Barcode Based Fare Ticketing System for AA LRT

Teklay Gebreslassie

A Thesis Submitted to
School of Electrical and Computer Engineering

Presented in Fulfillment of the Requirements for the Degree of Master of Science (Electrical Engineering for Railway Systems)

Addis Ababa University
Addis Ababa, Ethiopia
June 16, 2017

Addis Ababa University

Addis Ababa Institute of Technology (AAiT)

School of Electrical and Computer Engineering

This is to certify that the thesis prepared by Teklay Gebreslassie, entitled: *Barcode Based Fare Ticketing System for AA LRT* and submitted in partial fulfillment of the requirements for the degree of Master of Science (Electrical and Computer Engineering for Railway System) complies with the regulation of the University and meets the accepted standards with respect to originality and quality.

Signed by the Examining Committee:

Internal Examiner _____ Signature _____ Date _____

External Examiner _____ Signature _____ Date _____

Advisor _____ Signature _____ Date _____

_____

School or Center Chair Person

Declaration

I, the undersigned, declare that this thesis is my original work, has not been presented for a degree in this or any other university, and all sources of materials used for the thesis have been fully acknowledged.

Teklay G/slassie _____
Name Signature

Place: Addis Ababa

Date of Submission: _____

This thesis has been submitted for examination with my approval as a university advisor.

Mr. Birhanu Re'esom _____
Advisor's Name Signature

Abstract

Technological development has resulted in a boundary free digital world. This development has resulted in transaction through virtual money instead of real ones, e-ticketing is mostly used system for such transactions. But AA LRT uses weak and unreliable ticketing system which is called paper ticketing. The thesis system makes use of barcode for verification and identification of the user. A unique barcode will be generated for each customer that is registered to the system. Using this barcode, the customer will be able to make transactions, which is an automated fare collection. This system solves all the drawback of the manual ticketing system which currently happened in AA LRT. Two dimensional bar codes could provide for more complex ticket types. The barcode based card number of the user is used which provides the information of the user. This system provides an efficient way of travelling while maintaining the security. This system is implemented using Visual studio 2013 development environment, C# programing language and database (SQL server). In the implementation of this system it requires barcode scanner with gate controller which scans the profile from the ID card, then sends to the database to check the validation and desktop application to register new customers profile and amount paid, generate the barcode based ID card, update customer balances and configured the stations. Finally, the system software is successfully developed.

Keywords: -Barcode Scanner/reader, Electronics ticketing, Automatic fare collection (AFC), Database (SQL server), Wide Area Network, AA LRT.

Acknowledgment

First and foremost, I would like to express my sincere gratitude to my respected advisor Mr. Birhanu Re'esom for his invaluable advice, incessant guidance and continuous encouragement to accomplish my thesis.

Special thanks for Mr. Kalayu G/slassie database and asp.NET integration expert for his invaluable guidance and continuous supports.

As well, I would like to thank all the member of Ethiopian Railways Corporation for providing such an excellent education and research environment.

Finally, I would like to express my deepest appreciation to my family and my friends for their encouragement, support, and understanding throughout my work.

Table of Contents

List of Figures

Acronyms and Abbreviations

Abbreviations	Descriptions
AA LRT	Addis Ababa Light Rail Transit
AFC	Automatic Fare Control
ATM	Automatic Tailor Machine
API	Application Program Interface
CLR	Common Language Runtime
DB	Data Base
ERC	Ethiopian Railways Corporation
ICT	Information Communication Technology
IDE	Integrated Development Environment
IEC	International Electro Technical Commission
IMPS	Inter Bank Mobile Payment Service
IRCTC	Indian Railway Catering Tourism Corporation
ISO	International Standard Organization
LAN	Local Area Network
MAN	Metropolitan Area Network
MMID	Mobile Money Identifier
NFC	Near Field Control
OCC	Operation Control Center
OTP	One Time Password
PC	Personal Computer
PT	Project Team
QR	Quick Response
RAM	Random Access Memory
RDMS	Rational Database Management System
SMS	Short Message Service
SQL	Structural Query Language
WAN	Wide Area Network

Chapter One

1. Introduction

1.1 Background

One of the most popular forms of online trading is E-ticketing [1]. The e-ticketing system is a new conceptual approach in which the particular city will be able to collect and analyses a large volume of data about passenger profiles, strengthen the collection of money in advance, limit the number of fraudulent passengers and optimize the routes. The system will also facilitate the collection of detailed financial data for each public transport mode. In public transport, e-ticketing systems are not only means of payment but process huge amount of information which offer a large range of possibilities to make public transport easier to use, manage and control. They offer as well opportunities to introduce integrated pricing structure that are not easy to implement with traditional payment tools. Whatever are the fare structure and the payment scheme, for the passenger it is often the user- friendliness of the system that will be most important. In this respect, harmonizing and integrating fares and ticketing will facilitate the use of public transport [2]. An integrated ticketing system is defined as one in which it makes no difference, in terms of price, if a passenger has to board more than one public transport vehicle to complete their journey [3]. Fare integration provides an incentive to travel because public transport is much easier to use and more accessible for travelers. New technologies (e- ticketing) can be a great help in implementing complex fare structure and fare integration while keeping the system easy to use.

Ticketing system is a tool for the implementation of a pricing policy with the consideration of operational, commercial and social objectives [3]. The ticketing system is the translation of fares into concrete means of payment (for the passenger) and fare collection (for the operator).

Generally, the following types of tickets are in use in public transport
network:

- Single ticket: one journey (no time limit)
    - Zonal single ticket
    - Origin- Destination single ticket
- Single ticket: several journeys with in a limited duration (ex: 1 h.)
- Single- mode / Single- operator ticket

- Multi- mode / Multi- operator ticket
- Return ticket
- Multi- journey ticket (5, 10, 20)
- Season ticket (day, week, month, year)
- Value ticket (Pay- as- you - go)
- Off- peak ticket / Night ticket
- Combined ticket (ex: Park & Ride)
- Group ticket / Family ticket
- Special event ticket

Ticketing media include:

- Cash
- Tokens
- Paper tickets
- Magnetic strip ticket
- Contact - based smartcards
- Contactless cards
- Mobile ticketing

It is obvious that, nowadays, efficient and reliable public transportation is a critical task for metropolis (big cities like Addis Ababa). Our facility should be based on customer satisfaction. AA LRT is one of the popular and advanced technology public transport.

The Addis Ababa Light Rail Transit Project is composed of E-W line and N-S line. 70% low-floor modern tram cars are adopted [4]. Most of tracks are constructed on the ground, and some sections are built on overhead bridges or in underground tunnels. The Project is a semi-closed urban rail transit system. The line has level crossings with the municipal roads in some sections.

Now Phase I Project for the E-W and N-S lines it had been constructed, covering a total length of about 31.01 km, including a common rail section in length of about 2.61 km. The main track of the E-W line is about 16.998km, and a total of 22 stations are available on the line, among which there are 6 elevated stations (including 5 common rail stations) and 2 semi-underground stations, and the others are ground stations, with the average distance between stations being 0.798km. The main track of the N-S line is about 16.674km, and a total of 22 stations are designed on the line,

among which there are 8 elevated stations (including 5 common rail stations) and 1 underground station, and the others are ground stations. The maximum distance between stations is 1.972km, and the minimum distance is 0.435km, and the average distance is 0.775km [4].

For E-W line, Ayat depot is set near to the end point. And for N-S line, Kality depot is set near to the end point. The E-W line and N-S line share the same OCC, which is provided in the Kality depot [4].

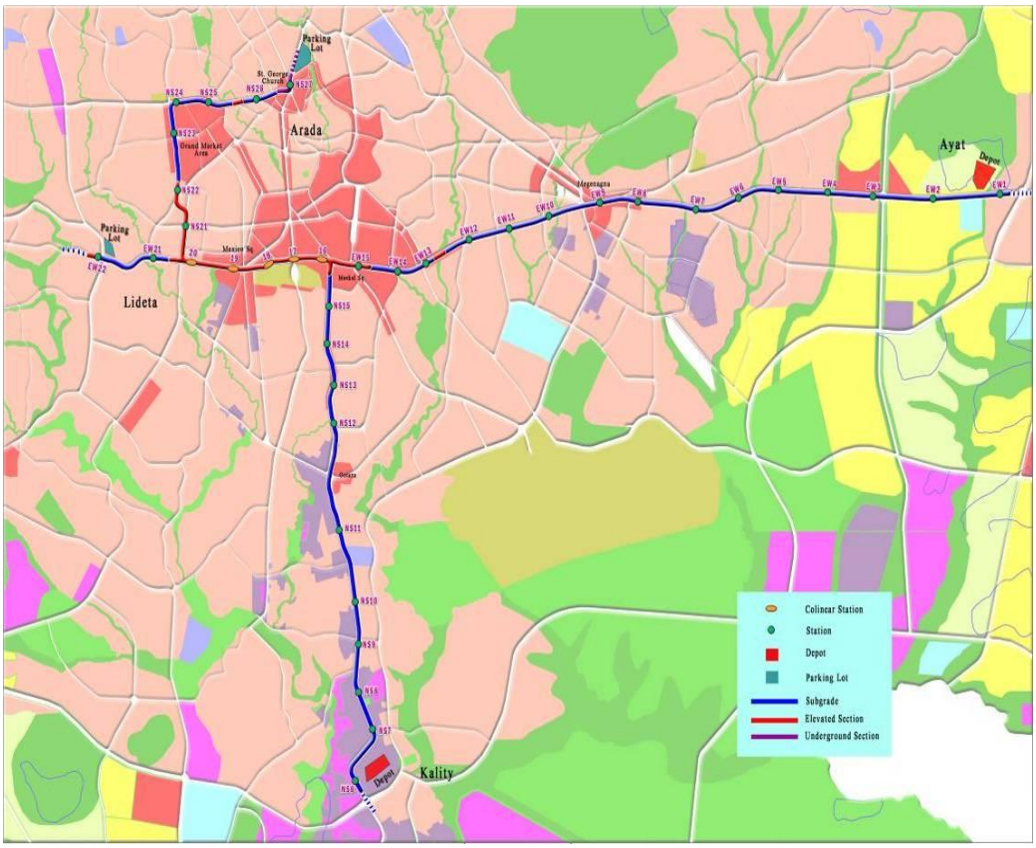


Figure 1-1: Alignment of E-W & N-S Lines (Phase I) Project [4]

The train runs in two directions, and 70% low floor light rail vehicle is used [4]. Four doors are set along the length direction of the train on each side. The ticketing system of AA LRT is manual due to this customer stand for long queues to buy a ticket makes them unsatisfied. Some of the passengers also travels without ticket this reduce the economic income of ERC as well as the country. To reduce the queues and cheating, ERC tries to use E-ticketing but this is too difficult to use with the current situation of AA LRT since leaving and getting passengers at the same time is too much and the machine is already installed inside the Train, and to disassemble the machine

from the train is too difficult since, the sensors and database of the machine are integrated with the train's signals, even if it is installed from the scratch it needs more money. So, the purpose of this thesis is to define the critical objectives, determine the key components and identify the key issues for developing comprehensive Algorithms for ticketing system of AA LRT to avoid the above problems such as long queues and cheating.

1.2 Problem Statement

In Addis Ababa City, transportation demand is higher than the supply. This is because of the number of population in the City is increasing day-to-day and the transportation facilities are not increasing according to the number of population. Thus, in the railway stations, long queues for long time especially at rush hours are becoming usual at this time some of the passenger travel without ticket due to the ticketing station is far away from train station and the cheater passenger knows the peak time is difficult to check the ticket with operators.

The system solves passengers cannot travel without ticket at peak time, efficient way of collecting and auditing money, avoid long queue, save time and energy, passengers couldn't cheat due to exchange of tickets between passengers (like, someone can buy a ticket from Kality to Autobus Tera by paying 6 Birr. But he can give it to anybody around Autobus Tera after getting off) and someone also can use the ticket two three times per day since the control mechanism is very poor.

Figure 1-2: Station and Ticket Office

1.3 Objective

1.3.1 General Objective

The general objective of this thesis is to develop e-ticketing system using barcode for AA LRT by studying the problem of current ticketing system.

1.3.2 Specific Objective

The specific objectives of this study are to:

- Introduce new technology for AA LRT ticketing system
- Develop two application software (system admin software and transaction software).
- Get the train on time
- Save time that spent to get a ticket
- Audit on time for the collected money.
- Avoid cheating tickets

1.4 Methodology

The methods used to achieve the desired objectives of this thesis were as follows. First, literature reviews about e-ticketing system in general and ticketing system for railway in different countries, as well as AA LRT. Secondly, design the structure of the system then develop an algorithm then, develop the system by writing the code in visual studio environmental tool and C# programing language integrating with the database (SQL server). Finally deploy and test the system then results and conclusions are collected from.

Chapter Two

2 Ticketing Media for Public Transports

Smartcards are still the most common form of smart-media currently being used, with cards being used from a variety of suppliers (Sony, Mifare, Desfire, FeliCa, Infineon) [2]. A couple of schemes also referred to the use of m-ticketing (SMS, NFC) technologies, and how they are trialing these, but they are still in their infancy. (M-tickets are sent to a mobile device containing text with event and ticket data and a unique, able to scan, 2D barcode). There are a number of different fare/tariff structures/ payment methods/technology approaches currently in place:

- Touch-on Touch-off / Check-in Check-out / Scan-on Scan-off
- Touch-on (often used when a flat fare scheme is in operation)
- Zonal based system
- Time based system (e.g. single journey made within 90 minutes)
- Distance based system
- Post-pay credit system

One key advantage is that smart-ticketing can be used to automatically provide the user with the most suitable fare for their travel, including fare-capping, where after a certain number of single transactions, the fare is capped at the relevant day rate.

A diverse range of front-end and back-office systems are in use, each scheme having its own specific set-up. Most systems have a central system under their own control, although some have outsourced the management and maintenance of this to major ICT suppliers. Funding for the equipment needed for these systems has primarily come from government sources, at various levels of the hierarchy, although there are examples of partnership agreements between the PT operators and the relevant Local/Regional authority [2].

Security measures are in place, although it was noticeable that some schemes did not understand some of the terminology used, which may prove to be a barrier for future interoperability. This is also one area where some schemes were not willing to share details, which may be necessary in the future should interoperability require them to do so. Particular terms/features mentioned pertaining to security issues include:

- Full audit trail

- Secure data stores
- Cryptographic keys
- Standards, including ISO24014 and National Security Standards
- Data privacy and protection
- Credit-card style protection

User Benefits

All respondents were of the opinion that smart-ticketing brings a number of benefits to the user that traditional paper-based ticketing cannot necessarily deliver. Smart-ticketing was perceived to be a lot more reliable, convenient, faster and easier to use, which delivered a better overall product allowing users to travel with more liberty.

Tariff structures such as 'Pay As You Go' delivered greater flexibility for all users, not just those who used Public Transport on an irregular basis. Operational benefits included a decrease in dwell times at the bus stop, faster transactions and less cash-handling increased the safety for bus drivers and other on-board staff. Overall, smart-ticketing could have the benefit of influencing peoples' perceptions on Public Transport for the better.

Not all schemes offered additional benefits to smart-ticket holders. In some area s, smart-ticketing exists alongside traditional paper-based ticketing, offering identical products with the assumption that the paper-based system would eventually be phased out in favor of the smart-ticketing. It was identified that smart-ticketing could be used as a marketing initiative to offer travel discounts over cash transactions (two schemes reported the level of discount as 17% and
20%) which increased customer usage levels [2].

The flexibility provided by smart-ticketing could be used to personalize travel costs by providing user-specific zonal based fares, tailored to their most frequent journeys, removing the need for pre-defined zonal systems. Again, reducing the level of cash-handling improved the personal safety of the individual when travelling on Public Transport.

The opportunity to provide additional non-transport functionality and services through an individual smart-ticketing scheme has been taken up by some schemes, who offer parking payments, micropayments for shopping, payment for access to leisure and community facilities. Some schemes would like to consider offering such services, particularly through/on existing

smartcard based systems (e.g. identity smartcards for company staff or university students), which could also be used to promote individualized travel information and ticketing options.

All respondents stated that smart-ticking can remove barriers to travel for the irregular and unfamiliar traveler, a couple of schemes commenting on how existing paper-based systems were complex even for the regular user. Automatic fare calculation and auto-reload functionalities provide greater flexibility to fare policies, which means that irregular and regular users would not have to worry about finding information on the appropriate fare, nor having the right money available to pay their fare.

2.1 Public Acceptance of the Technology

A key to understanding the potential for smart ticketing to encourage additional usage of public transport and the role that smart cards and other media might play in this is an appreciation of end users' perceptions of the technology involved.

Passenger Focus surveys of passengers' perceptions regarding Smart card technologies, undertaken in association with the planning and operation of existing schemes, but also as part of more general consultations on the subject, indicate the user benefits of integrated smart ticketing to be a lowering of queuing times when accessing public transport and of the time taken to otherwise purchase conventional tickets, better value products (supporting a wider range of tariffs, without increasing the complication of ticketing for individuals and the passing on of operator benefits through reduced fares) and a general enhancement of the convenience of public transport for end users is reported [2].

As a result of the enhanced information available from the technology to transport authorities and to operators, related to actual usage of public transport services, passengers perceive that they also benefit from enhanced information on local ticketing opportunities and through the availability of real time service information (particularly when mobile phones are used to receive such information) [2].

There is also a perception amongst some users that the provision of integrated smart ticketing reduces the lock in between users and a single operator, allowing a wider range of services to be

more easily accessed, with integration also making fares easier and simpler to display and leading to increasing standardization of fare structures within and across operator services.

Overall, integrated smart ticketing is seen by transport authorities and public transport operators to help in addressing public concerns that Ticketing is fragmented and overly complicated with a stated desire from the Public for greater integration of tickets, particularly across local networks and better use of the technology, including pay-as-you go style ticketing [2].

2.2 Types of Smart Ticketing and Fare Payment Systems

2.2.1 Contactless Smartcard

Contactless smartcards conforming to ISO/IEC 14443 are now common place in public transport, used both to convey tickets and as a payment mechanism. Banking cards are now taking advantage of the same technology providing scope for interoperability [2].

The primary advantages and disadvantages of contactless smartcards include:

- Acceptability. Experience to date with the schemes implemented has shown that contactless smartcards are generally very well accepted both as a payment means and as a means of conveying entitlement to services, proving identity, and conveying tickets.
- Interoperability. Widely acceptable but only where compatible readers are provided. To date there has been little interoperability between the various schemes implemented, meaning that a smartcard issued in one country, is very unlikely to be acceptable in others.
- A contactless smartcard is not in itself divisible, however, a store of value held within the smart card can be divided by a suitable reader.
- Stable, i.e. it conveys the same meaning over long periods of time
- Durability. A contactless smartcard contains electronic circuits entirely encapsulated within a plastic case. As such it is less robust than coins or bank notes, but more robust that magnetic stripe cards (in which the storage medium is exposed on the face of the card at risk of damage) or mobile phones which are significantly more complex
- Recognizable. No special skills or intelligence should be required to understand how to identify and use money. Smartcards are well short of this so far as virtually none show what value is in them. A separate device is needed.
- Portable. A contactless smartcard can contain a high value in relation to its size.

- Anonymous. Clearly there is potential for tracking of card holder's activities with a contactless smartcard system, however this can be overcome by measures such as anonymous smartcards and encryption of data records.

2.2.2 Cash

The most common application for smartcards in public transport is payment, in which they mainly compete with coins and bank notes. Coins must be one of the most successful products in the history of commerce, and the product lifetime of bank notes must also rank amongst the longest. Whilst neither fully satisfies all the modern needs of consumers, they do meet the most important criteria for recognition as money.

The advantages of cash are that coins and banknotes are:

- Widely acceptable and interoperable, The Euro provides for interoperability between states participating in monetary union. Even in non-participating countries such as the UK, ticket vending machines can easily be constructed to accept both Euro and local currency and some do [2].
- Divisible
- Stable, i.e. it conveys the same meaning over long periods of time
- Durable. Coins last much longer than bank notes, but the ageing is due to use in transactions
- Recognizable. No special skills or intelligence are required to understand how to identify and use money.
- Portable. It must have a high value in relation to its size.
- Anonymous. Under normal circumstances there is no record linking banknote serial numbers to the holder and no possibility of linking coins to their holder.

Some of the limitations of coins and bank notes when used to pay fares have been overcome by transport operators issuing tokens and stored ride cards of various technologies, each of which shifts the balance of advantages vs. disadvantages.

The disadvantages of using coins and banknotes in public transport are principally that they are expensive to handle. In metro, light rail and bus ticketing the costs of handing cash and change giving at the point of the transaction is significant and particularly so for buses where dwell time not only increases the operators' costs but increases passengers' journey times and can affect

reliability. Further costs of cash transactions arise in counting, transporting and banking coins and banknotes, some of which could be avoided through the use of smartcards.

Counterfeit and fraudulent coins and banknotes can be a serious problem in ticketing vending machines leading to substantial losses to the operator unless avoiding action is taken swiftly.

Security is a further disadvantage with the use of cash for fare payment particularly on buses where the crew might be attacked for the cash on-board.

2.2.3 Contact Smartcard

The smart cards are a type of ATM cards, by which the passengers may travel from one place to another simply by scratching the card in the driver machine. The more number of driver machine (or) the vending machine placed in every railway station helps to verify the codes and prints the ticket for the passenger. We may also recharge the card at any times and may use often, this is the most advantage of our proposed ticketing system. This is the hottest development in the Indian Railways [5]. The codes can be verified by the vending machine and we may also check the remaining balance.

Smartcards that rely on electrical contact with a ticket issuing machine offer the possibility of not only providing payment but also of storing the ticket resulting from a transaction. With suitable and adequate security designed in the card and ticket machine some of the disadvantages of cash may be overcome. However, because the card needs to be inserted in a slot to be read, transaction times are much greater than for a contactless card and in the case of the Mondex trial in the UK, transaction times on buses were greater than for cash transactions [2]. Such smartcard types are therefore unsuited for use on buses, light rail and closed transit systems. In considering the most common uses of contact smartcards, namely as identity for either credit or debit functions, privacy of the holder is potentially compromised in transactions. In the case of the credit function the name and credit worthiness is at risk and where a debit transaction is conducted the holders name and bank account details are at risk.

2.2.4 Optical Card

Optical memory cards which function in a similar way to CDs and DVDs provide a large memory capacity of several Mbytes and the capability of being used as an erasable store of value. The cards have been used widely in harsh environments and have not only withstood high temperatures but

have been proven to retain integrity after having suffered significant physical damage. However, the card cost is probably similar to the cost of a smartcard and the cost of terminal equipment configured as a ticket issuing machine would be much higher than for a smartcard terminal device. Furthermore, the read/write device for an optical memory card has relatively delicate moving parts and would be less reliable, particularly on buses, than a smartcard reader.

Another type of optical card which has been used as a telephone card is printed with a fine line grating representing a store of value. The grating may be disrupted to change the angle of reflection of light and to represent cancellation of a unit of value. The science involved in the definition of the fine line structure gives the system another layer of security in addition to the high cost of the manufacturing tools. The card cost is relatively low and the effective memory size is small. There is no possibility of recharging the card and the read/write device is expensive. As with the CD type optical card the read/write device is also unsuitable for use on buses.

2.2.5 Mobile Phone Ticketing

Ticket delivery schemes using the mobile phone network to transmit either a text message description of a purchased ticket or a bar coded ticket typically involve a third party ticket coding organization.

Depending on national interpretation of the e-money directive, payment may be either by deduction from the back office mobile phone pre-pay account, by direct debit or by a debit or credit card arrangement.

The advantages to the transport operator are a relatively fast transaction although inspection of the displayed ticket is probably slower than the automatic inspection of a ticket stored in a contactless smartcard. A further advantage is that the transport operator does not need to provide the ticket carrying artefact. This is supplied by the mobile phone owner.

Various approaches to security by the mobile phone ticketing service providers have so far seemed to be effective.

The technique is only suitable for certain types of ticket, typically tickets valid during a defined time period. It would not be suitable for a carnet of defined journeys as without an NFC interface, cancellation of a tick et cannot be carried out at the point of use. Interoperability is achievable at the commercial level but is unlikely to be viable across borders unless the mobile phone operators

reduce their interchange charges. This is likely to remain an obstacle to effective multi-operator, multi-modal ticketing. Privacy of the passenger is at risk by virtue of the record of the ticket transaction being linked with the mobile phone contract.

Although the third party ticketing service provider would probably allow for a ticket to be re-transmitted to the purchaser's mobile phone in the event that 'low battery' prevents presentation of a ticket, the mobile phone user is most likely to be denied travel in this event.

An advantage of mobile phones is that the status of payment and ticketing products can be determined using the mobile phones display. India is one of the country using this type of ticketing system.

Indian Railways ticketing has always been cumbersome. While the online booking system indeed solved some of the issues, the IRCTC website always makes to the customer nostalgic of the long waiting queues at stations and be the pinnacle of utter disappointment at times. While the website offers infinite control over the ticket booking, there are a lot of times when they are just want it done, with minimal effort. Till now, it hasn't been possible but worry not, a new and easy way of booking train tickets for Indian Railways is here, and it takes just two steps to book a ticket for up to six passengers! [6].

Prerequisites to book a ticket through SMS on 139. User should be registered on IRCTC's website (www.irctc.co.in).User should have MMID & OTP (One Time Password) for IMPS. The MMID & OTP (One Time Password) for the IMPS (Inter Bank Mobile payment service) transaction that is about to happen. You can get the MMID from the bank if you haven't already.

MMID stands for Mobile Money Identifier and is 7digit number that is provided by Bank to customer. This number is used to identify customer Bank and is linked to the account number. The combination of mobile number and MMID is unique for the particular account, and customer can link same mobile number with multiple accounts in the same Bank, and get separate MMID for each account [5].

2.2.6 NFC on Mobile Phone

Adding NFC (Near Field Communication) capabilities to the near ubiquitous mobile phone has the potential to provide for the purchase of public transport and other types of ticket over the

mobile phone network and to subsequently offer the ticket for travel at a smartcard reader. Mobile phone providers are intending that the NFC functionality of their handsets is compliant with ISO/IEC 14443 [2].

The issues of interoperability should therefore be the same as for contactless smartcards compliant with ISO/IEC 14443. Security issues are likely to be broadly similar to those for contactless smartcards except that mobile phones are more vulnerable to being stolen. Privacy could be an issue where tickets are purchased via the mobile phone network as the travel transaction can be traceably linked to the mobile phone contract [2].

The combination of mobile phone and NFC technology has the following advantages:

- The public transport operator does not need to provide the ticketing/payment artefact;
- Tickets and stored value could be purchased over the mobile phone network for presentation to ticket machines via the NFC interface. However, the commercial viability of this depends on the charge made by the mobile phone network provider and who pays and also the widespread deployment of NFC in mobile phones;
- Potential for interoperability with contactless smartcards tickets could be purchased and value added at any smartcard ticketing terminal in the system for which the NFC device has been configured.
- The effective personalization of period passes ticket products. It is unlikely that the owner of a mobile phone will part with it to someone wishing to take a bus journey free of charge.
- Depending on the design of mobile phone with NFC interface, the mobile phone display could provide a window on the store of value and tickets available at the NFC interface.
- Recognizable: the status of payment and ticketing products can be determined using the mobile phones display.

Disadvantages include:

- Purchasing tickets over the mobile phone network depends on there being adequate signal strength at the place of purchase and the phone battery having sufficient charge for the transaction to take place. However, if the NFC interface is ISO/IEC 14443 compliant tickets and monetary value could be transferred directly to the phone's store via the NFC interface from a source other than the mobile phone network [2].
- Concern from the owner of the mobile phone that privacy could be compromised.

2.2.7 Magnetic Stripe Ticketing

Magnetic stripes on credit card size (ISO/IEC 7810) paper tickets have provided for automatic validation for closed mass transit networks and on buses and trams [2]. The main advantages are low cost of the card and multiple use although wear out is much faster than for contactless smartcards.

The principle disadvantages have been the high cost of reader maintenance, and poor reliability, due to the need for fine adjustment and moving parts. Another disadvantage is that certain ticket types can be easily subjected to fraud.

The memory capacity is significantly less than smartcards are capable of providing, which further limits the complexity of ticket types that can be written to the card, but it does also mean that recording the identity of the holder is not usually practicable leading to protection of privacy.

2.2.8 Barcode

Two dimensional bar codes could provide for more complex ticket types. The main advantages of printed bar coded tickets is the increased security provided where tickets are sold off-bus/tram combined with automatic scanning for validation. This is the reason why this thesis wants to implementing barcode based ticketing system for AA LRT.

2.3 The Existing Ticketing System in the Addis Ababa LRT

2.3.1 Paper Ticketing Method

Addis Ababa LRT currently uses manual ticketing system. Passenger go to the ticket offices by telling where the destination is to the ticket officer and by paying money according the distance (number of stations). The tickets are checked at entrance of stations manually and passengers enter to the train.

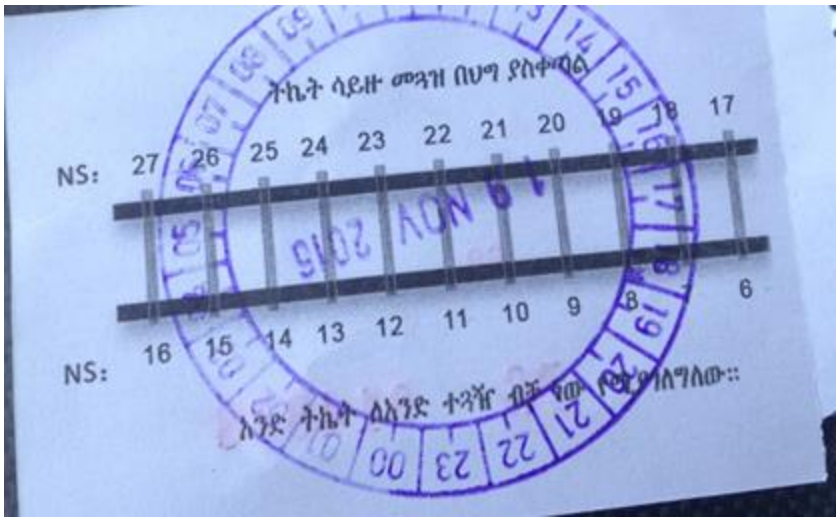


Figure 2-1: Paper Ticket

2.3.2 Using Smart Card

In a month before ERC announces new technology ticketing system which is called E-ticketing system this system works using smart card [7]. Smart card is an electronic card like ATM. All the passengers are provided with a smart card. The smart card carries a number which is issued on the basis of any proof of the passenger it may be a driving license or a pan card or a ration card. Hence on any public issues the system can be checked for the passengers list. The smart card has an account balance if the balance is reduced the amount will top up again. Then a system is fixed in the public transport. When a passenger enters the public transport the smart card should be swiped and the destination chose using the keypad. Hence swiping and choosing is done by the passenger all other work is carried out by the system. The system calculates the distance between entry and exit point. Then according to the distance the amount is reduced from the passengers account. Smart cards are more convenient, they can be purchased and "reloaded" using automated processes and in some cases at home on the Internet. Because cards can be personalized, they can be cancelled if stolen. They are also more efficient to use: the contact functioning of many cards allows more rapid movement through stations and onto different modes of travel.

The machine or the reader is installed inside the train, when the passenger enters to the train touch his smart card to the reader and the machine sense the card and identify owner of the card directly access his/her account and take the maximum birr (6 birr),then when the passenger leaves the train

or arrives on his/her destination again sense the card on the reader according the distance traveled recalculate the balance of the passenger.

But the two existing systems have their own drawbacks. The first system its problem is in terms of long queues, reliability and far away from the train station. The second system works for few numbers of passengers but, it is difficult in AA LRT, since trains are not working according to the time table promised by ERC during the inauguration of the project and more passengers use the train at the same time especially at peak up time. And, the dwelling time will increase at stations.

Figure 2-2: Smart Card Installed inside the Train

Chapter Three

3 System Design and Development

3.1 Introduction

In the fast forward world of technology everyone is running behind time. Thus, the main motivation of technology is to produce a time and cost efficient product. Even in the railway department online ticket booking or e-ticketing was introduced for facilitating the users to book ticket on internet via a governmental website. The printout of the ticket may be used for validation. Later M-ticketing (Mobile ticketing) was introduced which sends user messages of tickets for validation purposes after booking the tickets through online ticket portals. In foreign countries, Oyster and Octopus, cards are compulsory for travelling but it would be too costly to fabricate the smart card and the machine [1].

E-ticketing system using barcode is a system which helps passenger to travel from source to destination using barcode. This barcode will help in storing information about the passenger or the customer of this system. The information, that will be stored regarding the passenger, will be the information provided in the customer ID of the user. This information name, ID number, phone, address, date of birth etc. and the in the database the amount that the user is currently having in its account will be stored. Passenger line flow in Addis Ababa is huge, and when it comes to peak periods such as rush hours, festivals, holidays etc., there are a lot of inconvenience happened to the passengers.

In public transport, e-ticketing systems are not only means of payment but process huge amount of information which offer a large range of possibilities to make public transport easier to use, to manage and to control. They offer as well opportunities to introduce integrated pricing structure that are not easy to implement with traditional payment tools. Mining on the public transport data collected through the e-ticketing system provides valuable information on network usage and travel patterns which could be used for planning, operation and marketing purposes e.g.- monitor capacity utilization and loading on different routes, monitor bus headways and punctuality, monitor boarding and alighting at stops and estimate passenger volumes at stops, estimate ridership per operator and ticket types, analyze travel patterns for different groups of passengers,

introduce incentives, estimate time, cost, modes, transfer information, related to any journey. On the other hand, restrictions imposed by individual freedom related regulations will limit the potentialities of exploiting passenger related data [8].

In the present situation communication is a big issue in different cities [8]. The passengers sometimes do not know whether they should travel by bus or by train so that they can reach their destination as soon as possible. Their decision is affected by the time also i.e. in rush hours they are not able to easily choose the more efficient and convenient mode of transportation. What more sometimes they forget to bring change which creates difficulties for all. This thesis would help in help in overcoming such kind of ambiguities by developing a system that will provide the freedom of a malleable mode of transportation to the public transport passengers.

The advantage use of electronic ticketing systems in the AA LRT market is not only related to the above mentioned phenomena but also, and mainly, to the advantages that those systems provide to train operators. Among those advantages, we can highlight the replacing of physical means by information management that, besides speeding up the procedures, allows a better control of the operation, with less effort, consequently resulting in a lower operational cost.

The speed in knowing the financial status of a train route operation is one of the immediate results of the information management in the automated fare collection procedure. Under this scenario, a cultural change in the transport sector could also be a consequence of such procedure of technological improvement. This shows that the adoption of this new technology is possibly an unchangeable strategy, with clear impacts on the development of new learning areas for the company itself and a direct consequence on the increase of the quality of services provided.

It is not easy to clearly identify the main objective of ERC when they choose an automatic ticketing system, since that there are multiple possible purposes. Each one has its own priority within specific situations.

This thesis uses the manual ticketing system and Barcode based ticketing methods. For the passengers not familiar with the technology and passengers use the AA LRT for short time they can buy ticket manually on the stations. But for the passengers who are familiar with the technology uses the Barcode based ticketing system. The machines are installed at entrance of the

station passengers cannot go long distance to buy ticket and the value of the ticket is calculated according the distance of the station not 2,4 or 6 Birr. To avoid the queue number of machines are installed parallel.

3.1.1 Brief Survey on Barcode

Figure 3-1: Sample Barcode

A barcode is the small image of lines (bars) and spaces that is affixed to retail store items, identification cards, and postal mail to identify particular product number, person or, location. The code uses a sequence of vertical bars and spaces to represent numbers and other symbols. A barcode symbol typically consists of five parts: a quiet zone, a start character, data characters (including an optional check character), a stop character, and another quiet zone. A barcode essentially is away to encode information in a visual pattern that a machine can read. The combination of black and white bars (elements) represents different text characters which follows a set algorithm for that barcode type. If you change the sequence of elements, you get different text. A barcode scanner reads this pattern of black and white that is then turned into a line of text your computer can understand. We will be using this barcode to identify and verify the users that are willing to travel to different locations. A barcode will be generated during the registration of the user with full information. A unique barcode will be generated for every user being registered into the system. Using this barcode, the user will be able to book tickets for their travelling. The database is composed of the tables that stores the information regarding admin and customer and also there are tables which are used for barcode [8].

3.2 Required Materials

3.2.1 Hardware Requirements

Hard Disk (550 GB), Processor (Pentium 4), Mother Board (Intel core i3), Device (Laptop), Speed (2.5 GHz), RAM (4GB), Barcode Reader Checks the Barcode Card.

Barcode scanner

Figure 3-2: Barcode Scanner [7]

A barcode reader (or barcode scanner) is an electronic device that can read and output printed barcode to a computer. Like a flatbed scanner, it consists of a light source, a lens and a light sensor translating optical impulses into electrical ones. Additionally, nearly all barcode readers contain decoder circuitry analyzing the barcode's image data provided by the sensor and sending the barcode's content to the scanner's output port.

3.2.2 Software Requirements

Visual Studio (Ultimate v2013), Language (C-sharp), Operating System (Windows 10), Database (SQL server).

3.2.2.1 Microsoft Visual Studio

C# is the programming language, while Visual Studio is thedevelopment environment. Microsoft Visual Studio is an integrated development environment (IDE) from Microsoft [9]. It is used to develop computer programs for Microsoft Windows, as well as web sites, web

applications and web services. Visual Studio uses Microsoft software development platforms such as Windows API, Windows Forms, Windows Presentation Foundation, Windows Store and Microsoft Silverlight. It can produce both negative code and managed code.

New projects are created from the "New Project" window:

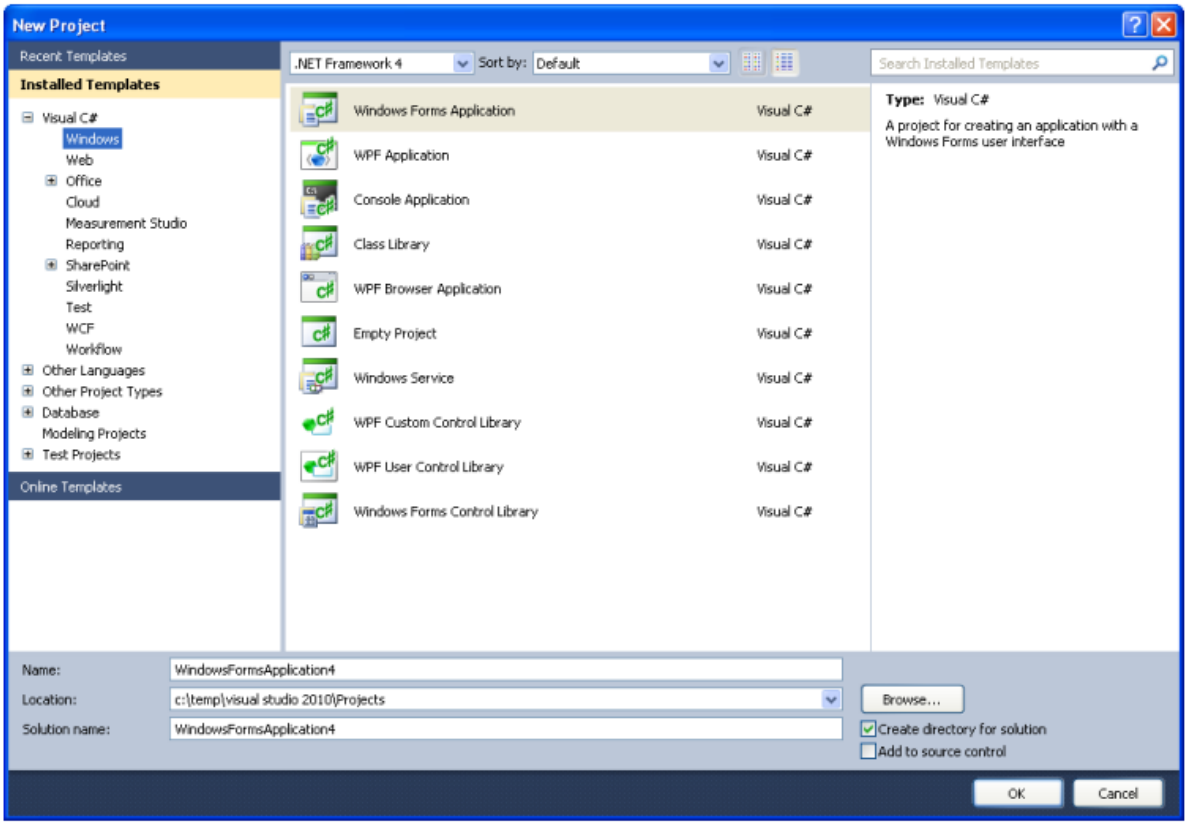


Figure 3-3: New Project Window Form [10]

3.2.2.2 C#

C# is pronounced "see sharp". C# is an object –oriented programming language and part of The .NET family from Microsoft. C# is very similar to C++ and Java. C# is developed by Microsoft and works only on the Windows platform.

3.2.2.3 .NET Framework

The.NET Framework (pronounced "dot net") is a software framework that runs primarily on Microsoft Windows. It includes a large library and supports several programming languages Which allow language interoperability (each language can use code written in other languages). The.NET library is available to all the programming languages that .NET supports. Programs written for the.NET Framework execute in a software environment, known as the Common Language Runtime (CLR), an application virtual machine that provides important services such as

security, memory management, and exception handling. The class library and the CLR together constitute the.NET Framework.

Visual studio.net has different futures editor to write code, graphical interface, data access, debug and deploy.

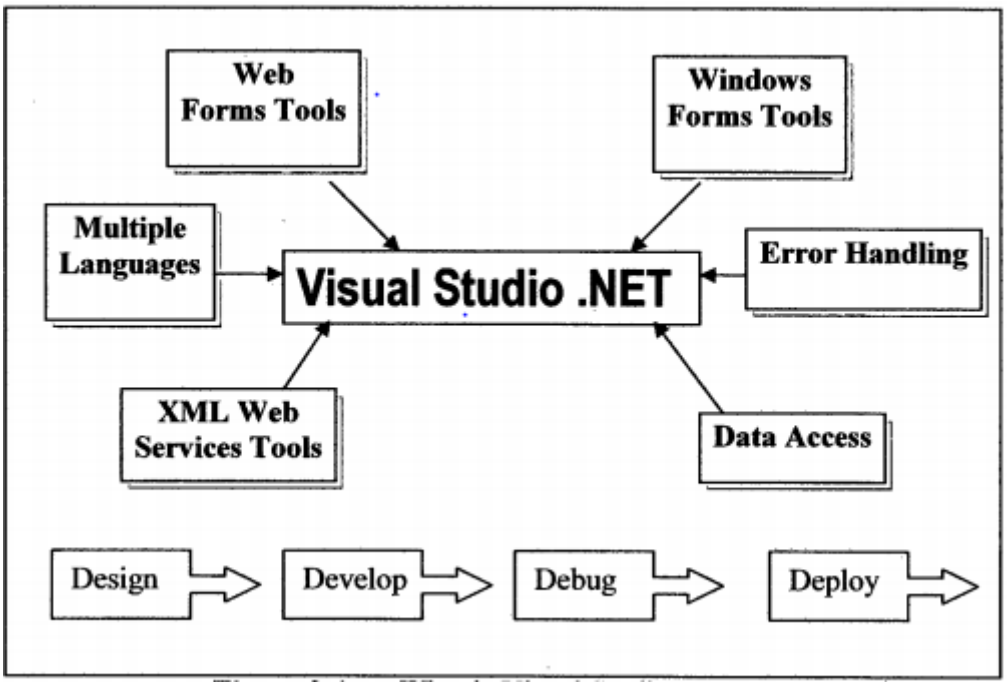


Figure 3-4: What is Visual Studio.NET [11]

3.2.2.4 What is a SQL Server?

SQL Server is a Microsoft product used to manage and store information [10]. Technically, SQL Server is a "relational database management system" (RDMS). Broken apart, this term means two things. First, that data stored inside SQL Server will be housed in a "relational database" and second, that SQL Server is an entire "management system", not just a database. SQL itself stands for Structured Query Language. This is the language used to manage and administer the database server.

What can SQL do?

SQL has one basic statement for retrieving information from a database: the SELECT statement. The basic form of the SELECT statement, sometimes called a mapping or a select-from-where block, is formed of the three clauses SELECT, FROM, and WHERE and has the following form:

SELECT <attribute list>, FROM <table list>, WHERE <condition>;

where:

- <attribute list> is a list of attribute names whose values are to be retrieved by the query.
- <table list> is a list of the relation names required to process the query.
- <condition> is a conditional (Boolean) expression that identifies the tuples to be retrieved by the query.

Using this concept, we can do the following activities on SQL:

- SQL can execute queries against a database
- SQL can retrieve data from a database
- SQL can insert records in a database
- SQL can update records in a database
- SQL can delete records from a database
- SQL can create new databases
- SQL can create new tables in a database
- SQL can create stored procedures in a database
- SQL can create views in a database

SQL can set permissions on tables, procedures, and views

3.3 Architectural Design of the System

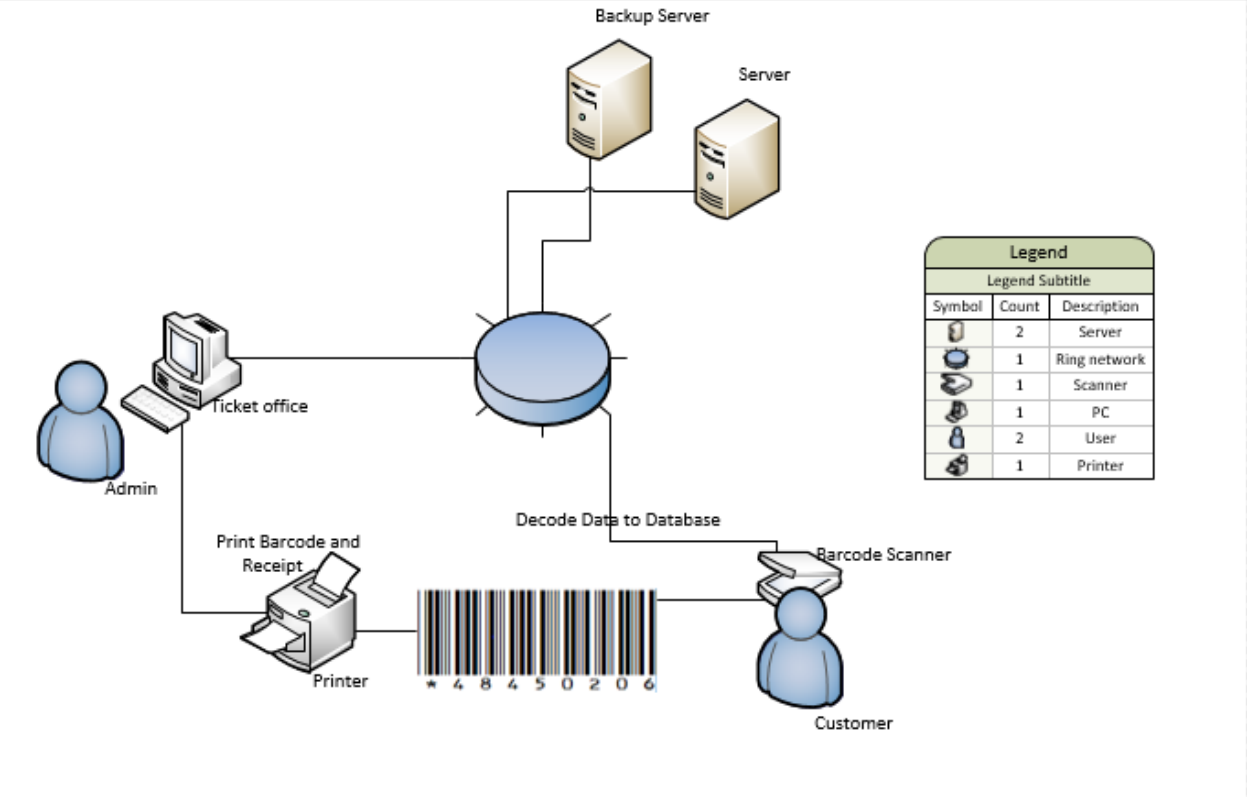


Figure 3-5: Architectural Design of the System

At entry gate barcode scanner with controller will be installed then the customer will be scratch the barcode based ID on the machine and sent to SQL server to check the validation.

The software of this thesis ticketing system consists of application program and database. The application program can be developed with Microsoft C# programming language using Microsoft visual studio framework. It provides a user interface for the proposed system. because this programming language easily runs on both Microsoft operating system and Unix operating system. It can easily communicate with database. The main component of this thesis's ticketing system is its database. For this purpose, the SQL server database can be used. Because SQL Server can store and maintain a large number of data. It is very fast and easy to operate. The database will record the Passenger Barcode ID, Full name, address, some amount of money, starting station and destination station in a table.

Flow chart of the system

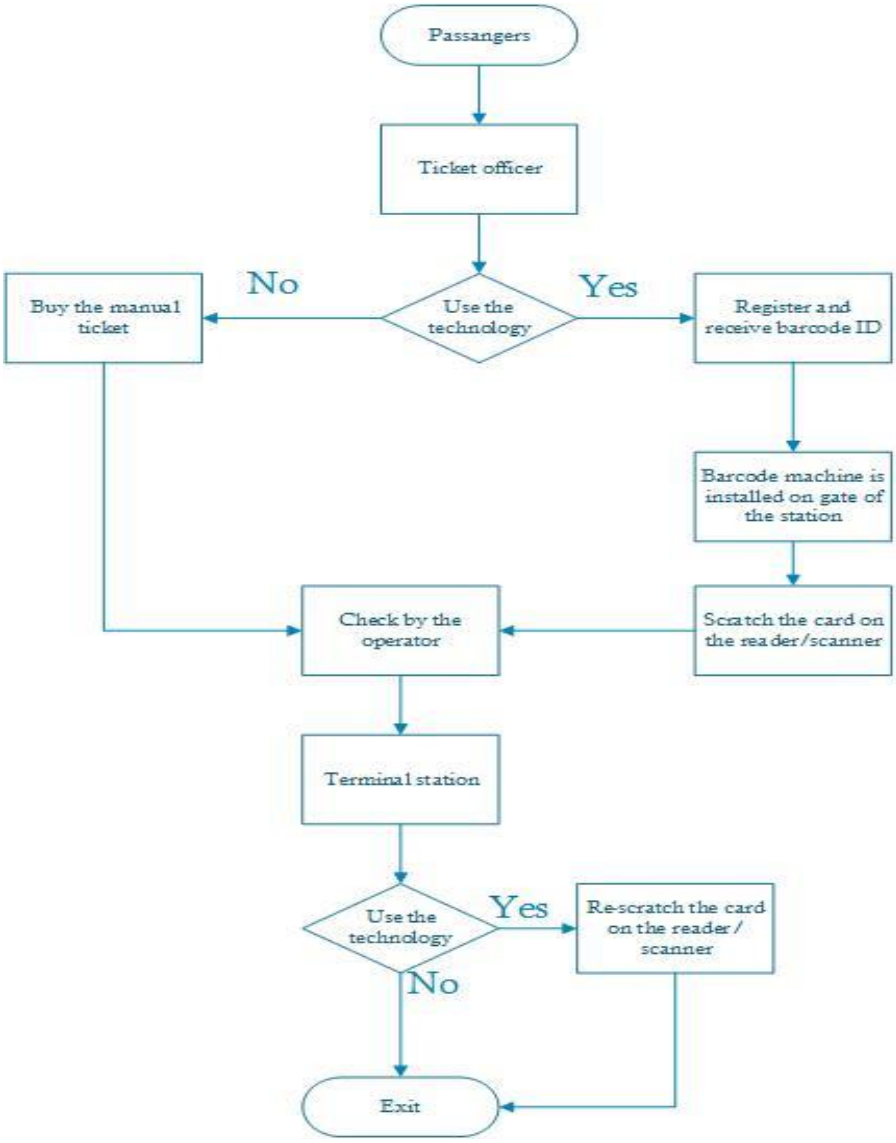


Figure 3-6: Flow chart of the System

3.4 Features of the System Software

First of all, a controller will register different admins into the system by providing them a user ID and password. These admins will register different customers. They will also manage the account of the customers and also add amount to the user's account. First the controller will register admins. Then the admins will register new customers using their personal profiles. Whenever any new user is registered by the admin, a new barcode will be generated for that user. The admin also deals with the existing users and adds amount to the existing user's account. If the ID of the user gets stolen or lost, then the admin will deal with this
issue and try to resolve it. Rules may be added to users according to the feedback of ERC.
The paper is divided mainly into two modules: -

- Admin Module
- Customer Module

3.4.1 Admin Module

1) In the case of new customer-

The new customer first needs to be registered. The system generates barcode which is used as an ID number for the customer. For this, the admin will proceed in the following manner

- The customer will deposit some amount of money to AA LRT account
- The admin will add a new customer by registering all the required personal information's
- Now unique barcode will be generated for the customer.
- Then the customer details will be generated corresponding to the customer unique barcode in ID card form.

2) In the case of existing customer: -

In the case of existing customer, the customer is already registered and there is an option for recharging or adding amount to the user's account. It is accomplished in the following manner: -

- First the admin will select update balance.
- Then it will scan the barcode of the user that is being generated earlier when the customer was first registered.
- Now it will enter the amount details.
- It will now select the amount that has to be added based on the demand of the customer.

- Recharge is successfully completed.

3.4.2 Customer Module

The other module is the customer module that gives the process of booking a ticket by the customer. The module is completed in following steps: -

- First the customer will scratch the e-card on the scanner machine to select its starting location.
- Then it deduces maximum fee from the account.
- Then it will re-scratch the e-card on the scanner machine to identify destination.
- Then recalculate the transaction (amount paid) according to the distance traveled.
- Then the bill, providing the details such as amount to be paid by the customer, is generated.
- At the end the transaction will be successfully done.

3.5 Algorithm for the Transaction

Step 1: To use the train scratch the barcode on the driver machine

Step 2: The machine checks the validation of the card

- ✓ If it is invalid alert warning signal
- ✓ For valid card check balance
    - o Insufficient balance alert warning signal
    - o For sufficient balance

Step 3: Is the scratching ticket is once?

- → Yes: Register the starting station and deduce 6 Birr from total balance

  Balance=Balance-6 Birr
- → No: Register the end station

  Check time if time greater than 1hr take maximum fee

  Else recalculate the fee according the distance traveled

Step 4: Recalculate the fee

If

line of start station=line of end station

Length of travel=absolute value of order end station-order of start station

Fee=0.5+length of travel/6 + length of travel/12

Deduction=6-fee

Updated balance=Balance + Deduction

Else

Length of travel one=absolute value of order of common line-order of start station

Length of travel two=absolute value of order of end station-order of common line

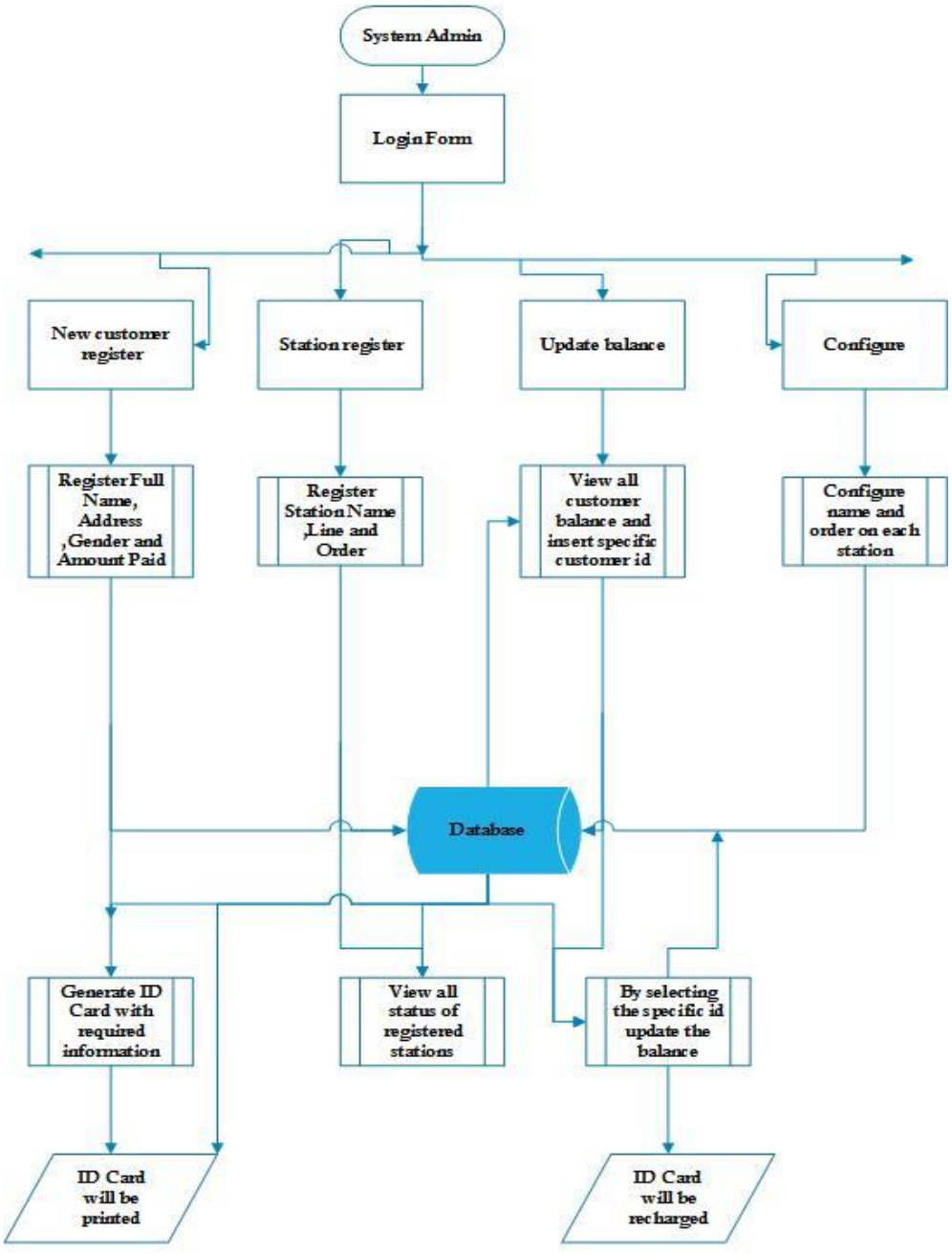
Total length= length of travel one + length of travel two

Fee=0.5 +total length/6 + total length/12

Deduction =6-fee

Updated balance=balance + deduction

3.6 Flowchart of the system software



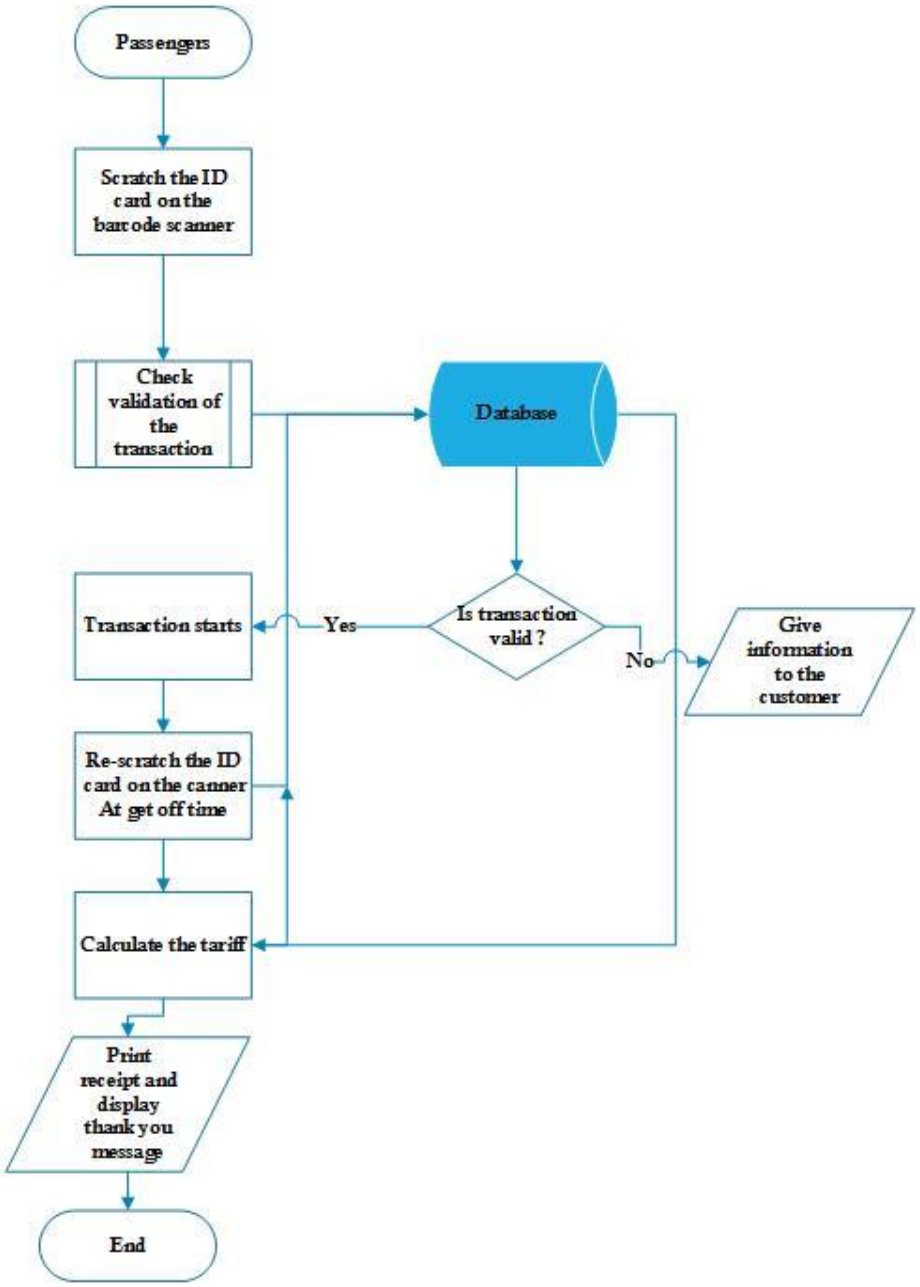


Figure 3-7: System Flow Diagram

3.6.1 Network Design

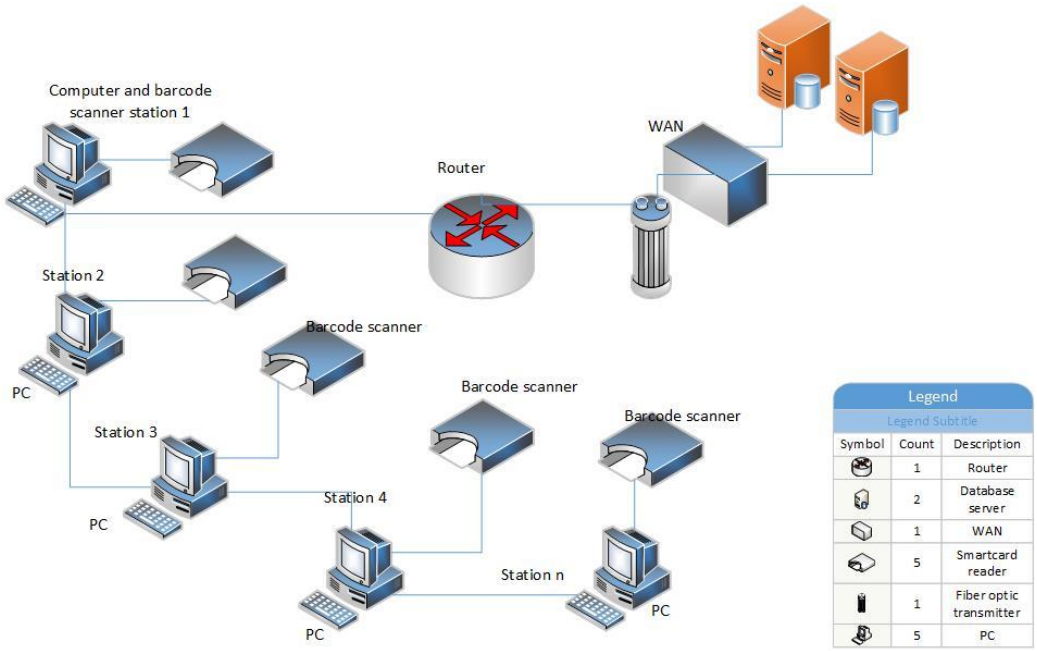


Figure 3-8: Network Design

Server

- consists application and sever database
- personal information and updated billing

Station machine

- has application and local database

  Local database holds customer list and un updated billing list (while offline)
- request customer information and balance

Connection of the Network

In the network case ERC will buy the WAN network from Ethio-telecom to connect each stations transaction with central database.

Wide Area Network (WAN)

- WAN covers a large geographic area such as country, continent or even whole of the world.
- A WAN is two or more LANs connected together. The LANs can be many miles apart.
- To cover great distances, WANs may transmit data over leased high-speed phone lines or wireless links such as satellites.

- Multiple LANs can be connected together using devices such as bridges, routers, or gateways, which enable them to share data.

The world's most popular WAN is the Internet [12].

Figure 3-9:Wide Area Network [12]

Local Area Network (LAN)

- A LAN is a network that is used for communicating among computer devices, usually within an office building or home.
- LAN's enable the sharing of resources such as files or hardware devices that may be needed by multiple users
- Is limited in size, typically spanning a few hundred meters, and no more than a mile
- Is fast, with speeds from 10 Mbps to 10 Gbps
- Requires little wiring, typically a single cable connecting to each device
- Has lower cost compared to MAN's or WAN's

- LAN's can be either wired or wireless. Twisted pair, coax or fiber optic cable can be used in wired LAN's.
- Every LAN uses a protocol a set of rules that governs how packets are configured and transmitted.

Routers

A router is a device that forward data packets over networks. Most commonly, a router is connected to at least two networks (normally LANs or WANs). Routers are located at gateways, the place where two networks are connected. Routers do little data filtering; they mainly deliver the data.

In this thesis the network should be implemented, when the WAN network configures at server side (central database) then connect to LANs, multiple LANs can be connected together using devices routers and the router should be installed at each station. This router interconnects between read/scanner machine and local database and also local database with central database(server) through twisted pair, coaxial or fiber optic cable.

3.7 System Operation

3.7.1 Ticket System and Charging Method

The fare collection system of Addis Ababa Light Rail Transit adopts a distance and time based fare system charging mode. Passengers can pay for the ride by using the digital ticketing method and cash, where digital tickets are access personal account of the passenger by scratching his/her Barcode card on the barcode reader (sensor).

There are two gates on each station, the machines are installed on gates for the passengers using Barcode ticketing and for the passengers use manual ticket there is ticketing station around the train station.

3.7.1.1 The Ride Procedure for Passengers with Digital Tickets

When the passenger scratch's Barcode card on the installed machine (barcode reader) the machine access all profile and account of the passenger from the database and check the balance whether it is sufficient or not. If it is sufficient it takes the maximum amount of money paid (6 Birr) in transportation and print receipt with its details such as date, departure station, arrival station and

time, price per KM. When the passenger leaves the train (end the journey) he/she must re-scratch the Barcode and re-calculate the balance according the distance of the station unless the maximum payment of the journey will reduce from the passengers account.

3.7.1.2 The Ride Procedure for Passengers with Cash

- The passenger tells his/her travel distance to the conductor when boarding the vehicle and pays required amount in cash;
- The conductor gives change and a paper ticket;
- The passenger flights from the vehicle when arriving at the destination.

3.7.2 Barcode Card Sales and Recharge Method

Selling and recharging provides on all the ticketing station currently parallel with the manual ticketing used are set for E-W & N-S lines. Passengers purchase the code by registering on the system and pay some amount of birr to the coordinator and the coordinator gives Barcode card. To recharge simply the passengers, give their Barcode card and pay some amount of money, then the administrator updates the users balance.

3.7.3 Ticket Validation Method

Conductors are responsible for monitoring and preventing passengers from fare evasion. At least one conductor should available at each machine to help the passenger and to check passengers' ticket to judge whether fare evasion exists.

3.7.4 Database Checking

This is a backup plan in case the server database failed, damaged or shows any problem. Directly all the information of users will be accessed from the backup computer. In the control center two server computers are installed the server database parallel.

3.8 Feasibility Check

This finds out the strength, weakness of the existing system, the scopes of the existing system, threats faced by the system, availability of the resources and so on. Feasibility studies are carried out before implementing the project.

3.8.1 Economic Feasibility

Most of the technologies utilized in this thesis are available freely. Thus the implementation of this thesis is economically feasible.

3.8.2 Technical Feasibility

The proposed system is technically feasible also since minimal changes on the existing system may result in this new system.

3.8.3 Operational Feasibility

This study is to check the level of acceptance of the system to the user. This should be user acceptable as it provides feature to help the user to utilize time in lieu of a negligible amount of money.

Chapter Four

4 Results and Discussions

4.1 Simulation Results and Discussions

Admin Login Form

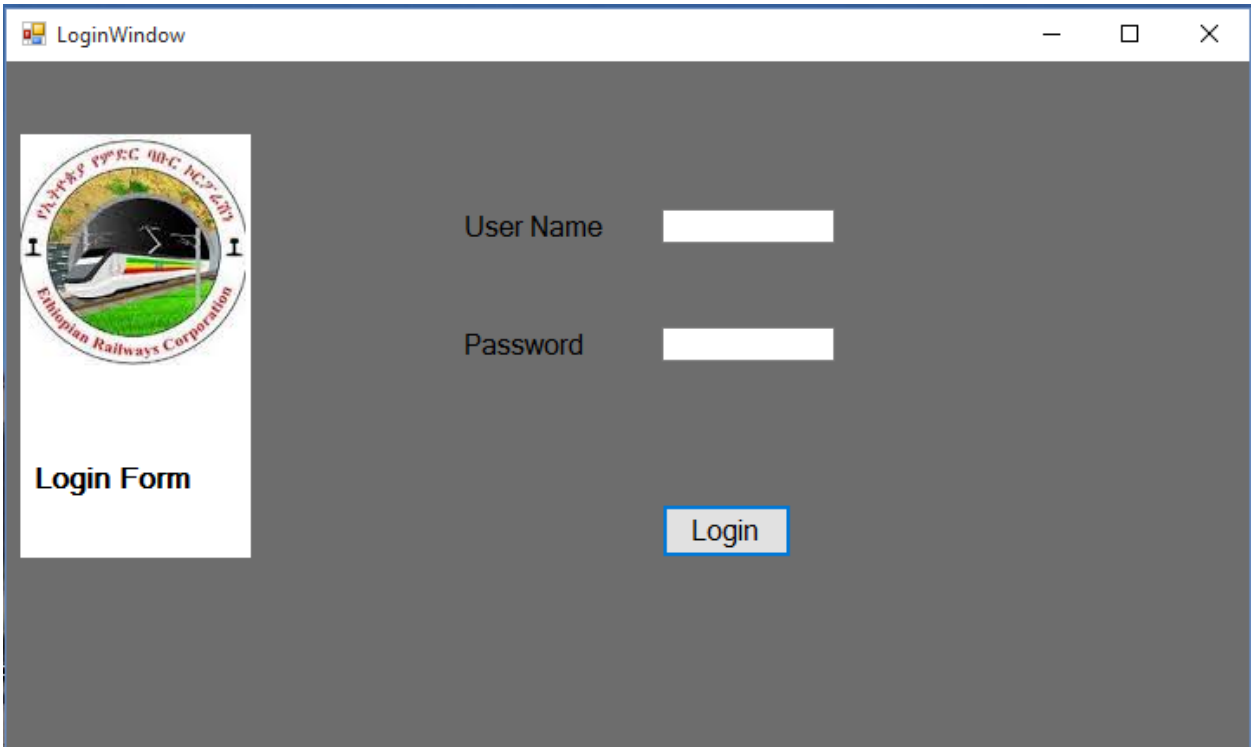


Figure 4-1: Admin Login Form

To access all activities of the system it needs authorizations.

The admin has his/her own authentication (user name and password), after login the admin can register new customers, register stations and can update the balance if the customer needs to recharge his/her system card.

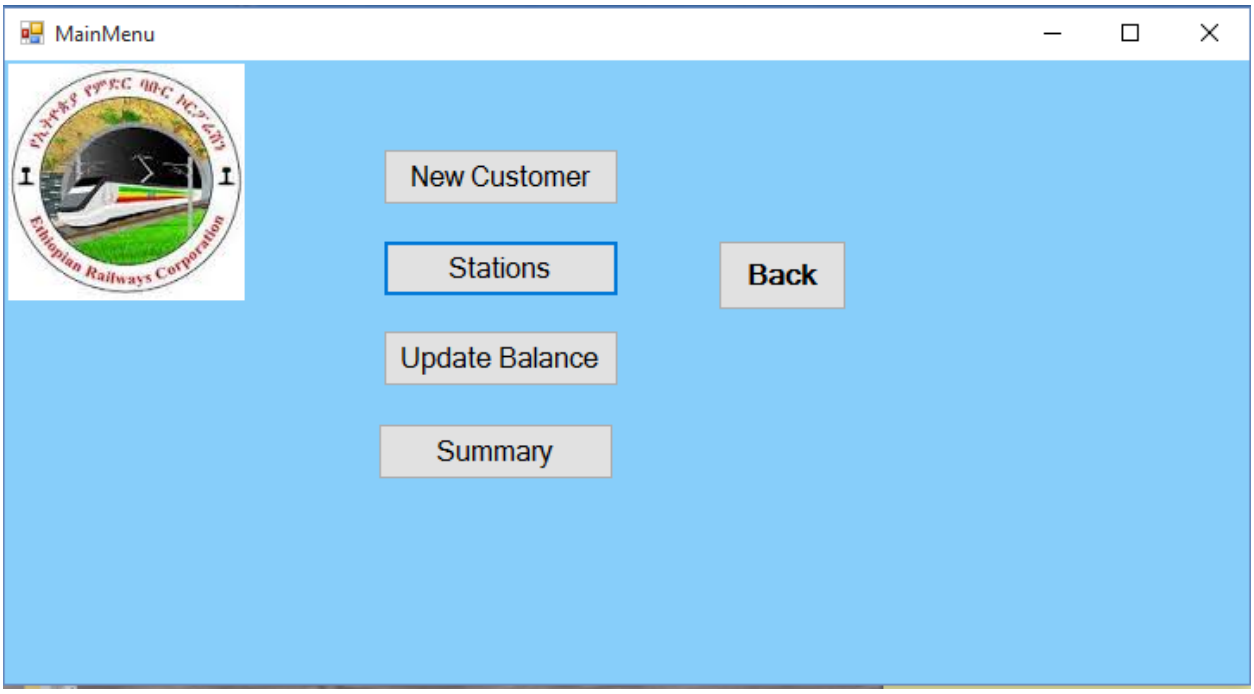


Figure 4-2: Main Menu Form

This form shows main menu of the system and also these are main tasks of the system admin.

Stations Registration Form

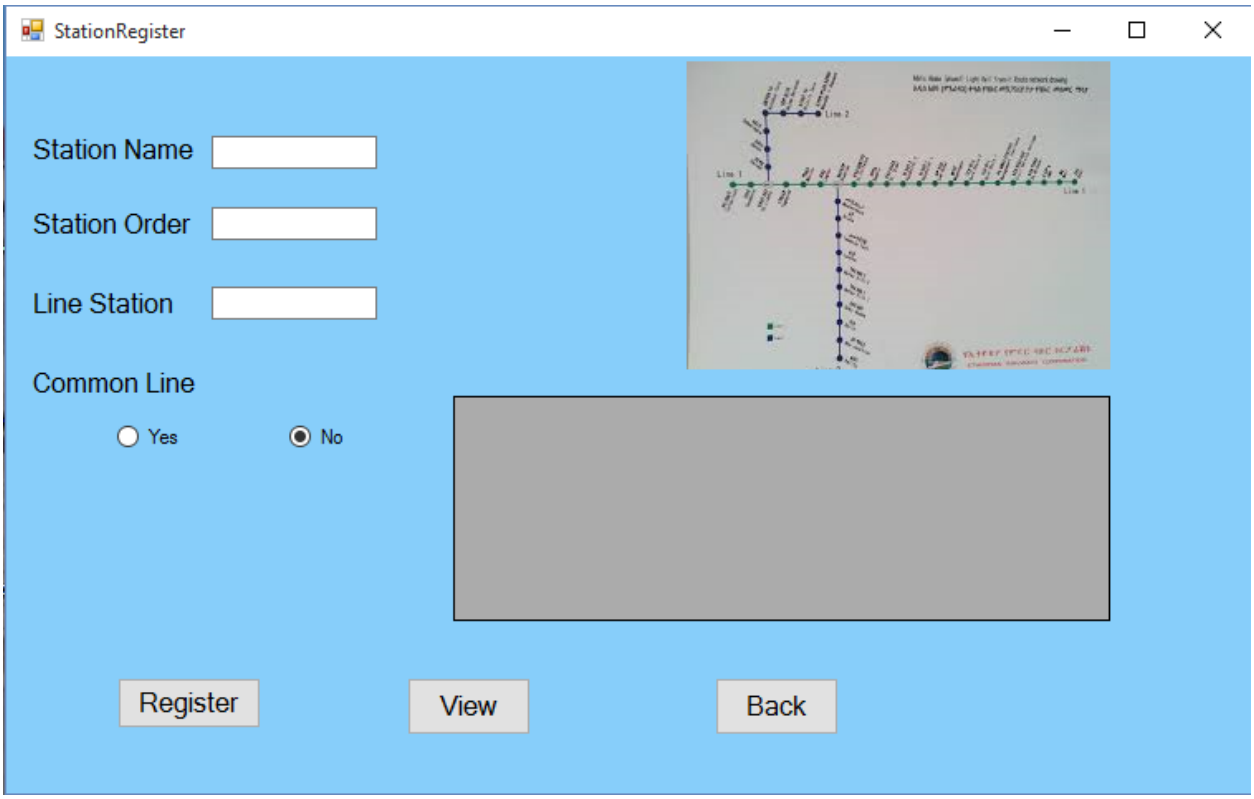


Figure 4-3: Station Registration Form

This form uses to register AA LRT stations; when the admin registers all these stations considers on the following parameters: -

- Line of the station as we know AA LRT has two lines: **Line 1(E-W)** from Ayat to Torhailochn with 22 total stations, **Line 2(N-S)** form Kality to Minilik square II with 22 total stations.
- Station name:-All the stations will be registered by its unique name like Ayat, Leghar,kaliti and Mieksco etc…
- Station order:- This helps to calculate the tariff the passenger travelled. The station order is assigned numerically from 1 up to 22. Example Ayat is order 1 and Torhailoch is order 22 the same is true with line 2
- Common line:- This also helps to calculate the tariff when depart passengers from line 1 to line 2 or vice versa

There are about five common line stations from Stadium to St. Lideta

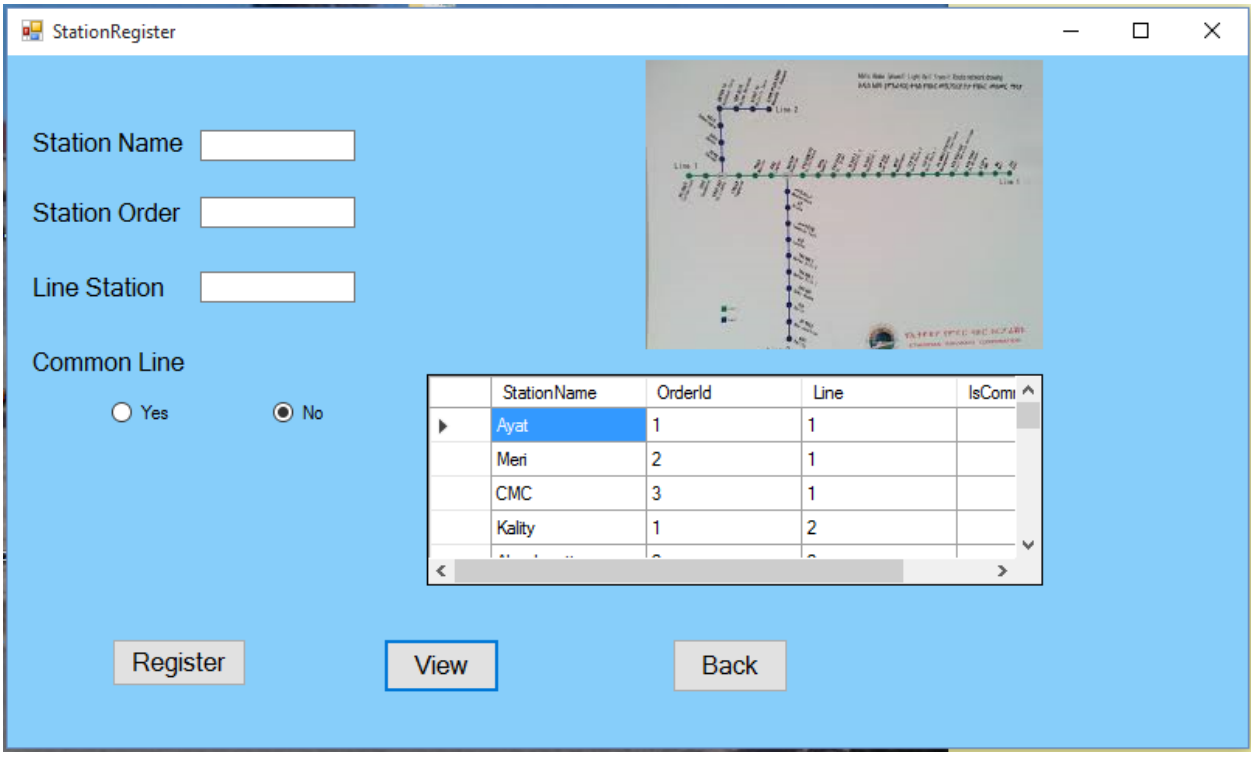


Figure 4-4: View Sample Registered Stations

This figure shows the already registered parameter of the stations.

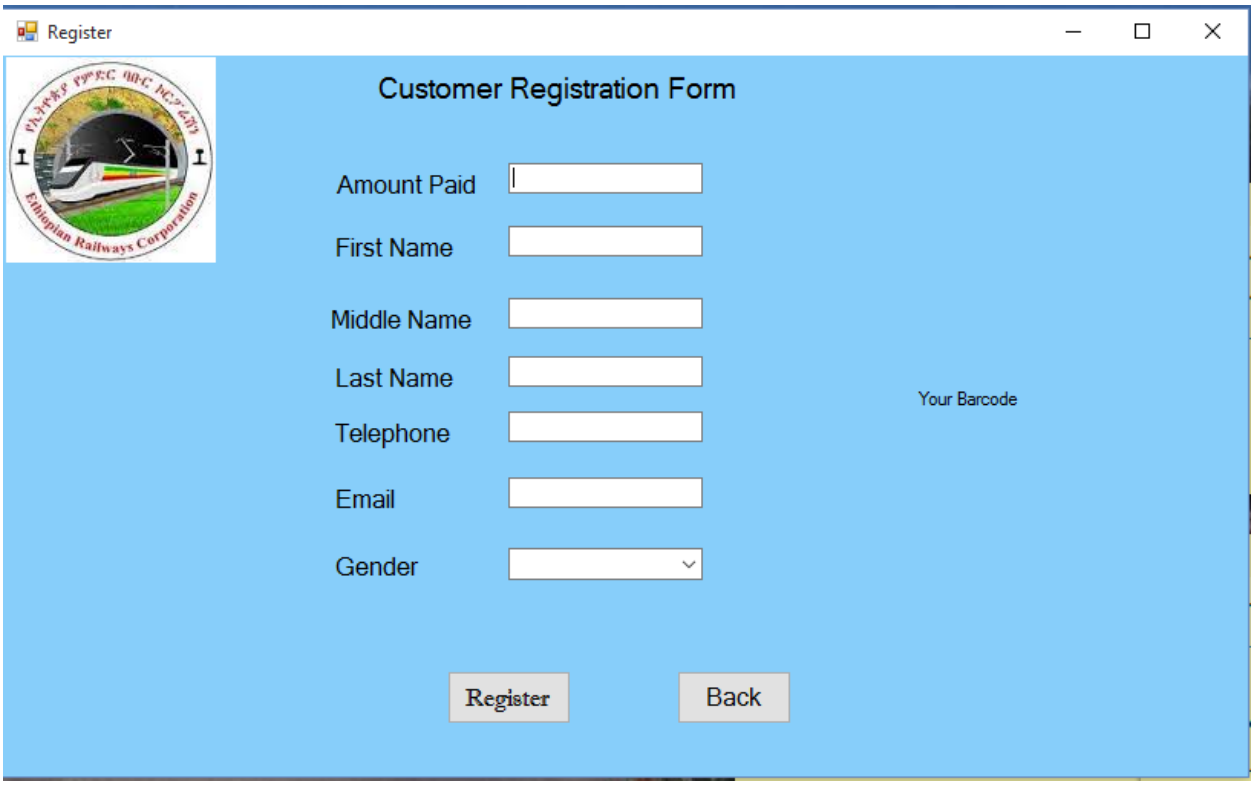


Figure 4-5: New Customer Registration Form

This form uses to register new customer by filling all the required personal information(like full name, address and gender) and the amount paid. When the passenger registered the identity barcode id will be generated and printed in ID Card form, then customer uses the card when travelling with AA LRT until the amount paid birr vanishes at this time passenger can recharge the card again.

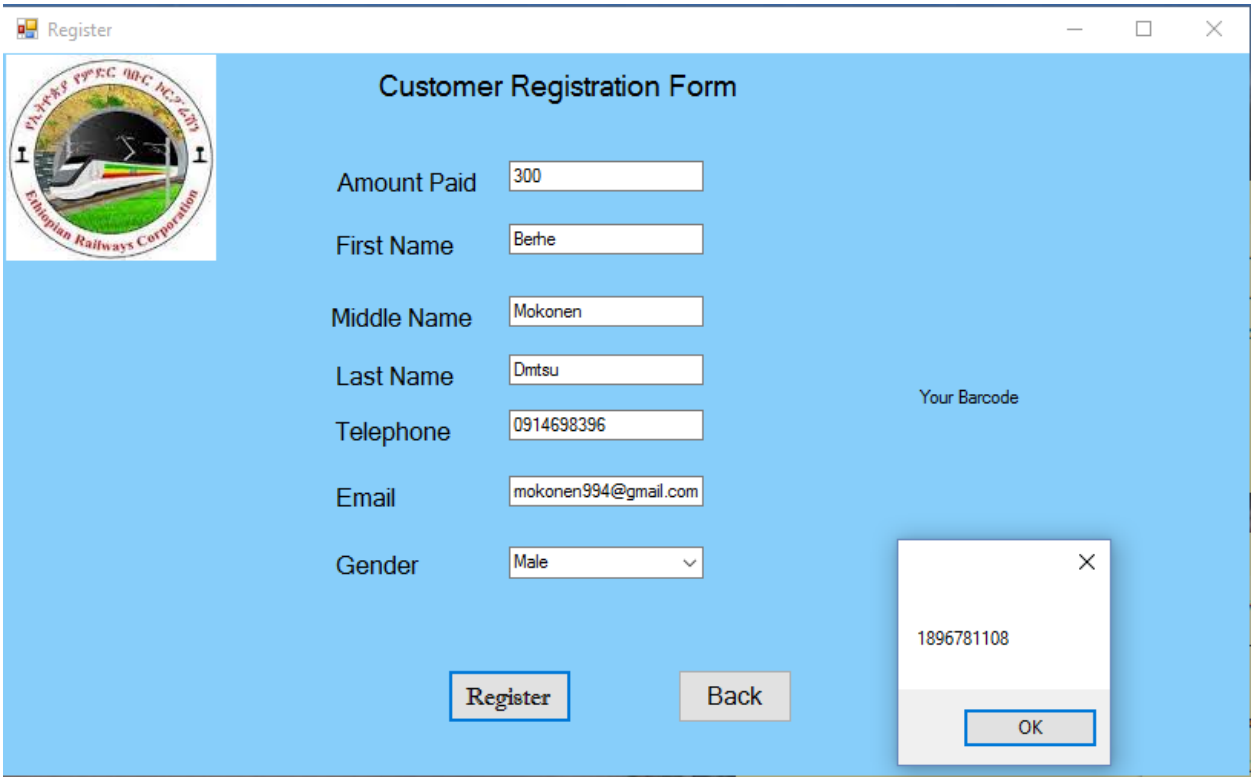


Figure 4-6: View Sample Registered Customer

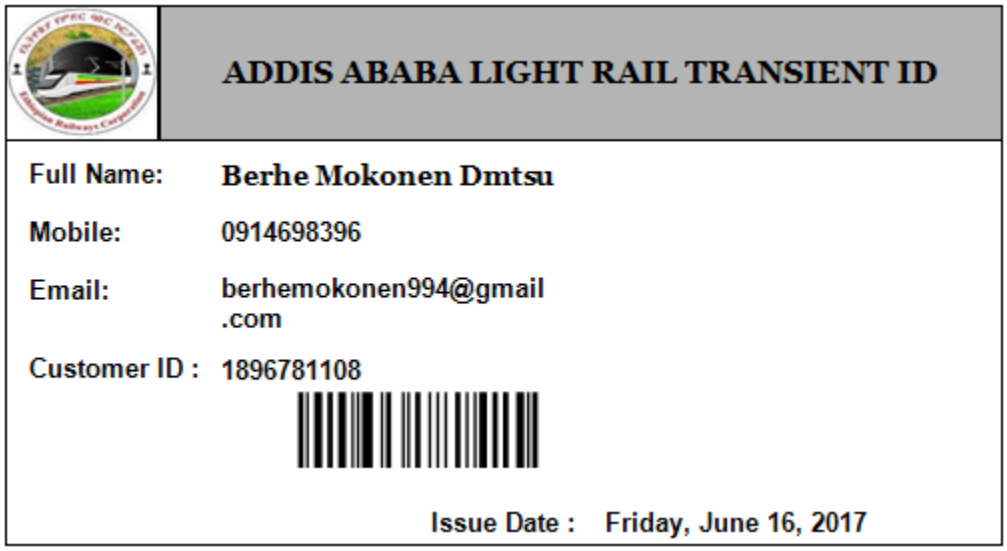


Figure 4-7: AA LRT ID Card

Recharging the Card

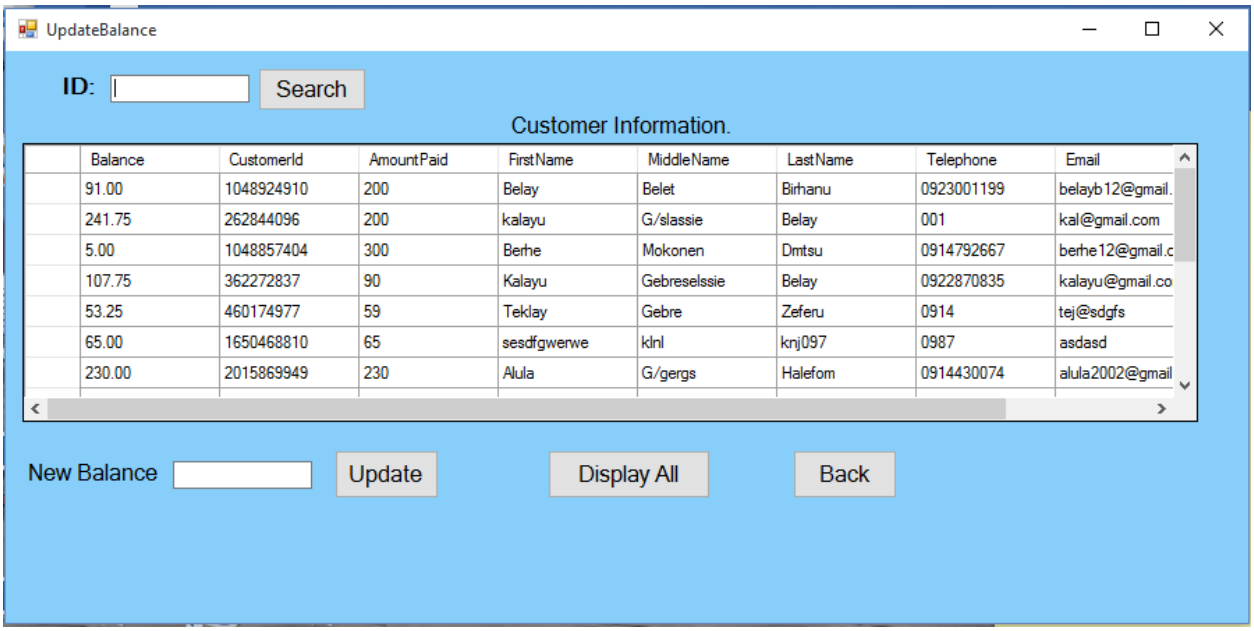


Figure 4-8: Update Balance Form

This form uses to update or recharge the passengers balance.

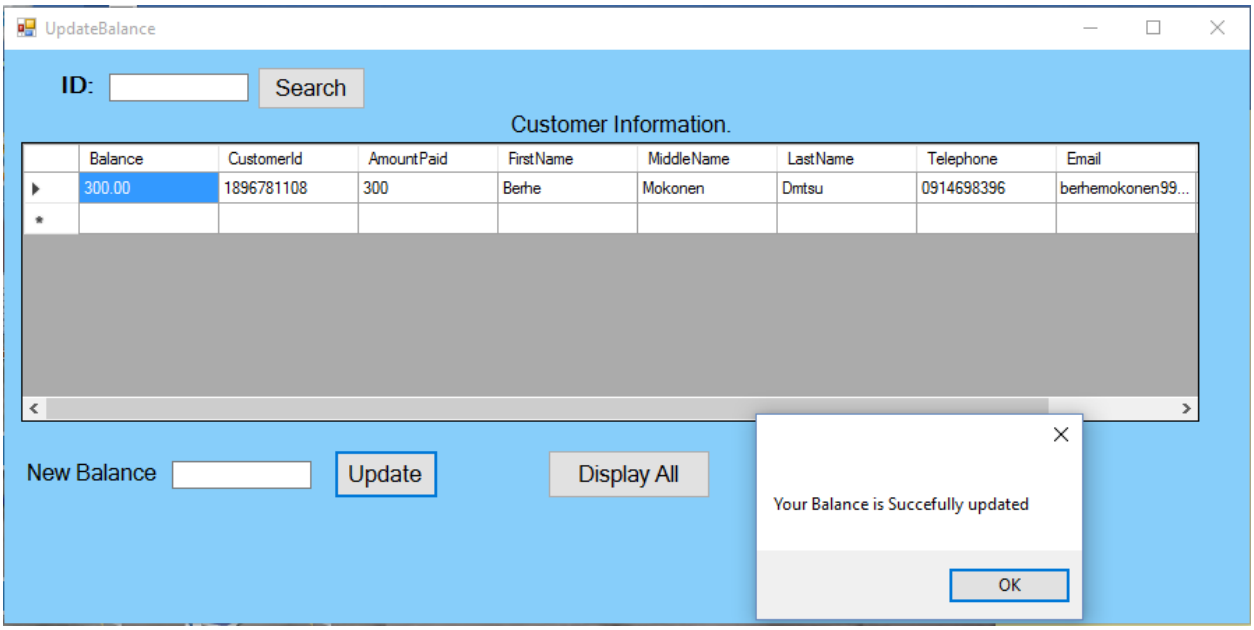


Figure 4-9: View Sample Updated Balance

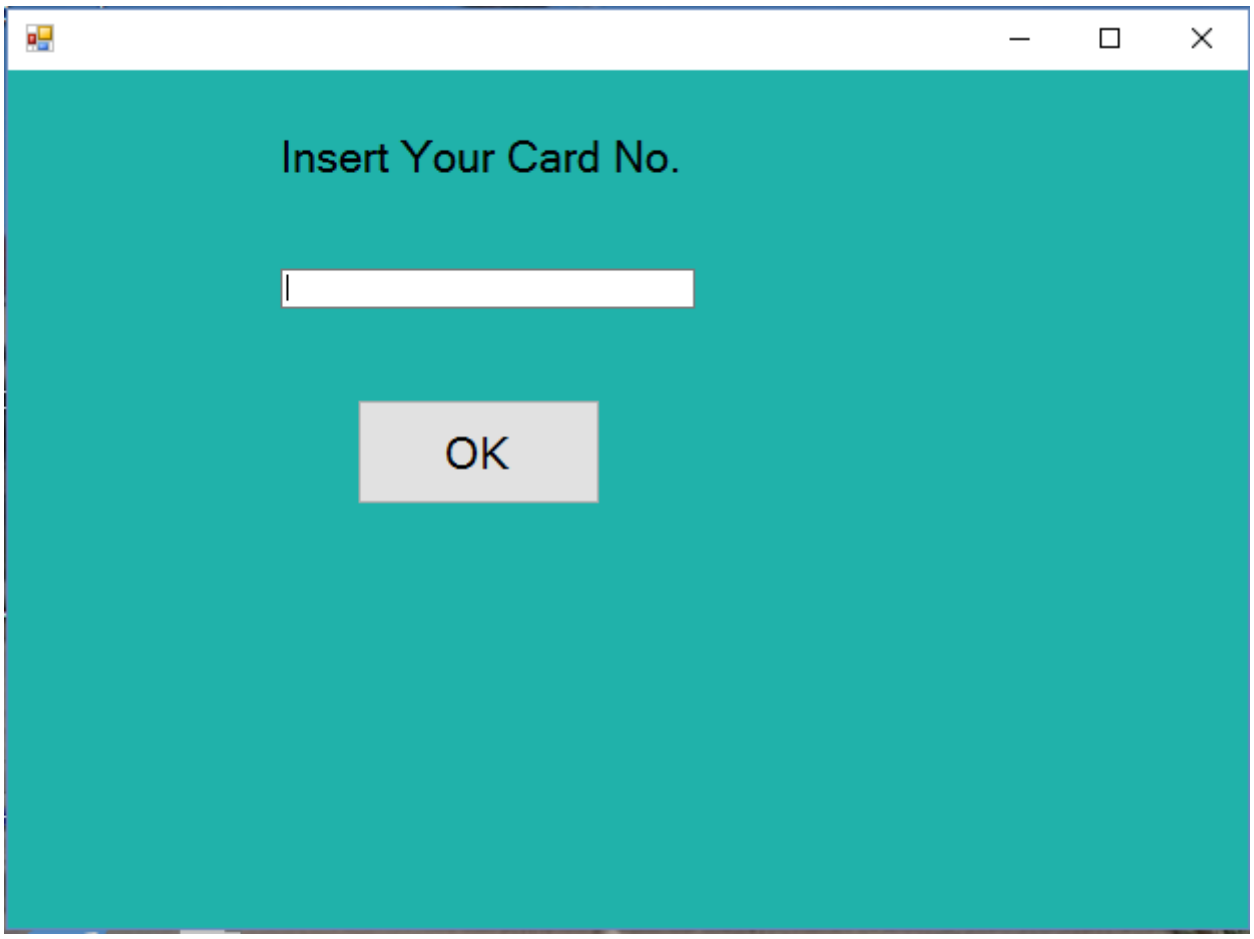


Figure 4-10: Customer ID Receiver from Reader

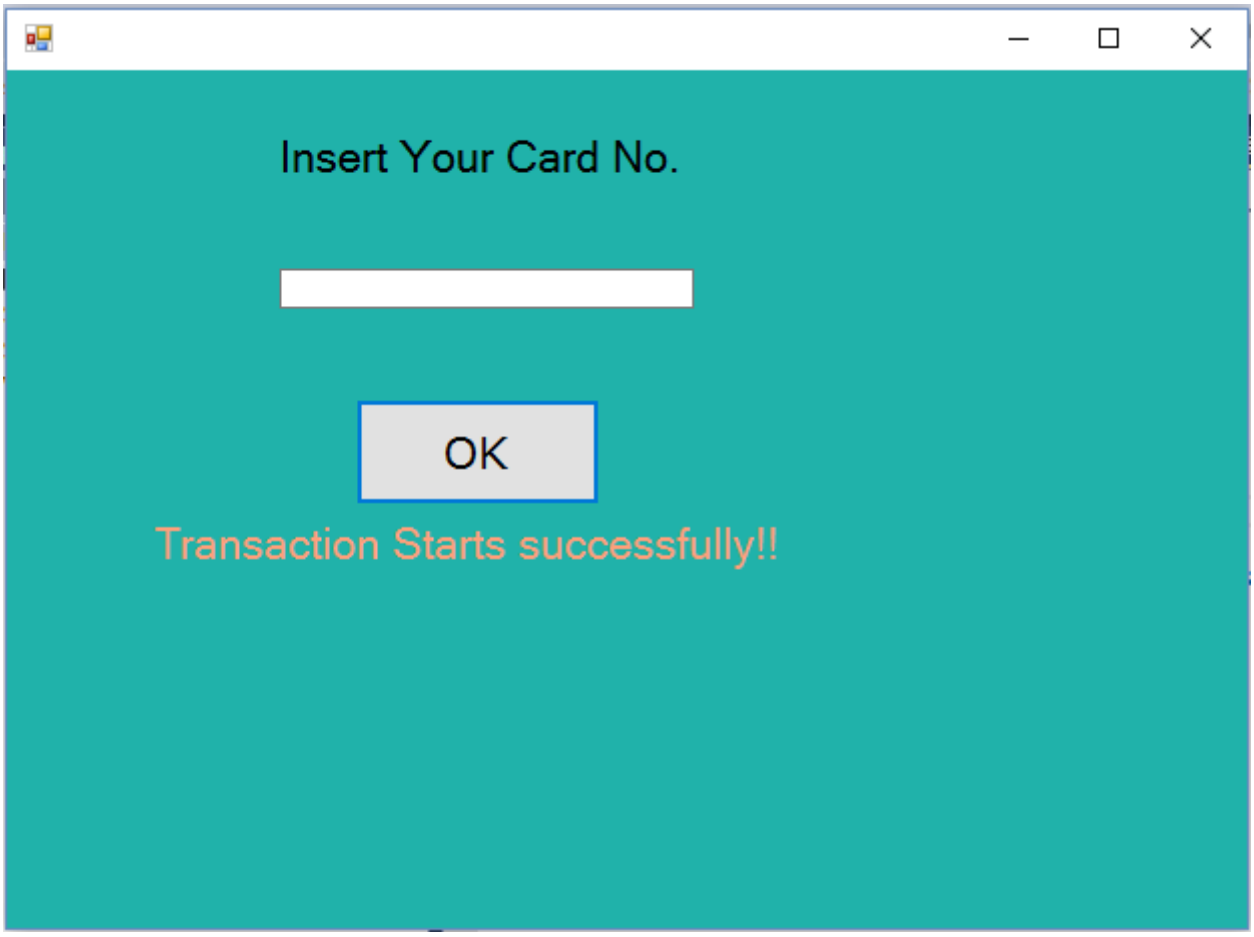


Figure 4-11: Transaction Process Start Station

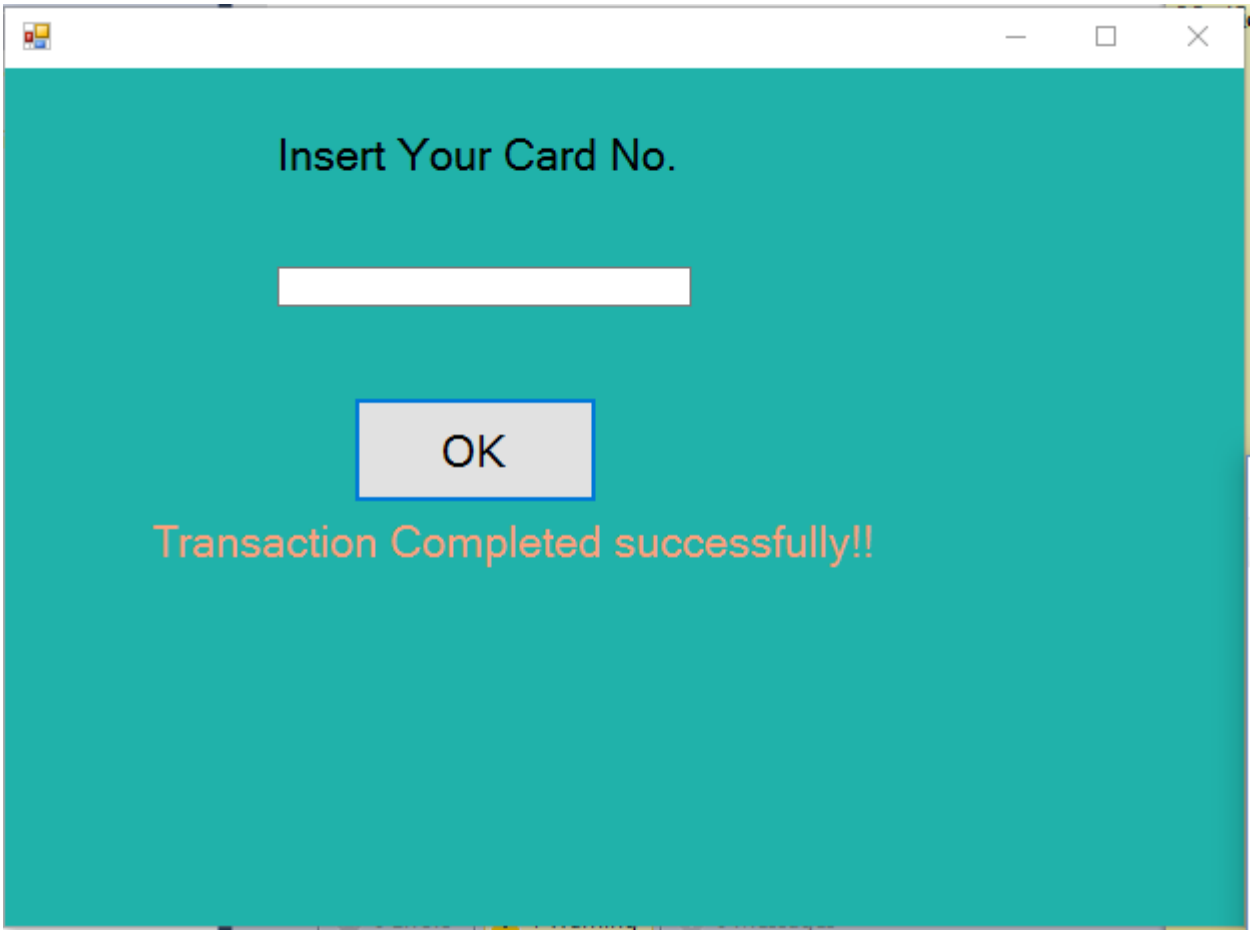


Figure 4-12: Transaction Process at the End of Station

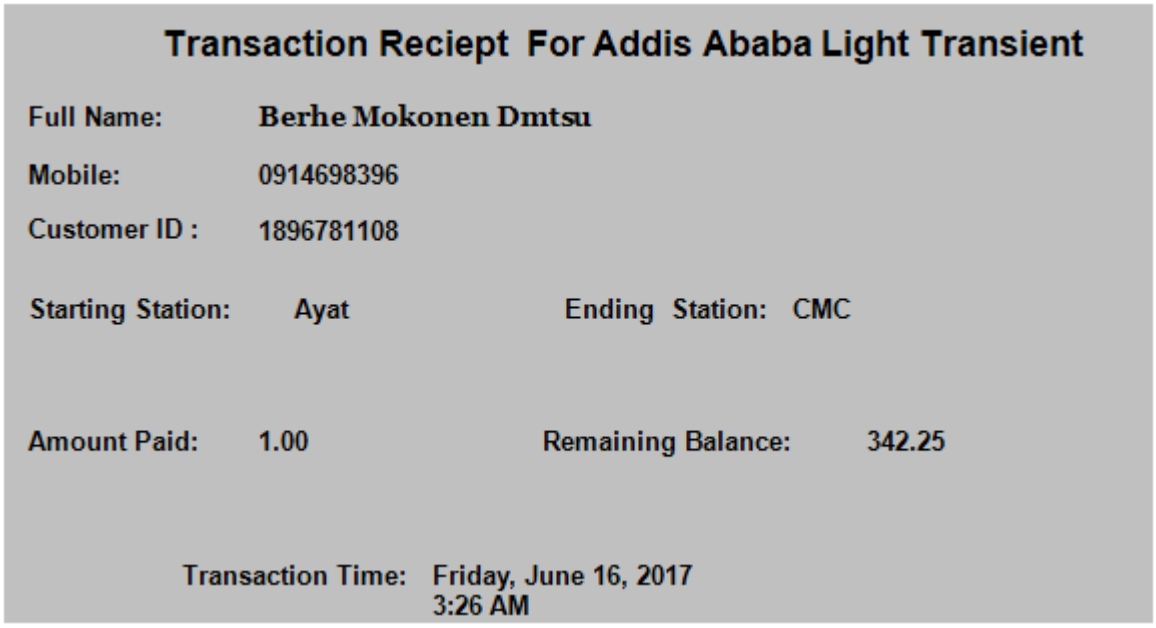


Figure 4-13: Transaction Receipt

Summary of the transaction

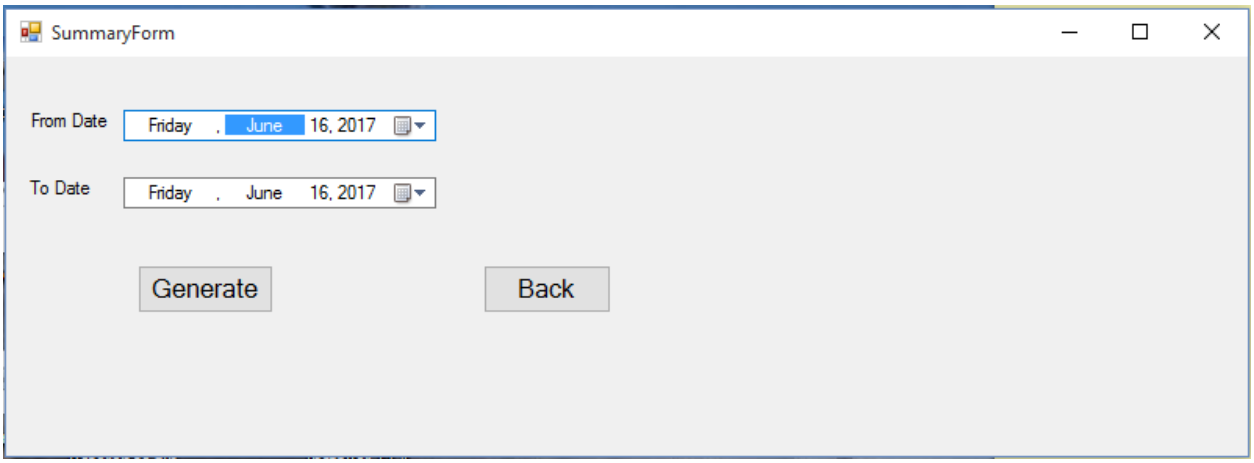


Figure 4-14:Summary

We can generate the report by selecting the date want to know. This is helpful for auditing the transaction and income of AA LRT.

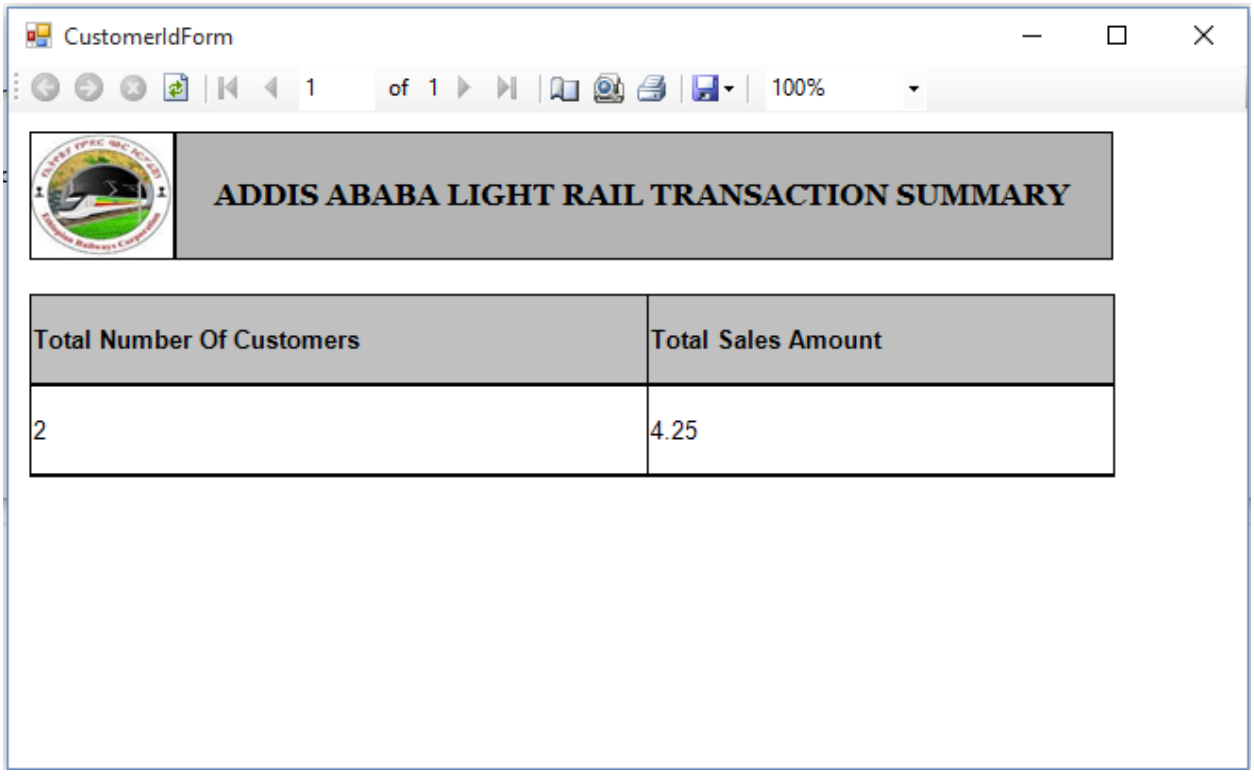


Figure 4-15: Report

This report shows the total number of passengers travelled per day, week, month and year and also total income corresponds.

Chapter Five

5 Conclusions and Recommendations

5.1 Conclusions

This thesis provides an effective and efficient concept for buying tickets using barcode. This thesis covers up various reasons which make do not let us support the existing ticketing system and then design and develop a ticket booking system that is secure, more convenient, unbiased using barcode to sufficiently increase the efficiency of the ticket buying system in transportation. A brief introduction of the whole system includes: - can support online transactions, primarily passengers do not feel any difficulty, reducing the pressure on passenger line flow, effective ticket booking process, secure and safe, will save a lot of time that is wasted in long queues. The information regarding the travel of the passenger will also be transparent and it provides quick and easy ticket buying. This concept can be extended to include all the transportation on land and various other online buy and pay services which will be very efficient and convenient for the customer which can access these different types of services using this single concept.

The system is implemented using visual studio 2013 software with C-Sharpe(C#) programming language, the code and graphical interface is done there and also integrated with the database called SQL server. The fee is automatically reduced according to the distance travelled by the passenger. All the account details and barcode are generated and printed in card form. The card number (barcode) is issued based any proof of the passenger.

5.2 Recommendations for Future Work

Here is list of recommendations to the possible extensions of the works of this thesis work:

- In future enhancement instead of paper card an electronic card should be better to store all the card number (barcode) and balance details using the electronic printer.
- Balance payment in this thesis carried out customers deposed some amount of money to AA LRT bank account. Further works can be extended instead of depositing money to AA LRT bank account it can integrate the customer's bank account to AA LRT account directly.
- The card can be lost or stolen at this time someone can use it, to avoid such problems the system can be extended to notify the customer through SMS on his/her mobile when someone uses the card.
- Other technologies can be integrated with it like finger print.
- The ID card can be prepared to use for family, friends, and others together.
- Finally, Ethiopian Railways Corporation is recommended to test and implement it within short period of time.

Reference

[1] S. Subarnarekha Ghosal, "Android Application for Ticket Booking and Ticket Checking in Suburban Railways".

[2] Paddington, "Study on Public Transport Smartcards," 2011.

[3] Mezghani, "Study on electronic ticketing in public transport".

[4] CHINARAILWAYGROUP, "Addis Ababa E-W & N-S(Phase I) Light Rail Transit Project," Jul 2013.

[5] R. Kumar, "Train Ticketing System using Smart Card".

[6] B. Chandramouli, "How to book a Indian Railways train ticket from your mobile phone," July 10, 2013 – 12:07 pm.

[7] "Wikipedia," 1at 03:46. December 2016. [Online]. Available: https://en.wikipedia.org/wiki/Barcode_reader. [Accessed 2 1 2017].

[8] Saumitra Vatsal, "Universal e-Ticketing System Using Barcode," May 2016.

[9] M. Halvorson, "Microsoft Visual Basic 2010," 2010.

[10] Navathe, "Fundamentals of Database Systems, Third Edition," 2000.

[11] MAHMOD, "STUDENT ATTENDANCE ONLINE SYSTEM USING BAR CODE," NOVEMBER 2005.

[12] M. Kaur, "TYPES OF COMPUTER NETWORKS".

[13] Lili Fan, Xinhua Liu, Jianwen Wang, "An Evaluation of the Operation of the Railway," *iBusiness*, vol. 4, pp. 164-167, 2012.

[14] Garima Sinha , "Ticketing System of Indian Railways through SMS and Swapping Machine," *International Journal of Advanced Research in Computer Science and Software Engineering*, vol. 3, no. 8, pp. 543-548, 2013.

[15] Praveen, Gopal, "E-TICKETING SYSTEM FOR PUBLIC BUS TRANSPORT USING PRE-PAID SMART CARDS," *INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN TECHNOLOGY*, vol. 1, no. 12, pp. 503-507, 2015.

[16] Maike Puhe , "Integrated urban e-ticketing for public transport and touristic sites," January 2014.

[17] K.Lakshmi Sudha, "Barcode based Student Attendance System," *International Journal of Computer Applications (0975 – 8887),* vol. 119, no. 2, pp. 1-4, 2015.

[18] V.VENKATAKRISHNAN, "PUBLIC TRANSPORT TICKETING AND MONITORING," *Journal of Theoretical and Applied Information Technology,* vol. 38, no. 1, pp. 31-34, 2012.

[19] Somnath Sarkar, "Biometric Ticketing System for Railway," *International Journal of Latest Trends in Engineering and Technology (IJLTET),* vol. 4, no. 3, pp. 90-93, 2014.

[20] R.Valarmathi, "Smart Ticketing System in Metro Rail".

[21] S. Mala, "Automated Fare Collection System for PublicTransport Using GPS".

Appendix

Source code

Customer register

```
using System;
using System.Collections.Generic;
using System.ComponentModel;
using System.Data;
using System.Drawing;
using System.Linq;
using System.Text;
using System.Threading.Tasks;
using System.Windows.Forms;
using System.Data.SqlClient;
using System.IO;
using System.Drawing.Imaging;
using AdminAcount.Report;

namespace AdminAcount
{
publicpartialclassRegister : Form
    {
int cId;
public Register()
        {
            InitializeComponent();
        }
SqlConnection reg = newSqlConnection(@"Data
Source=(LocalDB)\v11.0;AttachDbFilename=C:\Users\Teklay\Documents\Visual Studio
2013\Projects\DB\TickettingSytem.mdf;Integrated Security=True;Connect Timeout=30");
//SqlCommand comand = new SqlCommand();
SqlDataReader dataRead;
privatevoid button1_Click(object sender, EventArgs e)
        {
Random r = newRandom();
            cId = r.Next();

if ( textBox1.Text != ""& textBox2.Text != ""& textBox3.Text != ""& textBox4.Text != ""&
textBox5.Text != ""& textBox6.Text != ""& comboBox1.Text != "")
            {
MessageBox.Show(cId.ToString());
String barcode = cId.ToString();
Bitmap bitmap = newBitmap(barcode.Length * 40, 150);
using (Graphics graphics = Graphics.FromImage(bitmap))
                {
Font ofont = new System.Drawing.Font("IDAutomationHC39M", 20);
PointF point = newPointF(2f, 2f);
SolidBrush black = newSolidBrush(Color.Black);
SolidBrush white = newSolidBrush(Color.White);
                    graphics.FillRectangle(white, 0, 0, bitmap.Width, bitmap.Height);
                    graphics.DrawString("*" + barcode + "*", ofont, black, point);
                }
using (MemoryStream ms = newMemoryStream())
```

```
                {
                    bitmap.Save(ms, ImageFormat.Png);
                    pictureBox3.Image = bitmap;
                    pictureBox3.Height = bitmap.Height;
                    pictureBox3.Width = bitmap.Width;
                }
                reg.Open();
SqlDataAdapter sda1 = newSqlDataAdapter(
"insert into
Register(CustomerId,AmountPaid,FirstName,MiddleName,LastName,Telephone,Email,Gender)
Values ('" + cId.ToString() + "','" + textBox1.Text + "','" + textBox2.Text + "','" +
textBox3.Text + "','" + textBox4.Text + "','" + textBox5.Text + "','" + textBox6.Text +
"','" + comboBox1.Text + "')", reg);
                 sda1.SelectCommand.ExecuteNonQuery();

SqlDataAdapter sda2 = newSqlDataAdapter(
"insert into CustomerBalance(CustomerId,Balance) Values ('" + cId.ToString() + "','" +
textBox1.Text + "')", reg);
                 sda2.SelectCommand.ExecuteNonQuery();

                reg.Close();
//
var custCard = newCustomerIdDesign();
var fullName = textBox2.Text + " " + textBox3.Text + " " + textBox4.Text;
                custCard.txtFullName.Value = fullName;
                custCard.txtAddress.Value = textBox6.Text;
                custCard.txtMobile.Value = textBox5.Text;
                custCard.txtIssueDate.Value = DateTime.Now.ToString("D");
                custCard.txtCustId.Value = cId.ToString();
                custCard.barcode1.Value = cId.ToString();
//
var reportForm  = newCustomerIdForm();
                reportForm.reportViewer1.ReportSource = custCard;
                reportForm.Show();
//MessageBox.Show("Data is succefully registerd");
//             //textBox7.Clear();
                textBox1.Clear();
                textBox2.Clear();
                textBox3.Clear();
                textBox4.Clear();
                textBox5.Clear();
                textBox6.Clear();
                comboBox1.SelectedIndex = -1;
            }
        }

privatevoid Register_Load_1(object sender, EventArgs e)
        {
//comand.Connection = reg;
        }

privatevoid button2_Click(object sender, EventArgs e)
        {
this.Hide();
var mainMenu = newMainMenu();
            mainMenu.Show();
        }
```

```
privatevoid Register_Load(object sender, EventArgs e)
        {

// this.reportViewer1.RefreshReport();
        }

privatevoid pictureBox3_Click(object sender, EventArgs e)
        {

        }

    }
}
```

Balance Update

```
using System;
using System.Collections.Generic;
using System.ComponentModel;
using System.Data;
using System.Drawing;
using System.Linq;
using System.Text;
using System.Threading.Tasks;
using System.Windows.Forms;
using System.Data.SqlClient;
namespace AdminAcount
{
publicpartialclassUpdateBalance : Form
    {
public UpdateBalance()
        {
            InitializeComponent();
        }

publicvoid button2_Click(object sender, EventArgs e)
        {
if (textBox1.Text != " ")
            {
SqlConnection con = newSqlConnection(@"Data
Source=(LocalDB)\v11.0;AttachDbFilename=C:\Users\Teklay\Documents\Visual Studio
2013\Projects\DB\TickettingSytem.mdf;Integrated Security=True;Connect Timeout=30");
DataTable dt = newDataTable();
SqlDataAdapter sda = newSqlDataAdapter("Select cs.Balance,r.* From Register as r " +
" INNER JOIN CustomerBalance as cs" +
" on r.CustomerId=cs.CustomerId " +
" Where cs.CustomerId='" + textBox1.Text + "' ", con);
                sda.Fill(dt);
                dataGridView1.DataSource = dt;

            }
else
            {
MessageBox.Show("Please Insert an ID");
            }
        }
```

```
privatevoid button3_Click(object sender, EventArgs e)
        {

SqlConnection con = newSqlConnection(@"Data
Source=(LocalDB)\v11.0;AttachDbFilename=C:\Users\Teklay\Documents\Visual Studio
2013\Projects\DB\TickettingSytem.mdf;Integrated Security=True;Connect Timeout=30");
DataTable dt = newDataTable();
SqlDataAdapter sda = newSqlDataAdapter("Select cs.Balance,r.* From Register as r " +
" INNER JOIN CustomerBalance as cs" +
" on r.CustomerId=cs.CustomerId ", con);
            sda.Fill(dt);
            dataGridView1.DataSource = dt;
        }

privatevoid button1_Click(object sender, EventArgs e)
        {


SqlConnection con = newSqlConnection(@"Data
Source=(LocalDB)\v11.0;AttachDbFilename=C:\Users\Teklay\Documents\Visual Studio
2013\Projects\DB\TickettingSytem.mdf;Integrated Security=True;Connect Timeout=30");
DataTable dt = newDataTable();
SqlDataAdapter sda = newSqlDataAdapter(" Update  CustomerBalance set Balance=Balance+" +
textBox2.Text +
" Where CustomerId='" + textBox1.Text + "' ", con);

            sda.Fill(dt);
            textBox1.Clear();
            textBox2.Clear();
MessageBox.Show("Your Balance is Succefully updated");
        }

privatevoid button2_Click_1(object sender, EventArgs e)
        {
this.Hide();
var mainMenu = newMainMenu();
            mainMenu.Show();
        }
    }
}
```