A Study and Implementation of Fuzzy Cryptographical Techniques Across Distributed Network

THESIS

SUBMITTED TO

BABASAHEB BHIMRAO AMBEDKAR UNIVERSITY

LUCKNOW

BABASAHEB
BHIMRAO
AMBEDKAR
UNIVERSITY

LUCKNOW

प्रज्ञा शील करुणा

ESTABLISHED 1996

FOR THE DEGREE OF

Doctor of Philosophy

IN

COMPUTER SCIENCE

Submitted by

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Enrollment No. – 955/13

Under the Supervision of

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DEPARTMENT OF COMPUTER SCIENCE

SCHOOL FOR INFORMATION SCIENCE & TECHNOLOGY

BABASAHEB BHIMRAO AMBEDKAR UNIVERSITY

(A CENTRAL UNIVERSITY; NAAC- 'A' GRADE)

VIDYA VIHAR, RAEBARELI ROAD, LUCKNOW-226 025 (U.P.), INDIA

2018

Dedicated

to

My Beloved Parents

DECLARATION

I hereby declare that the thesis entitled **"A Study and Implementation of Fuzzy Cryptographical Techniques Across Distributed Network"** has been prepared by me under the supervision of **Prof. Vipin Saxena**, Department of Computer Science, School for Information Science & Technology, Babasaheb Bhimrao Ambedkar University, Lucknow (U.P.).

This work has not been submitted in a part or full to any other University/Institute for any degree/diploma or any other academic award anywhere before. I further declare that I have completed research work for the full time prescribed and that the thesis embodies the results of my investigation conducted during the period I worked as a Ph.D. research scholar. I hereby also declare that the thesis is essentially free from all kinds of plagiarism.

Place: Lucknow

(Rashmi Singh)
Research Scholar

CERTIFICATE

This is to certify that the thesis titled **"A Study and Implementation of Fuzzy Cryptographical Techniques Across Distributed Network"** submitted by **Ms. Rashmi Singh** is an original research work and has not been previously submitted in part or full for the award of any other degree or diploma to this or any other University.

The thesis submitted to Babasaheb Bhimrao Ambedkar University Lucknow satisfies all the requirements as stipulated in the Doctor of Philosophy (Ph.D.) regulations -1999 as amended in 2010 and it is fit for submission and evaluation for the award of the degree of Doctor of Philosophy of the University.

Date: 3/8/18

Supervisor

Head of the Department

ACKNOWLEDGEMENTS

Foremost I would like to "Thank God", who gave me this opportunity to extend my gratitude to all those people who have helped me and guided me throughout my life. I bow my head in complete submission before him for the blessing poured on me.

I consider myself most lucky to work under the guidance of ***Prof. Vipin Saxena, Professor, Department of Computer Science, Babasaheb Bhimrao Ambedkar University, Lucknow*** *(U.P) for his continuous encouragement and invaluable suggestions during this work. I wish to thank him for unflattering trust and constant encouragement, which have been essential to this success.*

I express my heartly and humble thanks to ***Dr. Manoj Kumar, Dr. Narendra Kumar, Dr. Deepa Raj, Dr. Shalini Chandra****, Department of Computer Science, Babasaheb Bhimrao Ambedkar University, Lucknow (U.P) for their support and suggestions.*

I wish to offer my sincere thanks to ***Prof. R. C. Sobti****, Honourable Vice Chancellor of Babasaheb Bhimrao Ambedkar University, Lucknow for providing the computational facilities in the Department of Computer Science.*

My sincere thanks also go out to ***Prof. R. A. Khan****, Head of Department, Department of Computer Science, Babasaheb Bhimrao Ambedkar University, Lucknow for providing all the facilities available to me.*

I also want to acknowledge the ***University Grant Commission****,* ***Government of India*** *for providing me fellowship to pursue the research work.*

I must place on record very special thanks to my batchmates and friends, ***Ms. Snehlata, Ms. Neetu, Ms. Priyanka Chaudhary, Ms. Sonam Gautam, Ms. Ankita Vaish and***

Ms. Manjari Singh *for their charming company, kind co-operation and encouragement throughout my doctoral study.*

I wish to thank to ***Mr. Ankit Pandey*** *for providing all the needful official accessories.*

I shall be failing in my duty if I miss to appreciate the help of my dear parents, brother, sister, niece (Misthi) and friends who left no stone unturned in supporting, helping and providing me each facility during the period of doctoral study. Most importantly, I would like to pay my best regards to my parents for their never ending support.

Finally, my greatest regards to the Almighty for bestowing upon me the courage to face the complexities of life and complete this work successfully.

RASHMI SINGH

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LIST OF ABBREVIATIONS

- Adaptive Network Based Fuzzy Inference System (ANFIS)
- Adaptive Neuro Fuzzy Inference System ($ANFIS_1$)
- Automatic Repeat Request (ARQ)
- Description Logics (DLs)
- Digital Right Management System (DRM)
- Digital Signature Standard (DSS)
- Dynamic Priority (DP)
- Enhanced and Secure RSA Key Generation Scheme (ESRKGS)
- Finite State Machine (FSM)
- First Information Report (FIR)
- Fuzzy Document-Based Information Retrieval Scheme (FDIRS)
- Fuzzy Inference System (FIS)
- Fuzzy Logic Control (FLC)
- Fuzzy Russell's Approximation Method (FRAM)
- Hidden Markov Model (HMM)
- Istanbul Stock Exchange (ISE)
- Local Area Network (LAN)
- Logical Development of Vogel's Approximation Method (LD-VAM)
- Markov Processed (MPs)
- Media Access Control (MAC)
- Metropolitan Area Network (MAN)
- Multi Input-Single Output System (MISO)

- National Bureau of Standards (NBS)
- Network Interface Controller (NIC)
- Object Management Group (OMG)
- Pretty Good Privacy (PGP)
- Radio Frequency Identification (RFID)
- Rivest, Shamir and Adleman (RSA)
- Semantic Relationship Library (SRL)
- Sequential Adaptive Fuzzy Inference System (SAFAI)
- Steganography Pattern Discovery (SPD)
- Unified Modeling Language (UML)
- Unmanned Aerial Vehicles (UAVs)
- Vogel's Approximation Method (VAM)
- Wide Area Network (WAN)

LIST OF PUBLICATIONS

A. INTERNATIONAL JOURNALS

(1) **Rashmi Singh** and Vipin Saxena, "Fuzzy Rule Based Inference System for Implementation of Naval Military Mission", **International Journal of Computer Network and Information Security, (IJCNIS), (ISSN No. 2074-9090),** Vol. 10, No.4, pp. 28-37, 2018.

(2) **Rashmi Singh** and Vipin Saxena, "A New Ranking Based Fuzzy Approach for Fuzzy Transportation Problem", **Computer Modelling & New Technologies, (ISSN No. 1407-5806),** Vol. 21, No. 4, 2017.

(3) **Rashmi Singh** and Vipin Saxena, "A New Data Transfer Approach Through Fuzzy Vogel's Approximation Method", **International Journal of Advanced Research in Computer Science, (ISSN No. 0976-5697),** Vol. 8, No. 3, 2017.

(4) **Rashmi Singh** and Vipin Saxena, "Enhancement of the Level of Security in ATM Using Biometric Techniques" **International Journal of Control Theory and Applications (0974-5572),** Vol. 9, No. 21, pp.267-271, 2016.

(5) Kenam Verma, **Rashmi Singh** and Vipin Saxena, "Security Authorization for MAC Address Under Distributed Environment", **International Journal of Computer Applications, (ISSN No. 0975-8887),** Vol. 131, No.-12, pp. 21-24, 2015.

(6) Narander Kumar, **Rashmi Singh** and Vipin Saxena. "Modeling and Minimization of Cyber Attacks Through Optimization Technique", **International Journal of Computer Applications, (ISSN No. 0975-8887)**, Vol. 99, No.-1, pp. 30-34, 2014.

B. INTERNATIONAL AND NATIONAL CONFERENCES

(7) **Rashmi Singh** and Vipin Saxena, "A Unified Modeling Language Model for Occurrence and Resolving of Cyber Crime", In proceedings of Springer on **Information Systems Design and Intelligent Applications. Advances in Intelligent Systems and Computing, Springer, New Delhi,** Vol. 433, pp. 687-698, 2016.

(8) **Rashmi Singh** and Vipin Saxena "Optimization Techniques for Minimization of losses due to Cyber Attack", **Presented in 3rd Lucknow Science Congress (LUSCON- 2015) on 31st Oct. 2015,** Organised by Babasaheb Bhimrao Ambedkar University, Lucknow UP, INDIA.

(9) **Rashmi Singh** and Vipin Saxena "Implementation of MAC Address Security Technique for the Distributed Computing Network System", **Presented in the International Conference on Modeling and Computing (ICMC-2014)** organized by Babasaheb Bhimrao Ambedkar University, Lucknow UP, INDIA.

(10) **Rashmi Singh** and Vipin Saxena "A Brief Review on the Fuzzy Cryptosystem", **In proceedings of RDA's 18th International Conference on "Sustainable Growth & Innovation In The New Millennium – Frontier Global Issues and Challenges" (IC-SGINM),** Organised by Research Development Association &Research Development Research Foundation, Jaipur, Held on March 26 & 27, 2016.

(11) **Rashmi Singh** and Vipin Saxena, "Enhance The Level of Security in ATM Using Password With Biometrics", Presented in **National Conference on Mathematical Techniques in Engineering and Technology (MTET-2016),** Organised by Babasaheb Bhimrao Ambedkar University, Lucknow, UP, INDIA.

(12) **Rashmi Singh** and Vipin Saxena, "Security Algorithms For the Internet Protocol Addredd Transmitted on Wide Area Network", Presented in **National Conference on Recent Advances in Mathematics and Applications (NCRAMA-2014),** Organised by Babasaheb Bhimrao Ambedkar University, Lucknow, UP, INDIA.

(13) **Rashmi Singh** and Vipin Saxena "Solution of Transportation Problem Using Fuzzy Encryption", **Presented in 4th Lucknow Science Congress (LUSCON- 2017) on 3rd & 4th March 2017,** Organised by Babasaheb Bhimrao Ambedkar University, Lucknow UP, INDIA.

(14) **Rashmi Singh** and Vipin Saxena "Evaluation of Sustainable Transportation System Using Fuzzy Logic", International Conference on Science and Technology for Sustainable Future, **Presented in 1st North India Science Congress (NISC-2018) on 10th & 11th January 2018,** Organised by Babasaheb Bhimrao Ambedkar University, Lucknow UP, INDIA.

C. LIST OF WORKSHOP ATTENDED

(1) Three Week Research Methodology Course, Organized by the Department of Information Technology, Babasaheb Bhimrao Ambedkar University, Lucknow UP, INDIA, from 05th January 2017 to 28th January 2017.

(2) One Week Workshop on Emerging Research Trends in Computer Science (ERTCS-2017), Organized by the Department of Computer Science, Babasaheb Bhimrao Ambedkar University, Lucknow UP, INDIA, During 20th -24th March 2017.

(3) One week Faculty Development Programme on Natural Language Processing (WNLP-2017) sponsored by Dr. A. P. J. Abdul Kalam University, Lucknow, UP, India, Organized by Hindustan College of Science & Technology Mathura, from July 25, 2017 to July 29, 2017.

(4) One week workshop on Current Trends in Cyber Crime and Security (CTC^2S-2018), Sponsored by ISEA- Phase II, Meity, Govt. of India, Organized by Motilal Nehru National Institute of Technology Allahabad, 27^{th} -31^{th}, January 2018.

(5) Two Weeks Training Course on Cyber Security (TCCS-2018), Organized by the Department of Information Technology, Babasaheb Bhimrao Ambedkar University, Lucknow UP, INDIA, during 01^{st} -15^{th} February 2018.

SUMMARY

In routine life of human being and due to E-commerce applications, the usage of internet is very common over worldwide. The rapid growth in electronic transactions has result a great desire for fast and valid user identification as well as authentication. In this aspect, data security is the most critical and important issue for the safety of information through the internet. Network security related issues are now becoming most important because the society is moving towards the digital information age. Network security and cyber crimes are reversible to each other as more users connect to the internet, it attracts a lot of cyber crime. The network information is controlled by the network administrator. The task of network security is not only to secure the end systems but also to provide the security to the entire network.

In the present era, cryptography is used to provide the security of digital data across the distributed network. The purpose of data security is to provide secure data transmission over the unreliable network. Network security involves authentication of access to the data which is controlled by the network administrator. Fuzzy logic and cryptography together provide the security in the field of network security. The key formed by fuzzy logic is in the form of a function which is hard to break. Therefore, content data would be used as an input data for cryptography so that the data become unreadable for the unauthorized users and the data will remain same from them. Network security covers a variety of computer networks, both private and public that is used in routine transactions and communications.

The use of fuzzy logic provides more accurate results as compare to boolean algebra. The applications of fuzzy logic are implemented at every step of fuzzy transportation mechanism which is employed for optimized data flow across the distributed network.

Fuzzy inference system is employed for effective decision making in data distribution process and other applications. Fuzzy logic deals with vague, ambiguous and unclear nature of sophisticated system. Fuzzy logic also provides an alternative to the mechanism of probability, probably which is suitable for software credibility.

In this present study, the concept of network security and cryptography is introduced and discussed the state of art in real life applications using cryprographic applications. We have analyzed few noval and efficient cryptographic security techniques, fuzzy set and fuzzy inference system techniques while facilitating new modified algorithms. The main focus of the present study is to provide cryptographic security in real life applications across distributed networks in such a way that enhance security level can be achieved while providing optimal cost.

This work is also related to propose a model which is based upon the object-oriented technology for occurring of cyber crime across the distributed network. A well known Unified Modeling Language is used and one can easily write the code for implementation of model in any object-oriented programming language. The chapter-wise summary of the present work is given below in brief:

CHAPTER I INTRODUCTION

An approach of cryptography and fuzzy logics is described in the present work. Therefore this chapter deals with the concept of cryptography and tools that are needed for implementing the system. The confidentiality of the files was maintained while providing the access to the trusted user in any organization. By this, the data has been accessed only through authorized person. The confidentiality, availability and integrity of the data were maintained through trusted users but the unauthorized person attacks the security network

like data manipulation, retransmission of data, service malfunction, simulation etc. So, the use of cryptography techniques, fuzzy inference system and fuzzy logic, is to make the process secure and efficient while in some cases maintaining the optimal cost across distributed network.

CHAPTER II REVIEW OF LITRATURE

The present chapter described the review of literature related to fuzzy rule based systems and cryptographical techniques in distributed network. In this specific area, very few works are described therefore the present work is an attempt in the direction of fuzzy cryptographical techniques and fuzzy rule based systems. The relevant literature review on cryptographical techniques and fuzzy rule based systems for various aspects in distributed network are summarized in this chapter. Fuzzy cryptography is very useful technique and the few advantages of fuzzy cryptographic techniques are supply chain management, transportation and software security in distributed networks. All the important research papers, review papers, book chapters and books are described in this chapter in brief.

CHAPTER III FUZZY RULE-BASED INFERENCE SYSTEM

In this chapter, fuzzy rule based inference system was implemented on naval military mission. On a military mission, the choice of changing unit requires complicated judgments like data about the well being status of the hardware and natural conditions. The fuzzy rule based inference system help in the choice about changing a unit to a mission using the methods of fuzzy concepts. A numerical application is also introduced to demonstrate the validity of above said approach. The contents of this chapter have been

published in International journal of Computer Network and Information Security (IJCNIS), Vol.10, No.4, pp. 28-37, 2018.

CHAPTER IV FUZZY DATA TRANSFER APPROACH IN DISTRIBUTED NETWORK

In this chapter, a new data transfer approach using fuzzy Vogel's Approximation Method (VAM) was introduced along with a new ranking based approach for fuzzy transportation problem. The fuzzy VAM gives the optimal solution while taking less number of iterations for fuzzy transportation in comparison to Vogal's Approximation Method (VAM). On the other side a fuzzy ranking based approach was used to solve the fuzzy transportation problem in which the trapezoidal fuzzy numbers were represented the transportation cost, availability and demand of the product. The contents of this chapter have been published in Computer Modelling &New Technologies, Vol. 21, No. 4, 2017, and International Journal of Advance Research in Computer Science, Vol. 8, No. 3, 2017.

CHAPTER V CRYPTOGRAPHIC SECURITY FOR MAC ADDRESS IN DISTRIBUTED ENVIRONMENT

In this chapter, an approach for secure transfer of information along with MAC address is depicted with well known algorithm Rivast, Shamir and Adleman (RSA). In this study, the algorithm is tested on various MAC address through object oriented JAVA programming language. UML approach was also introduced for the making of cryptosystem model. The contents of this chapter have been published in International journal of Computer Applications Vol. 131, No. 12, 2015.

CHAPTER VI A UML MODEL FOR OCCURRENCE AND RESOLVING OF CYBER CRIME

In this chapter, the model is proposed which is based upon the object oriented technology for occurring and resolving the cyber crime approach through Unified Modeling Language (UML) across distributed network. UML is used for this purpose by which one can easily write the code for implementation of this model in any object oriented programming language. The contents of this chapter have been published in Information Systems Design and Intelligent Systems and Computing, Vol. 433, Springer proceedings, 2016.

CHAPTER VII MINIMIZATION OF CYBER ATTACKS THROUGH OPTIMIZATION TECHNIQUES

In this chapter, a technique was presented which enumerates the minimization of cyber crime through optimization technique. An algorithm named Hungarian technique with state transition deterministic finite automation is used and different test cases were provided for the evaluation and validation of the results using UML. The contents of this chapter have been published in International journal of Computer Applications, USA, Vol. 99, No.1, 2014.

CHAPTER VIII CONCLUSIONS AND FUTURE SCOPE

This thesis includes data related to fuzzy cryptography in distributed network. Fuzzy logic and UML were also used. This work has been done for transportation problem, naval military system, MAC address security in data transfer, minimize the cyber crime and in future this work can be implemented for real life applications such as biometric based cryptographic security, supply chain management, communication, E-commerce applications, etc. In future by implementing other cryptographic techniques we can secure

the data across the distributed network. The above work can be further extended in the field of data mining, where the huge amount of database of different kinds is available on the system.

Chapter I
Introduction

CHAPTER I

INTRODUCTION

1.1 MOTIVATION OF PRESENT RESEARCH

In the present era, human beings living in the information span, we have to keep knowledge about everything in our lives. In other words, information play equal and prominent role in our lives like any other assets, so that we have to secure the information from all types of attacks. For the purpose of securing the information, it needs to be hidden from unauthorized access, it should be protected from unauthorized change and the information should be easily accessible to the authorized entity when it is required.

In past time, the information was collected through the organization and stored in the physical files. The confidentiality of the files was maintained by providing the access to the authorized and trusted person in the organization. In that context, only a few authorized people have to access the change of the content of the file. Availability of the information was achieved by one or two people who designated for retrieving the information at any time. Now a days, computers are used for the storage of information as they are the electronic device. The advantage of using the computer is that the information is directly stored into the hard disks and no separate physical device is needed for the storage of information. However, the security levels like confidentiality, availability, and integrity did not change in computers but the implementation and requirement of these parameters are different and challenging. The usage of computer networks created a revolution from last two decades and the information is now distributed. With the help of computer networks, the authorized person can send or retrieve the information from anywhere anytime and the confidentiality, availability, and integrity of the data have not changed but they have some limitations of various types of

security attacks on data over network like data manipulation, retransmission of data, service malfunction, simulation etc. The information, as well as the security levels, should be maintained while transferring the information over network.

The aim of the present study is to brought down security threats, instate security goals and confer secure data transmission over distributed network by using various cryptographic techniques. Let us briefly explain all the fundamentals used in the present work.

1.2 SECURITY GOALS

There are three major goals of information security which are shown in the figure 1.1 and described below briefly:

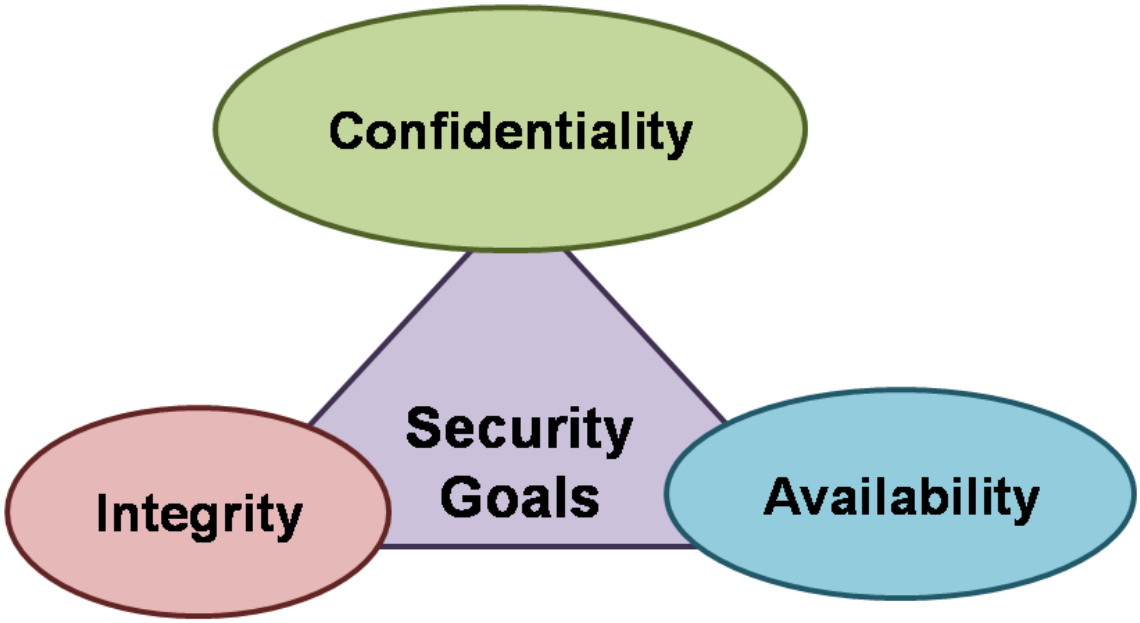

Figure 1.1 Security Goals

- **Confidentiality**

  In information security, Confidentiality is reasonably the most common aspect. Everyone needs to protect their confidential information. Confidentiality not only

enacted to the storage of the information but also applies to the transmission of information [65].

- **Integrity**

  Information needs to be alteration regularly. Integrity defines that alteration needs to be performed only by an authorized individual using the authorized procedure.

- **Availability**

  Information generated and stored by an organization needs to be available to the authorized entities. There is no use of information if it is not available. Information needs to be changed regularly which means it must be accessible to the authorized entities. For an organization, it creates lack of confidentiality or integrity if it is unavailable [28].

1.3 SECURITY SERVICES AND MECHANISMS

1.3.1 Security Services

Security services ensure the substantial security of data transfer and systems. Security services proposed to prevent security attacks. Security services employ security policies and are employed by security mechanisms [99]. Security services may have more than one security mechanisms. X.800 categories these services into five types, which are data confidentiality, data integrity, authentication, non-repudiation and access control represented in figure 1.2.

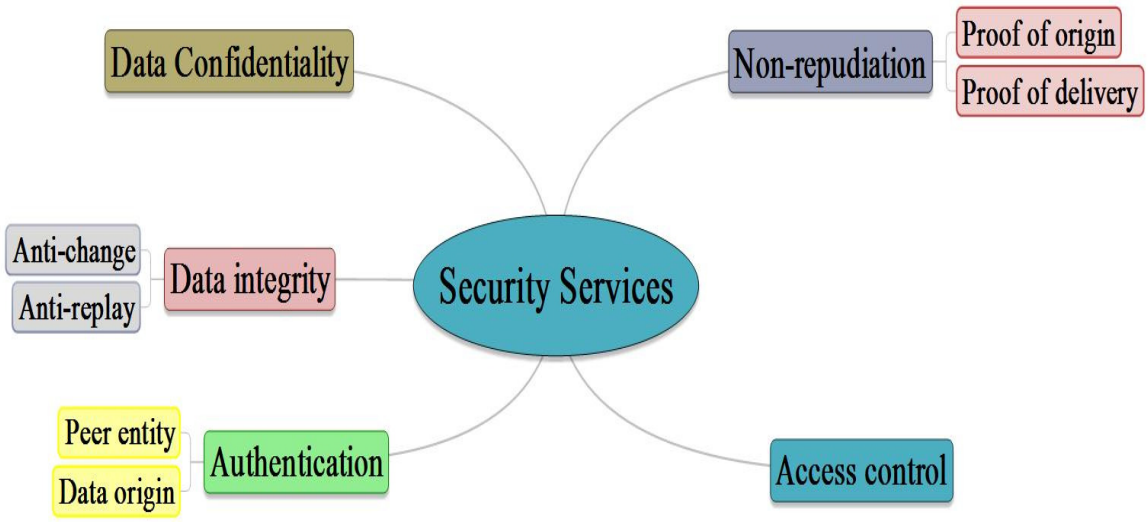

Figure 1.2 Security Services

1.3.2 Security Mechanisms

Security mechanism is a salient feature originates to detect, recover, or to prevent from various security attacks [28]. Security mechanism is further categorized in reversible encipherment which permits subsequent encryption and decryption of data and irreversible encipherment which uses hash algorithm and message authentication as represented in the figure 1.3.

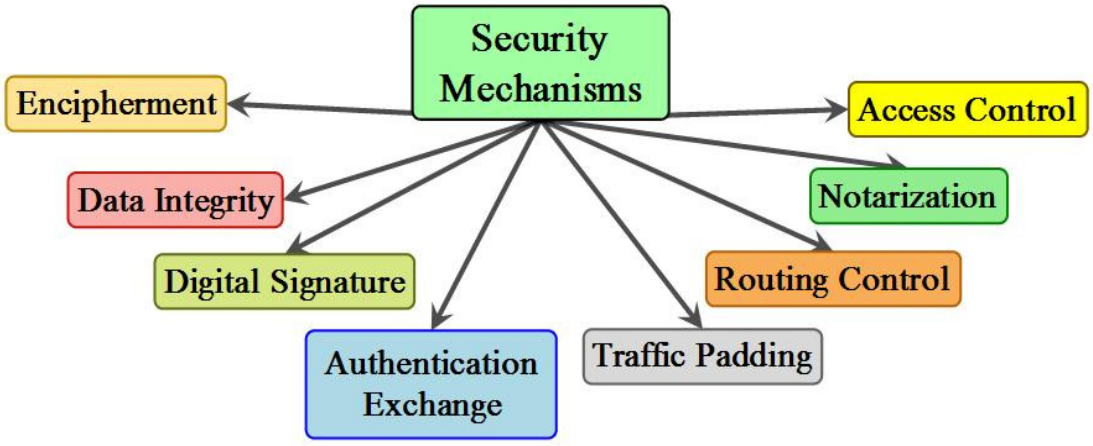

Figure 1.3 Security Mechanisms

1.4 INTRODUCTION TO CRYPTOGRAPHY

Information security is a major concern during effective data transfer across the network. In the present research, cryptography is employed to achieve various security goals during the flow of information across the distributed network and makes data secure from all type of security attacks during all the stages of transmission.

Cryptography is a secret writing which is used in the ancient art. The cryptography was used in writing dates back to 1900 b. c. Some authors said that cryptography was simultaneously invented with its applications ranging from diplomatic missives to war time battle plans [119]. After that, the new form of cryptography is widespread in computer communications. Cryptography is important in the field of data and telecommunications where the communication is going through with an untrusted medium i.e. internet. Cryptography is used for secure communication in the presence of malicious third party which is known as adversaries. The major component of cryptography is encryption which used an algorithm and key to transform the input plain data into an encrypted cipher output. If the same key is used for the given algorithm then the same plain text is transformed into the same cipher text. The algorithm is considered as safe if the attacker cannot identify the properties of plain text or key given by cipher text [121]. An attacker is unaware about the key which is given for a large number of plain text/cipher text combinations which are used by the key. Cipher text is an art in which the information is protected and converted into the unreadable format. The information is only readable by the person who has the secret key and converted into plain text. Encrypted messages can be broken and this process is known as cryptanalysis whereas the modern cryptography techniques are unbreakable. Cryptography is generally

used to secure emails, credit/debit card information and corporate data. The most popular cryptography system is Pretty Good Privacy (PGP) as it is effective and free. Cryptography system can be divided into symmetric key systems and public key systems [120]. In symmetric key system, single key is used for both sender and recipient, whereas in public key system two keys are used one for public and another for private. The basics of cryptography are defined below in brief:

1.4.1 Primary Functions of Cryptography

The primary functions of cryptography are explained below in brief:

- **Confidentiality:** The information cannot be comprehended by anybody for whom it was unintended.
- **Integrity:** The information cannot be modified in storage or transit amongst sender and intended receiver without the modification being distinguished.
- **Non-repudiation:** The originator/sender of the information cannot deny at a later stage with his or her aims in the creation or transmission of the information.
- **Authentication:** The sender and receiver can affirm each other's identity and the source/destination of the information.
- **Key exchange:** The procedure by which crypto keys are distributed between sender and receiver.

1.4.2 Terminologies Used in Cryptography

- **Plaintext:** The original message or data that is provided by the algorithm as input is known as plaintext.

- **Encryption algorithm**: The encryption algorithm is the algorithm that performs different substitutions and transformations on the plaintext. Encryption is the process of converting plaintext into cipher text.

- **Cipher text:** Cipher text is the encrypted type of the message. It is the scrambled message generated as output. It relies upon the plain text and the key.

- **Decryption algorithm:** The process of changing cipher text into plain text is known as decryption. Decryption algorithm is basically the reverse of the encryption algorithm. To generate the original plain text it uses the cipher text and the key.

- **Key**: It also acts as input to the encryption algorithm. The exact substitutions and transformations performed by the algorithm rely upon the key. Thus a key is a number or a collection of a number that the algorithm uses to perform encryption and decryption.

1.4.3 Types of Cryptography

1.4.3.1 Secret Key Cryptography

Secret key cryptography method uses a single key for both encryption and decryption. As shown in figure1.4, the sender uses the key to encrypt the plain text and sends the cipher text to the receiver [50]. The receiver applies the same key to decrypt the message and obtains again the plain text. While using a single key for both functions, secret key cryptography is also known as symmetric encryption.

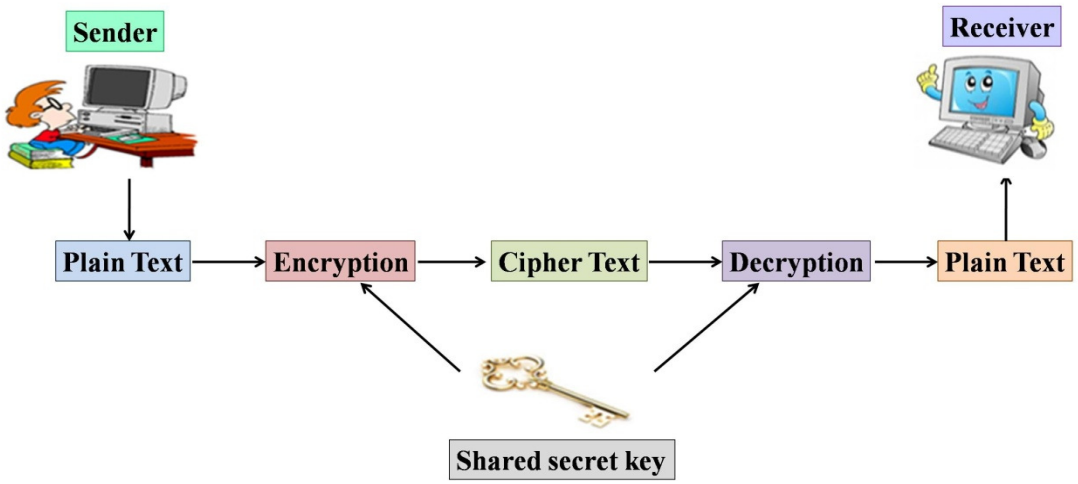

Figure 1.4 Secret Key Cryptography

1.4.3.2 Public Key Cryptography

In this, one of the key is assigned the public key and may be promoted as widely as the owner wants. The other key is assigned as a private key and is never disclosed to another party. It is straightforward to send messages under this plan [86]. Because a pair of a key is needed, this approach is also known as asymmetric cryptography and represented below in figure 1.5.

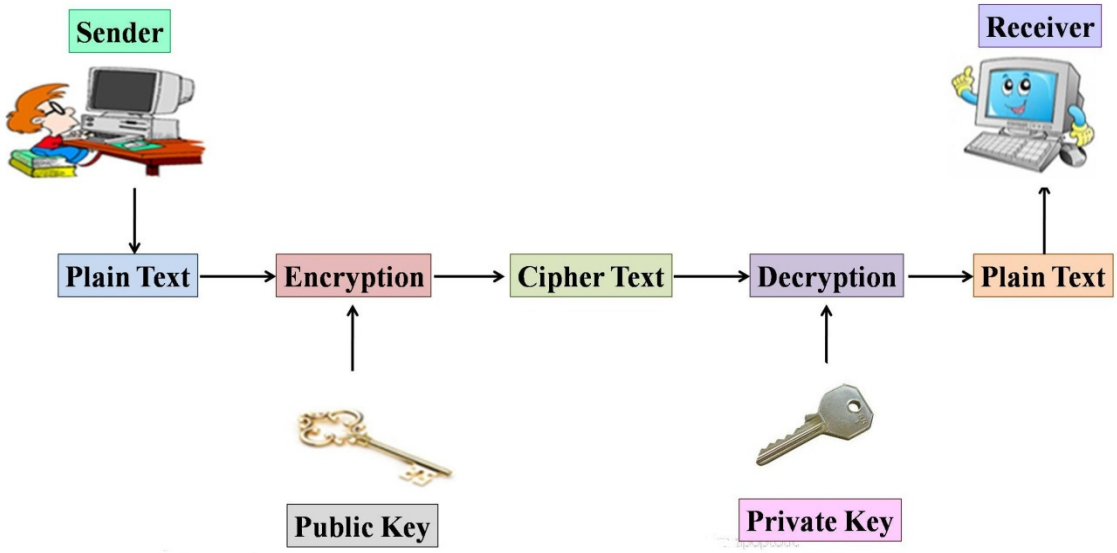

Figure 1.5 Public Key Cryptography

1.5 HASH FUNCTIONS

Hash functions as shown in figure 1.6 are algorithms that are also known as message digests and unidirectional encryption, which essentially use no key. Preferably, a fixed-length hash value is evaluated as concern the plain text that makes it impossible for either the contents or length of the plain text to be recovered. Hash functions also are unremarkably put into practice by various operative systems for password encryption. Hash functions are generally employed to implement digital fingerprint in files frequently used to ascertain that the content of the file has not been modified by virus or an intruder [50]. Hash functions, then, endow a mechanism to make sure the integrity of a file. The basic of hash functions are described below in brief:

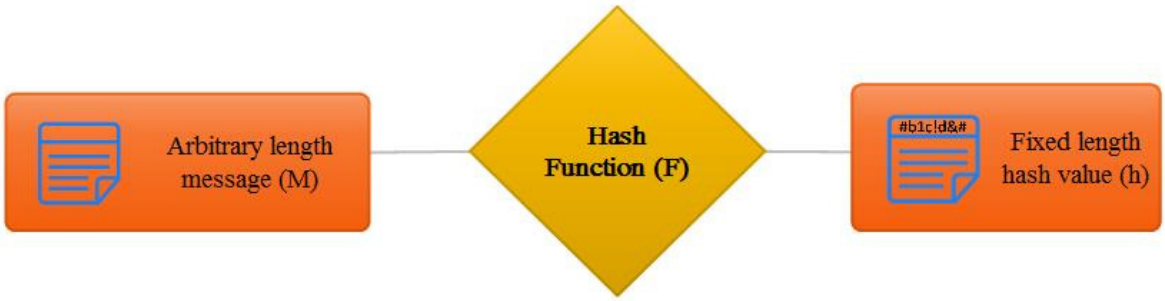

Figure 1.6 Representation of Hash Function

1.5.1 Features of Hash Functions

The essential features of hash functions are as follows:

1.5.1.1 Definite Length Output (Hash Value)

- Normally, hash functions are quite succinct than input data; due to this hash functions are also known as compression functions;

- Hash function transforms arbitrary length data into a definite length. This process is known as **hashing the data**;
- A hash is a smaller illustration of a larger data that's why it is also known as a **digest**;

1.5.1.2 Adequacy of Operation

- Practically hash functions are substantially quicker than a symmetric encryption;
- Normally for any hash function F with input p, reckoning of F(p) is a fast operation;

1.6 CRYPTOGRAPHIC SECURITY IN DISTRIBUTED NETWORK

A distributed network as shown in figure 1.7 is accumulated by various discrete computer systems that seem like a single coherent system to its user. A distributed network is needed for the likelihood of various services, information sharing, to improve the credibility of the whole system by adding various components as per the need, error permissiveness and throughput enhancement of the overall system. From this elucidation, it appears that distributed networks have some important aspects. The prime aspect is that a distributed network is the combination of various computing devices that are efficient to work as an individual system. A computing device is commonly denoted by a node that can be a software/hardware which is able to perform own task independently and the other aspect is that a distributed network presents itself as a coherent single system to its user. Components of the distributed network are concurrent in nature. A distributed network offers real-time sharing of resources. A distributed network can have various nodes but all are independent in nature [46]. The features of distributed network are described below in brief:

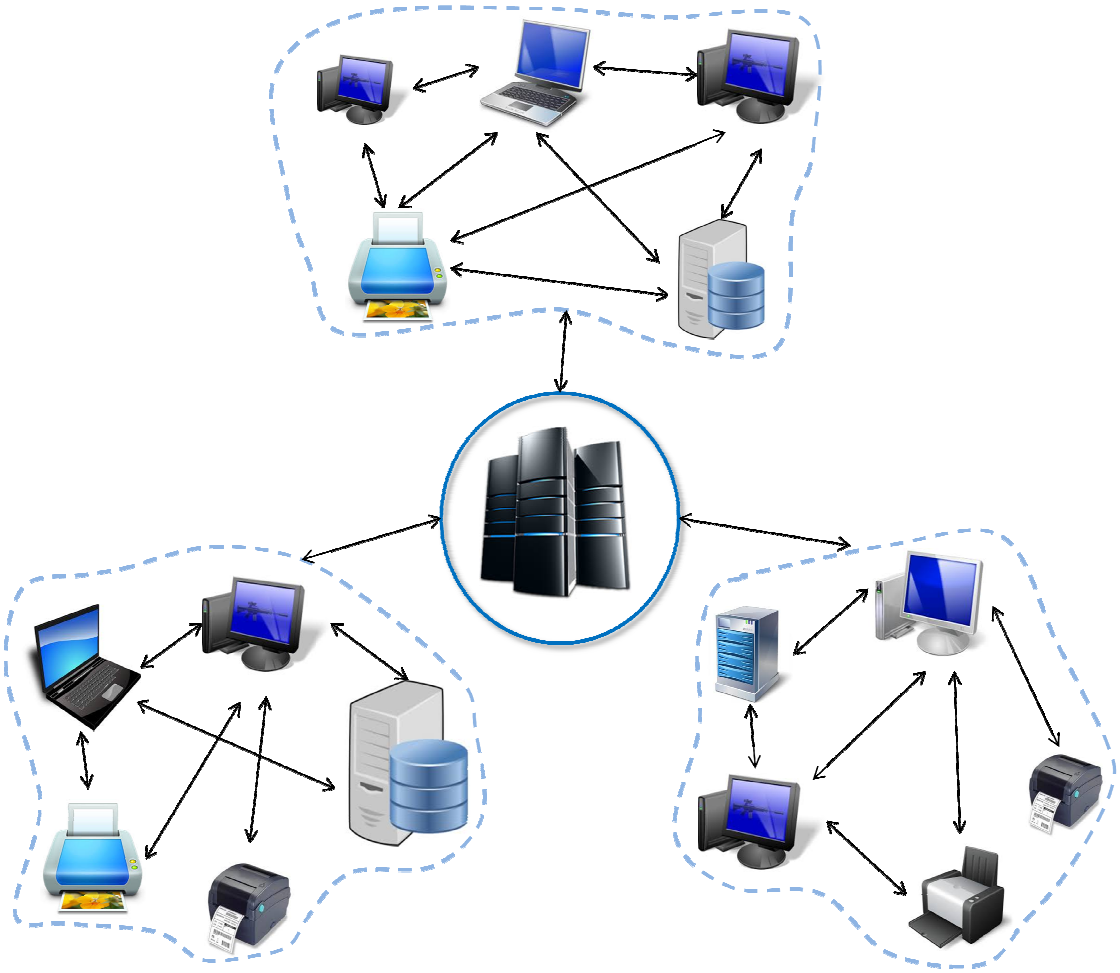

Figure 1.7 A Distributed Network

- **Group of independent computing devices**

A basic aspect is that each and every node of a distributed system performs autonomously. In a distributed network, all the nodes work together exclusive to accomplish a common goal by interacting with each other via message passing system;

- **Coherent system**

A distributed system represents itself as a single independent system to its user. In particular, we can say that in a single independent system all the nodes together work to accomplish the same goal, without any concern how interaction takes places among them;

1.6.1 Distributed Security

Security is a major task in a distributed network, mainly in public networks [103]. Whenever there is a discussion about distributed network, then the first thing that comes to mind is, "security". Network security mainly incorporates with two things that are authentication and access control [122]. Authentication means validation of a permeable user and the other one is access control which endeavors to intercept unauthorized manipulation with data and resources of the network.

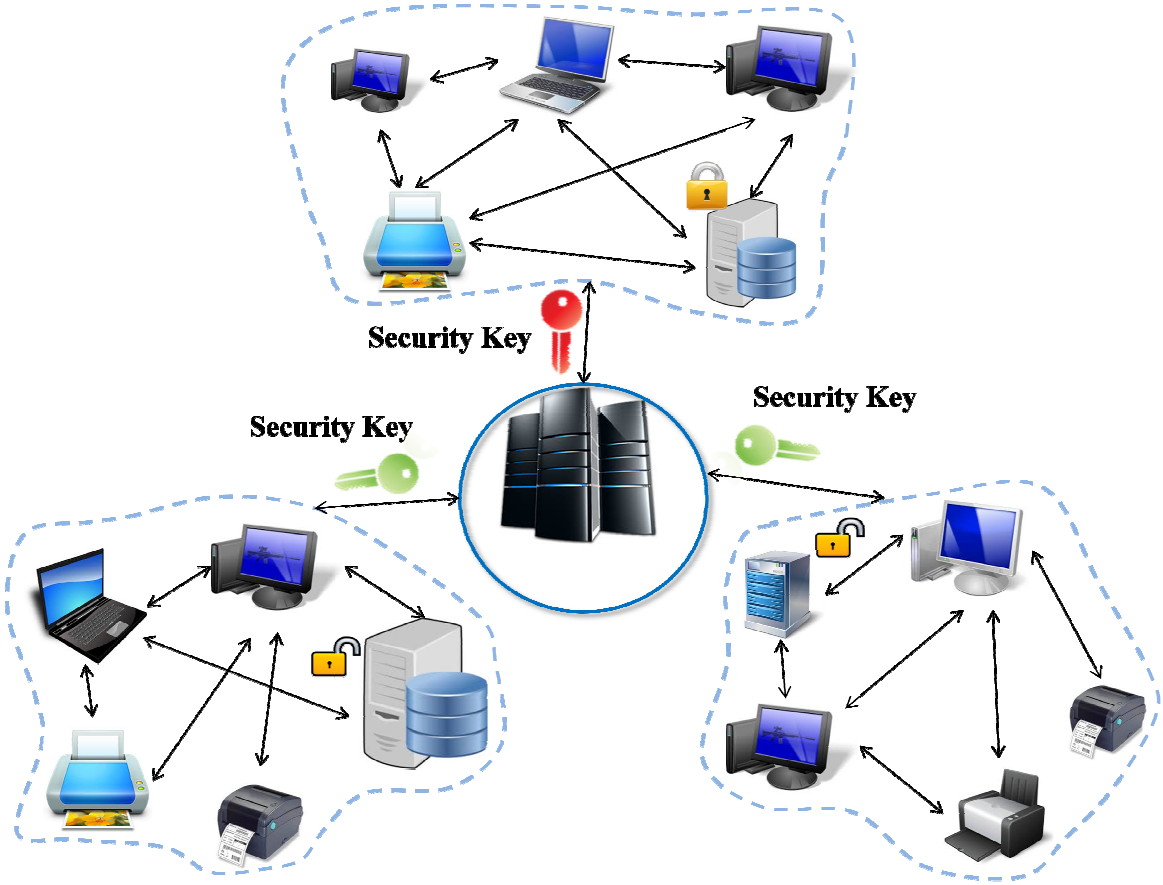

Figure 1.8 Security in Distributed Network

Distributed network security as shown in figure 1.8 is an emerging research domain, there is a need to understand the various security problems and implement the crucial

mechanism to overcome these security problems effectively. In distributed network communication, such hardware security practices cannot be employed. Instead of hardware security, here cryptographic techniques are used for any type of system security [100]. Now we have to understand the type of security risks in a distributed network, then understanding the various cryptographic encryption mechanisms to overcome these security risks effectively. Basically, cryptographic security uses an encryption key to secure data and secure distribution of keys to its recipient [123].

1.6.2 Type of Security Risks

There are various security attacks as shown in figure 1.9. The two important security attacks are described below in brief.

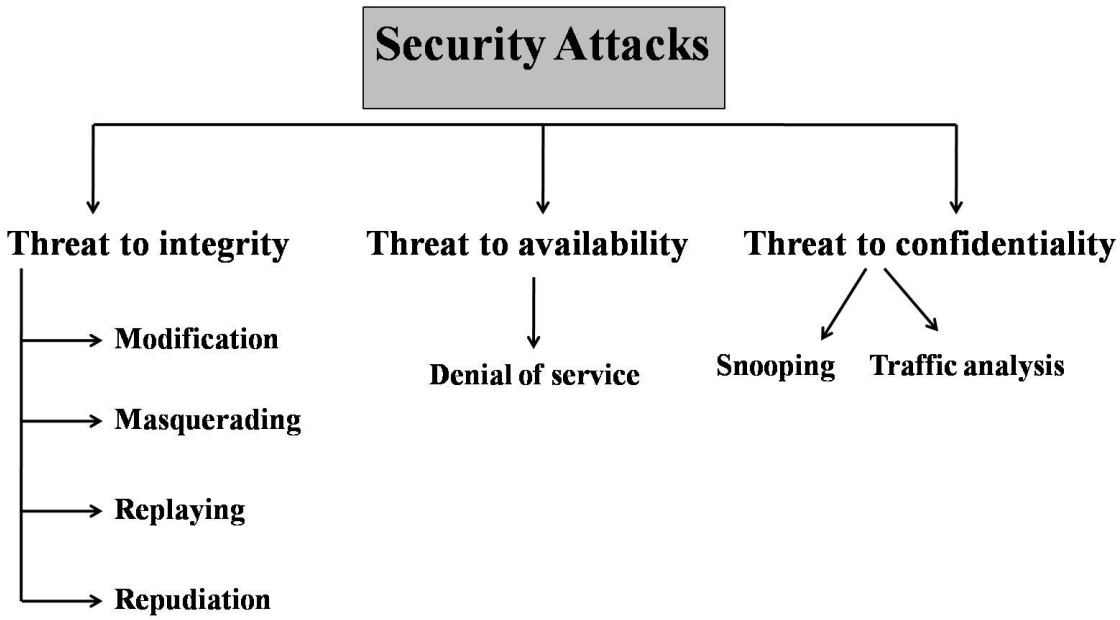

Figure 1.9 Security Attacks

1.6.2.1 Passive Attacks

A passive attack incorporates the surveillance of watch over the ongoing communication

in the network. This type of security attacks stealing the information from the system without affecting the data and network resources [101]. In this, the objective of the rival is to steal the information from ongoing data transmission. Passive attacks are the bit easier in a shared network.

1.6.2.2 Active Attacks

An active attack tries to alter data, affect system resources and their working. It incorporates the manipulation of data streams over the transmission. There are various types of active attacks like Service malfunction, data manipulation, retransmission of data, simulation.

1.6.3 Cryptographic Mechanism

Generally, everyone needs a secure data transmission over the distributed network. To fulfill these aspects, there is an effective mechanism that can transmit data over distributed network safely by using cryptographic mechanism [28]. A cryptographic mechanism for data security in the distributed network is a way of transmitting data over a distributed network in an encrypted form so that only concerned person is able to understand it by decrypting the data with associated key and data remains secure from unauthorized access. The term encryption is referred to scrambling the data or plain text i.e. normal text into cipher text i.e. known as encrypted text and another term decryption is termed as the conversion of cipher text back to plain text via decryption algorithm so that it can be understood by the concerned recipient. Encryption incorporates the encoding of data via an encrypting key in such a way that security threats cannot access the data. This encoded data is termed as cipher text. There are basically two types of cryptographic mechanism are available to achieve secure transmission over a distributed

network. First one is secret key (or symmetric) cryptography, second one is public-key (or asymmetric) cryptography. These are described below in brief:

1.6.3.1 Symmetric Encryption

In symmetric encryption, the encryption process is implemented by using a single key for both encryption and decryption [50]. This encryption process is also known as secret key encryption or conventional encryption.

$$E(p, k) = C \ \& \ D(C, k) = p \tag{1.1}$$

where,

p = plain text

C = cipher text

E = encryption method

k = The key

D = decryption method

1.6.3.2 Asymmetric Encryption

In asymmetric encryption, the encryption process is accomplished by implementing two different keys i.e. public and private key. Here one key is required for encryption process and the other one is required for decryption process.

1.6.4 Authentication

Firstly authenticate all the concerned nodes of the network so that only concerned nodes make use of resources of the network. This process required various steps to implement secure authentication in a distributed network. The first step is verifying that a user is authenticated or not. Basically, there are three methods for performing this authentication

process. Firstly, identify a user by a commonly known method i.e. password verification, but this process does not provide more security. Another one is key base verification; in this, a user authentication is dependent on the key and the last one is biometric verification, in this the identity of a user is verified by the retina of eyes, DNA, fingerprint etc; this is the most costly method among all. These methods are also sufficient for providing authentication in centralized network systems [99]. A common practice to all these anxiety is implanting a certificate management system. A certificate is an authenticated packet of a digitally generated document which is required to use network resources frequently and conveniently. A certification is also continuously time-valid in nature which means it hampers itself to be used again. This can be done by the use of timestamp or any random unique value i.e. nonce value, for each data transmission over a distributed network [81]. Therefore it guarantees that each and every certificate is unique in nature and there is no repetition of a certificate.

List of the certificates is dependent on public-key cryptography. A certificate contains the identity of the users and this identity can reside in a certificate list. Now the authentication process came into action and verifies the identity and public key of the user. After user verification process, the authentications of certificates are done via digital signatures.

There are three types of authentications are as follows:

1.6.4.1 One-Way Authentication

In one-way authentication process, the integrity and protects the originality and integrity of the transmitted message. Here the only receipt of the message is authenticated that's

why it is known as one way authentication [102].

1.6.4.2 Two-Way Authentication

In the two-way authentication process, both the sender and receiver authenticate each other for the transmitted messages. Here a receiver also sends an acknowledgment to the receiver that contains new and a previous nonce.

1.6.4.3 Three-Way Authentication

Three-way authentication is implemented when both the sender and receiver do not have synchronized clocks or do not depend on the clock. Here a sender again sends an acknowledgment to the receiver for the acknowledgment of the receiver that contains a new nonce.

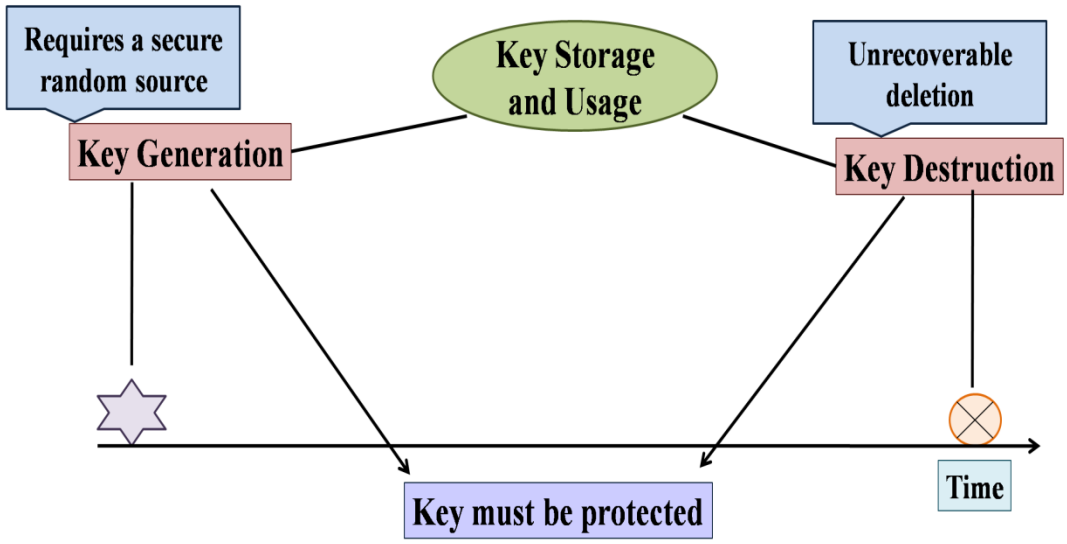

Figure 1.10 Key Distribution

1.6.5 Key Distribution

Key Distribution as shown in figure 1.10 is a process of transmitting keys to concerned peers in a distributed network. This is a very crucial process in cryptographic security for

secure data transmission over a distributed network. Keys are basically used for traditional encryption. Exchange of keys should be frequent for secure and fast transmission. For more continuous the keys will be transmitted, the more data will be safe. Key distribution is the strength of cryptographic mechanism. Mostly, a secure transmission fails due to the breach of key distribution mechanism.

1.7 INTRODUCTION TO FUZZY LOGIC

Fuzzy Logic is the core module of this research. The application of fuzzy logic is wide in this research even at every phase of the research like fuzzy transportation mechanism is employed for optimized data flow across the distributed network, fuzzy inference system (FIS) is employed for effective decision making in data distribution process and many more other applications.

Fuzzy logic concept is very simple and easy for the ill-defined to defecate as frivolous. Fuzzy logic is logic of boolean algebra discovered by Lotfi A. Zadeh [124]. Fuzzy logic is different from boolean algebra in such a way that it provides the result more accurate than the simple yes/no or on/off. Boolean algebra deals with 1 and 0 means one true and false whereas fuzzy logic provides all the possibilities that comes in between exact true and false. Fuzzy logic is very helpful for the real world events because it deals with the possibilities or probabilities of the events to be occur. We can also say that fuzzy logic is a generalization of the simple boolean set [125]. Fuzzy logic is comprehensively easy to understand. The mathematical logic of fuzzy is very clear and simple in nature. It can also be blended with traditional command mechanism. Fuzzy logic doesn't supersede the traditional mechanism instead fuzzy logic amplifies those mechanisms and illuminates execution. Fuzzy logic refers to all the terminologies and mechanism which implement

fuzzy sets that are unclear boundaries. Fuzzy logic basically deals with vague, ambiguous and unclear nature of a sophisticated system [126]. It also provides an alternative mechanism to probability, probably which is immensely suitable for software credibility that is having ambiguous data. The most important thing is that the application area of fuzzy logic is vast due to its prediction mechanism on unclear or vague data input. The varied application area of fuzzy logic consists of Artificial Intelligence, robotics, weather forecasting, aerospace, automotive, naval decision support aids, Stock market predictions, medical, train schedule control, pattern recognition, psychology, supply chain management, criminal investigation etc. The basics of fuzzy logic are described below in brief:

1.7.1 The Linguistic Variables

The idea of a linguistic variable produces an approximate characterization of situations which are too ambiguous or too vague to be susceptible to the description of traditional quantitative expression [127].

In fuzzy logic, the words or terms that are used are common language words which are known as linguistic variables. Each fuzzy set corresponds to a linguistic concept for example *Very low*, *Low*, *Moderate*, *High*, *Very High* if we consider temperature than it is a linguistic variable. Now temperature can be considered as being very hot or cold, slightly hot or cold, very warm, slightly warm, etc. These words very, slightly are the linguistic surroundings.

Calculation with linguistic likelihood requires the solution of nonlinear programs and leads to results which are vague to the same degree as the underlying likelihood. The prime applications of the linguistic technique lie in the field of realistic systems.

Especially in the fields of pattern recognition, diagnosis, artificial intelligence, medical, linguistics, information retrieval human decision processes, psychology, law etc

1.7.2 Fuzzy Set Theory

In 1965, Lofti Zadeh gave an extension to the classical set notation i.e. fuzzy set. In a classical set, the membership function of set elements are in yes or no form i.e. in binary format but in fuzzy logic, there are multiple values based on the degree of truth or the degree to which a certain value is true or false. A fuzzy set allows the membership function have some degree between [0, 1]. Generally, we can say that fuzzy set theory is an extension to the classical set theory where the elements of the set have some degree of membership [129].

In the real world, there are various situations or we can say that most of the situations that are vague, ambiguous and uncertain in nature. At that time to deal with these ambiguous and uncertain situations, we need fuzzy knowledge. Due to ambiguous boundaries of a fuzzy set, we are able to cope up with these uncertain and vague situations of real life. In many cases our existing classical system is unable to give satisfactory result due its fixed and certain boundaries that are only build to deal with exact or fixed situations but Lofti Zadeh gave an extension to this classical system and introduced the concept of fuzziness that is capable of providing satisfactory result to the unclear, incomplete and uncertain situations [130].

A fuzzy set $\tilde{F}$ is defined in the Universe of discourse U may be represented as ordered pairs and v is the particular element of U.

$$\tilde{F} = \{ (v, \mu_{\tilde{F}}(v)), v \in U \} \tag{1.2}$$

Let E = {e_1, e_2, e_3, e_4, e_5, e_6} be the reference set of Employees.

Let $\tilde{F}$ be the Fuzzy set of "Hardworking" employees, where "Hardworking" if the fuzzy Linguistic variable. Than the Fuzzy set $\tilde{F}$ can be defined as follows:-

$$\tilde{F} = \{(e_1, 0.5), (e_2, 0.6), (e_3, 1), (e_4, 8), (e_5, 9)\} \tag{1.3}$$

Where, $\tilde{F}$ is the hardworking capacity of e_1 is 0.5; e_2 is 0.6 and so on.

1.7.3 Fuzzy Set Operations

Let us consider two fuzzy sets $\tilde{P}_1 \& \tilde{P}_2$ in the Universe of discourse U and v is the particular element of U then,

$$\tilde{P}_1 = \{v, \mu\tilde{P}_1(v) \mid v \in U\} \text{ and } \tilde{P}_2 = \{v, \mu\tilde{P}_2(v) \mid v \in U\} \tag{1.4}$$

For example:

$$\tilde{P}_1 = \{(v_1, 0.2), (v_2, 0.5), (v_3, 0.3)\} \tag{1.5}$$

$$\text{and } \tilde{P}_2 = \{(v_1, 0.3), (v_2, 0.1), (v_3, 0.4)\} \tag{1.6}$$

The fuzzy set operations are defined as follow:

1.7.3.1 Union

The union of two fuzzy sets $\tilde{P}_1 \& \tilde{P}_2$ having membership functions μP_1 and μP_2 is defined by:

$$\mu\tilde{P}_1 \cup \tilde{P}_2(v) = \max[\mu\tilde{P}_1(v), \mu\tilde{P}_2(v)] \tag{1.7}$$

From (1.5) & (1.6) the union of two fuzzy sets $\tilde{P}_1 \& \tilde{P}_2$ is:

$$\tilde{P}_1 \cup \tilde{P}_2 = \{(v_1, 0.3), (v_2, 0.5), (v_3, 0.4)\} \tag{1.8}$$

1.7.3.2 Intersection

The intersection of two fuzzy sets $\tilde{P}_1 \& \tilde{P}_2$ having membership functions μP_1 and μP_2 is defined by:

$$\mu\tilde{P}_1 \cap \tilde{P}_2(v) = \min[\mu\tilde{P}_1(v), \mu\tilde{P}_2(v)] \tag{1.9}$$

From (1.5) & (1.6) the intersection of two fuzzy sets $\tilde{P}_1 \& \tilde{P}_2$ is:

$$\tilde{P}_1 \cap \tilde{P}_2 = \{(v_1, 0.2), (v_2, 0.1), (v_3, 0.3)\} \tag{1.10}$$

1.7.3.3 Complement

The complement of two fuzzy sets $\tilde{P}_1 \& \tilde{P}_2$ having membership functions μP_1 and μP_2 is defined by:

$$\mu\tilde{P}_1(v) = 1 - \mu\tilde{P}_1(v) \tag{1.11}$$

From (1.5) & (1.6) the complement of two fuzzy sets $\tilde{P}_1 \& \tilde{P}_2$ is:

$$\tilde{P}_1^C = \{(v_1, 0.8), (v_2, 0.5), (v_3, 0.7)\} \tag{1.12}$$

1.7.4 Fuzzy Membership Functions

In 1965, Lofti A. Zadeh introduced Membership Functions (MF) in his first research paper "fuzzy sets" [133]. A MF is a degree that defines the mapping of each element of the particular set to a membership value (or degree of membership) between 0 and 1. A

MF $\mu_{\tilde{F}}\ \mathrm{U} \rightarrow [0,1]$ is defined in the universe of discourse U for a fuzzy set $\tilde{F}$, where each element of U is mapped to a degree of membership between 0 and 1 and this value is known as membership value. A membership function provides a degree of similarity of every element of a fuzzy set.

A fuzzy set $\tilde{F}$ in the universe of information U may be defined as a set of ordered pairs and v is represented as $\tilde{F} = \{(\mathrm{v}, \mu_{\tilde{F}}(\mathrm{v})), \mathrm{v} \in \mathrm{U}\}$ where, $\mu_{\tilde{F}}(\mathrm{v})$ is the MF.

A fuzzy set can be represented graphically through MF. The *x*-axis represents the universe of discourse, whereas the *y*-axis represents the degrees of membership in the [0, 1] interval.

1.7.4.1 Increasing Membership Function

An increasing membership function as shown in figure 1.11 is framed by a lower limit P_1, an upper limit P_2 and value v, where the value of v is 0 when v is less than P_1, 1 when is greater than P_2 and the value of v is increasing from P_1 to P_2.

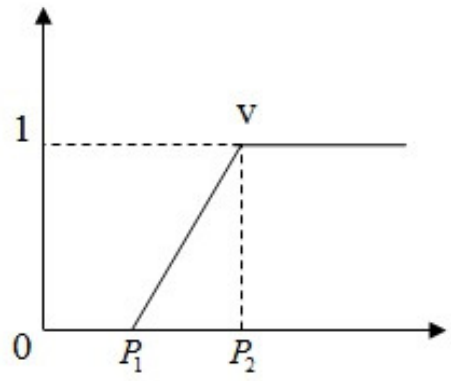

Figure 1.11 Increasing Membership Function

$$\mu_{\tilde{F}}(v) = \begin{cases} 0 & v \le P_1 \\ (v - P_1)/(v - P_2) & P_1 - P_2 \\ 1 & v \ge P_2 \end{cases} \quad (1.13)$$

1.7.4.2 Decreasing Membership Function

A decreasing membership function as shown in figure 1.12 is framed by the lower limit P_1, an upper limit P_2 and value v, where the value of v is 1 when v is less than P_1 , 0 when v is greater than P_2 and the value of v is decreasing from P_1 to P_2 [130].

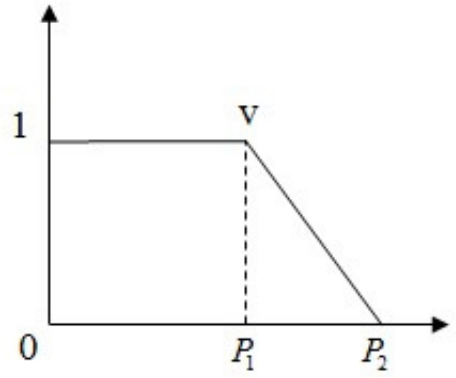

Figure 1.12 Decreasing Membership Function

$$\mu_{\tilde{F}}(v) = \begin{cases} 1 & v \le P_1 \\ (P_2 - v)/(P_2 - P_1) & P_1 - P_2 \\ 0 & v > P_2 \end{cases} \quad (1.14)$$

1.7.4.3 Triangular Membership Function

A triangular membership function as shown in figure 1.13 is framed by three parameters P_1, P_2 and P_3, where P_1 is a lower limit, P_3 is an upper limit and a value v is lies between P_1 and P_3.

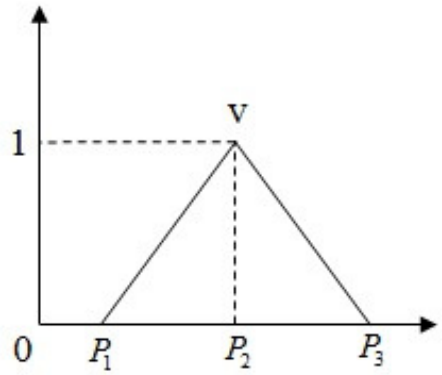

Figure 1.13 Triangular Membership Function

$$\mu_{\tilde{F}}(v) = \begin{cases} 0 & v \le P_1 \\ (v - P_1)/(P_2 - P_1) & P_1 \le v \le P_2 \\ (P_3 - v)/(P_3 - P_2) & P_2 \le v \le P_3 \\ 0 & v \ge P_3 \end{cases} \quad (1.15)$$

1.7.4.4 Trapezoidal Membership Function

A trapezoidal membership function as shown in figure 1.14 is framed by four parameters P_1, P_2, P_3 and P_4, where P_1 is a lower limit, P_4 is an upper limit, P_2 is the backing limit of P_1, and P_3 is the backing limit of P_4.

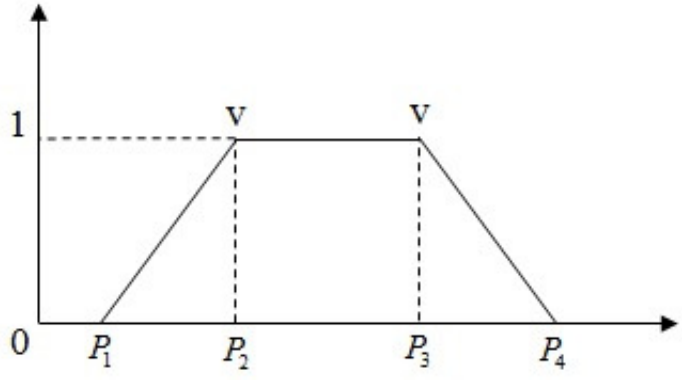

Figure 1.14 Trapezoidal Membership Function

$$\mu_{\tilde{F}}(v) = \begin{cases} 0 & v \le P_1 \\ (v - P_1)/(P_2 - P_1) & P_1 \le v \le P_2 \\ 1 & P_2 \le v \le P_3 \\ (P_4 - v)/(P_4 - P_3) & P_3 \le v \le P_4 \\ 0 & P_4 \le v \end{cases} \quad (1.16)$$

1.7.4.5 Gaussian Membership Function

A Gaussian membership function as shown in figure 1.15 is framed by two parameters P_1 and σ, where P_1 is the centre of membership function and σ is the width of membership function.

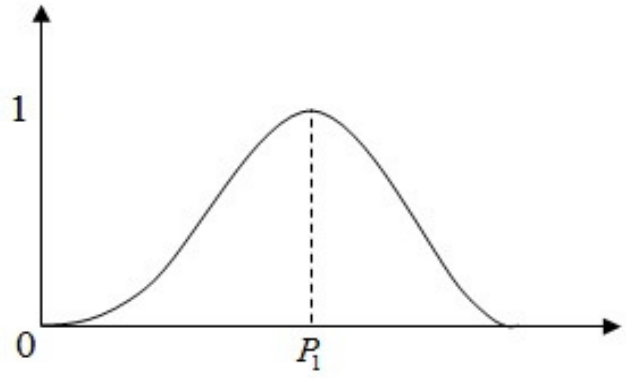

Figure 1.15 Gaussian Membership Function

$$\mu_{\tilde{F}}(v) = e^{-\frac{1}{2}\left(\frac{v - P_1}{\sigma}\right)^2} \quad (1.17)$$

1.7.4.6 Bell Membership Function

A Bell membership function as shown in figure 1.16 is framed by three parameters P_1, P_2 and P_3, where P_2 is generally positive [130].

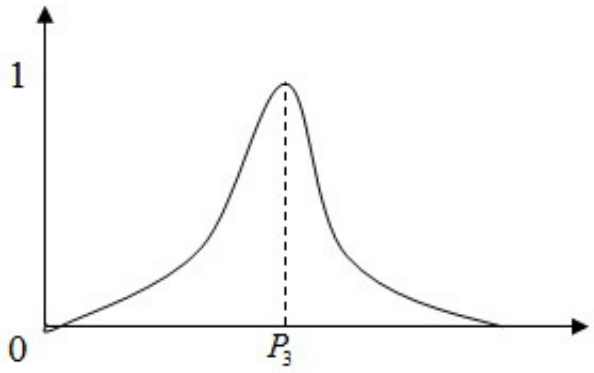

Figure 1.16 Bell Membership Function

$$\mu_{\tilde{F}}(\mathrm{v}) = \frac{1}{1+\left|\frac{v-P_3}{P_1}\right|^{2P_2}} \tag{1.18}$$

1.7.4.7 Sigmoidal Membership Function

A Sigmoidal membership function is framed by two parameters P_1 and P_2, where P_1 is the slop at the crossover point v= P_2. Depending on the sign of the parameter P_1, a sigmoid membership function is inherently open right or left.

$$\mu_{\tilde{F}}(\mathrm{v}) = \frac{1}{1+\exp[-P_1\{(\mathrm{v}-P_2)\}]} \tag{1.19}$$

1.8 INTRODUCTION TO RULE-BASED FIS

The purpose of employing FIS in our proposed system is decision making so that the effective decision making is done at each phase in the distributed network for secure transmission of data across the network. The intention of chosen FIS is because of its rule-based nature of decision making which is best suited for our proposed system.

FIS is basically a decision-making methodology of the fuzzy logic system. It performs the logical integration with If-then rules to produce effective outcome rules [132]. It is the formulating process of computing an output from an input using fuzzy rules. This computation process provides a backbone through which patterns are recognized or decisions made.

FIS can become an effective tool for various decision-making processes like software re-engineering, real-time batch processing, forecasting and in various real-time processes. Rule-Based FIS has been found as an effective method to resolve various complex situations of the real world. Therefore, the rule-based fuzzy inference becomes a very effective tool for analyzing the nature of prediction system of various real-time applications. A FIS adorns the reasoning capability of general English terms via fuzzy rules i.e. If-then rules. The main advantage of FIS is that it is based on complete practical approach because it uses If- then methodology [135].

Rule-Based FIS as represented in figure 1.17 is acknowledged by various names due to its versatile nature, such as

- Fuzzy expert system.
- Fuzzy logic controller
- Fuzzy rule-based
- Fuzzy system
- FIS etc.

A rule-based FIS is an amalgamation of set of crisp input, a fuzzifier that converts the crisp values in fuzzy one, an inference engine that performs the operation on input by

using knowledge base, a knowledge base that contains membership functions and fuzzy rules, a defuzzifier that converts the fuzzy output to crisp output, and last one is crisp output. A rule-based FIS is basically an expert system that presupposes the data by using knowledge base which implies fuzzy rules and membership functions. In various real-world applications, the rule-based FIS is implemented prosperously like in data classification, decision making, forecasting etc.

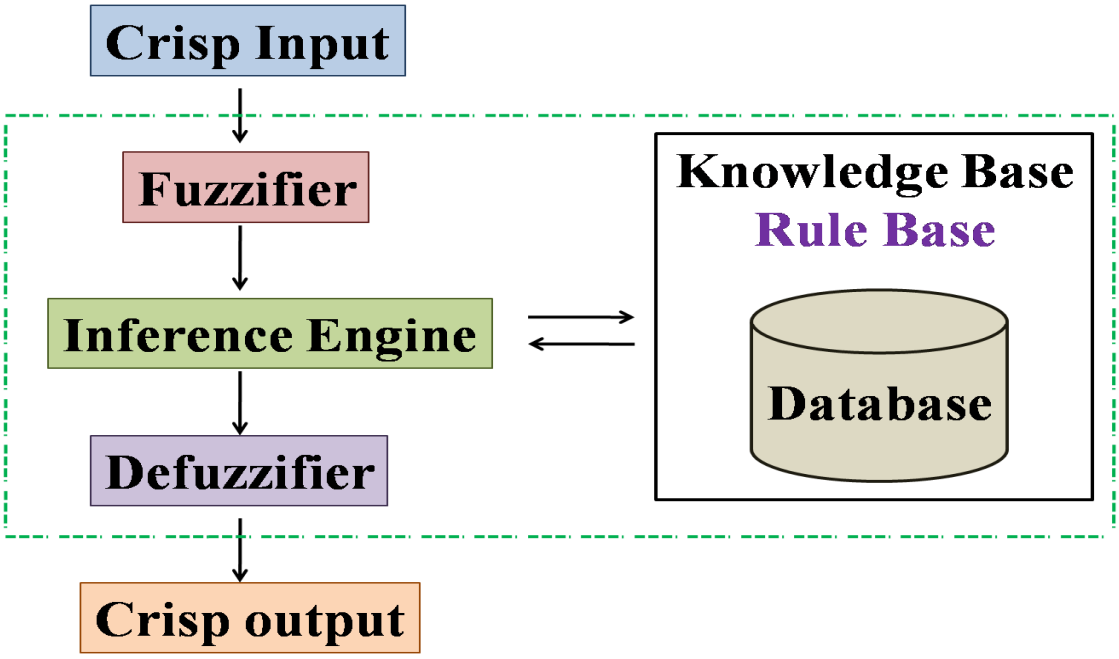

Figure 1.17 Rule-Based FIS

- **Fuzzifier** converts the crisp value into fuzzy value.
- **Inference engine** processes the fuzzy input using knowledge base.
- **Knowledge base** comprises of all the fuzzy rules and membership functions. This unit works collectively with inference engine to process fuzzy input.

- **Defuzzifier** converts the processed output which is received from inference engine into the crisp value.

1.8.1 Fuzzy If-Then Rules

A fuzzy If-Then rule comprises from a range of "if x is then y is " rules, where and are articulated linguistic terms that are represented by fuzzy sets. Fuzzy If-Then rule system is very much favorable for those systems where the logical reasoning mechanism or action-reaction rapports are implicitly ambiguous or fuzzy. Here analogous If-Then draws the conclusion from produced input values onto output consequences [134]. The form of fuzzy If-Then rules is as follows:

The If-part is known as the antecedent and Then- part is known as consequent. Where, X is input variable and Y is output variable. The If-Then conditional statements are universally admissible forasmuch both A and B are linguistic terms in various cases and these conditional statements functions in a consentaneous way with the human verdict. For example, an appropriate If-Then rule might be "If river is upstream, then swimming speed is slow". A is considered as a fuzzy set which is outlined via particular membership function, and B is either a polynomial or a fuzzy set with respect to input X hinge on particular FIS. The antecedent part is directed to figure out the membership value of input variable X parallel to fuzzy set A. whereas the consequent part allocates a crisp value to the output variable Y. Here, "is" is represented in a different sense in both the antecedent

and consequent of the If-Then rule because the antecedent is an elucidation that gives outcome which is lies between 0 and 1, while the consequent allocates a Fuzzy set B to the output Y. The If-Then rules are implementing by enforcing a fuzzy implication, whose parameters are the antecedent and consequent values. The implication of this mechanism is a fuzzy set which is the outcome of the IF-Then rule.

1.8.2 Categorization of FIS

FIS is further classified into two methods. First one are direct methods which comprises of Mamdani's method and Sugeno's method that, are the most widely used (basic difference in these methods are how they generate the outcome). Second one is indirect methods that are complex in nature. This is represented in figure 1.18.

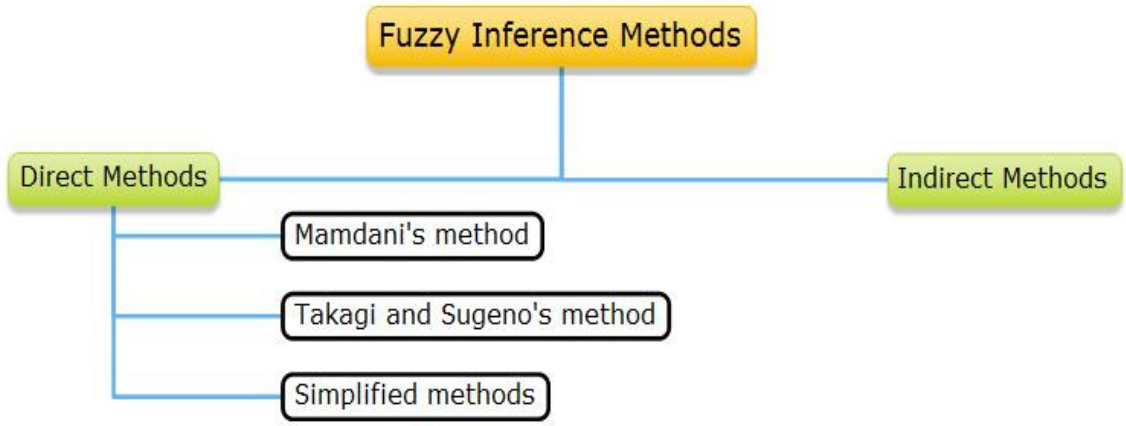

Figure 1.18 Fuzzy Inference Methods

We will emphasis on Mamdani's method in this work.

Mamdani's method is most widely used in real-world applications because of its simplicity and effective implementation [131]. Mamdani's method was first introduced in 1975 by Ebhasim Mamdani. This method was generally used to prognosticate the

working of a boiler and a steam engine together by incorporating a set of fuzzy rules which were acquired from the experienced workers of the system. Mamdani's inference system is the extremely used FIS [106].

1.8.3 Mamdani-Type FIS

Mamdani-type FIS consists of five steps as shown in figure 1.19.

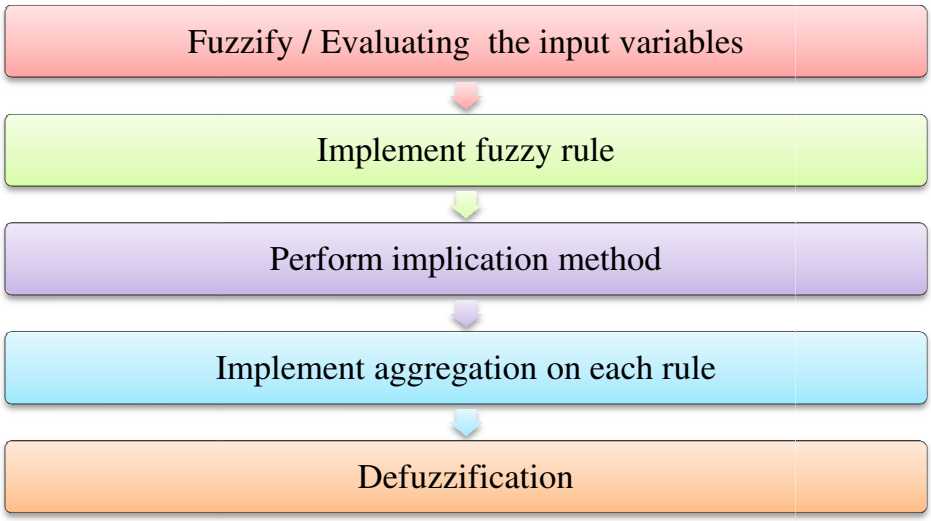

Figure 1.19 Mamdani-Type FIS

1.8.3.1 Fuzzify/Evaluating the Input Variable

Firstly, we convert the given input value i.e. crisp value into its equivalent fuzzy value by using appropriate membership function, this process is known as fuzzification of input values as shown in figure 1.20. Whatever the input value is, but the fuzzification process converts those values in to fuzzy linguistics term which only lies between 0 and 1. If there are more than one input value than fuzzy operator is applied to reduce a single value by using membership function. Let take an example below.

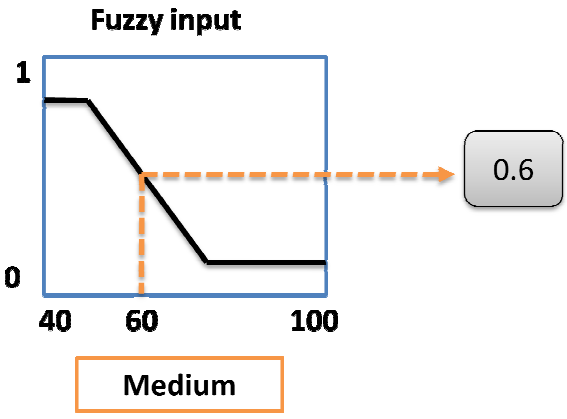

Figure 1.20 Fuzzy Input Evaluation

1.8.3.2 Implementation of Fuzzy Rule

After fuzzifying both the input variables i.e. INPUT 1 and INPUT 2, we get membership degrees of both the input variables [114]. Now we can see that the degree of INPUT 1 is 0.5, that represents the sensitivity of membership value is Medium and the degree of INPUT 2 is 0.2, that represents the sensitivity of membership value is Low. Now it is time to reduce both the input values to a single value via implementing the fuzzy rule on both the inputs by applying AND (Minimum) operation. After combining both the input values by a conjunction (AND) operator, the obtained membership value is 0.2 i.e. the minimum. It is shown below in figure 1.21.

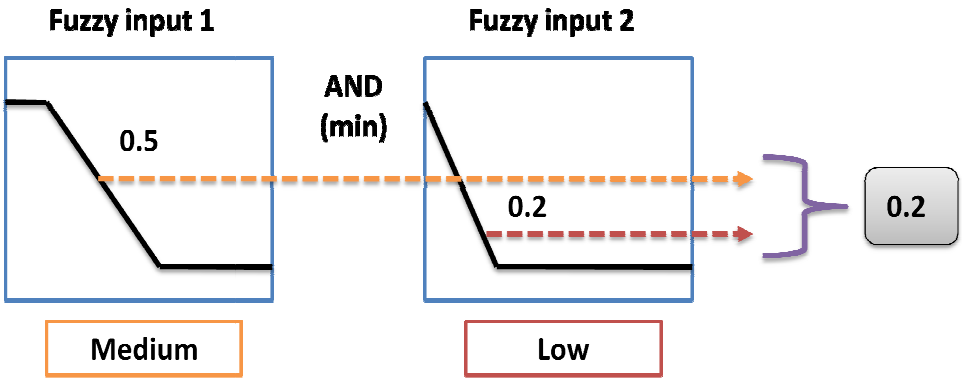

Figure 1.21 Fuzzy Rule Implementation

1.8.3.3 Perform Implication Method

The obtained consequent value of each fuzzy rule is another linguistic term outlined by the proper membership function. The consequences from the If-part of the rule is a single obtained value, now the inference method is applied to the obtained value i.e. on Then-part to reshape the consequences obtained from the associated If-part [135]. This is known as implication process. Generally, there are two widely used implication processes, to reduce the consequent values. Here we are using minimum operator which is shown below in figure 1.22.

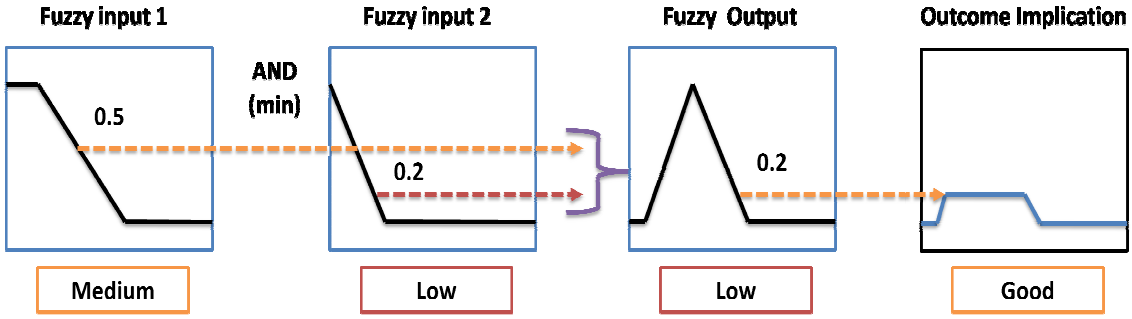

Figure 1.22 Fuzzy Implication

1.8.3.4 Implement Aggregation on Each Rule

After performing implication on each rule, in this step, we are performing aggregation process on each implication to obtain a single fuzzy outcome. Here aggregation process is done by using some aggregation operator. There are various aggregation operators are available like sum, probabilistic sum, maximum. Here we are using maximum aggregation operation to reduce all the implication to a single fuzzy output. It is shown below in figure 1.23 and 1.24.

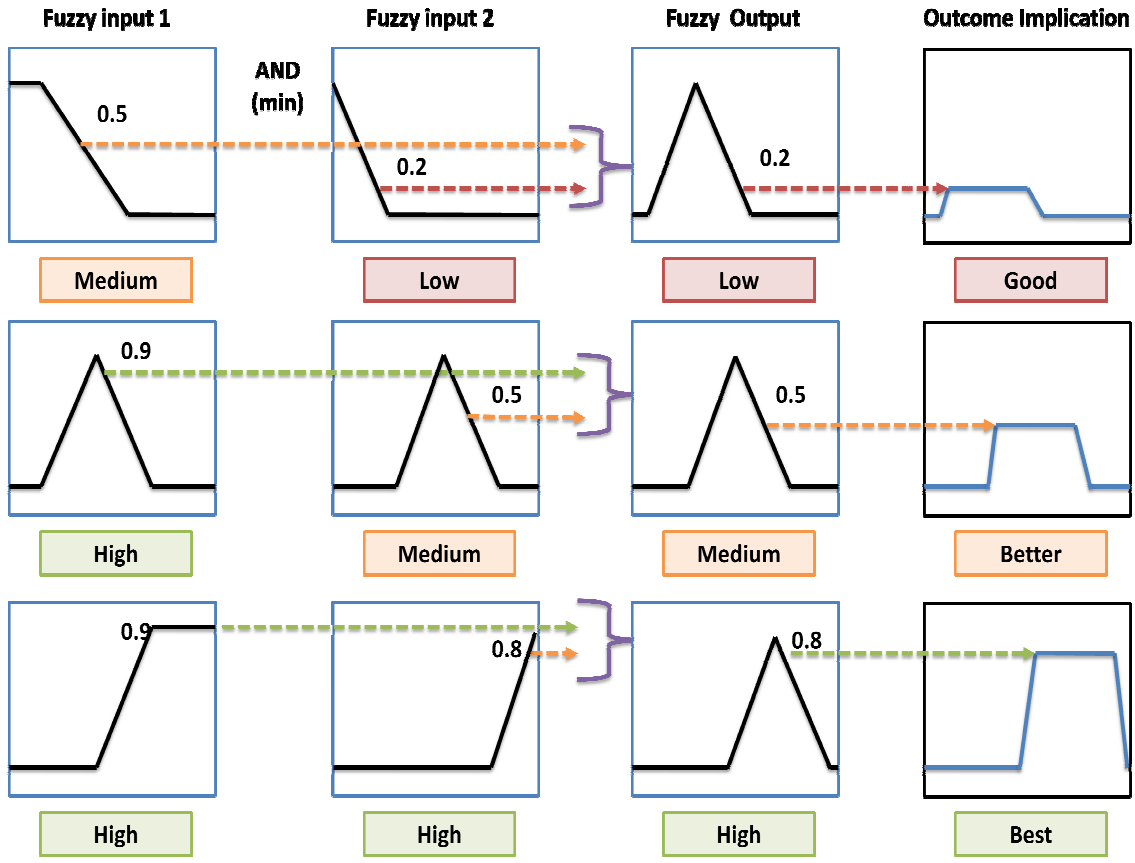

Figure 1.23 Fuzzy Aggregation

The result of aggregation is as follows:

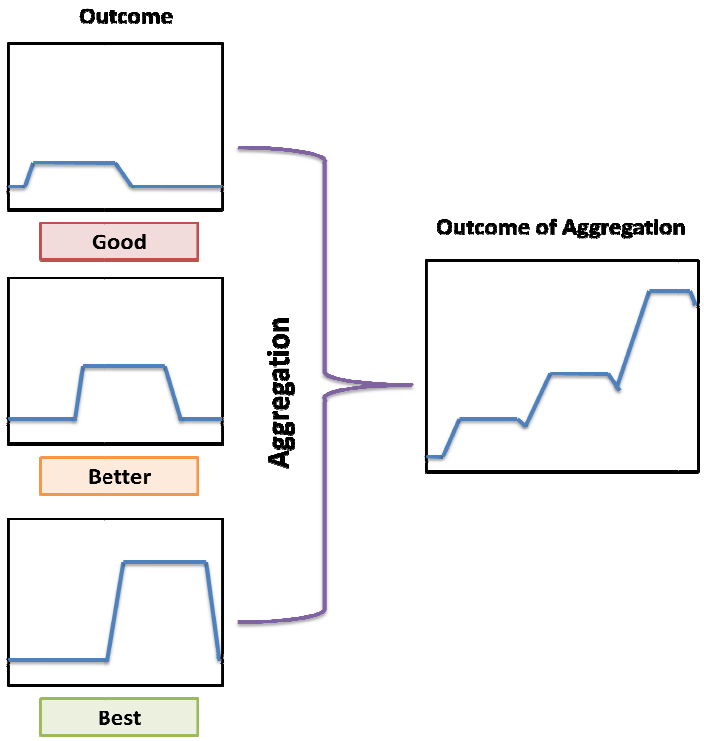

Figure 1.24 Result of Aggregation

1.8.3.5 Defuzzification

In the last step, the defuzzification process is implemented, which is the opposite process of the first step i.e. fuzzification. In this process, the assorted value of aggregation process is then converted into a single crisp value through a defuzzification method [133]. There are various defuzzification methods are available in the literature but we are using the most widely used centroid defuzzification method, which is the merely endorsed method in this thesis. The centroid method provides the center of gravity.

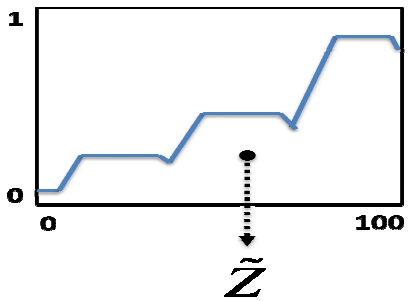

Figure 1.25 Defuzzification through Centroid Method

1.9 INTRODUCTION TO UNIFIED MODELING LANGUAGE (UML)

Basically, we are using UML for prototyping the proposed system so that the complications, goals, success of the proposed system clearly recognized and chances of the failure of the proposed system become minimal [136]. Although prototyping is must for each and every system so that the system meets its desired goal.

UML is a standard modeling language containing a coordinated set of diagrams, made to encourage framework and programming engineers for specifying, envisioning, developing, and documenting the antiques of software systems. It also uses for business modeling and other non-software systems. The UML is an essential part of software development process and developing object-oriented software [138]. The UML is a general-purpose modeling language which includes standardized graphical notations to show the design of software projects. Utilizing the UML helps in exploring potential outlines, and validates the architecture design of the software.UML has acknowledged software developers to focus more on design and architecture [75].

1.9.1 Origin of UML

UML is predominantly procreated for a wide range of applications. The main aim of UML is to endow the graphical notation to each and every object-oriented system. It also plays an important role in selection and integration of optimum elements of notations. UML provides a prototype for a wide range of applications and systems like distributed networks, Enterprise information systems, Banking and financial services, Distributed web services, Defense, Transportation, Telecommunication, Research etc [139].

Fundamentally, UML is a developed version of OMT unification from:

1. Object Modeling Technique OMT [James Rumbaugh 1991] - for analysis and data-intensive information systems.
2. Booch [Grady Booch 1994] - for design and implementation.
3. OOSE (Object-Oriented Software Engineering [Ivar Jacobson 1992]) –for Use Cases.

Jim Rumbaugh constructs OMT in 1994, he wonderstruck the information technology world by abandoning the General Electric and team up with Grady Booch at Rational Corp. Their partnership aims to commingle their thoughts and develop the unified method. In 1995, Ivar Jacobson, the architect of OOSE, also team up with Rational Corp and he introduces the concept of "Use Cases" and then they named it as "UML".

1.9.2 History of UML

In 1994, there are notably two renowned object-oriented modeling methods i.e. Booch method of Grady Booch, for object-oriented design and OMT method of Rumbaugh for object-oriented analysis. They both were bringing together their methodologies and started development of Unified Method. Later they also team up with Ivar Jacobson, the inventor of OOSE method. They all were collectively Eminent as The Three Amigos. Since The Three Amigos started working together and interacting with each other in respect of the development of methodological preferences.

In 1996, The Three Amigos together found that the using UML was more feasible than Unified methods. And they started working towards the development of UML. Under their combined supervision they organized an international consortium to get the overall

specification of UML and make it as of OMG Request for Proposals (Object Management Group). In Jan 1997, The UML 1.0 specification of UML partners was given to the OMG. In the same month, a special Semantics Task Force was created by the UML Partners, under the Chairmanship of Cris Kobryn and Administration of Ed Eykholt, for integration and finalization of specification with other normalization standards. In August 1997, the outcome of their efforts i.e. UML1.1 was submitted in OMG and which was successfully implemented by the OMG in November 1997.

The impact of the OMT notation is governing in form of modeling notation like exercising of rectangles for objects and classes. Even the "Cloud" notation of Booch was drooped down but the ability of Booch to represent lower-level details was employed very well. The Booch's Component notation and the Objectory's Use Case notation were together integrated with all the remaining notations. In UML 1.1 the semantic integration of components was comparatively weak, that wasn't resolved up to the major revision of UML 2.0. UML endorse all the object-oriented methods. It is very helpful for a wide range of engineering practices, distributed networks and mostly in all real-world applications.

1.9.3 Need of UML

UML is a very strong methodology for system analysis and design that can enhance the quality of your system and with improved efforts; this will transform your system in a higher grade system. There is a vast need of UML iteratively to analyzing and designing the system so that one can instate much better mutual understanding among Information technology conglomerate and business conglomerate about processes and the

requirements of the system so that the developed system meets all the communicated requirements.

In the first stage of UML, analysis process of the system is done to recognize all the requirements of the system and also validation process is performed by using use case analysis. The initial level of UML is recognizing the requirements and preparing the initial use case model. Further analysis of the system requirements is accomplished through the creation of use cases, class diagrams, state chart diagrams, sequence diagrams and so on. Each level of UML development presents the more detailed version of the system design until all the relationships of the components and requirements are clearly defined in UML.

After the first stage of analysis and design is accomplished, an actual and more specific set of requirements are available for all the activities, classes, sequencing and scenarios of the system. After this phase of analysis and design, you can forecast the overall development process of the system and the quality of the outcome of the proposed system.

By using UML the risk and overall development time are reduced by shifting design of application from the development stage to an analysis and design stage. This also provides a way to test the basic architecture of the proposed system before start coding. Various UML tools provide prototype/skeleton code that is object-oriented, promote up gradation, effective, and efficient. With the changing system requirements, you have to redevelop some diagrams of UML. A sufficient amount of time and expenditure is required during the redevelopment of the system. After overall analysis and design of the

requirements, you have to ensure that the developed system completely meets the requirements of the proposed system.

1.9.4 Views of UML

UML diagram furnishes the visual representation a system. It represents the measurable facts of a system that can represent visually, like structure, functionality, relationship etc. UML diagrams provide both types of views i.e. high-level and low-level for the design and analysis of an application. Software architect and developers use UML diagrams to understand the whole systems and isolated applications into minor objects for development. In UML a wide range of diagram patterns and styles are available for prototyping an application. One can develop a model based on the system requirement and its application. Based on your diagram choice, you are able to define the complexity and abstraction level of the diagram [137]. UML model comprises of various types of diagrams and each diagram represents a unique view of the proposed system.

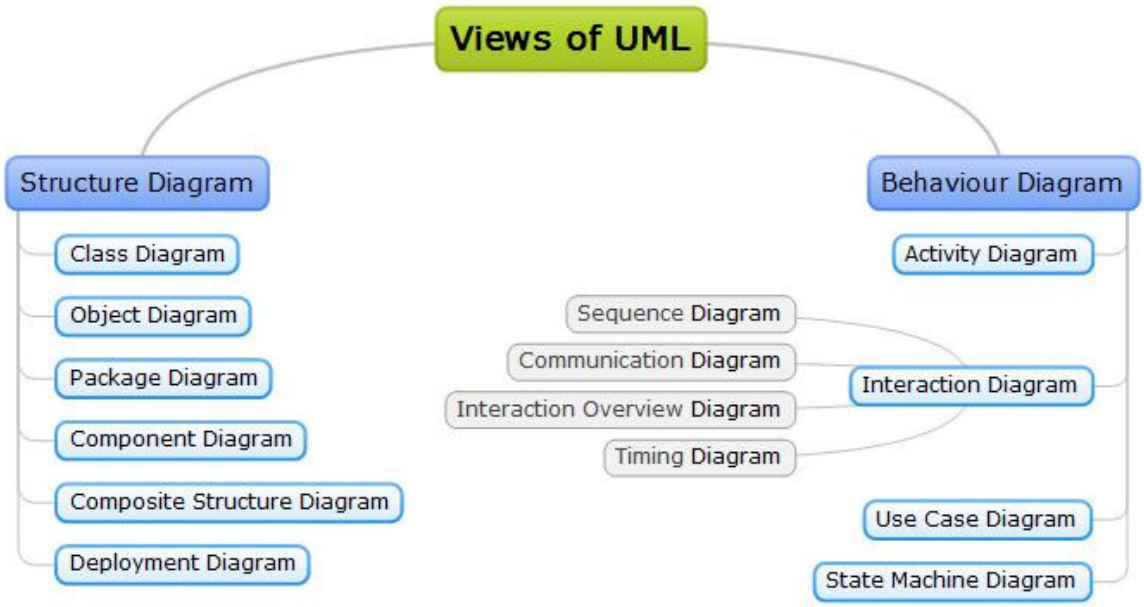

Figure 1.26 Views of UML

As shown in figure 1.26 there are various types of diagrams are available in UML like class, object, package, component, composite structure, deployment, activity, use case, state machine, sequence, communication etc. All these diagrams are distributed among two different categories i.e. structure diagrams and behavior diagrams.

1.9.4.1 Structure Diagram

Structure Diagrams are very critical and widely used view of the UML. Structure diagrams represent the static behavior of the system and its components on the different level of abstraction and their interaction with each other. Components of the structure diagram describe the meaningful picture of a system. They also used to establish the relationship and dependencies among elements of a system. Structural diagrams are classified as Class diagrams, Object diagrams, Package diagrams, Component diagrams, Composite Structure diagrams, Deployment diagrams.

1.9.4.1.1 Class Diagram

Class diagrams are very crucial for an object-oriented method. It gives the core meaning to the UML diagram because it dissociates the design and coding of the system. Class diagrams are the building block of every object-oriented system. It represents the static view of the system and is extremely helpful in explaining the interaction among classes and interfaces.

1.9.4.1.2 Object Diagram

An object diagram pondered as an exclusive case of class diagram. Object diagram basically focuses on the interaction among instances of classes at a significant moment of

time. Object diagram symbolizes the instance of a class. There are unlimited numbers of unique instances of a class.

1.9.4.1.3 Package Diagram

Package Diagram is basically an organized collection of similar type of elements of a system. Package diagram represents the packages and their elements of an organization. Elements of a package share common namespace. Basically, packages are used to manage class diagrams and use case diagrams.

1.9.4.1.4 Component Diagram

Component diagrams represent the different parts of the system, that will come together to build a system. Abstraction level of a component diagram is higher than a class diagram. A component diagram is a visual representation of interaction and organization of all the components of a system.

1.9.4.1.5 Composite Structure Diagram

Composite structure diagrams are identical to class diagrams; however, composite diagrams represent a particular part rather than entire class. In Composite structure diagrams, ports are used to establish the interaction amid classifiers and inner parts. You can also use collaborations in a composite structure diagram to delineate the roles and properties that can determine the functioning of a classifier.

1.9.4.1.6 Deployment Diagram

Deployment diagrams represent the physical resources of a system like components, nodes, relationships etc. A Deployment diagram represents the run-time structure of a

system. It displays the hardware configuration and represents the relationship between the different components of a system. A Deployment diagram is comprised of various UML diagrams. An effective deployment diagram manages various system parameters like maintainability, scalability, performance, portability etc.

1.9.4.2 Behavior Diagram

Behavioral diagrams represent the relationship in a system. It shows the relationship among various structural diagrams. Behavioral diagram represents the dynamic behavior of a system. Behavioral diagrams are classified as activity diagrams, interaction diagrams, use case diagrams and state–machine diagrams.

1.9.4.2.1 Activity Diagram

Activity diagrams represent the dynamic behavior of a system by molding the flow of control among all the activities of a system. A typical activity diagram represents the behavior and workflow of internal functions. An activity diagram is simply a flowchart that shows the flow of control among different activities of a system. Members of activity diagram are as follows:

- Start node
- End node
- Actions
- Control flows
- Decision node

1.9.4.2.2 Interaction Diagram

Interaction diagrams represent the collaboration among various objects of a system. The term "Interaction" describes itself that is displays interactions between different objects in a system. It holds the dynamic nature of a system, represents the anatomical arrangement of objects and interaction between objects. Interaction diagrams are classified as follows:

- **Sequence diagrams:** Focuses on the sequence of messages conveyed among different objects.
- **Communication diagrams:** Represents the messages flow among different objects.
- **Interaction Overview diagrams:** Represents the combined behavior of sequence and activity diagram. Focuses on the flow of curb of interactions.
- **Timing diagrams:** Focuses on the events that occur during specific time duration.

1.9.4.2.3 Use Case Diagram

Use case diagrams represent the behavior of a system via actors and use cases. A typical use case diagram comprises of actors, use cases and relationships between them. It represents the behavior of a set of actions of the system that can work in association with users of the system. Each use case diagram represents a specific functionality of a system. Actors of use case diagram are recognized by internal and external agents.

1.9.4.2.4 State Machine Diagram

State machine diagram also represents the dynamic nature of a system in respect of foreign stimuli. State machine diagrams are basically worthwhile for representing dynamic objects whose states are triggered by a particular event. State machine diagram

shows the changing states of an object during its whole life cycle. It also depicts the control flow

among various states of an object.

The main objectives of using State machine diagrams:

- Represents the dynamic phase of a system.
- Depicts the life time of a responsive system.
- Describes the life cycle of an object.

1.10 PRESENT RESEARCH WORK

On the basis of above fundamentals, the present work deals with the implementation of Fuzzy Rule-Based Inference System on a case study of military mission for selecting the units for getting the mission based on the various judgments. Further a Fuzzy Vogel's Approximation method is implemented on a new ranking method based approach for transportation problem based on transporting the secure data from one machine to another machine under distributed environment. Since a machine represents MAC address hence a technique of security of MAC address hence a technique of security of MAC address is also elaborated and supported with a case study. When one transmits the information from one machine to other machine then risks occurs always, hence estimations of various risks have been collected with several case study and a method is proposed for resolving the risks along with a model is proposed by the use of Unified Modeling Language. Intruders are always online when authenticated used is transferring the data from one machine to another machine then called as cyber attack under distributed environment. As technique is implemented for minimizing the cyber attacks on the

crucial data. The presented work is useful for minimizing the risks when user is online and transferring the important information from one location to another location. Further the presented work is also used for extension in the data mining field in which data grows rapidly.

Chapter II

Review of Literature

CHAPTER II

REVIEW OF LITERATURE

An exhaustive review of the literature has been collected on fuzzy cryptography and it is observed that a very few research work is done related to fuzzy cryptographical techniques in distributed network. The advantages of fuzzy cryptographical techniques are applicable in the real-life applications such as supply chain management, transportation, software security in the distributed network, etc. Let us first describe a brief review about cryptography which includes various techniques on various aspects.

In 1976, Whitfield and Hellman [108] have suggested some techniques to solve current problems related to security and also discussed the tools to solve long standard cryptographic problems. In 1994, Cetin Kaya Koc [15] described modular exponentiation based cryptosystems which include the RSA algorithm, the Diffie-Hellman key exchange mechanism, and Digital Signature Standard (DSS) of the National Institute for Standards and Technology. In 1996, Pointcheval and Stern [79] provided security proofs for signature schemes in the random oracle model. In the year 2003, Krishnamurthy et al. [54] presented a new method which implemented the montogomery squaring reduction along with speed up squaring reduction by 10 to 15 percent for different key sizes.

In 2004, Fan et al. [25] proposed a work with two aspects. Firstly they developed a prefix-preserving anonymization technique based on cryptography which is verifiable as secure as the existing TCPdpriv technique and this cryptographic-based technique provided consistent prefix- preservation in a broad-scale distribution setting. Secondly, in this method, the security evaluation is performed which inherent in all prefix IP address. Lim and Robshaw [59] stated the use of identity in grid security structure which is based on cryptography. Identity-based cryptography has a big demand due to its well align of properties. In 2005, Gaubatz et al. [34] described that public key mechanism can be used

on a sensor node for ultra-low power hardware implementations and shows the power savings. Canniere et al. [13] have described the cryptographic techniques. In the symmetric encryption, two parties share a same secret key for encrypting the data and this encryption scheme is efficiently used. The author addressed the performance issues in the currently available cryptographic algorithm. In 2006, Ateniese et al. [6] have provided the performance measurements of applications through re-encryption. For assurance of a secure file the proxy re-encryption scheme is used and it evaluates an implementation of this re-encryption.

In 2007, Hars Laszlo [41] has described the embedded system such as cell phones, wireless modems, portable media player, cable modems, secure disk drives, cryptographic tokens etc. Now days these devices are mostly used and based on public key cryptography and resource constrained. The speed improvement through an algorithm is important including power consumption and dissipation of heat and cost.

In 2009, authors [56] investigated the usage of palm print in a fuzzy vault to develop a user-friendly and reliable cryptosystem. In this method both asymmetric and symmetric approaches are used for encryption. Reed and Salomon's codes are used for an asymmetric key for providing error tolerance. Cheung et al. [18] have discussed the privacy protection in multimedia systems. In the recent time, the combination and collaborations among cryptography experts, multimedia experts, pattern recognition experts and data mining experts have provided better solutions for practical applications. This collaboration enhances the level of security as well as proves the privacy protection.

In 2010, Xiao and Yang, [111] have developed a system that uses facial recognition technology to identify the user because of security authentication and authorization

problem. In this method, if the authenticated face disappeared then the system is automatically logoff or screen lock.

In 2011, Ntalianis et al. [72] have proposed a steganographic system for authentication of biometrics over error-prone networks which are encrypted by a chaotic cipher module. Lim et al. [60] have proposed a decided piece distribution based discretization method which incorporates discriminative feature extraction, discriminative feature selection, unsupervised quantization and linearly separable sub code based coding for the binary representation of cryptographic applications. Duman and Ozcelik [23] have developed a method to detect credit card fraud which is presently used in a bank. This method minimized the wrongly classified transactions. Cetin et al. [14] have described the modern technologies used by youngsters which are creating environments in which youngsters can exhibit bullying behavior in schools through electronic devices.

In 2012, Jamieson et al. [44] have addressed the identity crime and how to prevent identity theft of individuals or an organization. Gupta et al. [38] have used two popular mechanisms named RSA algorithm and Diffie Hellman algorithm for encryption of data. The use of Diffie Hellmen algorithm in encryption through steganalysis shows no effect in time complexity instead of RSA algorithm.

In 2013, Solms and Niekerk [98] have described the sustain overlap among cyber security and information security. In the year 2014, Crawford and Renaud [20] told the transparent authentication of the smart phone's password. A transparent authentication delivers an effortless solution. The outcome of transparent authentication on Smartphone provides a valuable understanding and needs of the user. Xia et al. [110] have proposed a semantic expansion based on similar search solution encrypted cloud data. In this method, a

corresponding metadata is prepared for each file after that both the encrypted metadata and file collection are uploaded to the cloud server. The cloud server builds the inverted index and constructs a semantic relationship library (SRL) for preparing keywords.

In 2015, Karabat et al. [47] have introduced a biometric verification and template protection system known as THRIVE. In this system, novel enrolment and authentication protocols are used and a private key is shared between user and verifier. This Framework stored encrypted binary biometric templates in a database and its verification is performed utilizing homomorphically randomized templates. Barman et al. [8] have proposed an approach to generate the cryptographic key from the cancellable fingerprint template. In this approach, a fingerprint template was used by both sender and receiver. Through a unique fingerprint template, both are safely transmitted to each other utilizing a key based steganography. Iwakiri and Thanh [43] have proposed a fragile watermarking methodology which is based on incomplete cryptography for the protection of copyright. The proposed scheme solved the leakage problem in original content through the digital right management system (DRM).

In 2016, Wei et al. [107] have defined the concept of attributes based signature which enables us signer to sign a message in respect of signing policy. In this method, the person can make a signature and ensure that the signature satisfies the signing policy without prior knowledge of signer identity. Luy et al. [62] have presented the cryptanalysis of enhanced and secure RSA key generation scheme (ESRKGS). According to authors, ESRKGS is highly secured and it is not easily breakable scheme.

Distributed Network preferred centralized approach and provides various services such as sharing information, reliability, scalability etc. It improves the credibility of the entire

system by adding a large number of components as required and increased the throughput of the whole system. In 1989, Gasser et al. [33] have described the comprehensive specification for security in a distributed system which employs modern concepts required in both government and commercial environment. The digital distributed system security framework covers user and system authentication, necessary security, secure booting and loading, delegacy in the all-purpose computing environment of different systems where there is no global trust, no central authorities. Cristian and Fetzer [21] have proposed a timed asynchronous distributed system model with an extensive determination of delay in process scheduling and actual message assure that this model appropriately defines current distributed systems constructed from networked workstations.

Ryutov and Neuman [90] presented a model for maintaining authorization which integrated both local and distributed access control schemes and also adaptable across administrative and applications division. Renesse et al. [85] developed a new distributed information management system named astrolabe. Astrolabe accumulates large-scale system state allowing fast updates and provided the cross attribute aggregation. The combination of characteristics makes it applicable to solve a wide collection of management and self- structured problems. In the year 2005, Wu et al. [109] have applied a remote password authentication scheme using smart cards which are based on cryptographic primitives of pairing on an elliptic curve. In this proposed scheme there is no requirement of a password table to check the legitimacy of the login user and it permits the user to select and change their password. Sen [94] have discussed various types of attacks and security mechanism for wireless sensor network and also described that how built the security mechanisms for wireless sensor security in future prospects.

Padmavathi and Shanmugapriya [76] have discussed a variety of attacks in the wireless sensor network and their categorization techniques. These security techniques handle them with some challenges. Baber et al. [7] used the concept of distributed cognition to advise the design, advancement, and a technology to support crime scene examination is reported. Phua et al. [78] have described a rapid technology for streaming credit application based links.

In 2011, Tanenbaum and Watherall [104] have distinguished between the computer network and distributed system. In a distributed system, software system constructed on top of the network. Gnanaraj et al. [37] have proposed an authentication scheme which uses biometric data of any user along with the user id and password. This data is used through a smart card for providing authentication and the performance of the proposed scheme is compared with the existing scheme along with the time efficiency.

The term fuzzy logic was introduced with the proposal of fuzzy set theory by Lotfi A. Zadeh. Fuzzy logic has been applied in various fields in the form of multi-value logic and gives the more accurate result.

In 2004, Liu and Kao [61] have developed a method to find the fuzzy objective value of fuzzy transportation problem while transportation cost, supply and demand are considered as fuzzy numbers. Chakraborty and Pal [16] have proposed a scheme for the distribution of feature selection along with neuro-fuzzy. This scheme is tested on both the real set of data and synthetic data. In the year 2006, Rong et al. [88] have developed a sequential adaptive fuzzy inference system (SAFAI) which is based on the functional equivalence among a FIS and a radial based function network for the better performance in terms of accuracies as compared with existing algorithms.

Razavi et al. [84] have proposed fuzzy logic control (FLC) of automatic repeat request (ARQ). FCL shows the outperformance of the default Bluetooth scheme and an alternate Bluetooth adaptive scheme in terms of reduced delay so that the video quality can be improved. Aarabi et al. [1] have proposed a new expert's knowledge-based fuzzy rule-based approach for seizure detection which is automatically detecting seizures in a patient's intracranial EEG recording. Zarandi et al. [115] have proposed a new method for stock price analysis which is based on type two fuzzy rule-based systems.

In 2010, Fernandez et al. [27] have studied a preprocessing process for a class imbalance in the fuzzy rule-based system. They examined the fuzzy rule-based behavior with adaptive FIS. Guzel [39] investigated a fuzzy transportation problem with fuzzy quantities according to the maximum satisfaction level of rearrangement. Boyacioglu and Avci [10] have examined the stock market return forecasting by employing Adaptive Network Based Fuzzy Inference System (ANFIS) and measures the Istanbul Stock Exchange (ISE) by ANFIS. Kurnaz et al. [57] have proposed an autonomous flight controller for Unmanned Aerial Vehicles (UAVs) using Adaptive Neuro-Fuzzy Inference System ($ANFIS_1$). Pandian and Natarajan [77] have evolved a new algorithm named fuzzy zero point approach towards locating a fuzzy optimal solution of a transportation problem using trapezoidal fuzzy numbers. Ustundag et al. [105] have introduced radio frequency identification (RFID) by which the facility of identified and tracking of goods increase. There are various applications in which RFID may use. The cost of RFID may be challengeable in various applications. So a framework is proposed for economic analysis for RFID investment. This framework determines the element cost and benefits in order to measure the value of the investment of RFID using a fuzzy rule-based system.

In the year 2011, Kaur and Kumar [49] have proposed a new method to solve fuzzy transportation problem while considering that a decision maker is uncertain for the precise values of transportation cost, availability and demand of the goods. Khokhar et al. [53] have proposed a routing protocol which is based on the fuzzy rule that determines the social behavior of humans on the road for making an optimal and secure routing decision. In FAST, one can make a critical decision based upon prior global knowledge of real-time vehicular traffic information based upon FIS.

Samuel and Venkatachalapathy [93] have proposed a new algorithm named Modified VAM for solving the fuzzy transportation problem. Buyukozkan and Cifci [12] have proposed a new fuzzy network approach based on multi-person decision making in partial preference relation and also examines the supplier sustainability.

In 2012, Gani and Assarudeen [31] have defined a new operation which is based on triangular fuzzy numbers in which subtraction and division techniques have been modified. Mohanaselvi and Ganesan [68] have proposed a new algorithm for solving fully fuzzy transportation problem to obtain an initial fuzzy feasible solution. Poonam et al. [80] have presented a ranking technique with an alpha optimal solution to solve fuzzy transportation problem using triangular fuzzy numbers. Olugu and Wong [73] have explained the concept of fuzzy rules and arithmetic via fuzzy rule base using visual basic dot Net. Akgun et al. [3] have examined landslide sensitive mapping by employing expert advice approach in which various parameters and landslide locations are analyzed via Mamdani inference system. Amindoust et al. [5] have introduced a FIS for supplier selection to determine and rank among a set of suppliers.

Fegade et al. [26] have proposed a ranking method to solve fuzzy transportation problem using triangular fuzzy number. Kumar and Kaur [55] have proposed two new methods to obtain the fuzzy optimal solution occurred in real life situation transportation problem based on fuzzy linear programming and classical transportation problem. Kaur and Kaur [48] have also developed a FIS for air conditioning systems using both mamdani-type and sugeno-type fuzzy model. The analysis of the result using both models shows the better choice in the selection of FIS for air conditioning system.

In 2013, Shanmugasundari and Ganesan [95] have developed a new method for solving fuzzy transportation problem to solving obtain the optimal solution using fuzzy parameters. Chauhan and Joshi [17] have proposed a ranking method to obtain the fuzzy optimal solution of fuzzy transportation problem using improved VAM with trapezoidal fuzzy numbers. Narayanamoorthy et al. [70] have proposed a new algorithm using any type of fuzzy numbers to obtain an initial basic feasible solution. Chrysafiadi and Virvou [19] have presented an approach for knowledge representation for better support in an adaptive learning system using fuzzy cognitive maps. This approach is useful in presenting graphically type of information.

In 2014, Das et al. [22] have developed a new method named Logical Development of Vogel's Approximation Method (LD-VAM) which fined feasible solution near to optimal result. Khalaf [51] has developed a new approach i.e. Fuzzy Russell's Approximation Method (FRAM) for solving the fuzzy transportation problem. Rani et al. [83] have proposed a method which gives the additional information regarding the future demand at less cost. Solaiappan and Jeyaraman [96] have proposed a new method to obtain the optimal solution in terms of fuzzy numbers. Gani et al. [30] have determined the efficient

solution for large-scale transshipment problem.

In 2015, Narayanamoorthy and Kalyani [69] have proposed a new method for transportation problem to obtain the initial basic feasible solution. Khefacha and Belkacem [52] have developed and tested an economic psychological model for influencing individuals to run their own business. A new measurement of entrepreneurial intention based on logic fuzzy technique is introduced. Zareiforoush et al. [116] have developed a FIS associated with image processing technique acting as a decision-support system for qualitative ranking of milled rice. FIS rule base considered some rules, AND operator and Mamdani inference system to evaluate the performance of developed system compared with the expert's judgments. Zadeh [113] has represented a concise explanation about fuzzy set theory and fuzzy logic development and also discussed the concept of fuzzy set, FL generalization, Linguistic variable concept, Information granulation, a theory of uncertainty, a concept of restriction, restriction centered theory and basic definition of possibility and probability. Nareshkumar and Kumaraghuru [71] have presented the closed, bounded and non-empty feasible region of the transportation problem using fuzzy trapezoidal numbers. Mendivil and Garitagoitia [66] have described a proposal to convert a fuzzy automation which is based on the construction of a fuzzy automation with ε-moves for the fuzzy regular expression and the composition of correspondent fuzzy finite automata along with ε-removal operation.

In 2016, Radhika and Parvathi [82] have presented different kinds of intuitionistic fuzzification function like triangular, trapezoidal, bell-shaped, Gaussian, Sigmoidal etc which will more beneficial in displaying true circumstances in the fuzzy environment. Ebrahimnejad [24] has proposed a new technique to solve fuzzy transportation problem in

which cost, demand and supply are maintained by non-negative LR-flat fuzzy numbers. Roy [89] displayed a novel scheme named fuzzy document-based information retrieval scheme (FDIRS) with the goal of stock market index forecasting. The method uses a modified tf-idf scoring scheme for predicting the future trend of a stock market index. Li et al. [58] have proposed a scheme in which homomorphic encryption is used for protecting the location privacy of the user. Maliniand and Ananthanarayanan [64] have presented a new ranking method in which a fuzzy transportation problem is converted into crisp transportation problem and then apply the MODI method to obtain the fuzzy optimal solution. Butt and Akram [11] have described a novel intuitionistic fuzzy rule-based decision-making system. In this system, the fuzzy scheduling algorithm inputs the nice value and burst time of all the available process in the ready queue and triggers rules of an intuitionistic fuzzy inference engine for calculation of dynamic priority (DP). The maximum DP value is sent to the central processing unit for the purpose of its execution.

Samant et al. [92] have proposed a novel method for interaction between Humanoid robots in a fuzzy logic based environment and implemented the experimental platform using soccer gameplay. A vision based methodology has been used in this present method. Machado et al. [63] have described the use of artificial intelligence techniques like intelligent tutoring system as a teaching support tool. With the help of fuzzy logic system and intelligent tutoring system, a teacher can be taught more efficiently in a group or individual. Gasmi and Bourahla [32] have proposed decomposing fuzzy ALC to satisfy the requirement of representing and reasoning with fuzzy ontology in terms of the semantic web. Rizvi et al. [87] have proposed a structured framework to quantify the software reliability before starting the coding of the software. Initially, the need and the significance of the framework are necessary to be known. The authors use fuzzy set

theory to overcome the limitation of the subjectivity of the requirement. Honamore and Rath [42] have used Hidden Markov Model (HMM) and fuzzy logic prediction model to predict the reliability of web services. The authors conducted the experiments on real-time web services and using the Estimation Maximization algorithm to calculate maximum likelihood value in HMM. Francalanza et al. [29] have contributed a novel fuzzy logic based approach to support the manufacturing system designer. The present study supports the design of a changeable manufacturing system.

Ozdemir and Tekin [74] have presented the skill evaluation of pre-service teachers using fuzzy logic. Borgwardt and Penaloza [9] have provided an overview of the existing automated-based techniques for reasoning in fuzzy Description Logics (DLs) with a special attention on describing the ideas and requirement behind them. Hao et al. [40] have introduced a totally artificial intelligence car following model which has no analytical model is developed to inform a human driver. This model consists of various parts like classic stimulus-response framework, extensive five-layer structure, Perception-Anticipation-Inference-Strategy-Action and a fuzzy logic based inference mechanism. Almaraashi et al. [4] have described the use of simulated annealing for the development of the more efficient fuzzy logic system to model problems associated with uncertainties.

Ghosh et al. [35] have proposed a novel algorithm utilizing fuzzy methodology to check the embedded uncertainty and ambiguity connected to the conversation blocks. Zhou et al. [118] have proposed a fuzzy logic method to design and simulate pedestrian dynamical nature, which follows individual observation and intuitive information achieved from interactions with surrounding conditions. Sajedi [91] has proposed an approach for detecting high accuracy using Steganography Pattern Discovery (SPD) which employs an

evolutionary mechanism to extract the signature of stego images with respect to clean images through fuzzy if-then rules.

In 2017, Yang [112] has addressed standard efficiency for non-associative, non-commutative sub-structural fuzzy logic and their axiomatic extensions. Aghili and Hajian-Hoseinabadi [2] have presented the material required for the fuzzy reliability application, impacts of repair and data uncertainty. Through an example, it is clear that the degree of uncertainty is measured firstly Markov Processed (MPs) namely equivalent translation rate is introduced to get an analytical formalism. After that fuzzy arithmetic method was applied and the performance of the proposed technique was evaluated. Jiang et al. [45] have presented a dynamic fuzzy stochastic neural network model for the identification of non-parametric system using ambient vibration data. Milovancevic et al. [67] have investigated the potential of $ANFIS_1$ for deciding the most appropriate variables for predictive models of vibration monitoring of pellet mills power transmission. Zhang and Yang [117] have also investigated an adaptive fuzzy output constrained and developed this method because it is based on the dynamic surface back stepping control design technique. The results of this study revealed the stability of closed-loop system in terms of uniformly ultimately boundedness and preserved both transient and steady state performance of the output.

UML is based on real-world concepts to make interaction with each other through a model. It provides a new way to solve a problem by generating the models and reduce the complexity of a problem.

In 1995, Soley and Stone [97] have stated that the reference model constructs a conceptual layout for associating technology that assures the OMG technical objectives.

In 1998, Giantdino et al. [36] have stated that the UML performance started in an official manner in October 1994 and invented by Booch et al. It is a standard language for creating software prototype.

Chapter III

Fuzzy Rule-Based Inference System

CHAPTER III

FUZZY RULE-BASED INFERENCE SYSTEM

3.1 INTRODUCTION

FIS is a well-known system based on the fuzzy logic. It is a computational process applied to fuzzy rules for evaluating the output from given input. It implements the logical unification over if-then rules to prepare effective conclusion rules. A rule-based fuzzy inference framework is a commixture of few subsystems which comprises of, a fuzzifier that produces the fuzzy values from crisp values, an inference system that performs computational operations over fuzzy input by utilizing knowledge base; a knowledge base incorporates fuzzy rules and membership functions, a defuzzifier that transforms the fuzzy outcome to crisp value. This computation procedure endows a backbone through which decisions are made and patterns are recognized.

This chapter explains the deputation of Rule-Based FIS on Naval military units for decision making. Naval military units are complex frameworks that are prescribed to accomplish their seaward goals in definite amount of time with full of effectiveness. Any meticulous delay in time during mission execution primordially impacts the overall achievement of goals. Any minor change to mission parameters at any stage of the mission requires labyrinthine judgments accompanied with all circumstances. The present study assists in decision-making process during any change in mission parameters pondering the unpredictability and vagueness of knowledge by using fuzzy concepts and emulates the selection mechanism of skilled personal by using rule-based inference system. Let us demonstrate the numerical application of the present study in brief:

3.2 PROPOSED MODEL FOR FIS

The strategy here exhibited, as said recently, plans to help to make a choice about the changing a unit to a particular mission. As expressed before, a few parameters that impact

such choice ought to be considered. However, goes for introducing an approach as opposed to formalizing the total choice system. In this way, four delegate parameters have been taken into the record and they have been distinguished by experts in military transport. Such parameters are the selection and maintenance of aim, efficiency of sub system, aim distance and sea condition. The efficiency of the framework associated with a mission is an essential concern and support operations are definitely restricted in seaward conditions. Moreover, the working states of frameworks and machinery must be considered as per the particular mission profile since the specific number of machines is required in every mission. Hence, it is begins with expected to individuate the dispatch subsystems (Cooperation and Synergy, Concentration of Force, Morale Security, ammunition etc...) whose operability is required to achieve mission tasks. Additionally, for every subsystem, the components must be distinguished and their efficiency must be connected to the efficiency of the whole ship as per the useful relations communicated by the model for Fuzzy Rule-Based Inference System diagram as represented in figure 3.1.

The FIS is applied to every subsystem by utilizing if-then rules and fuzzy operators, to decide the effect of every subsystem on the operational preparation. At the last stage of the proposed methodology, by considering the minimum value among the output values, a measure of the ship operational status, with the connection to a given mission, is provided. The less operator is selected to assure effectively perform mission undertakings.

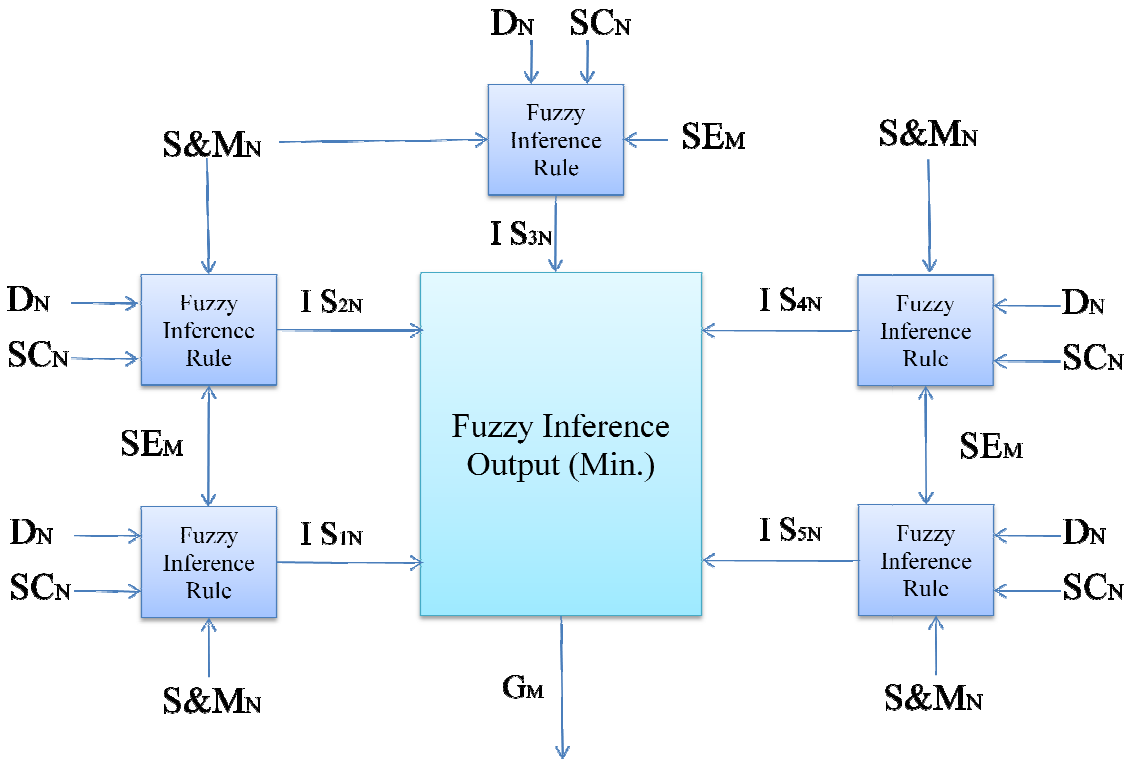

Figure 3.1 Model for Fuzzy Rule-Based Inference System

Where,

N= Mission/ AIM

M=Subsystem

D_N=Distance to Aim

SC_N=Sea Condition

$S\&M_N$=Selection and Maintenance of AIM

SE_M= Efficiency of Subsystem M with respect to the Mission/AIM

$I\ S_{MN}$=Impact of subsystem M on the Mission/Aim N.

G_M=Global Outcome exhibits the possibility of executing the Mission/AIM

A fundamental fuzzy logic system is constituted of four segments: a rules set, a fuzzifier, a fuzzy inference engine and a defuzzifier. The center of a FIS is its knowledge base, which is demonstrated as fuzzy principles. Here the fuzzy logic system utilized multi

input-single output system (MISO), utilizing the mamdani implications and the focal point of strategy as defuzzifier. At initial step of the inference procedure, it is expected to define the fuzzy set numbers to represent the crisp input values that are the fuzzification process, which comprises in allocating fuzzy semantic variables in the universe of each input value. Specifically, in this chapter, each input parameter is depicted by triangular and trapezoidal fuzzy numbers.

The next stage in the fuzzy logic system is to characterize the possible rules deriving from incorporating the fuzzy inputs. Principles are generally given by a group of specialists and are presented into the FIS. Afterward, since the value of the judgment parameters is crisp, the fuzzifier maps the input crisp numbers into the fuzzy sets to acquire degrees of membership. The inference engine of the FIS maps the forerunner fuzzy (IF part) sets into subsequent fuzzy sets (THEN part) considering the principles already expressed. The inference procedure decides the fuzzy subset of the output variable for each rule by utilizing the MIN operator (Mamdani operator) as suggestion operator. If more than one rule gives a similar outcome, an operator must aggregate the results of these rules. Specifically, the MAX operator is utilized. At last, the defuzzifier maps the fuzzy outcome into a crisp number, which turns into the outcome of the fuzzy logic system that is the effect of the generic subsystem on ships operational preparation is communicated in the block diagram as shown in figure 3.2.

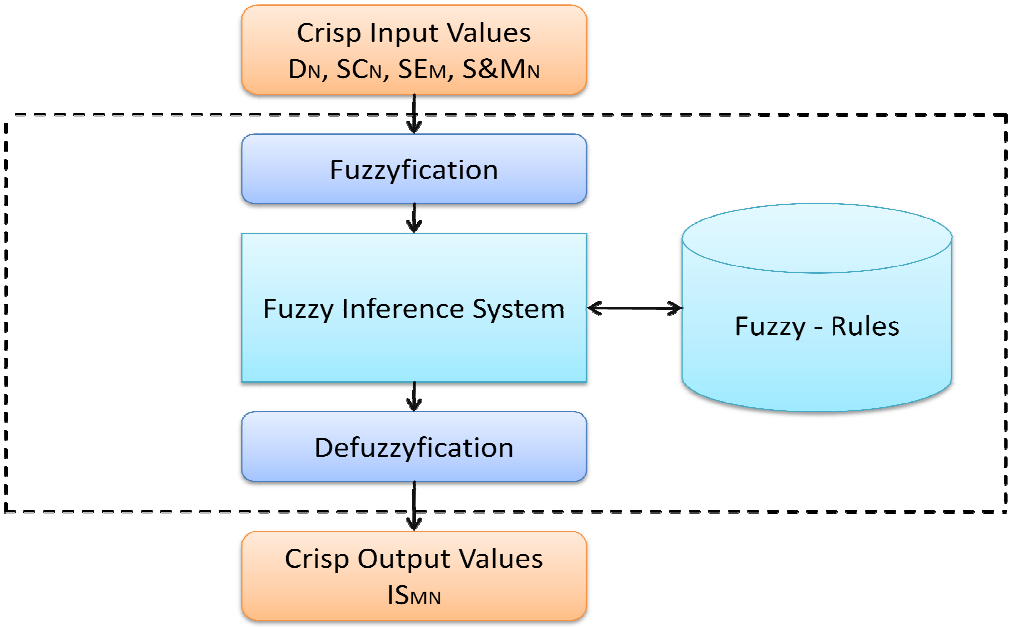

Figure 3.2 Block Diagram of FIS

3.3 IMPLEMENTATION OF PROPOSED MODEL

The proposed technique is connected to a recreated case with the connection to a military ship. The inference procedure is carried out by MATLAB [128]. It is gathered that the ship is constituted by the accompanying subsystem individuated as basic for the mission's prosperity: cooperation and synergy, concentration of force, morale security, ammunition, and logistics. Such a framework may experience distinctive stacking and business conditions in various missions' profiles with various dependability esteems. The reasonable structure is consequently constituted by the frameworks dependability (concurring to the mission profile), the separation from the nearest port and the states of the ocean. Each input parameter has three linguistic i.e. variables low, medium and high as shown in figures 3.3, 3.4, 3.5 and 3.6 portrayed by triangular and trapezoidal fuzzy numbers. The output parameter has five linguistic factors i.e. very low, low, medium, high and very high as shown in figure 3.7.

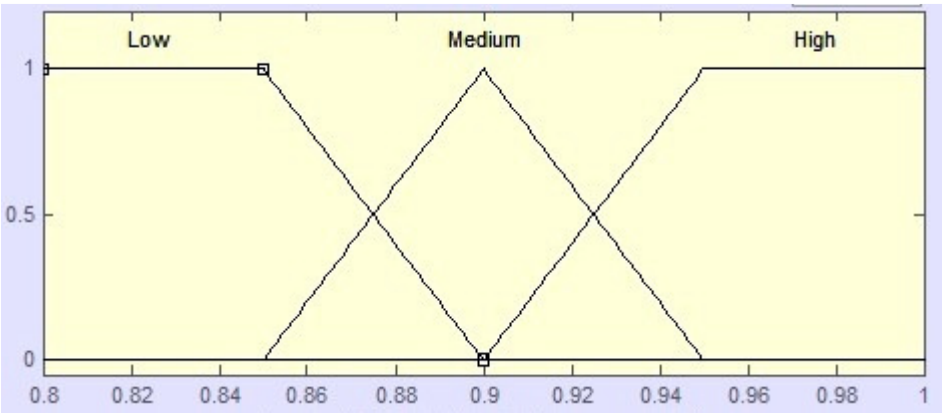

Figure 3.3 Selection and Maintenance of AIM

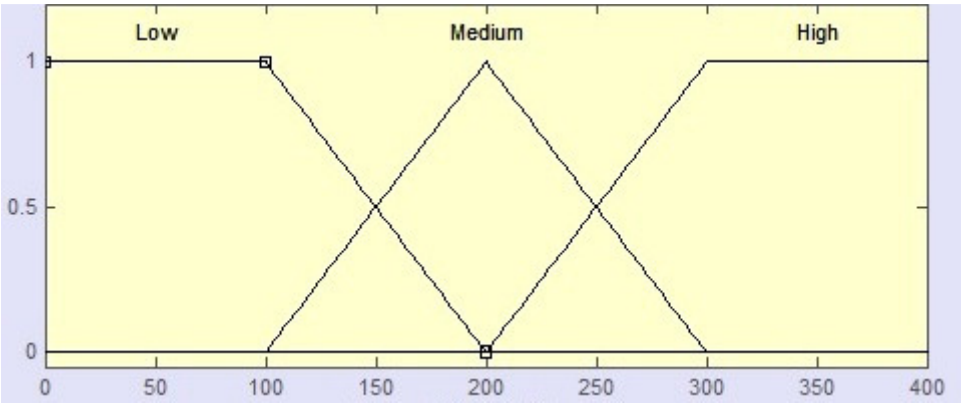

Figure 3.4 AIM Distance

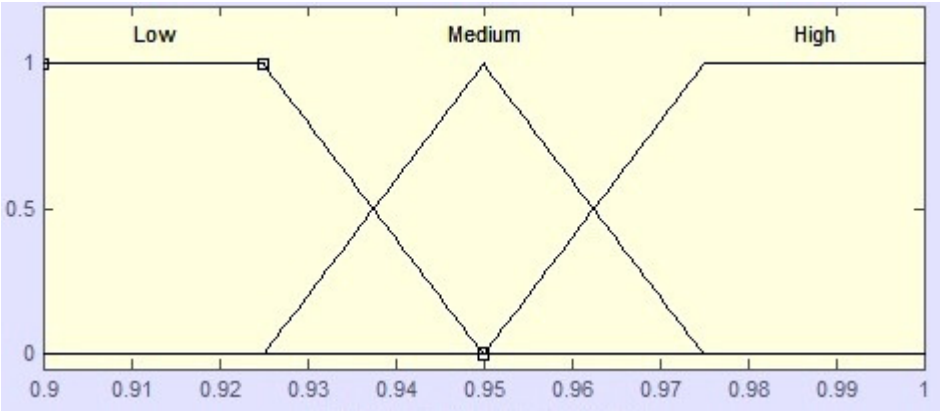

Figure 3.5 Subsystem Efficiency

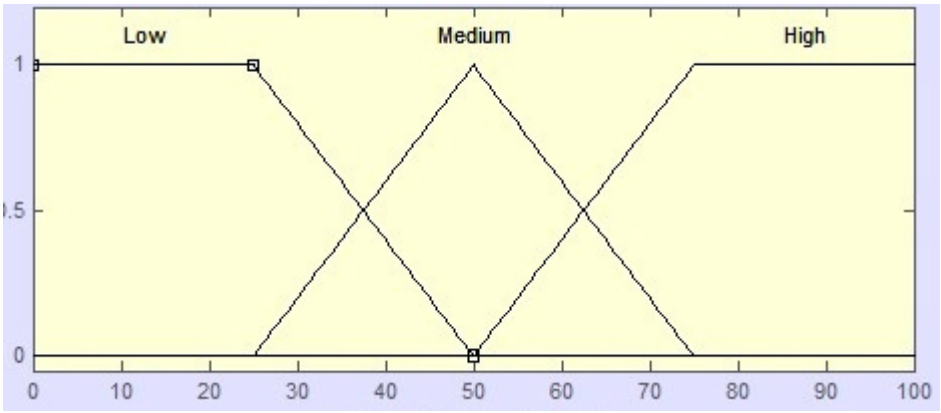

Figure 3.6 Sea Condition

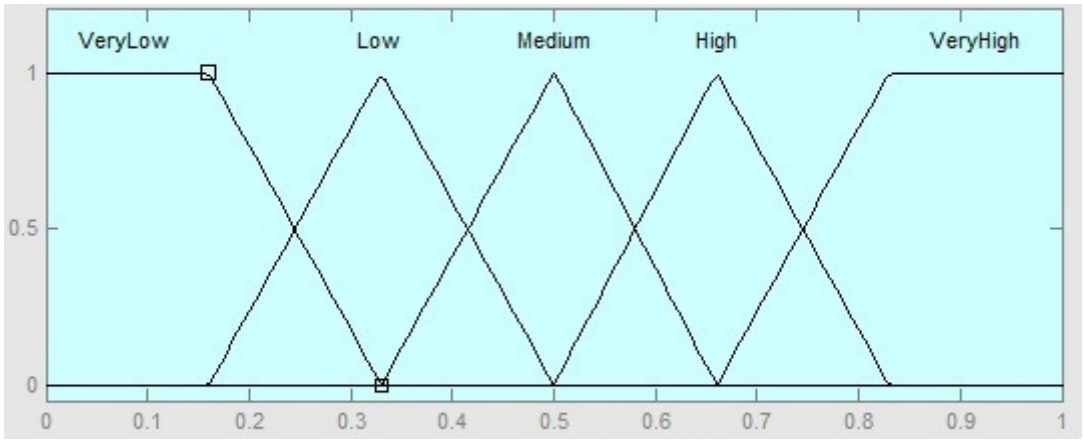

Figure 3.7 Impact on Successful Execution of Mission

The contribution of the generic subsystem M to the probability of executing the mission IS_{MN} is communicated by values having a place with the range [0; 1] and it can be represented. The dependability of each subsystem for the mission N, which constitutes a contribution to the decision framework, as shown in table 3.1 and the other input data of the mission N is shown in table 3.2. The set of standards individuated by the specialists are given in table 3.3. The related outcomes got by the inference procedure are accounted for in table 3.4. Subsequently, in this case, by applying the proposed strategy that is by taking the minimum value among the output value, the ship operational preparation with

the connection to a given mission is measured in the range [0, 1].

Table 3.1 Subsystem Efficiency

Subsystem	**Efficiency**
Cooperation and Synergy	0.98
Concentration of Force	0.95
Morale Security	0.92
Ammunition	0.94
Logistics	0.97

Table 3.2 Other Mission Execution Input Parameters

Selection and Maintenance of AIM	**Distance**	**Sea Condition**
0.92	250	60

Table 3.3 Fuzzy Rules

Selection and Maintenance of AIM	**Subsystem Efficiency**	**Distance of AIM**	**Sea Condition**	**Impact on Mission Execution G_M**
L	L	L	L	L
L	L	L	M	VL
L	L	L	H	VL
L	L	M	L	L
L	L	M	M	VL
L	L	M	H	VL
L	L	H	L	L

L	L	H	M	VL
L	L	H	H	VL
L	M	L	L	M
L	M	L	M	M
L	M	L	H	L
L	M	M	L	M
L	M	M	M	L
L	M	M	H	VL
L	M	H	L	VL
L	M	H	M	VL
L	M	H	H	VL
L	H	L	L	H
L	H	L	M	M
L	H	L	H	M
L	H	M	L	M
L	H	M	M	M
L	H	M	H	M
L	H	H	L	M
L	H	H	M	M
L	H	H	H	VL
M	L	L	L	M
M	L	L	M	M
M	L	L	H	L
M	L	M	L	M
M	L	M	M	M

M	L	M	H	L
M	L	H	L	L
M	L	H	M	L
M	L	H	H	VL
M	M	L	L	H
M	M	L	M	H
M	M	L	H	M
M	M	M	L	M
M	M	M	M	M
M	M	M	H	L
M	M	H	L	M
M	M	H	M	M
M	M	H	H	L
M	H	L	L	H
M	H	L	M	M
M	H	L	H	M
M	H	M	L	M
M	H	M	M	M
M	H	M	H	M
M	H	H	L	M
M	H	H	M	M
M	H	H	H	L
H	L	L	L	H
H	L	L	M	M
H	L	L	H	L

H	L	M	L	H
H	L	M	M	M
H	L	M	H	L
H	L	H	L	L
H	L	H	M	L
H	L	H	H	VL
H	M	L	L	H
H	M	L	M	H
H	M	L	H	M
H	M	M	L	H
H	M	M	M	H
H	M	M	H	M
H	M	H	L	M
H	M	H	M	M
H	M	H	H	L
H	H	L	L	VH
H	H	L	M	H
H	H	L	H	M
H	H	M	L	H
H	H	M	M	M
H	H	M	H	L
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H	H	H	M	M
H	H	H	H	L

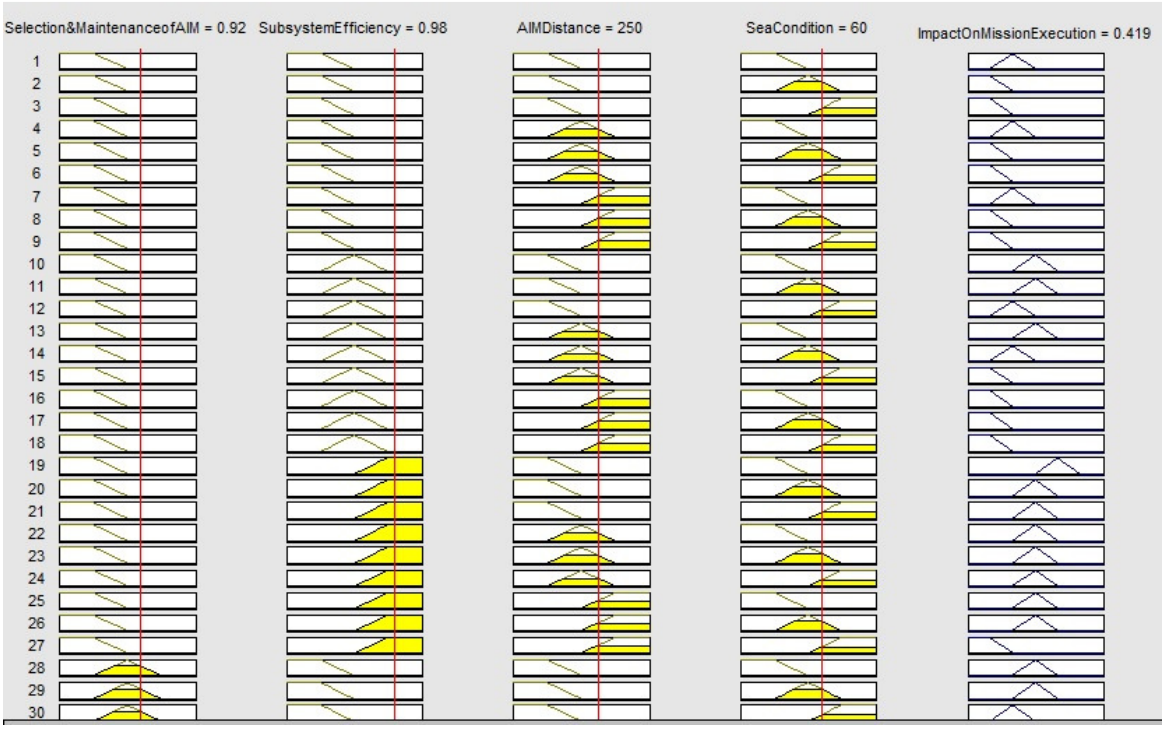

Figure 3.8 Impact of Cooperation and Synergy System

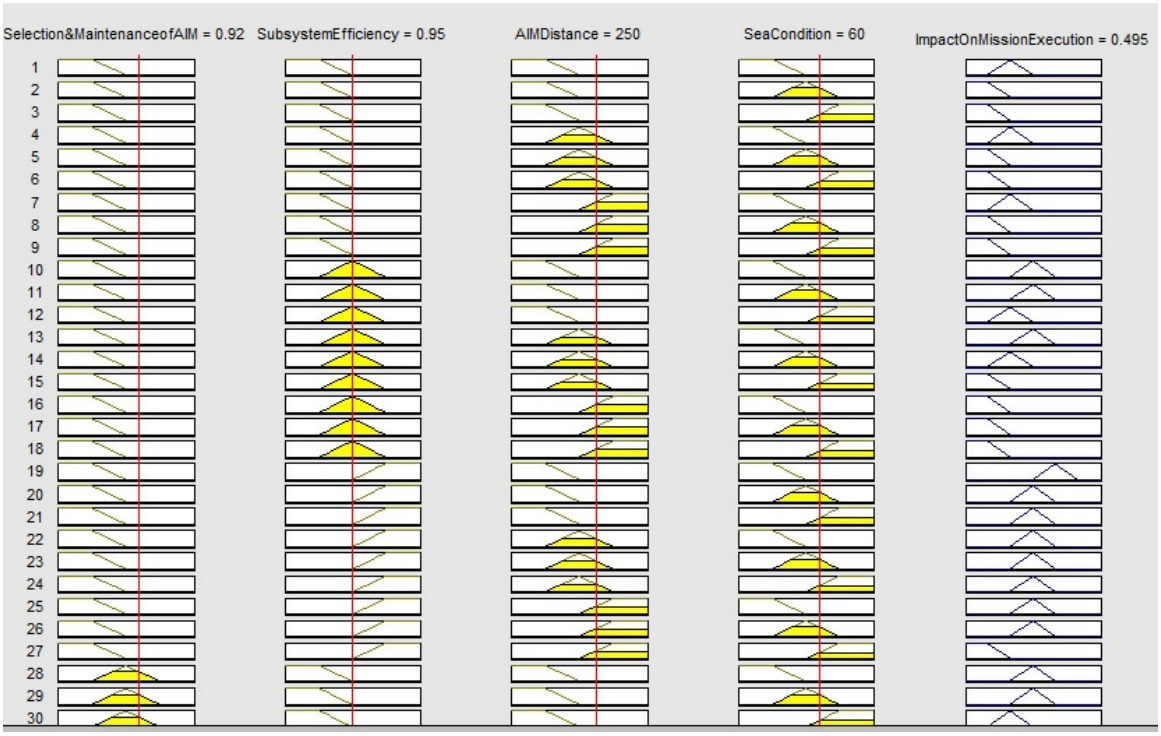

Figure 3.9 Impact of Concentration of Force system

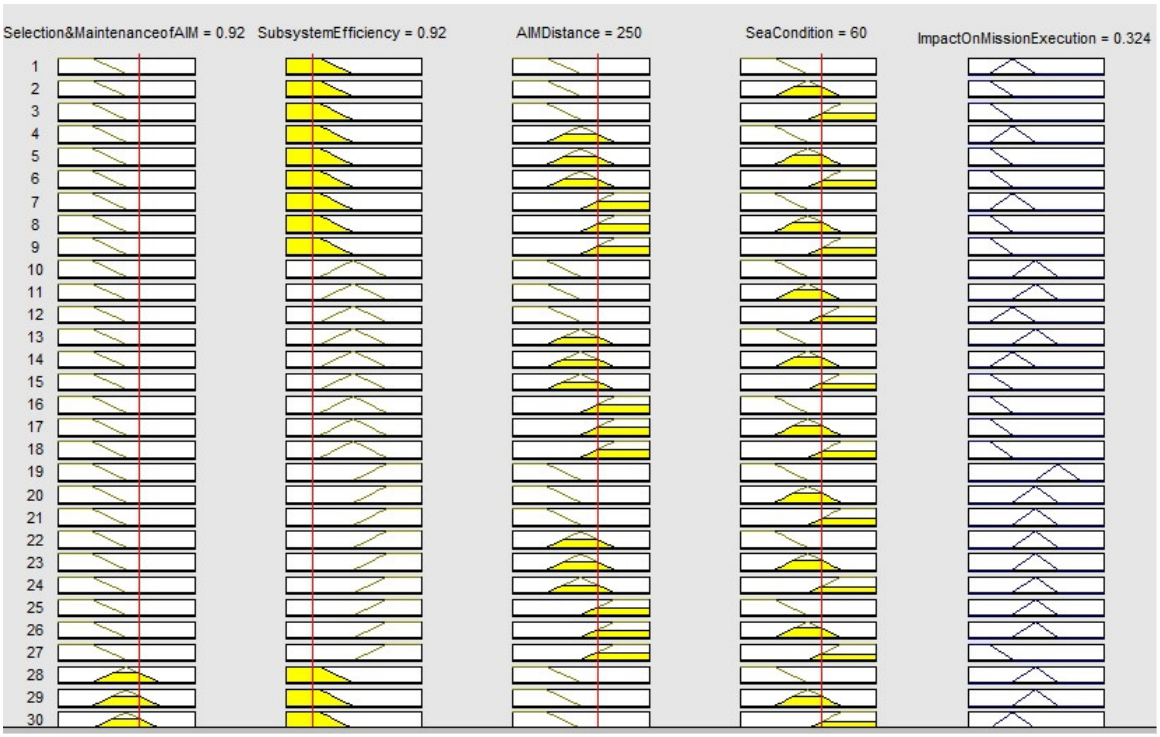

Figure 3.10 Impact of Morale Security system

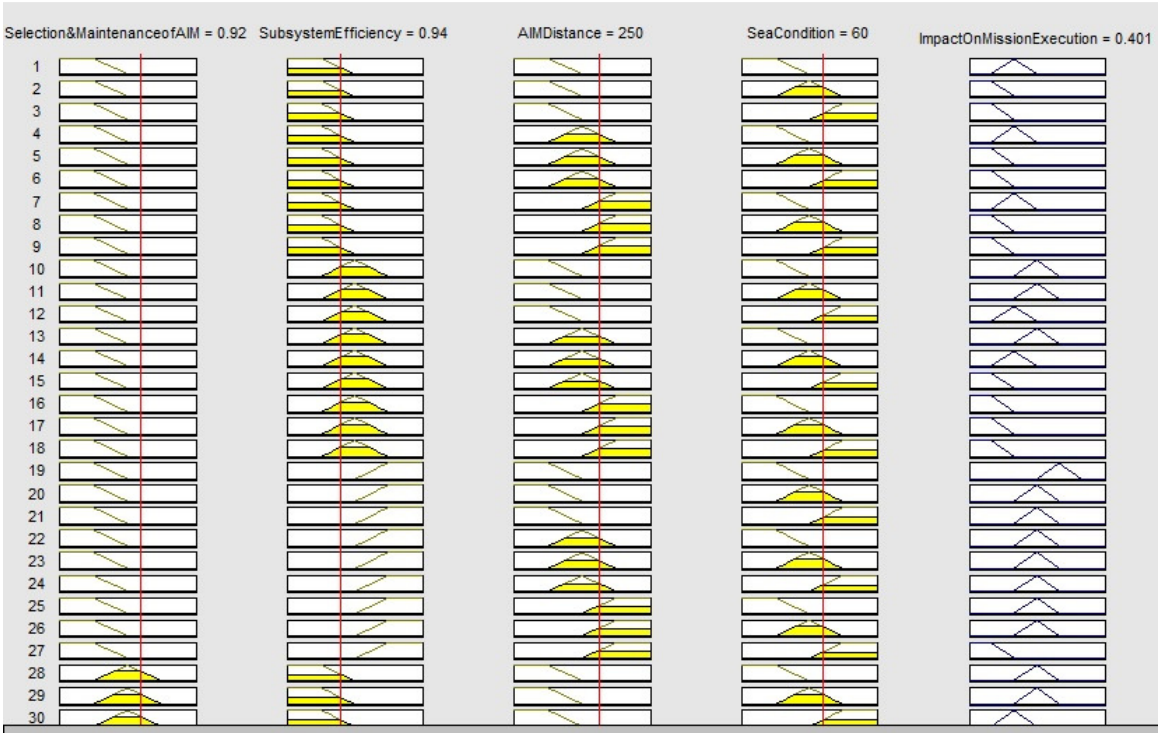

Figure 3.11 Impact of Ammunition system

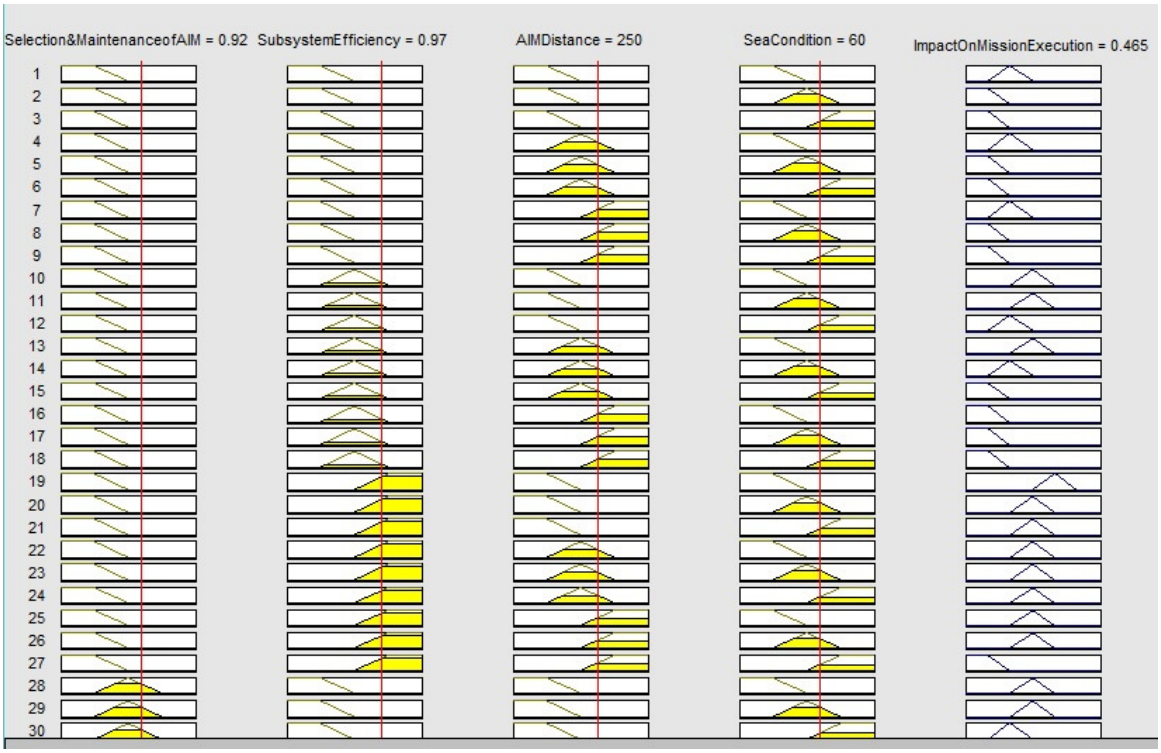

Figure 3.12 Impact of Logistics system

Table 3.4 Subsystem Impact on Mission Success

Subsystem	**Impact on Successful Execution of Mission**
Cooperation and Synergy	0.419
Concentration of Force	0.495
Morale Security	0.324
Ammunition	0.401
Logistics	0.465

3.4 RESULT ANALYSIS

The impact of each subsystem on mission success is calculated by applying various fuzzy rules in FIS. In this system, we have taken five different subsystem efficiency parameters

and three basic mission executing input parameters to calculate the outcome of our FIS. The subsystem parameters are cooperation and synergy, concentration of force, morale security, ammunition and logistics. We put these subsystem parameters with basic mission input parameters that are selection and maintenance of AIM, distance and sea condition. We put selection and maintenance of AIM is 0.92, distance is 250, sea-condition is 60 with different subsystem efficiency parameters as shown in table 3.1 and 3.2. After processing all these basic inputs with each subsystem inputs in FIS the outcome is generated.

The impact of cooperation and synergy on mission is 0.419 when cooperation and synergy is 0.98 as shown in figure 3.8, similarly the impact of concentration of force on mission is 0.495 when concentration of force is 0.95 as shown in figure 3.9, the impact of morale security on mission is 0.324 when morale security is 0.92 as shown in figure 3.10, the impact of ammunition on mission is 0.401 when ammunition is 0.94 as shown in figure 3.11 and impact the of logistics on mission is 0.465 when logistics is 0.97 as shown in figure 3.12.

3.5 MAJOR FINDINGS

In this chapter, the decision-making process for employing a naval military unit to a mission has been acknowledged. The process of decision making generally imploring human intelligence which comprises of awareness concerning natural conditions, the functioning of ammunition, sufficient logistics and so on. These type of information is difficult to validate by ordinary numerical methods due its vagueness and ambiguity, though these parameters require specialist decision making and thinking for making the process effective. In this study, an expert's decision choice assists in light of a rule-based

FIS is presented, which allows pondering expert's participation in the judgments of the likelihood of a naval military unit accomplishing the mission. The mission is drafted by a specific mission profile which represents the beginning of the mission, execution time and the organization of subsystem are considered. The numerical application determines that proposed methodology is effective to help in choice based decision making process providing a universal score transmitting the likelihood of the naval military unit to accomplish mission goals, hence it supports the viability of rule-based fuzzy inference mechanism in decision making.

Chapter IV

Fuzzy Data Transfer Approach Across Distributed Network

CHAPTER IV

FUZZY DATA TRANSFER APPROACH ACROSS DISTRIBUTED NETWORK

4.1 INTRODUCTION

Lotfi A. Zadeh discovered the Fuzzy logic, which is a new approach in boolean algebra. Apart from Boolean algebra, the fuzzy logic is different in such a way that it gives more accurate consequences than the simple on/off or yes/no. Boolean algebra works only with true and false which denotes 1 and 0 whereas fuzzy logic yields all the possibilities that lie between the exact YES and NO. To deal with real-world problems, fuzzy logic is very beneficial because it deals with the probabilities or likelihood of the events to be occur. We can also say that fuzzy logic is simply a generalization of the boolean set. The extremely crucial thing is that the function area of fuzzy logic is massive due to its forecasting mechanism on uncertain or ambiguous data input. The massive functional areas of fuzzy logic consist of robotics, artificial intelligence, aerospace, weather forecasting, automotive, Stock market predictions, naval decision support aids, pattern recognition, medical, train schedule control, supply chain management, psychology, criminal investigation etc.

In the current scenario of the competitive world, to improve the services and reduce the cost as per user need, the transportation model plays an important role in supply chain management. Today the main adversity of an organization is to explore the best mechanism to construct and deliver values and services to consumers as per consumer's need within feasible time and cost. A robust framework was furnished by the transport model to fulfill these requirements effectively. For resolving real-world problems and obtain the feasible solution, there are various methods to resolve transportation problem in fuzzy conditions like Row minima, Column minima, North-West Corner method,

VAM etc. Literature manifested that various researchers have resolved many different types of security threats by use of various methodologies with special context to transportation problems but still there is less amount of research work is available for fuzzy transportation.

In this chapter, two different methodologies are proposed to resolve fuzzy transportation problems and provide the feasible solution with less number of iterations as compared to other existing methods. A fuzzy transportation problem is a transportation problem where the transportation quantities i.e. supply, demand, and costs are articulated in fuzzy numbers. Both the proposed methodologies are based on the different degree of membership functions of fuzzy numbers i.e. the first one is based on the triangular fuzzy number and the other is based on the trapezoidal fuzzy number with a ranking function. Basically, in this chapter, both the proposed methodologies are illustrated for secure and optimal data transmission in a distributed network across the various source and destination nodes which comprises of desktop, mobile devices, laptop, hand-held devices and other network devices. Both the proposed methodologies are easy to understand and can be implemented in real-world problems for effective and efficient decision making. Apart from secure and optimal data transmission across a distributed network, both the proposed methodologies can also be applied to solve other real-world problems like weather forecasting, automotive, aerospace, naval decision support aids, stock market predictions, pattern recognition, medical, railway traffic system, supply chain management, criminal investigation etc.

To exemplify both the proposed methodologies, there are different numerical examples are solved and the obtained results are compared with the other existing methods. After

the comparison, it is observed that both the proposed methodologies performed well and produced the feasible result as compare to other existing methods. Let us briefly illustrate both the proposed methodologies.

4.2 PRELIMINARIES

4.2.1 Fuzzy Number

As described by Lotfi A. Zadeh [113], a fuzzy number Ã is a fuzzy subset of real number R if their memberships function $\mu_{\tilde{A}}$ qualifies the three following properties,

(i) $\mu_{\tilde{A}}(x)$ is a continuous function from R to a closed subset [0, 1];

(ii) $\mu_{\tilde{A}}(x)$ is strictly increasing in the closed interval $[a_1, a_2]$;

(iii) $\mu_{\tilde{A}}(x)$ is strictly decreasing on $[a_3, a_4]$ where $a_1 < a_2 < a_3 < a_4$ and $x \in [a_1, a_4]$

Definition 1: A fuzzy number is said to be a convex normalized fuzzy set of the real line R, whose membership function is section wise continuous. We represent the set of fuzzy numbers on R as F(R).

Definition 2: A fuzzy set distinguished by a membership function mapping element of a domain, universe of discourse X to the unit interval [0, 1] i.e. $A = \{x, \mu_{\tilde{A}}(x); x \in X\}$, Here $\mu_{\tilde{A}} : X \to [0,1]$ is a mapping known as the degree of membership function of the fuzzy set A and μA(x) is known as the membership value of $x \in X$ in the fuzzy set A. These membership categories often represented by real numbers ranging from [0, 1].

Definition 3: A Fuzzy set $\tilde{A}$ explained as a set of ordered pairs $(X, \mu_{\tilde{A}}(x))$, where X is a component of the universe of discourse U and $\mu_{\tilde{A}}(x)$ is the membership function that

imputes to each $X \in U$ a real number $\in [0,1]$ relating the degree to which X belongs to the set.

Definition 4: A type n fuzzy set is a fuzzy set whose membership values are type $n-1,\ n>1,$ fuzzy sets on $[0,1]$.

Definition 5: For a finite fuzzy set $\tilde{A}$ the cardinality $\left|\tilde{A}\right|$ is defined as $\left|\tilde{A}\right| = \sum_{x \in X} \mu_{\tilde{A}}(\mathrm{x})$

$\left\|\tilde{A}\right\| = \frac{\left|\tilde{A}\right|}{X}$ is called the relative cardinality of $\tilde{A}$.

Definition 6: A crisp set is a particular case of fuzzy set in which membership function uses only two values 0 and 1.

4.2.2 Properties of Trapezoidal Fuzzy Number

The following are properties of trapezoidal fuzzy number:

1. The trapezoidal fuzzy number $\tilde{\mathrm{A}} = (\mathrm{a}_1, \mathrm{a}_2, \mathrm{a}_3, \mathrm{a}_4)$ is said to be non- negative trapezoidal number Iff $a_1 - a_3 \geq 0$.
2. The trapezoidal fuzzy number $\tilde{\mathrm{A}} = (\mathrm{a}_1, \mathrm{a}_2, \mathrm{a}_3, \mathrm{a}_4)$ is said to be zero trapezoidal fuzzy number Iff $\mathrm{a}_1 = 0, \mathrm{a}_2 = 0, \mathrm{a}_3 = 0, \mathrm{a}_4 = 0$.
3. Two trapezoidal fuzzy number $\tilde{\mathrm{A}} = (\mathrm{a}_1, \mathrm{a}_2, \mathrm{a}_3, \mathrm{a}_4)$ and $\tilde{B} = (\mathrm{b}_1, b_2, b_3, b_4)$ are said to be equal Iff $\mathrm{a}_1 = \mathrm{b}_1,\ \mathrm{a}_2 = b_2,\ \mathrm{a}_3 = b_3,\ \mathrm{a}_4 = b_4$.

4.2.3 Arithmetic Operators for Solving Trapezoidal Fuzzy Number

Let us consider $\tilde{X} = (p_1, q_1, r_1, s_1)$ and $\tilde{Y} = (p_2, q_2, r_2, s_2)$ are two trapezoidal fuzzy numbers then the basic arithmetic operations on $\tilde{X}$ and $\tilde{Y}$ as follows:

(i) Addition $\tilde{X}+\tilde{Y}=(p_1+p_2,\ q_1+q_2,\ r_1+r_2,\ s_1+s_2)$

(ii) Subtraction $\tilde{X}-\tilde{Y}=(p_1-s_2,\ q_1-r_2,\ r_1-q_2,\ s_1-p_2)$

(iii) Multiplication $\tilde{X}\bullet\tilde{Y}=(m_1,m_2,m_3,m_4)$

where

m1 = minimum $\{p_1p_2, p_1s_2, s_1p_2, s_1s_2\}$

m2= minimum $\{q_1q_2, q_1r_2, r_1q_2, r_1r_2\}$

m3 = maximum $\{q_1q_2, q_1r_2, r_1q_2, r_1r_2\}$

m4 = maximum $\{p_1p_2, p_1s_2, s_1p_2, s_1s_2\}$

Example:

Let $\tilde{X}\ and\ \tilde{Y}$ are two trapezoidal fuzzy numbers

Where $\tilde{X}=(4,5,6,7)$ and $\tilde{Y}=(6,7,8,9)$ *then,*

$$(i)\ \tilde{X}+\tilde{Y}=(4,5,6,7)+(6,7,8,9)$$
$$=(4+6,\ 5+7,\ 6+8,7+9)$$
$$=(10,12,14,16)$$

$$(ii)\ \tilde{X}-\tilde{Y}=(4,5,6,7)-(6,7,8,9)$$
$$=(4-9,5-8,6-7,7-6)$$
$$=(-5,-3,-1,1)$$

$$(iii)\ \tilde{X}\bullet\tilde{Y}=(4,5,6,7)\bullet(6,7,8,9)$$

= (min (24, 36, 42, 63), min (35, 40, 42, 48), max (35, 40, 42, 48), max (24, 36, 42, 63))

= (24, 35, 48, 63)

4.2.4 Ranking Function

We define a ranking function F (R), which maps each fuzzy into the real line. F(μ) represents the set of all trapezoidal numbers. If R be a ranking function and let $\tilde{a} = (a_1, a_2, a_3, a_4) \in F(\mu)$. Then,

$$R(\tilde{a}) = (a_1 + a_2 + a_3 + a_4)/4 \tag{4.1}$$

For any two trapezoidal Fuzzy number $\tilde{a} = (a_1, a_2, a_3, a_4)$ and $\tilde{b} = (b_1, b_2, b_3, b_4)$ in F(μ) then,

- $\tilde{a} \leq \tilde{b} \Leftrightarrow R(\tilde{a}) \leq R(\tilde{b})$
- $\tilde{a} \geq \tilde{b} \Leftrightarrow R(\tilde{a}) \geq R(\tilde{b})$
- $\tilde{a} = \tilde{b} \Leftrightarrow R(\tilde{a}) = R(\tilde{b})$

4.2.5 Fuzzy Transportation Problem

In a traditional transportation problem, it is required that the decision maker has right data about the facts of having a place of the issue. Although, in real-life situations, the transportation demands, supply and cost of an item may not be known well due to wild elements. To extricate such circumstances, the fuzzy set theory is implemented in the documentation for facing transportation issues. The fuzziness in a transportation issue might be recognized with the trouble of scaling or predicting the unit transportation demand, supply and cost. The fuzziness in the supply might be denoted as "the amount readily available is imprecise . . ." which demonstrate that there is versatility in the supply; or that a more perceptible supply might be conceivable. In the same style, the decision maker may be satisfied if the amount got a goal is an approximated esteem or might have the efficiency to undertake an amount lower than the objective esteem. The

objective is to minimize the total cost of the fuzzy transportation problem and the demand and supply constraints are available to each source and destination correspondingly.

A FTP; in which a decision maker is uncertain about the actual demand, supply and transportation cost proceedings might be calculated mathematically.

Consider a transportation issue with x supply nodes and y demand nodes, in that $s_j > 0$ units are provided by supply i and by demand node j the required nodes are dj> 0. Related to each connection (i, j) from supply node i to demand node j, for transportation there is a unit shipping cost C_{ij}. The issue is to decide an optimal method for transportation; the readily available add up to satisfy the demand that minimizes the overall transportation cost.

Let X_{ij} revealed the number of units which are transported from Supply i to Demand j. The mathematical formulation of the transportation problem is as follows:

$$Z = \min \sum_{i=1}^{m} \sum_{j=1}^{n} C_{ij} X_{ij} \tag{4.2}$$

$$s.t. \quad \sum_{j=1}^{n} X_{ij} \le s_i \qquad i = 1, 2, ...m,$$

$$\sum_{j=1}^{m} X_{ij} \ge d_j \qquad j = 1, 2, ...n,$$

$$X_{ij} \ge 0 \quad \forall i, j$$

4.3 PROPOSED METHODOLOGIES

In this chapter, there are two methodologies proposed and let us briefly explain both the methodologies:

4.3.1 Data Transfer Through Fuzzy Vogel's Approximation

Consider a transportation problem in which a cell C_{ij} represents the transportation cost from i to j, where i is the number of rows and j is the number of columns. Convert the transportation problem into fuzzy transportation problem and then solve with the following steps:

Step 1: Balance the given transportation problem if either (total supply > total demand) or (total supply < total demand) by adding dummy row or column;

Step 2: Compute the fuzzy penalty cost for each row and column of the transportation matrix by calculating the square root of the difference between minimum and next-to-the-minimum transportation cost C_{ij} in that row or column;

Step 3: If minimum transportation cost C_{ij} appear two or more times in a row or column then select this same transportation cost C_{ij} as a minimum and next to minimum transportation cost and penalty will be zero;

Step 4: Identify the row or column with the largest fuzzy penalty cost. If tie occurs, than select that row or column where transportation cost C_{ij} is minimum. If again tie occurs in minimum transportation cost C_{ij}, than select that row or column where total transportation cost of that row or column is minimum;

Step 5: Now allocate as much as possible feasible amount to that smallest transportation cost C_{ij} cell in that row or column;

Step 6: Adjust the supply and demand and cross out the satisfied row or column. If row and column are satisfied simultaneously then crossed out one of them and remaining row or column is assigned a zero supply or demand;

Step 7: Again compute the fuzzy penalty cost for each row and column of the transportation matrix until all requirements have been satisfied;

Step 8: Finally, calculate the total fuzzy transportation cost for the fuzzy feasible cost allocations using the original balanced fuzzy transportation matrix;

4.3.1.1 Numerical Example

A sample of transportation problem is obtained from secure data transfer software shown in the following table 4.1. A secure data transfer software installed in both sender and receiver. A sender sends the same amount of data to various receivers and it has different completion time. Due to machine parameter, receiver receives same amount of data in different completion time. The absolute parameters of data transfer through data transfer software shows the status of data, size of data, create time, finish time, complete time, an average speed of transfer and time consumed. The completion time of data has been taken as sample data which is in seconds. In this process, the data has been send multiple times based on different parameters to the various receivers located at different locations. The following table 4.1 shows the data which took at random once. For accuracy, data is transferred multiple times which is shown in fuzzy form in table 4.2. On that fuzzy data, we applied proposed algorithm to find the more accurate optimal cost.

The following figure 4.1 shows the data transfer process form sender to receivers.

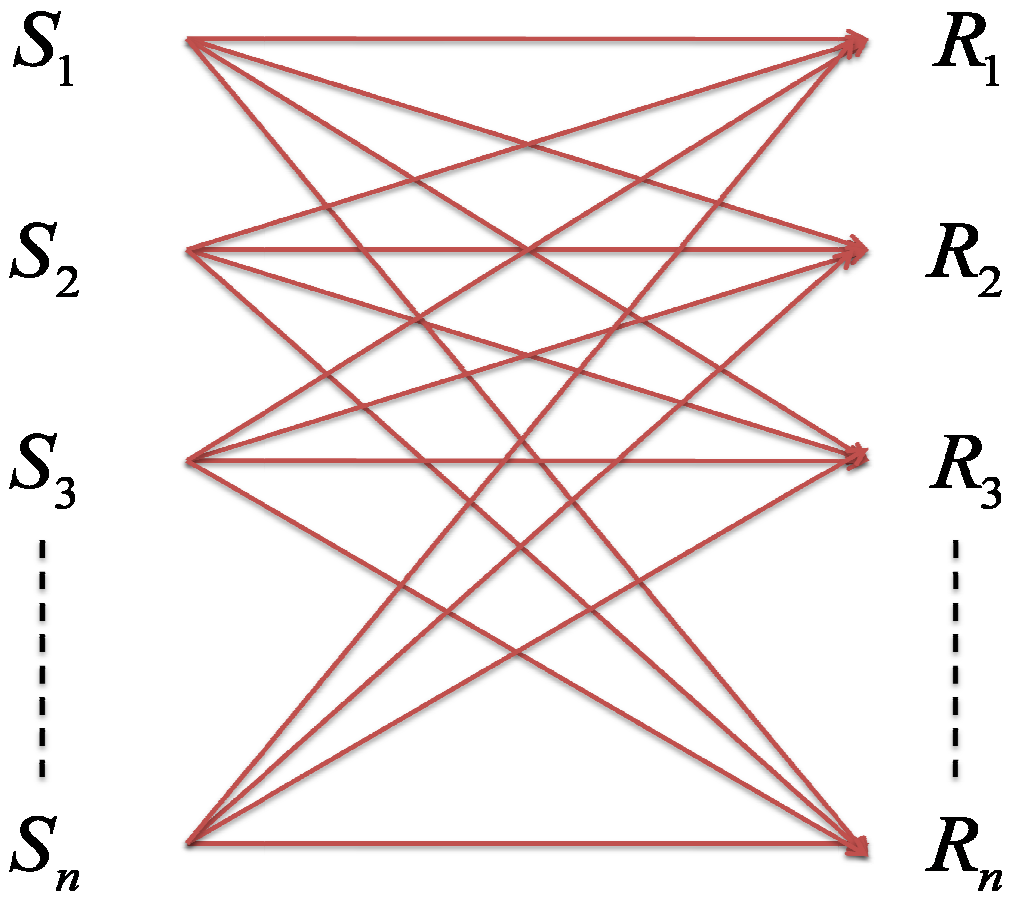

Figure 4.1 Data Transfer Process

Table 4.1 A Sample of Transportation Problem

	R_1	R_2	R_3	R_4	R_5	R_6	R_7	Supply
S_1	489	350	142	365	424	272	272	2314
S_2	272	410	350	489	365	489	253	2628
S_3	424	489	365	253	410	410	142	2493
S_4	365	257	472	272	350	410	142	2268
S_5	350	272	365	472	410	257	272	2398
Demand	1900	1778	1694	1851	1959	1838	1081	

Table 4.2 Conversion of Transportation Problem into Fuzzy Transportation Problem

RECEIVER / SENDER	R_1	R_2	R_3	R_4	R_5	R_6	R_7	Supply
S_1	(449,489,529)	(320,350,380)	(132,142,152)	(325,365,405)	(389,424,459)	(252,272,292)	(252,272,292)	(2014,2314,2614)
S_2	(252,272,292)	(385,410,435)	(320,350,380)	(449,489,529)	(325,365,405)	(449,489,529)	(223,253,283)	(2278,2628,2978)
S_3	(389,424,459)	(449,489,529)	(325,365,405)	(223,253,283)	(385,410,435)	(385,410,435)	(132,142,152)	(2213,2493,2773)
S_4	(325,365,405)	(222,257,292)	(422,472,522)	(252,272,292)	(320,350,380)	(385,410,435)	(132,142,152)	(2018,2268,2518)
S_5	(320,350,380)	(252,272,290)	(325,365,405)	(422,472,522)	(385,410,435)	(222,257,292)	(252,272,292)	(2118,2398,2678)
Demand	(1650,1900,2150)	(1578,1778,1978)	(1544,1694,1844)	(1601,1851,2101)	(1679,1959,2239)	(1638,1838,2038)	(981,1081,1181)	

In the first iteration, fuzzy penalty cost for each row and column of the transportation matrix is obtained by calculating the square root of the difference between the minimum and next-to-the-minimum transportation cost C_{ij} in that row or column. As shown in table 4.3, the fuzzy penalty cost for row S_1 is obtained by calculating the square root of the difference between 142 and 272 i.e. 11.40, similarly fuzzy penalty cost for each row and column is calculated. Now identify the row or column with the largest fuzzy penalty cost i.e. 14.42 than select that row or column where transportation cost C_{ij} is minimum i.e.142 (C_{13}). Now allocate as much as possible feasible amount i.e. (**1544, 1694, 1844**) to that smallest transportation cost C_{13} cell in that row or column than adjust the supply and demand and cross out the satisfied row or column. If row and column are satisfied simultaneously then crossed out one of them and remaining row or column is assigned a zero supply or demand. Again compute the fuzzy penalty cost for each row and column of the transportation matrix until all requirements have been satisfied. After satisfying all the requirements of the transportation matrix the final allocation matrix is obtained as shown in table 4.4.

Table 4.3 Computation of First Iteration for Fuzzy VAM

RECEIVER → / SENDER ↓	R_1	R_2	R_3	R_4	R_5	R_6	R_7	Supply	*Row Penalty*
S_1	(449,489,529)	(320,350,380)	(132,142,152) **(1544,1694, 1844)**	(325,365,405)	(389,424,459)	(252,272,292)	(252,272,292)	**(570,620,670)**	11.40
S_2	(252,272,292)	(385,410,435)	(320,350,380)	(449,489,529)	(325,365,405)	(449,489,529)	(223,253,283)	(2278.2628, 2978)	4.36
S_3	(389,424,459)	(449,489,529)	(325,365,405)	(223,253,283)	(385,410,435)	(385,410,435)	(132,142,152)	(2213,2493, 2773)	10.54
S_4	(325,365,405)	(222,257,292)	(422,472,522)	(252,272,292)	(320,350,380)	(385,410,435)	(132,142,152)	(2018,2268, 2518)	10.72
S_5	(320,350,380)	(252,272,290)	(325,365,405)	(422,472,522)	(385,410,435)	(222,257,292)	(252,272,292)	(2118.2398, 2678)	3.87
Demand	(1650,1900, 2150)	(1578,1778, 1978)	**0**	(1601,1851, 2101)	(1679,1959, 2239)	(1638,1838, 2038)	(981,1081, 1181)		
Column Penalty	8.83	3.87	**14.42**	4.36	3.87	3.87	10.54		

Table 4.4 Final Allocation Matrix

RECEIVER → / SENDER ↓	R_1	R_2	R_3	R_4	R_5	R_6	R_7	Supply
S_1	(449,489,529)	(320,350,380)	(132,142,152) **(1544,1694,1844)**	(325,365,405)	(389,424,459) **(539,589,639)**	(252,272,292) **(26,31,36)**	(252,272,292)	(2014,2314,2614)
S_2	(252,272,292) **(1650,1900,2150)**	(385,410,435)	(320,350,380)	(449,489,529)	(325,365,405) **(678,728,778)**	(449,489,529)	(223,253,283)	(2278,2628,2978)
S_3	(389,424,459)	(449,489,529)	(325,365,405)	(223,253,283) **(1601,1851,2101)**	(385,410,435) **(582,642,702)**	(385,410,435)	(132,142,152)	(2213,2493,2773)
S_4	(325,365,405)	(222,257,292) **(1037,1187,1337)**	(422,472,522)	(252,272,292)	(320,350,380)	(385,410,435)	(132,142,152) **(981,1081,1181)**	(2018,2268,2518)
S_5	(320,350,380)	(252,272,290) **(546,591,636)**	(325,365,405)	(422,472,522)	(385,410,435)	(222,257,292) **(1607,1807,2007)**	(252,272,292)	(2118,2398,2678)
Demand	(1650,1900,2150)	(1578,1778,1978)	(1544,1694,1844)	(1601,1851,2101)	(1679,1959,2239)	(1638,1838,2038)	(981,1081,1181)	

After applying the proposed Fuzzy VAM, The total obtained fuzzy transportation cost is **3096471** in **09** iterations only.

4.3.2 Ranking Based Fuzzy Data Transfer Approach

Convert the sample data into fuzzy transportation problem using a ranking method with the following steps:

Step 1: Balance the given transportation problem if either (total supply > total demand) or (total supply < total demand).

Step 2: Determine the fuzzy penalty cost for each row and column by calculating the negative mean of minimum cost and next to the minimum cost of each row and column i.e. dividing the difference of minimum cost and next to minimum cost by 2.

Step 3: If the minimum cost occurs more than one time in a row and column then choose the same transportation cost as minimum cost and next to minimum cost and penalty will become zero.

Step 4: Select the rows or columns with the highest penalty costs (breaking ties arbitrarily or choosing the lowest- cost cell). If there is tie occurs in highest penalty cost, then choose that row or column where cost is minimum.

Step 5: Compute transportation costs for selected rows or columns in step 4 by allocating as much as the possible amount to the feasible cell with the lowest transportation cost.

Step 6: Now adjust all the row and column and cross out satisfied row or column. If satisfied simultaneously then crossed out one of them and assign zero to remaining rows and columns.

Step 7: Repeat steps 2-6 until all requirements have been meet.

Step 8: Compute total transportation cost for the feasible allocations using the original balanced-transportation cost matrix.

4.3.2.1 Numerical Example-1

A sample of transportation problem has taken from table 4.1 which was taken at random once. For more accuracy, we fuzzified the data in trapezoidal fuzzy number shown below in table 4.5 which is based on transferring the data multiple times over the distributed network. Now, on that fuzzy data we applied our proposed ranking based fuzzy data transfer approach to finding the more accurate optimal cost.

Table 4.5 Conversion of Transportation problem into Fuzzy Transportation Problem (Trapezoidal Fuzzy Number)

RECEIVER → / SENDER ↓	R_1	R_2	R_3	R_4	R_5	R_6	R_7	Supply
S_1	(449,469,509,529)	(325,340,360,375)	(129,139,143,153)	(350,360,370,380)	(410,420,428,438)	(252,268,274,290)	(252,268,274,290)	(2291,2301,2321, 2331)
S_2	(252,268,274,290)	(393,405,413,425)	(325,340,360,375)	(449,469,509,529)	(350,360,370,380)	(449,469,509,529)	(231,247,257,273)	(2598,2613,2637, 2652)
S_3	(410,420,428,438)	(449,469,509,529)	(350,360,370,380)	(231,247,257,273)	(393,405,413,425)	(393,405,413,425)	(129,139,143,153)	(2459,2479,2499, 2519)
S_4	(350,360,370,380)	(240,252,260,272)	(437,462,482,507)	(252,268,274,290)	(325,340,360,375)	(393,405,413,425)	(129,139,143,153)	(2219,2249,2279, 2309)
S_5	(325,340,360,375)	(252,268,274,290)	(350,360,370,380)	(437,462,482,507)	(393,405,413,425)	(240,252,260,272)	(252,268,274,290)	(2379,2389,2399, 2409)
Demand	(1874,1889,1909, 1924)	(1760,1770,1780, 1790)	(1670,1685,1701, 1716)	(1829,1839,1859, 1869)	(1939,1949,1965, 1975)	(1814,1824,1844, 1854)	(1060,1070,1082, 1092)	

In table 4.6, fuzzy transportation problem is shown which is obtained after applying the ranking technique on trapezoidal fuzzy transportation problem shown in table 4.5.

Table 4.6 Transportation Problem After Applying Ranking Method (Example-1)

	R_1	R_2	R_3	R_4	R_5	R_6	R_7	**Supply**
S_1	489	350	141	365	424	271	271	2311
S_2	271	409	350	489	365	489	252	2625
S_3	424	489	365	252	409	409	141	2489
S_4	365	256	472	271	350	409	141	2264
S_5	350	271	365	472	409	256	271	2394
Demand	1899	1775	1693	1849	1957	1834	1076	

The proposed ranking based fuzzy data transfer technique was applied to the above data of table 4.6. The total obtained fuzzy transportation cost is **3077806** and on the same data of table 4.6 VAM was applied and got the cost **3096471.**

4.3.2.2 Numerical Example-2

Another example has also been taken which is shown in table 4.7 that was solved by various authors [77, 17, 70] which is also tested by the proposed methodology 4.3.2.

Table 4.7 Trapezoidal Fuzzy Transportation Problem

	D_1	D_2	D_3	D_4	**Supply**
S_1	(1,2,3,4)	(1,3,4,6)	(9,11,12,14)	(5,7,8,11)	(1,6,7,12)
S_2	(0,1,2,4)	(-1,0,1,2)	(5,6,7,8)	(0,1,2,3)	(0,1,2,3)
S_3	(3,5,6,8)	(5,8,9,12)	(12,15,16,19)	(7,9,10,12)	(5,10,12,17)
Demand	(5,7,8,10)	(1,5,6,10)	(1,3,4,6)	(1,2,3,4)	

In table 4.8, the transportation problem is shown which is obtained after applying the ranking technique on trapezoidal fuzzy transportation problem shown in table 4.7.

Table 4.8 Transportation Problem After Applying Ranking Method (Example-2)

	D_1	D_2	D_3	D_4	Supply
S_1	2.5	3.5	11.5	7.75	6.5
S_2	1.75	0.5	6.5	1.5	1.5
S_3	5.5	8.5	15.5	9.5	11
Demand	7.5	5.5	3.5	2.5	

After applying the proposed ranking based fuzzy data transfer technique, the total obtained fuzzy transportation cost is **116.25**.

4.4 RESULT ANALYSIS

Let us briefly analyze the outcomes of both the proposed methodologies of sections 4.3.1 and 4.3.2. In data transfer through proposed Fuzzy VAM methodology, the obtained fuzzy transportation cost for the sample transportation problem shown in table 4.1 after applying the proposed Fuzzy VAM is 3096471 in 09 iterations only. As shown in the comparison table 4.9, by using the proposed Fuzzy VAM, we got the optimal solution in less number of iteration as compared to VAM.

Table 4.9 Comparison between VAM and Fuzzy VAM

Method	No. of iteration	Optimal solution
VAM	11	3097060
Fuzzy VAM (Proposed Method)	**9**	**3096471**

In Ranking Based Fuzzy Data Transfer methodology, firstly calculate the ranking function and then applied the steps of the proposed methodology to the obtained data. Here in both the taken examples which are shown in table 4.5 and 4.7 we applied ranking function and then performs the steps of the proposed methodology on the obtained data of both the taken examples show in table 4.6 and 4.8.

The obtained fuzzy transportation cost for selected transportation problem in numerical example-1 using the proposed methodology based on ranking i.e. 4.3.2. is **3077806**. The comparison of the proposed method with existing VAM is tabulated below in table 4.10 in which it is clearly shown that the proposed method provides the optimal results.

Table 4.10 Comparison of Numerical Example-1 with Existing Method

Method	**Optimal Solution**
VAM	**3096471**
Proposed Method (Based on Ranking Method)	**3077806**

In the other chosen transportation problem in numerical example-2 the obtained fuzzy transportation cost using the proposed methodology based on ranking i.e. 4.3.2. is **116.25**. The comparison of the proposed method with existing methods is tabulated below in table 4.11 and also a comparison graph is shown in figure 4.2 in which it is clearly shown that the proposed method provides the optimal results.

Table 4.11 Comparison of Numerical Example-2 with Existing Method

Method	Optimal Solution
Panadian et al. [77]	132.17
Chauhan S. S., Joshi N. [17]	121
S. Narayanamoorthy, S. Kalyani [70]	121
Proposed Method (Based on Ranking Method)	**116.25**

4.4.1 Comparison with Existing Methods

Now we compare the results obtained from both proposed methodologies with existing methodologies. In data transfer through proposed Fuzzy VAM methodology, in the selected numerical example, as shown in table 4.1, suppose the availability i.e. $\tilde{p}_i$ of the data at supply S_1, S_2, S_3 and demand $\tilde{p}_j$ of the data at destination D_1, D_2, D_3, D_4 and the unit transportation cost C_{ij} of the product in each row and column is represented by triangular fuzzy number i.e. shown in table 4.2. First, we convert the crisp problem which is shown in table 4.1 into the triangular fuzzy problem for obtaining more accuracy as shown in table 4.2 by the approximating the fluctuation of data transfer rate during total transfer time, and then we implement the proposed methodology to find the optimal solution and after making the comparison, we found that the proposed methodology produces the optimal result in less number of iterations as compared to existing VAM which is clearly shown in table 4.9.

In both the taken examples of Ranking Based Fuzzy Data Transfer methodology the availability i.e. $\tilde{p}_i$ of the product at supply S_1, S_2, S_3 and demand $\tilde{p}_j$ of the product at destination D_1, D_2, D_3, D_4 and the unit transportation cost C_{ij} of the product in each row and column is represented by trapezoidal fuzzy number i.e. shown in both the numerical examples in table 4.5 and table 4.7 respectively. First, we convert the trapezoidal fuzzy problem which is shown in 4.5 and table 4.7 into the crisp problem as shown in 4.6 and table 4.8 respectively by applying ranking function, and then we perform proposed method to find the optimal solution and after making the comparison, we found that the result achieved by the proposed method is optimal as compared to other existing methods which is clearly shown in comparison table 4.10 for numerical example-1 and in comparison graph displayed in figure 4.1 for numerical example-2.

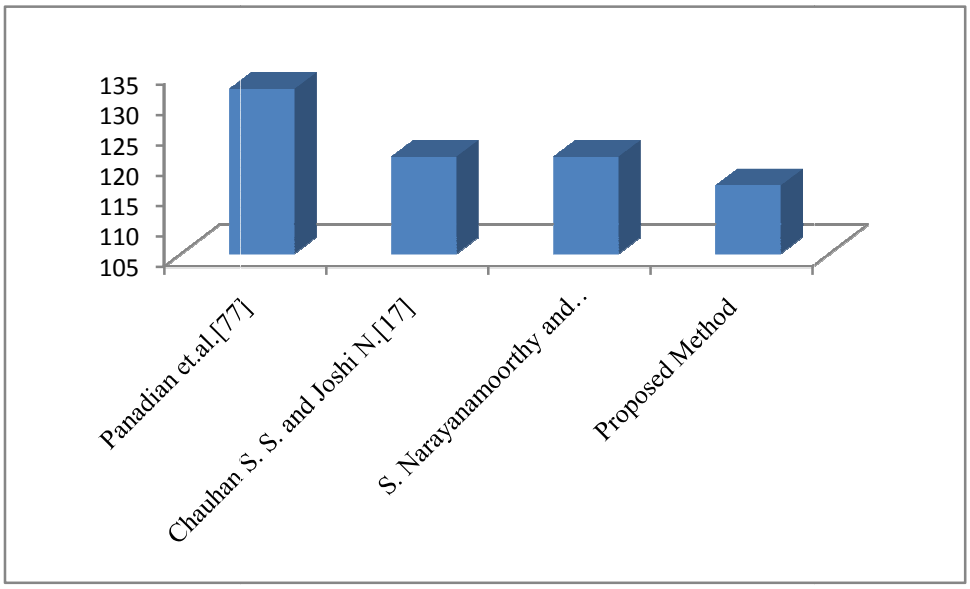

Figure 4.2 Comparisons with Existing Methods

4.5 MAJOR FINDINGS

In this chapter, two different methodologies are proposed to obtain an optimal solution for secure data transfer across a distributed network that provides the better consequences. Both the proposed methodologies are easy to understand and use. Both the methodologies implement different mechanisms to produce the optimal result like the first one employs the triangular fuzzy number over transportation problem and the other one employs the raking based fuzzy approach using the trapezoidal fuzzy number to produces effective and efficient outcome. There are different numerical examples are used for both the methodologies to show that the proposed methods produce the optimal results as compared to other existing methods as shown in different comparison table for both the methodologies i.e. in table 4.9, 4.10 and 4.11. Apart from optimal data transfer across the distributed network, proposed methodologies can also be applied to solve other real-world problems like assignment problem, network flow problem, project scheduling, linear programming problem etc.

Chapter V

Cryptographic security for Mac address in Distributed Environment

CHAPTER V

CRYPTOGRAPHIC SECURITY FOR MAC ADDRESS IN DISTRIBUTED ENVIRONMENT

5.1 INTRODUCTION

A distributed computing system makes communication process smooth across the network. It superimposes various network devices together, which reduces the complexities of besmeared in a network. This system comprises of hand-held and portable devices which are the handy tools for example with the help of distributed computing we can also connect our cell phones across the globe. It can either be wireless or wired. Now the communication is very much simple and smooth like an individual in India can quickly and smoothly communicate with any person sitting anywhere in the world. It enhances the performance and accuracy as well as the computation can be done remotely, for example, Local Area Network (LAN) and Wide Area Network (WAN) are the best examples of these types of systems. We also know that convenience also comes up with some difficulties and that implicates whether the communication across the network is secure or not.

In a distributed networking environment, the organization of various autonomous computing devices is one of the crucial jobs. Each and every device across the network contains unique Media Access Control (MAC) address. When the devices are connected across the network over the WAN, intruders can be caught smartly via the MAC address of the device. If someone sends the secret information over a network from one device to another device then it is necessary that the information is delivered safely with protected MAC address transmission, so that the MAC address cannot be broken by the intruders. A distributed networking environment is shown below in figure 5.1.

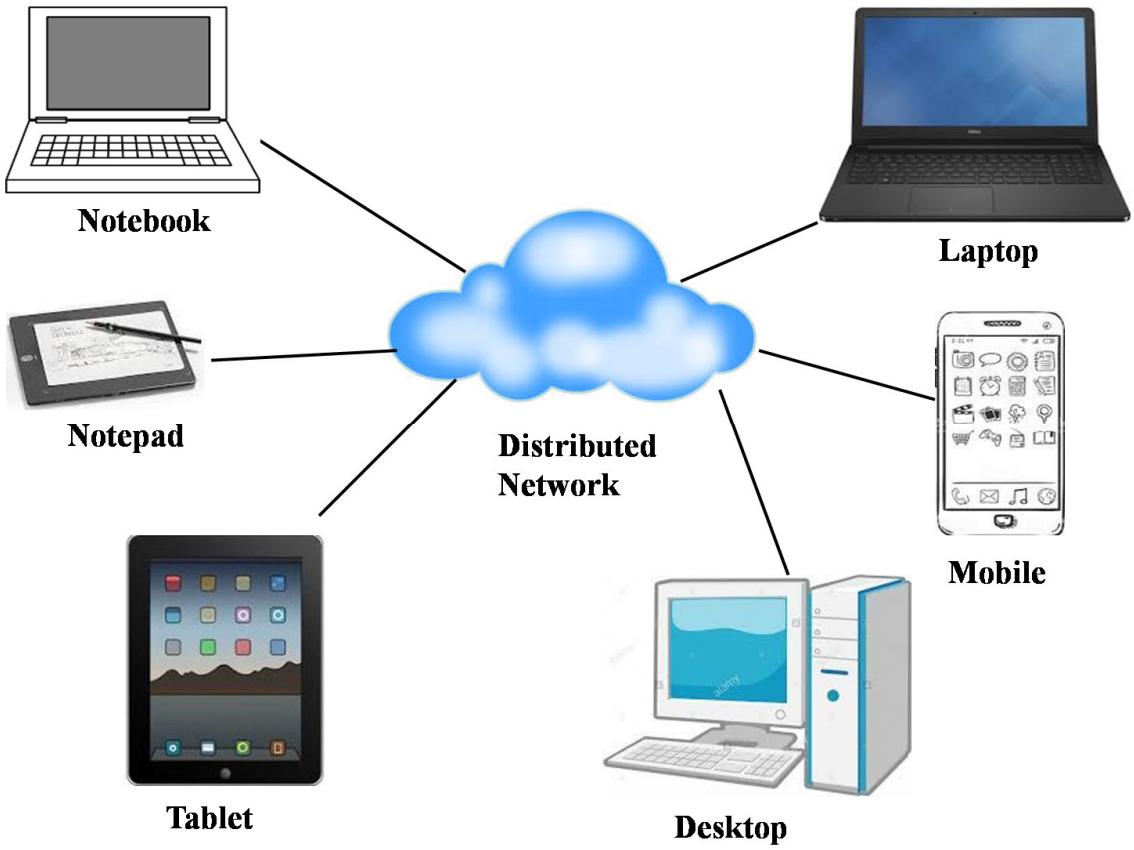

Figure 5.1 A Distributed Computing System

In this chapter, a new technique for secure data transmission with the MAC address is illustrated with eminent Rivest, Shamir and Adleman (RSA) algorithm for security mechanism. The proposed technique has experimented via JAVA programming language on different MAC addresses over multiple devices. Before implementation, the UML mechanism is employed to construct a framework of the cryptosystem.

MAC addresses are also recognized by various different names like hardware address, physical address, ethernet address, network interface controller (NIC) address. Basically, it stands for MAC which means unique addresses are provided to devices through which all the devices are uniquely identified across the network. MAC addresses are formed by

hexadecimal numbers (0-9, A-F). These are employed in MAC sub layer of the Data Link Layer in the OSI Model. A MAC address is represented by various notations. The EUI - 64 is widely used which is almost identical as MAC-48 notation which characterizes the address as six groups of 2 hexadecimal numbers separated by colons (:) or hyphens (-) in order of transmission. For example, 97:45: AC: FC: 01:43 or its coequal, 97-45-AC-FC-01-43.It is a 48-bit address. Hence, there are (2^48) presumable MAC addresses.

A communication becomes feasible just because of MAC addresses. When the sender device is transmitting the data to the receiver device, then there are various situations that it does not reach its receiver destination. It might be hacked during transmission. So, it is necessary that the MAC address is accurately matched before starting the transmission procedure. Generally, in various attacks, metropolitan area network (MAN) is the fine illustration of intermediate attack, a MAC address can also be recognized such that the sender considers that the information will be successfully delivered to the destination but the truth is that the intruders get all the information. Thus it is mandatory to encrypt the MAC address so that no intruder can have the MAC address of the devices and data transmission becomes secure. This encryption process metamorphoses the plain text into the incomprehensible cipher text. This cipher text is then transferred, which remains unreadable even after hacking. This cipher text can be easily decrypted in the plain text by using the private key at the destination.

UML is a process of graphically representing the overall procedure for the enhanced visualization. In the communication process, here a medium is known as a server which connects both the sender who sends data and the receiver who receives the data for effective communication. So basically, the process of communication occurs in three

steps. In the first step, the data acquires the shortest path all the way through the server and reaches the receiver. In the second step, the data is first encrypted at the sender's end and then gets transmitted through the communication channel and finally decrypted at the receiver's end. The third step acquires the longest path, where the data is sent to the server by the sender and the server encrypts and decrypts the data and transmits it to the destination. These communications steps are graphically represented below in figure 5.2 via UML Class model.

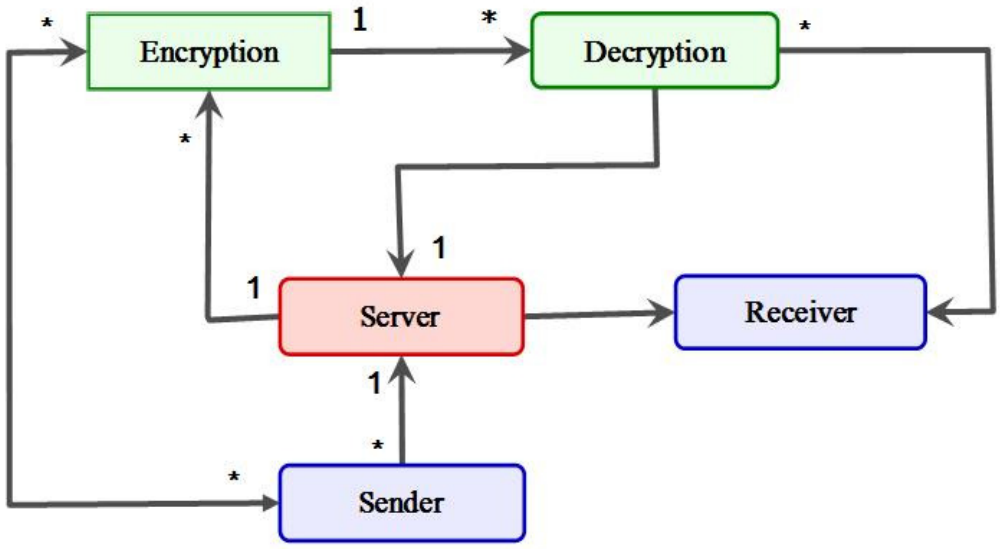

Figure 5.2 UML Class Representation

5.2 CRYPTOGRAPHIC SECURITY

The objective of the present chapter is to overcome the security threats and establish the secure data transmission across the distributed network by using well know cryptographic algorithm RSA. During data transmission across the distributed network, the security of data is a big anxiety. In this chapter, the cryptography is implemented to achieve the security goals comes during the effluent of data across the distributed network and

secures the data across all the phases of transmission. Cryptography is crucial in the world of data communication where the medium of communication is untrusted i.e. internet. Cryptography is employed for secure transmission of data in the existence of malicious intruder. The essential function of cryptography is to encrypt the plain data using an encryption algorithm into the cipher data.

A distributed network is a network where various devices are connected together and made the communication process more convenient and reduce the complexity besmeared in the network. In the distributed computing environment each system has a unique MAC address. Intruders can easily grab the MAC addresses of the devices that are connected across the WAN. If a user sends the secret information across the network than it is necessary that the information must be delivered with secure MAC address so that the MAC address remains unbreakable. MAC addresses are also denoted by the physical addresses or NIC address. MAC address provides the unique identification to the device. The process is communication is only made possible by the MAC address. When data is transmitted across the network from one device to another then there is a possibility that the data does not arrive at the destination due to the interference of the intruder across the route. That's why it is necessary that the MAC address is accurately matched before starting the transmission. Hence, it is must to transmit the MAC address securely by encrypting the MAC address via a cryptographic approach so that the MAC address of the device can't be ruined by the intruder. Here in this work, RSA is used to encrypt the MAC address of the devices of the network, so that the data communication across the network becomes secure and effective.

5.3 RSA ALGORITHM

Ron Rivest, Adi Shamir, and Leonard Adleman [99] developed a cryptographic algorithm known as RSA algorithm, which was basically conquered the less secure National Bureau of Standards (NBS) algorithms. The RSA algorithm can be employed for both the digital signatures and the public key encryption. Basically, the security mechanism of RSA algorithm is based on the complexity of factoring large prime numbers. The RSA algorithm is employed by modern computers to make communication more secure by encrypting and decrypting the messages.

RSA is an asymmetric key cryptography. Basically asymmetric means that it facilitates two different keys i.e. **Private Key** and **Public Key.** As the name depicts that the Private key which is kept private at the receiver's end and the Public Key which is provided to everyone.

The RSA cryptography algorithm is the most predominantly employed public key cryptosystem in the world. It can also be put into service to encrypt a message without the need to interchange a secret key individually. The public key comprises two different numbers in which one number is the product of two large prime numbers and another number is the small exponent number. The private key is also obtained from the same prime numbers. Hence the private is compromised if anyone can factorize the large numbers. Therefore the strength of encryption is fully lying on the size of the key and if we increase the key size, then the encryption strength grows exponentially. Typically the RSA key is of 1024 or 2048 bits, but specialist reckon that 1024 bits long key could be destroyed in the upcoming future. But till now it appears to be an inefficient operation.

5.3.1 Key Generation

The keys for the RSA algorithm are generated in the following ways:

5.3.1.1 Public Key Generation

- Select two different prime numbers M and N.

  For safety reasons, the numbers M and N should be selected at random and should be equal in magnitude but distinct in length by certain digits to make factoring difficult. Prime numbers can be efficiently selected via primality test.

  Let M = 53 and N = 59.

  Now the first section of the Public key: R = M*N = 3127.

- We also required a minor exponent i.e. T :

  But T must acquire some properties:

  - ✓ T is not the factor of R.
  - ✓ T is an integer.
  - ✓ $1 < T < \Phi(R)$ [$\Phi(R)$ is discussed below],

  Now consider it to be 3.

- Above Public Key is made up of R and T.

5.3.1.2 Private Key Generation

- Calculate $\Phi(R)$:

  Such that $\Phi(R) = (M-1)(N-1)$

  Therefore, $\Phi(R) = 3016$

- Calculate Private Key, B :

  $BT \cong 1 \bmod \Phi(R)$

B = (1 + L*Φ(R)) / T for some integer L

For L = 2, value of B is 2011.

Now our – Public Key (R = 3127 and T = 3) and Private Key (B = 2011)

Let us take an example:

Encrypt "HI":

- Transform letters into numbers : H = 8 and I = 9
- Thus Encrypted Data is $V = 89^T \bmod R$.

Thus the retrieved Encrypted Data is 1394

Now Decrypt 1394:

- Decrypted Data = $V^B \bmod R$.

Thus the retrieved Decrypted Data is 89

8 = H and I = 9 i.e. "H+I=HI".

5.4 PROPOSED METHODOLOGY

In this chapter, public key cryptography is used to make data transmission more secure by transmitting the encrypted MAC address across the network. To encrypt the MAC address, firstly the MAC address is separated into parts and then each part is encrypted by using RSA, a well known public key cryptography technique. In this way, the transmitted data remains safe from the interference of the intruder. Here a sample JAVA programming code is also given below to demonstrate the overall methodology.

```
public class methodology
{
        static BigInteger d=BigInteger.valueOf(23);
```

```
static BigInteger p=BigInteger.valueOf(17);

static BigInteger q=BigInteger.valueOf(11);

static BigInteger e=BigInteger.valueOf(7);

static BigInteger m =

p.subtract(BigInteger.ONE).multiply(q.subtract(BigInteger.ONE));

static BigInteger n=p.multiply(q);


//encryption

private static BigInteger encrypt(int a)

{

// create printstream object

PrintStream ps = new PrintStream(System.out);

BigInteger a1 = BigInteger.valueOf(a);

BigInteger c=a1.modPow(e, n);

//print the cipher text

ps.printf("The  cipher  text  for  %d  is %d    \n", a,c);

//flush the stream

ps.flush();

return c;

}


//decryption

private static char decrypt(BigInteger a)
```

```
{
BigInteger bp=a.modPow(d, n);

//calculating the plain text after decryption
int p1=bp.intValue();

//print the plain text after decryption
System.out.print("The  plain  text  for " + a + " is ");
System.out.println(p1);
char ch=(char)p1;
return ch;
}
public static void main(String args[])
{
Scanner scanner = new Scanner(System.in);
System.out.println("Please enter the Mac Address:");
String text = scanner.nextLine();
System.out.println("Plain text before encryption is : "+text);
BigInteger[] data = new BigInteger[20];
char[] plain = new char[17];
int i;
while(m.gcd(e).intValue() > 1 )
{
        e.add(BigInteger.ONE);
}
```

```
        d= e.modInverse(m);
        System.out.println("The value of d is \n " +d);

        System.out.println("The value of e is \n " +e);
        for(i=0;i<text.length();i++)
        {
                if(text.charAt(i)!=':' ||text.charAt(i)!=' ')
                {
                   data[i]= encrypt((int)text.charAt(i));
                }
                else
                {
                        data[i]=encrypt(186);
                }
        }
        for (i=0;i<17;i++)
        {
                plain[i]=decrypt(data[i]);
        }
        String pt=new String(plain);
        System.out.println("\n Plain text after the decryption is : "+pt);
        scanner.close();

        }
}
```

The output of the code is given below in tabular form. Plain text before encryption is:

23:45:67: AC: BD: EF

where, p=17, q=11, d=23, e=7 have been taken as input.

Table 5.1 The Output of Java Programming Code

Plain Text (p)	ASCII Value (p)	(P^e) mod(n)=c	(c^d) mod(n)=p	Plain Text
2	50	118	50	2
3	51	17	51	3
4	52	35	52	4
5	53	26	53	5
6	54	164	54	6
7	55	132	55	7
A	65	142	65	A
C	67	67	67	C
B	66	110	66	B
D	68	51	68	D
E	69	86	69	E
F	70	60	70	F

5.5 RESULTS ANALYSIS

In this section, we show the description of the steps which are included in this algorithm. Firstly we calculated the value of n i.e. p*q =187 and now find (p ^ e) mod (n) =17^7 mod 187 => 118 which is the value of c i.e. cipher text which is not the original message so receiver decrypts this using private key d. Now we put the value of c i.e. 118, d=23 and n=187 in (c ^ d) mod (n) = p and find the value of p i.e. 50 which is ASCII value of 2 and 2 is the original message. This procedure continues for each bit and gets the original message. The above table shows all bits conversion using the algorithm.

Plain text after the decryption is:

23:45:67: AC: BD: EF

5.6 MAJOR FINDINGS

In the present chapter, an application of the RSA algorithm on MAC address is articulated for secure transmission of information from one device to another device across the distributed network. For secure transmission of data across the distributed network, the sender has to transmit the encrypted data along with the encrypted MAC address for denoting the sender's device. With the help of UML model, a block diagram is also introduced which shows the encryption and decryption process intelligibly and the proposed methodology has been employed by using JAVA programming language. The reckoning based on prime numbers turns more complex and difficult to crack RSA algorithm that's why it is extremely used for protecting the digital signature. The presented work can also be upgraded in the future for secure transmission of text, audio and video data.

Chapter VI

A Model for Occurrence and Resolving of Cyber Crime Across Distributed Network

CHAPTER VI

A MODEL FOR OCCURRENCE AND RESOLVING OF CYBER CRIME ACROSS DISTRIBUTED NETWORK

6.1 INTRODUCTION

In the present time, the distributed computing system plays an important role for the assessment of different kind of internet services. The different hand held devices like palmtop, laptop, cell phones etc can be connected to the distributed network. In daily routine, people are used to social networking websites, online purchasing websites and online transaction websites whereas on the other side hackers are hack these websites and perform the illegal activity. In the present work, a model is proposed which is based on the object oriented technology for occurrence of cyber crime across the distributed network. In this model, a well known UML is used by which any one can write the code for implementation of model in any object-oriented programming language. A UML model is also proposed for filing the first information report (FIR) against the cyber crime. The activities of the above said procedure are represented by UML activity diagram which is finally validated through the concept of finite state machine (FSM).

The present work is related with the development of model based on object oriented technique for the identification of cyber crime and filing the FIR against the unauthorized user. The advantage of this model is that one can develop the model in any programming language based upon the object oriented methodology. The rationale of the proposed model is the identification of the cyber crime and the same was implemented and tested through the concept of software engineering. Various test cases are generated for validation purpose of the proposed model and it was observed that the model is effective, reliable and robust.

6.2 UML MODELING FOR OCCURRENCE AND FILING OF CYBER CRIME

6.2.1 UML Class Model

UML class is a static representation of the problem in which the behavior and movement of problem towards the achievement of goal is studied. In figure 6.1, the occurrence of cyber crime is represented through different class and the diagram is designed by the use of standard symbol available in Booch [36]. The user is categorized in two classes one is authorized and another is unauthorized. Both kinds of users have internet facility and different web portals are grouped on the internet for users.

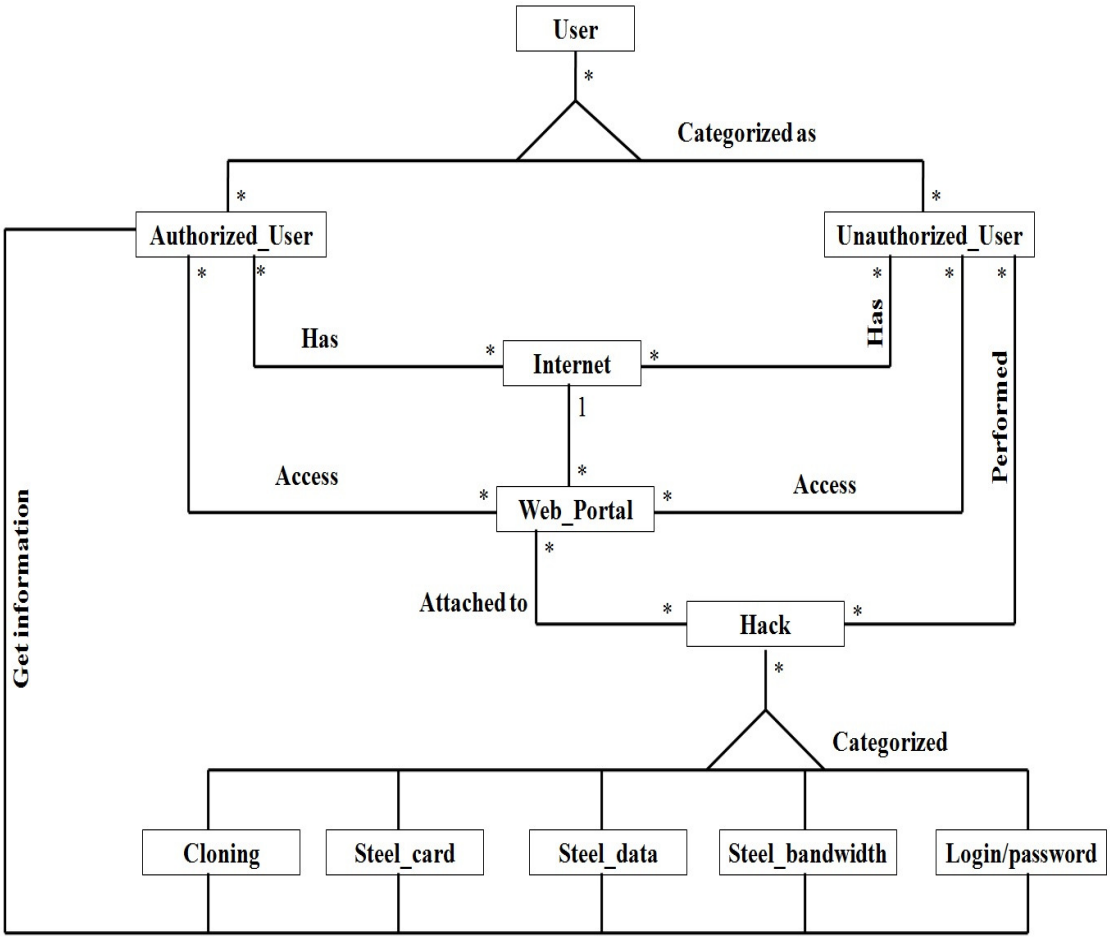

Figure 6.1 UML Class Model for Occurrence of Cyber Crime

As shown in above class diagram, unauthorized user hacks the web portals in multiple times. Hacking is controlled by hack class which is the type of cloning, steel card, steel data, steel band width, login/password etc. When hacking occurs, the authorized user got the information about the hacking. The various types of attributes and operations used to model the above diagram are recorded in the following table 6.1.

Table 6.1 Attributes and Operations Used for UML Class Model

Name of Class	Attributes	Operations
User	User_id User_name Mobile_number Nationality Gender	Surf_webpages() Surf_apps() Login() Logout()
Authoriozed_User	Categorization_user Address Date_of_birth E-mail	Mail_access() Online_transaction()
Unauthorized_User	Login_in_time Login_out_time Login_duration Session_record_time	Steel_data() Steel_password() Steel_card() Unauthorized_login()
Internet	Connection_id Service_provider No._of_users Bandwidth	Access() Security() Surfing()

Web_Portal	Physical_location Security_type Contact_information Business_information Validation	Universal_login() Facilitates_messaging Multi_channel_consistency() Search()
Hack	Hacker_name Age Gender	Access_unauthorized_data() Hack_websites() Hack government_sites & data()
Cloning	Cloning_type Cloning_device	Credit_card_cloning() Debit_card_cloning() Websites_cloning()
Steel_Card	Card_holder_name Expiry_date Organization_name Card_number Card_type	Removing_funds() Illegal_purchasing() Identity_theft()
Steel_Data	Type_of_data Storage_device Data_amount Data_Address	Data_modification() Access_Data()
Steel_Bandwidth	Service_provider_name Bit_rate Capacity City/State	Data_transmission() Media_file_transmission() Video_compression()

6.2.2 UML Activity Model

The activity model represented the dynamic aspects of the problem. The present work shows an activity model for the occurrence of cyber crime. This is shown in below figure 6.2.

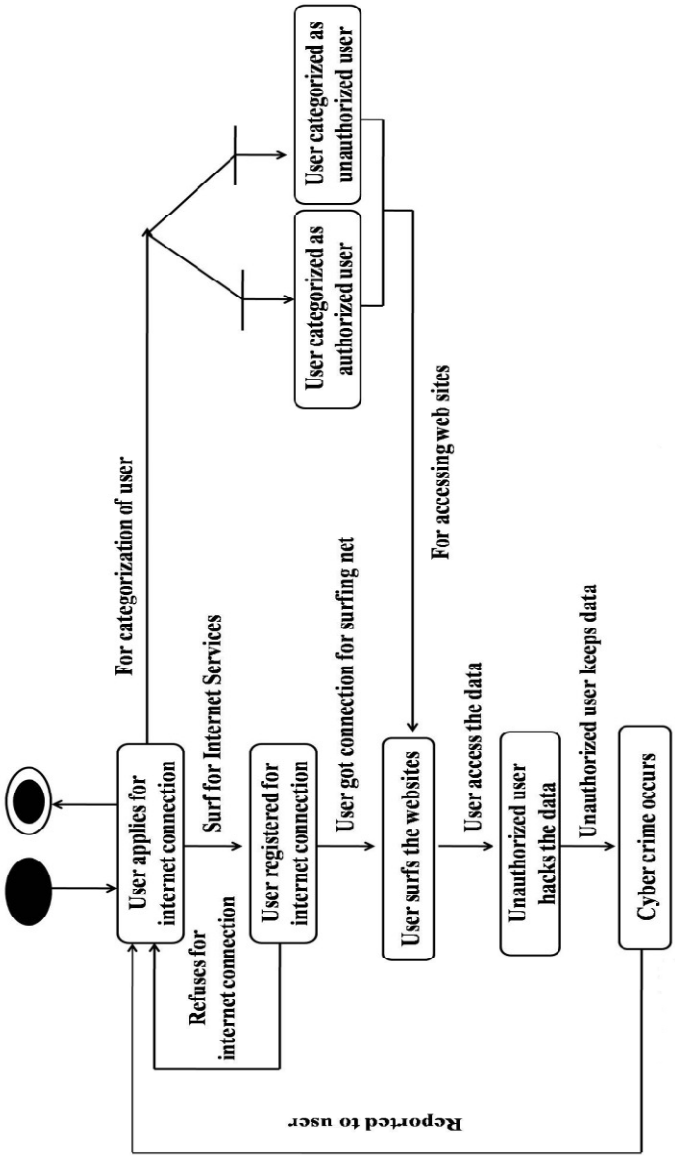

Figure 6.2 UML Activity Model for Occurrence of Cyber Crime

In this model the links are connected from one activity to another activity to control an event. These activities are summarized in the following steps:

Step 9: User applies the Internet Connection for surf the internet services;

Step 10: User categorized either authorized or unauthorized;

Step 11: User registered for internet connection, if user got connection then move to next step else user go to step 1;

Step 12: When user got connection for surfing net, user surfs the websites and access the data;

Step 13: According to step 2, user may be authorized or unauthorized who can access the websites;

Step 14: When unauthorized user hacks the data follow next step;

Step 15: Cyber crime occurs then it is reported to the user and moves to step 1;

The above steps are represented in the figure 6.2 which show the occurrence of cyber crime.

6.2.3 Validation of UML Activity Model through FSM

Let us first explain the concept of FSM which is a mathematical model of computation and is used to design logic circuits. A sequential logic unit takes an input and a current state to produce an output and new state. It can be represented using state transition table which shows current state, input state, new output state and the next state. It can also be represented using state transition diagram. It is defined by M and explained as

$$M = (\Sigma, Q, \delta, q_0, F)$$

Where,

Σ = set of Inputs (Alphabets and symbols);

q_0 = an initial state;

F = final state;

δ = transition between two states;

Q = set of finite states;

On the basis of above definition of automata the figure 6.2 is converted into FSM by means of state and transition from one state to another state. The different states are recorded in the table 6.2 and these are represented as ($q_0, q_1, q_2, q_3, q_4, q_5$ and q_6).

Table 6.2 Description of States Selected from UML Activity Model

Name of State	Description of State
q_0	User applied for internet connection
q_1	User categorized as authorized user
q_2	User categorized as unauthorized user
q_3	User registered for internet connection
q_4	User surfs the websites
q_5	User hacks data
q_6	Cyber crime occur

The two states let q_0 & q_1 are grouped through a transition event. The different transition events are given in table 6.3. From the definition of automata Σ= {a, b, c, d, e, f, h} shows

the set of input which are shown in the table 6.3.

Table 6.3 Description of Events Selected from UML Activity Model

Name of Input	Description of Input
a	Categorization of user
b	Accessing websites
c	Surf for internet services
d	User got connection for surfing net
e	Reported to user that cyber crime occur
f	User access the data
g	User keeps data
h	User refuses for internet connection

On the basis of above, a state transition diagram is designed which is represented in figure 6.3.

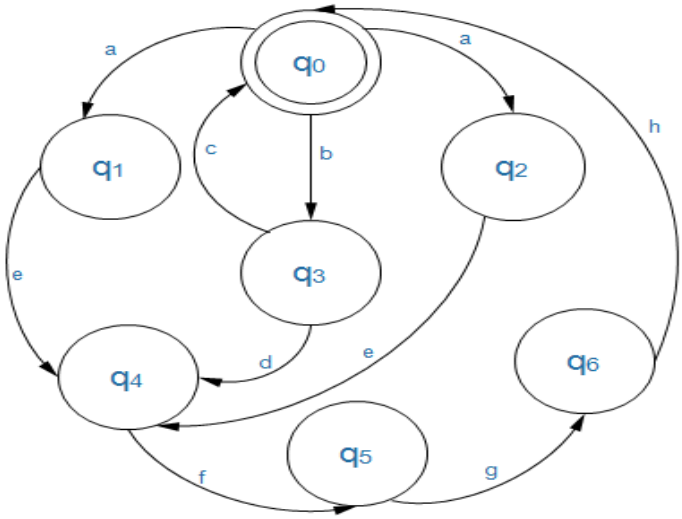

Figure 6.3 FSM Representation from UML Activity Model

Above figure 6.3 is used for validation purpose of UML activity model and different test cases are generated on the basis of transition table recorded in table 6.4.

Table 6.4 Transition Table

Event→ State↓	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**H**
q_0	q_1/q_2	q_3	-	-	-	-	-	-
q_1	-	-	-	-	q_4	-	-	-
q_2	-	-	-	-	q_4	-	-	-
q_3	-	-	q_0	q_4	-	-	-	-
q_4	-	-	-	-	-	q_5	-	-
q_5	-	-	-	-	-	-	q_6	-
q_6	-	-	-	-	-	-	-	q_0

Valid Test Case 1:- If unauthorized user hacks the data, cyber crime occurs and it is reported to the user.

$$\delta (q_0,a) \rightarrow q_1 \quad => \quad q_0 \rightarrow a\, q_1$$

$$\delta (q_1,e) \rightarrow q_4 \quad => \quad q_1 \rightarrow e\, q_4$$

$$\delta (q_1,f) \rightarrow q_5 \quad => \quad q_1 \rightarrow f\, q_5$$

$$\delta (q_5,g) \rightarrow q_6 \quad => \quad q_5 \rightarrow g\, q_6$$

$$\delta (q_6,h) \rightarrow q_0 \quad => \quad q_6 \rightarrow h\, q_0$$

After removing the non-terminals the string is

$$q_0 = aefghq_0 = aefgh$$

Valid Test Case 2:- The user is not registered for internet connection.

$$\delta\ (q_0,b) \rightarrow q_3 \quad => \quad q_0 \rightarrow b\ q_3$$

$$\delta\ (q_3,c) \rightarrow q_0 \quad => \quad q_3 \rightarrow c\ q_0$$

After removing the non-terminals the string is

$$q_0 = bcq_0 = bc$$

Valid Test Case 3:- If cyber crime occurs then it is reported to the user.

$$\delta\ (q_0,b) \rightarrow q_3 \quad => \quad q_0 \rightarrow b\ q_3$$

$$\delta\ (q_3,d) \rightarrow q_4 \quad => \quad q_3 \rightarrow d\ q_4$$

$$\delta\ (q_4,f) \rightarrow q_5 \quad => \quad q_4 \rightarrow f\ q_5$$

$$\delta\ (q_5,g) \rightarrow q_6 \quad => \quad q_5 \rightarrow g\ q_6$$

$$\delta\ (q_6,h) \rightarrow q_0 \quad => \quad q_6 \rightarrow h\ q_0$$

After removing the non –terminals the string is

$$q_0 = bdfghq_0 = bdfgh$$

6.2.4 UML Model for Filing Cyber FIR

UML model shows that how an authorized user is filing cyber FIR. The diagram shows that many authorized users have many internet connections. Police station and cyber cell both are connected with internet. Different police stations have different cyber cells. When an authorized user submitted cyber FIR to the police station, police station has cyber cell so the cyber cell performs enquiries and generate a feedback which is delivered to the authorized user, which is shown in figure 6.4.

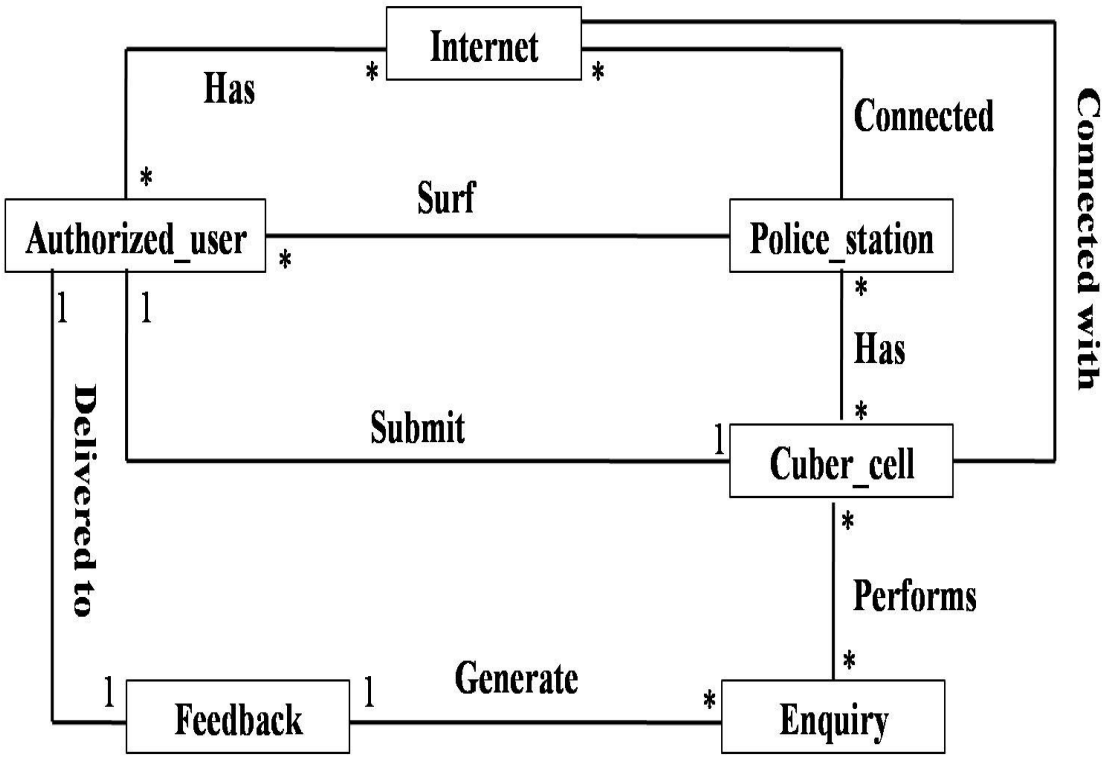

Figure 6.4 UML Model for Filing Cyber FIR

6.2.5 Risk Analysis for Occurrence of Crime

Risk is directly related to the loss due to cyber crime. In the present work percentage of loss due to cyber crime items has been evaluated. Let us define the two important factors associated to the risk analysis, these are given below:

(a) Probability of fault (CA_N)

(b) Cost (affected due to loss CA_N)

Where, CA_N are the items responsible for the cyber attack, then risk is computed by the following

$R(CA_N) = P(CA_N) * C(CA_N)$

The cyber attack algorithm for the computation of risks is recorded in table 6.5.

Table 6.5 Calculated the Risk Based on Cyber Attack

Code	List of cyber attack	Probability of occurrence $P(CA_N)$	Cost affected $C(CA_N)$	$R(CA_N)$
CA_1	Stealing of Database	0.20	0.80	0.16
CA_2	Hacking of Websites	0.35	0.70	0.245
CA_3	Job Scams/Frauds	0.10	0.60	0.06
CA_4	Mobile Crimes	0.45	0.70	0.315
CA_5	Antisocial Activities	0.20	0.50	0.1
CA_6	Stealing of Bandwidth	0.15	0.40	0.06
CA_7	Cloning of Debit/Credit Card	0.20	0.70	0.14
CA_8	E-Commerce Fraud	0.30	0.60	0.18
CA_9	Unauthorized Network Access	0.15	0.55	0.0825
CA_{10}	Theft of Password	0.50	0.80	0.4
CA_{11}	Identity Theft	0.15	0.70	0.105
CA_{12}	Cyber Blackmailing/Harassment	0.25	0.60	0.15

The list of cyber attack is purely taken from the cyber crime cell and it consists of real data which is observed by grouping the 100 cyber cell complaints i.e. FIR. It is registered FIR either through online/offline mode and attacks are categorized through the unique code.

The decreasing sequence of losses is CA_{10}, CA_4, CA_2, CA_8, CA_1, CA_{12}, CA_7, CA_{11}, CA_5, CA_9, CA_6, and CA3. From the table 6.5 it is observed that the maximum loss is due to

"Theft of Password" therefore, it should be resolved first to minimize the losses and the losses are minimized according to the said sequence of cyber attacks. A graphical view of computation of risk is also represented in figure 6.5.

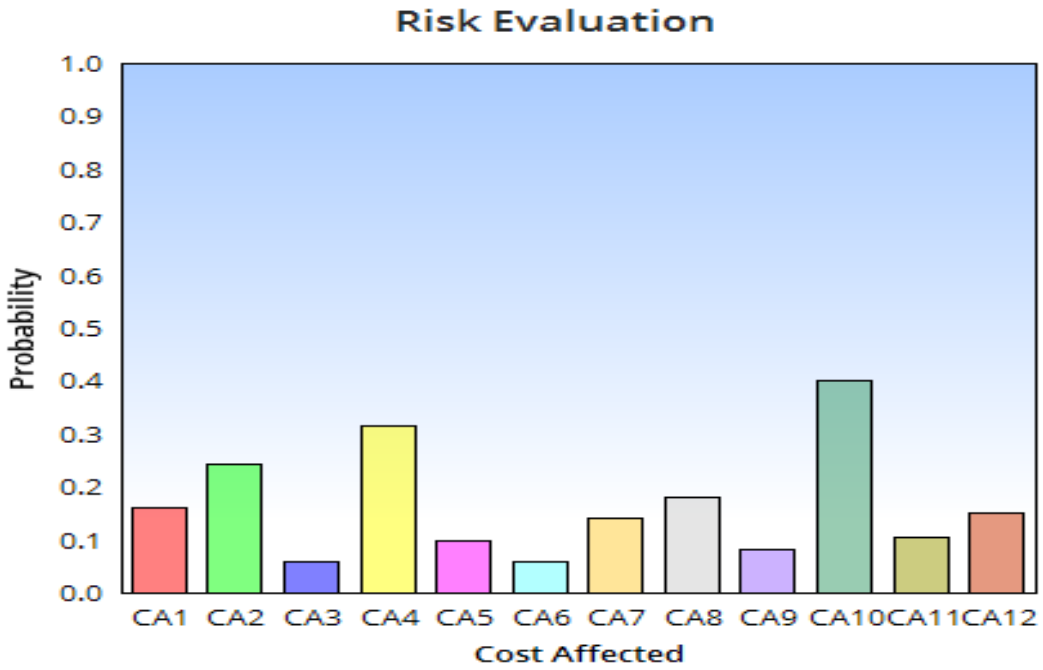

Figure 6.5 Risk Evaluation on the Basis of Probability and Factor

6.3 MAJOR FINDINGS

From the above work, it was concluded that UML is a powerful modeling language for solution of the complex research problems. In the present work, a UML model is proposed for the online FIR and computation of losses from the cyber attacks. The UML model is validated through FSM technique and various valid test cases have been generated for validation of proposed model. In the end, a technique for computation for risk analysis is proposed and finds the cyber attack having maximum risk analysis should be resolved first. The present paper can be extended further for method which can be suggested for minimization of losses like curve fitting method, optimization method, etc.

Chapter VI

A Model For Occurrence and Resolving of Cyber Crime Across Distributed Network

CHAPTER VII

A METHOD FOR MINIMIZATION OF CYBER ATTACKS ACROSS DISTRIBUTED NETWORK

7.1 INTRODUCTION

In the current scenario, people are using the services like email, online money transaction, accessing of websites, communication, downloads, social communication, online shopping, etc in their daily routine work. The current trends of digitization of information enhance the facilities with time but on the other hand, Cyber attacks may increased. Hackers hack the websites, emails, passwords sniffing, unauthorized access, steel the data and so on, which are categorized as cyber attacks. This chapter presents the cyber attacks in the Indian scenario. There are variety of cyber attacks have been identified and these attacks are optimized by applying a well known optimization procedure known as Hungarian technique which depends on the number of individual are affected with minimization of loss. A well known UML model is used to create a prototype of UML activity model which is validated through a FSM and observed that the proposed method is optimized for getting minimum losses over the cloud which is based on distributed computing network.

In the present work, we used survey methodology to assess thoughts, opinions and feeling of individuals from a population. Some major cyber attack have been identified which are faced by the users in their daily routine work and losses due to attacks are computed and thereafter an optimization technique is used for the minimization of the losses.

7.2 UML MODELING

A UML activity diagram is designed for the minimization of individual loss to the department and also consolidated loss to the organization. The steps involved for the minimization of losses are summarized below:

Step 1: Identify the types of Cyber Attacks & let us consider N;

Step 2: Categorize and fix the Priority of Cyber attacks which can be minimized for loss i.e. arrange in the decreasing order which shows that the maximum loss shall be minimized first;

Step 3: If the prioritized losses are already minimized then go to step 1 else follow the next step 4;

Step 4: Compute % loss to the user;

Step 5: Design a matrix of N*N order where N is the different types of Cyber Attacks;

Step 6: Apply the algorithm to optimize the loss due to the Cyber Attacks;

Step 7: Compute the minimization loss to the users and to the organization.

The representation of above said steps are shown in figure 7.1 through UML activity diagram. It consists of six major steps which are controlled by one condition. After creation of N*N matrix, the hungarian method is applied and the cells are represented as loss of percentage. The data is considered for twelve major cyber attacks and the proposed steps are applied upto N number of cyber attacks. A mathematical formulation of this problem is also generated using Hungarian method as it is based upon N number of cyber attacks. After that N*N matrix is generated for the finding of minimum percentage loss.

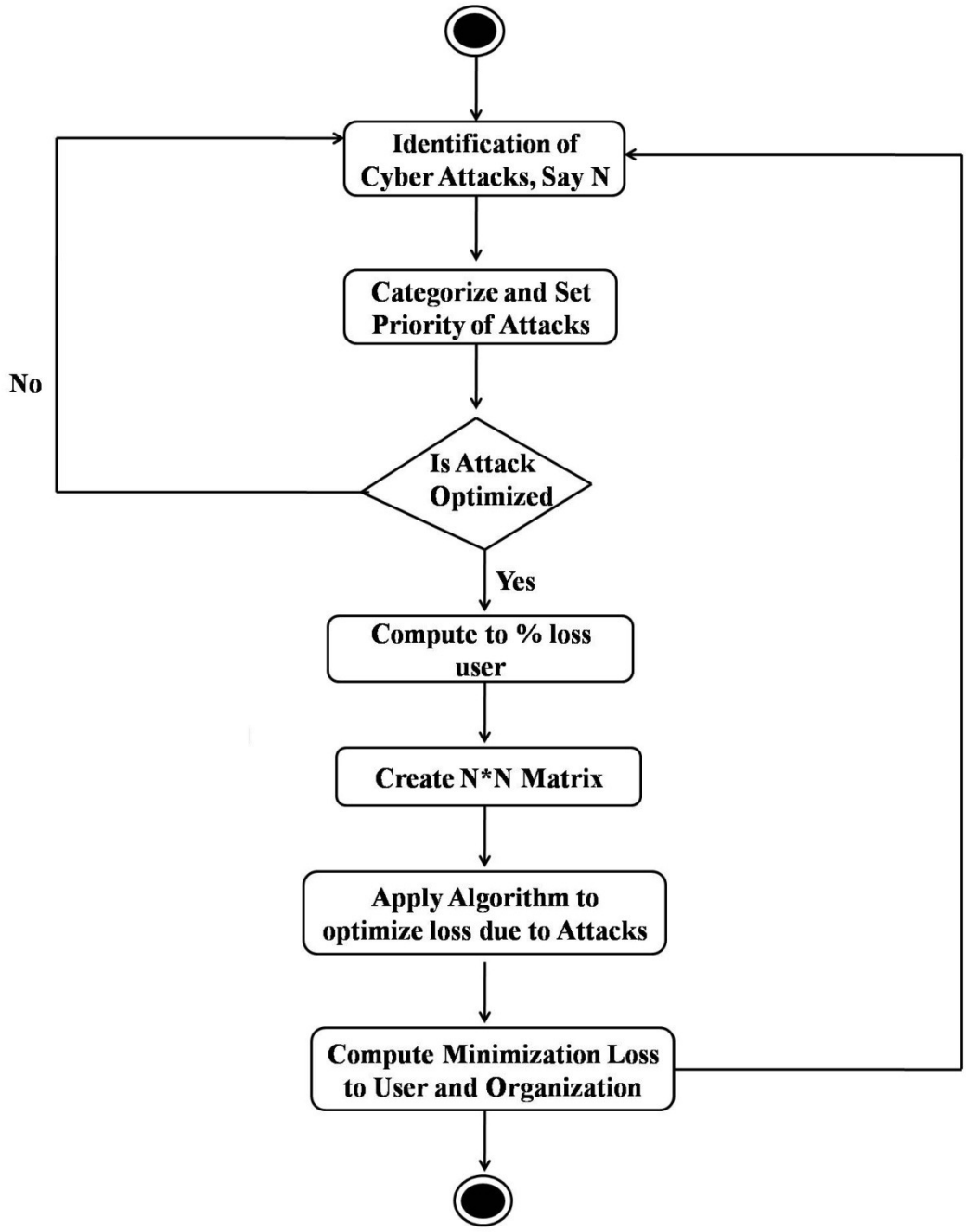

Figure 7.1 UML Activity Representation

7.3 HUNGARIAN METHOD

In 1955, Hungarian method was developed by Harold Kuhna [140]. This strategy was initially developed for the best task of an arrangement of people to an arrangement of occupations. The best allocating occupations by a one-for-one coordinate to distinguish the most minimal cost arrangement. Each activity must be allocated to just a single machine. It is accepted that each machine is capable for dealing with each activity and that the expenses or qualities related with every task mix are known and settled. The number of rows and columns must be equal. The steps of Hungarian method are described below:

Step 1: Arrange the data in the form of a matrix with the "people" on the left and the "activity" along the upmost, with the "cost" of each pair in the middle.

Step 2: Ensure that matrix has the equal number of rows and columns if not then add dummy rows/columns.

Step 3: Subtract row minima. Subtract the minimum value of each row from that entire row.

Step 4: Subtract column minima. Subtract the minimum value of each column from that entire column.

Step 5: Cover all zeros with the minimum number of horizontal and vertical lines. If the number of lines is equal to number of rows then move to step 9.

Step 6: Add the minimal uncovered element to every covered element.

Step 7: Subtract the minimal element from each element in the matrix.

Step 8: Again, cover the zero elements with the minimum number of lines. If the number of lines that covered zero elements is not equal to the number of rows then move to step 6.

Step 9: Elect a matching by choosing a set of zeros such that each row and column has only one selected.

Step 10: Apply the coordinating to the actual matrix while ignoring dummy rows. This shows who should do which activity, and including the cost will give the minimal cost.

7.4 MATHEMATICAL FORMULATION

Let Cyber attacks are categorized by the set CA= {CA_1, CA_2, CA_3 ,…….CA_N}. Let these attacks are detected and taken upto N attacks and due to these attacks let losses are L_1,L_2,L_3…….L_N then to minimize these losses the following objective function is formulated

$$Z=\text{Min} \sum_{i=1}^{N} L_i * CA_i \qquad (7.1)$$

Then the problem is converted into N*N matrix and in this case N is covered as N=12 and attacks are shown in table 7.1.

Table 7.1 List of Cyber Attacks

Code	Description
CA_1	Stealing of Database
CA_2	Hacking of Websites
CA_3	Job Scams/Frauds
CA_4	Mobile Crimes
CA_5	Antisocial Activities
CA_6	Stealing of Bandwidth
CA_7	Cloning of Debit/Credit Card
CA_8	E-Commerce Fraud
CA_9	Unauthorized Network Access
CA_{10}	Theft of Password
CA_{11}	Identity Theft
CA_{12}	Cyber Blackmailing/Harassment

The different departments are consulted to make loss table as shown in table 7.2 and it is based upon the sample questionnaire and survey is completed for the 100 users but for computation purpose the sample size is considered as N=12.

The steps for Hungarian method [140] are described below in the object-oriented form:

Step 1: Let us define obj.A[i][j], where i=1(1)12,j=1(1)12 and store the losses in 12x12 matrix A[i][j];

Step 2: Select Min A[i][j] for each row i and subtract it from each element of each row

of A[i][j] i.e. obj.A[m][j]=obj.A[m][j]-min A[m][j] where m=1(1)12 and update obj.A[i][j];

Step 3: Select Min A[i][j] for each column j and subtract it from each element of each column of A[i][j] i.e. obj.A[i][n]=obj.A[i][n]-min A[i][n] where n=1(1)12 and update obj.A[i][j];

Step 4: Cut the lines row wise first & then column wise with coverage of maximum zeros.

Step 5: If number of cut lines are equal to the order of matrix then encircle zero in each row for finding the minimum loss and remaining zeros are discarded in that row/column.

Step 6: Select minimum element from non cut lines, subtract it from each element and add it at intersection of cut lines, update obj. A[i][j] go to step 4, till number of cut lines are equal to order of matrix N.

Table 7.2 Data Representation of Cyber Attacks versus Departments

Deptt→ Cyber↓ Attacks	**D_1**	**D_2**	**D_3**	**D_4**	**D_5**	**D_6**	**D_7**	**D_8**	**D_9**	**D_{10}**	**D_{11}**	**D_{12}**
CA_1	20	30	20	20	30	40	20	30	40	50	30	20
CA_2	60	70	50	70	50	65	35	45	55	60	65	75
CA_3	10	20	15	25	35	25	15	35	10	20	25	35
CA_4	75	60	70	45	55	60	60	75	65	55	45	50
CA_5	25	35	25	30	40	35	30	25	20	30	35	40
CA_6	15	25	10	15	25	30	25	15	20	25	15	20
CA_7	40	30	35	30	20	25	30	30	25	20	30	20
CA_8	50	60	40	50	40	30	35	45	35	35	40	45
CA_9	15	25	15	25	15	25	25	35	25	35	45	25
CA_{10}	40	50	60	50	40	60	55	65	45	55	65	55
CA_{11}	15	25	15	25	35	30	15	20	25	15	20	30
CA_{12}	40	50	45	55	35	45	50	55	45	35	25	35

Table 7.3 Final Matrix after Applying Hungarian Method

Deptt→ Cyber↓ Attacks	**D_1**	**D_2**	**D_3**	**D_4**	**D_5**	**D_6**	**D_7**	**D_8**	**D_9**	**D_{10}**	**D_{11}**	**D_{12}**
CA_1	0	0	0	0	10	20	0	5	20	30	0	**0**
CA_2	25	25	15	35	15	30	**0**	5	20	25	30	40
CA_3	**0**	0	5	15	25	15	5	20	0	10	15	25
CA_4	30	5	25	**0**	10	15	15	25	20	10	0	5
CA_5	5	5	5	10	20	15	10	0	**0**	10	15	20
CA_6	5	5	0	5	15	20	15	**0**	10	15	5	10
CA_7	20	0	15	10	0	5	10	5	5	**0**	10	0
CA_8	20	20	10	20	10	**0**	5	10	5	5	10	15
CA_9	0	0	0	10	**0**	10	10	15	10	20	30	10
CA_{10}	0	**0**	20	10	0	20	15	20	5	15	25	15
CA_{11}	0	0	**0**	10	20	15	0	0	10	0	5	15
CA_{12}	15	15	20	30	10	20	25	25	20	10	**0**	10

From the above table, minimum loss is computed for each of the department and observed that the minimum loss is to department 1 which is just 10%. The overall loss to all the departments is also computed which is 25% for all twelve cyber attacks and for all

the departments. These are summarized below in following table 7.4.

Table 7.4 Representation of Loss Computed

Cyber Attack	**Deptt. No.**	**Minimum Loss Computed**
CA_1	D_{12}	20
CA_2	D_7	35
CA_3	D_1	10
CA_4	D_4	45
CA_5	D_9	20
CA_6	D_8	15
CA_7	D_{10}	20
CA_8	D_6	30
CA_9	D_5	15
CA_{10}	D_2	50
CA_{11}	D_3	15
CA_{12}	D_{11}	25

Grand total = 300

Over all percentage loss to all departments = 25%

7.5 GENERATION OF TEST CASES:-

Let us consider the theory of automata for designing the FSM which is defined by M and given by following

$M = (Q, \Sigma, \delta, q_0, F)$

where,

Q = finite set of states;

Σ = finite set of input symbols;

(Alphabets and Numbers);

δ = Transition between two states;

q_0 = Initial state;

F = Final state;

From the above definition of automata, a finite state diagram is represented in the figure 7.2. In which there are seven states represented as Q = {q_0, q_1, q_2, q_3, q_4, q_5, q_6} and these are according to the activity diagram represented in the figure 7.1 and it is represented in the following table 7.5.

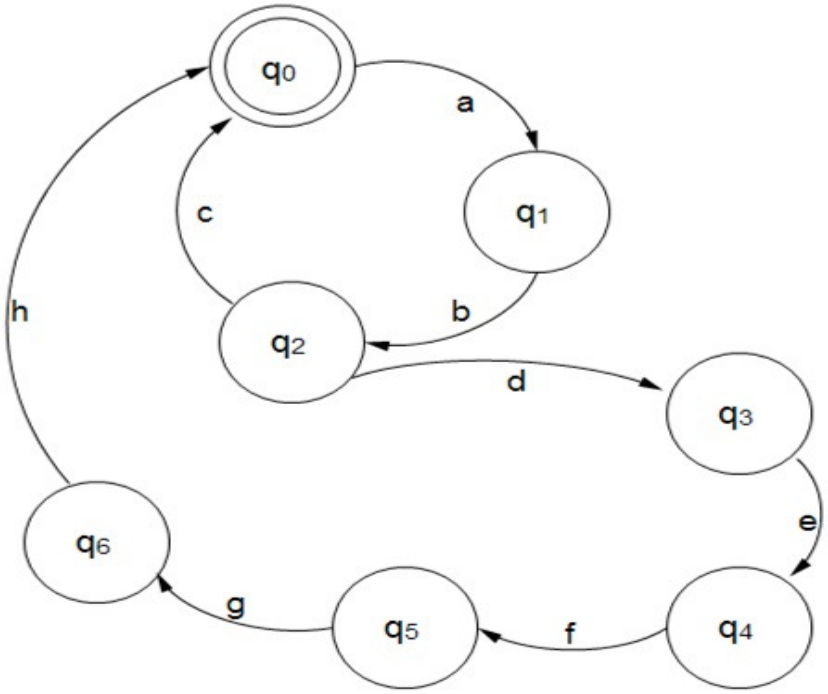

Figure 7.2 FSM Representation of Activity Diagram

Table 7.5 Representation of States

Name of State	Description of State
q_0	Identification of Cyber Attack
q_1	Categorize and set priority of Attacks
q_2	Attack optimization
q_3	Compute to % loss user
q_4	Create matrix
q_5	Apply algorithm to optimize loss
q_6	Compute minimum loss to user

Now, the transition is represented by δ (q_0, a), where a is the set of inputs and inputs are considered as Σ = {a, b, c, d, e, f, g, h} and representation is recorded in the following table 7.6.

Table 7.6 Representation of Input Symbols

Name of Input	Description of Input
A	List of Cyber Attacks
B	Priority list of Cyber Attacks
C	Not optimized list of Cyber Attacks
D	Optimized list of Cyber Attacks
E	List of losses
F	Resultant matrix with Cyber Attacks and Losses
G	Final optimized matrix
H	Minimum loss result

On the basis of above, a transition table is given below i.e. table 7.7 with following figure:

$$\delta (q_0,a) \rightarrow q_1$$

$$\delta (q_1,b) \rightarrow q_2$$

$$\delta (q_2,c) \rightarrow q_0$$

$$\delta (q_2,d) \rightarrow q_3$$

$$\delta (q_3,e) \rightarrow q_4$$

$$\delta (q_4,f) \rightarrow q_5$$

$$\delta (q_5,g) \rightarrow q_6$$

$$\delta (q_6,h) \rightarrow q_0$$

Table 7.7 A Transition Table

	A	**b**	**c**	**d**	**e**	**F**	**G**	**h**
q_0	q_1	-	-	-	-	-	-	-
q_1	**-**	q_2	-	-	-	-	-	-
q_2	**-**	-	q_0	q_3	-	-	-	-
q_3	**-**	-	-	-	q_4	-	-	-
q_4	**-**	-	-	-	-	q_5	-	-
q_5	**-**	-	-	-	-	-	q_6	-
q_6	**-**	-	-	-	-	-	-	q_0

By the use of above grammer different test cases are generated and explained below in brief:

Valid Test Case 1:- Cyber attacks losses are not optimized

It is represented by

$$\delta (q_0,a) \rightarrow q_1 \Rightarrow q_0 \rightarrow a\, q_1$$

$$\delta (q_1,b) \rightarrow q_2 \Rightarrow q_1 \rightarrow b\, q_2$$

$$\delta (q_2,c) \rightarrow q_0 \Rightarrow q_2 \rightarrow c\, q_0$$

After changing the states or removing the non terminals, the string is given by

$$q_0 = abc\ q_0 = abc$$

This represents that the Cyber Attack losses are not optimized.

Valid Test 2:- Cyber attacks losses are optimized

It is represented by

$$\delta (q_0,a) \rightarrow q_1 \Rightarrow q_0 \rightarrow a\, q_1$$

$$\delta (q_1,b) \rightarrow q_2 \Rightarrow q_1 \rightarrow b\, q_2$$

$$\delta (q_2,d) \rightarrow q_3 \Rightarrow q_2 \rightarrow d\, q_3$$

$$\delta (q_3,e) \rightarrow q_4 \Rightarrow q_2 \rightarrow e\, q_4$$

$$\delta (q_4,f) \rightarrow q_5 \Rightarrow q_2 \rightarrow f\, q_5$$

$$\delta (q_5,g) \rightarrow q_6 \Rightarrow q_2 \rightarrow g\, q_6$$

$$\delta (q_6,h) \rightarrow q_0 \Rightarrow q_2 \rightarrow h\, q_0$$

After changing the states or removing the non terminals, the string is given by

$$q_0 = abdefghq_0 = abdefgh$$

This represents that the cyber attack losses are optimized which is as per expectation.

7.6 MAJOR FINDINGS

It was concluded that UML is a powerful modeling language which is used to make design of any kind of research problem. The UML is used for the minimization of losses from the cyber attacks. The UML activity diagram is converted into the FSM for finding the valid test cases which also validates the proposed model. In this present method, Hungarian approach is also used for minimizing the cyber attacks and it was also observed that the cyber attacks give the percentage losses to the corresponding departments. The same work can also be extended for finite number of departments and according to the list of cyber attacks and limitation of the matrix N*N, the numbers of attack should be equal to the number of departments.

Chapter VIII

Conclusion and Future Scope of Work

CHAPTER VIII

CONCLUSION AND FUTURE SCOPE OF WORK

From the presented work based on the various cryptographical method existing as well as designed in the present work and after survey of extensive research work it is observed that the distributed network is a backbone for transmission of information in the form of text, numerals, audio, video, etc from one to one communication, one to many communication, many to one communication and many to many communication, without the evolution of distributed network, the aforesaid communication among the wire based or wireless devices in the form of laptop, desktop, mobile or handheld devices would not be possible from the existing literature. It is observed that a very little information on the fuzzy cryptographical technique is available while vast literature is available on symmetric or asymmetric cryptography. Therefore, present work is an attempt for the implementation of fuzzy crtyptographical techniques for sharing information from one device to another device. Based on the results presented in the thesis, the following important findings are concluded:

- An efficient decision making expert technique is proposed to assists in the light of rule based procedure which helps for taking the right decision by naval military unit moving towards the mission. The mission is formulated by a particular mission profile which depicts the commencement of the mission, accomplishment time and the preparations of subsystem are observed. The FIS is employed to each and every subsystem by implementing fuzzy operators and if-then rules, to determine the consequences of each and every subsystem on the operational groundwork. The presented technique has been validated through a numerical example; hence it endorses the feasibility of rule-based fuzzy inference approach in decision making.

- A fuzzy data transfer approach has been presented by the Fuzzy Vogel Approximation method for optimizing the data transfer time from one device to another device connected across the distributed network which includes mobile devices, desktop, hand-held devices, laptop and other network devices. In this technique, the data has been transmitted number of times to different selected destination located at multiple locations based on different parameters like size of data, create time, status of data, finish time, an average speed of transfe,r etc. The proposed techniques are easy to understand and can be employed in real-world situations for effective decision making.

- Further the above approach has also been implemented through ranking based fuzzy approach which produced the optimal results as compared to the existing techniques. In this methodology, firstly the ranking function is computed and then the proposed methodology is employed on the obtained data. A comparison of the presented results is also given with the existing results and proved that our results are optimal and efficient to be used for transfer the data from one location to the another location.

- For the detection of fraud only MAC address can be retrieved through which faults can be detected. Hackers may hack the information by entering into the system or device through software and may manipulate or steal the information. Hence, a crptographical security on the MAC address is proposed and observed that the existing technique for security of MAC address is efficient and may be used by the software industries. Results have been validated through a numerical example.

- For presentation of various proposed models, UML has been used. A model is proposed for occurrence and resolving the risks on the desktops/devices connected across the distributed network. Hundred percentage risks cannot be omitted from the cyber world however it can be minimized. A suitable method is proposed for minimizing the cyber crime across the distributed network.

- For minimizing the cyber crime, FSM concepts are used for generation of the test cases which has been validated through JAVA code.

- In the presented work, an optimization Hungarian approach is used for minimizing the cyber attacks when multiple users are attached across the distributed network. The results have been validated through numerical example.

- In the entire work, efficient approaches/ techniques have been presented and well supported through the numerical examples. The solutions of the proposed problems as said above have been presented through the MATLAB.

Further, the presented work can be extended in many directions and some of important ones are given below:

- The presented methodologies in Chapter III may be used for the solution of the real-life problems like assignment problem, network flow problem, etc.

- Since limited information in the literature is available for the researchers hence, there is vast scope for proposing the various techniques based on the fuzzy concepts and it proved that from the presented work the fuzzy approaches may give further optimized results through normal fuzzy approach. The fuzzy approach may be

fuzzy transportation problem, fuzzy assignment problem, fuzzy network flow problem, fuzzy economic order quantity and many more.

- When fuzzy methods are used for transfer of vast data, then suitable methods based on the fuzzy rule may be extended by considering the several numerical examples from the data mining field.
- The proposed work can be extended in any branch of engineering and designs.

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Appendix

Reprints of Published Research Papers

I. J. Computer Network and Information Security, **2018, 4, 28-37**
Published Online April 2018 in MECS (http://www.mecs-press.org/)
DOI: 10.5815/ijcnis.2018.04.04

Fuzzy Rule Based Inference System for Implementation of Naval Military Mission

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Received: 18 November 2017; Accepted: 16 January 2018; Published: 08 April 2018

***Abstract*—**Naval military units are convoluted frameworks required to work in specific time periods in seaward assignments where support operations are radically restricted. A decline at the time of mission is an analytical fact that can radically impact the mission achievement. The choice of changing a unit to a mission subsequently requires complex judgments including data about the well being status of hardware and the natural conditions. The present system expects to help the choice about changing a unit to a mission considering that ambiguity and unpredictability of information by methods of fuzzy concepts and imitates the selection procedure of a human trained by means of a rule-based inference system. A numerical application is introduced to demonstrate the viability of the approach.

***Index Terms*—**Inference system, fuzzy concept, analytical fact, naval military, hardware.

I. Introduction

A lot of works has been done by researchers on inference system but it is limited towards fuzzy rule based inference system and the present work is an attempt in this direction. Let us explain some important references. Singh K. proposed modified adaptive modulation technique in this article. The proposed technique adapts nature of communication based on present modulation sequence, code rate, bit error rate and signal to noise ratio [1]. Mustapha S. et al. introduced a neuro fuzzy networks sequential adaptive fuzzy inference system (SAFIA) for the evaluation of performance of controlled robot manipulation [2]. Olugo et al. developed a fuzzy rule base system by using visual basic.Net. They also described the fuzzy rules and arithmetic [3]. Akgun et al. have studied landslide susceptibility mapping using a completely expert opinion based approach which is applied for Sinop (Northern Turkey) region and its close vicinity. A program named as "MamLand" was used for the construction of Mamdani Fuzzy Inference System and employed in MATLAB. Seven conditioning parameters are used in this study that characterizes topographical, geological and environmental conditions. In these studies, 351 landslide locations were used. After completing the data production study, the data was analyzed using a computing approach named as Mamdani type fuzzy inference system [4]. Amindoust et al. have regulated the sustainable supplier selection criteria and sub criteria and proposed a methodology for evaluation and ranking for a given set of suppliers. The fuzzy logic has been applied and a new ranking method named as Fuzzy Inference System (FIS) is proposed for the supplier selection problem [5]. Singh and Chandra presented an Adaptive Network Based Fuzzy Inference System (ANFIS) for the estimation of speed and position of Permanent Magnet Synchronous Generator (PMSG). ANFIS tune estimator is used to estimate the rotor position and its speed accurately against parameter variation. This system consists of two back to back connected invertors in which one is used to controlling the PMSG whereas the other one is used to synchronize the grid. The proposed system is simulated by MATLAB/Slim Power System (SPS) tool box [6]. Büyüközkan, Çifçi here examined the problem to identify a beneficial model based on sustainability principles for supplier selection operation in supply chains. The sustainable supplier evaluation proves an appropriate multi criteria analysis and solution approach because it has the multi criteria nature. During the evaluation process, the decision maker might face various situations like time pressure, lack of expertise in related issues etc.

In this study, authors developed a new strategy which is based on fuzzy analytical network process within multi person decision making under incomplete preference relation and they also analyzed the sustainability of supplier in real life problems by which the validity of model can be evaluated [7]. Farnandez et al. described multiclass classification for linguistic fuzzy rule based classification system and proposed an idea in

which the original data is decomposed into binary classification problems using the pairwise learning approach (Confronting all pair of classes) and finally obtained an independent fuzzy system for each one of the fuzzy rule based classification system produce an associate degree for both the corresponding classes along with inference process and these values are encoded into a fuzzy preference relation [8]. Ustundag et al. introduced Radio Frequency Identification (RFID) technology by which the chance of visibility is increased through easy tracking and identifying of goods, assets and even living things. The cast and benefits of element were determined with the help of RFID system whereas the accepted increase of customer order is determined in the form of delivery accuracy and delivery time by using fuzzy rule based system. The expected net present value (NPV) of RFID investment is determined with the help of Monte Carlo simulation method [9]. Kurnaz et al. described an Adaptive Neuro Fuzzy Inference System (ANFID) based autonomous flight controller for Unmanned Aerial Vehicles (UAVs). Three fuzzy logic modules are developed to control the location of the UAV in three dimensions space as altitude location, longitude location and latitude location. the Heading, and the speed are controlled with the help of adjustment of the pitch angle, the roll angle and the throttle position of the UAV. MATLABs standard configuration and the Aerosim aeronautical simulation block set are used for the implementation of the framework [10]. Boyacioglu and Avci investigated the predictability of stock market return by using Adaptive Network Based Fuzzy Inference System (ANFIS) and used a model in which the predictability of the return on stock price index of the Istanbul Stock Exchange (ISE) is measured by ANFIS [11]. Aarabi et al. presented a method for automatic detection of seizures in the intracranial EEG recording of the patients which are suffering from medically intractable focal epilepsy. The author designed a fuzzy rule base seizure detection system which is based on the expert's reaching knowledge [12]. Zarandi et al. have developed a type two fuzzy rule based expert system for the analysis of stock price. In this model, the technical and fundamental indexes are used as input variables. This model is also validated on stock price estimation of an automotive manufactory in Asia [13].

Fernandez et al. used a preprocessing step to deal with class imbalance in a fuzzy rule based classification system. They analyzed the behavior of fuzzy rule base classification system in the framework of datasets with the application of an adaptive inference system along with parametric conjugative system [14]. Fernandez et al. tried to improve the performance of fuzzy rule based classification systems like imbalanced domains, increased the granularity of the fuzzy partitions in the boundary areas between the classes and proposed the use of hierarchical fuzzy rule base classification system i.e. based on the refinement of a simple linguistic fuzzy method by using the extension of the structure of the knowledge based in a hierarchical way and used a genetic rule selection process by which a compact and accurate model is achieved [15]. Quek et al. described the application of a specific class of neuro fuzzy system which is known a Pseudo Outer Product Fuzzy Neural Network using Truth Value Restriction method (POPFNN-TVR) for modeling of traffic behavior. This model is highly applicable to the modeling of interlane relationship in a highway traffic stream and the results are better than the traditional system [16]. Chang and Liu introduced a Takagi-Sugeno-Kang(TSK) type fuzzy rule base system for the prediction of stock price. This model applied to the technical index because the input variable and the consequent parts is a linear combination of the input variables. This model tested on Taiwan electronic share from the Taiwan stock exchange (TSE) [17]. Taheri and Jahromi proposed a new learning rule for fuzzy rule based classification system. The method can be applied her single wiener of weighted vote methods of reasoning is used. The proposed method is much faster and more effective. The major advantage of this proposed method is that; the redundant rules are removed during the learning process [18]. Fernandez et al. studied the behavior of fuzzy rule base classification system in the scheme of imbalanced datasets, focusing on the synergy along with preprocessing mechanism of instances and the configuration of fuzzy rule datasets [19]. Ying and Pan predicted the regional electricity loads using adaptive network based fuzzy inference system. The objective of this study is to apply the Adaptive Network Based Fuzzy Inference System (ANFIS) model to predict the regional electricity loads and determine the predicting performance of this model [20]. Keshwani et al. developed two types of fuzzy models (3 inputs – 1 output and 2 inputs – 1 output) to detect the permeability of compounds through human skin. The information about the compound (molecular weight and octonal – H_2O partition coefficient) and the application temperature are stored as an input. By comparing the predicted and actual fuzzy classification and defuzzification of the output compounds was quantify through this model to get crisp values for correlating estimates and published value [21]. Angelov has described a new approach to fuzzy rule based system structure identification in online mode. The author elaborated the previous approach i.e. Takaji-Sugeno (ETS) by introducing self learning aspects and also elaborate the mechanism of formation of new fuzzy sets and new fuzzy rules by using the online data density estimation [22]. Mansoori et al. considered the automatic design of fuzzy rule based classification system from the labeled data. The two main important fuzzy classification parameters are classification accuracy and interpretability of generated rules. The author proposed a weighting function for compatibility grade of patterns so that the performance fuzzy classification system was improved without degrading the interpretability of fuzzy rules [23]. Sun et al. investigated the accessibility of applying a novel neural network technique named as extreme learning machine (ELM) to estimate a neuro fuzzy Takaji-Sugeno-Kang (TSK) fuzzy inference system. This method is an updated version of regular neuro fuzzy TSH Fuzzy inference system. The proposed method has the

advantage that eliminates the curse of diementiability i.e. measured in backpropagation and hybrid adaptive neuro fuzzy inference system [24]. Firat and Gungor used an Adaptive Network Based Fuzzy Inference System (ANFIS) approach to construct a river flow forecasting system. The river great Menderes which are located in the west of turkey is the most important water resource of great menderes catchment's was selected for the applicability and capability of ANFIS and found very imperative result of ANFIS upon the accuracy and reliability for river flow estimation [25]. Polat and Gunes detected on diabetes disease, which is an ordinary disease using Principal Component Analysis (PCA) and ANFIS. This study improves the accuracy of diagnosis diabetes disease using PCA and ANFIS [26].

Chang and Chang introduced a neuro fuzzy hybrid approach which is used in the construction of water level forecasting system during flood periods and used an ANFIS for the management of reservoir. The result of the presented study demonstrates that ANFIS can be successfully applied to the reservoir water level forecasting system and provide high accuracy results [27]. Polat and Gunes detected Adaptive Neuro Fuzzy Inference System (ANFIS) on thyroid disease using PCA, k-nearest neighbor (k-NN) based weighted preprocessing. This model consists of three stages. K-NN was utilized as a preprocessing step before the main classifier in the second stage. The Adaptive neuro fuzzy inference system was used in 3rd stage for the diagnosis of thyroid disease [28]. Rong et al. introduced a Sequential Adaptive Fuzzy Inference System (SAFIS) which was based on the functional equality between a radial basis function network and a Fuzzy Inference System (FIS). The concept of "Influence" of a fuzzy rule is introduced in SAFIS system. In this method the fuzzy rules can be added or removed on the input data. "clasest" (in a Euclidean space sense) parameter was applied when the input data do not follow the adding of fuzzy rules. The closes rules are updated using an Extended Kalman Filter (EKF scheme) [29]. Kazeminezhad et al. predicted the wave performance of Adaptive Hardware Based Fuzzy Inference System (AHFIS) and Coastal Engineering Mahual (CEM). The data used in this study is fetched limited wave data. The result shows that AHFIS is more accurate in comparison to CEM method [30]. Guler and Ubeyli described the applicability of Adaptive Neuro Fuzzy Inference System (ANFIS) for the classification of electroencephalogram (EEG) signal. In this method the decision making was performed in two steps: One is feature extraction using the Wavelet Transform (WT) and the other one is ANFIS trained with backpropagation gradient descent method along with least square method. The performance of this model was evaluated in terms of training performance [31]. Chakraborty and Pal proposed a neuro fuzzy scheme for classifier designing along with feature selection. The network is trained in three phases in the first phase the important features and the classification rules are learn by the network whereas in the subsequent phase the, network represents an optimal set of rules. This system is tested on both synthetic and real set of data [32]. Lu and Antony proposed a method which has the advantage over Taguchi Method and fuzzy rule based inference system. This method is more robust and has the capability who tackles multiple response optimization problems [33]. Ho et al. proposed a method by using an Adaptive Neuro Fuzzy Inference System (ANFIS) which established a relationship between the surface image and the roughness of surface. This method effectively predicted the roughness of surface using cutting parameters (cutting speed, federate and depth of cut) and the gray level of surface image [34]. Kasabov introduced a new type of fuzzy inference system named as Dynamic Evolving Neural Fuzzy Inference System (DENFIS) for adaptive learning through online and offline and their application for dynamic time series prediction. DENFIS works though incremental, hybrid, learning and new data input, new features, new class through tuning of local elements. DENFIS effectively learns the complex sequences in an adaptive way and give the good results in comparison to other existing methods [35]. Cordon et al. proposed a method by which simple generation method is derived by Rule Base (RB) by using an appropriate Data Base (DB) by means of genetic algorithm [36]. Ishibuchi examined the effect of rule weights in fuzzy rule based classification system and used fuzzy reasoning method which based on single winner rule. The winner rule contains the pattern of fuzzy IF-THEN rule with the capability grade with new pattern. The author described the fuzzy IF-THEN rules with the help of drawing classification boundaries [37]. Chakrborty and Pal proposed a neuro fuzzy system which can simultaneously be done the feature analysis and system identification in an integrated manner. This method is a five layered feed forward network which is based on fuzzy rule based system. This system also maintained the non-negative characteristics of certainty factors of rule.

This system is validated on both synthetic and real data and results are quite satisfactory [38]. Cordon et al. proposed a new method in such rule base can be derived automatically through the knowledge base of a fuzzy rule based system by finding an appropriate database using genetic algorithm [39]. Casillas et al. presented a genetic feature selection process that can be used more efficiently to obtain a multistage genetic learning method. This proposed method affix, a prairie, elected the number of features, and accomplished, by using sonar example base [40]. Cordon et al. introduced new fuzzy reasoning method which is helpful in the improvement of system performance maintaining its interpretability and described the behavior of a general reasoning method, analyze six proposals for this general method and also presented a method to learn the various parameters of this fuzzy reasoning method [41]. Ishibuchi et al. examined two types of voting scheme based on fuzzy systems for the identification of pattern classification problems. In first type of voting machine, voting is done by multiple fuzzy if-then rules, I- a single fuzzy based classification system and the other type voting is done by multiple fuzzy rule based classification system [42]. Kuo and Xue utilized

the fuzzy logic for learning process by using Fuzzy Neural Network (FNN) to grasp the expert's knowledge and proposed a system which consists of four parts; Data collection, general pattern model (ANN), unique pattern model (FNA), and decision integration (ANN). The findings from the proposed system indicated that this model could be performed more accurately as compared to other conventional statistical method and single ANN [43]. Czogala and Leski introduced a new artificial Neural Network Based Fuzzy Inference System (ANNBFIS). This system consist the moving fuzzy consequent if-then rules. The linear combination of system inputs are used to determine the location of the fuzzy set. This system automatically generates rules from the numerical data. The proposed system operated with Gaussian membership functions. Gradient and Least square methods were used for parameter estimation [44]. Tolias and Panas presented a new approach for upgrading the results of fuzzy clustering by applying spatial constraints for resolving the image segmentation problem. A sugeno (185) type rule-constructed system which takes three inputs and 11rules that connected with clustering results acquired by the well known Fuzzy C-Means (FCM) and Possibilistic C-Means (PCM) algorithm. It gives good image segmentation concerning area smoothness and removes noisy effect [45]. Bernard designed a rule based, digital, closed loop controller fuzzy logic and implemented it for the control of power on the 5 – MWT Massachusetts Institute of Technology (MIT) research reactor under steady and transient conditions. The author compared the rule based and analytical approach based upon his previous experiences. The major advantage of the rule based system is that it is more robust than their analytical counter parts [46]. Jouffe concluded the Fuzzy Inference System (FIS). The learning process is the system feedback mechanism which is described in terms of reward and punishment task. In each step the agent received a signal according to the last action which was performed in the previous state. For the comparison of the methods, author used a well known Card-Pole Balancing and Mountain-Car Problems and focus on the important characteristics of Fuzzy Actor Critic Learning (FACL) and Fuzzy Q-Learning (FQL) [47]. Nozaki et al. proposed an adaptive method to build a fuzzy rule base classification system with high performance. This method contains two procedures: One is an error correction based learning process and the other one is additional learning process. In error correction based learning process; the grade of certainty of each fuzzy rule was adjusted. The authors also proposed a method for selection of significant fuzzy rule by processing unnecessary fuzzy rule and also constructed a compact fuzzy rule based classification with high performance [48]. Sun summarized the Jang's architecture of applied as adaptive network and the Kalman filtering algorithm to identify the system parameters. A date structure named as fuzzy binary boxtree was introduced which is helpful in the organization of rules so that the rule base can be matched to the input signals with logarithm efficiency [49]. Jang described the structure and learning process of ANFIS which is implemented in the framework of adaptive networks. The proposed ANFIS is constructed by a hybrid learning procedure in which input output mapping is done on both human knowledge and stipulated input-output data pairs [50].

II. Proposed Model for Fuzzy Inference System

The strategy here exhibited, as said recently, plans to help to make a choice about the changing a unit to a particular mission. As expressed before, a few parameters that impact such choice ought to be considered, this paper, however, goes for introducing an approach as opposed to formalizing the total choice system, in this way four delegate parameters have been taken into record and they have been distinguished by experts of military transport. Such parameters are the selection and maintenance of aim, efficiency of sub system, aim distance and sea condition. The efficiency of the framework associated with a mission is an essential concern since, as expressed recently, support operations are definitely restricted in seaward conditions. Moreover, the working states of frameworks and machinery must be considered as per the particular mission profile since specific number of machines is required in every mission. Hence it is to begin with expected to individuate the dispatch subsystems (Cooperation and Synergy, Concentration of Force, Morale Security, ammunition etc...) whose operability is required to achieve mission tasks. Additionally, for every subsystem, the components must be distinguished and their efficiency must be connected to the efficiency of the whole ship as per the useful relations communicated by the block diagram.

The FIS is applied to every subsystem by utilizing IF-THEN rules and fuzzy operators, to decide the effect of every subsystem on the operational preparation. At the last stage of the proposed methodology, by considering the minimum value among the output values, a measure of the ship operational status, with connection to a given mission, is provided. The less operator is selected to assure effectively perform mission undertakings.

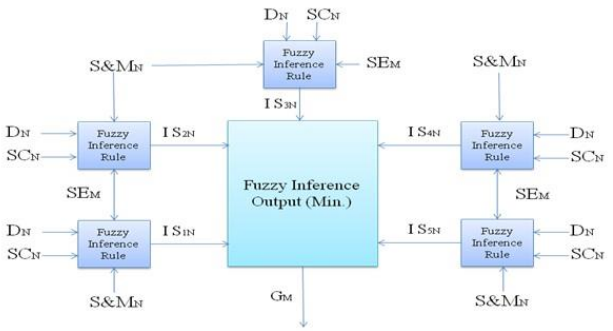

Fig.1. Model for Fuzzy Rule Based Inference System

Where,

N= Mission/ AIM
M=Subsystem

D_N=Distance to Aim
SC_N=Sea Condition
$S\&M_N$=Selection and Maintenance of AIM
SE_M= Efficiency of Subsystem M with respect to the Mission/AIM
I S_{MN}=Impact of subsystem M on the Mission/Aim N.
G_M=Global Outcome exhibits the possibility of executing the Mission/AIM

A fundamental fuzzy logic system is constituted four segments: a rules set, a fuzzifier, a fuzzy inference engine and a defuzzifier. The center of a FIS is its knowledge base, which is demonstrated as fuzzy principles. Here the fuzzy logic system utilized multi input-single output system (MISO), utilizing the mamdani implications and the focal point of strategy as defuzzifier. At initial step of the inference procedure, it is expected to define the fuzzy set numbers to represent the crisp input values that are the fuzzification process, which comprises in allocating fuzzy semantic variables in the universe of each input value. Specifically, in this paper, each input parameter is depicted by triangular and trapezoidal fuzzy numbers.

A. Triangular Fuzzy Number

A fuzzy number Ã= (a_1, a_2, a_3) is said to be triangular fuzzy number and interpreted as membership functions and holds the following conditions

(i) a_1 to a_2 is increasing function
(ii) a_2 to a_3 is decreasing function
(iii) $a_1 \le a_2 \le a_3$.

$$\mu_{(A)}(x)=\begin{cases}0, & x < a_1\\ \dfrac{x-a_1}{a_2-a_1}, & a_1 \le x \le a_2\\ \dfrac{a_3-x}{a_3-a_2}, & a_2 \le x \le a_3\\ 0, & x > a_3\end{cases} \quad (1)$$

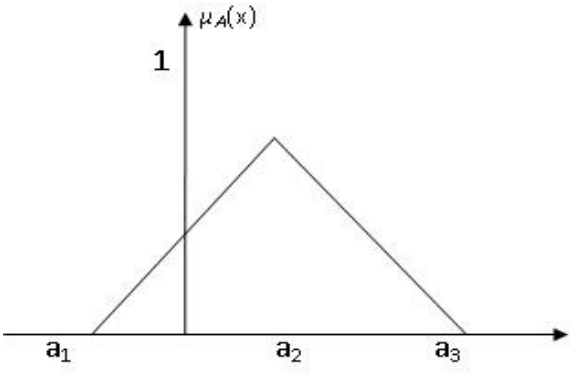

Fig.2. Triangular Fuzzy Number

B. Trapezoidal Fuzzy Number

A fuzzy number $\tilde{A}=(a_1,a_2,a_3,a_4)$ is said to be a trapezoidal fuzzy number if its membership function interpreted as follows (Figure 3).

$$\mu_{(\tilde{A})}(x)=\begin{cases}0, & x < a_1\\ \dfrac{x-a_1}{a_2-a_1}, & a_1 \le x \le a_2\\ 1, & a_2 \le x \le a_4\\ \dfrac{a_4-x}{a_4-a_3}, & a_2 \le x \le a_3\\ 0, & x > a_4\end{cases} \quad (2)$$

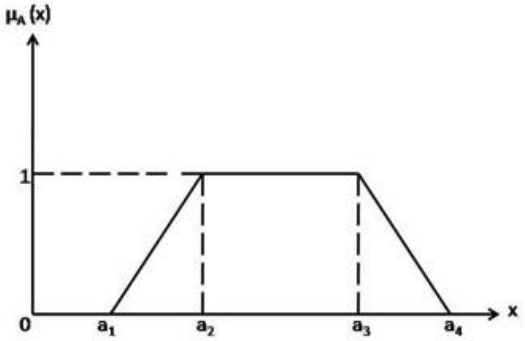

Fig.3. Trapezoidal Fuzzy Number

The next stage in the fuzzy logic system is to characterize the possible rules deriving from incorporating the fuzzy inputs. Principles are generally given by a group of specialists and are presented into the FIS. Afterward, since the value of the judgment parameters is crisp, the fuzzifier maps the input crisp numbers into the fuzzy sets to acquire degrees of membership. The inference engine of the FIS maps the forerunner fuzzy (IF part) sets into subsequent fuzzy sets (THEN part) considering the principles already expressed. The inference procedure decides the fuzzy subset of the output variable for each rule by utilizing the MIN operator (Mamdani operator) as suggestion operator. If more than one rule gives a similar outcome, an operator must aggregate the results of these rules. Specifically, the MAX operator is utilized. At last, the defuzzifier maps the fuzzy outcome into a crisp number, which turns into the outcome of the fuzzy logic system that is the effect of generic subsystem on ships operational preparation.

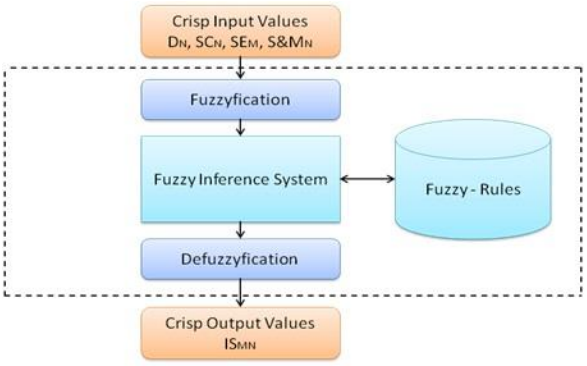

Fig.4. Block Diagram of FIS

III. Implementation of Proposed Model

The proposed technique is connected to a recreated case with connection to a military ship. The inference procedure is carried out by MATLAB. It is gathered that the ship is constituted by the accompanying subsystem individuated as basic for the mission's prosperity: cooperation and synergy, concentration of force, morale security, ammunition, and logistics. Such framework may experience distinctive stacking and business conditions in various missions' profiles with various dependability esteems. The reasonable structure here considered is consequently constituted by the frameworks dependability (concurring to the mission profile), the separation from the nearest port and the states of the ocean. Each input parameter has three linguistic variables (low, medium and high) as shown in figures 5, 6, 7 and 8 portrayed by triangular and trapezoidal fuzzy numbers, as appeared above. The output parameter has five linguistic factors (very low, low, medium, high and very high) has appeared in Figure 9.

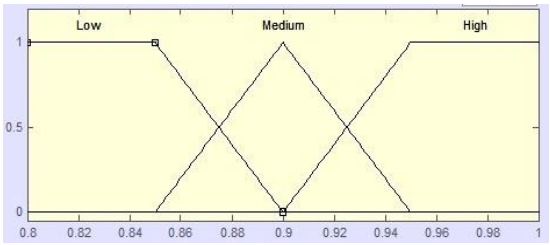

Fig.5. Selection and Maintenance of AIM

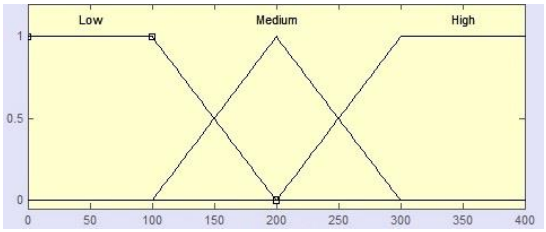

Fig.6. AIM Distance

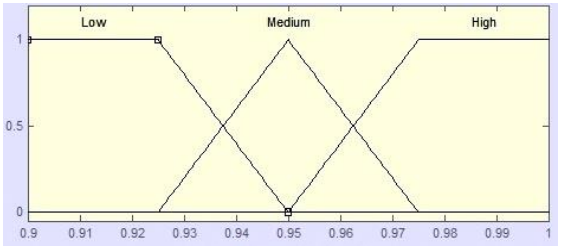

Fig.7. Subsystem Efficiency

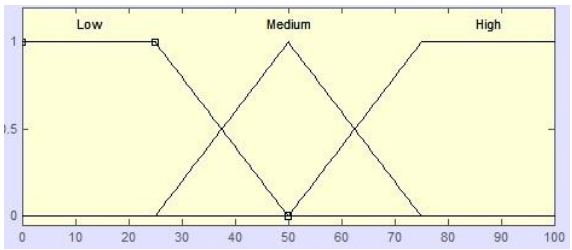

Fig.8. Sea Condition

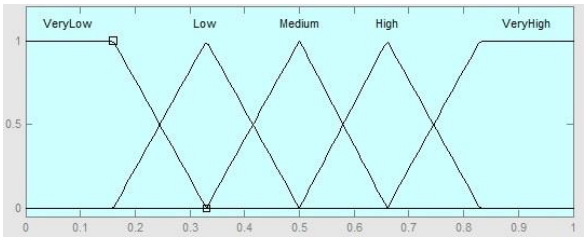

Fig.9. Impact on Successful Execution of Mission

The contribution of the generic subsystem M to the probability of executing the mission IS_{MN} is communicated by values having a place with the range [0; 1] and it can be represented. The dependability of each subsystem for the mission N, which constitutes a contribution to the decision framework, is given in Table-1.The other input data of the mission N appear in Table-2. The set of standards individuated by the specialists given in Table-3.The related outcome got by the inference procedure are accounted for in Table-4. Subsequently, in this case, by applying the proposed strategy, that is by taking the minimum value among the output value, the ship operational preparation with connection to a given mission is measured in the range [0,1].

Table 1. Subsystem Efficiency

Subsystem	Efficiency
Cooperation and Synergy	0.98
Concentration of Force	0.95
Morale Security	0.92
Ammunition	0.94
Logistics	0.97

Table 2. Other Mission Execution Input Parameters

Selection and Maintenance of AIM	Distance	Sea Condition
0.92	250	60

Table 3. Fuzzy Rules

Selection and Maintenance of AIM	Subsystem Efficiency	Distance of AIM	Sea Condition	Impact on Mission Execution G_M
L	L	L	L	L
L	L	L	M	VL
L	L	L	H	VL
L	L	M	L	L
L	L	M	M	VL
L	L	M	H	VL
L	L	H	L	L
L	L	H	M	VL
L	L	H	H	VL
L	M	L	L	M
L	M	L	M	M
L	M	L	H	L
L	M	M	L	M
L	M	M	M	L
L	M	M	H	VL
L	M	H	L	VL

L	M	H	M	VL
L	M	H	H	VL
L	H	L	L	H
L	H	L	M	M
L	H	L	H	M
L	H	M	L	M
L	H	M	M	M
L	H	M	H	M
L	H	H	L	M
L	H	H	M	M
L	H	H	H	VL
M	L	L	L	M
M	L	L	M	M
M	L	L	H	L
M	L	M	L	M
M	L	M	M	M
M	L	M	H	L
M	L	H	L	L
M	L	H	M	L
M	L	H	H	VL
M	M	L	L	H
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M	H	L	L	H
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M	H	H	L	M
M	H	H	M	M
M	H	H	H	L
H	L	L	L	H
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H	L	L	H	L
H	L	M	L	H
H	L	M	M	M
H	L	M	H	L
H	L	H	L	L
H	L	H	M	L
H	L	H	H	VL
H	M	L	L	H
H	M	L	M	H
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H	M	M	M	H
H	M	M	H	M
H	M	H	L	M
H	M	H	M	M
H	M	H	H	L
H	H	L	L	VH
H	H	L	M	H
H	H	L	H	M
H	H	M	L	H
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H	H	H	L	H
H	H	H	M	M
H	H	H	H	L

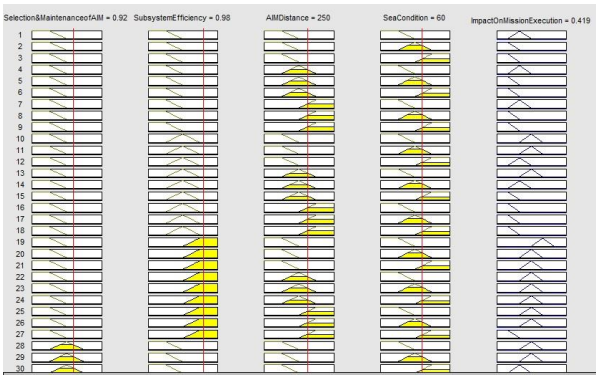

Fig.10. Impact of Cooperation and Synergy System

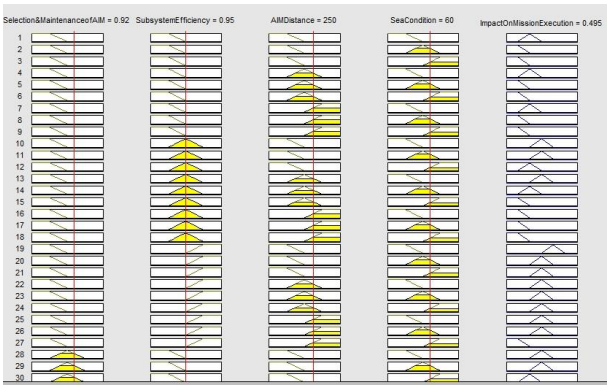

Fig.11. Impact of Concentration of Force System

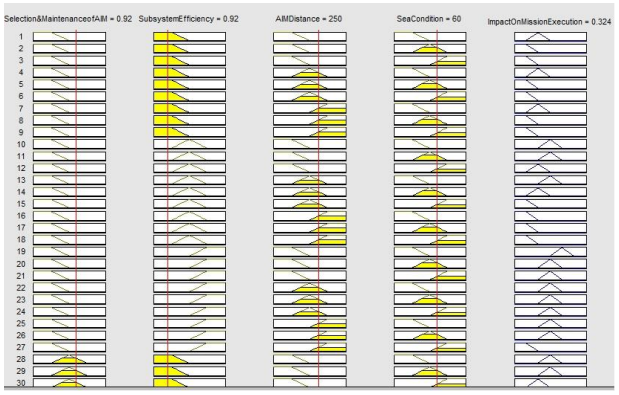

Fig.12. Impact of Morale Security System

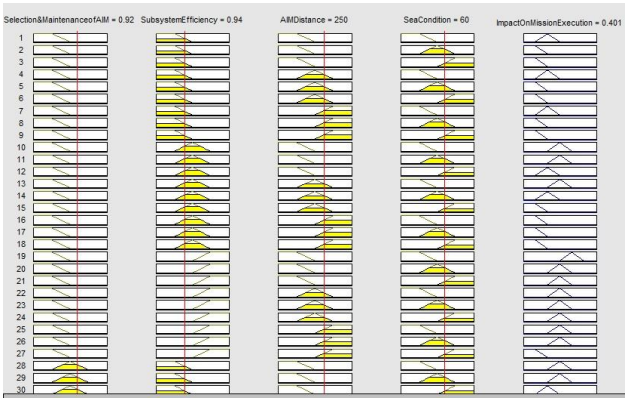

Fig.13. Impact of Ammunition System

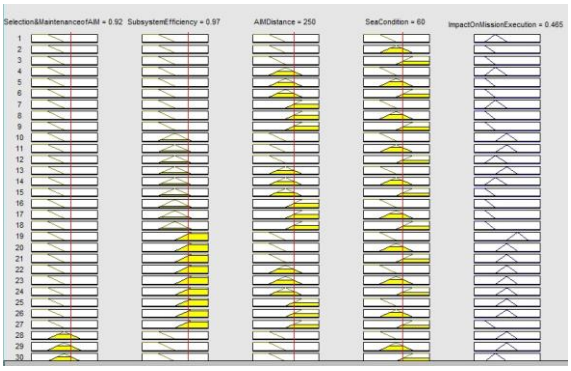

Fig.14. Impact of Logistics System

Table 4. Fuzzy Rules

Subsystem	Impact on Successful Execution of Mission
Cooperation and Synergy	0.419
Concentration of Force	0.495
Morale Security	0.324
Ammunition	0.401
Logistics	0.465

IV. Results

The impact of each subsystem on mission success is calculated by applying various fuzzy rules in fuzzy inference system. In this system, we have taken five different subsystem efficiency parameters and three basic mission executing input parameters to calculate the outcome of our fuzzy inference system. The subsystem parameters are cooperation and synergy, concentration of force, morale security, ammunition and logistics. We put these subsystem parameters with basic mission input parameters that are selection and maintenance of AIM, distance and sea condition. We put selection and maintenance of AIM is 0.92, distance is 250, sea-condition is 60 with different subsystem efficiency parameters. After processing all these basic inputs with each subsystem inputs in fuzzy inference system the outcome is generated.

The impact of cooperation and synergy on mission is 0.419 when cooperation and synergy is 0.98 as shown in Fig.10, similarly the impact of concentration of force on mission is 0.495 when concentration of force is 0.95 as shown in Fig.11, the impact of morale security on mission is 0.324 when morale security is 0.92 as shown in Fig.12, the impact of ammunition on mission is 0.401 when ammunition is 0.94 as shown in Fig.13 and impact the of logistics on mission is 0.465 when logistics is 0.97 as shown in Fig.14.

V. Conclusions

In this paper, the process of decision making that brings into service a military naval unit to a mission has been recognized. Such decision making process normally soliciting a human intelligence system includes knowledge about natural conditions, the working status of ammunition and so on. Such data cannot really validate by methods for customary (fresh) numerical models, because of its ambiguity and vulnerability, though such attributes can be productively considered utilizing estimated thinking. In this present paper, a specialist choice help in light of a fuzzy inference system is displayed, which permits to consider specialists' involvement in the judgments of the probability of a military naval unit playing out a mission. The mission is portrayed by a particular mission profile which characterizes the mission beginning and consummation time, and the arrangement of subsystem included. The numerical application introduced demonstrates that the approach displayed may effectively be utilized to help the chief in the choice based procedure giving a worldwide score communicating the probability of the ship to play out the mission assignments, consequently affirming the viability of fuzzy inference system in choice based examination.

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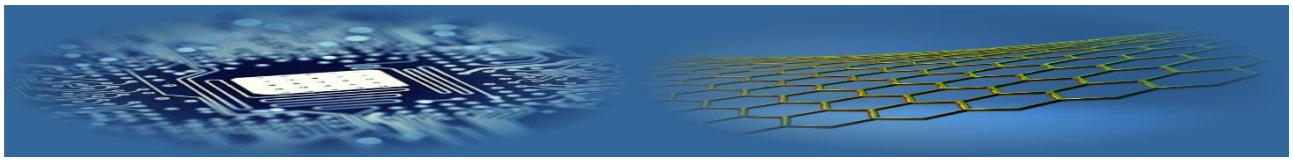
How to cite this paper: Rashmi Singh, Vipin Saxena,"Fuzzy Rule Based Inference System for Implementation of Naval Military Mission", International Journal of Computer Network and Information Security(IJCNIS), Vol.10, No.4, pp.28-37, 2018.DOI: 10.5815/ijcnis.2018.04.04



A new ranking based fuzzy approach for fuzzy transportation problem

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Abstract

In the current scenario of the competitive market, the adversity on the organization finds the better method to create and deliver values and services to the customers as per customer's requirement with in optimal cost and time. The transportation model provides a robust framework to meet these challenges. For solving real life problems, there are several methods to solve transportation problem in fuzzy circumstances. In this paper, a method is suggested to solve fuzzy transportation problem in which trapezoidal fuzzy numbers represent transportation cost, availability, and demand for the product. To illustrate the proposed method, a numerical example is solved and obtained results are associated with the results of existing methods. It is observed that proposed method gives the optimal result in comparison to previously existing method and it is very easy to explain and implement in real life transportation problem for the decision maker.

Keywords

Competitive market, ranking method, fuzzy transportation, robust framework

1 Introduction

A transportation problem permits only those shipments that go directly from a supply point to a demand point. A fuzzy transportation problem is defined as a transportation problem in which the transportation costs, supply, and demand quantities are fuzzy numbers. Most of the existing techniques give only crisp solutions for the fuzzy transportation problem. The aim of fuzzy transportation is to find the least transportation cost of some commodities through a capacitated network when the supply and demand of nodes and the capacity and cost of edges are interpreted as fuzzy numbers. Parameters of the transportation problem consist of the amount of cost, supply, and demand. In the usual form of this query, some parameters are fixed and definitive, but in the real world, the parameters are ambiguous and imprecise.

Singh and Saxena proposed a new method for optimization of cost in fuzzy transportation problem using secure data transfer technique, which gives optimal results as compared to existing methods and also takes less number of iterations [1]. Ebrahimnejad has given a new method for solving the fuzzy transportation problem in which non-negative LR flat, fuzzy numbers applied to the representation of transportation cost, supply and demand [2]. Radhika and Parvathi introduced various types of intuitionistic fuzzification function like triangular, trapezoidal, gaussian, bell-shaped, sigmoidal, S-shaped, Z-shaped functions, which are more useful in the real world [3]. Maliniand and Ananthanarayanan discussed about ranking fuzzy number, which plays an essential role in various problems such as analysis of data, decision-making problems, socio economic systems etc. It is important step in various mathematical models. Fuzzy ranking method provides a magnificent tool for managing the fuzzy transportation problem [4]. Nareshkumar and Kumaraghuru have presented closed, bounded and non-empty feasible region of the transportation problem by using fuzzy trapezoidal numbers and ensures the existence of an optimal solution to a balanced transportation problem. Fuzzy Vogel's Approximation Method (VAM) is used for finding the initial solution of the transportation problem. On the other side, fuzzy modified distribution method is used for determining the optimality of the obtained solution [5]. Narayanamoorthy and Kalyani derived a new technique for solving the fuzzy transportation problem and compared with previously existing method [6]. Khalaf has given for new fuzzy Russell's Approximation method to solve the fuzzy transportation problem when all the cost coefficients are in the form of fuzzy numbers while all demands and supplies are in the form of crisp numbers to find out the initial basic feasible solution [7]. Solaiappan and Jeyaraman investigated the fuzzy transportation problem by using zero termination method. In this way, the transportation cost, supply, and demand are assumed to lie in the interval of values. The Robust Ranking method is used for the arrangement of fuzzy numbers in a particular range. The α-cut method is also used for the formation of a new equation which is used to find out the optimal solution [8]. Rani et. al. have considered the fully fuzzy unbalanced transportation problem in which the total demand is less than the total availability/ production. Dummy destination is used for solving this type of problem [9]. Gani et al. have introduced an improved version of VAM for finding the initial solution for the large-scale transshipment problems [10]. Das have et al. discussed the limitations of the VAM and developed an improved algorithm to solve the transportation problem. The limitation of VAM is that it is not applied when highest penalty cost appears in two or more rows or columns. In this case, VAM does not give any logical solution, so a new algorithm named as a logical development of VAM applied for obtaining a feasible solution [11]. Narayanamoorthy et.

al. have accomplished a new algorithm called Fuzzy Russell's method to get the initial basic feasible solution of a fuzzy transportation problem [12]. Shanmugasundari and Ganesan proposed a new method to solve the fuzzy optimal solution by using a fuzzy version of Vogel's and Modified Distribution Method (MODI) method for finding fuzzy basic feasible and fuzzy optimal solution of fuzzy transportation problem without molding them into classical transportation problem [13]. Chauhan and Joshi developed a method in which Ranking method is used to find out the fuzzy optimal solution of balanced fuzzy transportation problem by using fuzzy trapezoidal numbers with the improvement of VAM [14]. Fegade et al. have found out the least shipping cost through a capacitated network when the supply, demand, capacity and the cost of edges are represented trough fuzzy numbers and proposed a ranking method for solving the transportation problem [15]. Mohanaselvi and Ganesan have proposed a new algorithm for the fuzzy feasible solution to an entirely fuzzy transportation problem [16]. Poonam et. al. have presented a ranking technique in which α-optimal solution used for solving the fuzzy transportation problem. The fuzzy demand and supply are in the form of triangular fuzzy numbers [17]. Gani and Assarudeen have used the triangular fuzzy number to find out a solution of the method in which subtraction and division modified, and these modified operators results in exact inverse of the addition and multiplication of numbers [18]. Kumar and Kaur have identified two new methods to find out the fuzzy optimal solution of the unbalanced fuzzy transportation problem. The method is based on fuzzy linear programming formulation and classical transportation method and also proposed a new representation of trapezoidal fuzzy numbers [19]. Samuel and Venkatachalapathy have suggested modified VAM for solving the fuzzy transportation problem. This method is more efficient than any other method [20]. Kaur and Kumar have proposed a new method for solving fuzzy transportation problems through a hypothesis in which the decision maker is uncertain about the precise values of transportation cost, availability, and demand for the product. The trapezoidal fuzzy numbers used in this method for the representation of transportation cost, availability, and demand of the product [21]. Pandian and Natarajan have proposed a new algorithm named as zero point method for obtaining a fuzzy optimal solution for fuzzy transportation problem where all the cost are in the form of fuzzy trapezoidal numbers [22]. Guzel has investigated a fuzzy transportation problem with fuzzy quantities in which the bounded fuzzy triangular numbers and fuzzy transportation cost per unit bounded with upper fuzzy numbers [23]. Abbasbandy and hajjari described about the major role of ranking fuzzy number in decision-making and other various fuzzy application systems. For ranking fuzzy numbers there are several approach have been proposed and in certain cases these approaches have been shown to generate non-intuitive results. A new technique for ranking of trapezoidal numbers which is based on left and right expansion at some α-levels of trapezoidal fuzzy numbers is also introduced [24]. Peidro et al. have discussed the today's global marketplace scenarios in which separate and individual enterprise do not fulfil as individualistic entities preferably as an essential part of a supply chain. A fuzzy mathematical programming model is proposed for supply chain planning which takes supply, demand and process uncertainties. This model has been specified as a fuzzy mixed-integer linear programming model in which data is ill-known and represented by triangular fuzzy numbers. The fuzzy model provides the efficient decision maker with other alternative decision plans for various degree of satisfaction. This model is tested by using data from real automobile supply chain [25]. Chen et al. considered fuzzy transportation problems with fulfilment degree of paths since excluding the cost of transportation of paths, its safety and transportation time etc factor should be considered into account. There are some other factors in transportation such as flexibility in demand and supply of any product should also be considered into account. Furthermore the fuzzy objective about total transportation cost is taken instead of minimizing the total transportation cost precisely. So there are two criteria are considered, one is to maximize the minimum satisfaction degree with respect to the flexibility and fuzzy objective. The other is to maximize the minimum satisfaction degree among path used in transportation. For fulfilment of both criteria, there are some non-dominated resolutions after describing non-domination [26]. Yang and liu explored the settled charge solid transportation issue under fuzzy condition, in which the immediate cost, the settled charges, the supplies, the demands and the movement limits are supposed to be fuzzy factors. Accordingly, a few new models, i.e., expected value model, chance-constrained programming model are built on the premise of credibility theory. From that point onward, the crisp equivalence is also talked about for various models. Keeping in mind the end goal to settle the models, hybrid intelligent algorithm is designed depend on the fuzzy simulation technique and tahu search algorithm [27]. Ganesan and Veeramani concerned with a variety of fuzzy linear programming including symmetric trapezoidal fuzzy numbers. There are some significant and compelling outcomes are acquired which sequentially move to an output of fuzzy linear programming problems without transforming them to crisp linear programming problems [28]. Cadenas and Verdegay outlined the importance and use of fuzzy linear programming models and techniques inside the wide area of soft computing. Its experimental and practical applications can be found in various area of real world. In fuzzy mathematical programming there are some techniques and models developed based on some factors such as fuzzy cost, fuzzy constraints to be analyzed [29]. Chiang described that how to fuzzify crisp transportation problem into fuzzy sense transportation problem while considering the amount of supply and demand from the origin to destination. The use of λ-level fuzzy number and (λ,ρ) interval-valued fuzzy number in the fuzzification of constraints. By using this, the crisp transportation problem is fuzzified in fuzzy sense based statically data [30]. Ammar and Youness stated that the solid transportation problem (STP) emerges when limits are given on three thing properties. Typically, these properties are supply, demand and sort of product or method of transport. The productive arrangements and dependability of multi objective solid transportation issue with fuzzy coefficient and fuzzy supply amount and fuzzy demand amount and fuzzy movements are examined. The idea of fuzzy productive is presented in which the ordinary

efficient solution is expended based on the α-level of fuzzy numbers. An important and adequate condition for such a solution is established [31]. Liu and Kao have developed a procedure to find out the fuzzy objective value of the fuzzy transportation problem in which the cost coefficient, supply and demand quantities are fuzzy numbers. There are two different types of queries were discussed in which one belongs to inequality constraints while the other one belongs to equality constraints [32]. Maleki described a strategy to bring together a portion of the current methodology, which is utilizing diverse positioning capacities, which are using different ranking function for solving fuzzy programming problem. Besides there is another technique for tackling linear programming with vagueness in limitations by utilizing any linear ranking function [33]. Maliniand and Ananthanarayanan have presented a new ranking method, in which fuzzy transportation problem converted into a crisp value transportation problem, which can be solved, by MODI method [34].

2 Preliminaries

Lotfi A. Zadeh has introduced fuzzy set theory in 1965. Fuzzy set theory has advanced in the variety of ways in various disciplines. There are miscellaneous applications of this theory such as in artificial intelligence, control engineering, computer science, expert system, management science, operation research, medicine, decision theory, pattern recognition, etc.

2.1 FUZZY NUMBER:

A fuzzy number Ã is a fuzzy subset of real number R if its membership function $\mu_{\tilde{A}}$ qualifies the three following properties,

(i) $\mu_{\tilde{A}}(x)$ is a continuous function from R to a closed subset [0, 1];

(ii) $\mu_{\tilde{A}}(x)$ is strictly increasing in the close interval $[a_1, a_2]$;

(iii) $\mu_{\tilde{A}}(x)$ is strictly decreasing on $[a_3, a_4]$ where $a_1 < a_2 < a_3 < a_4$ and $x \in [a_1, a_4]$

Definition-1: A fuzzy number is said to be a convex normalized fuzzy set of the real line R, whose membership function is section wise continuous. We represent the set of fuzzy numbers on R as F(R).

Fuzzy Set: A fuzzy set distinguished by a membership function mapping element of a domain, universe of discourse X to the unit interval [0,1] i.e. $A = \{x, \mu_{\tilde{A}}(x); x \in X\}$, Here $\mu_{\tilde{A}} : X \to [0,1]$ is a mapping known as the degree of membership function of the fuzzy set A and μA(x) is known as the membership value of x ε X in the fuzzy set A. These membership categories often represented by real numbers ranging from [0, 1].

Definition-2: A Fuzzy set $\tilde{A}$ explained as the set of ordered pairs $(X, \mu_{\tilde{A}}(x))$, where X is a component of the universe of discourse U and $\mu_{\tilde{A}}(x)$ is the membership function that imputes to each $X \in U$ a real number $\in$ [0,1] relating the degree to which X belongs to the set.

Definition-3: A type n fuzzy set is a fuzzy set whose membership values are type $n-1$, $n>1$, fuzzy sets on $[0,1]$.

Definition-4: For a finite fuzzy set $\tilde{A}$ the cardinality $|\tilde{A}|$ is defined as $|\tilde{A}| = \sum_{x \in X} \mu_{\tilde{A}}(x)$

$\|\tilde{A}\| = \frac{|\tilde{A}|}{X}$ is called the relative cardinality of $\tilde{A}$.

Definition-5: A crisp set is a particular case of fuzzy set in which membership function uses only two values 0 and 1.

2.2 OPERATIONS ON FUZZY SETS

Zadeh explained the following operations for fuzzy set as generalization of crisp sets and of crisp statements

Definition-6: Intersection (Logical AND): The membership function of the intersection of two fuzzy sets $\tilde{A}$ and $\tilde{B}$ is explained as:

$$\mu_{\tilde{A} \cap \tilde{B}}(X) = \text{Min}(\mu_{\tilde{A}}(X), \mu_{\tilde{B}}(X)) \forall x \in X).$$

Definition-7: Union (Exclusive OR): The membership function of the union is explained as:

$$\mu_{\tilde{A} \cup \tilde{B}}(X) = \text{Max}(\mu_{\tilde{A}}(X), \mu_{\tilde{B}}(X)) \forall x \in X).$$

Definition-8: Complement (Negation): The membership function of the complement is explained as:

$$\mu_{\tilde{A}}(X) = 1 - \mu_{\tilde{A}}(X) \forall x \in X.$$

2.3 FUZZY TRANSPORTATION PROBLEM

In conventional transportation problem, it is expected that the decision maker has correct data about the coefficients having a place of the issue. Although, in real–life circumstances, the transportation cost, demand and supply of an item may not be known exactly due to wild factors. To deal with such circumstances, the fuzzy set theory is applied in the documentation for tackling transportation issues. The fuzziness in a transportation issue might be identified with the trouble of measuring or anticipating the unit transportation cost and the supply or demand. The fuzziness in the supply might be intimated as "the amount accessible is approximately . . ."which shows that there is adaptability in the supply; or that a more noteworthy supply might be conceivable. In the same manner, the decision maker may be fulfilled if the amount got at a goal is an estimated esteem or might have the capacity to acknowledge an amount lower than the objective esteem. The objective outcome is to minimize the total cost of fuzzy transportation problem and the supply and demand constraints are available to each source and destination consequently.

A FTP; in which a decision maker is unverifiable about the exact transportation cost, supply and demand activity might be formulated mathematically.

Consider a transportation problem with x supply nodes and y demand nodes, in that sj > 0 units are provided by supply i and by demand node j the required nodes are dj > 0. Related with each connection (i, j) from supply node i to demand node j, for transportation there is a unit shipping cost C_{ij}. The issue is to decide a feasible method for

transportation the accessible add up to fulfill the demand that minimize the aggregate transportation cost.

Let X_{ij} express the number of units, which are, transported from Supply i to Demand j. The mathematical description of the transportation problem is:

$$z = \min \sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij}x_{ij}$$

$$s.t. \quad \sum_{j=1}^{n} x_{ij} \le s_i \qquad i = 1,2,.....m,$$

$$\sum_{j=1}^{m} x_{ij} \ge d_j \qquad j = 1,2,.....n,$$

$$x_{ij} \ge 0 \quad \forall i, j$$

3 Trapezoidal fuzzy number

A fuzzy number $\tilde{A} = (a_1, a_2, a_3, a_4)$ is said to be a trapezoidal fuzzy number if its membership function interpreted as follows (Figure 1)

$$\mu_{(\tilde{A})}(x) = \begin{cases} 0, & x < a_1 \\ \dfrac{x-a_1}{a_2-a_1}, & a_1 \le x \le a_2 \\ 1, & a_2 \le x \le a_4 \\ \dfrac{a_4-x}{a_4-a_3}, & a_2 \le x \le a_3 \\ 0, & x > a_4 \end{cases} . \qquad (1)$$

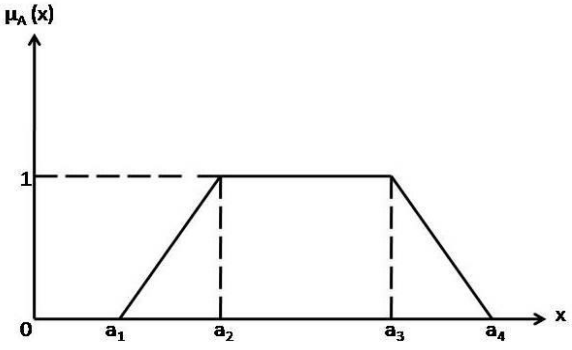

FIGURE 1 Trapezoidal fuzzy number

3.1 PROPERTIES OF TRAPEZOIDAL NUMBER

The following are properties of trapezoidal number:

1. The trapezoidal fuzzy number $\tilde{A} = (a_1, a_2, a_3, a_4)$ is said to be non- negative trapezoidal number Iff $a_1 - a_3 \ge 0$

2. The trapezoidal fuzzy number $\tilde{A} = (a_1, a_2, a_3, a_4)$ is said to be zero trapezoidal fuzzy number Iff $a_1 = 0, a_2 = 0, a_3 = 0, a_4 = 0$

3. Two trapezoidal fuzzy number $\tilde{A} = (a_1, a_2, a_3, a_4)$ and $\tilde{B} = (b_1, b_2, b_3, b_4)$ are said to be equal Iff $a_1 = b_1,\ a_2 = b_2,\ a_3 = b_3,\ a_4 = b_4$.

3.2 ARITHMETIC OPERATORS FOR SOLVING TRAPEZOIDAL FUZZY NUMBER

Let us consider $\tilde{X} = (p_1, q_1, r_1, s_1)$ and $Y = (p_2, q_2, r_2, s_2)$ are two trapezoidal fuzzy numbers then the basic arithmetic operations on $\tilde{X}$ and $\tilde{Y}$ as follows:

(i) Addition

$$\tilde{X} + Y = (p_1 + p_2,\ q_1 + q_2,\ r_1 + r_2,\ s_1 + s_2)$$

(ii) Subtraction

$$\tilde{X} - Y = (p_1 - s_2,\ q_1 - r_2,\ r_1 - q_2,\ s_1 - p_2)$$

(iii) Multiplication $\tilde{X} \bullet Y = (m_1, m_2, m_3, m_4)$

Where

m_1 = minimum $\{p_1p_2, p_1s_2, s_1p_2, s_1s_2\}$

m_2= minimum $\{q_1q_2, q_1r_2, r_1q_2, r_1r_2\}$

m_3 = maximum $\{q_1q_2, q_1r_2, r_1q_2, r_1r_2\}$

m_4 = maximum $\{p_1p_2, p_1s_2, s_1p_2, s_1s_2\}$

EXAMPLE:

Let $\tilde{X}$ and $\tilde{Y}$ are two trapezoidal fuzzy numbers Where $\tilde{X} = (4,5,6,7)$ and $\tilde{Y} = (6,7,8,9)$ *then,*

(i) $\tilde{X} + \tilde{Y} = (4,5,6,7) + (6,7,8,9)$
$= (4+6,\ 5+7,\ 6+8,7+9) = (10,12,14,16)$

(ii) $\tilde{X} - \tilde{Y} = (4,5,6,7) - (6,7,8,9) =$
$(4-9,5-8,6-7,7-9) = (-5,-3,-1,-2)$

(iii) $\tilde{X} \bullet \tilde{Y} = (4,5,6,7) \bullet (6,7,8,9) =$

$$\begin{pmatrix} min\ (24,\ 36,\ 42,\ 63),\ min\ (35,\ 40,\ 42,\ 48), \\ max\ (35,\ 40,\ 42,\ 48),\ max\ (24,\ 36,\ 42,\ 63) \end{pmatrix}$$

$= (24,\ 35,\ 48,\ 63)$

4 Ranking function

We define a ranking function F(R), which maps each fuzzy number into the real line. F(μ) represents the set of all trapezoidal numbers. If R be a ranking function and let $\tilde{a} = (a_1, a_2, a_3, a_4) \in F(\mu)$. Then $R(\tilde{a}) = (a_1 + a_2 + a_3 + a_4)/4$.

For any two trapezoidal Fuzzy number $\tilde{a} = (a_1, a_2, a_3, a_4)$ and $\tilde{b} = (b_1, b_2, b_3, b_4)$ in F(μ) then,

- $\tilde{a} \le \tilde{b} \Leftrightarrow R(\tilde{a}) \le R(\tilde{b})$
- $\tilde{a} \ge \tilde{b} \Leftrightarrow R(\tilde{a}) \ge R(\tilde{b})$
- $\tilde{a} = \tilde{b} \Leftrightarrow R(\tilde{a}) = R(\tilde{b})$

5 Methodology

The steps used for solution of numerical example are given below:

Step1: Balance the given transportation problem if either (total supply > total demand) or (total supply < total demand).

Step 2: Determine the fuzzy penalty cost for each row and column by calculating the negative mean of minimum cost and next to the minimum cost of each row and column i.e. dividing the difference of minimum cost and next to minimum cost by 2.

Step 3: If the minimum cost occurs more than one time

in a row and column then choose same transportation cost as minimum cost and next to minimum cost and penalty will become zero.

Step 4: Select the rows or columns with the highest penalty costs (breaking ties arbitrarily or choosing the lowest- cost cell). If there is tie occurs in highest penalty cost, then choose that row or column where cost is minimum.

Step 5: Compute transportation costs for selected rows or columns in step 4 by allocating as much as the possible amount to the feasible cell with the lowest transportation cost.

Step 6: Now adjust all the row and column and cross out satisfied row or column. If satisfied simultaneously then crossed out one of them and assign zero to remaining rows and columns.

Step 7: Repeat steps 2-6 until all requirements have been meet.

Step 8: Compute total transportation cost for the feasible allocations using the original balanced-transportation cost matrix.

5.1 NUMERICAL EXAMPLE

Let us consider the following numerical example

TABLE 1 Trapezoidal fuzzy transportation problem

	1	2	3	4	Supply
1	(1,2,3,4)	(1,3,4,6)	(9,11,12,14)	(5,7,8,11)	(1,6,7,12)
2	(0,1,2,4)	(-1,0,1,2)	(5,6,7,8)	(0,1,2,3)	(0,1,2,3)
3	(3,5,6,8)	(5,8,9,12)	(12,15,16,19)	(7,9,10,12)	(5,10,12,17)
Demand	(5,7,8,10)	(1,5,6,10)	(1,3,4,6)	(1,2,3,4)	

Now, we calculate R(1, 2, 3, 4) by applying ranking method i.e.

$$R(\tilde{a}) = \frac{a_1 + a_2 + a_3 + a_4}{4}$$

$$R(1,2,3,4) = 2.5$$

Similarly, the ranking for the fuzzy costs aij are calculated as:

R(a11)=2.5	R(a12)=3.5	R(a13)=11.5	R(a14)=7.75	R(a15)=6.5
R(a21)=1.75	R(a22)=0.5	R(a23)=6.5	R(a24)=1.5	R(a25)=1.5
R(a31)=5.5	R(a32)=8.5	R(a33)=15.5	R(a34)=9.5	R(a35)=11
R(a41)=7.5	R(a42)=5.5	R(a43)=3.5	R(a44)=2.5	

Now, after applying ranking technique, the trapezoidal fuzzy transportation problem is:

TABLE 2 Fuzzy transportation problem after applying ranking technique

	1	2	3	4	Supply
1	2.5	3.5	11.5	7.75	6.5
2	1.75	0.5	6.5	1.5	1.5
3	5.5	8.5	15.5	9.5	11
Demand	7.5	5.5	3.5	2.5	

After applying our Fuzzy VAM, The total fuzzy transportation cost is 116.25.

6 Comparison with existing methods

In the above chosen numerical example i.e. Table-1, suppose the availability i.e. $\tilde{p}_i$ of the product at supply S_1, S_2, S_3 and demand $\tilde{p}_j$ of the product at destination D_1, D_2, D_3, D_4 and the unit transportation cost Cij of the product in each row and column is represented by trapezoidal fuzzy number i.e. shown in Table 1. First, we convert the trapezoidal fuzzy problem i.e. Table 1 into crisp problem i.e. Table 2 by applying ranking function, and then we perform fuzzy modified VAM to find the optimal solution.

Now we compare the result obtained from proposed method to other existing methods i.e. shown in Table 3. and after making the comparison, we found that the result achieved by proposed method is optimal as compared to other existing methods which clearly shown in Table 3.

7 Result analysis

In fuzzy transportation problems, we are applying ranking function and then fuzzy modified VAM used on the obtained problem to find the optimal solution. The result of the fuzzy transportation problem for selected numerical example, obtained by using different proposed method shown in Table 3. The total fuzzy transportation cost for the given fuzzy transportation problem is 116.25.

The comparison of proposed method with existing methods is tabulated below in which it clearly is shown that the proposed method provides the optimal results.

TABLE 3 Comparison with existing method

Method	Optimal Solution
Panadian et al. [21]	132.17
Chauhan S. S., Joshi N. [13]	121
S. Narayanamoorthy, S. Kalyani [5]	121
MODI Method	121
Proposed Method	116.25

7.1 OPTIMAL SOLUTION

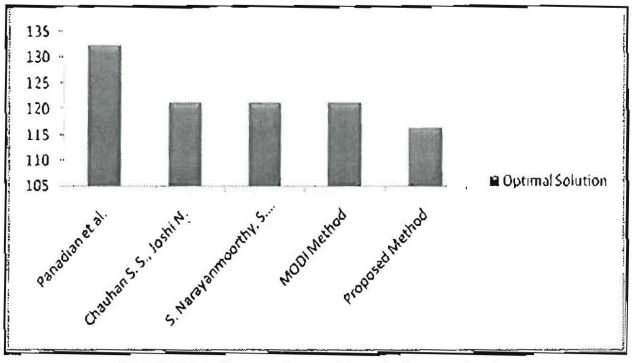

FIGURE 2 Comparison with existing methods

8 Conclusions

In this paper, a new method is proposed to obtain the initial basic feasible solution of the fuzzy transportation problem. The transportation cost, supply and demand are taken as fuzzy trapezoidal numbers which are more realistic and general in nature. The fuzzy transportation problem of trapezoidal number has been converted into crisp transportation problem using a ranking technique. A numerical example shows that the proposed method gives the better results as compared to other methods as shown in comparison table. This process is easy to understand and to implement. The proposed method can also be used for solving other problems occurring in real life like project schedules, assignment problems, linear programming problem, network flow problems, etc.

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ISSN No. 0976-5697

Volume 8, No. 3, March – April 2017

International Journal of Advanced Research in Computer Science

RESEARCH PAPER

Available Online at www.ijarcs.info

A New Data Transfer Approach Through Fuzzy Vogel's Approximation Method

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Abstract: In the present scenario, transportation model plays a crucial role in supply chain management that reduce the cost and improve the services as per user requirement. There are several methods to find the optimal solution like Vogel's Approximation Method (VAM), Row minima, Column minima, North-West Corner method etc. In this paper, the proposed method gives the optimal solution and takes less number of iterations for a fuzzy transportation problem as compare to VAM. The Proposed method is illustrated for the secure data transfer from source to the destination node which is considered as Laptop/ Desktop/ Mobile Devices/ Hand-held Devices.

Keywords: Fuzzy Transportation; North-West corner method; Optimal Solution; Supply Chain Management.

I. INTRODUCTION

From the literature, it is revealed that many researchers have solved various securities by the use of optimization technique with special reference to transportation methods however limited research work is available on the fuzzy transportation. Let us describe some of the important research paper available on these aspects. The algorithm for finding an initial basic feasible solution of a transportation problem is developed by Ahmed U.A. et al. They found the solution when the transportation matrix contains fuzzy numbers and real numbers then this new algorithm would be applied [1]. Kaur A. and Kumar A. developed a new method for solving fuzzy transportation problem by assuming that a decision maker is uncertain about the specific values of the transportation cost, availability and demand of the product. They represent these values as generalized trapezoidal fuzzy numbers [2]. Pandian P. and Natarajan G. introduced a new algorithm named as Fuzzy Zero Point Method. In this method, the solution for the fuzzy transportation problem is found by using the FZP method which is a trapezoidal fuzzy number [3]. Narayanamoorthy S. and Kalyni S. introduced a method in which the initial basic feasible solution for a fuzzy transportation problem is obtained by using a new method [4]. Chauhan S. S. and Joshi N. presented a study that revealed the solution of fuzzy transportation problem by finding the least transportation cost of commodities when supply, demand and cost of commodities are represented by fuzzy numbers. They proposed a ranking method to find out the fuzzy optimal solution by balanced fuzzy transportation problem by using trapezoidal fuzzy numbers with improved Vogel's Approximation Method (VAM) [5]. Radhika C. and Parvathi R. tried to introduce various types of intuitionistic fuzzification function such as triangular, trapezoidal, Gaussian bell shaped sigmoidal, S-shaped, Z-shaped functions which would be more useful for this intuitionistic fuzzy environment [6]. Gani N.A. tried to find out the efficient solution for the large scale fuzzy transshipment problem. The author improved the version of VAM through find out the efficient initial solution for the large scale transshipment problem [7]. In transportation problem, there are various applications in logistics and supply chain for minimizing cost. In actual-life circumstances, the parameters of transportation issues may not be known correctly due to some uncontrollable elements. Henceforth Ebrahimnejad A. proposed a new method for solving fuzzy transportation problem in which the cost of transportation, supply and demand are represented by non-negative LR flat fuzzy numbers. In real life applications, triangular and trapezoidal numbers are the most frequently used numbers that represent the fuzzy number. The basic reason behind using the triangular and trapezoidal fuzzy number is that they are easy to use and easy to interpret [8]. Nuran G. investigated a fuzzy transportation problem with fuzzy quantity in which fuzzy triangular numbers and fuzzy transportation cost per unit is bounded with upper fuzzy numbers. They solved this problem in two stages. In first stage maximum satisfactory level that satisfying balance between fuzzy supply and fuzzy demand is calculated. In the second stage, the unit transportation cost and the arranged problem have been investigated for the optimization of unit transportation cost [9]. Gani A. N. and Assarudeen S.N.M. proposed a new operation on triangular fuzzy number in which the method of subtraction and division has been modified. These modified operators results in exact inverse of addition and multiplication operators [10]. Khalaf W.S. studied a new approach which is known as fuzzy russell's approximation method for solving the fuzzy transportation. The initial fuzzy basic feasible solution has been obtained when all the cost coefficients are fuzzy numbers and all the demands and supplies are the crisp numbers. The initial fuzzy basic feasible solution is also used for the fuzzy optimal solution by using the approach known as fuzzy modified distribution method [11]. Solaiappan S.and Jeyaraman K. studied the fuzzy transportation problem and investigated it by using zero termination method. In this method the transportation cost, supply and demand values are assumed to lie in an interval of values. Robust ranking method is applied to arrange the fuzzy numbers in a perticular interval. This method is also helpful to convert the fuzzy transportation problem into crisp transportation problem [12]. Rani D. et al. considered the fully fuzzy unbalanced transportation problem in which the total production cost is more than the total demand and this problem is solved by adding a dummy destination. The advantage of this method over the existing method is that the fuzzy optimal solution did not involve the dummy destination as the dummy destination has no existence in reality. So the excess availability is not

transported and is held back at one or more origins [13]. Poonam S. et al. presented some new method for fuzzy transportation problem. A ranking technique was proposed with alpha optimal solution for solving fuzzy transportation problem. In this problem fuzzy demand and supply are in the form of triangular fuzzy numbers. Kumar A. and Kaur A. introduced two new methods to find out the fuzzy optimal solution for unbalanced fuzzy transportation problem. This method is based on fuzzy linear programming formulation and classical transportation method and also proposed a new representation of trapezoidal fuzzy numbers [15]. Shanmugasundari M. and Ganesan K. introduced a new method for fuzzy optimal solution to the transportation problem with fuzzy parameters. Vogel's and MODI algorithms have been modified for finding fuzzy basic feasible solution and fuzzy optimal solution of fuzzy transportation problems. They introduced the fuzzy version in these previously established methods without converting them to classical problems [16]. Fegade et al. find the least transportation cost of some commodities through a capacitated network when the supply cost, demand cost, capacity cost and cost of edges are represented as fuzzy numbers. A ranking technique has been proposed for solving the fuzzy transportation problem. In this technique the fuzzy demand and supply are in the form of triangular fuzzy numbers. Simple algorithms are used for solving the computed fuzzy transportation problem [17]. Mohanaselvi S. and Ganesan K. proposed a new algorithm for the initial fuzzy feasible solution to a fully fuzzy transportation problem and modified the fuzzy version into fully fuzzy transportation problem without converting it into a classical transportation problem [18]. Narayanamoorthy S. et al. proposed a new algorithm known as fuzzy Russell's method for the initial basic feasible solution to a fuzzy transportation problem. This method can be easily applicable to any kind of fuzzy numbers like normal or abnormal, triangular or trapezoidal or any other LR fuzzy number [19]. Nareshkumar S. and Kumaraghuru S. described a closed bounded and non empty feasible region of the transportation problem by using fuzzy trapezoidal numbers which ensures the existence of an optimal solution for the balance of transportation problem to find out the initial solution of the transportation problem, authors used fuzzy VAM and the optimality of the obtained solution was determined by using the fuzzy modified distribution method [20]. Maliniand P. and Ananthanarayanan M. presented a new ranking method which is helpful to convert the fuzzy transportation problem into a crisp valued transportation problem which can be solved by using MODI method for finding the fuzzy optimal solution [21]. Das U. K. et al. discuss the limitation of VAM and developed an improved algorithm for solving the transportation problem. The VAM is not applied when highest penalty cost is lying in two or more row or column. So in this case VAM fails to give a valuable output. In this paper, author proposed an approach for this problem and developed a new algorithm known as logical development of VAM which is more useful in finding the optimal solution [22]. Samuel, A. E. and Venkatachalapathy M. proposed a new method named as modified VAM for solving the fuzzy transportation problem [23].

II.PRELIMINARIES

Fuzzy Set: A fuzzy set is distinguished by a membership function mapping element of a domain, universe of discourse X to the unit interval [0, 1] i.e. A = {(x, μA(x); x ∈ X}, Here μA: X→[0,1] is a mapping known as the degree of membership function of the fuzzy set A and μA(x) is known as the membership value of x ε X in the fuzzy set A. These membership category are often represented by real numbers ranging from [0,1].

Triangular Fuzzy number: A fuzzy number Ã= (a_1, a_2, a_3) represented in figure 1 is said to be triangular fuzzy number and interpreted as membership functions and holds the following conditions

(i) a_1 to a_2 is increasing function
(ii) a_2 to a_3 is decreasing function
(iii) $a_1 \leqslant a_2 \leqslant a_3$.

$$\mu_{(A)}(x) = \begin{cases} 0, & x < a_1 \\ \dfrac{x - a_1}{a_2 - a_1}, & a_1 \le x \le a_2 \\ \dfrac{a_3 - x}{a_3 - a_2}, & a_2 \le x \le a_3 \\ 0, & x > a_3 \end{cases} \quad (1)$$

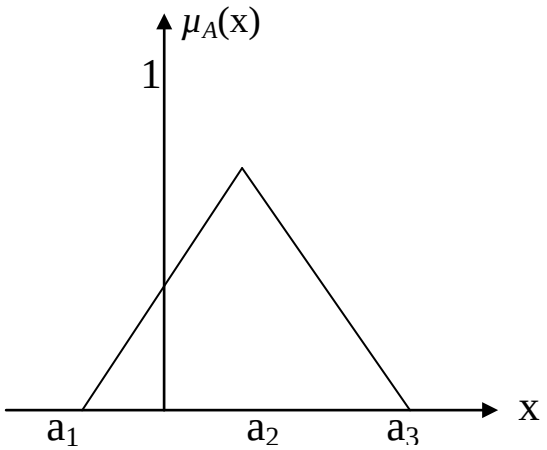

Figure 1- Triangular Fuzzy Number

III.MATERIALS AND METHOD

Consider a transportation problem in which a cell Cij represents the transportation cost from i to j, where i is number of row, j is number of column. Convert the transportation problem into fuzzy transportation problem and then solve with the following steps:

1. Balance the given transportation problem if either (total supply>total demand) or (total supply<total demand) by adding dummy row or column;
2. Compute the fuzzy penalty cost for each row and column of the transportation matrix by calculating the square root of the difference between minimum and next-to-the-minimum transportation cost Cij in that row or column;
3. If minimum transportation cost Cij appear two or more times in a row or column then select this same transportation cost Cij as a minimum and next to minimum transportation cost and penalty will be zero;
4. Identify the row or column with the largest fuzzy penalty cost. If tie occurs, than select that row or column where transportation cost Cij is minimum. If again tie occurs in minimum transportation cost Cij, than select that row or column where total transportation cost of that row or column is minimum;

5. Now allocate as much as possible feasible amount to that smallest transportation cost Cij cell in that row or column;
6. Adjust the supply and demand and cross out the satisfied row or column. If row and column are satisfied simultaneously then crossed out one of them and remaining row or column is assigned a zero supply or demand;
7. Again compute the fuzzy penalty cost for each row and column of the transportation matrix until all requirements have been satisfied;

8. Finally compute total fuzzy transportation cost for the fuzzy feasible cost allocations using the original balanced fuzzy transportation matrix;

A sample of transportation problem is obtained from secure data transfer software shown in the following table I, in which sender sends the data through the data transfer software and receiver receives the data from another device from where data transfer software is installed. This network flow data transfer shows the status of data, size of data, create time, finish time, complete time, average speed of transfer and time consumed.

In this example, the information on supplied and demanded as well as the fuzzy transportation costs per unit can be arranged in the following table II.

Table I. A SAMPLE OF TRANSPORTATION PROBLEM

	R_1	R_2	R_3	R_4	R_5	R_6	R_7	*Supply*
S_1	489	350	142	365	424	272	272	2314
S_2	272	410	350	489	365	489	253	2628
S_3	424	489	365	253	410	410	142	2493
S_4	365	257	472	272	350	410	142	2268
S_5	350	272	365	472	410	257	272	2398
Demand	1900	1778	1694	1851	1959	1838	1081	

Table II. CONVERSION OF TRANSPORTATION PROBLEM INTO FUZZY TRANSPORTATION PROBLEM

	R_1	R_2	R_3	R_4	R_5	R_6	R_7	*Supply*
S_1	(449,489,529)	(320,350,380)	(132,142,152)	(325,365,405)	(389,424,459)	(252,272,292)	(252,272,292)	(2014,2314,2614)
S_2	(252,272,292)	(385,410,435)	(320,350,380)	(449,489,529)	(325,365,405)	(449,489,529)	(223,253,283)	(2278,2628,2978)
S_3	(389,424,459)	(449,489,529)	(325,365,405)	(223,253,283)	(385,410,435)	(385,410,435)	(132,142,152)	(2213,2493,2773)
S_4	(325,365,405)	(222,257,292)	(422,472,522)	(252,272,292)	(320,350,380)	(385,410,435)	(132,142,152)	(2018,2268,2518)
S_5	(320,350,380)	(252,272,290)	(325,365,405)	(422,472,522)	(385,410,435)	(222,257,292)	(252,272,292)	(2118,2398,2678)
Demand	(1650,1900,2150)	(1578,1778,1978)	(1544,1694,1844)	(1601,1851,2101)	(1679,1959,2239)	(1638,1838,2038)	(981,1081,1181)	

In the first iteration fuzzy penalty cost for each row and column of the transportation matrix is obtained by calculating the square root of the difference between minimum and next-to-the-minimum transportation cost Cij in that row or column. In Table III, fuzzy penalty cost for row s_1 is obtained by calculating the square root of the difference between 142 and 272 i.e. 11.40, similarly fuzzy penalty cost for each row and column is calculated. Now identify the row or column with the largest fuzzy penalty cost i.e. 14.42 than select that row or column where transportation cost Cij is minimum i.e. 142 ($C_{1,3}$). Now allocate as much as possible feasible amount i.e. (**1544, 1694, 1844)** to that smallest transportation cost $C_{1,3}$ cell in that row or column than adjust the supply and demand and cross out the satisfied row or column. If row and column are satisfied simultaneously then crossed out one of them and remaining row or column is assigned a zero supply or demand. Again compute the fuzzy penalty cost for each row and column of the transportation matrix until all requirements have been satisfied.

Table III. COMPUTATION OF ITERATION 1 FOR FUZZY VAM

	R_1	R_2	R_3	R_4	R_5	R_6	R_7	*Supply*	*Row Panalty*
S_1	(449,489, 529)	(320,350, 380)	(132,142, 152) **(1544,16 94,1844)**	(325,365, 405)	(389,424, 459)	(252,272, 292)	(252,272, 292)	**(570,620,6 70)**	11.40
S_2	(252,272, 292)	(385,410, 435)	(320,350, 380)	(449,489, 529)	(325,365, 405)	(449,489, 529)	(223,253, 283)	(2278,2628 ,2978)	4.36
S_3	(389,424, 459)	(449,489, 529)	(325,365, 405)	(223,253, 283)	(385,410, 435)	(385,410, 435)	(132,142, 152)	(2213,2493 ,2773)	10.54
S_4	(325,365, 405)	(222,257, 292)	(422,472, 522)	(252,272, 292)	(320,350, 380)	(385,410, 435)	(132,142, 152)	(2018,2268 ,2518)	10.72
S_5	(320,350, 380)	(252,272, 290)	(325,365, 405)	(422,472, 522)	(385,410, 435)	(222,257, 292)	(252,272, 292)	(2118,2398 ,2678)	3.87
Demand	(1650,19 00,2150)	(1578,17 78,1978)	**0**	(1601,18 51,2101)	(1679,19 59,2239)	(1638,18 38,2038)	(981,108 1,1181)		
Column Penalty	8.83	3.87	**14.42**	4.36	3.87	3.87	10.54		

Table IV. FINAL ALLOCATION MATRIX

	R_1	R_2	R_3	R_4	R_5	R_6	R_7	*Supply*
S_1	(449,489,52 9)	(320,350,38 0)	(132,142,15 2) **(1544,1694, 1844)**	(325,365,40 5)	(389,424,45 9) **(539,589,63 9)**	(252,272,29 2) **(26,31,36)**	(252,272,29 2)	(2014,2314, 2614)
S_2	(252,272,29 2) **(1650,1900, 2150)**	(385,410,43 5)	(320,350,38 0)	(449,489,52 9)	(325,365,40 5) **(,728,)**	(449,489,52 9)	(223,253,28 3)	(2278,2628, 2978)
S_3	(389,424,45 9)	(449,489,52 9)	(325,365,40 5)	(223,253,28 3) **(1601,1851, 2101)**	(385,410,43 5) **(582,642,70 2)**	(385,410,43 5)	(132,142,15 2)	(2213,2493, 2773)
S_4	(325,365,40 5)	(222,257,29 2) **(1037,1187, 1337)**	(422,472,52 2)	(252,272,29 2)	(320,350,38 0)	(385,410,43 5)	(132,142,15 2) **(981,1081,1 181)**	(2018,2268, 2518)
S_5	(320,350,38 0)	(252,272,29 0) **(546,591,63 6)**	(325,365,40 5)	(422,472,52 2)	(385,410,43 5)	(222,257,29 2) **(1607,1807, 2007)**	(252,272,29 2)	(2118,2398, 2678)
Dema nd	(1650,1900, 2150)	(1578,1778, 1978)	(1544,1694, 1844)	(1601,1851, 2101)	(1679,1959, 2239)	(1638,1838, 2038)	(981,1081,1 181)	

IV. RESULT AND DISCUSSION

The total obtained Fuzzy transportation cost for the above transportation problem by using Fuzzy modified VAM is 3096471. The following table shows that by using modified Fuzzy VAM we got the optimal solution in less number of iteration as compared to VAM which is clearly shown in TableV.

Table V. COMPARISION BETWEEN VAM AND FUZZY VAM

Method	No. of iteration	Optimal solution
VAM	11	3097060
Modified VAM (Proposed Method)	9	3096471

V. CONCLUSION

The proposed method provides an optimal solution for a fuzzy transportation problem that gives better results. The proposed method is easy to understand and apply. With the help of numerical example this method gives the optimal solution of fuzzy transportation problem. The proposed technique can also be used to solve real time problems such as network flow problem, assignment problem, linear programming problem, project schedule etc.

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Modeling and Minimization of Cyber Attacks through Optimization Technique

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ABSTRACT
In the daily routine work on the internet, the people are using the services like email, money transfer, accessing of web pages, social networking, downloads, communication on network, etc. Hackers are hacking the web pages, emails, etc which are reported in the cyber police station. The present work is based upon the cyber attacks in the Indian scenario and different cyber attacks have been identified and these attacks are optimized by applying a well known optimization technique known as Hungarian method which is based upon that the number of person are affected with minimization losses delete. A well known Unified Modeling Language (UML) modeling is also used to design the UML activity model which is validated through a Finite State Machine (FSM) technique and observed that the proposed method is optimized method for getting minimum losses across the network which is based upon distributed computing network.

Keywords
Modeling, Cyber Attacks, Hungarian, Optimization, UML and FSM

1. RELATED WORK
In the present paper, a well known Platform Independent language is used to construct various UML models. UML stands for Unified Modeling Language and invented by Booch et al. [1-2]. They described all the important diagrams related to static and dynamic representation of the research problem. OMG [3-4] is the Object Management Group who has released various versions of UML. The modeling is necessary for representing the research problem in the pictorial way and thereafter coder develops the code for the proposed model. Since, the present work is related to the Cyber Security models therefore let us describe some important contribution done by the researchers in these field. Communal Analysis Suspicion Scoring (CASS) for generating numeric suspicion scores are well described by Phua et al.[5] for the streaming of the credit card applications. Baber et al.[6] stated that computer conditions(tablets and computers) lead to faster performance when compared with paper conditions while there was no difference in content and quality of reports. Cetin et al.[7] described the recent developments in technology used by youngsters which are increasingly creating environments in which students can exhibit bullying behaviors in schools via electronic devices. Cyber bullying and Cyber victim can be used as scale for determining the level of exposure to or exhibiting cyber bullying behaviors among students in high school. Daman and Ozecilik[8] described a novel combination of the two well known meta heuristic approaches, namely the Genetic algorithm and the Scatter search which can be applied to improve the credit card fraud detection solution. Jamieson et al.[9] described a deep understanding of identification of crime by using the concept of hierarchical classes and explained clear structure for crime management. All these are defined as per the current status of law and proposed a solution for the minimization of the crime. Solms and Niekerk[10] described that Information security is the protection of information, which is an asset, from possible harm resulting from various threats and vulnerabilities. Cyber security, on the other hand, is not necessarily only the protection of cyberspace, but also the protection of these function in cyberspace and any of their assets that can be reached via cyberspace. Tehrane et al. [11] described Cyber terrorism is a transnational crime; it should be subjected to universal jurisdiction through multinational cooperation. The most suitable method to counter future transnational crimes such as cyber terrorism is universal jurisdiction. Maskun et al. [12] stated that Internet has become a global phenomenon; numerous advantages and disadvantages (crimes) which are being gotten and committed through the internet. To cope with both advantages and disadvantages, cyber security is needed to guarantee people to use internet safely.

The present work is based upon the identification of the major cyber attacks which are faced by the users in the daily routine work and losses due to attacks are computed and thereafter an optimization technique is used for the minimization of the losses. UML is also used for a model based on the minimization of the losses and the model is also validated through the FSM technique.

2. UML MODELING

A UML activity diagram is designed for the minimization of individual loss to the department and also consolidated loss to the organization. The steps involved for the minimization of losses are summarized below:

Step 1: Identify the types of page which should fit within a rectangle of Cyber Attacks & let us consider there are N;

Step 2: Categorize and fix the Priority of Cyber attacks which can be minimized for loss i.e. arrange in the decreasing order which shows that the maximum loss shall be minimized first;

Step 3: If the prioritized losses are already minimized then go to step 1 else follow the next step 4;

Step 4: Compute % loss to the user;

*Step 5: Design a matrix of N*N order where N is the different types of Cyber Attacks;*

Step 6: Apply the algorithm to optimize the loss due to the Cyber Attacks;

Step 7: Compute the minimization loss to the users and to the organization.

The above steps are represented through UML activity diagram and shown in the figure 1. It consists of six major activities which are controlled by one condition. The Hungarian method is applied after creation of NxN matrix and the cells represent percentage of loss. The data is considered for the twelve major cyber attacks and proposed steps can handle the data upto N numbers of cyber attacks. A mathematical formulation of the problem is also done for the Hungarian method as it supports for N numbers of cyber attacks. After that a matrix for NxN is generated and it can be easily programmed for finding the minimum percentage of loss.

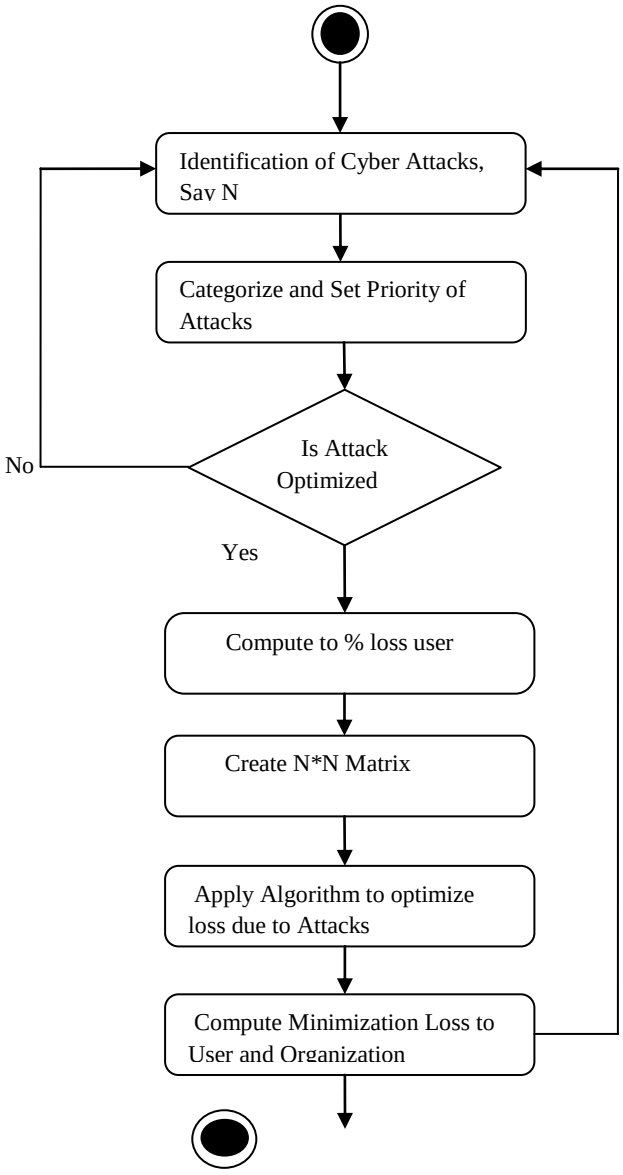

Figure 1 UML Activity Representation

3. MATHEMATICAL FORMULATION

Let Cyber attacks are categorized by the set CA= {CA_1 , CA_2, CA_3 ,……CA_N}. Let these attacks are detected and taken upto N attacks and due to these attacks let losses are L_1,L_2,L_3…….L_N then to minimize these losses the following objective function is formulated

$$Z=\text{Min} \sum_{i=1}^{N} L_i * CA_i$$

Then the problem is converted into N*N matrix and in this case N is covered as N=12 and attacks are shown in table 1.

Table 1. List of Cyber Attacks

Code	Description
CA_1	Stealing of Database
CA_2	Hacking of Websites
CA_3	Job Scams/Frauds
CA_4	Mobile Crimes
CA_5	Antisocial Activities
CA_6	Stealing of Bandwidth
CA_7	Cloning of Debit/Credit Card
CA_8	E-Commerce Fraud
CA_9	Unauthorized Network Access
CA_{10}	Theft of Password
CA_{11}	Identity Theft
CA_{12}	Cyber Blackmailing/Harassment

The different departments are consulted to make loss table as shown in table 2 and it is based upon the sample questionnaire and survey is completed for the 100 users but for computation purpose same size is considered as N=12. The steps for Hungarian method are described below in the object-oriented form:

Step 1:- Let us define obj.A[i][j], where i=1(1)12,j=1(1)12 and store the losses in 12x12 matrix A[i][j];

Step 2:- Select Min A[i][j] for each row i and subtract it from each element of each row of A[i][j] i.e. obj.A[m][j]=obj.A[m][j]-min A[m][j] where m=1(1)12 and update obj.A[i][j];

Step 3:- Select Min A[i][j] for each column j and subtract it from each element of each column of A[i][j] i.e. obj.A[i][n]=obj.A[i][n]-min A[i][n] where n=1(1)12 and update obj.A[i][j];

Step 4:-Cut the lines row wise first & then column wise with coverage of maximum zeros.

Step 5 :- If number of cut lines are equal to the order of matrix then encircle zero in each row for finding the minimum loss and remaining zeros are discarded in that row/column.

Step 6 :- Select minimum element from non cut lines, subtract it from each element and add it at intersection of cut lines, update obj. A[i][j] go to step 4, till number of cut lines are equal to order of matrix N.

Table 2 Data Representation of Cyber Attacks versus Departments

Deptt→ Cyber Attacks↓	D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	D_9	D_{10}	D_{11}	D_{12}
CA_1	20	30	20	20	30	40	20	30	40	50	30	20
CA_2	60	70	50	70	50	65	35	45	55	60	65	75
CA_3	10	20	15	25	35	25	15	35	10	20	25	35
CA_4	75	60	70	45	55	60	60	75	65	55	45	50
CA_5	25	35	25	30	40	35	30	25	20	30	35	40
CA_6	15	25	10	15	25	30	25	15	20	25	15	20
CA_7	40	30	35	30	20	25	30	30	25	20	30	20
CA_8	50	60	40	50	40	30	35	45	35	35	40	45
CA_9	15	25	15	25	15	25	25	35	25	35	45	25
CA_{10}	40	50	60	50	40	60	55	65	45	55	65	55
CA_{11}	15	25	15	25	35	30	15	20	25	15	20	30
CA_{12}	40	50	45	55	35	45	50	55	45	35	25	35

Table 3. Final Matrix After Applying Hungarian Method

Deptt→ Cyber Attacks↓	D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	D_9	D_{10}	D_{11}	D_{12}
CA_1	0	0	0	0	10	20	0	5	20	30	0	**0**
CA_2	25	25	15	35	15	30	**0**	5	20	25	30	40
CA_3	**0**	0	5	15	25	15	5	20	0	10	15	25
CA_4	30	5	25	**0**	10	15	15	25	20	10	0	5
CA_5	5	5	5	10	20	15	10	0	**0**	10	15	20
CA_6	5	5	0	5	15	20	15	**0**	10	15	5	10
CA_7	20	0	15	10	0	5	10	5	5	**0**	10	0
CA_8	20	20	10	20	10	**0**	5	10	5	5	10	15
CA_9	0	0	0	10	**0**	10	10	15	10	20	30	10
CA_{10}	0	**0**	20	10	0	20	15	20	5	15	25	15
CA_{11}	0	0	**0**	10	20	15	0	0	10	0	5	15
CA_{12}	15	15	20	30	10	20	25	25	20	10	**0**	10

From the above table, minimum loss is computed for each of the department and observed that the minimum loss is to department1 which is just 10%. The overall loss to all the departments is also computed which is 25% for all twelve cyber attacks and for all the departments. These are summarized below in following table:

Cyber Attack	Deptt. No.	Minimum Loss Computed
CA_1	D_{12}	20
CA_2	D_7	35
CA_3	D_1	10
CA_4	D_4	45
CA_5	D_9	20
CA_6	D_8	15
CA_7	D_{10}	20
CA_8	D_6	30
CA_9	D_5	15
CA_{10}	D_2	50
CA_{11}	D_3	15
CA_{12}	D_{11}	25

Grand total = 300

Over all percentage loss to all departments = 25%

GENERATION OR TEST CASES:-

Let us consider the theory of automata for designing the Finite State Machine (FSM) which is defined by M and given by following

$M = (Q, \Sigma, \delta, q_0, F)$

Where

Q = finite set of states;

Σ = finite set of input symbols;

(Alphabets and Numbers);

δ = Transition between two states;

q_0 = Initial state;

F = Final state;

From the above definition of automata, a finite state diagram is represented in the figure 2. In which there are seven states represented as $Q = \{q_0, q_1, q_2, q_3, q_4, q_5, q_6\}$ and these are according to the activity diagram represented in the figure1 and it is represented in the following table 4.

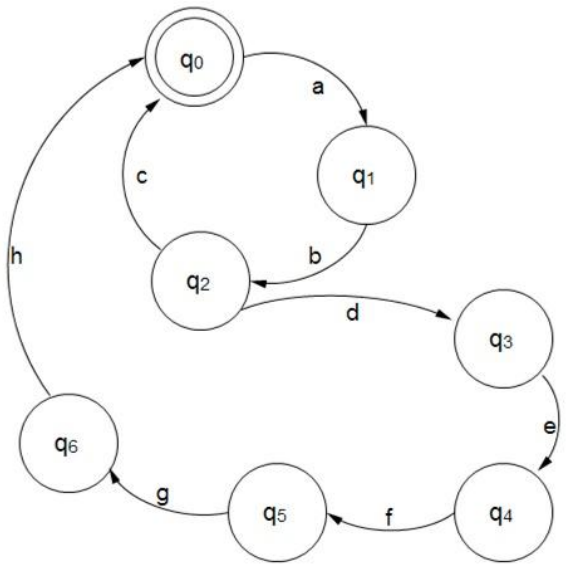

Figure 2 FSM Representation of Activity Diagram

Table 4.Representation of States

Name of State	Description of State
q_0	Identification of Cyber Attack
q_1	Categorize and set priority of Attacks
q_2	Attack optimization
q_3	Compute to % loss user
q_4	Create matrix
q_5	Apply algorithm to optimize loss
q_6	Compute minimum loss to user

Now, the transition is represented by $\delta(q_0, a)$, where a is the set of inputs and inputs are considered as

$\Sigma = \{a, b, c, d, e, f, g, h\}$ and representation is recorded in the following table 5.

Table 5.Representation of Input Symbols

Name of Input	Description of Input
a	List of Cyber Attacks
b	Priority list of Cyber Attacks
c	Not optimized list of Cyber Attacks
d	Optimized list of Cyber Attacks
e	List of losses
f	Resultant matrix with Cyber Attacks and Losses
g	Final optimized matrix
h	Minimum loss result

On the basis of above, a transition table is given below with following figure :→

$\delta(q_0,a) \rightarrow q_1$

$\delta(q_1,b) \rightarrow q_2$

$\delta(q_2,c) \rightarrow q_0$

$\delta(q_2,d) \rightarrow q_3$

$\delta(q_3,e) \rightarrow q_4$

$\delta(q_4,f) \rightarrow q_5$

$\delta(q_5,g) \rightarrow q_6$

$\delta(q_6,h) \rightarrow q_0$

Table 6. A Transition Table

	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**
q_0	q_1	-	-	-	-	-	-	-
q_1	-	q_2	-	-	-	-	-	-
q_2	-	-	q_0	q_3	-	-	-	-
q_3	-	-	-	-	q_4	-	-	-
q_4	-	-	-	-	-	q_5	-	-

q_5	-	-	-	-	-	-	q_6	-
q_6	-	-	-	-	-	-	-	q_0

By the use of above grammer different test cases are generated and explained below in brief:-

Valid Test Case 1:- *Cyber attacks losses are not optimized*

It is represented by

$\delta (q_0,a) \rightarrow q_1 \quad => \quad q_0 \rightarrow a\ q_1$

$\delta (q_1,b) \rightarrow q_2 \quad => \quad q_1 \rightarrow b\ q_2$

$\delta (q_2,c) \rightarrow q_0 \quad => \quad q_2 \rightarrow c\ q_0$

After changing the states or removing the non terminals, the string is given by

$q_0 = abc\ q_0 = abc$

This represents that the Cyber Attack losses are not optimized.

Valid Test 2:- *Cyber attacks losses are optimized*

It is represented by

$\delta (q_0,a) \rightarrow q_1 \quad => \quad q_0 \rightarrow a\ q_1$

$\delta (q_1,b) \rightarrow q_2 \quad => \quad q_1 \rightarrow b\ q_2$

$\delta (q_2,d) \rightarrow q_3 \quad => \quad q_2 \rightarrow d\ q_3$

$\delta (q_3,e) \rightarrow q_4 \quad => \quad q_2 \rightarrow e\ q_4$

$\delta (q_4,f) \rightarrow q_5 \quad => \quad q_2 \rightarrow f\ q_5$

$\delta (q_5,g) \rightarrow q_6 \quad => \quad q_2 \rightarrow g\ q_6$

$\delta (q_6,h) \rightarrow q_0 \quad => \quad q_2 \rightarrow h\ q_0$

After changing the states or removing the non terminals, the string is given by

$q_0 = abdefghq_0 = abdefgh$

This represents that the cyber attack losses are optimized which is as per expectation.

4. CONCLUSIONS

From the above work it is concluded that the UML is a powerful modeling language which is used to make design of any kind of the research problem and in the above work, it is used for designing of UML activity diagram for minimization of losses from the cyber attacks. The diagram is converted into the FSM for finding the valid test cases which also validate the proposed model. A well known Hungarian approach is used to minimize the cyber attacks and it is observed that the said attacks give the percentage losses to the corresponding departments. The same work can be extended for the finite numbers of the departments and according to the list of cyber attacks and limitation is that the matrix should be NxN matrix which means that the numbers of attacks should be equal to the numbers of the departments.

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Advances in Intelligent Systems and Computing 433

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Information Systems Design and Intelligent Applications

Proceedings of Third International Conference INDIA 2016, Volume 1

Springer

A Unified Modeling Language Model for Occurrence and Resolving of Cyber Crime

Singh Rashmi and Saxena Vipin

Abstract In the current scenario, distributed computing systems play significant role for accessing the various kinds of internet services. The different handheld devices like palmtop, laptop, mobile, etc. can be connected across the distributed network. People enjoy social networking websites, online purchasing websites, and online transaction websites in the daily routine life. On the other hand, hackers are regularly watching the activities of the people who are categorized as the authorized users connected across the globe. The present work is related to propose a model which is based upon the object-oriented technology for occurring of cyber crime across the distributed network. A well known Unified Modeling Language is used and one can easily write the code for implementation of model in any object-oriented programming language. After that a UML model is proposed for filing the FIR online against the cyber crime. The activities in the above procedure are represented by the UML activity diagram which is finally validated through the concept of finite state machine.

Keywords Cyber crime · UML · Activity diagram · FIR (first information report) · Finite state machine

1 Introduction

The Unified Modeling Language (UML) is widely used as a standard technique in software development and invented By Booch et al. [1, 2]. They characterized that how to show a problem in pictorial form through UML. There are various tools which have been produced to support UML model either static or dynamic model.

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S.C. Satapathy et al. (eds.), *Information Systems Design and Intelligent Applications*, Advances in Intelligent Systems and Computing 433,
DOI 10.1007/978-81-322-2755-7_71

Such UML tools translate any model into any programming language. UML includes a set of notations i.e. graphics notations which are used to create a model for easily understandable by anyone [3, 4]. Software engineers and researchers resolve the complex problem through UML by which they represent their problem in diagrammatic representation. Global decision reaction architecture built on the basis of requirement for the reaction after alert detection mechanisms in information system security and this security has been applied on telecom infrastructure system [5]. A model for security issues in distributed network, having features such as deployment of security strategy, cooperation of security components, automatic distribution, self-adaptive management function, etc. [6]. Cloud computing helps to remove high cost computing over distributed computing and minimize infrastructure for information technology based services and solutions. It provides a flexible and architecture accessible from anywhere through lightweight portable devices [7]. In network virtualization, virtualized infrastructure is also used to provide manifold independent networks over multiple framework providers [8]. Virtual networks managed by virtual network operator. A developed model that provides a structure to communities and can be used to purposive their level of alertness and to generate a strategy to upgrade their security perspective and magnify their possibility of auspiciously preventing and detecting from a cyber attack [9]. Cyber crime is typically occur when anyone accessing, modifying, destroying computer data without owner's permission. This unauthorized access can be committed against property, persons or government [10]. Cloud computing is used to circle components from technologies such as grid computing and autonomic computing into a new arrangement structure. This expeditious transformation around the cloud has stimulated concerns on a censorious issue for the victory of information security [11].

Cyber crime is usually mentioned as criminal actions using computer internet. What happens when cyber crime occurred in the real world and how people can protect and aware from occurrence of cyber crime [12]. In the modern scenario, day by day normal methods of cyber security become outmoded. They are getting failed in maintaining security [13]. Cloud computing provides a frame work for information technology based resolutions and favor that the industry and organizations uses. It also provides a flexible structure accessible through internet from all over the world using light weighted portable devices [14]. To calculated traffic congestion and standard of services during any attack over the network and how to provide network security under this situation [15]. In [16] the recent improvements to the potential of law as personal and public constructs are deployed for cloud association with crime and criminal activities. The research paper [17] reviewed that how to prevent the cybercrime influence from portable devices such as Smartphone, laptops, tablets etc. Models are described for permission based security and behavior-based detection for information security. In the present time countercyber attacks are mostly occurred in many countries due to cyber crime independently as an initial attack [18]. Cyber system must [19] also evolve to provide techniques for prevention and defense. Some experiments presents in this

paper are blend cyber warfare with some approaches including planning and execution for deception in cyber defense.

The present work is related to the development of the model based on the object-oriented technique for identification of the cyber crime and filing the FIR against unauthorized users. One can develop the model in any programming language based on the object-oriented methodology because developed model is platform independent model. The proposed model is also validated by the use of concepts of Finite State Machine (FSM).

The purpose of proposed model is for identification of cyber crime which has been implemented and tested through the concept of software engineering. Different test cases have been generated for validation purpose on the proposed model and it is observed that the model is effective, reliable and robust.

2 UML Modeling for Occurrence and Filing of Cyber Crime

2.1 UML Class Model

UML class is a static representation of the problem which shows, how the problem is behaving or moving towards achievement of goal. The diagram is designed by the use of standard symbol available in Booch [3, 4]. In Fig. 1, the occurrence of cyber crime is represented through different classes. User is categorized as the authorized or unauthorized users. Association is shown between the two classes algorithm the representation of cardinality. Both kinds of users have internet connection and different web portals are grouped on the internet for the use of users. As represented in the class diagram, unauthorized user hacks the web portals multiple times by multiple unauthorized users. Hacking is controlled by hack class which is the type of cloning, steel card, steel data, steel bandwidth, login/password, etc. When the hacking occurs, then authorized users get information about the hacking. The different types of attributes and operations used to model the above diagram are recorded in the following Table 1.

2.2 UML Activity Model

The activity model shows the dynamic aspects of the problem. In the present work, an activity model is designed for occurrence of cyber crime. It connects the links from one activity to another activity controlled by an event. The different activities are summarized below in the following steps:

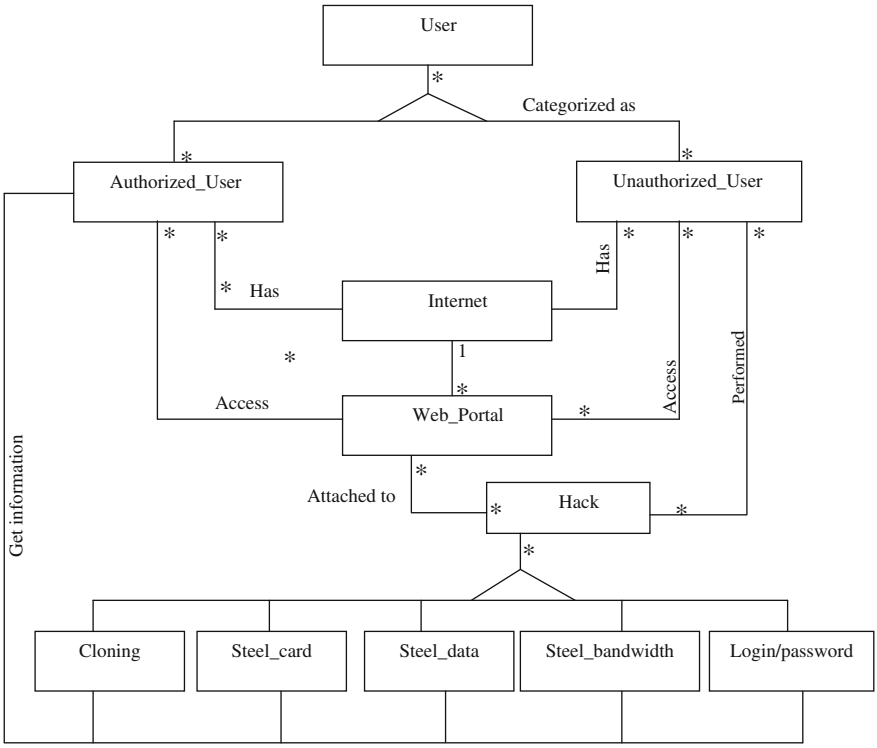

Fig. 1 UML class model for occurrence of cyber crime

Step 1 User applies for Internet Connection for surf the internet services;
Step 2 User categorized either authorized or unauthorized;
Step 3 User registered for internet connection, if user got connection then move to next step else user go to step 1;
Step 4 When user got connection for surfing net, user surfs the websites and access the data;
Step 5 According to step 2 user may be authorized or unauthorized who can access the websites;
Step 6 When unauthorized user hacks the data follow next step;
Step 7 Cyber crime occurs then it is reported to the user and moves to step 1;

The above steps are represented in the Fig. 2 which show the occurrence of cyber crime.

Table 1 Attributes and operations used for UML class model

Name of class	Attributes	Operations
User	User_id	Surf_webpages()
	User_name	Surf_apps()
	Mobile_number	Login()
	Nationality	Logout()
	Gender	
Authorized_User	Categorization_user	Mail_access()
	Address	Online_transaction()
	Date_of_birth	
	E-mail	
Unauthorized_User	Login_in_time	Steel_data()
	Login_out_time	Steel_password()
	Login_duration	Steel_card()
	Session_record_time	Unauthorized_login()
Internet	Connection_id	Access()
	Service_provider	Security()
	No._of_users Bandwidth	Surfing()
Web_Portal	Physical_location	Universal_login()
	Security_type	Facilitates_messaging
	Contact_information	Multi_channel_consistency()
	Business_information validation	Search()
Hack	Hacker_name	Access_unauthorized_data()
	Age	Hack_websites()
	Gender	Hack government_sites and data()
Cloning	Cloning_type	Credit_card_cloning()
	Cloning_device	Debit_card_cloning()
		Websites_cloning()
Steel_Card	Card_holder_name	Removing_funds()
	Expiry_date	Illegal_purchasing()
	Organization_name	Identity_theft()
	Card_number	
	Card_type	
Steel_Data	Type_of_data	Data_modification()
	Storage_device	Access_Data()
	Data_amount	
	Data_Address	
Steel_Bandwidth	Service_provider_name	Data_transmission()
	Bit_rate	Media_file_transmission()
	Capacity	Video_compression()
	City/State	

3 Validation of UML Activity Model Through Finite State Machine

Let us first explain the concept of Finite State Machine (FSM) which is a mathematical model of computation and is used to design logic circuits. A sequential logic unit takes an input and a current state to produce an output and new state. It can be represented using state transition table which shows current state, input state, new output state and the next state. It can also be represented using state transition diagram. It is defined by M and explained [20] as

$$M = \left(\sum, Q, \delta, q_0, F\right)$$

where
Σ set of Inputs (Alphabets and symbols);
q_0 an initial state;
F final state;
δ transition between two states;
Q set of finite states;

On the basis of above definition of automata the Fig. 2 is converted into FSM by means of state and transition from one state to another state. The different states are recorded in the Table 2 and these are represented as (q_0, q_1, q_2, q_3, q_4, q_5 and q_6).

The two states let q_0 and q_1 are grouped through a transition event. The different transition events are given in Table 3.

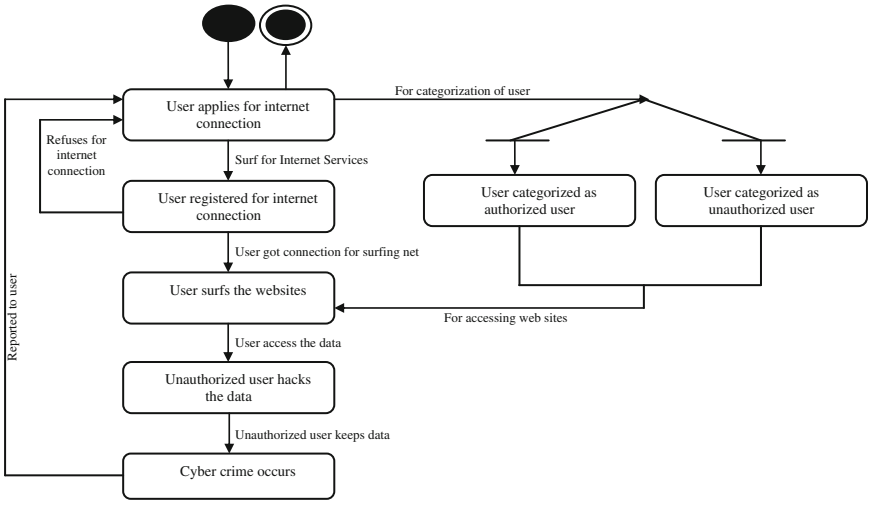

Fig. 2 UML activity model for occurrence of cyber crime

Table 2 Description of states selected from UML activity model

Name of State	Description of state
q_0	User applied for internet connection
q_1	User categorized as authorized user
q_2	User categorized as unauthorized user
q_3	User registered for internet connection
q_4	User surfs the websites
q_5	User hacks data
q_6	Cyber crime occur

Table 3 Description of events selected from UML activity model

Name of Input	Description of input
a	Categorization of user
b	Accessing websites
c	Surf for internet services
d	User got connection for surfing net
e	Reported to user that cyber crime occur
f	User access the data
g	User keeps data
h	User refuses for internet connection

From the definition of automata $\Sigma = \{a, b, c, d, e, f, h\}$ shows the set of input which are shown in the Table 3.

On the basis of above, a state transition diagram is designed which is represented in Fig. 3.

Above figure is used for validation purpose of UML activity model and different test cases are generated on the basis of transition table recorded in Table 4.

Valid Test Case 1 If unauthorized user hacks the data, cyber crime occurs and it is reported to the user.

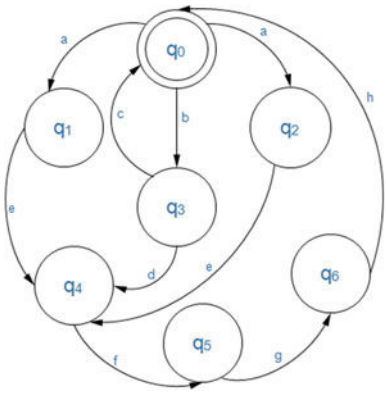

Fig. 3 FSM representation from UML activity model

Table 4 Transition table

State	Event							
	a	b	c	d	e	f	g	h
q_0	q_1/q_2	q_3	–	–	–	–	–	–
q_1	–	–	–	–	q_4	–	–	–
q_2	–	–	–	–	q_4	–	–	–
q_3	–	–	q_0	q_4	–	–	–	–
q_4	–	–	–	–	–	q_5	–	–
q_5	–	–	–	–	–	–	q_6	–
q_6	–	–	–	–	–	–	–	q_0

$$\begin{aligned}
\delta(q_0, a) \rightarrow q_1 \quad &\Rightarrow \quad q_0 \rightarrow a\ q_1 \\
\delta(q_1, e) \rightarrow q_4 \quad &\Rightarrow \quad q_1 \rightarrow e\ q_4 \\
\delta(q_1, f) \rightarrow q_5 \quad &\Rightarrow \quad q_1 \rightarrow f\ q_5 \\
\delta(q_5, g) \rightarrow q_6 \quad &\Rightarrow \quad q_5 \rightarrow g\ q_6 \\
\delta(q_6, h) \rightarrow q_0 \quad &\Rightarrow \quad q_6 \rightarrow h\ q_0
\end{aligned}$$

After removing the non-terminals the string is q_0 = aefghq_0 = aefgh

Valid Test Case 2 The user is not registered for internet connection.

$$\begin{aligned}
\delta(q_0, b) \rightarrow q_3 \quad &\Rightarrow \quad q_0 \rightarrow b\ q_3 \\
\delta(q_3, c) \rightarrow q_0 \quad &\Rightarrow \quad q_3 \rightarrow c\ q_0
\end{aligned}$$

After removing the non-terminals the string is q_0 = bcq_0 = bc

Valid Test Case 3 If cyber crime occurs then it is reported to the user.

$$\begin{aligned}
\delta(q_0, b) \rightarrow q_3 \quad &\Rightarrow \quad q_0 \rightarrow b\ q_3 \\
\delta(q_3, d) \rightarrow q_4 \quad &\Rightarrow \quad q_3 \rightarrow d\ q_4 \\
\delta(q_4, f) \rightarrow q_5 \quad &\Rightarrow \quad q_4 \rightarrow f\ q_5 \\
\delta(q_5, g) \rightarrow q_6 \quad &\Rightarrow \quad q_5 \rightarrow g\ q_6 \\
\delta(q_6, h) \rightarrow q_0 \quad &\Rightarrow \quad q_6 \rightarrow h\ q_0
\end{aligned}$$

After removing the non-terminals the string is q_0 = bdfghq_0 = bdfgh.

3.1 UML Model for Filing Cyber FIR

UML model shows that how an authorized user is filing cyber FIR. The diagram shows that many authorized users have many internet connections. Police station and cyber cell both are connected with internet. Different police stations have different cyber cells. When an authorized user submitted cyber FIR to the police station, police station has cyber cell so the cyber cell performs enquiries and generate a feedback which is delivered to the authorized user (Fig. 4).

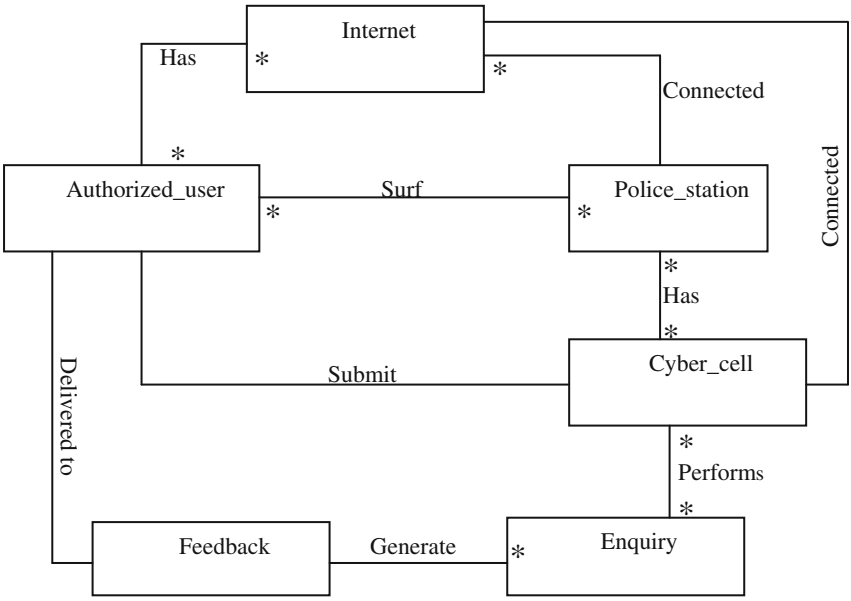

Fig. 4 UML model for filing cyber FIR

Risk analysis for occurrence of crime Risk is directly related to the loss due to cyber crime. In the present work percentage of loss due to cyber crime items has been evaluated. Let us define the two important factors associated to the risk analysis, these are given below:

(a) Probability of fault (CA_N)
(b) Cost (affected due to loss CA_N)

where CA_N are the items responsible for the cyber attack, then risk is computed by the following

$$R(CA_N) = P(CA_N) * C(CA_N)$$

The cyber attack algorithm for the computation of risks is recorded in Table 5.

The list of cyber attack is purely taken from the cyber crime cell and it consists of real data which is observed by grouping the 100 cyber cell complaints i.e. FIR. It is registered FIR either through online/offline mode and attacks are categorized through the unique code.

The decreasing sequence of losses is CA_{10}, CA_4, CA_2, CA_8, CA_1, CA_{12}, CA_7, CA_{11}, CA_5, CA_9, CA_6, and CA_3. From the Table 5 it is observed that the maximum loss is due to **Theft of Password** therefore, it should be resolved first to minimize the losses and the losses are minimized according to the said sequence of cyber attacks. A graphical view of computation of risk is also represented in Fig. 5.

Table 5 Calculated the risk based on cyber attack

Code	List of cyber attack	Probability of occurrence P (CA_N)	Cost affected C (CA_N)	R (CA_N)
CA_1	Stealing of database	0.20	0.80	0.16
CA_2	Hacking of websites	0.35	0.70	0.245
CA_3	Job scams/frauds	0.10	0.60	0.06
CA_4	Mobile crimes	0.45	0.70	0.315
CA_5	Antisocial activities	0.20	0.50	0.1
CA_6	Stealing of bandwidth	0.15	0.40	0.06
CA_7	Cloning of debit/credit card	0.20	0.70	0.14
CA_8	E-commerce fraud	0.30	0.60	0.18
CA_9	Unauthorized network access	0.15	0.55	0.0825
CA_{10}	Theft of password	0.50	0.80	0.4
CA_{11}	Identity theft	0.15	0.70	0.105
CA_{12}	Cyber blackmailing/harassment	0.25	0.60	0.15

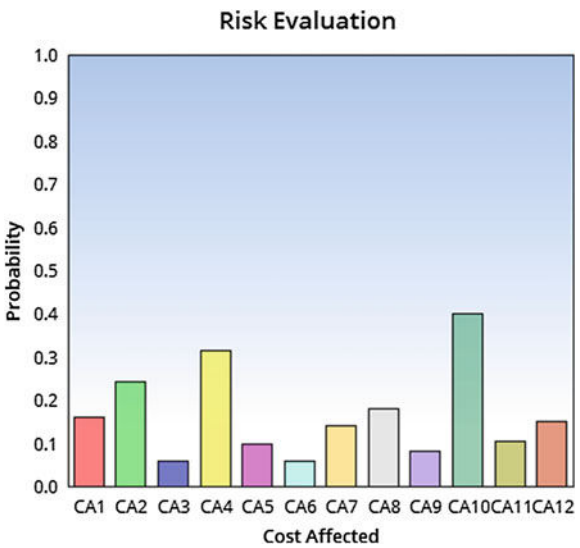

Fig. 5 Risk evaluation on the basis of probability and factor

4 Concluding Remarks

From the above work, it is concluded that UML is a powerful modeling language for solution of the complex research problems. In the present work a UML model is proposed for the online FIR and computation of losses from the cyber attacks. The UML model is validated through FSM technique and various valid test cases

have been generated for validation of proposed model. In the end, a technique for computation for risk analysis is proposed and finds the cyber attack having maximum risk analysis should be resolved first. The present paper can be extended further for method which can be suggested for minimization of losses like curve fitting method, optimization method, etc.

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This is to certify that Dr./Mr./Ms. RASHMI SINGH

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participated in workshop ***"Current Trends in Cyber Crime and Security (CTC²S-2018), 27th-31st, January, 2018"*** *organized by Department of Computer Science & Engineering, Motilal Nehru National Institute of Technology Allahabad, India.*

We wish his/her the best for future endeavors.

A. K. Singh
Convener

R.S. Yadav 31.1.18
Convener

BABASAHEB BHIMRAO AMBEDKAR UNIVERSITY

CERTIFICATE

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DEPARTMENT OF INFORMATION TECHNOLOGY

TWO WEEKS TRAINING COURSE ON CYBER SECURITY
(FEBRUARY 01-15, 2018)

CERTIFICATE OF PARTICIPATION

This is to certify that Prof./ Dr./Ms./Mr. Rashmi Singh.....
..... from ...BBAU Lucknow.....
has participated in Two Weeks Training Course on Cyber Security (TCCS- 2018) during February 01-15, 2018.

DR. ALKA	DR. P. K. CHAURASIA	DR. RAJ SHREE	PROF. R. A. KHAN
CONVENER	CONVENER	CONVENER	DIRECTOR