Dijkstra's Algorithm..... | 28 |
| 8.2 Computing Pre-calculations with ACO..... | 29 |
| 8.3 Comparison between Dijkstra and Ant Colony Algorithm..... | 30 |
| 9. Dijkstra Algorithm..... | 31 |
| 9.1 Single-Source Shortest Path Problem..... | 31 |
| 9.2 Output of Dijkstra's Algorithm..... | 33 |
| 10. Conclusion..... | 34 |

Third chapter

| | |
|---|----|
| 1. Introduction..... | 35 |
| 2. Use Case Diagram | 36 |
| 2.1 Use Case Diagram Representation | 37 |
| 3. Class Diagram | 38 |
| 3.1 Class Diagram Representation | 39 |
| 4. Interaction Diagram | 40 |
| 4.1 Sequence Diagram Representation | 40 |
| 4.1.1 Administrator Sequence Diagram Representation | 41 |
| 4.1.2 User Sequence Diagram Representation | 42 |
| 5. Activity Diagram | 43 |
| 5.1 Activity Diagram Representation | 44 |
| 5.1.1 Points Activity Diagram | 44 |
| 5.1.2 Trips Activity Diagram..... | 45 |
| 5.1.3 Paths Activity Diagram | 46 |
| 5.1.4Search Activity Diagram | 47 |
| 6. Conclusion | 48 |

Fourth chapter

| | |
|--------------------------------------|----|
| 1. Introduction | 49 |
| 2. The development environment | 49 |

| | |
|---|-----------|
| 2.1. Software aspect | 49 |
| 2.2. Language choice | 50 |
| 2.2.1 ASP | 50 |
| 2.2.2 C#.Net | 51 |
| 2.3. Database management system (DBMS)..... | 51 |
| 3. Test | |
| 3.1 Add Point..... | 52 |
| 3.2 Add Trip..... | 53 |
| 3.3 Get Trip Paths..... | 53 |
| 3.4 Add Path..... | 54 |
| 3.5 Search..... | 55 |
| 5. Conclusion..... | 56 |
| General conclusion | 57 |

LIST OF
TABLES

Chapter 2

| | | |
|-----------|--|----|
| Table 2.1 | Results for the Dijkstra algorithm on different instances of the SPP | 29 |
| Table 2.2 | Performance of ACO algorithm on different instances of the SPP | 27 |

LIST OF
FIGURES

Chapter 1

| | | |
|------------|---|----|
| Figure 1.1 | Representation of Multi-modal Network | 13 |
| Figure 1.2 | Representation of modes combinations | 14 |
| Figure 1.3 | Represent the land-sea-land operation | 16 |
| Figure 1.4 | Represent piggyback trailer train | 19 |

Chapter 2

| | | |
|------------|--|----|
| Figure 2.1 | Difference between Unimodal and Multi-modal Trip | 22 |
| Figure 2.2 | Modal Transfer..... | 23 |
| Figure 2.3 | Multi-Modal Graph | 24 |
| Figure 2.4 | Multi-Modal Path | 25 |
| Figure 2.5 | Comparison between Dijkstra and ACO | 30 |
| Figure 2.6 | Single-Source Shortest Path | 31 |
| Figure 2.7 | Shortest Path description | 32 |
| Figure 2.8 | Obtaining the shortest path of acquired path value | 33 |

Chapter 3

| | | |
|------------|--|----|
| Figure 3.1 | Use Case Diagram | 37 |
| Figure 3.2 | Class Diagram | 39 |
| Figure 3.3 | Administrator Sequence Diagram | 41 |
| Figure 3.4 | User Sequence Diagram | 42 |
| Figure 3.5 | Activity Diagram for Points Management | 44 |
| Figure 3.6 | Activity Diagram for Trips Management | 45 |
| Figure 3.7 | Activity Diagram for Paths Management | 46 |
| Figure 3.8 | Activity Diagram for Search operation | 47 |

Chapter 4

| | | |
|------------|--|----|
| Figure 4.1 | add point..... | 52 |
| Figure 4.2 | add a trip..... | 53 |
| Figure 4.3 | get trip path..... | 53 |
| Figure 4.4 | add a path..... | 54 |
| Figure 4.5 | search by all the models..... | 54 |
| Figure 4.6 | search by using the quickest option..... | 55 |

**GENERAL
INTRODUCTION**

General Introduction

Undoubtedly, that consists of a change of carrier during the travel, one or more times using different connections, is nowadays almost necessary in many kinds of transports, both concerning freight and passenger mobility. There is hence the need of establishing the proper sequence of means and commuting points that could allow advantages for the travellers. The costs of multimodal routes are given by the cost of the travels related to each modality plus the cost implied by the change of modality, that is the so called transition costs. When using multimodal routes some travelling costs can be reduced since economies of scales can be obtained when using different transportation modalities, especially those related to the mass transit modality. Moreover, the usage of a mass transit modality allows a great saving in terms of cost and pollution, Hence the importance of Multi-Modal Transport start to take its place, so it's important for us to be able to join the pace of change and the improvement all over the world, we have to develop a modern and innovation system that can help in the improvement of the transportation in our country, because the development of any country always depends on the quality and rationality of its transport system.

Objective of this work:

The objective of the work entitled “**Decision Support System case: Multi-Modal Transport System**” is the creation of an infrastructure of the multimodal network then search for minimum cost (Time, Money, Distance) paths on multimodal transport networks, also how to find the best path point to point. Here we seek to minimize the travel time, also decrease travel cost which make the things easier to the passengers to decide How, Where and When to displace from one point to another with an available and easy way.

Memory organization:

About the methodological plan of our work, our dissertation is divided into four chapters:

- In the first chapter we will discuss some notions about the decision support systems and also some important concepts related to the transport operations and systems.
- The second chapter presents the shortest path problem, graph representation and other methods and strategies that used in the MTS; we will also make a comparison between the available methods seeking to find a suitable one to implement in our system.
- Third chapter presents the conceptual study of our system, the principal structural and behavioral UML diagrams that give the user a visualization way to manipulate the system.
- Finally we will discuss the required tools used in the implementation of our system; also we will present various shots of the different sections of the system and the tasks of each section.

CHAPTER 01

FUNDAMENTALS

ABOUT DECISION

SUPPORT SYSTEMS

1. Introduction:

Academic Researchers from many disciplines has been studying DSS for approximately 40 years. According to Keen and Scott Morton (1978), the concept of decision support has evolved from two main areas of research: the theoretical studies of organizational decision making done at the Carnegie Institute of Technology during the late 1950s and early 1960s, and the technical work on interactive computer systems, mainly carried out at the Massachusetts Institute of Technology in the 1960s. It is considered that the concept of DSS became an area of research of its own in the middle of the 1970s, before gaining in intensity during the 1980s. In the middle and late 1980s, Executive Information Systems (EIS), group decision support systems (GDSS), and organizational decision support systems (ODSS) evolved from the single user and model-oriented DSS. Beginning in about 1990, data warehousing and on-line analytical processing (OLAP) began broadening the realm of DSS. As the turn of the millennium approached, new Web-based analytical applications were introduced. [1]

Studies on DSS development conducted during the last 15 years have identified more than 30 different approaches to the design and construction of decision support methods and systems. Interestingly enough, none of these approaches predominate and the various DSS development processes usually remain very distinct and project-specific. This situation can be interpreted as a sign that the field of DSS development should soon enter in its formalization stage, so in this chapter we'll discuss some notions about the decision support system, the fields that we can use DSS in our life and some important concepts related to the transport operations and systems.

2. Reasons for using decision support systems:

Increasing the complexity of decisions, the continuous increasing of the volume of data everywhere and not the time to think, big number and complexity of options, pace of change, increasing availability of computerized support and increasing usability of computers all that make DSS necessary and very important.

3. Decision support systems definition:

Decision support systems are interactive, computer-based systems that aid users in judgment and choice activities. They provide data storage and retrieval but enhance the traditional information access and retrieval functions with support for model building and model-based reasoning. They support framing, modeling, and problem solving. Typical application areas of DSSs are management and planning in business, health care, the military, and any area in which management will encounter complex decision situations. Decision support systems are typically used for strategic and tactical decisions faced by upper-level management, decisions with a reasonably low frequency and high potential consequences in which the time taken for thinking through and modeling the problem pays off generously in the long run.

4. Components of decisional support system:

There are three fundamental components of DSSs; we can list these components as follow:

4.1 Database management system (DBMS):

A DBMS serves as a data bank for the DSS. It stores large quantities of data that are relevant to the class of problems for which the DSS has been designed and provides logical data structures (as opposed to the physical data structures) with which the users interact. A DBMS separates the users from the physical aspects of the database structure and processing. It should also be capable of informing the user of the types of data that are available and how to gain access to them.

4.2 Model-base management system (MBMS):

The role of MBMS is analogous to that of a DBMS. Its primary function is providing independence between specific models that are used in a DSS from the applications that use them. The purpose of an MBMS is to transform data from the DBMS into information that is useful in decision making. Since many problems that the user of a DSS will cope with may be unstructured, the MBMS should also be capable of assisting the user in model building.

4.3 Dialog generation and management system (DGMS):

The main product of an interaction with a DSS is insight. As their users are often managers who are not computer-trained, DSSs need to be equipped with intuitive and easy-to-use interfaces. These interfaces aid in model building, but also in interaction with the model, such as gaining insight and recommendations from it. The primary responsibility of a DGMS is to enhance the ability of the system user to utilize and benefit from the DSS. In the remainder of this article, we will use the broader term user interface rather than DGMS. [2]

5. Characteristics of decisional support system:

The following part contains some characteristics of DSS:

- **Facilitation:** DSS facilitate and support specific decision-making activities and/or decision processes.
- **Interaction:** DSS are computer-based systems designed for interactive use by decision makers or staff users who control the sequence of interaction and the operations performed.
- **Ancillary:** DSS can support decision makers at any level in an organization. They are NOT intended to replace decision makers.
- **Repeated Use:** DSS are intended for repeated use. A specific DSS may be used routinely or used as needed for ad hoc decision support tasks.
- **Task-oriented:** DSS provide specific capabilities that support one or more tasks related to decision-making, including: intelligence and data analysis; identification and design of alternatives; choice among alternatives; and decision implementation.
- **Identifiable:** DSS may be independent systems that collect or replicate data from other information systems OR subsystems of a larger, more integrated information system.

- **Decision Impact:** DSS are intended to improve the accuracy, timeliness, quality and overall effectiveness of a specific decision or a set of related decisions.
- **Comprehensive Data Access:** It allows users to access data from different sources concurrently, leaving organizations the freedom to choose the data warehouse that best suits their unique requirements and preferences.

6. Capabilities of Decision Support System:

The key DSS capabilities are as follows:

1. Support for decision makers in semi-structured and unstructured problems.
2. Support managers at all levels.
3. Support individuals and groups.
4. Support for interdependent or sequential decisions.
5. Support intelligence, design, choice, and implementation.
6. Support variety of decision processes and styles.
7. DSS should be adaptable and flexible.
8. DSS should be interactive ease of use.
9. Effectiveness, but not efficiency.
10. Complete control by decision-makers.
11. Ease of development by end users.
12. Support modeling and analysis.
13. Data access.
14. Standalone, integration and Web-based.[3]

7. Decision support system advantages:

There are of course a lot of the benefits for DSS users, for example:

-Time savings: For all categories of decision support systems, research has demonstrated and substantiated reduced decision cycle time, increased employee productivity and more timely information for decision making. The time savings that have been documented from using computerized decision support are often substantial. Researchers, however, have not always demonstrated that decision quality remained the same or actually improved.

-Enhance effectiveness: A second category of advantage that has been widely discussed and examined is improved decision making effectiveness and better decisions. Decision quality and decision making effectiveness are however hard to document and measure. Most researches have examined soft measures like perceived decision quality rather than objective measures. Advocates of building data warehouses identify the possibility of more and better analysis that can improve decision making.

-Improve interpersonal communication: DSS can improve communication and collaboration among decision makers. In appropriate circumstances, communications- driven and group DSS have had this impact. Model-driven DSS provides a means for sharing facts and assumptions. Data-driven DSS make "one version of the truth" about company operations available to managers and hence can encourage fact-based decision making. Improved data accessibility is often a major motivation for building a data-driven DSS. This advantage has not been adequately demonstrated for most types of DSS.

-Competitive advantage: Vendors frequently cite this advantage for business intelligence systems, performance management systems, and web-based DSS. Although it is possible to gain a competitive advantage from computerized decision support, this is not a likely outcome. Vendors routinely sell the same product to competitors and even help with the installation. Organizations are most likely to gain this advantage from novel, high risk, enterprise-wide, inward facing decision support systems. Measuring this is and will continue to be difficult.

-Cost reduction: Some researches and especially case studies have documented DSS cost saving from labor savings in making decisions and from lower infrastructure or technology costs. This is not always a goal of building DSS.

-Increase decision maker satisfaction: The novelty of using computers has and may continue to confound analysis of this outcome. DSS may reduce frustrations of decision makers, create perceptions that better information is being used and/or creates perceptions that the individual is a "better" decision maker. Satisfaction is a complex measure and researchers often measure satisfaction with the DSS rather than satisfaction with using a DSS in decision making. Some studies have compared satisfaction with and without computerized decision aids. Those studies suggest the complexity and "love/hate" tension of using computers for decision support.

-Promote learning: Learning can occur as a by-product of initial and ongoing use of a DSS. Two types of learning seem to occur: learning of new concepts and the development of a better factual understanding of the business and decision making environment. Some DSS serve as "de facto" training tools for new employees. This potential advantage has not been adequately examined.

-Increase organizational control: Data-driven DSS often make business transaction data available for performance monitoring and ad hoc querying. Such systems can enhance management understanding of business operations and managers perceive that this is useful. What is not always evident is the financial benefit from increasingly detailed data.

8. Decision support system Disadvantages:

Although Decision Support System can create advantages for organizations and can have positive benefits, building and using Decision Support System can create negative outcomes in some situations as follow:

-Monetary cost: The decision support system requires investing in information system to collect data from many sources and analyze them to support the decision making. Some analysis for Decision Support System needs the advance of data analysis, statistics, econometrics and information system, so it is the high cost to hire the specialists to set up the system.

-Overemphasize decision making: Clearly the focus of those of us interested in computerized decision support is on decisions and decision making. Implementing Decision Support System may reinforce the rational perspective and overemphasize decision processes and decision making. It is important to educate managers about the broader context of decision making and the social, political and emotional factors that impact organizational success. It is especially important to continue examining when and under what circumstances Decision Support System should be built and used. We must continue asking if the decision situation is appropriate for using any type of Decision Support System and if a specific Decision Support System is or remains appropriate to use for making or informing a specific decision.

-Assumption of relevance: According to Winograd and Flores (1986), "Once a computer system has been installed it is difficult to avoid the assumption that the things it can deal with are the most relevant things for the manager's concern." The danger is that once Decision Support System becomes common in organizations, that managers will use them inappropriately. There is limited evidence that this occurs. Again training is the only way to avoid this potential problem.

-Transfer of power: Building Decision Support System, especially knowledge-driven Decision Support System, may be perceived as transferring decision authority to a software program. This is more a concern with decision automation systems than with Decision Support System. We advocate building computerized decision support systems because we want to improve decision making while keeping a human decision maker in the "decision loop". In general, we value the "need for human discretion and innovation" in the decision making process.

-Unanticipated effects: Implementing decision support technologies may have unanticipated consequences. It is conceivable and it has been demonstrated that some Decision Support System reduce the skill needed to perform a decision task. Some Decision Support System overload decision makers with information and actually reduce decision making effectiveness. We are sure that other such unintended consequences have been documented. Nevertheless, most of the examples seem correctable, avoidable or subject to remedy if and when they occur.

-Obscuring responsibility: The computer does not make a "bad" decision, people do. Unfortunately some people may deflect personal responsibility to a Decision Support System. Managers need to be continually reminded that the computerized decision support system is an intermediary between the people who built the system and the people who use the system. The entire responsibility associated with making a decision using a Decision Support System resides with people who built and use the system.

-False belief in objectivity: Managers who use Decision Support System may or may not be more objective in their decision making. Computer software can encourage more rational action, but managers can also use decision support technologies to rationalize their actions. It is an overstatement to suggest that people using a Decision Support System are more objective and rational than managers who are not using computerized decision support.

-Status reduction: Some managers argue using a Decision Support System will diminish their status and force them to do clerical work. This perceptual problem can be a disadvantage of implementing a Decision Support System. Managers and IS staff who advocate building and using computerized decision support need to deal with any status issues that may arise. This perception may or should be less common now that computer usage is common and accepted in organizations.

-Information overload: Too much information is a major problem for people and many Decision Support System increase the information load. Although this can be a problem, Decision Support System can help managers organize and use information. Decision Support System can actually reduce and manage the information load of a user. Decision Support System developers need to try to measure the information load created by the system and Decision Support System users need to monitor their perceptions of how much information they are receiving. The increasing ubiquity of handheld, wireless computing devices may exacerbate this problem and disadvantage. [4]

9. Fields of applying DSS in our life:

One of the ways where we can use the decision support system is in a system that helps the passengers to go from one place to another in an easy and available way; there are a lot of examples of applying this system like the famous RATP France web site. So let's discuss some important notions related to that system.

10. The importance of transport in our live:

Life would not have kept up with the fast changing times if there were no transport networks used by cars, buses, planes, trucks, trailers, cargo ships or large aircrafts. Transport makes the movement possible for goods from one place to another with great ease and speed, it also provides employment opportunity to a lot of peoples like drivers, conductors, gas stations workers, pilots, cabin crew, captain of the ship and more of people who are directly engaged in transport business. Transport is a key for the development of any nation or country, better transport allows more trade and a greater spread of people. Economic growth has always been dependent on increasing the capacity, quality and rationality of transport. Transport improvements are not always the best way to improve productivity or increase economic development. In general, such improvements only increase economic development where inadequate transport is a significant constraint on economic activity. An area that lacks paved roads may experience significant economic growth from a new highway or bridge that significantly reduces travel costs, but once an area has basic highway access, each increase in highway capacity tends to provide less overall benefit. [5]

11. The development of the transport system:

As we mentioned, any country cannot develop so fast without the development of its transport system, the purpose here is not only the improvement of roads and transport means, but also the improvement of the transportation systems, and that's what we'll discuss in this dissertation. To develop or improve the transportation system we have to create a system that allow passengers, employers, products and goods to go from one place to another in fast, efficient and easy way, in order to do that there are many techniques can be used, but no doubt that the

most popular and effective technique is the multi-modal transport system. So let's get to know what multi-modal transport system means, and why we actually use transport.

12. Reasons for preferring transport on driving:

Driving is often the fastest mode of travel, and although automobiles are expensive to own (considering fixed costs such as depreciation, insurance, registration fees, scheduled maintenance and residential parking expenses) they are relatively cheap to drive, typically costing just a few cents per mile in operating expenses. Automobile travel also tends to be more comfortable and prestigious than other modes. This explains why 70-90% of trips are made by automobile (depending on definitions and conditions).

But for various reasons travelers often need or prefer travel by alternative modes:

- Many people cannot drive. In a typical community, 20-40% of the total population, and 10-20% of adolescents and adults, cannot drive due to disability, economic, age constraints, or vehicle failures. Inadequate transport options reduces non-drivers ability to access activities and forces motorists to chauffeur non-drivers (according to the 2009 National Household Travel Survey, 5% of total trips were specifically to transport a passenger).
- Many people should not drive for some trips, due to inebriation, disability, or economic constrains. For example, efforts to reduce driving by higher-risk groups (people who are impaired by alcohol or drugs, young males, or people with dementia) can only be successful if there are good alternatives to driving. The high costs of automobile transport places a major financial burden on many lower-income people.
- Travelers sometimes prefer using alternative modes, for example, because walking and cycling are more enjoyable and provide healthy exercise, or public transit commuting imposes less stress and allows commuters to read, work or rest.

- Society could benefit from more efficient road, parking, fuel and insurance pricing, or more efficient management of road space, that favor higher value trips and more efficient modes in order to reduce traffic congestion, parking costs, accidents and pollution emissions.[6]

13. The definition of the multi-modal transport system:

Multimodal transport, as understood by many, refers to a transport system usually operated by one carrier with more than one mode of transport under the control or ownership of one operator. It involves the use of more than one means of transport such as a combination of truck, railcar, aero-plane or ship in succession to each other e.g. a container line which operates both a ship and a rail system of double stack trains. A multi-modal system example is represented in the figure 1.1 while (a), (b) are unimodal trips while (c), (d) and (e) are multi-modal trips P is park and ride location.[7]

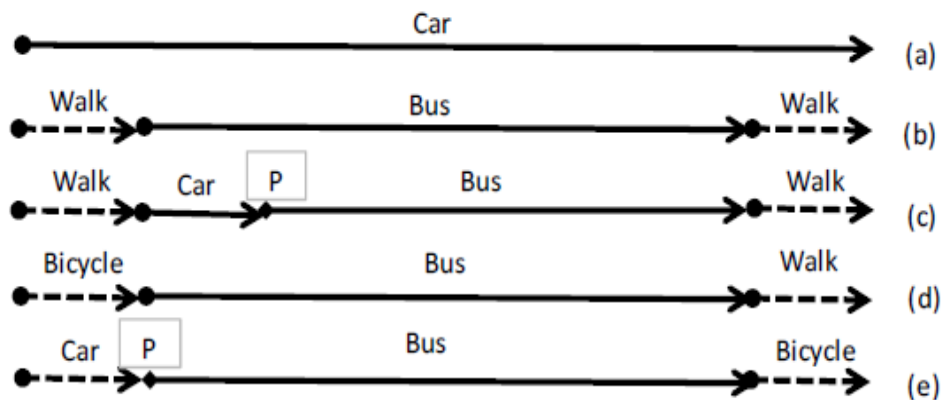


Figure 1.1 Representation of Multi-modal Network.

14. The reason for using multi-modal transport system:

Each mode of transport has its weaknesses and strengths and using a combination of modes cancels their negatives and maximizes their benefits. For example, cycling although its high spatial penetrating range as you can reach almost everywhere with a bike, it is cheap and environmentally friendly and can be used throughout the day but distance travelled with a bike will remain limited because of the bike limited speed and the associated physical effort. On the

other hand, public transport has almost unlimited travel distance range but it lacks flexibility because its dependency on a fixed schedule and no matter how large is the coverage of public transport system it will never serve every commuter from door to door. Furthermore, some unsolvable problems with only one mode view but if we considered the multimodal view it can be solved. [8]

As shown in the figure [2] many types of transportation modes can be applied to maximize the performance and the efficiency of the multi-modal transportation system.

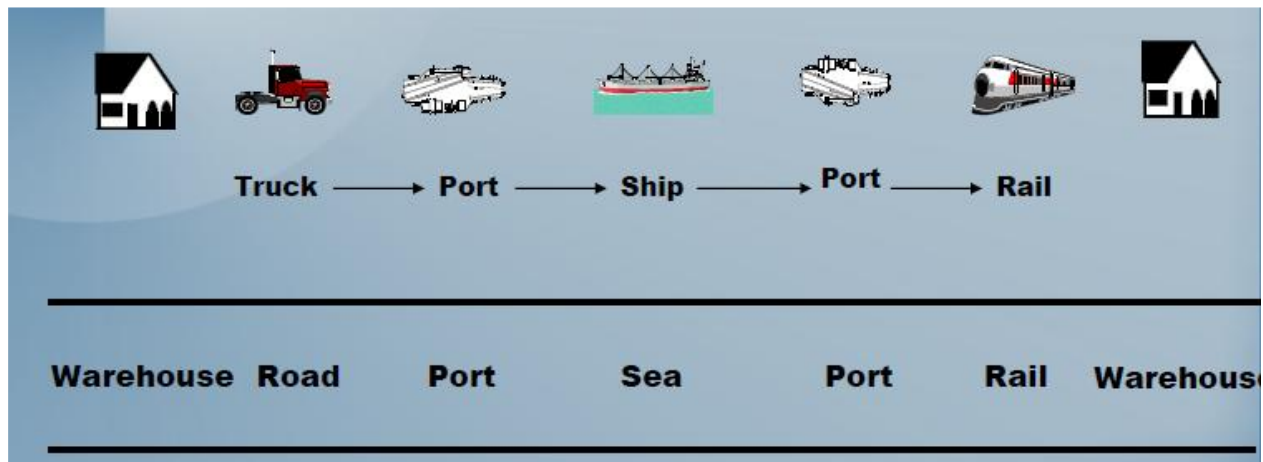


Fig1.2 Representation of modes combinations.

15. The advantages of multi-modal transport system:

Multi-modal transportation system offers a lot of benefits for the community thanks to its techniques; we can list the various advantages as follow:

15.1 Minimizes time loss at trans-shipment points:

Multimodal transport, which is planned and coordinated as a single operation, minimizes the loss of time and the risk of loss, pilferage and damage to cargo at trans-shipment points. The multimodal transport operator maintains his own communication links and coordinates interchange and onward carriage smoothly at trans-shipment points.

15.2 Provides faster transit of goods:

The faster transit of goods made possible under multimodal transport reduces the disadvantages of distance from markets and the tying-up of capital. In an era of Globalization the distance between origin or source materials and consumer is increasing thanks to the development of multimodal transport.

15.3 Reduces burden of documentation and formalities:

The burden of issuing multiple documentation and other formalities connected with each segmented of the transport chain is reduced to a minimum.

15.4 Saves cost:

The savings in costs resulting from these advantages are usually reflected in the through freight rates charged by the multimodal transport operator and also in the cost of cargo insurance, as savings are passed onto the consumer demand increases.

15.5 Establishes only one agency to deal with:

The consignor has to deal with only the multimodal transport operator in all matters relating to the transportation of his goods, including the settlement of claims for loss of goods, or damage to them, or delays in delivery at destination.

15.6 Reduces cost of exports:

The inherent advantages of multimodal transport system will help to reduce the cost of exports and improve their competitive position in the international market. [9]

16. Forms of multimodal transport operations:

Currently, different types of multimodal transport operations involving different combinations are taking place, such as:

16.1 Land-Sea-Land:

An example of this form of the transport is as follows:

An empty container is picked up from the line's container yard in Singapore and trucked to shipper's factory in Johore (Malaysia) for stuffing; thereafter the FCL is trucked to Singapore and transported by ocean vessel to New York.

Truck from vessel to rail-head New York

Rail from New York to rail-head Chicago

Truck from Chicago rail-head to consignee's warehouse.

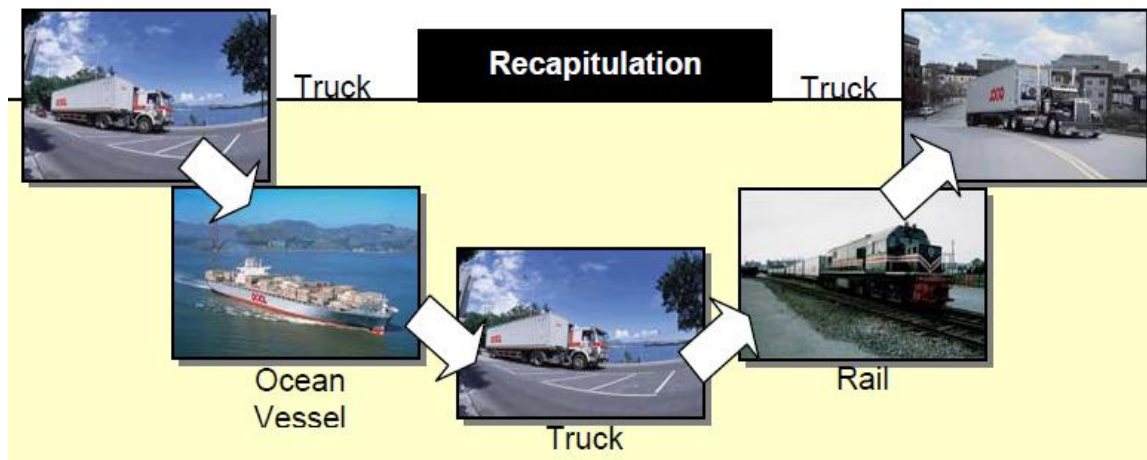


Fig1.3 Represent the land-sea-land operation.

16.2 Road/Air/Road:

A combination of air carriage with truck transport is a frequent method of multimodal service. Undoubtedly, pick-up and delivery services by road transport are usually incidental to air transport. But apart from this, road transport is now being increasingly used, particularly in Europe and U.S.A., for trucking air freight over long distances, sometimes across national boundaries, to connect with the main bases of airlines operating long haul services such as trans-Pacific, trans-Atlantic and inter-continental. Several airlines are building up a number of trucking hubs in Europe to act as focal points for road-based feeder operations.

Many airlines provide road service to cities which they either find uneconomical to service by air, or to which they do not enjoy landing rights. This road transportation is often effected with their own vehicles, and to and from their own facilities, but on occasion they do also use highway common carriers.

16.3 Sea/Air/Sea:

This combines the economy of sea transport and the speed of air transport and is becoming increasingly popular in several international trade routes like the Far East Europe route. The economics of this combination mode favour high value items like electronics, electrical goods, computers and photographic equipment as well as goods with high seasonal demand such as fashion wear and toys.

This multimodal operation is particularly applicable where the route to be covered combines large distances via land and water, and where transit time is important.

16.4 Rail/road/inland waterways/sea:

This combination mode is in common use when goods have to be moved by sea from one country to another and one or more inland modes of transport such as rail, road or inland waterways, have to be used for moving the goods from an inland centre to the seaport in the country of origin or from the seaport to an inland centre in the country of destination.

16.5 Ro-Ro (Roll-on/Roll-off):

This mode combines different means of transportation (sea and road), and is used most often with new automobiles, which are shipped by sea and then simply driven off the vessel to the importer's warehouse. Heavy and over-dimensional cargo is also suitable for Ro-Ro transport.

16.6 L.A.S.H. (Lighter Abroad Ship):

LASH transport is the combination of deep sea and inland waterway transportation. An example is the route from Germany to the Mississippi Ports where the barges sail down the Rhine, Elbe or Weser in Germany, are loaded onto LASH container vessels in Rotterdam, Hamburg or Bremen; are then carried across the Atlantic, only to be unloaded at a Mississippi delta port to sail upstream in the U.S. It must be noted that LASH vessels are expensive, and furthermore it is necessary to check on the availability of the special handling facilities necessary in the ports of destination.

16.7 Piggyback:

This is a system of unitized multimodal land transportation, a combination of transport by road and rail. It has become popular in Latin American and European countries because it combines the speed and reliability of rail on long hauls with the door-to-door flexibility of road transport for collection and delivery. The goods are packed in trailers and hauled by tractors to the railway station. At the station, the trailers are moved onto railway flat cars and the transport tractors, which stay behind, are then disconnected. At destination, tractors again haul the trailers to the warehouses of the consignee.

The system has undergone refinements and sophistication by the introduction of the so-called "trailer train" which uses the same trailer as a vehicle on the road and a rail vehicle on the rail. In other words, the trailer moves on its wheels as a truck on the road but the wheels can be retracted by an air suspension system and connected to a rail bogie for movement by rail. At the end of the rail journey, the conversion back to being road vehicle is effected for delivery of the goods to the customers as shown in the figure [4].



Fig1.4 Represent piggyback trailer train

16.8 Sea train:

This is another innovation in the multimodal transport system involving the use of rail and ocean transport. It was originally adopted in the U.S.A. It is similar to the roll-on, roll-off (Ro-Ro) system except that in the place of the Ro-Ro vehicle a rail car is used so that geographically separated rail systems can be connected by the use of an ocean carrier. Typically these vessels are long and thin and consist of one main deck running the length of the ship. They are quicker at loading trains than general cargo vessels since the train's carriages do not need to be detached from one another.

In actual practice, several other combination modes may be used depending upon the trade routes, trans-shipment points and the availability, of different modes of transport. New infrastructural developments are being proposed the world over to create a seamless flow of traffic e.g. the channel tunnel linking England and France, the Oresund bridge linking Sweden and Denmark.. As these projects have become reality so the flow of traffic changes. Other changes such as global warming pose the potential for new routes to open up via the northern sea between Russia's northern border and the North Pole. [9]

17. Conclusion:

In this chapter we have given a general and detailed idea about the decision support systems and its definition, purpose and capabilities, we also discussed how we can use these systems to serve our context, moreover we explained the term multi-modal transport system and its objectives, advantages and forms, which give the hand for the next step that consisting some theoretical notions of our system.

CHAPTER 02

MAKING

DECISIONS

PROBLEM

1. Introduction:

Making decisions concerning complex systems often strains our cognitive capabilities. Even though individual interactions among a system's variables may be well understood, predicting how the system will react to an external manipulation and various factors or variables is often difficult, especially with a problem such as MTS (Multi-Modal Transport System). Multi-modal transportation planning is complicated because modes differ in various ways, including their availability, speed, density, costs, limitations, and most appropriate uses. They are not perfect substitutes; each is most appropriate for specific users and uses.

Notwithstanding the fact that multimodal transport has always existed, there are not a specific methods or strategies for realization, so in this chapter we will discuss and suggest some important notions and methods that will help us finding a solution to resolve the MMT problem.

2. Problem Description:

Undoubtedly, that consists of a change of carrier during the travel, one or more times, using different connections, is nowadays almost necessary in many kinds of transports, both concerning freight and passenger mobility. There is hence the need of establishing the proper sequence of means and commuting points that could allow advantages for the travellers.

The central problem of this work is the creation of the infrastructure of the multimodal network then search for minimum cost (Time, Money, Distance) paths on multimodal transport networks. Finding minimum cost path actually covers different problems:

1. Calculating paths point to point routes from an departure point to any destination.
2. Trips from any departure point to any destination.
3. Isochronous calculation (area accessible from a departure point and respecting a given cost).
4. Calculation of single or multi-criteria paths, calculating a single best path, or the k best paths.

Since a transfer implies extra travel time and/or travel costs while no distance is covered, the transfer itself has serious consequences for the transport services included in a multimodal trip. In order to be attractive compared to a unimodal transport service, the speed or the costs of a transport service in a multimodal trip should compensate for the delay and inconvenience of the transfer. Multimodal transport requires fast or cheap transport services. [10]

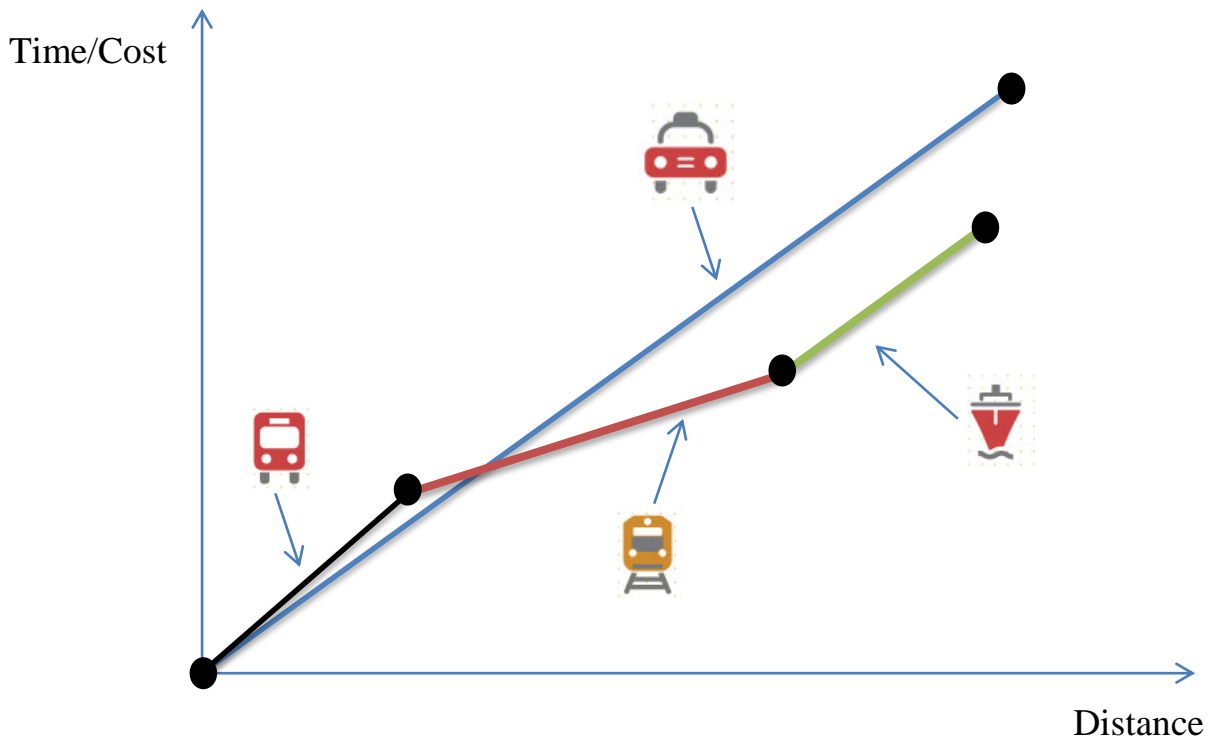


Figure 2.1 Difference between Unimodal and Multi-modal Trip.

Our main problem in this work is how to find the best path point to point. We seek to both minimize the travel time and the number of changes modes (modal shift). Moreover decrease travel cost and make the things easier to the passengers to decide How, Where and When to displace from one point to another with an available and easy way.

This is a multi-objective problem and time dependent because of the time variables are estimated according to the schedule.

3. Graph Representation:

Consider a directed graph $GT(V, E)$ with V set of vertex (bus stops, subway stations ...) and E set of edges. Each edge (i, j) is an origin i and destination j , a transport mode m ($m \in \{\text{subway, bus, car, walking, transfer}\}$) and a cost function delay (i, j, m, t) representing the travel time to go from vertex i starting at time t to vertex j using mode m . We search all the non-dominated paths (Pareto Optimal solutions) to go from an origin to a destination from a starting date, satisfying the constraints of different modes of considered transport. A multimodal path must satisfy a set of constraints on the sequences using different modes of transport. A path within these constraints is said viable.

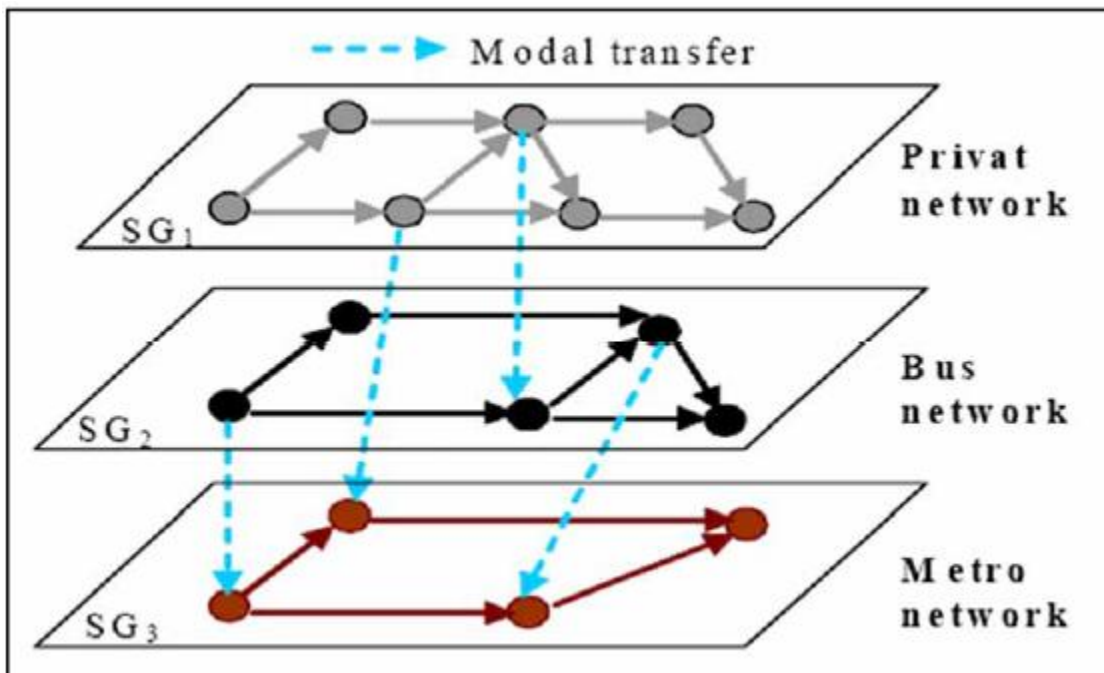


Figure 2.2 Modal Transfer.

In order to be able to represent our system into a graph (bus stops and ways into vertex and edges) we have to pass by the graph transfer model, so now we will move to some important definitions related to the graph transfer model.

4. Transfer Graph Model Definitions:

In this Section we describe briefly the transfer graph model. The main advantage of this abstraction is that it adapts to the distributed nature of real world transport information sources, and allows updates on each transport network independently, that is, without requiring any further recalculation. The transfer graph model is processed and transformed in a more compact structure, called relevant graph, from which the shortest path can be calculated. In next subsection we first give some definitions of the time-dependent multimodal networks, and then the transfer graph and relevant graph are presented.

4.1 Multi-Modal Graph Definition:

Let $G = (V, E, M)$ denote a multimodal directed graph or network, where $V = \{v_1, \dots, v_j\}$ is a set of elements called vertex, $M = \{m_1 \dots m_k\}$ is a set of transport modes (e.g., train, bus, and car), and $E = \{e_1, \dots, e_L\}$ is a set of elements called edges. An edge $e_L \in E$ can be identified by $(v_p, v_q) m_r$, where $v_p, v_q \in V$ and $m_r \in M$. The e_L expresses that it is possible to go from vertex v_p to v_q by using transport mode m_r . A value C_{e_L} is associated to each edge e_L , indicating the cost of including the edge in the solution (e.g., distance and time).

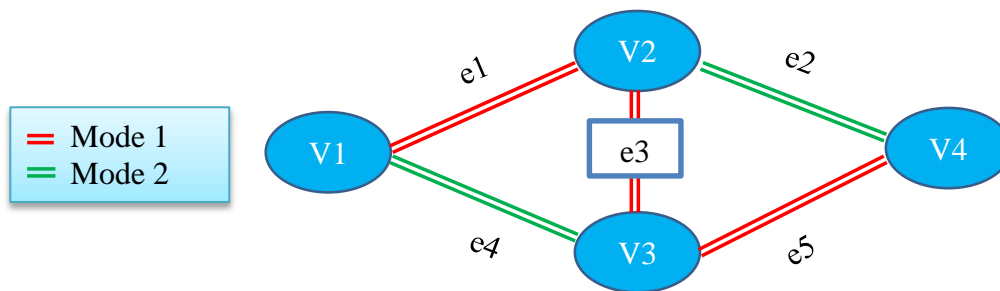


Figure 2.3 Multi-Modal Graph.

4.2 Multimodal path:

Given a graph $G = (V, E, M)$, a path or route p is a sequence of edges between a pair of vertices v_i and $v_k, ((v_i, v_2)m_1, \dots, (v_k, v_{k+1})m_k)$, where $\forall i, j \in \{1..k\}, v_i, v_j \in V, (v_i, v_{i+1})m_i \in E, m_i \in M$, and $i \neq j \Leftrightarrow v_i \neq v_j$. The multi-modal path can use different types of transport .

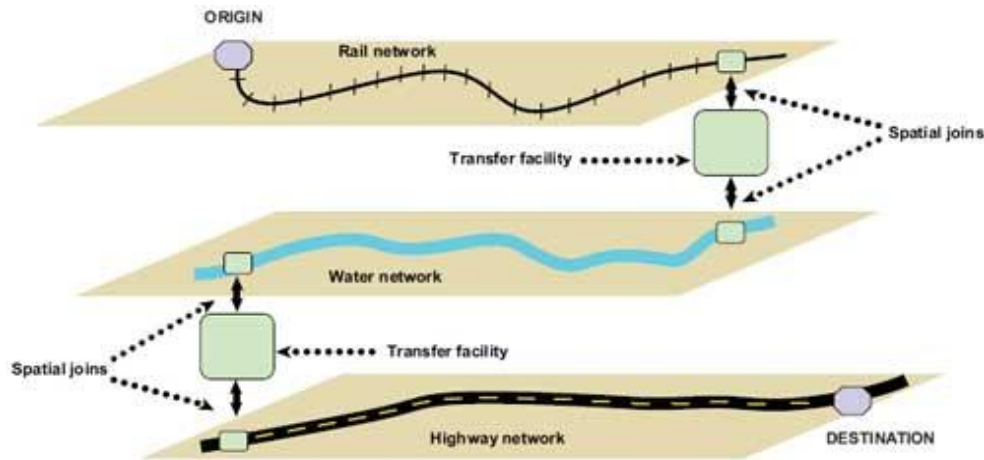


Figure 2.4 Multi-Modal Path.

4.3 Time-dependent multimodal network:

We define $G = (V, E, M, T)$ as a time-dependent multimodal network, where V is the set of vertex, E the set of edges, and M the set of modes. Each $e_i \in E$ has associated a set of departure/arrival times $\tau_i = \{(ts_1, ta_1), \dots, (ts_k, ta_k)\}$, being $|\tau_i| = k \geq 1$ and $\forall j \in \{1..k\}, ts_j, ta_j \in \{t_1, \dots, t_L\}; ts_j \leq ta_j$. ts_j denote the departure time and ta_j the arrival time. Finally, T is defined as the set of all departure/arrival time, $T = \cup_{e_i \in E} \tau_i$.

4.4 Time-dependent cost:

If P is the set of paths in a graph G , the function $f(p), f: P \rightarrow R$, represents the cost of the path p . We consider that the cost of edges are time-dependent, i.e. $\forall e_i \in E$ and $j, k \in \{1, \dots, L\}$ we can have $C_{e_i}(t_j) \neq C_{e_i}(t_k)$.

4.5 Shortest Path Problem, SPP:

Given a time-dependent multimodal graph $G = (V, E, M, T)$, two vertices $s, d \in V$ and a departure time $t \in \{t_1, t_2, \dots, t_L\}$, the Shortest Path Problem (SPP) is defined as: calculate a path p from vertex s to d , departing at t that $f(p)$ is minimal.

5. Transfer Graph:

Given $G = (V, E, M, T)$, we define a transfer graph as $T_g = (C, T_r)$ where $C = \{C_1, C_2, \dots, C_k\}$ is the set of monomodal time-dependent graphs, called components, and T_r is the set of virtual edges which interconnect them. Each component $C_i = (V_i, E_i, M_i, T_i)$ is such that $\forall j \in \{1, \dots, k\}, i \neq j \Leftrightarrow M_i \neq M_j$. Besides, $\bigcup_{i \in \{1..k\}} V_i = V$, $\bigcup_{i \in \{1..k\}} E_i = E$, $\bigcup_{i \in \{1..k\}} T_i = T$, and $\bigcup_{i \in \{1..k\}} M_i = M$. In addition, $T_r = \bigcup_{i \in \{1..L\}} t_{ri}$ where $t_{ri} = (v_x, v_y)$ represents a transfer from mode m_x to mode m_y at vertex v_x (or v_y). v_x, v_y are called transfer vertices and symbolize the same location.

6. Relevant Graph:

We have formally defined the transfer graph in Section 4 and 5. We present now a simplified structure calculated from transfer graph, called relevant graph, from which the SPP (Shortest Path Problem) can be more easily computed. At a high level, routes in a transfer graph can be divided into two groups: intra-components paths and inter-component paths. An inter-component path within a transfer graph T_g is considered as any route or sequence of edges which connects two vertices $v_i, v_j \in V$, where at least two edges belong to two distinct components. On the other hand, an intra-component path within C_g is any route which connects two vertices $v_i, v_j \in V_g$ whose edges belong only to one component.

Intra-component paths can be divided into the following categories:

6.1 Full path ($P_{s,d}^{*g}$): the smallest route which starts at source vertex s and ends at target vertex d within the component C_g .

6.2 Relevant head paths ($P_{s,-}^{*g}$): the smallest routes which start at source s and end at a transfer vertex within the component C_g .

6.3 Relevant intermediate paths($P_{+,-}^{*g}$): the smallest routes which start and end at any transfer vertex within the component C_g .

6.4 Relevant tail paths($P_{+,d}^{*g}$): the smallest routes which start at any transfer point and end at target d within the component C_g .

Given a transfer graph $T_g = (C, T_r)$ correspond to a time dependent multimodal network $G = (V, E, M, T)$, and an origin-destination pair $s, d \in V$, assuming that for all components $C_g \in C$ we have computed the shortest relevant path sets: $P_{s,d}^{*g}$, $P_{s,-}^{*g}$, $P_{+,-}^{*g}$ and $P_{+,d}^{*g}$. Having these relevant path sets in hand, it is possible to derive a reduced graph from which all possible shortest inter-component paths from s to d can be computed.

We call this graph the relevant graph and use R_g to denote it. The vertices of R_g are s , d and a subset of all transfer vertices in the transfer graph. The edge set of R_g is the shortest relevant intra-component paths viewed as edges, i.e., paths that are represented only by the initial and final vertices. In fact, R_g is a multigraph, but in general, its scale should be much smaller than the equivalent multigraph of the underlying transfer graph.

When a relevant graph is built from a transfer graph for vertices s and d and time t , we have a simplified monomodal multigraph where all shortest paths between transfer vertices, s and d are calculated. The computation of the shortest path from s to d in R_g is basically the classical origin-destination SPP on a reduced time-dependent monomodal network.

7. Solving the Transfer Graph:

Every time there is a request for obtaining the shortest path with (s) as a source, (a) as destination and (t) as a departure time, we need to calculate the shortest relevant paths for $P_{s,d}^{*g}(t)$, $P_{s,-}^{*g}(t)$, and $P_{+,d}^{*g}(t) \forall C_g \in C$. However, $P_{+,-}^{*g}(t)$ is calculated once, since it does not depend on s and d .

Taking advantage of this feature we can decompose the SPP in transfer graphs as follows:

- 1. Step 1:** Computing and storing the shortest paths for $P_{+,-}^{*g}(t_i)$, $\forall C_g \in C$, $\forall t_i == \{t_1, \dots, t_L\}$. This step is called pre-calculations.
- 2. Step 2:** When there is a request for two specific vertices s and d , and time t , then $P_{s,d}^{*g}(t)$, $P_{s,-}^{*g}(t)$, and $P_{+,d}^{*g}(t_i)$ $\forall t_i == \{t_1, \dots, t_L\}$ can be calculated.
- 3. Step 3:** R_g is constructed and the shortest path is computed. [11]

This decomposition reduces time complexity of the problem considerably, because pre calculations compute the most difficult set of paths in terms of computation time. Precalculations provide an important advantage if there are multiple and frequent requests (e.g. in a real web service). On the contrary, pre calculation must be partly recomputed when the network conditions changes (e.g., new edges are included or travel costs have changed). In this Work, we just focus on the first step of the algorithm, while the second and third step has been detailed in another works [12].

8. Approaches to Compute Pre-calculations:

So far, the transfer graph and the relevant graph are formally defined, as well as the decomposition of the SPP in transfer graphs. In this Section we propose several approaches to compute pre calculations.

As we have seen pre calculations consist in computing all shortest paths between transfer vertices within components. In order to calculate them, we have two choices, first one with the classical Dijkstra's algorithm [13], of Course with having some modifications to support time-dependence. Second choice is based on the ACO (Ant Colony Optimization) [14], we will present the performance of them both seeking to find the best one to apply in our system.

8.1 Computing Pre-calculations with Dijkstra's Algorithm:

While Dijkstra's algorithm calculates shortest paths from one vertex to all other vertices, we need to calculate the shortest path between transfer vertices. Therefore this algorithm must be executed for each possible departure time of all transfer vertices.

Presentation of the performance of the algorithm on the different instances, by giving the CPU time (seconds), the total number of paths computed and the maximum memory required, show us that the amount of memory used by the algorithm increases considerably according to the instance complexity. Due to the limitation of memory, this approach cannot apply to bigger instances of the SPP.

| $ V $ | $ E $ | Number Paths | CPU Time (s) | Maximum Memory (MB) |
|-------|-------|------------------|--------------|---------------------|
| 100 | 300 | $7.5 \cdot 10^3$ | 1.2 | 20 |
| 500 | 1000 | $5.4 \cdot 10^4$ | 2.7 | 40 |
| 1000 | 3000 | $3.8 \cdot 10^5$ | 25.0 | 170 |
| 2100 | 6000 | $1.0 \cdot 10^7$ | 100.0 | 510 |

Tab 2.1 Results for the Dijkstra algorithm on different instances of the SPP.

8.2 Computing Pre-calculations with ACO:

Ant Colony Optimization (ACO) [15] is a paradigm to design metaheuristic algorithms for combinatorial optimization problems, inspired in ants behavior. While walking from the nest to food sources, the ants deposit a substance called pheromone. When deciding about the direction to go, ants choose the path marked with higher pheromone concentrations. After the initialization of the pheromone, ants construct a solution and update the pheromone values. This procedure is repeated until the termination conditions are met.

Ants starts from one transfer vertex and try to explore the graph for finding paths to all possible transfer vertices. In each step, ants move applying a stochastic local decision to select the next neighbor. If such moving is not possible the ant is said to be blocked. When ants find a transfer vertex, the path from source to this vertex is stored. Likewise Dijkstra's algorithm, this approach calculates the shortest path from one transfer vertex to all. Therefore it must be executed as many times as transfer vertices are in each component. [16]

Presentation of the performance of the ACO approach when solving the selected instances of the problem show that the algorithm requires much less memory compared to the Dijkstra's algorithm, but in the other hand ACO consume a large quantity of resources in term of CPU time.

| $ V $ | $ E $ | CPU Time (s) | Maximum Memory (MB) |
|-------|-------|--------------|---------------------|
| 100 | 300 | 2.2 | 30 |
| 500 | 1000 | 6.7 | 46 |
| 1000 | 3000 | 80.3 | 68 |
| 2100 | 6000 | 1100.0 | 104 |

Tab 2.2 Performance of ACO algorithm on different instances of the SPP.

8.3 Comparison between Dijkstra and Ant Colony Algorithm:

The comparison between the two approaches in terms of CPU time showing that Dijkstra's algorithm is slightly better for small instances of the problem. However, the ACO becomes very slow for bigger instances compared to the other method.

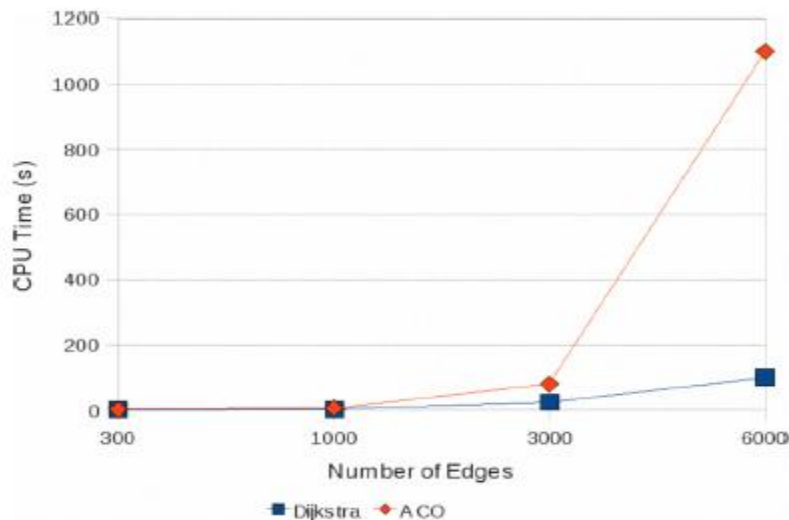


Figure 2.5 Comparison between Dijkstra and ACO approaches in terms of CPU time.

Finally we can say confidently that Dijkstra's algorithm is more suitable than the ACO Algorithm in term of speed and performance as we have seen in this section, also Dijkstra's algorithm is mostly the most famous algorithm used to solve shortest path problem.

9. Dijkstra Algorithm:

Edsger Wybe Dijkstra was born on May 11, 1930 to August 6, 2002, he was a Dutch computer scientist from Netherlands, and he received the 1972 A. M. Turing Award, widely considered the most prestigious award in computer science, he also known for his many essays on programming.

9.1 Single-Source Shortest Path Problem:

The problem of finding shortest paths from a source vertex v to all other vertices in the graph.

- Weighted graph $G = (E, V)$
- Source vertex $s \in V$ to all vertices $v \in V$

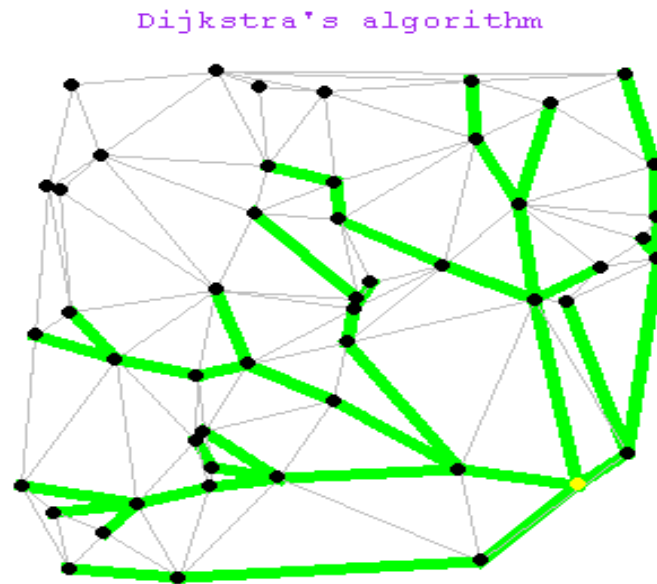


Figure 2.6 Single-Source Shortest Path.

Solution to the single-source shortest path problem in graph theory:

- Both directed and undirected graphs.
- All edges must have nonnegative weights.
- Graph must be connected.

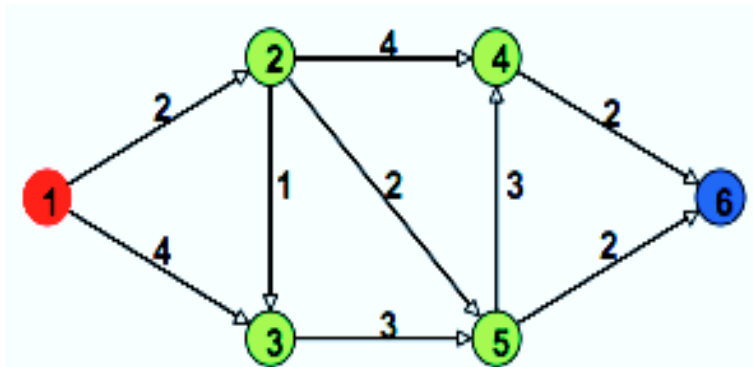


Figure 2.7 shortest path description.

```

dist[s] ← 0           (distance to source vertex is zero)
for all v ∈ V - {s}
  do dist[v] ← ∞      (set all other distances to infinity)
S ← ∅                 (S, the set of visited vertices is initially empty)
Q ← V                 (Q, the queue initially contains all vertices)
While Q ≠ ∅           (while the queue is not empty)
  Do u ← mindistance(Q, dist) (select the element of Q with the min. distance)
  S ← S ∪ {u}         (add u to list of visited vertices)
  For all v ∈ neighbors[u]
    Do if dist[v] > dist[u] + w(u, v) (if new shortest path found)
    Then d[v] ← d[u] + w(u, v) (set new value of shortest path)
    (if desired, add trace-back code)
Return dist
  
```

9.2 Output of Dijkstra's Algorithm:

Original algorithm outputs value of shortest path not the path itself, but with slight modification we can obtain the path:

Value: $(1,6) = 6$

Path: $\{1,2,5,6\}$

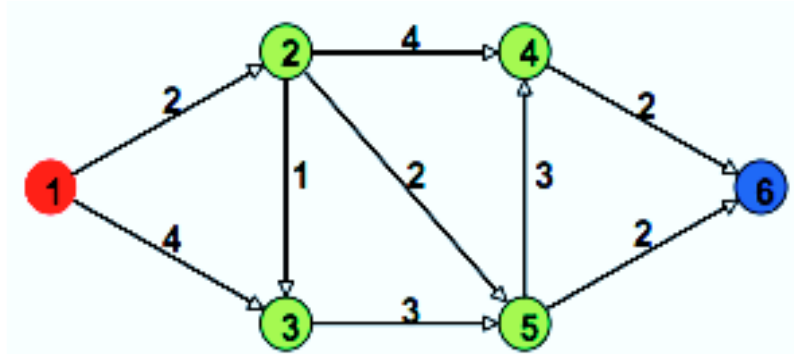


Figure 2.8 Obtaining the shortest path of acquired path value.

But the question here is, Why It Works Intuitively?

Lemma 1: Optimal Substructure

The sub-path of any shortest path is itself a shortest path.

Lemma 2: Triangle inequality

If (u,v) is the shortest path length between u and v , $(u,v) \leq (u,x) + (x,v)$ [17]

10. Conclusion:

In this chapter, we firstly present the different definitions related to the multi-modal transport system and shortest path problem, also several tests in order to select the appropriated parameters for the algorithm. After that, the performance of the algorithm on different instances of the problem is given in terms of computation time and space. Then we present a comparison between the two methods, after that we can make our choice to find the best Algorithm to apply in our system, finally, we give a brief look to the algorithm that we used in our system.

CHAPTER

03

THE

CONCEPTUAL

STUDY

1. Introduction:

The conceptual study is one of the most important steps in any computer science project, to conduct conceptual study we need to follow a conceptual method that responds to the user's requirements and gives a satisfied results of the user's needs.

Actually there aren't a lot of choices to deal with the conception problem and we don't have to think too much because UML offers a standard way to visualize the system's architectural blueprints, The Unified Modeling Language - UML - is OMG's most used specification, and the way the world models not only application structure, behavior, and architecture, but also business process and data structure.

UML, along with the Meta Object Facility (MOF), also provides a key foundation for OMG's Model-Driven Architecture, which unifies every step of development and integration from business modeling, through architectural and application modeling, to development, deployment, maintenance, and evolution, so in this chapter we will be interested of the conceptual study of the system. [18]

In order to give the user a clear vision of our system we use a combination of two kinds of diagrams, the first one is structural diagrams, and the second one is Behavioral diagrams. From the structure diagrams we choose two diagrams:

1. Use case Diagram.
2. Class Diagram.

And from the behavioral diagrams we choose also two diagrams:

1. Activity Diagram.
2. Sequence Diagram.

Now after we have explained what types of diagrams we will present, let's start presenting some UML diagrams of our system.

2. Use Case Diagram:

To model a system the most important aspect is to capture the dynamic behavior, to clarify a bit in details, dynamic behavior means the behavior of the system when it is running or operating, so only static behavior is not sufficient to model a system rather dynamic behavior is more important than static behavior, in UML there are five diagrams available to model dynamic nature and use case diagram is one of them, use case diagram is dynamic in nature, so there should be some internal or external factors for making the interaction, these internal and external agents are known as actors, so use case diagrams are consists of actors, use cases and their relationships. The diagram is used to model the system or subsystem of an application.

The purpose of use case diagram is to capture the dynamic aspect of a system. But this definition is too generic to describe the purpose, because other four diagrams (activity, sequence, collaboration and State-chart) are also having the same purpose. So we will look into some specific purpose which will distinguish it from other four diagrams.

Use case diagrams are used to gather the requirements of a system including internal and external influences. These requirements are mostly design requirements. So when a system is analyzed to gather its functionalities use cases are prepared and actors are identified, now when the initial task is complete use case diagrams are modeled to present the outside view.

So in brief, the purposes of use case diagrams can be as follows:

- 1- Used to gather requirements of a system.
- 2- Used to get an outside view of a system.
- 3- Identify external and internal factors influencing the system.
- 4- Show the interacting among the requirements are actors.

2.1 Use Case Diagram Representation:

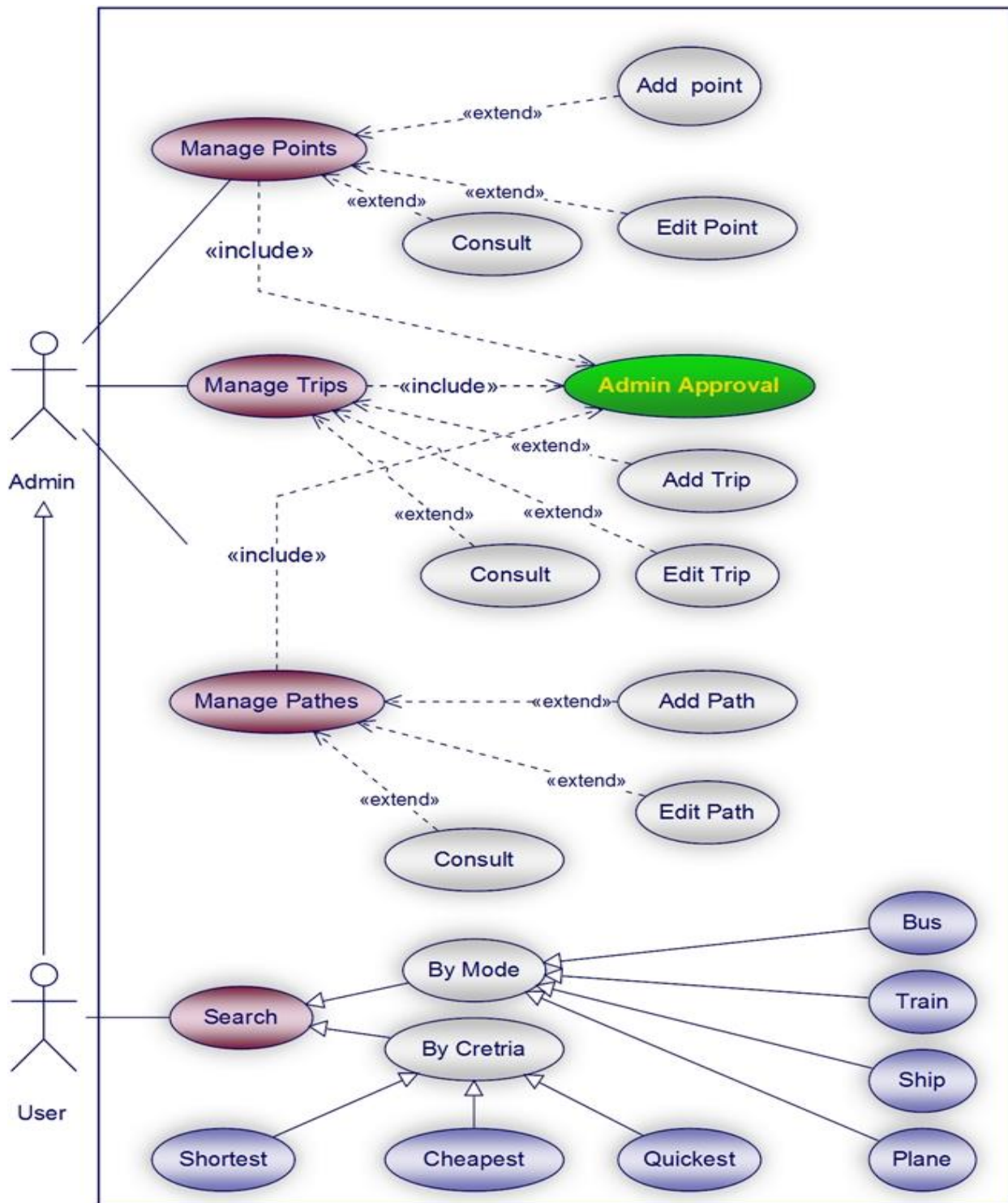


Figure 3.1 Use Case Diagram Representation.

3. Class Diagram:

The class diagram is a static diagram; it represents the static view of an application, class diagram is not only used for visualizing, describing and documenting different aspects of a system but also for constructing executable code of the software application.

The class diagram also describes the attributes and operations of a class and also the constraints imposed on the system, it is widely used in the modeling of object oriented systems because they are the only UML diagrams which can be mapped directly with object oriented languages,

Class diagram shows a collection of classes, interfaces, associations, collaborations and constraints, it is also known as a structural diagram.

The purpose of the class diagram is to model the static view of an application. The class diagrams are the only diagrams which can be directly mapped with object oriented languages and thus widely used at the time of construction.

3.1 Class Diagram Representation:

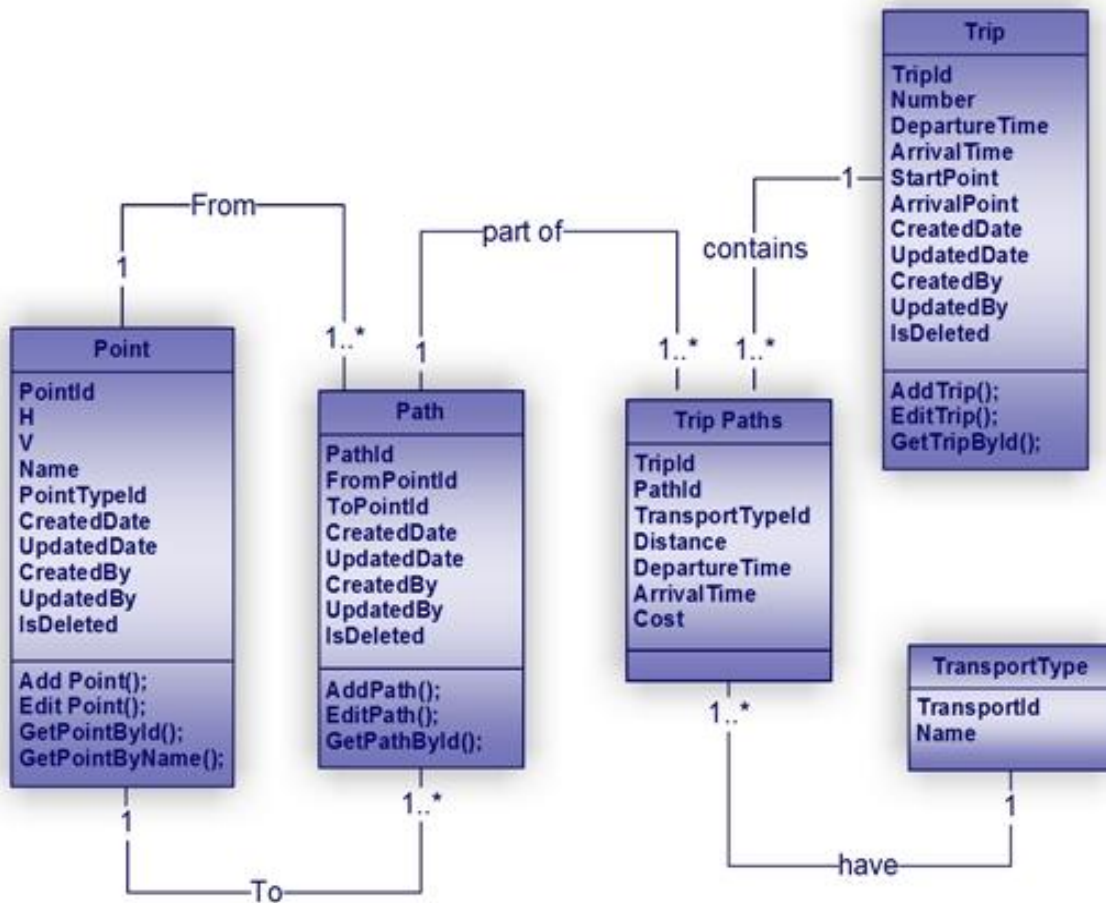


Fig 3.2 Class Diagram of the system.

This Figure represents the class diagram of the system in which we can identify the classes that appear in the system and the elements of each class, also the methods and operations applied on each class.

4. Interaction Diagram:

From the name Interaction it is clear that the diagram is used to describe some type of interactions among the different elements in the model. So this interaction is a part of dynamic behavior of the system.

This interactive behavior is represented in UML by two diagrams known as Sequence diagram and Collaboration diagram. The basic purposes of both the diagrams are similar, Sequence diagram emphasizes on time sequence of messages and collaboration diagram emphasizes on the structural organization of the objects that send and receive messages.

The purposes of interaction diagrams are to visualize the interactive behavior of the system. Now visualizing interaction is a difficult task. So the solution is to use different types of models to capture the different aspects of the interaction.

That is why sequence and collaboration diagrams are used to capture dynamic nature but from a different angle.

So the purposes of interaction diagram can be describes as:

- 1- To capture dynamic behavior of a system.
- 2- To describe the message flow in the system.
- 3- To describe structural organization of the objects.
- 4- To describe interaction among objects.

Here we will chose sequence diagram to represent our system.

4.1Sequence Diagram Representation:

The sequence diagram emphasizes on time sequence of messages between the different parts of the running system, in this system we have two parts administration part and user part,so to model the entire system we need to present the two activity diagrams.

4.1.1 Administrator Sequence Diagram Representation:

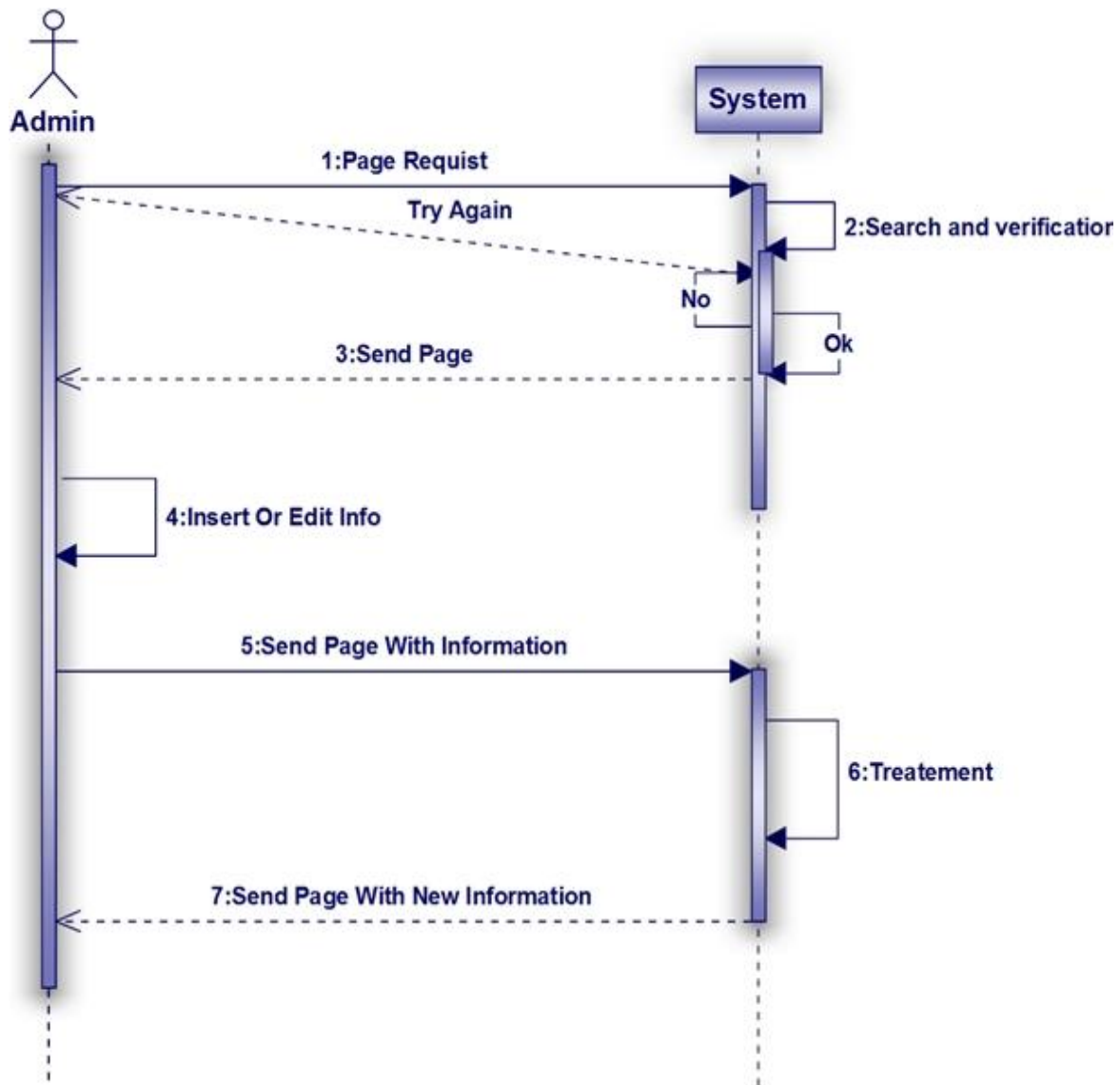


Fig 3.3 Administrator Sequence Diagram.

4.1.2 User Sequence Diagram Representation:

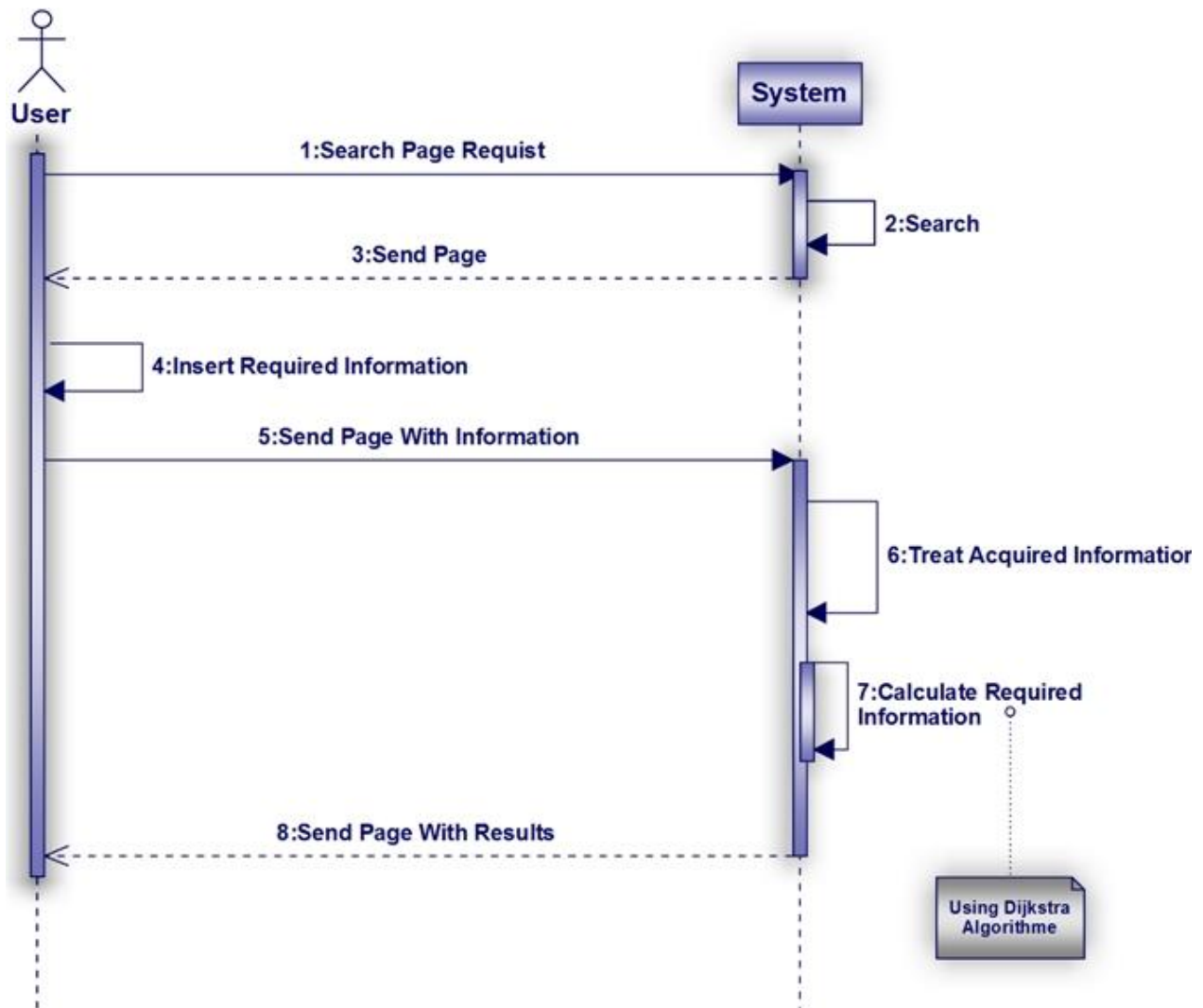


Fig 3.4 Sequence Diagram for User.

5. Activity Diagram:

Activity diagram is another important diagram in UML to describe dynamic aspects of the system; activity diagram is basically a flow chart to represent the flow from one activity to another activity. The activity can be described as an operation of the system.

So the control flow is drawn from one operation to another. This flow can be sequential, branched or concurrent. Activity diagrams deal with all types of flow control by using different elements like fork, join etc.

The basic purposes of activity diagrams are similar to other four diagrams. It captures the dynamic behavior of the system. Other four diagrams are used to show the message flow from one object to another but activity diagram is used to show message flow from one activity to another.

Activity is a particular operation of the system. Activity diagrams are not only used for visualizing dynamic nature of a system but they are also used to construct the executable system by using forward and reverse engineering techniques. The only missing thing in activity diagram is the message part.

It does not show any message flow from one activity to another. Activity diagram is sometimes considered as the flow chart. Although the diagram looks like a flow chart but it is not. It shows different flows like parallel, branched, concurrent and single.

So the purposes can be described as:

- 1- Draw the activity flow of a system.
- 2- Describe the sequence from one activity to another.
- 3- Describe the parallel, branched and concurrent flow of the system.

5.1 Activity Diagram Representation:

As we mentioned before, the activity diagram can describe the different operations of the system, so to model the entire system numbers of activity diagrams are used.

5.1.1 Points Activity Diagram:

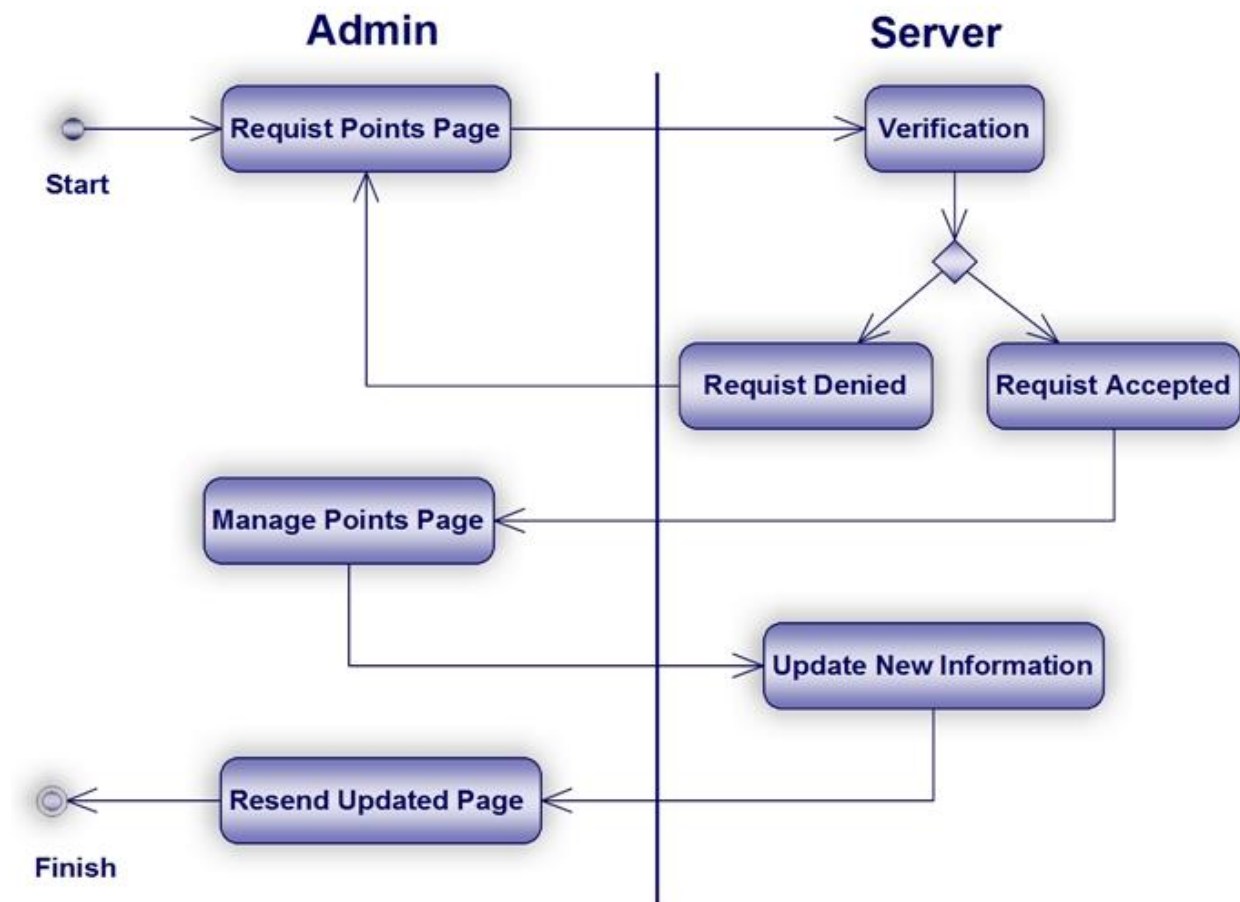


Fig 3.5 Activity Diagram for Points Management.

5.1.2 Trips Activity Diagram:

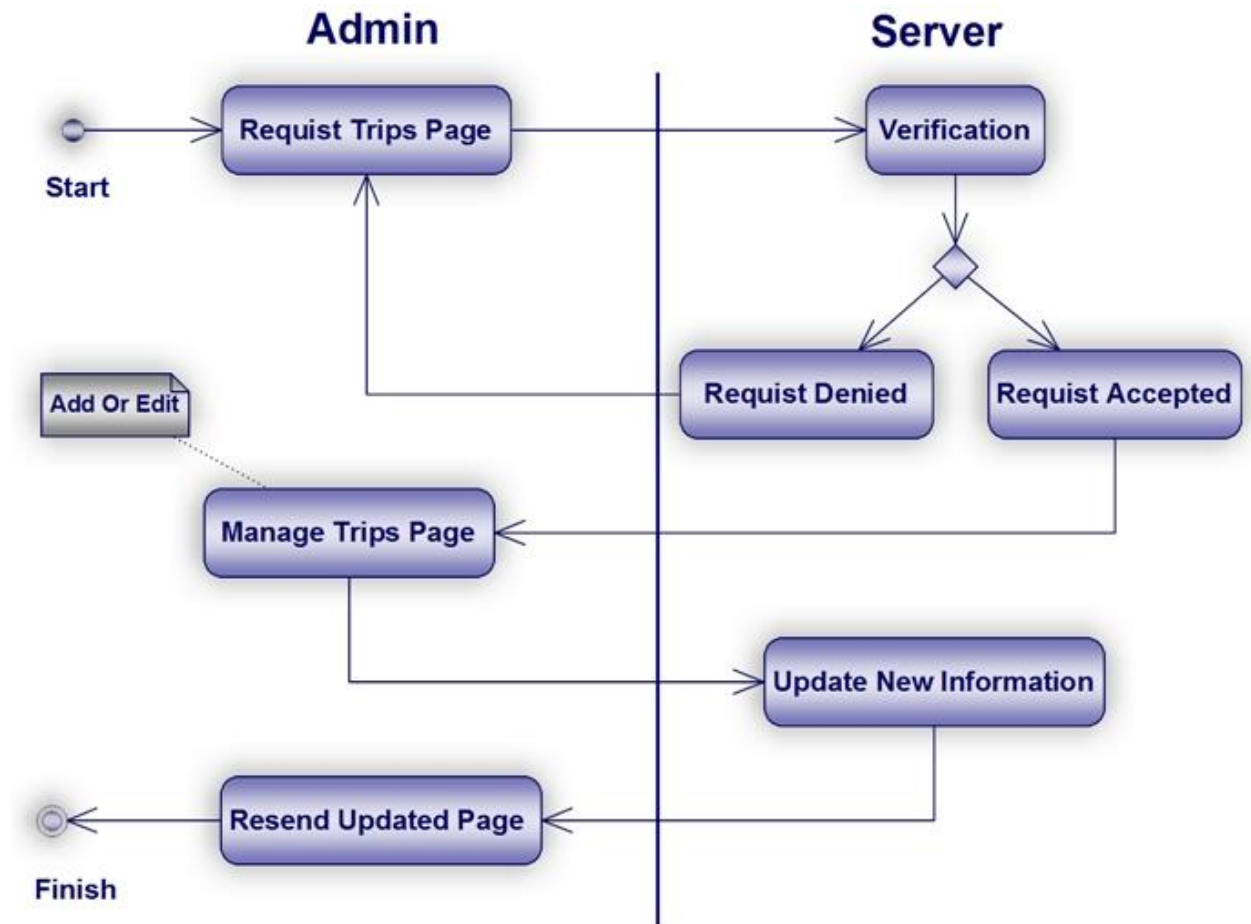


Fig 3.6 Activity Diagram for Trips Management.

5.1.3 Paths Activity Diagram:

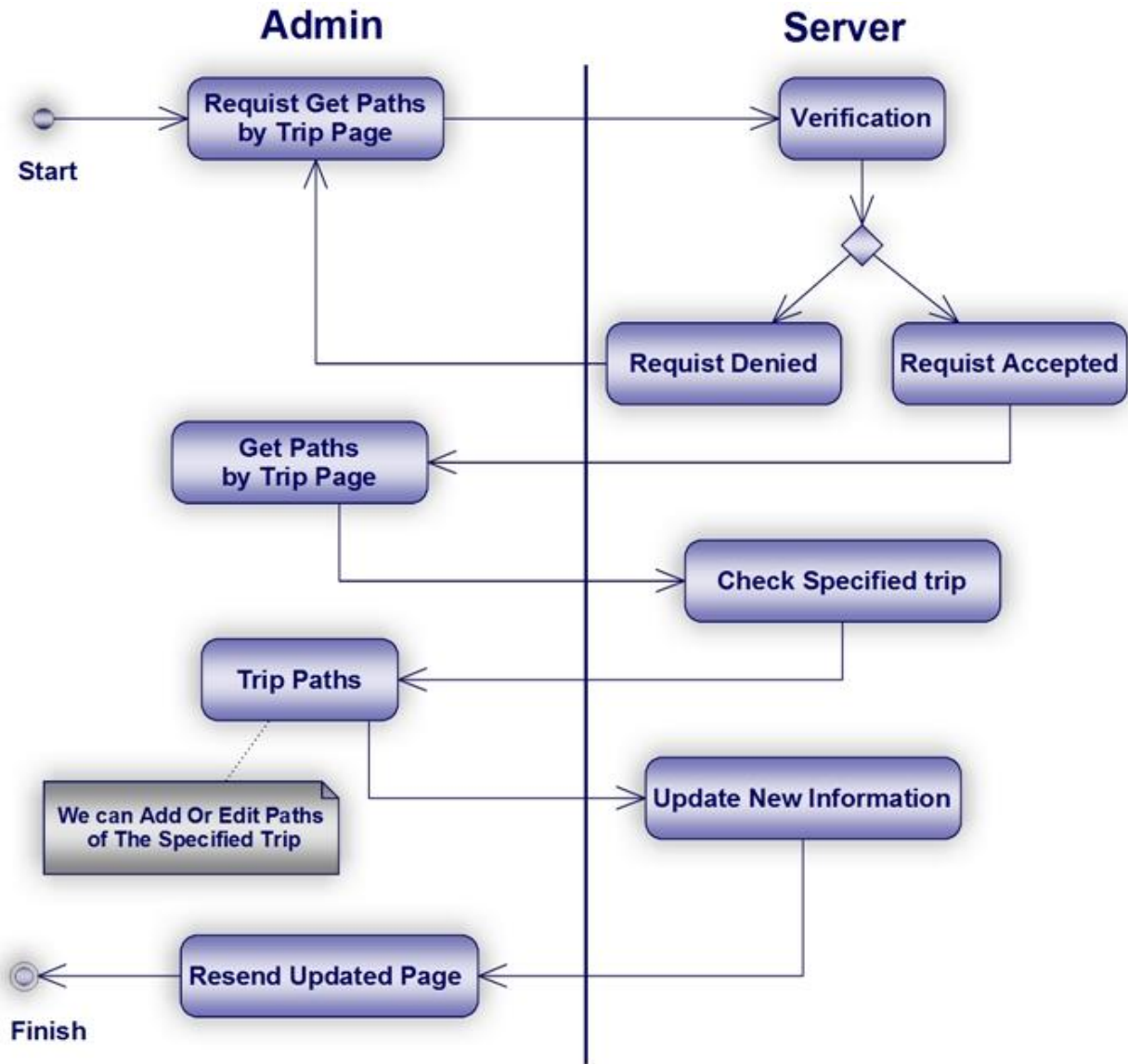
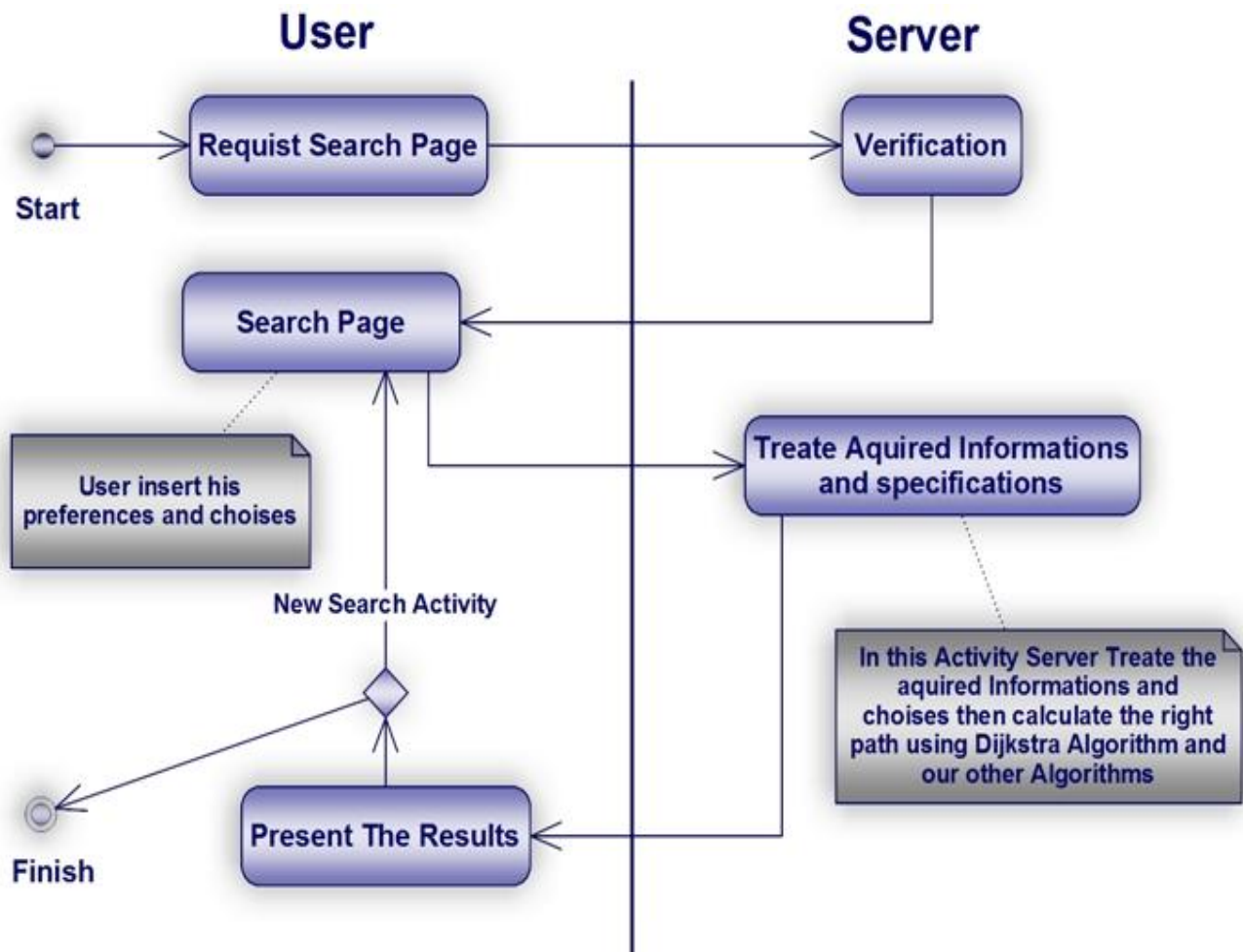


Fig 3.7 Activity Diagram for Paths Management.

5.1.4 Search Activity Diagram:

**Fig 3.8** Activity Diagram for Search operation.

6. Conclusion:

In this chapter, we used UML as modeling language for specifying the analysis and the conception of the system, after that we concentrated on the principal structural and behavioral diagrams such as class diagram use case diagram, activity diagram and sequence diagram, these diagrams give the user a visualization way to manipulate the system.

CHAPTER 04

IMPLEMENTATION

1. Introduction:

This chapter exposes the technical details associated to our system, the development environment, choice of programming languages and the database-management systems test and maintenance of our system.

2. The development environment:

In order to implement our web site we have to use the deferens features that offered by "MICROSOFT VISUAL STUDIO" with its integrated environment.

2.1. Software aspect

Microsoft Visual Studio is an integrated development environment (IDE) from Microsoft, it can be used to develop console and graphical user interface applications along with Windows Forms applications, web sites, web applications, and web services in both native code together with managed code for all platforms supported by Microsoft Windows, Windows Mobile, Windows CE, .NET Framework, .NET Compact Framework and Microsoft Silverlight.

Microsoft Visual Studio supports different programming languages by means of language services, which allow the code editor and debugger to support (to varying degrees) nearly any programming language, provided a language-specific service exists. Built-in languages include C/C++ (via Visual C++), VB.NET (via Visual Basic .NET), C# (via Visual C#), and F# (as of Visual Studio 2010). Support for other languages such as M, Python, and Ruby among others is available via language services installed separately. It also supports XML/XSLT, HTML/XHTML, JavaScript and CSS. Individual language-specific versions of Visual Studio also exist which provide more limited language services to the user: Microsoft Visual Basic, Visual J#, Visual C#, and Visual C++.

To use the **VISUAL STUDIO** we need to tune up the following conditions:

1. Installing the .Net Frame Work on the operation system: The .NET Framework (pronounced dot net) is a software framework that runs primarily on Microsoft Windows. It includes a large library and supports several programming languages which allows language interoperability (each language can use code written in other languages). The .NET library is available to all the programming languages that .NET supports. Programs written for the .NET Framework execute in a software environment (as contrasted to hardware environment), known as the Common Language Runtime (CLR), an application virtual machine that provides important services such as security, memory management, and exception handling. The class library and the CLR together constitute the .NET Framework.
2. Turning on the **IIS** on the operation system: internet Information Services (IIS) – formerly called Internet Information Server – is a web server application and set of feature extension modules created by Microsoft for use with Microsoft Windows. It is the most used web server after Apache HTTP Server: As of January 2011, it served 21.00% of all websites on the Internet [19] and 16.22% of the one million busiest websites on the Internet. IIS 7.5 supports HTTP, HTTPS, FTP, FTPS, SMTP and NNTP. It is an integral part of Windows.[20]

2.2. Language choice:

To develop the application we have chosen ASP.NET as web application frame work.

2.2.1 ASP:

ASP is a web application framework developed and marketed by Microsoft to allow programmers to build dynamic web sites, web applications and web services. It was first released in January 2002 with version 1.0 of the .NET Framework, and is the successor to Microsoft's Active Server Pages (ASP) technology. ASP.NET is built on the Common Language Runtime (CLR), allowing programmers to write ASP.NET code using any supported .NET language [21]

2.2.2 C#.Net:

C# (pronounced C-Sharp) is no doubt the language of choice in the .Net environment. It is a whole new language free of the backward compatibility curse with a whole bunch of new, exciting, and promising features. It is an Object Oriented Programming language and has at its core, many similarities to Java, C++ and VB. In fact, C# combines the power and efficiency of C++, the simple and clean OO design of Java and the language simplification of Visual Basic. [22]

2.3. Database management system (DBMS):

For the manipulation of all the tables in our database, we have chosen SQL server as a system of the database management. SQL Server is a relational database management system (RDBMS) from Microsoft that's designed for the enterprise environment. SQL Server runs on T-SQL (Transact -SQL), a set of programming extensions from Sybase and Microsoft that add several features to standard SQL[23]

3. Test:

3.1 Add Point:

Enter point name :

Choose point type : ▼

| Name | Edit |
|------------------|----------------------|
| Msila | Edit |
| Hammam Dalaa | Edit |
| M'Hir | Edit |
| Bouira | Edit |
| Alger | Edit |
| M'Tarfa | Edit |
| Ouled Deraj | Edit |
| Ouled Adi Lgbala | Edit |
| Berhoum | Edit |
| Magra | Edit |
| BelAiba | Edit |
| Djazar | Edit |
| Barika | Edit |
| Annaba | Edit |
| Hassi | Edit |
| wergla | Edit |
| ben Srour | Edit |

Figure 4.1 add point

3.2 Add Trip:

Trip Number :

Start Point :

Departure Time :

Arrival Point :

Arrival Time :

| Number | StartPoint | ArrivalPoint | DepartureTime | ArrivalTime | Edit |
|-----------------|------------|--------------|---------------|-------------|----------------------|
| 01 Msila Alger | Msila | Alger | 03:00:00 | 07:00:00 | Edit |
| 11 Msila Alger | Msila | Alger | 04:00:00 | 08:00:00 | Edit |
| 21 Msila Alger | Msila | Alger | 05:00:00 | 09:00:00 | Edit |
| 04 Msila Barika | Msila | Barika | 11:00:00 | 14:00:00 | Edit |
| 66 HassiAlger | Hassi | Alger | 01:00:00 | 07:00:00 | Edit |

Figure 4.2 add a trip.

3.3 Get Trip Paths:

Trip Number :

| Number | DepartureTime | ArrivalTime | StartPoint | ArrivalPoint |
|-----------------|---------------|-------------|------------|--------------|
| 01 Msila Alger | 03:00:00 | 07:00:00 | Msila | Alger |
| 11 Msila Alger | 04:00:00 | 08:00:00 | Msila | Alger |
| 21 Msila Alger | 05:00:00 | 09:00:00 | Msila | Alger |
| 04 Msila Barika | 11:00:00 | 14:00:00 | Msila | Barika |
| 66 HassiAlger | 01:00:00 | 07:00:00 | Hassi | Alger |

Figure 4.3 get trip path

3.4 Add Path:

From : To :

Transport Type :

Distance : Cost :

Departure Time : Arrival Time :

| From | To | Transport Type | Distance | Cost | Departure Time | Arrival Time | Trip Number | Edit |
|--------------|--------------|----------------|----------|------|----------------|--------------|----------------|----------------------|
| Msila | Hammam Dalaa | Bus | 30 | 40 | 01:00:00 | 01:30:00 | 01 Msila Alger | Edit |
| Hammam Dalaa | Alger | Bus | 100 | 460 | 01:30:00 | 03:30:00 | 01 Msila Alger | Edit |
| Bouira | Alger | Bus | 60 | 150 | 06:00:00 | 07:00:00 | 01 Msila Alger | Edit |

Figure 4.4 add a path

3.5 Search:

From : To :

Time : Date : 

Mode

- All
- Bus
- Train
- Plane
- Ship


Criteria

- All
- The Quickest
- The Shortest
- The Cheapest

| Point Name | Distance in KM | Cost in DA | Elapsed Time | DepartureTime | ArrivalTime |
|--------------|----------------|------------|----------------------------|---------------|-------------|
| Msila | | | | | |
| Hammam Dalaa | 30 | 40 | 0 Hour(s) and 30 Minute(s) | 01:00:00 | 01:30:00 |
| Alger | 100 | 460 | 2 Hour(s) and 0 Minute(s) | 01:30:00 | 03:30:00 |
| Point Name | Distance in KM | Cost in DA | Elapsed Time | DepartureTime | ArrivalTime |
| Msila | | | | | |
| Barika | 100 | 150 | 1 Hour(s) and 0 Minute(s) | 02:00:00 | 03:00:00 |
| Alger | 100 | 50 | 1 Hour(s) and 0 Minute(s) | 03:00:00 | 04:00:00 |
| Point Name | Distance in KM | Cost in DA | Elapsed Time | DepartureTime | ArrivalTime |
| Msila | | | | | |
| Hassi | 700 | 1000 | 1 Hour(s) and 55 Minute(s) | 02:05:00 | 04:00:00 |
| wergla | 70 | 100 | 1 Hour(s) and 0 Minute(s) | 06:15:00 | 07:15:00 |
| Alger | 500 | 1000 | 9 Hour(s) and 30 Minute(s) | 07:30:00 | 17:00:00 |

Figure 4.5 search by all the models

From : To :

Time : Date : 

Mode

All
 Bus
 Train
 Plane
 Ship

Criteria

All
 The Quickest
 The Shortest
 The Cheapest

| Point Name | Distance in KM | Cost in DA | Elapsed Time | DepartureTime | ArrivalTime |
|------------|----------------|------------|---------------------------|---------------|-------------|
| Msila | | | | | |
| Barika | 100 | 150 | 1 Hour(s) and 0 Minute(s) | 02:00:00 | 03:00:00 |
| Alger | 100 | 50 | 1 Hour(s) and 0 Minute(s) | 03:00:00 | 04:00:00 |

Figure 4.6 search by using the quickest option

4. Conclusion

In this chapter, we presented the different development environments and programming Language we used it to develop our Multi-modal Transport System we have studied in the previous chapter, than we presented our application and we explained its functionalities, after this, we test the performance of its different procedures

GENERAL CONCLUSION

General Conclusion

In this dissertation, we showed the meaning and the importance of the decision support systems in our life, we also showed how we can use it effectively and in efficient way in our life.

We also showed clearly the importance and the role of the transportation in our life, hence the need of an innovation system that make the transport system better and facilitate the available options to the passengers is needed and very important.

The system that can be used to satisfy our needs and responds to the passengers and travellers needs is called “MULTI-MODAL TRANSPORT SYSTEM”, we have explained clearly its meaning, advantages and uses, after that we discussed some strategies and techniques that used in this system.

We implemented these techniques to create the infrastructure of the MTS, in particular part of our work we used the shortest path problem, so to do that we have made a comparison between the available methods, in order to find a suitable method to implement in our system, moreover we showed the CPU computing speed and memory occupation of them.

One of our perspectives is to continue working on MTS systems and develop new approaches in solving its problematic, especially in SPP or shortest path problem in the enormous number of vertices and edges, and develop a hybrid algorithm to overcome this issue.

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الملخص

ان الهدف من هذه المذكرة هو انشاء نظام يساعد على اتخاذ القرار بالنسبة للمسافرين و مستخدمي وسائل النقل والمواصلات عن طريق انشاء البنية التحتية لنظام النقل متعدد الانماط، لذا قمنا بعمل دراسة لانظمة اتخاذ القرار ومن ثم استعمالها في انظمة النقل متعدد الانماط، وذلك بانشاء شبكة نقل متعددة الانماط وتغذيتها بكافة المعلومات المتعلقة بوسائل المواصلات المتاحة، الوقت المستغرق و المسافة و التكلفة لكل رحلة، ومن اجل تحقيق عملية البحث بسرعة وفعالية قمنا بعمل دراسة تحليلية ومقارنة بين اشهر انظمة البحث ومن ثم استخلاص افضل الطرق لتطبيقها في النظام، بعد ذلك حصلنا على النتائج المرجوة من ناحية الفعالية وتوفير الوقت وتسهيل الخيارات للمستخدم .

كلمات دلالية: النقل، شبكة طرق، متعدد الانماط، Dijkstra، Ant-Colony.

Abstract

The objective of this dissertation is to create a decision support system to help both passengers and transport users by create the infrastructure of the multi-modal transport system, so we studied the decision support systems and it's applications in multi-modal transport systems then we create a multi-modal network and provide it with all necessary information like available transport modes, elapsed time, distance and cost of each trip, so to make the search process efficient and fast, we have made an analytical study between the most famous search methods, and after the comparison from the speed and efficiency aspects of the obtained results we choose the best to implement in our system, then the obtained results showed us the firmness of our system .

Keys words: Transportation; Transport Network; Dijkstra; Ant-Colony; Multi-modal.

Résumé

L'objectif de ce mémoire est de créer un système d'aide à la décision pour aider les passagers et les utilisateurs des transports par créer l'infrastructure du système de transport multimodal, donc nous avons étudié les systèmes de soutien à la décision et c'est applications dans les systèmes de transport multimodal, puis nous créons un réseau multi-modal et de lui fournir toutes les informations nécessaires comme les modes de transport disponibles, le temps écoulé, la distance et le coût de chaque voyage, de sorte à rendre le processus de recherche efficace et rapide, nous avons fait une étude analytique entre les plus célèbres méthodes de recherche, et après la comparaison des aspects de la vitesse et de l'efficacité des résultats obtenus, nous choisissons le meilleur pour mettre en œuvre dans notre système, puis les résultats obtenus nous ont montré la fermeté de notre système

Mottes clés : Transportation; Transport Network; Dijkstra; Ant-Colony; Multi-modal.