DESIGNING A MODEL FOR WIRELESS LOAD DATA SHEET IN AIRCRAFT

BY

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This thesis is dedicated to:

- My Parents, who taught me the love of knowledge

- My Brother Alaa AL–Deen , and

- My Sisters Alaa, Suhad, and Enas

For their unwavering support; helping and encouraging me throughout the course of the thesis.

CONTENTS

Abbreviation/Glossary

Abbreviation	Used to be
B	Baggage
C	Cargo
M	Mail
IATA	International Air Transport Association
AACO	Arab Air Carriers Organization
CASA	Civil Aviation Safety Authority
TCAS	Traffic Control Anti-collision System
PAX	Revenue Passengers
PAD	Non-Revenue Passengers
XCA	Extra Cabin Crew
ACM	Additional Crew Member
EDP	Electronic Design Process
RTP	Real Time Bravo
DCS	Departure Control System
DHCP	Dynamic Host Control Protocol
STD	Schedule Time Departure
UL	Under Load
XCR	Stretcher
NOTOC	Notification to the Pilot
SI	Supplementary Information
LIZFW	Leading Index Zero Fuel Weight
LCG	Laden Centre of Gravity
E.I.C	Equipment in Compartment
Comat	Company Materials
ULDs	Unit Load Devices
X.C.A	Extra Cabin Attendant
A.C.M	Additional Crew Member
MALTOW	Maximum Allowable Take-off Weight
RTOW	Regulated Take-off Weight
MTOW	Maximum Take-off Weight
A.P.U.	Air Power Unit
F.C	Flight Close
F.F	Flight Finalize
C. G	Centre of Gravity
C . P	Centre of Pressure
DCS	Departure Control System
RTP	Real Time Bravo
WDR	Weight Data Record
LMF	Last Minute Fuelling
GOM	Ground Operational Manual
GSB	Ground Service Bolittein
SDLC	System Development Life Cycle)
VHF	Very High Frequency
HF	High Frequency

ATC	Air Traffic Control
CGO	Control
EZFW	Estimated Zero Fuel Weight
MVT	Movement
CRM	Customer Relationship Management
FIDS	Flight Information Display System
ZFW	Zero Fuel Weight
TOW	Take-Off Weight
LAW	Limiting Actual Weight
SSL	Secure Sockets Layer
ZFWCG	Zero Fuel Weight Centre of Gravity
TOCG	Take-Off Weight Centre of Gravity
V1	Take-Off Decision Speed
V2	Take-Off Safety Speed
VR	Rotation Speed
FOB	Fuel-on-Board
MLW	Maximum Landing Weight
RADIUS	Remote Authentication Dial-In User Service
DOI	Dry Operating Index
WEP	Wired Equivalent Privacy
WPA	Wi-Fi Protected Access
WPA2	Wi-Fi Protected Access2
WAPs	Wireless Access Points
GPE	Gigabit Ethernet
DOW	Dry Operating Weight

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تصميم نموذج لإصدار ورقة الوزن والتوازن في الطائرة لاسلكياً

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الملخص

يحتلُ عالمُ الطيران في الوقت الحالي مكانة متميزةً، وذلك بسبب أهميتهِ الكبيرة، لذلك فإن العملياتِ المرتبطة بعالمِ الطيران تحتاجُ إلى تطوراتٍ مستمرةٍ، خاصة فيما يتعلق بشحن الحمولة (Aircraft Loading) والتي بدورها تضمُ الركابَ، الشحنَ، الأمتعة، الحقائب، البضائع، طاقم الطائرة، وحتى الوقودَ الذي يغذي محركها؛ إذ إن كل هذه العوامل تؤثر وبشكلٍ مباشرٍ على عملية الإصدار (Load Sheet) ، والذي يشكلُ الأساسَ المهمَ في السماح للطائرة بالإقلاع عن أرض المطار أو عدمه.

وللتعامل وبشكل ناجح مع التطوراتِ والتحسيناتِ في بيئةِ المطار، وبناءاً على الخبرة العمليةِ في مجالِ الطيران خاصة في قسم (Load Control) فإن هناك العديدَ من المشاكل في عملياتِ جمع المعلوماتِ من أجل إصدار (Load Sheet) في منطقةِ مدرج إقلاع الطائراتِ ؛ لذلك فإن معظم الخطوطِ الجويةِ لا بدَّ أن تسعى لاستخدام الأنظمة اللاسلكية التي ستؤثرُ إيجابياً على كفاءةِ العملِ وبالتالي فإنها ستعمل على توفير الوقت والجهد والتكاليفِ بشكل عمليٍّ مفيد.

لكل ما تقدمَ وللعديد من الأسباب التي سيردُ شرحها بالتفصيلِ لاحقاً، فإن هناك حاجة ماسّة ومُلِحَّة لمعالجة كلِّ المشاكل التي ذُكرت وغيرها عن طريق ابتكار طرائق جديدة معتمدين على إنجازات التكنولوجيا الحديثة وتسخيرها لجمع المعلومات وجدولتها بالشكلِ الصحيح و إرسال الأمر بطباعتها لاسلكياً وتوزيعها على الجهات الأربع المسؤولة عما يُسمى ب (Load Sheet) كلٌّ في مكانه.

إن الهدف الأساسي لهذه الرسالة هو تصميم نموذج لإصدار ورقة الحمولة (الوزن والتوازن) للطائرة لاسلكياً في بيئة المطار. إن استخدام الاتصالات اللاسلكية قد توسع وبشكل كبير لاسيما خلال السنوات الأخيرة وذلك لأن الشبكات اللاسلكية تبرز بوصفها جانباً مهماً وفعالاً في مجال العمل في الإنترنت . بالإضافة إلى ذلك, فإن ورقة (Load Sheet) هي النتيجة النهائية لجميع العمليات التي نُفّذت على متن الطائرة.

وفي الختام , فإن تطبيق فكرة النموذج المقترح ستساعد في تسهيل العمل الجماعي في قسم (Load Control) لتمرير البيانات بشكل سريع وذلك لتسريع عملية إصدار وطباعة (Load Sheet) لاسلكياً . إضافة إلى ذلك ، فإنه سيعمل على حفظ الوقت والجهد وتخفيض التكاليف وتقليل عدد الموظفين المطلوبين لإنجاز العمل.

Designing a Model for Wireless
Load Data Sheet in Aircraft

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ABSTRACT

The aviation world nowadays occupies a very high and important position because of its great importance, so all operations associated with it should be subject to constant developments; especially with Aircraft Loading which in turn consists of passengers, cargo, baggage, goods, cabin crew, and even the fuel which feeds the engine of the aircraft. All these factors directly affect the process of generating and printing the load sheet which constitutes the essential basis for the approval or rejection of the aircraft departure from the airport.

To cope successfully with the developments and improvements in the airport environment and to be based on the practical experience in the domain of the aviation world; especially in Load Control Department, there are many problems in the operations of collecting data to generate and print the load sheet in the take off runway area. Therefore, many airline companies seek to use wireless systems which would positively affect the efficiency of the work by saving time, effort, and costs in a very useful and practical way.

Due to all of the above and for many other reasons, there is an urgent and immediate need to solve all the mentioned problems and many others by devising new

ways depending on the use of modern technology achievements in order to gather the needed information and schedule it in the appropriate format to send the order to be printed wirelessly and distribute it to each of the four directions responsible for what is called the load sheet.

The main goal of this thesis is to design a Wireless Model for Load Sheet Management in the Airport Environment. The use of the wireless communications expands largely; especially during the last years because wireless networking is emerging as a significant and efficient aspect of Internet working. In addition, the load sheet is the final outcome of all the operations carried out on the aircraft.

Finally, implementing the proposed model will help in facilitating the team work in the department of load control to pass the data quickly in order to speed up the process of generating and printing the load sheet wirelessly. As well as, it will save time, efforts, and reduce the costs and minimize the number of employees.

CHAPTER ONE

Introduction

Chapter 1
Introduction

Overview

Wireless communications are rapidly expanding and developing to include new systems and applications. They have become the subject of interest for many researchers nowadays in many domains; especially in the airport environment (The aviation world) since they can be used at any time and any place.

Because airlines in the aviation world depend largely on the wired systems, many problems may occur, but the use of the wireless communication suggests a model in generating and printing the load sheet that can be solved when applied.

A wireless model is designed to help the airline company (the employees working in the company) to print the Load Sheet wirelessly instead of using the wired systems which are limited in place and cause many problems. The wireless model will be used as main tools (Wireless Access Points), (wireless printer) (Lap Top) to be connected wirelessly to the office and help print Load Sheet directly from under the aircraft. These tools will directly be connected to the head office and data will be saved in the database of the head office and the head office should confirm that the data is received and then send it again to print the Load Sheet wirelessly including all the information of the aircraft directly by the employee who exits under the aircraft.

This chapter will consider the definition of different types of problems (financial problems, resources problems, technical problems, and logistic problems). After that, the thesis will take into account the proposed solution which is the wireless model designed mainly for the aviation world including (airlines companies , operations , aircraft maintenance , cargo department , ramp area for loading and offloading the aircraft , tour) based on observations of a real practical experience in the airport environment , as well as interviews. After all, there is the conclusion and the future work of the wireless communications in the Aviation World.

Finally, such a model is ideal to solve the problems that result from using the wired systems and will enhance a new technology, which is so much invaluable and important to save time, effort and cost as much as possible, besides raising the efficiency of the task to its highest level.

Statement of the Problem

This section will shed light on the problems and the difficulties which face the load sheet employees in airport environment and how such problems affect time, cost (expenses of the aircraft services), and the efficiency of the task performed. Financial problems include passengers compensation , fuel , light expenses during the night , ground services for each hour plane stays at airport chocks area, and overtime for staff. Resources problems include human resources by increasing the number of part time employees, suppliers including the civil aviation, ground aviation, and ground handling. Technical problems can be divided into uncertainty or inaccuracy of information exchange and distance between different areas of the airport while logistic problems deal with flight delay and interference in transmission. All these issues will be discussed in detail in the next sections.

Moreover, the proposed wireless model will be used for printing the load sheet using a wireless printer, and establishing the communication between the office in the airport buildings and the ramp area (the operational area). Few challenges might be faced when this wireless model is applied, but the perfect design of the proposed wireless model will help in overcoming all these challenges.

1.2.1 Financial Problems

There are many financial problems, these include:

1.2.1.1 Flight Delay

Flight delay is an essential part of the financial problems since it affects directly other parts especially the cost because the relationship between the flight delay and the cost is co-relational. In addition, time plays a crucial role both in the aviation world and the aircraft delay. In case of a flight delay, the cost will increase and as time passes, the expenses which should be paid will be continuously increasing to form a heavy burden.

The relationship that shows the effort of flight delay in hours on the cost of delay in US$ is shown in table 1.1.

Flight Delay in Hours	Cost of Delay in USD
1	3000
2	4500
3	6000

Table 1.1 Flight Delay

1.2.1.2 Passengers Compensation

Passenger compensation, as a part of financial problems, depends largely on the number of time passing in hours. For example, if aircraft delay lasts for two hours, the airline company has to pay more money as it has to offer passengers soft drinks. However, if it continues for more than two hours, the airline company has to offer the passengers not only a soft drink as a compensation of the delay, but also a meal. If the delay lasts for more than four hours, the passengers have to be compensated by booking them suites/rooms in hotels till the airline company manages to solve problems which cause that delay. Moreover, the relationship between the number of passengers and compensation due to flight delay that has to be paid for them is co-relational. For example, when the load of the plane reaches (200) passengers, the company has to pay more than (2000) US dollars in case that the flight delay lasts for about four hours. If the number of passengers runs over (300), the cost will increase directly; such relationship is shown in table 1.2.

Flight Delay In Hour	Passenger Compensation In USD
2	10
4	20
6	50

Table 1.2 Passengers compensation

1.2.1.3 Fuel

If the aircraft which has a delayed flight is already on the ground because of some technicalities or safety reasons, the aircraft will consume and burn more fuel.

If something wrong happens as the aircraft takes off, it has to return back to the ramp area to fix all the errors that occurred and make sure that everything is going on the right direction. Therefore, the aircraft will need more take off fuel , taxi fuel , and run a way fuel since the aircraft engeins are still running and burning fuel .This will increase the expenses of the airline company as it has to pay more money to the petroluim refinary. The expenses will increase as more time passes. Taxi fuel is the fuel used to park the aircraft on the gate while run a way fuel is the fuel used to make the aircraft ready for taking off or that used when the aircraft lands or is taken to the taxi way. However, take off fuel is used to make the aircraft ready to take off. The effect of flight delay on fuel is shown in table 1.3.

Flight Delay	Fuel
1	100
2	200
3	300

Table 1.3 Fuel

1.2.1.4 Light Expenses During the Night

Light is a source of energy and is used in the airport environment to facilitate the loading and offloading of the dead load from/to the aircraft. Therefore, the airline company has to pay for the consumed light as a source of energy; especially when flight schedule is at night. However, the consequence is that the airline company has to pay more and more money as it consumes and needs more light to solve the problems that result from delay. The relationship between flight delay and light expenses during the night is shown in table 1.4.

Flight Delay	Light Expenses
1	130
2	250
3	400

Table 1.4 Light expenses during the night

1.2.1.5 Ground Services for Each Hour the Plane Stays at the Airport Chocks Area

In the airport environment, the handling agent deals with many airline companies and each airline has a special schedule for the time its aircrafts have to takeoff or land. In addition, the handling agent company specifies a specific ground time for each aircraft which in turn differs according to the type of the aircraft. Therefore, staying for more than specified ground time for every flight results in an increase of ground chocks cost; especially that if one second passes out of the actual time departure (ATD), it will be calculated as one complete hour which is of course a burden on the station's budget. The effect of flight delay on the cost of ground chocks consumed time, expenses and ground services is shown in table 1.5.

Flight delay	Cost of ground chocks
1	200
4	400
7	700

Table 1.5 Ground services – Cost or Ground Chocks

1.2.1.6 Over Time for Staff

If there is a flight delay, more employees/staffs are needed to work overtime hours to solve the problems that the delay causes. Therefore, extra money has to be paid for them for their extra effort. In the aviation world, one hour flight delay will be counted as one and half past hour for each member of the staff , the impact of flight delay on the overtime which should be paid per employee is shown in table 1.6.

Flight delay	Over time paid per employee
1	15
2	30

Table 1.6 Over time for staff

Resources Problems

There are many problems related with the resources, these problems are devided into two cateogries according to their effect on the overall system:

1. Human Resources by Increasing the Number of Part Time Employees

Flight delay sometimes means that the employees working in the shift at which flight delay happened, are not enough to cover all the areas and handle all the problems which exist in the manual of the airline company. Therefore, there is an urgent need for the airline to summon up other employees from the previous and /or the following shifts to help tackle the problems which means in turn that the airline has to pay extra money for these later employees for their extra effort. In addition, the employees who have been working when the delay happened are to be paid more money if the flight delay lasts for more than their planned schedule.

2. Suppliers; Including the Civil Aviation, Ground Operations, Ground Handling

The civil aviation later named as Airport International Group (AIG) is responsible for everything in the airport environment. They account for the airlines in that in case of any delay, the airline will pay for the (AIG) and for ground operation which is responsible for the aircrafts' parking to the gates. They have an accounting system and if there is a flight delay, this system will automatically reveal the increase of the money that the airline has to pay for that delay. The airport deals with several airline companies and several flights have to be on ground at the same time. Therefore, delay in the landing of one aircraft as planned in the schedule will lead the ground operation to ask airline staff to push back the aircraft from the gate in order for the other aircrafts to chocks on at its place as planned in the flight schedules. On the other hand, the ground handling agent is responsible for providing employees in order to handle the aircraft. When the delay happens, the staff must still exist on the aircraft till solving the whole problem completely. At the same time, there are other airlines whose aircrafts land at the time when the staff of the ground handling is on the delayed aircraft. This means that the ground handling has to provide another staff for the other airlines. The airline that causes all these problems due to the delay must bear all the costs.

Technical Problems

The technical problems can be divided into two groups, these are:

1. Uncertainty or Inaccuracy of Information Exchange

Using the wired system may lead to several errors to happen, so there should be two or more employees in different places who are connected through the wireless devices, in a way that one or the first group has to be in the office and the other should be under the aircraft. The former waits a message to arrive from the latter and vise a versa. Consequently, inaccuracy or uncertainty of information exchange in the sent and received messages between the employees will result in case that one of the two parts doesn't hear the message or that the message is interrupted more than one time. Such inaccuracy results from using the wired systems which cannot cover vast areas and cutting messages will result from confusion which happened because of the aircraft hazard or ground equipments. Because of the shortcomings of the wired system, the employees in the airport environments tend most of the time to use their mobiles to make sure that everything is going on the right direction. However, this will be explained in further details in the next point.

2. Distance Between Different Areas of the Airport

The airport environment is huge and extends over vast areas which mean that the employees have to move quickly from one place to another, but time in the aviation world is vital since it affects the cost directly. However, there is a great distance between the office inside the airport building and the aircraft on the ramp area. Using the wired system will limit the abilities of the employees to control everything concerning the load sheet from one place and they have to move between all these places to print the wired load sheet as quickly as possible and confirm that everything is loaded as it should be. Sometimes, there is what is called Last Minute Change (LMC) in the final loading, so the employee/s has/have to restart the Load Plan (LP) again, to print a new Load Sheet within the resulted amendments. Moreover, there are limits determined by the manufacturer company since each flight has a different weight limit that can be loaded on it, which in turn depends on the type of the aircraft. All these processes need more time and effort since sometimes the limit of the (LMC) exceeds the permissible level of the acceptable (LMC) and necessary changes have to be made.

Logistic Problems

The Logistic problems can be divided into two logistic groups, these are:

1. Flight Delay

The aviation world is like a web in which each airline company is highly connected with other airline companies through certain type of agreement called (Code Share), so they all depend on each other and the accuracy in the application of flight schedule in one aircraft will affect directly both the station whose aircraft has a delay, the other destination that the aircraft must head to when it comes back to the office, as well as all the other stations scheduled either to land or takeoff at the same time since the flight schedule is not only arranged for one station and this will increase directly the cost for all the destinations which have a flight delay.

2. Interference in Transmission

Interference, also a significant issue in many wireless channels, is typically one of two types: multiple access interference and co-channel interference. Multiple-access interference refers to interference arising from other signals in the same network. However, co-channel interference refers to interference from signals from different networks, but operating in the same frequency band as the signal of interest (Wang & Poor 2004). Usually the quality of data transmission is affected by many noises. Noises are unwanted signals that are added to the message signal in the generation, transmission, reception, and detection processes employed in effecting telecommunication (Crane 1999). These noises come from the Engines of the aircraft, HF (High Frequency), VHF (Very High Frequency), ATC (Air Traffic Control), TCAS (Traffic Control Anti-collision System), and many other ground equipments which affect the efficiency of data transmission. In addition, such interruption might also be faced due to the fact that the airport environment is so large and the data sometimes might not be sent and/or received correctly. VHF (Very High Frequency) is short-term waves moving horizontally, but they are less efficient than HF (High Frequency) since the process of transmitting data will be hindered or even sometimes blocked if it crashes into a high mountain or a hill when it is sent. However, HF (high frequency) waves are more efficient than the former, since the possibility of data transmission interruption is less than that occurring within the use of (VHF) very high frequency because (HF) moves vertically rather than horizontally. The tour in the airport environment is the ATC (air traffic control) and it controls the aircrafts' movements of all the airline companies. Therefore, if something wrong happened, the pilot will immediately send frequencies or waves to the ATC to ask for help to solve the problems quickly. All these processes will directly affect data transmission when the wireless system is used, but the designed wireless model will take into consideration such problems to avoid and eliminate them. For example, interference in transmission might be caused by hijackers who might have an access to the network, but modern wireless access points used in the wireless model are provided with built-in-encryption which is difficult to crack when strong passwords or passphrases are used. In addition, the use of firewalls will help in providing security to prevent the occurrence of breaches. The technologies used in the wireless proposed model, like IEEE. 802. n , have the following characteristics: transmission speed is so high and the frequency bandwidth covers wide areas, so the possibility of interruption will be reduced to the minimum level and even eliminated. Moreover, the authentication process which is connected with the configuration and connecting processes will make sure that only the authorized people are the ones who connect to the specific network used.

Objectives of the Study

This research focuses on the advantages of using wireless technology to increase the efficiency of the work, the speed of achieving the tasks and to print the load sheet quickly in the aircraft

There are many objectives which can be summarized as follows:

1. Using the wireless technology in generating the load sheet in order to speed up the process of flight operation which in turn reduces time consuming resulting from the use of the wired system.
2. Reducing human effort needed to complete the load sheet process; especially that extra efforts have to be done in case of a flight delay to deal with the problem.
3. Reducing the overall operating cost of an aircraft.
4. Increasing the efficiency of the work and reducing the errors that might occur during the aircraft loading and offloading which will directly affect the process of printing the load sheet.
5. Providing the new wireless technology to cover all the different areas together, like the sorting area, baggage area, and the ramp area and which is much more improved and advanced than the current technology (wired system).
6. Introducing the new designed model will enhance the advantages of the wired system and meanwhile reduce the possibility of making errors or the shortcomings that result from the wired system. The model will go well with the preferences and needs of the airport environment which will interact with a continuous department in the airport environment.

Motivation

From our working experience in this field - load sheet - the load control employees in the airport environment suffer from various problems which result from the current process to generate load sheet, so we try to find an idea to solve such problems. The world around us is continually developing and improving day after another and every day a new technology is used in a new field. The wireless communications are developing, and all companies tend to prefer the use of wireless systems instead of using wired technologies. However, this research will propose the adoption and implementation of a new idea in the aviation world to improve the quality of the provided services and speed up the processes to save money, time and effort.

In addition, mobiles nowadays are used widely everywhere and at any time and using them will help in increasing the efficiency of the work. Therefore, this technology can be invested to open new horizons in the aviation world to benefit from using it and minimize the need for the desktop PCs which are used in the office. The proposed model will enhance the use of the laptop computers and a wireless printer connected with a wireless access point. All these reasons give us a strong motivation to handle this topic and make it real rather than a dream to be applicable in the airport environment through our designed model.

Significance of the Problem

In this research, the proposed model is intended to serve many departments in the airport environment; GHA (The Ground Handling Agent), all the airline companies, and even the employeess. The airline company will benefit by increasing the efficiency of the work performance as it tends to use the wireless communication system instead of the current wired system. The aircraft will takeoff as scheduled without any postponement, so the wireless communication system will provide more effective real-time solutions to the problem that might occur. The airline companies and the handling agent company will benefit from such new system which saves time, cost and the number of employees needed to tackle the default. Then, the wired system is restricted to one place and it might only cover limited areas. Therefore, the Load Control agents have to contact with the ramp agent who works in the GHA (ground handling agent) in order to know the needed information about the load sheet and if a mistake occurred from either the former or the latter, the safety of the aircraft and the passengers will be greatly affected.

However, the wireless system depends mainly on transmitting waves and frequencies, so it can extend and cover vast areas. Accuracy in sending and receiving information is very essential and it can be achieved through the use of the wireless communication since the possibility of making errors is less because the same load control agent employee can by himself control the whole situation directly. In addition, the current situation in the airport imposes having an employee (The Load Control Agent) who sets in the office, not moving, to control the process of printing the load sheet till being completed, but the use of the new technology does not require that since a single person can do the work of many employees as he can control the loading and printing the load sheet process from the same place without returning back to the office to modify and print another Load Sheet when there is a (LMC).

The use of PDA (Personal Digital Assistant) and CRM (Customer Relationship Management) within the wireless communication system will facilitate both the checking and signing processes which is easier not only for the employee, but also for the captain because the captain will not wait a long time to make sure that every data entered in the load sheet is exactly the same as the data given to the load control agent by the captain. Therefore, both the captain and the load sheet agent will sign it directly on the (PDA) and / or (CRM) devices or (laptop) instead of papers.

Boundaries

In this thesis, the main environments in the airport will be discussed as well as the different subdivisions of each environment. In addition, the processes associated with each subtopic will be further discussed along with their main environments which are all possible for the application of the wireless communications in the airport environment. The main topics include:

1- Airport Operations Requirements:

This section will summarize the main airport operation requirements which are Ground Handling, Catering, Fueling, Cabin Appearance, Maintenance, Ground Operations, Duty Free, Traffic Control (Tower), Baggage Services, Governments Sectors, and FIDS (Flights Information Display System).

2- Airport Environments Infrastructure:

This section includes the Ramp area, Sorting area, Arrival area, Departure area, Run way, Taxi way, Telecommunications, Power (commercial electricity (electrical generators, electrical power suppliers ……..)), Transit area, Cargo area, Maintenance area, Catering area, and Safety (Fire Ammbrigate).

3- Airport IT Environments:

Airport IT Environments include Main frames, Servers, Switches, Routers, Leased lines, PSTN line, Computers, Printers, Scanners, Telecom-faxes, Walky – Talky, Wireless access points, and Photo copies.

4- Airlines Operations Requirements:

Airlines Operations Requirements include Editing, Catering, EZFW (Estimated Zero Fuel Weight) (part of load control), Sales, Loading Instruction Report, Cargo (pre–flight manifest), Movement (MVT).Stands or gate, Luggage off – loading, Check the Aircraft Compartments (security check), Check Maintenance, and Gate open.

5- Airline Operations Requirements:

Airline Operations Requirements include CGO (Cargo)loading, Luggage loading, Counting the luggage pieces, Cabin appearance (intermediate), Catering (intermediate), Security check (cabin managers), Start boarding, Print load sheet, All on board, Load sheet signed, Door close, Flight pushes back, and Flight air pone.

6- Airline Operations Requirements:

Airline Operations Requirements include Departure messages, (Operations/ Dispatchers), FFM (Freight Forward Message), Sales revenue, Flight close, MC, @R, Load Control Documents.

7- Airline Applications and Systems :

Airline Applications and Systems include Reservations System, DCS (Departure Control System), (Visa Check), Baggage Re-Consolation System, and Baggage Tracing System.

8- Aircraft Operations :

Aircraft Operations include Flight plan, Weather messages (HDQ), ACARS, and Flight briefing (need navigation).

Limitations

The limitations / challenges being faced in this research proposal are many. On one hand, the using of wireless technology in the airport environment, primarily suffers from signal interferences. When wireless devices transmit data, they are susceptible to interference of microwaves, cordless, mobile phones, Bluetooth enabled devices, and other communication devices, closer the interfering devices will be the poor communication and vice versa. On the other hand, to apply such application (Proposed Model) efficiently and safely in the airport environment, it requires a wireless infrastructure with necessary bandwidth while meeting the short transmission distance restrictions is required to meet interference limits.

Thesis Organization

In addition to this chapter, the thesis includes four after chapters and appendixes.

This section will describe briefly the contents of thesis chapters

Chapter two provides an overview of the load sheet under the title: load sheet and related works; including the different types of load sheet; manual load sheet, EDP (Electronic Design Process) load sheet, ACARS (Air Craft Addressing Reporting System) preliminary load sheet, ACARS final load sheet, quick load sheet and LPC (Less Paper in Cockpit) load sheet. It will explain in detail the elements of each type; providing explanatory figures of each one followed by an analysis of its elements numbered on the figures. After that, it will initiate the proposed model; showing the differences and distinguishing characteristics it has and which the other types, on the other hand, do not.

Chapter three will give an explanation of analysis phase activities with an overview of system requirements in its relation to the users as stakeholders. Then, this chapter will show how all these steps and techniques will help in the building model; showing fact, finding methods, review existing reports, forms, and procedure descriptions. It will also show what modeling is, the reasons for modeling, types of models, and how models are used in analysis. All these previously mentioned techniques will help show how they give an inspiration to build the proposed model here, using all the techniques explained with some modifications and additions of newly-creative ideas.

Chapter four provides a complete description of the designed model. In chapter 4, proposed model introduction is given, followed by the design of the thesis proposed model which will describe the whole processes in detail to guarantee the successful implementation of it to generate and print the load sheet wirelessly. Furthermore, different diagrams are designed to show and support the interconnected relations between the components of each type of the designed model in their relation to the thesis proposed model.

Finally, chapter five is divided into two sections which are, 5.1, which summarizes the main conclusions on our proposed model, and section 5.2, lists the suggestions that we recommend for future research works.

CHAPTER TWO

Load Sheet and Related Work

Chapter 2
Load Sheet and Related Work

2.1 Overview

This chapter will give an overview of the load sheet and related works, including the different types of the load sheet; manual load sheet, (EDP) load sheet, ACARS preliminary load sheet, ACARS final load sheet, and quick load sheet as well as will explain in detail the elements of each type providing explanatory figures of each type followed by analysis of its elements numbered on the figures. Moreover, the load sheet which is an IATA (International Air Transport Association) standard format , also in accordance with AACO (Arab Air Carriers Organization) format, forms an essential part of the certificate of air worthiness of the aircraft .This document (load sheet) should be completed very systematically and accurately in accordance with the current load control/distribution procedure (Saudi Airline 2007).

The load sheet must be issued for every flight because it contains critical data about the airplanes weight and balance (Bradair), The crew uses it to get information about the actual weights of the aircrafts, the actual center of gravity and stabilizer settings, and the actual number of passengers. The agent who issues the load sheet must compare the total compartment weights with the weights calculated on the loading report by the loading supervisor (Delta Airline 2008). Passenger figures must correspond with the number established at the boarding gate. The load sheet has to be amended before bringing it to the commander (Swiss Airline).

Approved Loading System means a system prepared by an operator in accordance with the requirements of and approved by holder of an appropriate and valid Weight Control Authority for ensuring that an aircraft is loaded within approved limits at all times during flight. Load Sheet means a form for recording the weight and disposition of the disposable load together with other pertinent loading information. Approved Load Controller means a person nominated by an operator and approved by CASA (Civil Aviation Safety Authority) to carry out all or any of the duties involved in the control and supervision of aircraft loading for a particular aircraft. The pilot in command or the co-pilot of an aircraft may undertake the duties and assume the responsibilities of an approved load controller without special authorization by (Civil Aviation Safety Authority) (CASA). Where an aircraft has an approved loading system, the operator and the pilot in command shall ensure that the aircraft is loaded at all times in accordance with that system (Byron, B 2004).

The load sheet must be singed by an agent holding a valid load control qualification. The commander sings the load sheet for approving it. However, he only checks if flight number, date, registration, number of crew, routing, and fuel figures are correct to ensure that the aeroplane is loaded within its limits regarding its center of gravity and maximum permissible gross mass. In addition, each company has a particular procedure and system to deal with the load sheet and balance chart (Gainjet aviation 2009). The traditional way of delivering the load sheet is by hand to the cockpit before departure .The Final Load sheet is typically the last document that the pilot must have before departure . Saving a minute or two in the delivery of the load sheet is therefore important in order to improve on–time performance and reduce turn around times . For airlines with many short–haul flights with minimum turn–around times and remote parking positions, this is even truer (Bjrn 2005).

Finally, the summary of the Load sheet puproses is as follows (Etihad airways 2009):

1- computing weights of the total load sheet in the aircraft and its distribution.
2- ensuring that the maximum permissible weights are not exceeded.
3- indicating that the balance condition of the aircraft is in conjuction with the balance chart.

2.2 Analysis of Loadsheet Process

There are many crucial elements in loadsheet process which include Fuel Doket (completed and signed by the pilot for every departing flight), Loadsheet Plan, Finalize Loadsheet, and Ensure that Centre of Gravity and Weights are within the specified limits and Trim. Fuel Docket must include specific data inserted to the system; these elements are takeoff fuel , trip fuel, taxi fuel, crew count, aircraft registration, and MALTOW (Maximum Landing Takeoff Weight) or RTOW (Regulated Regulatory Takeoff Weight). Load Plan includes Bocked Passenger, Bocked Passenger Baggage, Baggage Container Tare Weight, E.I.C., and Final Cargo Mail Figures. These data are inserted with the system and can be controlled / changed by the load controller. Within Finalize Loadsheet Process; to generate the loadsheet, the passenger figures, baggage figures, and fuel figures must be finalized by system and are also controlled by the load controller. The final element / step within loadsheet process which is ensuring that Centre of Gravity and Weights are within the specified limits and Trim will lead necessarily to a successful completion of the whole process (Load Sheet Process). However, Last Minute Change (LMC) should be taken into account and there are two possibilities for that. It is either that there should be

LMC or not. In the first case (yes), changes should be made to make sure that limits are not exceeded or underloaded before moving to the next step, but if it is (No), the successfully completed loadsheet should then be offered to the Commander at no later than – 10 STD (Schedule Time of Departure). Last minute change means any change concerning traffic load : passengers, baggage, cargo, fuel (useable or not) occuring after the insurance of the load and trim sheet (Saudi Airline 2007) and (Etihad Airways 2009). It is only permitted if load sheet changes are within prescribed tolerances which in turn must ensure that :

- none of the maximum operational limiting weights are not exceeded (ZFW (Zero Fuel Weight), TOW (Takeoff Weight), and LDW (Landing Weight).
- no loading limitation is exceeded.
- ZFW CG (Zero Fuel Weight Centre of Gravity) and TOW CG (Takeoff Weight Centre of Gravity) remain within allowed limis.

The use of LMC box enables changes to be made to the total traffic load after the completion of the loadsheet. LMC can be made without any other changes to the loadsheet within the aircraft and changes in the Traffic Load are done by entering the item in the LMC box. Provided the total change is within the Underload figure, no correction is made to the Zero Fuel Weight, Takeoff Weight, or Landing Weight**.**

The successful completion of each step depends largely on the success of the one before it. Figure (2.1) shows the load sheet process and how each step depends largely on the one before and after it. For example, finalizing the loadsheet depends largely on completing successfully loadsheet plan and Fuel Docket as shown in Figure (2.1) Load Sheet Process.

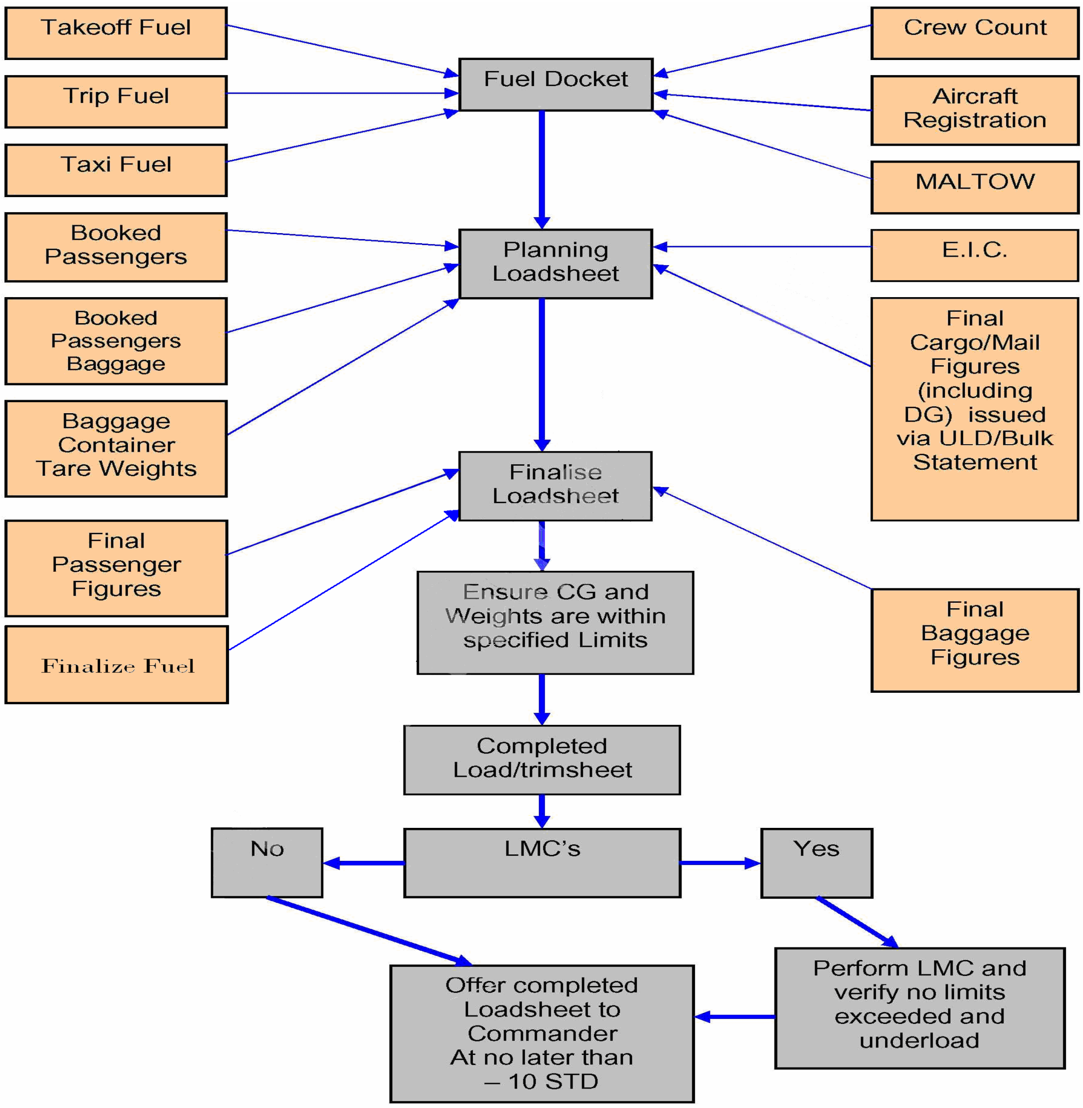


Figure 2.1 Load Sheet Process

Before starting to handle the different types of the loadsheet, analysis of major elements of the loadsheet present in every type is very important and will be described here in details.

2.2.1 Take-off Fuel (TOF)

Weight of the fuel planned on board at take-off and which consists of the following :

- The amount of fuel calculated to operate the flight to destination.
- The amount of fuel calculated to operate from destination to an alternate airport.

- The amount of fuel necessary to provide a laid down reserve for holding in Air Traffic Control (A.T.C) patterns. Laid down reserve is the case in which the aircraft has to wait stand still in the air or move to an alternative airport because of an emergency case.
- This can also include extra fuel over the above requirements when it is cheaper at the originating station to save costs in uplifting fuel at a high cost station or because of a bad weather in route.

2.2.2 Trip Fuel (TIF)

Weight of the fuel necessary to cover the normal flight sector without any reserves and it can be also called (Burn-off Fuel).

2.2.3 Taxi Fuel (STF)

Fuel expected to be used prior to take-off, including engine start, taxi and (Air Power Unit) APU consumption. For simplification, a standard quantity of fuel (conservative value) will be calculated for computer plans as given in the table below. Quantities may be adjusted according to Commander's discretion. Table (2.1) shows aircaft types and the quantity of the taxi fuel needed for each aircraft.

Aircraft Type	Standard Taxi Fuel	Aircraft Type	Standard Taxi Fuel	Aircraft Type	Standard Taxi Fuel
A319	200 kg	A343	400 kg	B773	600 kg
A320	200 kg	A345	600 kg		
A332	400 kg	A346	600 kg		

Table 2.1 Standard Taxi Fuel

Note : Maximum Ramp Weight shall not be exceeded.

2.2.4 Ramp Fuel / Block Fuel (FIT)

The total amount of fuel on board prior to engine startup.

(Ramp Fuel / Block Fuel = Take-off Fuel + Taxi Fuel).

Note: Entering Take-off Fuel (TOF) and Trip Fuel (TIF) allows the system to calculate an allowed traffic load. The (TOF) has to be split to show the fuel in wings and centre tail tanks.

2.2.5 Crew Count

The crew version is divided into two parts x / y where x indicates the number of crew inside the cockpit area (captain and the first officer) while y stands for the number of crew inside the aircraft. The number of each part differs from one aircraft to another.

2.2.6 Aircraft Registration

It is divided into four major parts, the first part stands for the carrier code while the second for the airline company itself, the third for the type of the aircraft and the fourth stands for the aircraft number shown in alphapetical order.

2.2.7 MALTOW (Maximum Allowable Take-off Weight)

It is the lower of Regulated Regulatory Take-off Weight (RTOW) and Maximumm Take-off Weight (MTOW) certified. Figure (2.2) shows the divisions of MALTOW (Maximum Allowable Take-Off Weight) and the subdivisions of each type in turn.

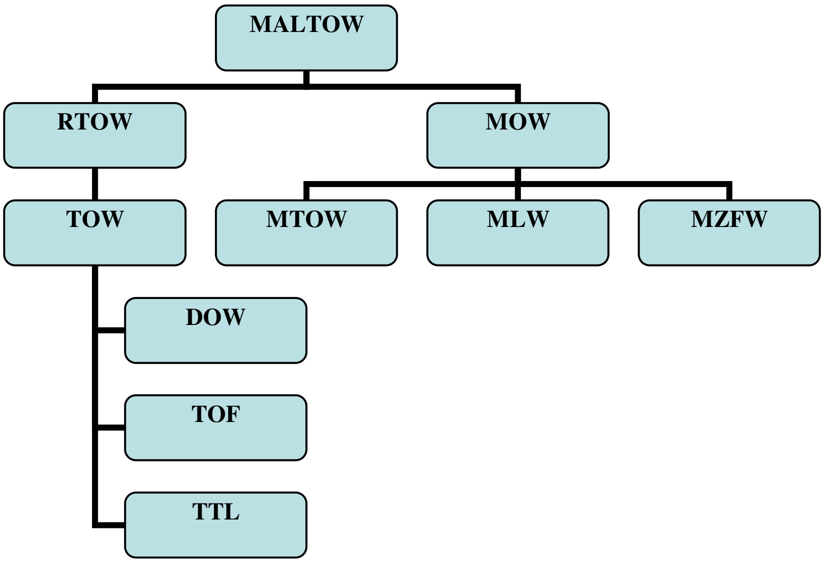


Figure 2.2 MALTOW (Maximum Allowable Take-off Weight)

2.2.7.1 Regulated Regulatory Take-off Weight (RTOW)

It is the performance limited take-off weight which is calculated by the flight deck crew and it is the lower of the :

- Maximum Authorized Take-off Weight.
- Performance limited take-off weight which is calculated by the flight deck crew.

Maximum Take-off Weight can be limited to a lower figure due to one or more of the following factors when the performance requirements will not be met by the aircraft at its maximum take-off weight. To enable the requirements be met, the take-off is reduced and is called Regulated or Reduced Take-off Weight.

The following factors affecting the Maximum Take-off Weight to be reduced and / or limited :

- Length and strength of the runway.
- The wind speed and direction in relation to the runway in use.
- High temperatures.
- High altitudes.
- Airport terrain such as mountains, buildings, etc.

- The slope of the runway.
- The runway surface conditions, such as snow, slush, etc.
- Noise abatement procedures (according to some countries policies).
- Destination Landing Restrictions.

2.2.7.2 Take-off Weight (TOW)

The weight at take-off, is equal to the addition of the zero fuel weight and take-off fuel (Etihad airways 2009).

It is made up of three items :

1. Dry Operating Weight.

2. Fuel for the Flight (Take-off Fuel).

3. Total Traffic Load.

Each of these items includes a number of different things which when added altogether give us the weight of the aircraft at take-off.

1. Dry Operating Weight

The first item consists of the following :

a. Basic Empty Weight which comprises the weight of the aircraft with all fixed equipment, system, fluids, unuseable fuel and configuration equipment including galley structure.

b. Operating variables which comprises standard flight crew complement and all cabin attendants, XCA (Extra Cabin Crew), ACM (Aditional Crew Member) occupying passenger seats.

c. Pantry on Cabin Supplies which comprises all food, catering, galley dry goods, bod sales goods, cabin supplies; such as pillows, blankets, newspapers, and magazines, etc.

d. Additional Cockpit Crew above standard and occupying cockpit seats.

2. **Fuel for the Flight (Take-off Fuel)**

This item is explained earlier in section 2.2.1.

3. **Total Traffic Load**

This item comprises what follows :

- Passengers and their baggage weights.
- Cargo weight.
- Mail weight.
- Company mail and service stores weight (Comat: Company Materials).
- ULD's tare weight (wide body aircraft only) (Unit Load Device).

Note : The total weights of these items (A + B + C) must never exceed the Maximum Take-off Weight (Saudi Airline 2007).

2.2.7.3 Maximum Operational Weight (MOW)

The structure of an aircraft has certain limitations which ensure that they are not exceeded, so the aircraft will be able to operate safely and efficiently. The manufacturer of the aircraft has determined that the different limitations must never be exceeded. The main weights subject of concern are the three major maximum operational weights which are used in the preparation of the loadsheet. These are :

1. Maximum Take-off Weight (MTOW).
2. Maximum Landing Weight (MLW).
3. Maximum Zero Fuel Weight (MZFW) :

This weight has no performance or operational restrictions and it is primarily a Structural Limitation.

Each one of these is a limiting factor to the amount of the load that an aircraft can carry. In addition, there are limitations to the amount of weight that can be put on the floors of the cabin and holds.

2.2.7.4 Maximum Take-off Weight (MTOW)

The maximum weight that the aircraft can uplift,considering the current take-off conditions which comprise :

- Tempreture .
- QNH (atmospheric pressure at nautical height)
- Runway conditions
- Wind

Note : Q – code designation for atmospheric pressure mean sea level**.**

2.2.7.5 Maximum Landing Weight (MLW)

The Maximum Authorized Landing Weight which should not be exceeded at the time of the expected landing.

The weight of an aircraft when it LANDS consists of three items :

- Dry Operating Weight.
- Landing Fuel or Remaining Fuel.
- Total Traffic Load.

Note : (Saudi Airline 2007).

1. Landing Fuel marks the difference between the fuel weight at take-off and cosumption fuel (Used Fuel / Burn-off Fuel / Trip Fuel).

2. TOW - Trip Fuel = Landing Fuel.

2.2.7.6 Maximum Zero Fuel Weight (MZFW)

The Maximum Zero Fuel Weight Authorized is to prevent undue stress on the aircraft wing routes to the fuslage. It is primarily a Structural Weight . It has no performance or operational restrictions and it is primarily a Structural Limitation.

Note : It is the weight of an aircraft without fuel comprising the following items :

1. Dry Operating Weight.

2. Total Traffic Load.

2.2.8 Booked Passengers

The total number of passengers and transit passengers (male / female / child / infant) (M, F, C, & I). The passenger's weight calculated in the loadsheet must include the allowance of the handbag .

2.2.9 Booked Passengers Baggage

The total weight of each passenger travelling on board the aircraft.

2.2.10 Bggage Container Tare Weight

The total weight of the empty container which will be loaded on compartment of the aircraft.

2.2.11 E.I.C. (Equipment In Compartment)

The total weight of equipments which will be loaded due to technical reasons.

2.2.12 Cargo / Mail Figures

The Cargo / Mail which will be loaded at aircraft and is considered a main source of revenue for the airline company.

2.2.13 Finalize Loadsheet

There are three major elements which are essential to finalize loadsheet and these are :

1. Finalize Fuel Figures.
2. Final Passenger Figures.
3. Final Baggage Figures.

2.2.14 Finalize Fuel Figures

The system will assume maximum authorized weights for Taxi (Ramp), Take-off, Landing, and Zero Fuel when calculating allowed Traffic Load. Standard Taxi Fuel will also be assumed once they are entered. Fuel Figures must be finalized.

2.2.15 Final Passenger & Baggage Figures

The employee of the counter staff should check in each passenger and his / her baggage and at the end the total number of passengers which have been accepted and the total weight of their baggage will be calculated systematically in the loadsheet. Then, there are two major steps which should be made before the final generating process of the loadsheet which are Flight Close (F. C.) and Flight Finalize (F. F.). Flight Close is to ensure for the system that no more passengers will be accepted at the counter check in area. Flight Finalize is to generate the final loadsheet.

Centre of Gravity { Aircraft Laden Centre of Gravity (Loaded Aircraft)}

The empty centre of gravity is not the one used for flying the aircraft. Load – fuel, crew, passengers, and dead load is added, so another centre of gravity position should be determined. This is known as the Laden Centre of Gravity (After Loading). The Laden Centre of Gravity must fall in an area determined by the flight characteristics of the aircraft.

A point at which the forces of gravity are expected to take place on the aircraft. The closer the C. G. (Centre of Gravity) to the C. P. or wing lift (Centre of Pressure), the greater the fuel saving as the tail trim requirement is reduced. Figure (2.3) shows how the centre of gravity plays a large role in determining the balance of the aircraft.

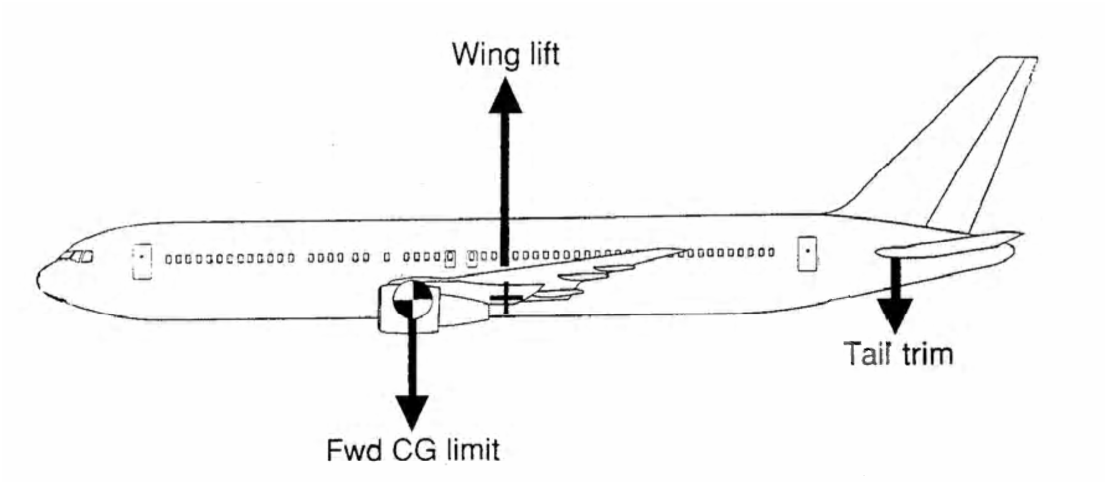


Figure 2. 3 Centre of Gravity { Aircraft Laden Centre of Gravity (Loaded Aircraft)}

2.2.17 Ideal Trim

In interests of fuel economy, the load in the cabin and compartments shall, where possible, be distributed in such a way that LIZFW (the leading index at Zero Fuel Weight) be aft (afterwards) of the ideal trim limit.

2.3 Related Works

Related works section is a review of the works which are related to the problem that the thesis is attempting to solve. It identifies and evaluates current and past approaches. Reviewing the successes and/or limitations of the related works is important to avoid past mistakes , taking advantages of previous succsesses , and most importantly , improving the solution (proposed model) when applied. It also motivates interest in the work by demonstrating its relevance and importance. Therefore, discussing the related works is the best way to compare the proposed model with other works.

2.3.1 EDP Load Sheet (Electronic Design Process)

The DCS (Departure Control System) and Automation Manager are resposible to maintain Departure Control System called RTP (Real Time Bravo). Any irregularities concerning data in EDP Load sheet shall be reported to specific management addresses. EDP loadsheet is produced when the DCS is given an order to generate it.

2.3.1.1 EDP Weight and Balance Control

All Departure Control System's (DCS) handling flights shall be approved by the performance department. The performance department controls balance and weight information for use with Departure Control Systems via the release of the monitors for each aircraft type. The operator of the Departure Control System imports the data and sends a test load sheet to the Performance Department for approval.

The Performance Department checks the data to ensure the safety of the aircraft and then gives an approval for use with flights every six months.

2.3.1.2 Description to example EDP load sheet

Figure (2.4) shows an example of an EDP load sheet and the numbers on the figure are explained afterwards in terms of what they refer to.

```
L O A D S H E E T      CHECKED       APPROVED/TIME       EDNO
ALL WEIGHTS IN KILOS          (1)           (2)            01        (3)

FROM/TO FLIGHT         A/C REG VERSION      CREW     DATE     TIME
AMM AUH EY0516/02      A6EIN   16J120Y      2/5      02JUN10 1611
                         WEIGHT           DISTRIBUTION
LOAD IN COMPARTMENTS       3315      1/  1673 3/  1241 4/    400
                                     5/      1
(4) PASSENGER/CABIN BAG      8064  57/ 39/  0/  3 TTL  99
                               PAX   0/ 16/ 80 SOC   0/  0/  0
                               BLKD   0
...............................................................
TOTAL TRAFFIC LOAD        11379                  (5)
DRY OPERATING WEIGHT      45817
ZERO FUEL WEIGHT ACTUAL   57196 MAX  62500  L   ADJ       (6)
TAKE OFF FUEL              8500
TAKE OFF WEIGHT  ACTUAL   65696 MAX  72100      ADJ
TRIP FUEL                  6100
LANDING WEIGHT   ACTUAL   59596 MAX  66000      ADJ


                               ................................
BALANCE AND SEATING CONDITIONS .      LAST MINUTE CHANGES
BI    53.0    DOI    58.5      .DEST  SPEC    CL/CPT | - WEIGHT
LIZFW    72.5   LITOW    69.6  .
MACZFW  34.3    MACTOW  32.1   .
STAB TO  0.8 NOSE DOWN         .                (8)
(7) A16.B37.C43.               .
SEATROW TRIM                   .                            .
UNDERLOAD BEFORE LMC      5304.           LMC TOTAL           .
CAPTAINS INFORMATION/NOTES
...............................................................
LOADMESSAGE BEFORE LMC
CAPTAIN - 16947
TAXI FUEL    200 TAXI WGT    65896 MAX    77400
(9) -AUH.57/39/0/3.T3315.1/1673.3/1241.4/400.5/1.

(10) PAX/0/16/80.PAD/0/0/0.COM/5/1

(11) CATERING 1640/6.5

(12) SERVICE WEIGHT ADJ WGT/IND
ADD
NIL
DEDUCTIONS
NIL
(13)  .... PL TEXT ADDITION ....

(14) PANTRY CODE M
AUTHORISED WEIGHTS USED FOR PASSENGERS CREW AND BAGGAGE
(15) LOADSHEET PREPARED BY
ALEX 008 LAQUI
AUH  FRE    1410    POS        0   BAG    116/  1904   TRA        0
        (16)           (17)           (18)                (19)
```

Figure 2.4 Example EDP load sheet

1. CHECKED - Load Controller's signature or approved person to check the following:
    a) Flight Number and Date
    b) Aircraft Registration
    c) Crew version
    d) Load Controllers Name and License Number

       N0T0C YES/No Comment
2. APPROVED/TIME - Captain's signature
3. EDNO 01 - Edition number
4. PASSENGER/CABIN BAGS - Total weight of passenger's and baggage, passenger totals in the following order: male / female / children / infant

   PAX - Total Diamond / Pearl / Coral

   SOC - seats unoccupied by anything other than passengers

   BLKD - Number of blocked seats
5. L - Limiting factor for maximum weight
6. ADJ - Maximum weight adjusted
7. SEATROW TRIM - cabin trim calculation based on seat row, can be changed to cabin zone
8. LMC - all last minute changes
9. LHR - total pay load for first sector in the following order:

   Male / female / children / infants

   T7404- total compartment weights

   1/320- total weight in compartment 1

   2/1846 - total weight in compartment 2

   3/2064- total weight in compartment 3

4/2852 - total weight in compartment 4

5/322 - total weight in compartment 5

10. PAX - total passengers Diamond / Pearl / Coral

    PAD - total staff passengers Diamond / Pearl / Coral

    EIC - Equipment in Compartment / hold / Weight

    Note: there are many special load codes that can be displayed

11. CATERING - Total catering weight and index

12. SERVICE WEIGHT ADJ - Used to adjust the DOW and DOI where required

13. PL TEXT ADDITION - Plain language text which is available for the load controller to enter any relevant information.

14. PANTRY CODE - The code can be S/Short Range M/Middle Range L/Long Range

15. LOADSHEET PREPARED BY - Load Controller's name and Etihad License number

16. FRE - Total cargo figure

17. POS - Total mail figure

18. BAG - Total baggage figure by pieces / weight

19. TRA - Total transfer

2.3.2 Preliminary and Final ACARS Load Sheet (Etihad Airways) (1999)

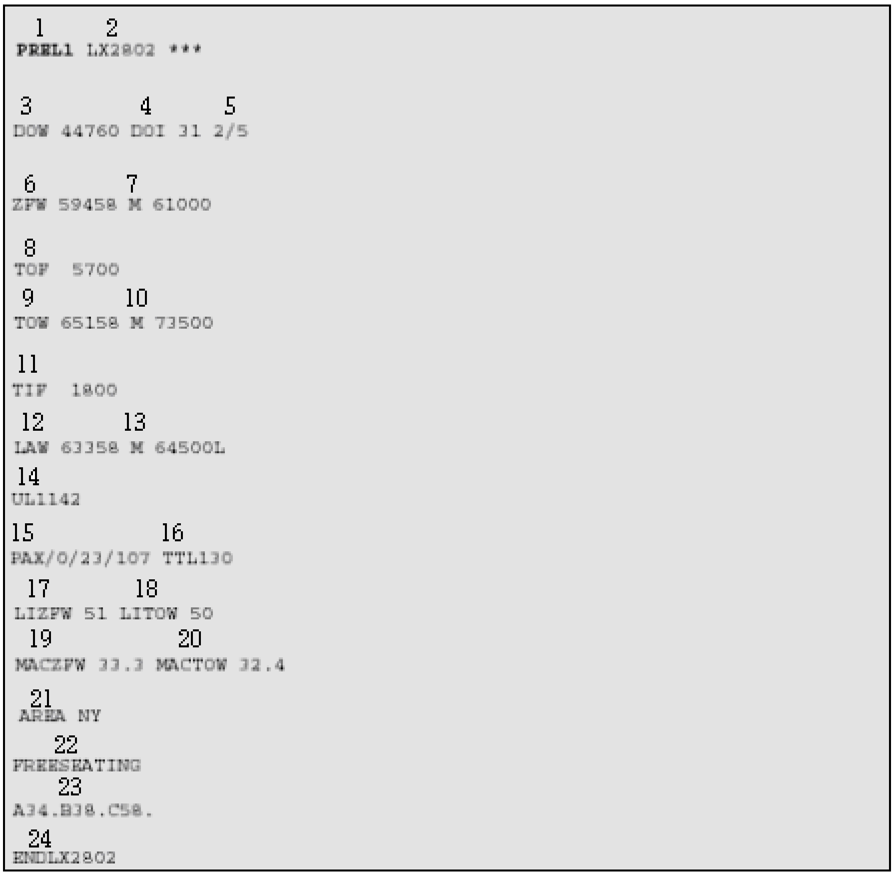
2.3.2.1 Introduction to ACARS Closeout

A closeout procedure via ACARS (the Aircraft Communication Addressing and Reporting System) has been developed to assist local station personnel in assuring an on-time departure. ACARS closeout is the preferred methodology used in developing the load sheet, and has been approved for the entire system. Several factors, such as latest changes in the cargo and passenger counts or remote aircraft parking, can cause flights to be delayed waiting for paper work to reach the aircraft. By sending WDR (Weight Data Record) update to the flight deck via ACARS, the need for the crew to wait for a hard-copy to reach the aircraft is alleviated. This should make it easier to dispatch flights on time (Delta Airline 2008).

The ACARS Preliminary and Final Load sheet can only be issued on stations working with axs-Control DCS (Departure Control System). Before using ACARS load sheet, approval from the manufacturer company to the airline companies to provide their aircrafts with special specific devices must be given. The load control agent must sign the copy of the conventional DCS load sheet going to the flight file. The signature of the commander (pilot) is replaced by his OK for pushback / engine to start. The communication between the commander and the load control agent is achieved through satellite systems. Airline companies can obtain an approval from the satellite system operator or through a service agreement with foreign telecommunications entity operating in the country to use the satellite system of the other through landing rights. Landing rights refers to the right to transmit signals to and/or from the territory of a country other than the one that licensed the satellite system(Schwartz 1996). In case of weight problems or LMF (Last Minute Fuelling), the commander can request a preliminary load sheet containing estimated ZFW (Zero Fuel Weight), TOW (Take-Off Weight), LAW (Limiting Actual Weight), which will be sent some 20 minutes before departure. After receiving the preliminary load sheet, the commander tells the controller his request or his decision about the final or additional fuel and then the final ACARS will send that the loading is finished and no more changes will occur (Swiss airline).

Note : The Preliminary Load Sheet usually does not contain the final loading figures and aircraft weights.

Figure (2.5) shows an example of a preliminary load sheet and its main elements.


1 2
PREL1 LX2802 ***

3 4 5
DOW 44760 DOI 31 2/5

6 7
ZFW 59458 M 61000

8
TOF 5700

9 10
TOW 65158 M 73500

11
TIF 1800

12 13
LAW 63358 M 64500L

14
UL1142

15 16
PAX/0/23/107 TTL130

17 18
LIZFW 51 LITOW 50

19 20
MACZFW 33.3 MACTOW 32.4

21
AREA NY

22
FREESEATING

23
A34.B38.C58.

24
ENDLX2802

Figure 2.5 Preliminary ACARS Load sheet

These explain the elements pointed out in the figure above:

1- PREL 1 Preliminary copy 1
2- LX2802 The beginning of the Document Number.
3- DOW Dry Operating Weight.
4- DOI Dry Operating Index.
5- 2/5 Crew Version.
6- ZFW Zero Fuel Weight.
7- MZFW Maximum Zero Fuel Weight.
8- TOF Take-off Fuel.
9- TOW Take-off Weight.
10- MTOW Maximum Take Off Weight.

11- TIF Trip Fuel.

12- LAW Limiting Actual Weight.

13- MLAW Maximum Limiting Actual Weight.

14- UL Under Load

15- PAX 0/23/107 according to class levels First Class / Business Class / Economy Class.

16- TTL An abbreviation for "Total" word which indicates the total number of passengers who already are on board the aircraft.

17- LIZFW Leading Index Zero Fuel Weight.

18- LITOW Leading Index Take-off Weight.

19- MACZFW MAC Zero Fuel Weight.

20- MACTOW MAC Take-off Weight.

21- AREA Trim Option used on the load sheet and there are two options : ROWS (the aircraft was seated by row on system) or AREA (distributed cabin area or class).

22- FREE SEATING Seating method by class and there are two variables: S (Seat Number) or F (Free Seating).

23- FREE ZONE The aircraft is divided into 3 zones A, B, C and each zone should have a specific number of passengers which in turn differs from one aircraft type to another; for example A 34. B 38. C 58.

Figure (2.6) shows the zones of the aircraft which differs from one aircraft type into another.

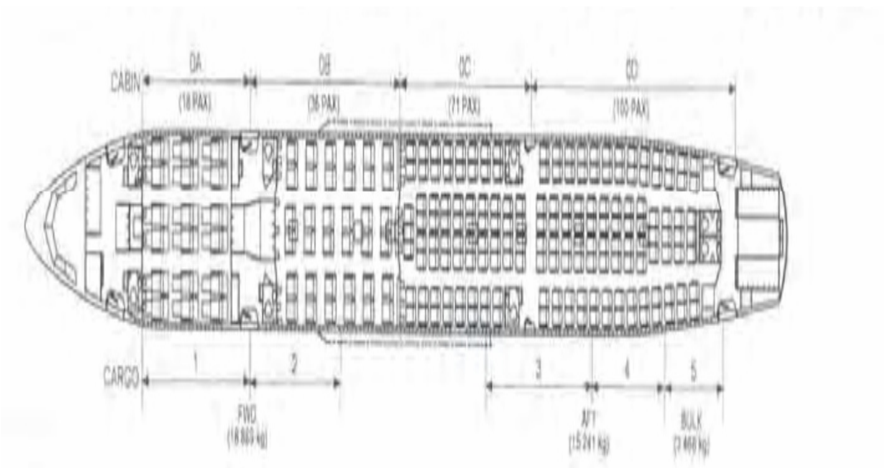
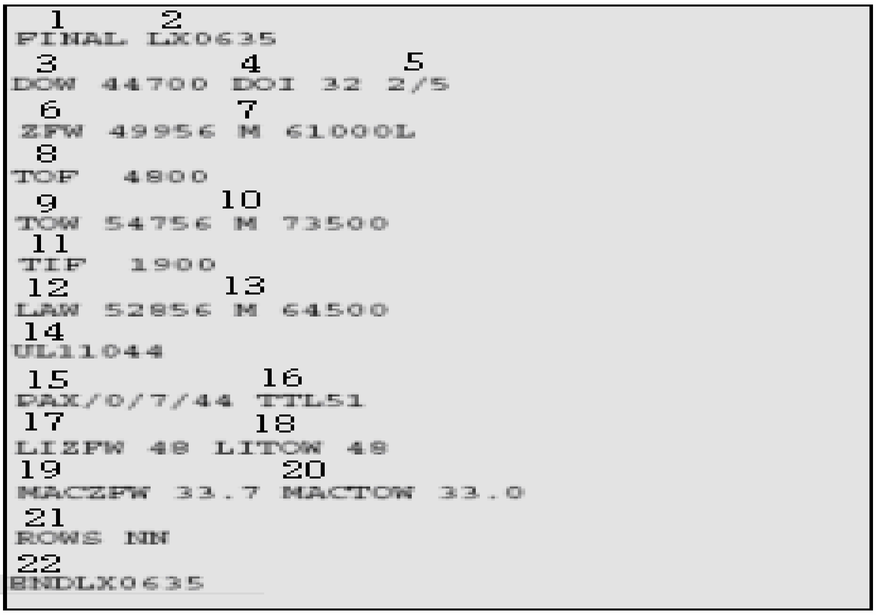


Figure 2.6 FREE ZONE

24- LX2802 The end of the Document Number.

Figure (2.7) shows an example of Final ACARS load sheet and its main elements which are explained earlier in Figure (2.5).



```
 1      2
FINAL LX0635
 3          4         5
DOW  44700 DOI  32  2/5
 6         7
ZFW  49956 M  61000L
 8
TOF   4800
 9         10
TOW  54756 M  73500
 11
TIF   1900
 12        13
LAW  52856 M  64500
 14
UL11044
 15         16
PAX/0/7/44 TTL51
 17          18
LIZFW  48  LITOW  48
 19            20
MACZFW  33.7  MACTOW  33.0
 21
ROWS  NN
 22
ENDLX0635
```

Figure 2.7 Final ACARS Load sheet

2.3.3 E-Load Sheet (JEPPESEN AIRLINE) (2003)

E-Load Sheet is an internet based aircraft load sheet production system. No installation software is needed, but just an internet web browser and connection to the Internet. The site is protected by 128 Bit SSL (Secure Sockets Layer) encryptions supplied by Veri Sign in company offering the best available security.

Rely on eloadsheet.net, the on-line weight and balance system for aircraft that offers the latest in load sheet production system available. The simplicity of a single database makes management of mission critical information a breez. In addition, the site is protected by SSL encryptions, offering the best possible security (Dixit & Prasad 2003). No software set-up or configuration is needed for the computer that operates eloadsheet.net. Simply log on through the Internet explorer secure sign-on which means that eloadsheet.net can be used from anywhere in the world without any setup or configuration (Jeppesen airways).

2.3.4 Quick Load Sheet (Brad Air Aviation Consultancy Ltd) (1988)

The following demonstration will prepare a QUICKLOAD Load sheet for a B737-300 aircraft. The principals involved are the same for any aircraft loaded into QUICKLOAD. The only information required are the passenger, baggage and loading details and QUICKLOAD does the rest. (Bradair). Its features:

1- QUICKLOAD is a fast & low cost Loadsheet Calculator

2- QUICKLOAD can prepare and print a loadsheet within 2 minutes without reference to the load controllers loading manual.

3- QUICKLOAD is fast, accurate and simple to use on any PC.

4- QUICKLOAD can be used

- By ramp agents and dispatchers
- By pilots (inside / outside the aircraft).
- And For Quality auditing and checking of third party loadsheets.

5- QUICKLOAD is already programmed for B737- 3/4/500,A320/A321 and Fokker 100 / 70 – other aircraft available.

Figure (2.8) shows an example of QUICK load sheet and its main elements numbered on the figure and explained afterwards.

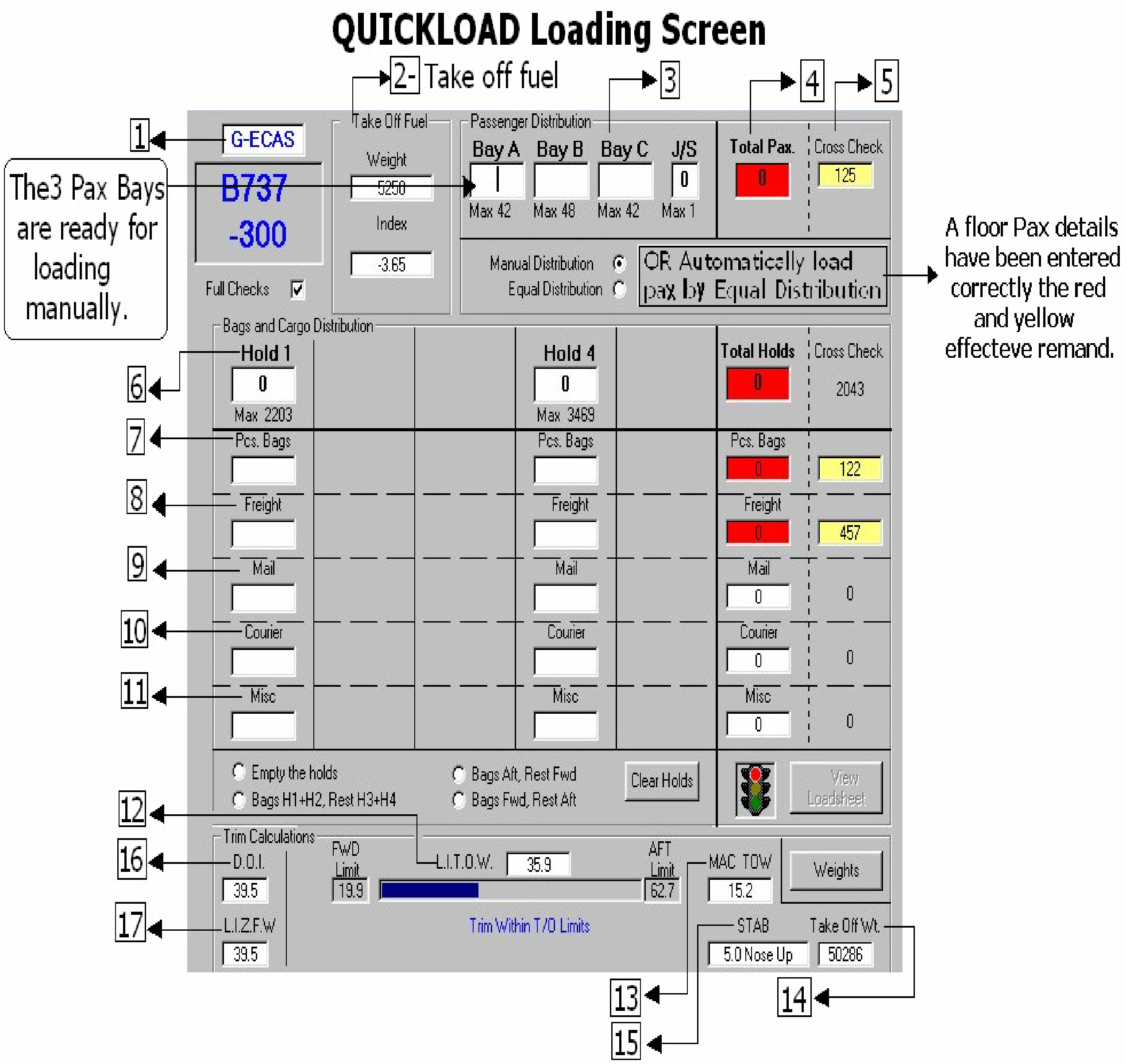


Figure 2.8 Quick Load Sheet

1. Aircraft Registration.
2. Take-off Fuel and its index.
3. Passenger distribution by Bays.
4. Total number of passengers.
5. After passengers details have been entered correctly, the total will be cross checked in this check box.
6. Aircraft Holds.

7.The number of bags pieces in each hold.

8.The Mail weight in each hold.

9. The frieght Weight in each hold.

10. courier : The Baggage which will be handed from the cargo company, such as Aramix DHL or any government document which will be loaded on the aircraft.

11. Misc : Additional Miscellaneous Bags which are loaded.

12. Leading Index Take-off Weight.

13. Mac Take-off Weight.

14. Take-off Weight.

15. Stabilizer.

16. Dry Operating Index.

17. Leading Index Zero Fuel Weight.

2.3.5 LPC Load Sheet (Less Paper in Cockpit) (Airbus) (1997)

Many Airlines companies use LPC (Less Paper in Cockpit) software to Calculate ZFWCG (Zero Fuel Weight Centre of Gravity), TOCG (Take-Off Weight Centre of Gravity), V1 (Take-Off Decision Speed), V2 (Take-Off Safety Speed), VR (Rotation Speed), and other parameters. LPC software consists of the next modules:

- Airline information, such as aircraft registration, flight number, date, crew version, etc.

- W&B module (with Payload distribution and Fuel distribution): Calculating different weights ZFW/ZFWCG/TOCG, needed FOB (Fuel-on-Board) and to check their operational limitations.

- Take-Of module**:** Calculating V1/V2/VR (Serge 2007).

These speeds are defined in FAR 25 for transport category aircraft.

- V1 is the takeoff decision speed - if an engine failure occurs below this speed, you abort or reject the takeoff. If it occurs above this speed, you continue the takeoff.

- VR is the rotation speed - where the nose gear is raised off the runway surface, but must allow the aircraft to accelerate to V2 before the aircraft reaches 35ft above the takeoff surface.
- V2 is the takeoff safety speed - this minimum speed must be reached before the aircraft reaches 35ft above the takeoff surface with one engine inoperative (Steve 2001).

- Landing module: Actual landing distance, Approach climb limiting weight, VAPP in case of in-flight failure.

- In-Flight module: Maximum & Optimum altitudes, Climb Performance, Cruise Performance, Descent Performance, Holding Performance (Serge 2007).

Figure (2.9) shows an example of LPC load sheet with its elements.

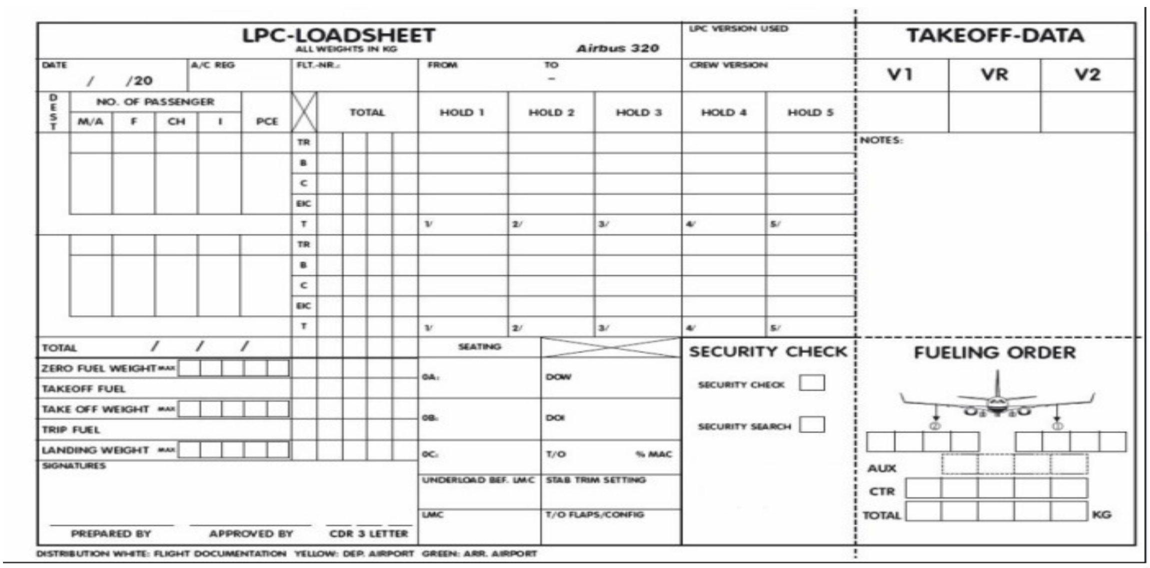

LPC-LOADSHEET
ALL WEIGHTS IN KG
Airbus 320
LPC VERSION USED
TAKEOFF-DATA
DATE / /20
A/C REG
FLT.-NR.
FROM
TO
CREW VERSION
V1
VR
V2
DEST
NO. OF PASSENGER
M/A F CH I
PCE
TOTAL
HOLD 1
HOLD 2
HOLD 3
HOLD 4
HOLD 5
NOTES:
TR
B
C
EIC
T
TOTAL / / /
ZERO FUEL WEIGHT MAX
TAKEOFF FUEL
TAKE OFF WEIGHT MAX
TRIP FUEL
LANDING WEIGHT MAX
SIGNATURES
PREPARED BY
APPROVED BY
CDR 3 LETTER
SEATING
0A
0B
0C
DOW
DOI
T/O
% MAC
UNDERLOAD BEF. LMC
STAB TRIM SETTING
LMC
T/O FLAPS/CONFIG
SECURITY CHECK
SECURITY CHECK
SECURITY SEARCH
FUELING ORDER
AUX
CTR
TOTAL
KG
DISTRIBUTION WHITE: FLIGHT DOCUMENTATION YELLOW: DEP. AIRPORT GREEN: ARR. AIRPORT

Figure 2.9 LPC Load Sheet

2.3.6 Manual Load Sheet

Manual Load Sheet shown here in Figure NO. (2.10) is issued on stations working manually or in the case of system failure.

Description to example manual load sheet (Etihad Airways 2009).

Figure (2.10) shows an example of manual load sheet and the numbers inside the figure are explained directly afterwards.

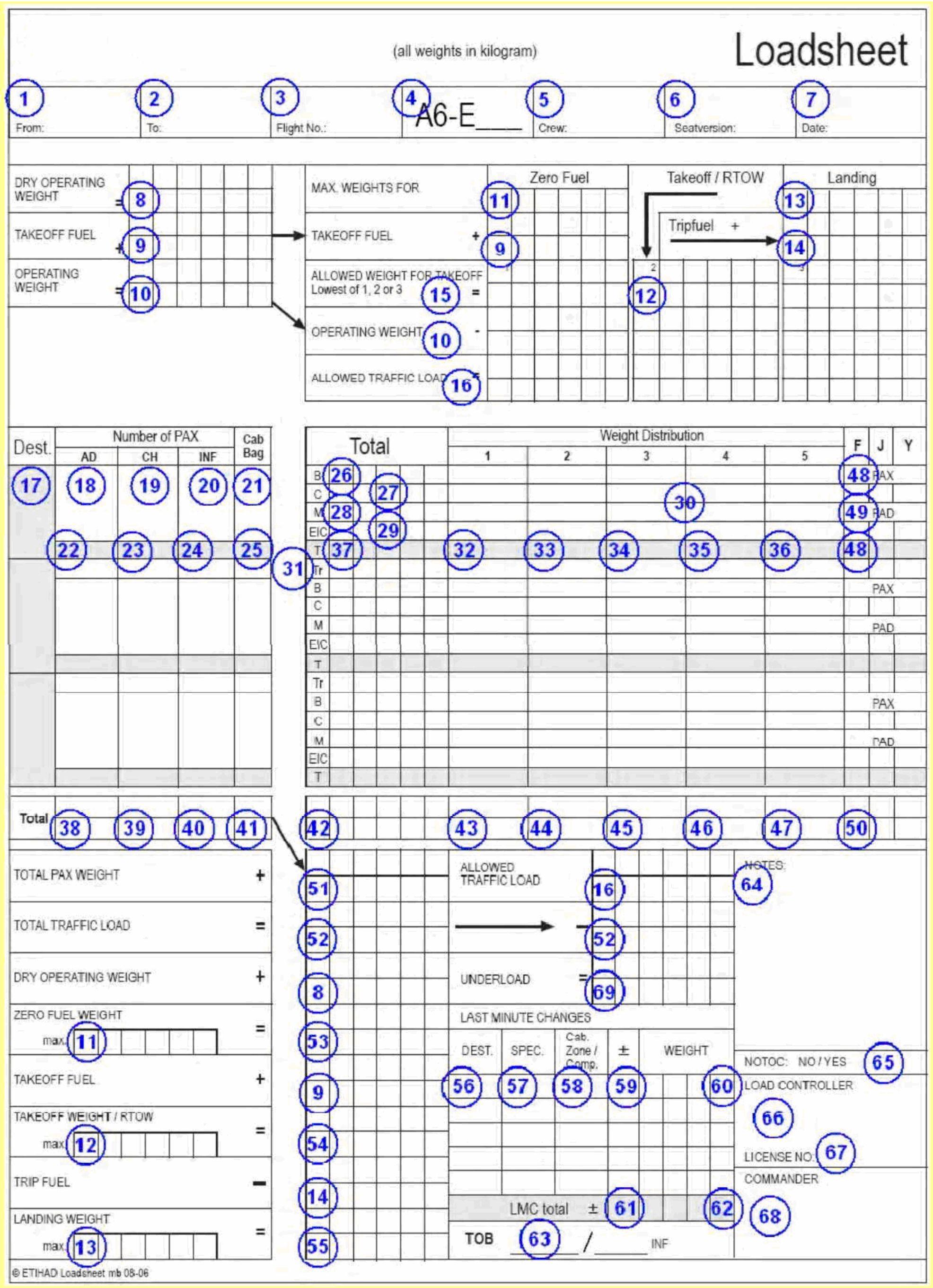


Figure 2.10 Manual Load Sheet

1- Origin

2- Destination

3- Flight Number

4- Aircraft Registration

5- Crew Configuration

6- Seat Version

7- Date

8- Dry Operating Weight (DOW)

9- Takeoff Fuel (TOF)

10- Operating Weight

11- Maximum Zero Fuel Weight (MZFW)

12- Maximum or Regulated Takeoff Weight (MTOW/RTOW — Circle as appropriate)

13- Maximum Landing Weight (MLDW)

14- Trip Fuel (TIF)

15- The allowed weight for take-off which is the lowest of columns 1,2 and 3

16- Allowed Traffic Load

17- Destination

18- Number of Joining Adults

19- Number of Joining Children

20- Number of Joining Infants

21- Joining Cabin Baggage Weight (not in use)

22- LDM figures including LMC — Adults

23- LDM figures including LMC — Children

24- LDM figures including LMC — Infants

25- LDM figures including LMC — joining cabin baggage weight (not in use)

26- Joining gross checked baggage weight

27- Joining gross cargo weight

28- Joining gross mail weight

29- Joining gross EIC weight

30- Distribution weights of each different load category by compartment number

31- Transit Load (if multi sector flight)

32- LDM figures including LMC — Comp 1

33- LDM figures including LMC — Comp 2

34- LDM figures including LMC — Comp 3

35- LDM figures including LMC — Comp 4

36- LDM figures including LMC — Comp 5

37- LDM figures including LMC — all compartments and loading categories

38- Total adult count

39- Total child count

40- Total infant count

41- Total cabin baggage (not in use)

42- Total gross weight for all compartments and loading categories

43- Total gross weight — Comp 1

44- Total gross weight — Comp 2

45- Total gross weight — Comp 3

46- Total gross weight — Comp 4

47- Total gross weight — Comp 5

48- PAX split by class (including PAD)

49- PAD split by class

50- Total PAX split by class (including PAD)

51- Total PAX Weight

52- Total Traffic Load

53- Zero Fuel Weight (ZFW)

54- Take-off Weight (TOW)

55- Landing Weight (LDW)

56- LMC Destination

57- LMC Specification

58- LMC Cabin Zone *I* Compartment

59- LMC+/ 60

60- LMC weight

61- LMC total+/ 62

62- LMC total weight

63- Total On Board (TOB) — (i.e. Adult & Child total *I* Infants) e.g. 230 *I* 5 INF

64- Any applicable notes

65- NOTOC on board — circle yes or no as appropriate

66- Load Controller’s Name

67- Load Controller’s EY license number

68- Captain's Signature

69- Under Load

2.4 Summary

In brief and on the basis of the previously mentioned related works, there are some elements not available in these works and raise the need to find solutions for them. These elements can be solved by using the proposed model that concerning in generating and printing the load sheet wirelessly. Sometimes, the system is interrupted temporarily for particular reasons, so the load controller should insert some entries and undertake specific procedures to cancel/end this interruption. This process takes a lot of time which in turn will cause a delay in generating and printing the load sheet and this will result in a flight delay. In addition, the manual load sheet takes a lot of time in its preparation and there are several difficulties that might be faced throughout the process since the load controller has to refer to particular references like GOM (Ground Operational Manual) and GSB (Ground Service Bolittein) to take the necessary information needed to make load sheet arithmatical operations, such as those of (Mac ZFW, MTOW (RTOW), MLW (Maximum Landing Weight), DOW (Dry Operating Weight), DOI (Dry Operating Index)). However, in the proposed model, the whole system will be available under the aircraft and by using wireless system, there is no need to print the load sheet manually. Another important point is to make some modifications or changes in the load sheet within the LMC or LMF processes and those changes should be carried to the required and due locations.

This process will therefore, lead to time and effort consuming especially within the continuous movement of aircrafts in the airport (Landing / Take-off). Waste of time will cause a flight delay and this will affect the whole time schedule of the other aircrafts in the head office. However, the load sheet will be generated and printed directly under the aircraft wirelessly using the proposed model, and no need to move between buildings and the need for extra man power to transfer the data is cancelled since the same load controller can do this and control the whole process alone.

For all these reasons, the level of accuracy achieved through the use of the wireless communication system is very important because the load sheet is the safety paper of the aircraft and the data it contains is highly accurate, precise, correct, and valid since any error will put the aircraft, the passengers, and the crew in danger. QUICK Load Sheet use is limited to specific types of aircrafts while the proposed model covers a much wider range of aircrafts' types. In addition, not all aircrafts are well-prepared to work with ACARS system because the manufacturer aircraft companies do not provide them with the systems working with the ACARS. Since the system requires specific devices (receiving / sending / transmission sets) to send and / or receive data from / to the airline company/ies. Preliminary and Final Load Sheet is also highly expensive in terms of costs. Therefore, any failure in the ACARS system will require the need to work on another system and if there is a failure in that system, the load sheet should be generated and printed manually, While the wireless communication model proposed in this thesis does not need to use the ACARS system in its two types because the load sheet will be received directly to the captain in very short time.

CHAPTER THREE

Analysis of the Proposed Model

Chapter 3
Analysis of the Proposed Model

3.1 introduction

Systems are created to solve problems. Therefore, it needs to see all sides of the problem to come up with an acceptable solution. Analysis involves studying the systems and showing how they interact with the entities outside and inside the system.

Moreover, it will come out with detailed specifications of what the system will accomplish based on the user requirements. System design will take the requirements and analysis into consideration and come out with a high level and low level design that will form a blue print to the actual solution of the problem in hand. In this dynamic world, analysis and design have to look into making systems that are flexible enough to accommodate changes as they are inevitable in any system. The different phases of software development life cycle (SDLC) are shown in figure 3.1, with an emphasis on the analysis phase activities.

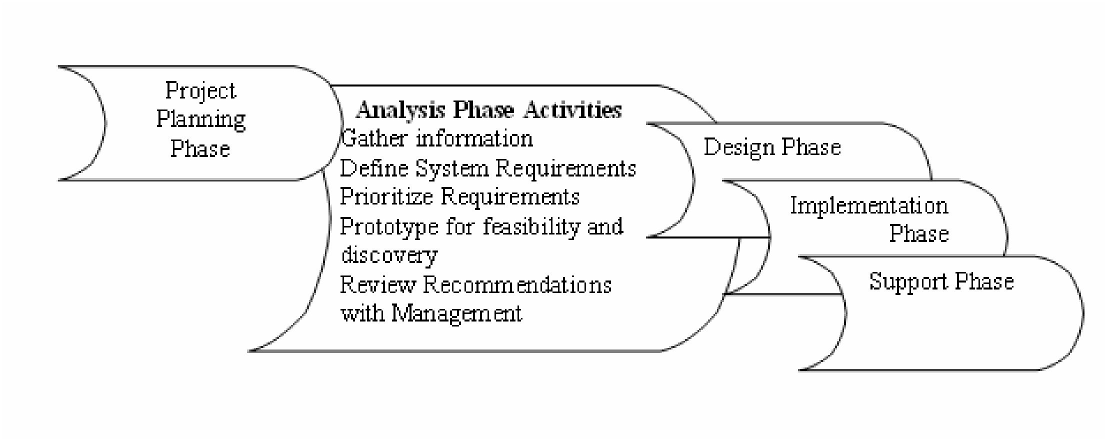


Figure 3.1 SDLC and the Activities of the Analysis Phase

Naturally, different system development methodologies recommend different techniques for completing these activities in some cases, different models might be created to complete an activity, but the activities always involve answering the same key questions (Satzinger, Jackson, & Burd 2004). Figure (3.2) shows the activities of the analysis phase and the key questions that the analyst should answer while designing the proposed model.

Analysis Phase Activities	Key Questions
Gather information	Do we have all the information (and insight) we need to define what the system must do?
Define system requirements	What (in detail) do we need the system to do?
Prioritize Requirements	What are the most important things the system must do?
Prototype for feasibility and discovery	Have we proven that the technology proposed can do what we think we need it to do? Have we built some prototypes to ensure the users fully understand the potential of what the new technology can do?
Review Recommendations with management	Should we continue and design and implement the system we proposed?

Figure 3.2 The Activities of the Analysis Phase and Their Questions

The analysis phase involves defining in great detail what the information system needs to accomplish to provide the organization with the desired benefits. Many alternative ideas should be proposed and the best design solution selected from among them (Satzinger, Jackson, & Burd 2004).

3.2 Analysis Phase Activity of the proposed model

3.2.1 Gather Information

The analysis phase involves gathering a considerable amount of information, systems analyst obtains some information from people who will be using the system, either by interviewing them or by watching them work. Analyst can obtain additional information by looking at what other (particularly vendors) have done when faced with a similar business need. In short, analyst needs to talk to nearly everyone who will use the new system, or has used similar systems, and they must read nearly everything available about the existing system (Satzinger, Jackson, & Burd 2004).

The analyst must become an expert in the business area the system will support. In our propped model, the information is gathered from the work experience in the airport environment, investigating the problem which results from using the wired system in generating and printing the load sheet trying to propose an efficient solution.

In the proposed model, many resources are used in the phase of gathering information process. In addition, work experience in the airport environment has helped a lot to investigate the problem with all its aspects.

It is important for the analyst if he has a technical knowledge in the domain area. The domain area ranges from a general understanding of how technology is used to solve the problems to detailed knowledge of a specific system of technologies.

The analysis role includes being able to make solution recommendations to the business. Knowledge of what the business technical assets, their capabilities, and limitations can help the analysis be more efficient in this domain area.

This seems to be the area where an analyst with deep knowledge is inclined to overstep the bounds of solution definition and amble into solution design.

From the above it is that specialists (analyst) have a good knowledge in both the technical and practical side of the airport environment. Generally, generating, printing the load sheet, and studying its workflow help a lot in obtaining essential information of how many problems they have faced because of using the current systems and how much these problems require finding efficient solutions that meet the business needs. The information is gathered through both interviewing the specialists many times and watching them work. For example, related works are tackled in further details in chapter two including EDP load sheet (Electronic Design Processes), preliminary and final ACARS load sheet, E-load sheet, Quick load sheet, and manual load sheet. Studying these related works gives an insight into the shortcomings and errors that might result from the use of these systems.

Using these systems leads to waste of time, effort, and increases of the costs. Moreover, it causes flight delay not only for the aircraft in question, but also for other aircrafts, because of the interrelation between the aircrafts movements. Therefore, taking an advantage of knowing all these problems has led to well design of the proposed model which will remove all these problems.

3.2.2 System Requirements

System requirements are all of the capabilities and constraints that the new systems must meet. In general, requirements are partitioned into two categories, these are, functional and non-functional requirements.

Functional requirements are the activities and services that the system must provide and perform.

Functional requirements include the following (Satzinger, Jackson, & Burd 2004):

- Description of the processing which the system will be required to carry out.
- Details of the inputs into the system from papers forms and documents, from interactions between people, such as telephone calls, and from other systems.
- Details of the outputs that are expected from the system in the form of printed documents and reports, screened displays and transfers to other systems.
- Details of data that must be held in the system (Bennett, Mc robb, & Farmer 1999).

In this proposed model functional requirements include the following processes: 1- "connecting": The connection which is established between the wireless printer in the cockpit and in the ramp area. These are connected with the laptop in the wireless environment. Then, 2- "Entering Final Data": A phase in which the load controller must enter the data obtained from the captain. 3-"Checking": is carried out by both the load controller and the captain who must then both sign the load sheet digitally.4- "Printing" print the load sheet by the load controller and send a copy to the printer in the cockpit area, a copy to the car used by load controller and a copy for the office.

On the other hand, the non-functional requirements are the characteristics of the system other than activities it must perform or support. These requirements must fulfill such as performance – related issues, reliability issues, and availability issues.

These types of requirements are often called quality of service (QOF) requirements service- level requirements or non-functional requirements.

The non-functional requirements include the following (Satzinger, Jackson, & Burd 2004):

- Performance criteria, such as desired response ties for updating data in the system or retrieving data from the system.
- Anticipated volumes of data, either in terms of throughput or of what must be stored.
- Security considerations (Bennett, Mc robb, & Farmer 1999).

Both functional and non-functional systems requirements are needed for a complete definition of a new system and both are investigated and documented during systems analysis. Functional requirements are most often documented in graphical and textual models. Non-functional requirements are usually documented in narrative descriptions that accompany the models.

3.2.3 Technical Requirements and Installations of the Proposed System

There are many technical devices and tools needed to establish a wireless communication in the ramp area at the airport environment such as the wireless printer, wireless router, wireless access point, and laptop computer.

1. Wireless Printer:

Frequently, wireless printers are not only convenient, but often a necessity, especially with working on networked desktop computers or remote laptops. With a reliable wireless printer server and a wireless card for the computer, the tools are available to print from a remote location and produce the documents needed for business. In addition to standard wireless printer, the office depot also offers multifunctional wireless network printers, which serve as fax machines, copiers, and scanners, so the employee can get the functionality they need and save valuable office space.

In home office of UK, multifunctional wireless network printer is used in order to offer many advantages, such as:

a. Rather than having to invest in a copier, a scanner, a fax machine and a printer, one intelligent purchase can be made to get them all in one. In addition, they are all being portable, all from one piece of equipment, a multifunctional wireless network printer which added flexibility to them.

b. Investing in a multifunctional wireless network printer saves a lot of space because one piece of equipment takes up much less space then several pieces of equipment.

c. It costs the organization less time and money because the more pieces of equipment at office, the more chance is of multiple service calls to repair technicians and maintenance is an issue on any electronic device.

Therefore, the use of a wireless printer or several wireless printers at work, especially in the airport environment area is an intelligent decision to resolve all the challenges, especially if the portability, space limitations, time, and costs are of concern.

Wireless Printer Establishment Steps:

For the wireless printer to be ready for use, five steps should be followed (Dasbootjoe 2008):

1- A wireless computer is needed with a wireless network card included and which can be brought from any computer store if the computer doesn't have one.

2- The router is the next thing needed. The wireless printer and the router should be 802.11 (compliant). There is 802.11b (standard) and also 802.11g (if the employee is working on printing a large a mount of pages).

3- The wireless router should be setup to the computer. D-LINK software as one of two (D-LINK and LINKSYS) or of many companies that will help with this process.

4- When the computer recognizes the wireless router, the process starts.

5- Once the printer software is installed onto the computer, the following steps should be followed :

6- XP/VISTA Directions

   a. Starts.
   b. Control Panel.
   c. Go to hardware and sound → printers (just printers in XP).
   d. On the tool bar click add a printer.
   e. Click the box; add a network, wireless or Bluetooth printer.
   f. Finally, the computer will search for the printer which the employee can then click on, and then he is done (Dasbootjoe 2008).

2. Wireless Accesses Point

Wireless access points (AP or WAP) are specially configured needs on WLANs (Wireless Local Area Networks). Access points act as a central transmitter and receiver of (WLAN) radio signals (Mitchell 1999).

Setting up a computer network in a business office often requires running many cables through walls and ceilings when the wired network is used to deliver network access to the entire network enabled devices in the building. However, network users are now able to add devices that access the network with few or no cables with the advent of the wireless access point. Today's (WAPs) are built to support a standard for sending and receiving data using radio frequencies rather than cabling. Those standards and the frequencies used are defined by the IEEE. Most (WAPs) use IEEE 802.11 standards.

Wireless access point has special security considerations. Many wired networks base the security on physical access control by trusting all the users on the local network. However, if wireless access points are connected to the network, anyone on the street or in the neighboring could connect.

Modern access points come with built-in encryption. Wireless traffic encryption is the most common solution. The first generation encryption scheme WEP (Wired Equivalent Privacy) proved to be easy to crack, but the second and third generation schemes, WPA (Wi-Fi Protected Access) and WPA2 (Wi-Fi Protected Access2) are considered secure only if a strong enough password or passphrase is used. The use of firewalls will help with security breaches which can help to fix security problems in some wireless networks which are more vulnerable.

Some WAPs (Wireless Access Points) support hotspot style authentication using RADIUS (Remote Authentication Dial-In User Service) and other authentication servers.

3. Wireless Router:

Wireless router is a device that performs the functions of a router. It is commonly used to allow access to the Internet or a computer network without the need for a cable connection. It can function in a wireless only LAN, a wired LAN (Local Area Network), or a mixed wired/wireless network. Most current wireless routers have the following characteristics:

a• LAN Ports, which function in the same manner as the ports of a network switch.

b• AWAN Port, used to connect to a wide area network. The routing functions are filtered by using this port. Many functions of the router will be bypassed if it is not used.

c• Wireless antenna which allow connections from other wireless devices.

Reviews say the Apple Air Port Extreme is the best wireless router which can be bought, especially with an all–Mac or Mixed Mac–PC network. Experts say it offers a great range which is simple for novices to setup and use, and owners say Apple Air Port Extreme uses the latest simultaneous dual-band, dual-radio, wireless–N technology with GPE (Gigabit Ethernet). It allows wireless external hard drive sharing, and – unlike most routers – wireless printer sharing and guest networking (McNulty 2009).

4. The Technology Used in the Proposed Model

Technology is a broad concept that refers to the knowledge and use of tools and crafts, and how these affect the ability to control and adapt the environment. In human society today, technology is a result of science and engineering. A specific definition for the word "technology" is difficult to determine, because "technology" can refer to material objects of use to humanity, such as machines, hardware or utensils, but can also encompass broader themes, including systems, methods of organization, and techniques (Cotton 2008). It is a body of knowledge to create tools, develop skills, and extract or collect materials.

IEEE 802.11 is a set of standards to carry out WLAN (Wireless Local Area Network) computer communication in the 2.4, 3.6 and 5 GHz frequency bands. The standards are created and maintained by the IEEE LAN/MAN Standards Committee (IEEE 802).

The 802.11 family includes over-the-air modulation techniques which use the same basic protocol. The most popular techniques are those defined by the 802.11b and 802.11g protocols. These technologies are amendments to the original standard. 802.11-1997 was the first wireless networking standard, but 802.11b was the first widely accepted one, followed by 802.11g and 802.11n. Security was originally purposefully weak due to export requirements of some governments, but was later enhanced via the 802.11i amendment; especially after governmental and legislative changes. 802.11n is a new multi-streaming modulation technique. Other standards in the family (c–f, h, j) are service amendments and extensions to the previous specifications.

Moreover, 802.11n is a recent amendment technology which improves upon the previous 802.11 standards by adding MIMO (Multiple-Input Multiple-Output) and many other newer features.

The additional transmitter and receiver antennas are used to allow increased data throughput through spatial multiplexing and increased range by exploiting the spatial diversity through coding schemes like Alamouti coding. The real speed would be 100 Mbit/s (even 250 Mbit/s in PHY level), and up to 4-5 times faster than 802.11g.

3.2.4 Prioritize Requirements

Once the system requirements are well understood and detailed models of the requirements are completed, it is important to establish which of the functional and non-functional requirements are the most crucial for the system (Satzinger, Jackson, & Burd 2004).

In the proposed model, the establishment of the wireless environment in the ramp area is the first and most important step which should be done before other steps. Then, the Internet service will be connected to the wireless network infrastructure because specific information concerning the load sheet should be sent and / or received, so the load controller can then have them. Either via the wireless printer or by having an access to network to get them from certain websites. In addition, the establishment of wireless communication requires the presence of the wireless router, wireless access point, wireless printer, and laptop respectively.

3.2.5 Prototype for Feasibility and Study

Creating prototypes of parts of the new system can be very valuable during system analysis. The primary purpose for building prototypes during analysis –often called discovery prototypes – is to better understand the users' needs. Discovery prototypes are not built with the intent of being fully functional, but to check the feasibility of certain approaches to the business needs. In many cases, users are trying to improve their business processes or streamline procedures. So, to facilitate the investigation of new business processes, the analyst can build prototypes.

If the system involves a new technology, it is also important early in the project to assess whether the new technology will provide the capabilities to address the business needs. Then, the team can be sure that the technology is feasible. Prototypes can prove that the technology will do what it is supposed to do. Also, if the system will include a new or innovative technology, the users might need help visualizing the possibilities available from the new technology when defining what they require; prototypes can fill that need (Satzinger, Jackson, & Burd 2004).

In the proposed model (chapter four), the DFD (Data Flow Diagram) represents a logical prototype as well as a discovery prototype which helps to better understand the business needs, of what the users need and what the system is supposed to achieve. In other words, it helps in identifying the processes and technologies required to successfully and efficiently complete the process of generating and printing the load sheet wirelessly.

3.2.6 Review Recommendations with Management

The final analysis phase activity- review recommendation with management – is usually done when all of the other analysis activities are complete or nearly complete. Management should be kept informed of progress through regular project reporting and the project manager must eventually recommend a solution and obtain a decision from management (Satzinger, Jackson, & Burd 2004).

In the proposed model recommendations from management have been gathered through interviews with the specialists in the aviation world who recommend the use of this new technology since it will solve almost all the problems they encounter and will keep them up with the latest technological developments all over the world. They are convinced because of the multiple advantages and efficient solutions the proposed model suggests. Moreover, questioners have been filled by the workers in the aviation world whose results support strongly the success of that project.

CHAPTER FOUR

Designing the Proposed Model

CHAPTER 4
Designing the Proposed Model

4.1 Introduction

The proposed model represents an efficient integrated method, which takes the advantages of the wireless communication to performing all activities and processes of generating and printing the Load Sheet in large airport environment area.

The proposed model, suggests generating wirelessly load sheet, including all processing of filling, checking, signing, and printing the load sheet from the loading area, depending on the communication capabilities that already available between all devices, such as wireless printer, wireless Access points, and wireless router (explained in details in chapter3, section 3.2.3).

The proposed model connects with the office through wireless connection. The office is already supported with hardware and software to store and generate load sheet and the database contains all data and information about the airline. Therefore, the proposed model will benefit from the database and equipments in the airline office. The wireless equipments preferred in the proposed model have the capabilities to cover wider areas and strength signals, as well as, protected from all types of collisions. Figure 4.1, represents the work area of the proposed model.

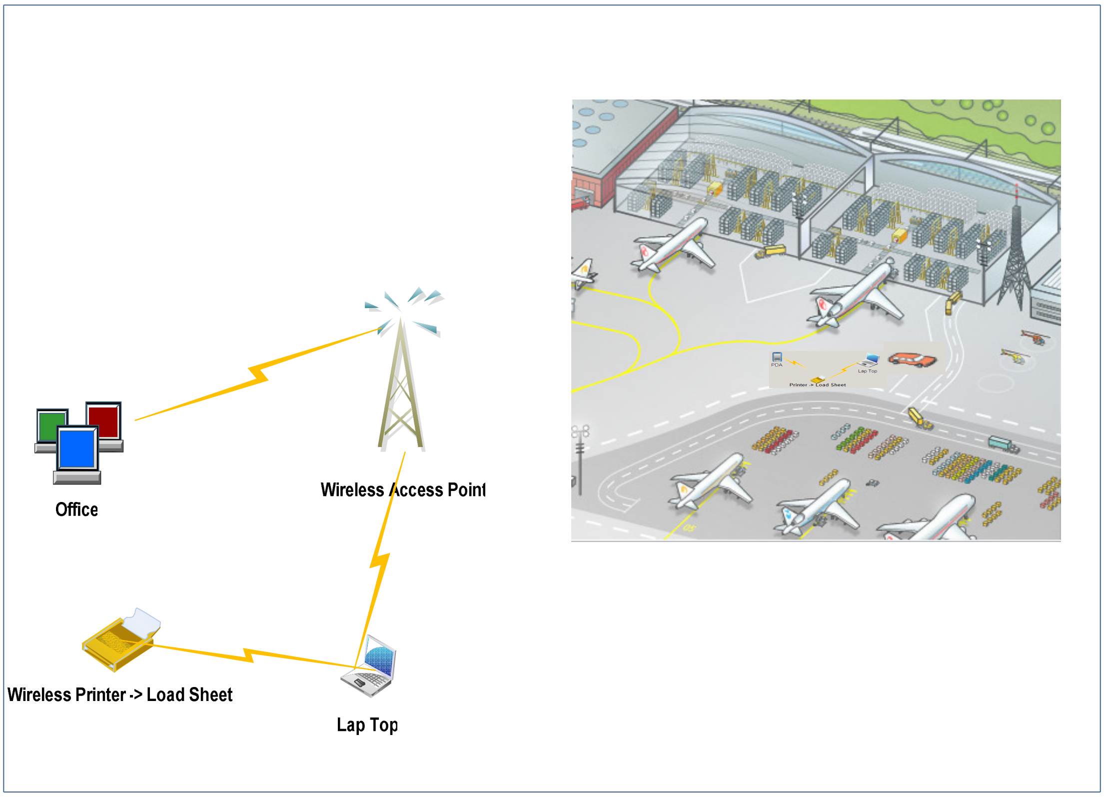


Figure 4.1 Proposed Model Work Area

4.2 Designing the Proposed Model

The model proposed in this thesis is called "Designing a Model for Wireless Load Data Sheet in Aircraft". It represents an integrated environment for generating and printing the load sheet wirelessly as shown in figure 4.2. The figure shows all activities and processes done by the proposed system. This section will describe in detail the processes needed to connect to the WLAN (Wireless Local Area Network) and all devices used in the proposed model which are connected to the WLAN. These are office printer, car printer, aircraft printer, and the laptops. One laptop will be in the ramp area and the other in the cockpit. The laptop in the ramp area will be with the employee who has the license to sign the load sheet, while the other, will be in the cockpit with the captain who is authorized to sign the load sheet.

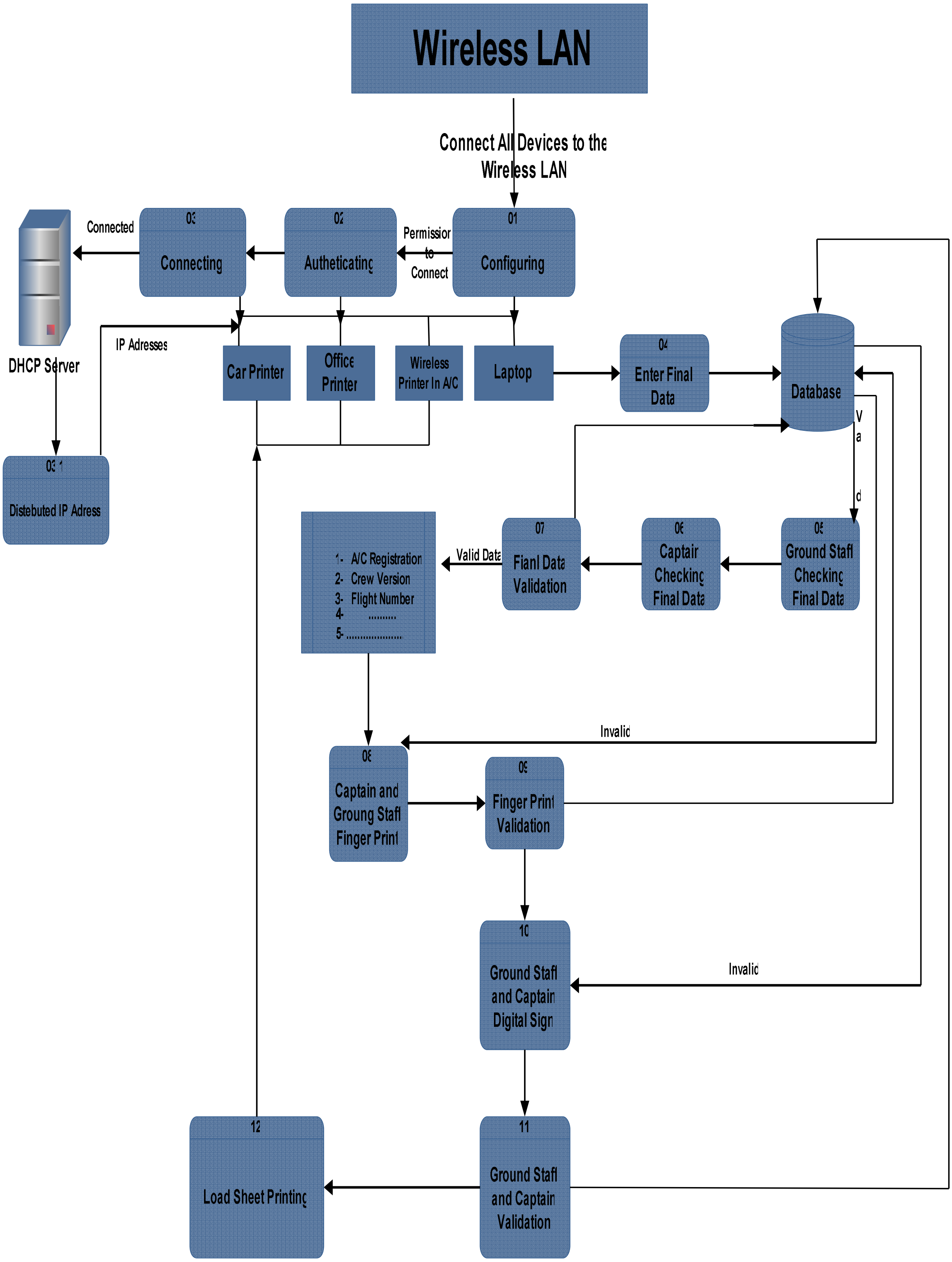


Figure 4.2 Proposed Models (DFD)

WLAN uses spread-spectrum technology based on radio waves to enable communication between devices in a limited/vast area. This gives the users the mobility to move around within a broad coverage area and still be connected to the network. Nowadays, using the WLAN has become widespread due to ease of installation and location freedom, especially within the increasing gaining popularity of laptops. The popularity of using WLANs is due to its convenience, cost efficiency, and ease of integration with other networks and network components. The majority of the computers sold to consumers today are already pre-equipped with all necessary wireless LAN technology.

Using the WLAN in the proposed model will facilitate the whole work (generating and printing the load sheet) outside the office (under the aircraft).

As shown in figure 4.2 (DFD of the proposed system), there are many processes, these will be described in detail as follows:

"Configuration".

This process will setup all devices of the proposed model to the WLAN which can be simple or complex. It will be simple if it consists of two PCS equipped by the wireless adapter cards to setup an independent network if they are within the range of each another. It is called peer to peer network and this type of networks does not need reconfiguration because each one of the clients has access to the resources of the other client and not to a central server.

However, it will be complex when the wireless access point is installed and this will extend the range to the ad-hoc network, efficiently doubling the range at which the devices can communicate. Each wireless access point can accommodate with many clients depending on the number of clients and nature of transmission involved. The proposed model will use the ad-hoc network because it uses many devices, and because the ranges it covers. Configuration process depends on the operating system running on the PC, which is connected on windows XP operating system.

"Authentication".

With WLAN, DHCP (The Dynamic Host Configuration Protocol) provides a framework for passing configuration information to hosts on a TCP/IP network. DHCP is a computer networking protocol used by hosts (DHCP clients/computers) to retrieve IP address assignments and other configuration information. It uses client-server architecture.

Administrating the authentication of users, and assigning unique IP addresses to incoming network access requests. Network administration is simplified because the DHCP server automates the task of keeping track of IP addresses, eliminating the need to manage the task manually. New computers can be added to a network without having to manually assign each a unique IP address. Because WLAN was not physically secured, DHCP will allocate IP addresses only to authorize network users.

Request for Comment (RFC 3118) adds authentication to DHCP and allows a client/hardware to verify whether a particular DHCP server can be trusted and whether a request for DHCP information comes from a client authorized to use the network. This two-way authentication in DHCP provides the added security benefit of helping to prohibit rogue (and possibly malicious) DHCP clients and servers from attacks or gaining unauthorized access to the network.

"Connecting" .

All devices in the proposed model will be connected to the WLAN in the connecting process. The server will be connected with the devices through the DHCP which can be defined as a protocol for assigning dynamic IP addresses to devices or hardware on a network. With dynamic addressing, a device can have different IP addresses every time it connects to the network. In addition, the devices' IP address can even change while it is still connected. DHCP also supports a mix of static and dynamic IP addresses.

When the aircraft lands, the wireless printer of the aircraft will connect to the airport WLAN. The wireless printer will search for an IP adress using DHCP technology. When the wireless printer manages to have an IP address, the connection between the wireless printer inside the cockpit and the WLAN then is established

The laptops and all other devices on the network will use the DHCP to connect to the WLAN. When it is made sure that the connection process by IP addresses is successful, the load sheet processes will start.

"Enter Final Data".

The ground staff is responsible for taking the final data and enter it to the form provided in the system (already installed on the laptop), the form contains data about (flight number, flight regestration, crew version,take-off fuel, trip fuel, block fuel, regulated take-off weight). Then, the entered data will be sent to the database at the head office to ensure to the head quarter that the data has been entered. A response from the database will be sent to ensure that the data is received successfully.

"Ground Staff Checking Final Data".

After entering load sheet data, the ground staff must validate to see if entered data is correct. In addition, the load plan will be checked by the ground staff to ensure that the actual loading is identical to the load plan on the system. All these processes will help the load controller to make sure that the aircraft is not out of trim.

"Captain Checking Final Data" .

The load sheet data must be send directly to the captain who will check and update ,if necessary, some of these data. However, if the data is wrong, the data must return back to the process of "Enter Final Data" again to be checked by the ground staff and a new altered copy will be sent to the captain. This facilitates the communication between the captain and the ground staff because instead of returning back to the office within the far distance in the airport environment, they can check it from their own places under the aircraft. This increases the level of certainty and accuracy of the received and sent data because one employee can do everything.

"Captain and Ground Staff Fingerprint Checking".

When checking process is finished successfully by both sides,(the captain and the load controller), the captain must put his fingerprint to sign the load sheet using the fingerprint reader device, and store it to the load sheet system of the laptop. Also, The ground staff must put his fingerprint to be scanned and stored to the load sheet system. The load sheet data will be submitted to the database at the head office to check if the fingerprint belongs to the authorized captain who is licenced to sign the load sheet or not. As well as, to check the validity of fingerprint if it is of the authorized load controller who is licenced to sign the load sheet or not.

"Ground Staff and Captain Digital Signature".

The digital signature process is used to double the security of the load sheet signing. The ground staff first will sign the load sheet and then captain will sign, using digital signature that are porovided by the laptop touch screen. The signature of both the ground staff, and the captain must be checked with the one stored in the database for the validity purposes to ensure that this signature matches the signature of the authorized person (captain or load control agent) whose signature is already stored in the database.

" Printing ".

This is the final process in the proposed system. The ground staff will print the load sheet through sending copies to the wireless printers which exist in the cockpit in the aircraft, in the office, and in the car.

4.3 Context Diagram of the Proposed Model

Figure 4.3 represents the Context Diagram of the proposed model. It shows the proposed model boundaries in its actual environment. As well as, it shows all objects/ devices that communicate with these are captain, load controller, host server, aircraft printer, database, car printer, and office printer.

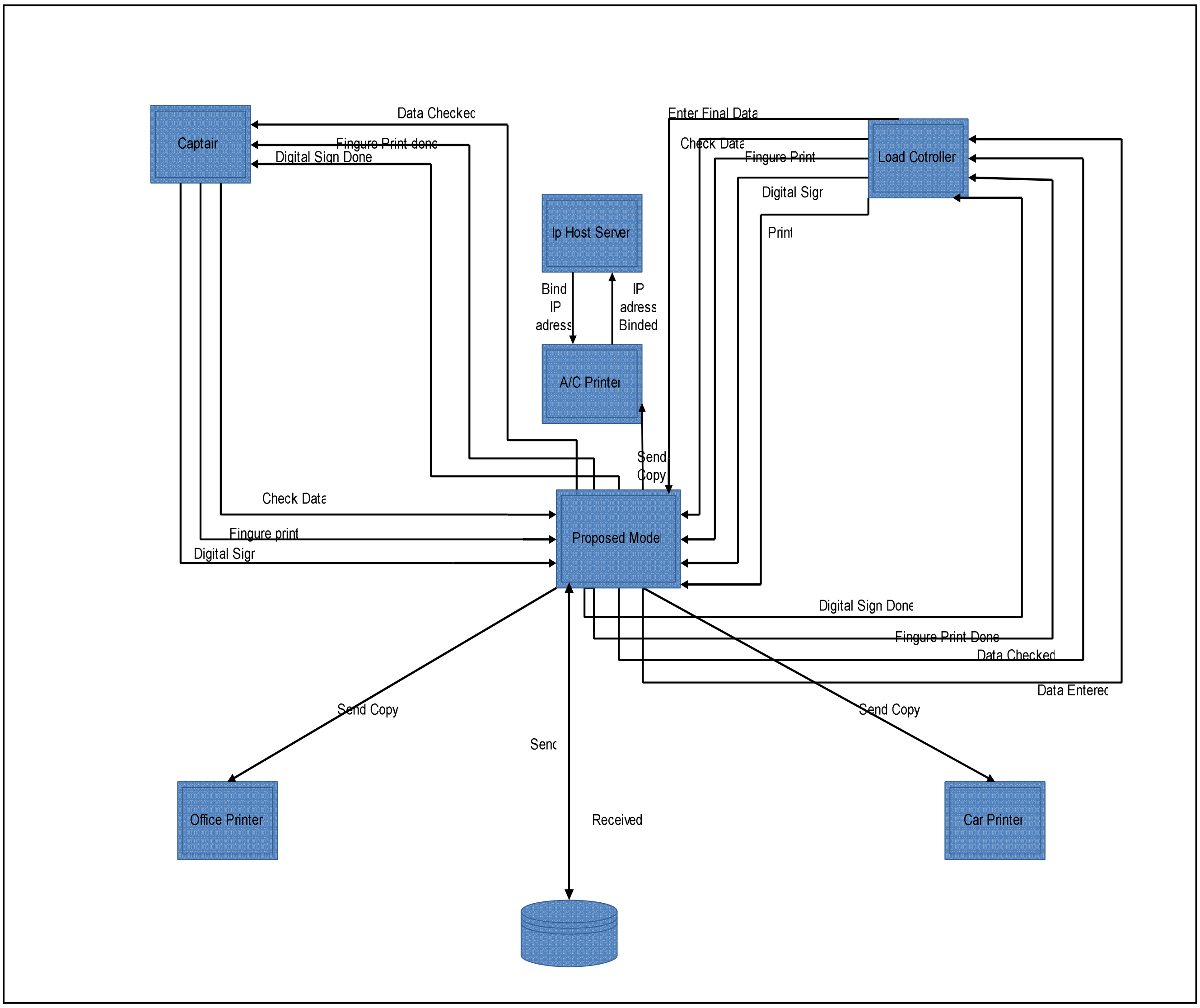


Figure 4.3 Context Diagram of the Proposed Model

4.4 Activity Diagram of the Proposed Model

Figure 4.4 represents the activity diagram of the proposed model. As shown in the figure, the rounded rectangles represent the activities inside the model. These are, aircraft printer connected, enter final data, send to database, ground staff checked data, captain checks data, captain fingerprint, the load controller fingerprint, send to database, ground staff digital sign, captain digital sign, send to database, and finally the process of printing the load sheet. However, the diamond shapes represent the decisions (if-else).

1- A black circle represents the start (initial state) of the workflow;

2- An encircled black circle represents the end (final state).

Finally, 3-Arrows represent the order in which activities happen from the start towards the end.

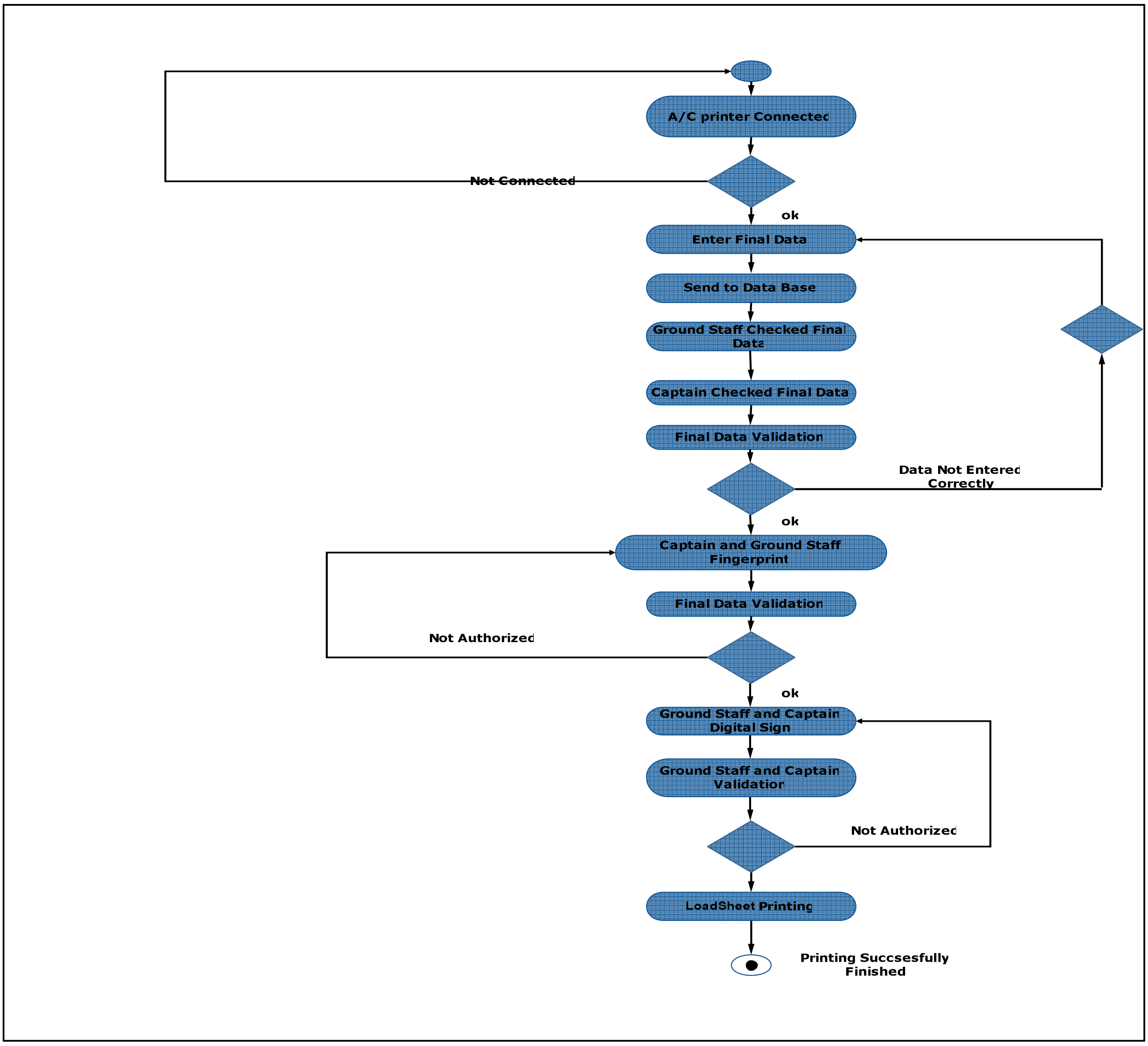


Figure 4.4 Activity Diagram of the Proposed Model

4.5 Use Case Diagram of the Proposed Model

Figure 4.5 represents the use-case diagram of the proposed model. It shows the actors (captain and load controller) and also shows processes in the proposed model, these are: enter final data, check data, fingerprint, digital sign, and print.

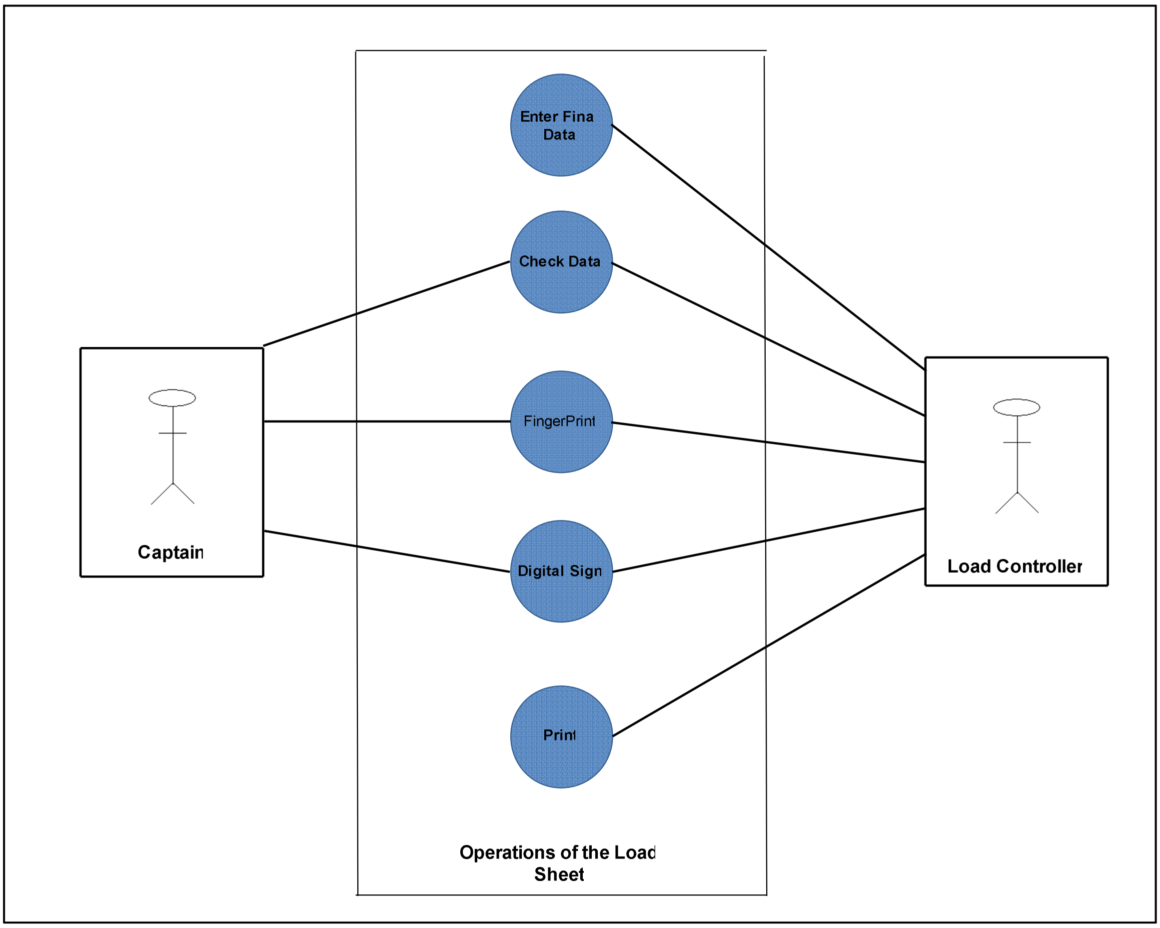


Figure 4.5 Use Case Diagram of the Proposed Model

4.6 Comparison of the Proposed Model with Other Load Data Sheet Types

In this section, a comparison will be made between the proposed model and the related work showing the most important features of these load sheet types. Table (4.6) shows the comparison between the proposed model with other load data sheet types.

T1: EDP Load Sheet (Electronic Design Process).

T2: Preliminary and Final ACARS Load Sheet.

T3: E-Load Sheet.

T4: Quick- Load Sheet.

T5: LPC Load Sheet.

T6: Manual Load Sheet.

T7: Proposed Model.

C1: Possibility of System Failure.
C2: Cover a Wider Range of Aircrafts' Types.

C3: High Level of Efficient and Immediate Communication between the Captain and Ground Staff.

C4: High Level of Accuracy and Efficiency.

C5: Saving Time, Effort, and Cancellation of Extra Man Power.

Type / Comparison	C1	C2	C3	C4	C5
T1	YES	NO	NO	NO	NO
T2	YES	NO	NO	NO	NO
T3	YES	NO	NO	NO	NO
T4	YES	NO	NO	NO	NO
T5	YES	NO	NO	NO	NO
T6	YES	NO	NO	NO	NO
T7	NO	YES	YES	YES	YES

Table 4.6 Comparison of the proposed model

CHAPTER FIVE

Conclusions and Future works

CHAPTER 5

Conclusions and Future works

5.1 Conclusions

In this section, we will summarize the conclusions that are established from our proposed work, these are:

1. The completion of generating the load sheet process should be highly successful, accurate, and systematic because of the great importance of the Load Sheet as an IATA standard format. It contains critical information about each element on board /onload to the aircraft, such as ZFW (Zero Fuel Weight) and RTOW (Regulated Take-Off Weight).
2. The proposed model will solve the problems that the airline companies might face such as, financial, technical, and logistic problems as a result of the wired system use to print the Load Sheet.
3. From the practical experience in the load sheet, using the wired system leads to flight delay, time and effort consuming, increasing the costs, and reducing the level of accuracy and efficiency achieved in the work. However, time, effort, and cost are important business needs in the aviation world.
4. The load control agent who produces a load sheet for the aircraft in accordance to the actual load of the aircraft, he must move from one place to another (from the office to the ramp area) to accomplish his task, which will take much time and waste more efforts fruitlessly because of the airports vast areas.

5. From studying the previous works, different types of load sheet are discussed to show how it generates and prints the load sheet using different systems. These systems have certain disadvantages that the proposed model tries to avoid in order to achieve the desired results and serve the purposes in a better way.
6. The proposed model represents a complete blueprint designed to generate and print the load sheet wirelessly. This is through two main phases, Phase one explains how the wireless connection will be established through authentication and configuration while phase two describes the load sheet processes in detail.
7. All communication will be done through using the WLAN which must be established in the ramp area and in the airport building through using wireless router.
8. All devices in the proposed model use an authentication which means taking the permission for these wireless devices to be connected on the WLAN.
9. The proposed model will increase the level of efficiency by reducing the possibility of making errors.
10. The main benefits from the proposed model are: it saves time, effort, and reduces the overall operating cost of the aircraft.
11. The proposed model will be suitable for all types of airport environment, through making the task for the load control agent and the captain achieved more efficiently.

5.2 Future Works

In order to implement and extend the model proposed in this thesis, we suggest several recommendations for future works, these are:

1. The airline companies are to be invited to adopt this new proposition in order to carry it to the practical sphere. To assess its efficiency and take an advantage of all the distinguishing features that this new technology (Proposed Model) offers.
2. Adding some other features to improve and expand its application and uses it for other domains in generating and printing the load sheet wirelessly, such as: shipping ports.
3. The aircrafts manufacturer companies should provide the aircrafts with wireless technology such as wireless printer to enable the aircraft connection process between the captain and the station be completed successfully, especially when the aircraft Airborne or Lands by sending specific telegrams from the system which is already installed on the laptop.