ADAMA SCIENCE & TECHNOLOGY UNIVERSITY

SCHOOL OF GRADUATE STUDIES

DEPARTMENT OF COMPUTING

A MASTER'S THESIS
ON

APPLICATION OF CASE BASED RECOMMENDER SYSTEM TO ADVICE NEW IMPORTERS AND EXPORTERS IN PRODUCT SELECTION

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ADAMA SCIENCE & TECHNOLOGY UNIVERSITY

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DECLARATION

I confirm that this thesis is my original work and has not been presented for academic award in any university or institution.

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AMARE WORKINEH

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List of Acronyms

AI----------Artificial Intelligence

CBR----------Case Based Reasoning

CBRRS----------Case Based Reasoning Recommender System

GUI----------Graphical User Interface

IE----------Import Export

JCOLIBRI----------Java Cases and Ontology libraries Integration for Building Reasoning Infrastructure

KBS----------Knowledge Based System

KNN----------K-Nearest Neighbor

ML----------Machine Learning

MOT----------Ministry of Trade

RS----------Recommender System

ABSTRACT

There are various products which are imported from different countries to Ethiopia and that are exported from Ethiopia to different countries. But to select products to import or export to new importers and exporters based on their interest is much difficult. There is no automated system that can assist new importers and exporters in product selection process. Therefore the main objective of this study is to design a prototype case based recommender system that can support new importers and exporters in product selection and to enable them to make timely decision. The knowledge is acquired using semi-structured interview, document analysis and observation to develop the prototype case based recommender system of import and export product selection. The acquired knowledge is modeled using hierarchical tree structure model and represented using feature value case representation. The prototype of the case based recommender system is implemented using JCOLIBRI2.0 tool.

For this study, 1561 case were collected from ministry of trade and 7 attribute were selected as a description and solution attribute to develop the prototype. K-nearest neighbor algorithm was applied to compute the similarity between new case and cases retained in the case base. Then the system retrieves top 10 cases and adapts the solution through direct copy method. The solution is revised by domain experts and the final solution is retained for future use.

The system recommends the amount of capital to import or export products based on the input or query. The recommendation system of fitness of the final solution to new problem is evaluated by domain experts and other users of the system. The system is evaluated in terms of its performance and user acceptance testing by different domain experts and importers and exporters. According to the evaluation of user acceptance testing, the average performance of the system is 87% and 80% of domain experts and importers and exporters respectively. The system also was evaluated similarity retrieval and relevant cases from retrieved cases performance using recall and precision. The average result of recall and precision is 85% and 59% respectively

CHAPTER ONE: INTRODUCTION

1.1. Background of the Study

We are often making choices without sufficient personal experience of the alternatives that are available to us in different circumstance. In our everyday life, we sometimes rely on recommendations from other people either by word of mouth, recommendation letters or on movie and book reviews to select from the huge amount of information that is available in different places. But these suggestions are not enough in this digital age [1]. Recommender systems are a type of information filtering system that gives advice on products, information, or services that a user may be interested in. They assist users with the decision making process when choosing among multiple alternatives [2].

Currently, recommender systems could be found in many modern applications that expose the user to huge collections of items both commercially and in the research community, where many approaches have been suggested for providing recommendations. Such systems typically provide the user with a list of recommended items they might prefer, or predict how much they might prefer each item. It helps to match the users with items to ease information overload; making decision about items and sales assistance [3]. Recommender Systems (RSs) are software tools and techniques providing suggestions for items to be of use to a user. The suggestions relate to various decision-making processes, such as what items to buy, what music to listen to, or what online news to read [4].

Recommender or *Recommendation Systems* (*RS*) aim to help a user or a group of users in a system to select items from a crowded item or information space. In order to generate recommendations, a *RS* might try to match users' characteristics with items' characteristics by performing content filtering, or it might look at previous interactions of the user in the system to match users with similar patterns. A typical domain where RS are useful is the World Wide Web (WWW): with its overwhelming growth of available information and the continuously growing number of different devices that can be used to access it recommender system (*RS)* have taken on an important role in the daily lives of people to find relevant resources [4].

Service, product, information and item, suggestions provided by recommender systems are useful when users are overwhelmed by a large number of options to consider or when they do not have enough knowledge about a specific domain to make autonomous decision [5]. A recommender system that recommends individuals who have a few expertise with a problem holds the guarantee to provide, in an exceptionally little way, a service similar to that given by key individuals. Expertise recommendation systems can diminish the stack on individuals in these roles and give optional recommendations when these individuals are inaccessible [6].

Solving a problem by CBR involves getting a problem depiction, measuring the similarity of the current problem to past problems stored in a case base (or memory) with their known solutions, retrieving one or more similar cases, and endeavoring to reuse the solution of one of the retrieved cases, conceivably after adapting it to account for differences in problem depictions. The solution proposed by the system is at that point evaluated [7]. Following the revision of the proposed solution if required in light of its evaluation, the problem depiction and its solution can at that point be retained as a new case, and the system has learned to solve a new problem [13]. Case-Based Reasoning recommender system (CBRRS) is one of the most fruitful machine learning techniques that exploit a knowledge-rich representation of the application area. Fundamentally, CBR is a problem solving technique that addresses a new problem by first retrieving a past, already solved similar case, and at that point reusing that case for solving the current problem [8].

The foremost point of CBR is to utilize past experience and knowledge of a problem area in order to solve new problems. CBR compares the new problem (or case) with all the similar problems experienced in the past and adapt the solution for the new one. Instead of utilizing all the knowledge of a particular domain problem, CBR is able to utilize only the information required of past experience. A new problem is solved remembering past similar situations and reusing the information in the new problem situation. CBR is moreover a predictive system and it is quite important the learning process in this system. It should be able to learn from experience and other methods [9]. In a Case-Based Reasoning Recommender System (CBR-RS) the effectiveness of the suggestion is based on: the capacity to match user preference with item depiction; the tools utilized to clarify the match and to enforce the validity of the recommendation; the range of accessible functionalities and the graphical interface that bolster the user in browsing the information content, either the cases or the items to suggest [8].

From the early 1960s, policy makers and researchers had a great interest in the relationship between export and economic growth. Their main reason and motivation is that they want to know if a country should increase its export to achieve a better economic growth or whether they should stimulate economic growth from the outset to lead to more export. [10]

Ethiopia's annual exports recently reached a never-before-seen level of $2 billion, a growth of 38 percent from the year before. Based on recent data on the composition of exports, this note reviews where this growth came from in terms of both supply-side factors (i.e., which commodities showed the largest increases) as well as demand-side contributors (what foreign markets mattered most) [11].

In terms of the commodity composition of exports, although coffee continues to dominate the top spot, its relative share of total exports is now at a historic low and the ranking of other key commodities is changing rapidly. Ethiopia now has five major non-coffee exports (oilseeds, gold, chat, flower, and pulses) which each bring in more than $100 million per year compared to none in 2000. Fifteen products (other than coffee) show annual exports of at least $10 million compared to just five in 2000. Despite these positive developments, we see many of Ethiopia's non-coffee exports being overly dependent on demand from just a single country [11].

As described by [12] if the businesspersons want to be exporter from and importer to Ethiopia has some procedures. Export procedures in Ethiopia: Businessperson that wishes to export products from Ethiopia should know the export procedures:

- Obtain export permit by commercial banks
- Should prepare application quality testing and certification to obtain export authorization certificate from the quality and standards authority of Ethiopia
- Should fill the customs declaration
- VAT registration for exporters from Ethiopia and VAT rate applied on goods exported from Ethiopia

Import procedures in Ethiopia:

- Pre-shipment inspection on goods
- Application submitted to commercial banks in Ethiopia to obtain import permit
- Modes of payment allowed for import, documentation requirements to effect payment and document checking and verification

An importer who wishes to import goods to Ethiopia should pay USD through commercial banks. All payments above USD 2000 should be made through letter of credit or cash against document. Pre shipment inspections apply for all imports from china. According to [50] most countries want to increase their exports. Their companies want to sell more. The more they export, the greater their competitive advantage. Exports also increase the foreign exchange reserves held in the nation's central bank.

Import export has a great impact on the development of the economy especially export plays a vital role on the growth of the economy. But still Ethiopia has low performance regarding to export because most Ethiopian export products are depend on agricultural products. This study stimulates new importers and exporters by providing recommendation or suggestion at product selection to import and export products based on their preferences. The prototype recommender system recommends how much capital they should prepare based on the data they input or based on the query given.

1.2. Background of MOT

Ever since Ethiopia adopted free market economic policy conditions conducive to a system of trade and business that are up to the times have been put in place. However, because of an understanding of what the free market enterprise was all about which was less clear and the absence of strong and modern regulatory system that is capable of steering the system effectively, the trade sector has largely remained without significant role in terms of its contribution to the country's economic development and the benefits accruing to the society. With regard to trade regulation, a trade registration and licensing system was introduced throughout the country, from federal to kebele levels. Generally, measures were taken to ensure competitive trade practices and protect consumers from unfair trade practices. The Ministry had undertaken into this since 2007, it was able to identify as some of the problems which include: problems associated with traceability of goods and services throughout the chain of transactions they go through, the undesirable effects of trade registration and licensing system in the market system, absence of up-to-date and consolidated information useful for decision making, absence of unique identification for trade registration and licensing and overlapping of responsibilities and absence of coordinated approach among stakeholders.

Thus on the basis of the foregoing the Ministry, having undertaken a study that lasted from 2007-2010 had taken various measures to address the issues. Some of the measures include: institutional reorganization, capacity building undertakings, introduction of new legislation and amendment of the existing ones [52].

1.3. MoT powers and duties

According to [53] Ethiopian ministry of Trade has the following powers and duties to:

- Promote the expansion of domestic trade and take appropriate measures to maintain lawful trade practices.
- Create conducive conditions for the promotion and development of the country's export trade and extend support to exporters.
- Establish a system that enable to ascertain that export or import goods are sold or bought at the appropriate price; make follow ups in collaboration with the concerned executive bodies, and take measures in accordance with the law against those who export or import by under invoicing.
- Establish foreign trade relations, coordinate trade negotiations, sign and implement trade agreements.
- Establish and follow up the implementation of comprehensive system for the prevention of anti-competitive trade practices; provide protection to consumers in accordance with the law.
- Provide commercial registration and business licensing services, and control the use of business licenses for unauthorized purposes.
- Undertake and submit to the Council of Ministers price studies relating to basic commodities and services that have to be under price control and, upon approval, follow up the implementation of same.
- Establish the legal metrological system of the country, regulate its enforcement and coordinate the concerned regulatory bodies.
- Control the qualities of export and import goods; prohibit the importation and exportation of goods that do not comply with the requirements of the standards, and work in collaboration with the concerned organs.

- Control the compliance of goods and services with the requirements of mandatory Ethiopian standards, and take measure against those found to be below the standards set for them.
- Cause the coordinated enforcement of standards applied by other enforcement bodies, organize and direct implementation review conferences.
- Organize the trade data of the country, and disseminate same to the concerned bodies.
- Encourage the establishment of cooperative societies, including those of consumers, and chambers of commerce and sectoral associations, and strengthen those already established.

1.4. MOT visions and missions

The researcher investigated various relevant documents and ministry of trade website, but the researcher did not get any goals and objectives of the MoT. But instead of goals and objectives, the researcher has got visions and missions of the MoT described as follows.

Visions of Ethiopian ministry of trade: Secure globally competitive trade sector that would be well founded on the basis of consistent development.

Missions of Ethiopian ministry of trade

One of the missions of Ethiopian MoT is ensuring social benefit through establishing transparent, fair and competitive trade systems and generating foreign exchange earnings.

1.5. Motivation

As we know import export is the backbone of the country's economy growth. But many businesspersons face a problem on searching the right product to import or export products based on their preferences or to import and export products how much capital they should prepare. They need recommendations or advice from others or domain experts. This study is therefore encouraged to develop recommender system that empowers new importers and exporters to have the right decision when they want to be importer or exporter. Ethiopia shipped US$2.6 billion worth of goods around the globe in 2016, up by 61.7% since 2009. Ethiopia's top exports are highly concentrated, representing 97.2% of the overall value of Ethiopian global shipments. The following export product groups represent the highest dollar value in Ethiopian global shipments during 2016. As shown below in table 1.1 is the percentage share of each export category represents in terms of overall exports from Ethiopia [51].

Table 1.1 Major commodities, USD values and percentage share

Rank	***Major Commodities***	***USD values***	***Percentage share***
1	Coffee, tea, spices	US$757.3 million	28.9%
2	Vegetables	$527 million	20.1%
3	Oil seeds	$516.9 million	19.8%
4	Live trees, plants, cut flowers	$216.2 million	8.3%
5	Gems, precious metals	$117.6 million	4.5%
6	Meat	$93.6 million	3.6%
7	Live animals	$90.7 million	3.5%
8	Raw hides, skins not furskins, leather	$67.6 million	2.6%
9	Footwear	$37.1 million	1.4%)
10	Knit or crochet clothing, accessories	$32 million	1.2%)

According to [51] knit or crochet clothing and accessories were the fastest-growing among the top export categories, up 1,690% over the 7-year period starting in 2009. In second place for improving export sales was footwear which was appreciated by 461.5%. Ethiopia's exported meat posted the third-fastest gain in value up by 259.6%. The slowest gainer among the top Ethiopian exports was gems and precious metals via its 26.4 increase. The fast increment of import export products in Ethiopia has a great positive impact on the growth of economy. Therefore this growth really the researcher highly motivated to solve problems related at import and export product selections to new importers and exporters.

1.6. Statement of the Problem and Justification

People want to be entrepreneurs. But most of the people have no idea to start the business based on their requirement or interest. Choosing the right product plays very important role before starting any business especially for export business. In the context of investing, the wise words of the vision emphasize that success depends on selecting the best investment activity that fits with your personal and socio-economic characteristics.

Even though all investors are trying to make money, each one comes from a diverse background and has different characteristics and capabilities, each individual follows specific investing vehicles and methods that are suitable for certain types of investors.

Import export is one part of the business. It plays a vital role for the development of the country especially for developing countries like Ethiopia. But in Ethiopia import export performance is very low. To be importer and exporter of products is difficult for new entrepreneurs because there is no system is still developed that recommend or suggest in how much capital which type of product they can import and export and in which area the products are more accessible. Ministry of trade has its own website to announce some information but this site is not sufficient to get appropriate information especially to new importers and exporters. Even though there is lack of domain experts related to import export cases that provides advice.

Difficulty of getting business advice is a critical issue for importers and exporters since knowing the right products is a key factor to new importers and exporters. Importers and exporters tend to lose money by choosing the wrong products without consideration of some factors such as capital, location and product type to import and export. In import export advising system there are a number of problems faced by domain experts to provide advice in Ethiopian import export system. The problems faced by experts on import export advising system are lack of appropriate, relevant and organized information to give advice to customers.

There is no integration and collaboration between different experts that are found in different import export sectors in advisory system to new importer or exporter. Therefore one of the major problems faced in Ethiopian import export system is difficulty of getting fast and consistent expert advice. Inadequacy of experienced experts and consulting customers who can give advice on import export issues are another problem. So to fill the above stated problems in import export sector the researcher developed a case based recommender system that will help customers to get fast and consistent advisory service on import export system.

The study also attempts to explore and answer the following research questions.

- What are the attributes used by the system to recommend importers and exporters product selection based on the availability of capital?
- How the case base recommender system model will develop?
- What is the impact of a case based recommender system to customers in providing advice?

1.7. Objective of the Study

In order to contribute towards addressing the problem which is described in section 1.3 above the study proposed the following general and specific objectives.

1.7.1. General Objective

The general objective of the study is to design a prototype case based recommender system that provides advice to new exporters and importers.

1.7.2. Specific Objectives

- To review literatures and understand the concept of recommender system and how it is designed.
- To design architecture of recommender system
- To develop a prototype for recommender system
- To evaluate the performance of the recommender system

1.8. Research Methodology overview

Selecting the right research methodology is the fundamental task of the study. It is clear that the research methods that we use will make our research to have good result or not. To answer the research question; different tools and techniques have been used. Tools, instruments and techniques used for data/information collection, analysis, prototype development and testing and evaluation of the system.

1.8.1. Literature Review

Several previously proposed related literatures (books, articles and the Internet) have been reviewed in order to have detail understanding on this research works. Different techniques and tools which are relevant for this research have been analyzed, modified and used from previous works.

1.8.2. Data Collection Methods

The researcher has been contacted frequently with the concerned bodies to gather the relevant information. The researcher used different data collection methods for this study. The methods are interview, document analysis and observation. The researcher interviewed the concerned bodies from Ethiopian Ministry of trade, domain experts, importers and exporters. Ethiopian ministry of trade (MoT) sector documents and manuals has been analyzed to gather the relevant information. Attributes and cases were collected from experts and customers to create knowledge base.

1.8.3. Programming Techniques and Tools

There are many tools which are used to develop case based recommender system prototype. The tools are listed below:

- CBR Express/ART-IM from Inference Corporation
- Esteem from Esteem Software Inc.
- MyCBR
- JCOLIBRI

But in this study jcolibri2 was used due to its latest version. The features of this tool discussed in detail chapter four.

1.8.4. Evaluation/Testing procedures

To check whether the research objective is achieved or not the developed prototype case based recommender system is tested and evaluated. To evaluate and test the developed recommender system domain experts from ministry of trade and private exporters and importers were selected.

The evaluation process is concerned on the system's user acceptance, similarity retrieval performance, and reuse performance of the system. Precision and recall value of the system was used to calculate the retrieval performance of the system. User acceptance testing was performed to test the system and user feedbacks were collected to calculate the system performance. The system performance has seen in terms of relevancy of retrieved cases, similarity of final solution to the new cases and so forth.

1.9. Scope and Limitation of the Study

The study focus on developing prototype case based recommender system for importers and exporters on the selection of the right product with their suitable capital. The objective of this prototype recommender system provides advice for new importers and exporters.

The previous importer and exporter cases were collected from ministry of trade. In this study the limitation is unbalanced cases from the collected cases which mean the same cases more dominated and the developed prototype recommender system will recommend mostly the same cases due to this problem. The other limitation is the two attributes such as group and subgroup sometimes have the same cases. In general getting the relevant attributes and cases from ministry of trade was the main limitation of this study.

1.10. Significance and Application of the Study

From this study private importers and exporters are the primary beneficiary from developed import export recommender system. In addition to this the developed recommender system has a great significance for ministry of trade, inexperienced domain experts, and some governmental organizations. Import export recommender system that helps specifically new importers and exporters to choose the right products with their appropriate capital.

Therefore, those import export experts can use the system in recommending product selection to importers and exporters based on their personal and economical characteristics in the sector where highly qualified import export expert professionals are unavailable. The developed recommender system is used to provide advising services for importers and exporters. The recommender system is developed using the knowledge of different domain experts and documentary sources. Therefore the developed prototype gives better recommendation services.

1.11. Organization of the Thesis

This study is organized in to six chapters as follows:

Chapter One includes background of the study, statement of the problem, objectives, research methodology, scope and limitation of the study, and significance and application of the study. **Chapter Two** basically contains literature review and related works of the study.

Chapter Three knowledge based system, knowledge acquisition techniques, knowledge based system architecture, knowledge representation methods and knowledge modeling and hierarchical structure of cases are included in this chapter**.**

Chapter Four discusses methodology of the study and development of prototype.

Chapter Five includes presentation, analysis and interpretation of the result.

Chapter Six contains conclusion and recommendation (future work) of the study.

CHAPTER TWO

2. Literature Review

The problem of information overload is broadly identified currently. Residing in an information society, we are bombarded with information whether or no longer we actively searching for it. We are all tormented by the increasing variety of sources from which information emanates. Who does no longer obtain undesirable information via the letter box almost day by day? Growing numbers of television channels offer more viewing desire and bring about burgeoning application guides to be ploughed via in the frequently elusive search for an interesting program to observe amongst the escalating dross churned out. Newspapers, radio and television regularly disseminate the identical information items with such an intensity of coverage that you can soon expand a notion of data overload but here you can still select to disregard that information. In the work place, however, information is seen as the key to success for corporations and plenty of people ought to address an awesome amount of facts from many resources as part of their job. Locating information on a big net website online can be a tough and time-consuming system. Recommender systems can help users locate information through providing them with personalized recommendations [13].

Decision making is a mental manner that identifies possible opportunity actions and chooses one from the options for the given scenario. It requires for capability of analyzing available facts and information approximately the situation in order to compare and comparison the options in order that the best and proper option may be selected. The quality of a decision depends on its rightness and being made in time. Capability of creating the right decision is the result of the choice maker understands about the area, availability of vital facts, and experience & ability of applying the knowledge on the given data. On occasion missing of necessary data and the time it takes to analyze large amount of facts prevents from making the right decision [14].

A system is wanted that supports the consumer in finding and deciding on products, services or information while there are too many items to consider or the consumer has a lack of knowledge about the topic or area. This system is called a recommender system; it uses knowledge about the consumer and products to present suitable recommendations [13].

2.1. Basic concept of Recommender system

Recommender system is part of web-based application that uses facts about customers and their behavior to offer them with items which might be the maximum applicable to them. The recommended items are typically matters which are answerable to user taste, like books, music, news, etc. With the growth of the internet usage and the available of huge data, recommendations have become part of life [15]. No matter what the domain is, a large quantity of information is online and it will become a difficult task to choose items which might be essential. Recommender systems attempt to overcome this undertaking and goal to map people with the proper items [16].

Recommender systems provide advice to users about objects they might wish to purchase or look at. Suggestions made by such systems can assist customers navigate via large information areas of product descriptions, news articles or different items. As on-line information and e-commerce burgeon, recommender systems are an increasingly more critical tool [17]. Recommender systems are a special type of information filtering systems. Information filtering deals with the delivery of items selected from a large collection that the user is likely to find interesting or useful and can be seen as a classification task [18]. Recommender system is part of information filtering system that provides relevant and accurate items to the user by filtering useful items from a huge collection of information base. So in this study the developed IE recommender system provides solution to the user in this case importers and exporters by integrating users' choices with their needs and interests.

Recommender systems had been at the beginning described as ones in which 'people offer recommendations as inputs, which the system then aggregates and directs to appropriate recipients'. The time period now has a broader connotation, describing any system that produces individualized recommendations as output or has the impact of guiding the consumer in a personalized manner to interesting or beneficial objects in a big area of possible options. So it is able to be stated that, the recommender system is a mapping among customers and items involving a value of interest [17].

Recommender systems allow human beings to exchange their opinions and gain from each other's experience. They can be described as "any system that produces individualized suggestions as output or has the effect of guiding the user in a personalized way to exciting or beneficial items in a big space of feasible options". Recommender systems have been initially evolved to aid web customers in their decision-making in each day life situations in terms of pre-deciding on information that might be interest to them, where they confronted conditions without enough revel in the available options [15]. The two fundamental entities which appear in any recommender system are the person/customer and the object/product. A user is a person who utilizes the recommender system providing his opinion about diverse items and gets recommendations about new objects from the system [16].

Recommendation systems have arisen to provide handy recommendations to the customers. These systems may be used for different functions in several domains from offering papers to researchers to supporting consumers in e-commerce. There are recommendation systems in unique domain names which include movies, television programs, video, music, books, news, images, and web pages. It could be said that, recommendation systems essentially aim to overcome the difficulty of finding right information. Some of the maximum well-known ones, Amazon recommends books in book domain; Last.fm facilitates users to find the songs that they need to listen; and Movie Lens attempts to guide users to reach the movies they might like [19].

Recommender systems can now be found in many modern applications that expose the user to large collections of items both commercially and in the research community, where many techniques have been advised for providing suggestions. Such systems generally provide the user with a list of recommended items they might prefer, or predict how much they might prefer every item. It supports to match the users with objects to make ease information overload and sales assistance [20]. It is an web based application that uses the opinions of the community of customers to assist customers in the decision making and product selection process to discover content of interest from big set of choices [20].These selections may be books, music CDs, movie DVDs, flight tickets, lodge reservations, websites, and they may be humans (e.g. discover an expert, a person to follow) [21].

In recommender systems, the items of interest and the person preferences are represented in diverse forms, which may also involve one or more variables. Especially in systems in which recommendations are based on the opinion of others, it is important to combine a multiple of criteria that have an effect on the users' opinions into the recommendation problem. Numerous recommender systems have already been engaging multiple criteria for the production of recommendations. Such systems, referred to as multi-criteria recommenders, early confirmed the ability of applying multi-criteria decision making (MCDM) methods to facilitate recommendation in several application areas [22].The purpose of a recommender system is to generate meaningful recommendations to a group of customers for objects or products that might interest them. Suggestions for books on Amazon, or movies on Netflix, are real global examples of the operation of industry-strength recommender systems.

The predominant goal of recommender systems is that of complexity discount for the human being, sifting via very big units of information and choosing those pieces that are relevant for the lively user. Furthermore, recommender systems follow personalization techniques, considering that distinct customers have unique preferences and different information desires, so the intention of recommender systems is to generate recommendations about new objects or to predict the utility of a selected item for a specific user. In each instances the method is based on the input provided, that's associated with the preferences of that user. As an instance, supposing the area of book recommendations, historians are supposedly more interested in medieval prose [19].

2.2. Architecture for Recommender System

A recommendation seeker may ask for a recommendation, or a recommender may produce recommendations with no prompting. Seekers may volunteer their own preferences, or recommenders may ask about them. Based on a set of known preferences – his/her own, the seeker's, and those of other people, often people who received recommendations in the past – the recommender recommends items the seeker probably will like. In addition, the recommender may identify people with similar interests. The seeker may use the recommendation to select items from the universe or to communicate with like-minded others [23].

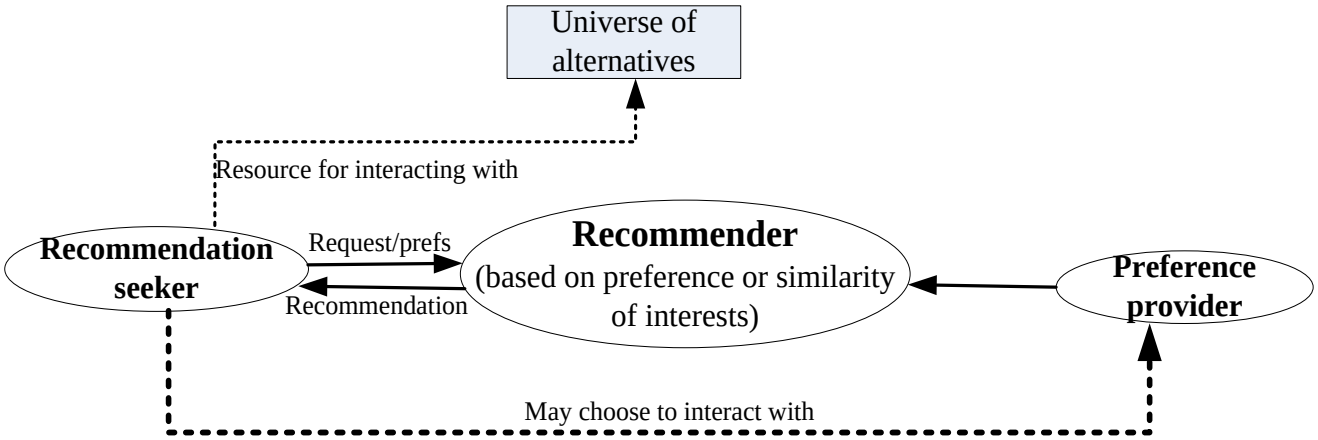

Figure 2.1 Architecture of recommender system (source: [23])

As shown in the above figure, the recommendation seeker (exporters/importers) asks recommendation with the help of recommender system from preference provider and universe of alternatives by entering the required queries by them. Based on the items listed in the preference provider, the system provides solution or recommendation by measuring similarity between new cases which is provided by the exporters/importers and existing case stored in the case base. Finally, the system will provide best similar cases to the exporter/importer from the existing cases.

In recommender systems, the utility of an item is typically represented by using a rating, which measures how much a particular user is interested by the item. Depending on the software, the ratings can either be specified by the customers, or be computed with the aid of the system. Each element of the user space U can be described with a profile that may consist of several demographic characteristics, such as gender, age, nationality, marital status, and so forth. Some information about the users tastes interests and preferences [24].The way in which such user profiles and item descriptions are defined is a key point in any recommender system. However, it is not the only factor that influences the efficiency and effectiveness of the recommendation processes [24]. Analogously, each element of the item space I may be described with a set of characteristics or features. For example, in a movie recommender system, movies can be described not only by their titles, but also by their genres, principal actors, etc.

As shown below, the basic components of a recommender system make interaction to give recommendation for the user. First, a user profile learning module (explicitly or implicitly) captures the preferences from the user. Once the system "knows" about the user's tastes and interests, it compares and/or combines user profiles and item descriptions. Then item with a maximum gain to the user is recommended [20].

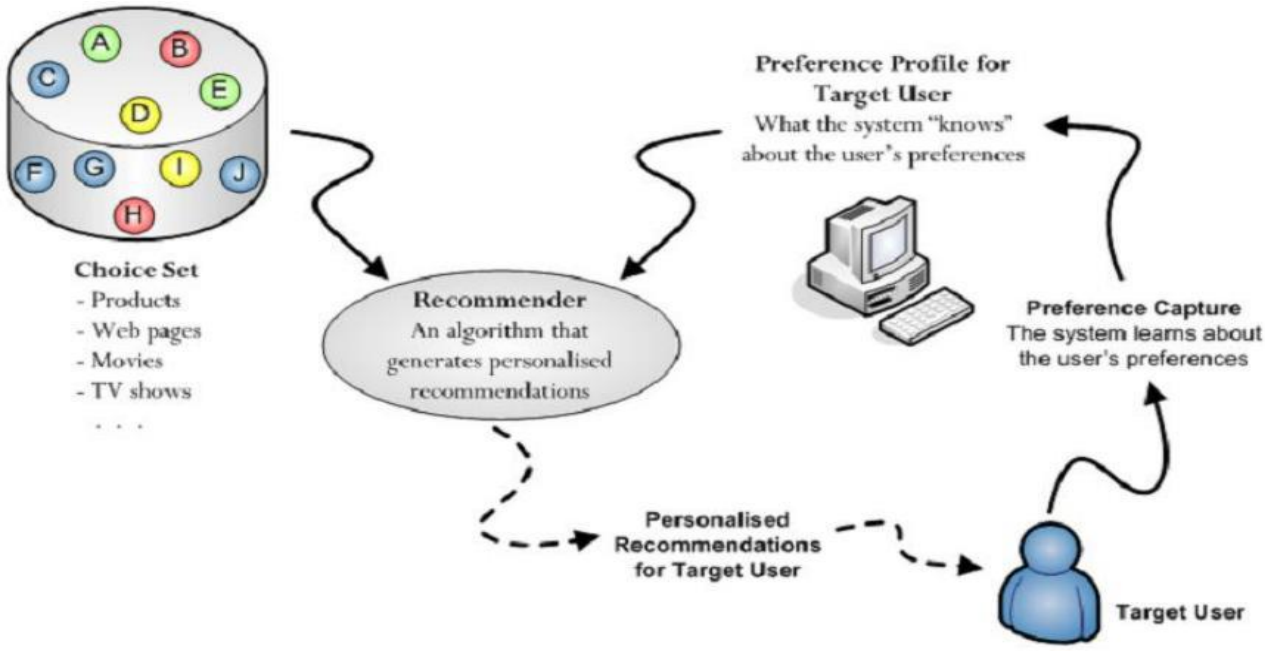

Figure 2.2 Recommender System Process (source: [20])

2.3. Types of Recommender System

2.3.1. Collaborative Filtering

Collaborative filtering (CF) is a popular recommendation algorithm that bases its predictions and suggestions at the ratings or behavior of different users inside the system. The fundamental assumption behind this approach is that different users' opinions can be selected and aggregated in such a way as to provide a reasonable prediction of the lively user's preference [13].

2.3.1.1. Advantage of Collaborative Filtering

The primary benefits of this kind of recommender systems is that they are more effective with regards to customer satisfaction as they suggest the most suitable items to users which can be personalized at the same time. The collaborative filtering algorithms are designed such that the

accuracy in their prediction will increase enormously over time as more user preferences are added to the database, regardless of the dimensions of the database [13].

2.3.1.2. Disadvantage of Collaborative Filtering

New user problem: It has the equal trouble as with content-based gadget. If you want to make correct recommendations, the system has to first learn the user's preference from the ratings that the user offers.

New item problem: New items are delivered regularly to recommender systems. Collaborative systems depend totally on users' preferences to make recommendations. Consequently, until the new item is rated through a substantial number of users, the recommender system could not be able to recommend it [13].

2.3.2. Content-Based Recommender System

Content-based recommendation systems attempt to advise items just like the ones a given user has liked in the past. Indeed, the fundamental process performed via using a content-based recommender consists in matching up the attributes of a user profile in which preferences and interests are stored, with the attributes of a content item (object), on the way to recommend to the person new interesting items [13].

2.3.2.1. Advantages of Content Based Recommender Systems

- ***USER INDEPENDENCE***- content-based recommenders exploit solely ratings provided through the active user to construct her own profile. As an alternative, collaborative filtering methods want ratings from other users in order to find the "nearest neighbors" of the lively user, i.e., users which have similar tastes since they rated the same items similarly. Then, simplest the items which can be most favored by the neighbors of the lively user can be recommend;

- ***TRANSPARENCY*** - explanations on how the recommender system works may be offered by explicitly listing content features or descriptions that caused an item to occur in the list of recommendations. Those features are signs to consult as a way to determine whether to trust a recommendation. Conversely, collaborative systems are black boxes since the only explanation for an object recommendation is that unknown users with similar tastes liked that item;

- ***NEW ITEM*** - content-based recommenders are able to recommending objects not yet rated by any user. As a consequence, they do not be afflicted by the first-rater problem, which affects collaborative recommenders which depend entirely on users' preferences to make recommendations. Consequently, till the new object is rated by substantial number of users, the system could not be capable of recommend it [25].

2.3.2.2. Shortcomings of Content Based Recommender Systems

- ***LIMITED CONTENT ANALYSIS*** - content-based techniques have a natural restriction within the range and type of features which can be associated, whether or not automatically or manually, with the items they endorse. Area knowledge is frequently wanted, e.g., for film recommendations the system wishes to know the actors and directors, and sometimes, area ontologies also are wanted. No content-based recommendation system can offer suitable suggestions if the analyzed content does not comprise enough information to discriminate objects the user likes from items the user does no longer like. A few representations capture only certain aspects of the content; however there are numerous others that could impact a user's experience. For example, often there is not sufficient information in the word frequency to version the user pursuits in jokes or poems, at the same time as techniques for affective computing could be maximum suitable. Once more, for web pages, feature extraction strategies from text completely forget aesthetic qualities and further multimedia information.

- ***OVER-SPECIALIZATION*** - Content-based recommenders don't have any inherent method for finding something unexpected. The system suggests items whose rankings are high while matched against the user profile; consequently the user is going to be recommended items just like those already rated. This downside is also known as serendipity hassle to spotlight the tendency of the content-based systems to produce recommendations with a constrained degree of novelty. To provide an example, while a user has only rated movies directed by Stanley Kubrick, she can be recommend just that kind of films. A "perfect" content-based technique would rarely find anything novel, restricting the range of programs for which it might be useful.

- ***NEW USER*** - Enough ratings have to be amassed before a content-based recommender system can really recognize user preferences and offer accurate recommendations.

Consequently, while few ratings are to be had, as for a new user, the system will not be able to offer dependable recommendations [25].

2.3.3. Knowledge Based Systems

The idea of knowledge based system is derived from the sector of artificial intelligence (AI). AI intends understanding of human intelligence and building of computer programs which are able to simulating or acting one or more of intelligent behaviors. Computer programs that attempt to solve problems in a human professional-like style with the aid of using knowledge about the application area and problem fixing techniques are known as knowledge based system. Human experts use the knowledge they have about the domain and techniques that lead the way to use the knowledge to fix problems. Knowledge base includes all vital knowledge about the domain that is required to deal problems. The knowledge can be obtained from professionals, documents, books and/or different sources [28].

It is formalized and organized with a method called knowledge representation. There are several methods to represent knowledge within the knowledge base. Cases and rules are the two strategies to represent knowledge [14]. Knowledge based system is a broad term and used to refer many systems. In knowledge based system explicit knowledge is represented via various appropriate tools such as ontologies, rules and cases where as case based recommender system is a specific term and the domain knowledge is represented in the form of cases. So, case based recommender system is part of knowledge based system. Both knowledge based system case based recommender system uses knowledge to recommend users or to solve complex problems.

2.3.3.1. KBS Advantages and Limitations

Knowledge-based systems are more useful in many situations than the traditional computer based information systems. Some major situations include:

1. When expert is not available.
2. When expertise is to be stored for future use or when expertise is to be cloned or multiplied.
3. When intelligent assistance and/or training are required for the decision making for problem solving.
4. When more than one experts' knowledge have to be grouped at one platform.

With the proper utilization of knowledge, the knowledge-based systems increase productivity, document rare knowledge by capturing scare expertise, and enhance problem solving capabilities in most flexible way. Such systems also document knowledge for future use and training. This leads to increased quality in problem solving process. However, the scarcity and nature of knowledge make the KBS development process difficult and complex. The transparent and abstract nature of knowledge is mainly responsible for this. In addition, this field needs more guidelines to accelerate the development process. Following are some of the major limitations with the KBS:

1. Acquisition, representation and manipulation of the large volume of the data/information/ knowledge.
2. High-tech image of the AI field.
3. Abstract nature of the knowledge.
4. Limitations of cognitive science and other scientific methods [13].

2.3.4. Rule-Based Reasoning

Rule based systems are knowledge based systems that represent the area knowledge with set of rules and recommend a solution or conclusion of a problem by using rule based reasoning approach. A rule based system has one greater component, which is referred to as working memory, further to knowledge base and inference engine. The inference engine receives a problem from the working memory and gives the reasoning end result to the working memory. The working memory consists of the description of the problem and updates its content based at the reasoning outcomes received from the inference engine.

Rules: Commonly regulations represent what to do or not to do at the same time as certain situations are met.

Similarly, the application area knowledge is represented with set of rules that constitute the facts that would be true while a few conditions are given true. A typical rule has a format of If<conditions> then <conclusion>; where situations represent premises or facts, and conclusion represents associated movements for the premises. The condition is probably a premise or set of premises that are related with logical operators: AND & OR. The conclusion can be an action to be taken or facts which can be inferred from the given premises. [14].

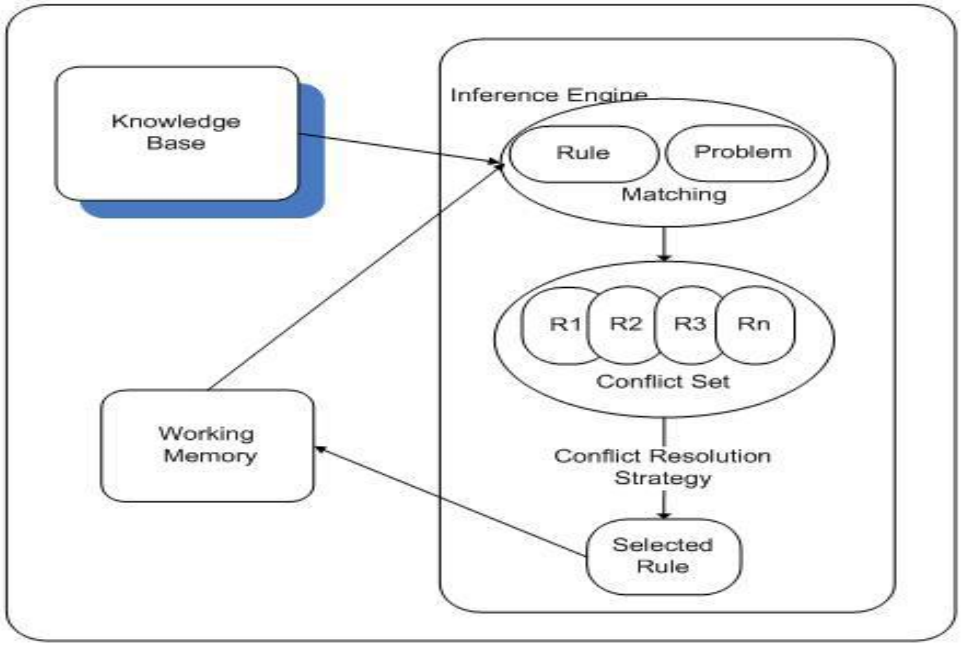

Figure: 2.3 Rule Based Reasoning (source [14])

2.3.4.1. Advantages of a rule-based approach

1) The ability to use, in a very direct fashion, experiential knowledge acquired from human experts. This is particularly important in domains that rely heavily on heuristics to manage complexity and/or missing information.

2) Rules map into state space search.

3) The separation of knowledge from control simplifies development of expert systems by enabling an iterative development process where the knowledge engineer acquires, implements, and tests individual rules.

4) Good performance is possible in limited domains. Because of the large amounts of knowledge required for intelligent problem solving, expert systems are limited to narrow domains. However, there are many domains where design of an appropriate system has proven extremely useful.

5) Good explanation facilities. Although the basic rule-based framework supports flexible, problem-specific explanations, it must be mentioned that the ultimate quality of these explanations depends upon the structure and content of the rules [13].

2.3.4.2. Disadvantages of rule-based reasoning

According to [13] rule based approach has the following disadvantages.

1) Often the rules obtained from human experts are highly heuristic in nature, and do not capture functional or model-based knowledge of the domain.

2) Heuristic rules tend to be "brittle" and can have difficulty handling missing information or unexpected data values.

3) Another aspect of the brittleness of rules is a tendency to degrade rapidly near the "edges" of the domain knowledge. Unlike humans, rule-based systems are usually unable to fall back on first principles of reasoning when confronted with novel problems.

4) Explanations function at the descriptive level only, omitting theoretical explanations. This follows from the fact that heuristic rules gain much of their power by directly associating problem symptoms with solutions, without requiring (or supporting) deeper reasoning.

5) The knowledge tends to be very task dependent. Formalized domain knowledge tends to be very specific in its applicability. Currently, knowledge representation languages do not approach the flexibility of human reasoning.

2.3.5. Case-Based Reasoning

Case-based reasoning is a problem solving paradigm that in many respects is fundamentally different from other major AI approaches. Instead of relying solely on general knowledge of a problem domain, or making associations along generalized relationships between problem descriptors and conclusions, CBR is able to utilize the specific knowledge of previously experienced, concrete problem situations (cases). The advantages of case-based reasoning include:

1) The ability to encode historical knowledge directly. In many domains, cases can be obtained from existing case histories, repair logs, or other sources, eliminating the need for intensive knowledge acquisition with a human expert.

2) Allows shortcuts in reasoning. If an appropriate case can be found, new problems can often be solved in much less time than it would take to generate a solution from rules or models and search.

3) It allows a system to avoid past errors and exploit past successes. CBR provides a model of learning that is both theoretically interesting and practical enough to apply to complex problems.

4) Extensive analysis of domain knowledge is not required. Unlike a rule-based system, where the knowledge engineer must anticipate rule interactions, CBR allows a simple additive model for knowledge acquisition. This requires an appropriate representation for cases, a useful retrieval index, and a case adaptation strategy.

5) Appropriate indexing strategies add insight and problem-solving power. The ability to distinguish differences in target problems and select an appropriate case is an important source of a case-based reasoner's power; often, indexing algorithms can provide this functionality automatically.

The disadvantages of case-based reasoning include:

1) Cases do not often include deeper knowledge of the domain. This handicaps explanation facilities, and in many situations it allows the possibility that cases may be misapplied, leading to poor quality or wrong advice.

2) A large case base can suffer problems from store/compute trade-offs.

3) It is difficult to determine good criteria for indexing and matching cases. Currently, retrieval vocabularies and similarity matching algorithms must be carefully hand crafted; this can offset many of the advantages CBR offers for knowledge acquisition [13].

2.3.6. Hybrid Recommender System

Disadvantages of the Collaborative Filtering and Content Based approaches can be solved by combining the two into a hybrid method. Many hybrids approaches use two recommendation algorithms and combine their results in some manner, such as combining the results by their relevance, mixing the output of the two algorithms, switching from content based in to

collaborative once the cold start phase is over, or using the output of one algorithm as input to the second algorithm. Using hybrid approaches we can avoid some limitations and problems of other recommender systems, like the cold-start problem [20]. The combination of approaches can proceed in different ways.

- Separate implementation of algorithms and joining the results.
- Utilize some rules of content-based filtering in collaborative approach.
- Utilize some rules of collaborative filtering in content based approach.
- Create a unified recommender system that brings together both approaches.

Some of the hybrid recommenders according to [20] are:

Weighted recommenders: The results of all the recommendation techniques are used to compute the score of an item which is to be recommended. The assumption used in this technique is that relative value of numerous other techniques is uniform across the space of possible items.

Switching recommenders: This hybrid incorporates the item level sensitivity to its strategy using which, the recommender switches between the techniques used for recommendation. The notable characteristic of this system is that it is sensitive to the strength and weakness of the constituent recommenders.

Mixed recommenders: These types of recommenders are used when there is a need to make large number of recommendations in a short period of time. This type of recommender takes suggestions from multiple sources to generate final results [20].

2.4. Case Based Reasoning

Case-based reasoning systems rely on a database (or case base) of past problem solving experiences as their primary source of problem-solving expertise. Every case is typically made up of a specification part, which describes the problem at hand, and a solution part, which describes the solution used to solve this problem. New problems are solved by retrieving a case whose specification is similar to the current target problem and then adapting its solution to fit the target situation [13].Most approaches to problem solving in Al treat each problem as a unique case. One deficiency of such problem solver is that they cannot rely on previous experience.

The same problem presented two different times requires the same (possibly long and complex) set of reasoning steps.

- Over the last few years, case-based reasoning (CBR) has grown from a rather specific and isolated research area to a field of widespread interest.
- Activities are rapidly growing - as seen by the increased rate of research papers, availability of commercial products, and also reports on applications in regular use.

Case-based reasoning is a problem solving paradigm that in many respects is fundamentally different from other major AI approaches. Instead of relying solely on general knowledge of a problem domain, or making associations along generalized relationships between problem descriptors and conclusions, CBR is able to utilize the specific knowledge of previously experienced, concrete problem situations (cases). A new problem is solved by finding a similar past case, and reusing it in the new problem situation [13].

Solving a problem by CBR involves getting a problem depiction, measuring the similarity of the current problem to past problems stored in a case base (or memory) with their known solutions, retrieving one or more similar cases, and endeavoring to reuse the solution of one of the retrieved cases, conceivably after adapting it to account for differences in problem depictions. The solution proposed by the system is at that point evaluated [7]. Following revision of the proposed solution if required in light of its evaluation, the problem description and its solution can then be retained as a new case, and the system has learned to solve a new problem [13].

In the simplest recommendation process, the user is supposed to be looking for some product to purchase and therefore is asked by the system to provide some product requirements, those that he/she considers as the most important. In reply, the system initiates a search in the case base to identify products that should be recommended, i.e. those that satisfy these requirements. In this process we can identify some basic elements, such as, the input (where the user provides his/her requirements), the products retrieval (where the system searches the products according to user requirements) and the output, where some recommendation is given to the user [13].

2.4.1. Cases

Cases are used to represent domain knowledge of a case based system. A case refers to specific experience or knowledge tied to specific situation that is worth remembering for future use. So that cases in the knowledge base represent collection of specific experienced, captured and learned situations of the application domain [14].

2.4.2. Case Base

A case base is a memory; it contains a collection of cases that is used in the context of the CBR methodology for the purpose of performing a reasoning task [13].

2.4.3. Organization and Representation of Cases

Cases are used to symbolize domain knowledge of a case based system. A case refers to specific experience or knowledge tied to specific situation this is really worth remembering for future use. In order that cases inside the knowledge base constitute series of specific skilled, captured and learned situations of the application area. Every case is constituted with 3 primary elements:

- Situation/hassle description: describes precise circumstances, states of a situation, and state of the surroundings while this precise case is recorded.
- Solution: presents how the problem defined inside the hassle description was solved or treated with in a particular example.
- Outcome: describes the final result or effect and feedback received from following the proposed solution [14].

2.4.4. Case-Based Reasoning Cycle (CBR)

At the highest level of generality, a general CBR cycle may be described by the following four processes:

1. RETRIEVE the most similar case or cases

2. REUSE the information and knowledge in that case to solve the problem

3. REVISE the proposed solution

4. RETAIN the parts of this experience likely to be useful for future problem solving.

A new problem is solved by *retrieving* one or more previously experienced cases, *reusing* the case in one way or another, *revising* the solution based on reusing a previous case, and *retaining* the new experience by incorporating it into the existing knowledge-base (case-base) [26].

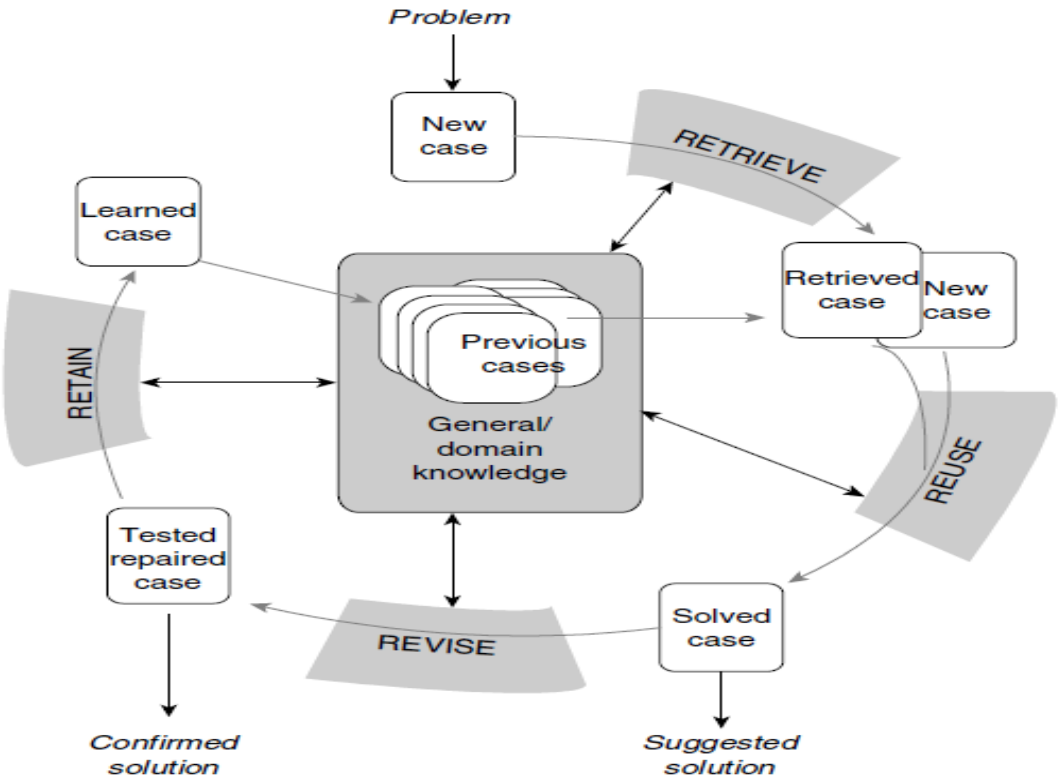

Figure 2.4 Architecture of case based reasoning (source **[26]**):

2.4.4.1. Retrieval

In CBR, retrieval is remembering previous cases stored inside the case base to solve new problems at hand. Step one which is the maximum critical step in CBR cycle is retrieval of previous cases that can be used to solve the target situation (new problem). Given a target hassle, retrieve cases from memory the ones are relevant to solving it. A case consists of a problem description, its solution, and commonly annotations about how the solutions become derived. When you consider that retrieval is the first step in CBR, it impacts the complete CBR system due to the others cycles are primarily based on it. The selection of corresponding useful cases is then left to the CBR system which retrieves cases used for fixing the problem by means of employing so called similarity measures. To retrieve applicable cases to the target problem,

appropriate similarity measurement must be used. Step one is the retrieval of one or several instances considered to be useful to help solving the current problem [16].

To understand this retrieval task, CBR systems employ special similarity measures that permit the computation of the similarity among two hassle descriptions. Because the interpretation of this similarity strongly relies upon on the unique domain, similarity measures are a part of the overall knowledge of the system. Different researchers describe the primary task during retrieval of cases. As an instance grouped case retrieval subtasks into three [16]:

- ***Identify features***: - Involves indexing the problem with the most descriptive feature in order to match it with indexed matched cases. In other words, it identifies its descriptive properties and takes out the properties which don't describe the problem strongly.

- ***Initially match***: - Finding previous cases that match with the problem at hand and it retrieves a set of plausible candidates. That means it involves searching and similarity assessment to produce similar cases.

- ***Select***:- Selecting the best-matched case from the set of similar cases. It is based on the similarity assessment result that best matched case or set of cases is selected as output of the retrieval process.

The other prominent author in CBR subdivides the retrieving process into [16]:

- ***Recall previous cases***: - The main goal of this step is to retrieve "good" cases that have the potential to make relevant predictions about the new case.

- ***Select the best subset***: - The objective of this step is to select the best cases from the result of the first step. Sometimes it is appropriate to choose one best case; sometimes a small set is needed.

In CBR there are different case retrieval algorithms but the two most frequently used are nearest neighbor and induction case retrieval algorithms. These algorithms can be used alone or in combination with each other [16].

2.4.4.2. Nearest Neighbor Retrieval Algorithm

Nearest-neighbor retrieval technique is to measure similarity between the source case and the case which we are searching. The nearest neighbor algorithm measures the similarity of stored cases with a new input case, based on matching a weighted sum of features. When a new case doesn't exactly match with old cases then this algorithm will return nearest match from CBR library. It is suitable when there are attributes that have numeric (continuous) value [16].But the retrieval time of this algorithm increases linearly as the case in the case base increases. The algorithm for nearest neighbor can be written as follows [27]:

- *For each feature in the input case*
- *Find the corresponding feature in the stored case*
- *Compare the two values to each other and compute the degree of similarity*
- *Multiply by a coefficient representing the importance of the feature to the match*
- *Add the results to derive an average match score*
- *This number represents the degree of match of the old case to the input.*
- *A case can be selected by choosing the item with the largest score.*

2.4.4.3. Case Adaptation (Reuse)

After deciding on one or numerous similar cases, the reuse step attempts to apply the contained solution information to solve the new hassle. Often a direct reuse of a retrieved solution is impossible due to variations among the current and the old problem situation. Then the retrieved solutions need to be modified in order to fit the new situation. How this adaptation is performed strongly depends at the unique application scenario [16].

In general, adaptation techniques require additional general knowledge about the application area. Because this leads in additional knowledge acquisition effort, many CBR systems used today do no perform case adaptation automatically, but go away this task to the user. Then, of course, the quality of the retrieval step influences the problem-solving abilities of the entire CBR system commonly. Even though automatic adaptation is provide, the qualities of the retrieval result will strongly impact the performance of the system because of its effect on the required adaptation effort. After adapting the retrieved case automatically or manually to in shape the current situation, a solved case is acquired containing a recommended solution for the current problem [16].

2.4.4.4. Case Revision

Depending on the employed adaptation procedure, the correctness of the recommended solution often can't be guaranteed immediately. Then it becomes essential to revise the solved case. How such a revision is performed, strongly depends at the unique application scenario. As an example, it is probably possible to apply the recommended solution within the actual-world to look whether it really works or not. However, regularly a direct application of an uncertain solution is not possible because of the corresponding risks (e.g. scientific analysis systems). Then the revision must be performed manually by way of a human domain expert or through opportunity techniques which include computer simulation. Commonly, the focus of the revise phase lays on the detection of errors or inconsistencies in the suggested solution and the initiation of further problem-fixing attempts [16].

2.4.4.5. Case Retain (Learning)

If the solved case has passed the revise step successfully, an examined/repaired case can be available representing a new experience that is probably used to resolve comparable problems in the future. The task of the CBR cycle's final step is to preserve this new case knowledge for future usage. Consequently, the new case may be added to the case base. In most cases, a general storage of all generated instances isn't always useful. In order to permit better control of the preserve process, diverse techniques for selecting cases to be retained had been developed.

These approaches regularly suggest a reorganization of the complete case base while adding a new case, as an instance, by means of eliminating different cases [16]. Generally, the capability to obtain new case knowledge during a CBR system's lifetime principally adds these systems to the class of learning systems. Conversely, many CBR systems developed thus far do no longer exploit this concept of the CBR cycle at all. This holds actual in particular for the commercially employed systems. Similarly, the original concept of the CBR cycle focuses on learning of case knowledge [16].

2.5. Process of Recommender System

A recommendation seeker may ask for a recommendation, or a recommender may produce recommendations with no prompting. Seekers may volunteer their own preferences, or recommenders may ask about them.

Based on a set of known preferences – his/her own, the seeker's, and those of other people, often people who received recommendations in the past – the recommender recommends items the seeker probably will like. In addition, the recommender may identify people with similar interests. The seeker may use the recommendation to select items from the universe or to communicate with like-minded others [23].

In this study, the developed IECBRS produce recommendation to the users (importers and exporters). The recommendation seeker needs recommendation from developed IE case based recommender system. The users (recommendation seeker) enter problem description or new query to the system. Then the system computes the similarity between the new query (cases) and existing cases through KNN algorithm and retrieve best top cases based on the users (importers and exporters) preferences or interests.

2.6. Related research works

There is no research papers which are done by Ethiopian researchers related to import and export recommender system. In order to have detail understanding, the researcher reviewed different research papers. Here are some of the relevant research works which are conducted by the researcher.

[26] Has done this research with the title of "application of case based recommender system to advice students in field of study selection at higher education in Ethiopia". The objective of the study was to develop a prototype case based recommender system that advices student in their appropriate field of study selection process. The system provides recommendation to the students based on previously solved cases and new query given by the student.

The author used 105 cases which are collected from successful students and 13 attributes which are collected from experts are used as case base.

These attributes and cases are used as knowledge base to construct case base recommender. The system calculates similarity between existing case and new queries that are provided by the students and provides solution or recommendation by taking best cases to the new query. In this study, the researcher used JCOLIBRI tool to develop the prototype of case based recommender system.

JCOLIBRI contains both user interface which enables students to enter their query and programming codes with the help of Java script language. Testing of the prototype for case base recommender system was done to evaluate the performance of the system. Based on prototype testing, the average performance of the system is 77.2% and 80.2% by the domain experts and students respectively.

[13] Has done this research with the title of "application of case based recommender system in investment sector and investment activity selection to new investors in the case of Ethiopia". The aim of the study was to develop case based recommender system for investment sector and investment activity selection that assists investment experts and investors to make timely decisions. The researcher was collected the required knowledge from twelve domain experts and four investors to develop case based recommender system for investment sector and investment activity selection. The acquired knowledge was modeled using hierarchical structure.

The acquired knowledge was represented using feature value case base representation and implemented using JCOLIBRI programming tool. Nearest neighbor retrieval algorithm is used to measure the similarity of new case (query) with cases in the case base. As a result, if there is a similarity between the new case and the existing case the system assigns the solution (recommended investment sector and investment activity) of previous case as a solution to new case.

To determine the applicability of the prototype system in the domain area, the system has been evaluated by the domain experts and investors through visual interaction based on the criteria of easiness to use, time efficiency, applicability in the domain area and providing correct recommendation. According to the evaluation through user acceptance 82% system performance is obtained from domain experts and 84% system performance is obtained from investors.

And also the performance of the prototype is measured using recall, precision and accuracy measures, where the system achieves 85% recall, 64% precision and 87% accuracy.

[18] Has done with the title of **"**application of case based recommender system in the tourism sector for the selection of tourist attraction areas in Ethiopia". The aim of this research is to design a prototype case based recommender system for tourist attraction area and visiting time selection that can assist experts and tourists to make timely decisions.

Eight domain experts and fourteen visitors were interviewed to elicit the required knowledge about the selection process of attraction area. The acquired knowledge was modeled using hierarchical tree structure and it was represented using feature value case representation. At the end, JCOLIBRI programming tool was used to implement the system.

As a retrieval algorithm, nearest neighbor retrieval algorithm is used to measure the similarity of new case (query) with cases in the case base. Accordingly, if there is a similarity between the new case and the existing case, the system assigns the solution (recommended attraction area and visiting time) of previous case as a solution to new case.

To decide the applicability of the prototype system in the domain area, the system has been evaluated by involving domain experts and visitors through visual interaction using the criteria of easiness to use, time efficiency, applicability in the domain area and providing correct recommendation. Based on prototype user acceptance testing, the average performance of the system is 80% and 82% by domain experts and visitors respectively. The performance of the system is also measured using the standard measure of relevance (IR system) recall, precision and accuracy measures, where the system registers 83% recall, 61% precision and 85.4% accuracy.

[17] Has done with the title of **"**application of case based recommender system for real estate appraisal". The objective of this thesis is to build case based automatic recommender system in case of real estate appraisal. The methodologies employed in this study are data collection tools like interview, questionnaire and assessment of existing documents. This study used knowledge based recommender system to assess the users input and compare with the stored cases. For this, 152 cases were collected from 5 real estates and 9 attributes were selected for query of users as well as for their solution.

The best solutions are displayed for a user after the similarity calculation of the query and the stored cases. Then the users are able to decide of which similar case satisfies their need. To develop the prototype, JCOLIBRI development tool has been used.

The system is tested in terms of performance and its user acceptance. From these perspectives, the average performance of the system is found 4.39 and 4.15 from domain experts and customers respectively. Developing a recommender system in this study therefore helps people to have a right and clear decision about the house they want to buy.

[16] Has done with the title of "application of case based reasoning in legal case management: An experiment with Ethiopian labor law case". The objective of this study is to design a prototype application of case based reasoning in legal case management in the domain of Ethiopian labor law context at the federal Supreme Court.

Fifty legal cases were selected in this study through document review and discussion from FSCE. In this study the researcher used JCOLIBRI tool for implementing CBR application.

The performance of the prototype system is evaluated using statistical analysis (precision and recall) and user acceptance (satisfaction). Thus, the system has a recall of 71% and precision of 86% performance. Moreover, the system was accepted by domain experts 86% of the time.

Similarly, the proposed recommender system provides significant information to importers and exporters. The main objective of the study is to develop the case based recommender system to assist importers and exporters in product selection process. The developed case based recommender system provides information about products to import and export in how much capital.

CHAPTER THREE

3. Knowledge Acquisition and Representation

The idea of knowledge based system is derived from the sector of artificial intelligence (AI). AI intends understanding of human intelligence and building of computer programs which are able to simulating or acting one or more of intelligent behaviors. Computer programs that attempt to solve problems in a human professional-like style with the aid of using knowledge about the application area and problem fixing techniques are known as knowledge based system. Human experts use the knowledge they have about the domain and techniques that lead the way to use the knowledge to fix problems. Knowledge base includes all vital knowledge about the domain that is required to deal problems [28]. Knowledge based system consists of a repository of expert knowledge with utilities designed to facilitate the knowledge retrieval in response to specific queries, along with learning and justification, or to transfer expertise from one domain of knowledge to another, in particular, KBS focus on using knowledge based techniques to support human decision making, learning, and action. Such systems are capable of cooperating with human users and are being used for problem solving, training , and assisting users and experts of the domain for which the system are developed, in some cases KBSs are even better than human are, as they are enriched with the virtues of efficiency and effectiveness [29].

According to [30] Knowledge based system (KBS, also called expert system) is a broad term referring to the special kind of a computer program that works with information stored in the knowledge base. Knowledge base (KB) contains the explicit knowledge of human experts in a specific domain encoded in a machine-readable format. An intelligent computer program to infer implicit information from the stored knowledge with reasoning mechanism is called the inference engine. The knowledge can be obtained from professionals, documents, books and/or different sources. It is formalized and organized with a method called knowledge representation. There are several methods to represent knowledge within the knowledge base. Cases and rules are the two strategies to represent knowledge [28].

3.1. Knowledge Acquisition

The knowledge engineer should focus on the two most crucial steps during knowledge based system development. The first one is acquiring the needed knowledge from domain experts, relevant documents and other sources. The second one is after acquiring the needed knowledge from different sources is representing the knowledge with appropriate format.

Knowledge acquisition is the process of eliciting, structuring, and representing relevant knowledge usually from domain experts and other sources like books, databases, manuals, journal articles, computer files, etc. In knowledge based system development knowledge acquisition is the first step and difficult task. In this study, tacit and explicit sources of knowledge used to develop the knowledge based system [16].

During knowledge acquisition process the researcher used various techniques to acquire knowledge. In order to get tacit and explicit knowledge for the development of KBS various techniques like interview, document analysis and observation were applied. **Interview** was common and most widely used in this study. This technique was a direct (face-to-face) communication between the researcher and domain experts and other concerned bodies. The researcher has been conducted with successful exporters and importers through interview. Specifically, interview with domain experts was crucial in this study to collect the whole attributes. After collecting attributes the researcher selected 7 most important attributes with help of domain experts. Generally, during knowledge acquisition process through interview all relevant cases were collected. Another technique during knowledge acquisition process was **document analysis**. The researcher analyzed relevant published documents in MoT, brochures of MoT, manuals, guidelines, etc. related to import export cases. The researcher acquired knowledge through document analysis. **Observation** was one method to acquire knowledge. The researcher observed the working environment and focused on some activities like how to start the license procedures related to import export cases, how the domain experts provide advice to new importers and exporters etc.

As described above, knowledge acquisition is difficult task. During knowledge acquisition process there are various factors that are made. Some of the factors are listed below.

- Experts may not be willing to response
- Experts may not have sufficient time
- The researcher may be lose the relevant documents
- The case collected may not be completed

In the knowledge acquisition process of this research comprise some basic activities such as gathering the required knowledge, analyzing the knowledge, identifying important concepts and modeling the knowledge using hierarchical structure in import export process. According to [31] there are certain crucial steps that the knowledge engineer need to carried out during knowledge acquisition process. These are:

- Eliciting data and information from the domain experts
- Interpreting the acquired information to understand human expert reasoning processes
- Building model to represent the expert's knowledge
- Repeating step I-III as the knowledge base system involves into a functional system

3.2. Architecture of Knowledge Base System

Knowledge base system consists of two basic parts such as knowledge base and a search program called inference engine. Knowledge base can be used as a repository of knowledge in different forms whereas inference engine is a software program which infers the knowledge available in the knowledge base. Figure 3.1 shows the basic components of knowledge base system architecture [28].

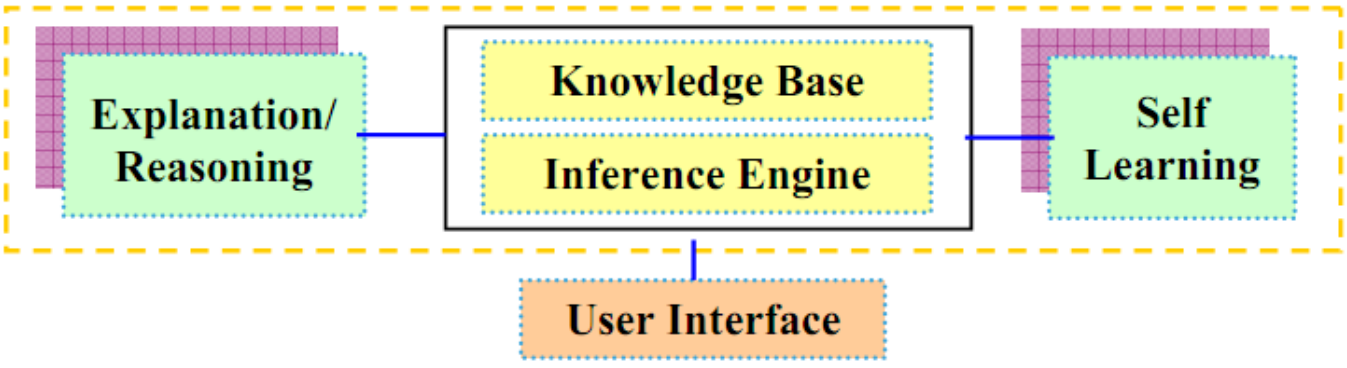

Figure 3.1 Architecture of a Knowledge-Based System (sources [28])

Inference engine: Also known as rule interpreter. It is a software program and problem solving component, which infers the knowledge available in the knowledge base. It allows new inferences to be made from the case specific data and the knowledge in the knowledge base.

Explanation/reasoning: Analyzes the structure of the reasoning performed by the system and explains it to the user.

Domain expert: Individuals who currently are experts in solving problem of the domain area.

User: Individuals who consults with the system to get advice with the system which would have been provided by the expert.

Knowledge base: Contains necessary knowledge about the domain that is required to handle many techniques to represent knowledge such as rules, semantic network, and frames.

3.3. Knowledge Representation Methods

When we come to write AI program we find that there are a number of various kinds of things that we want our program to know. It will need to know a large number of facts, and to know about the processes which cause those facts to change. It will need to know about the objects which those facts concern, and the relationships in which those objects stand to one another. If it is intended to solve problems of some sort, it will need to know about the problem and what will count as a solution to the problem, together with some strategies for solving such problems. The study of knowledge representation concerns the ways in which we might go about encoding them in a computer program [13].

After the needed knowledge is acquired from different sources, the next step is representing the knowledge in a well-organized manner. This activity involves the preparation of knowledge map and encoding the knowledge in the knowledge base [32].

Knowledge representation is a way of representing a validated knowledge collected from experts or induced from a set of data in a manner understandable by humans and executable on computers. It is a systematic means of encoding knowledge of human experts in an appropriate medium [49]. To develop knowledge based system there are various knowledge representation scheme. The acquired knowledge should be documented in a knowledge representation scheme. The most common representation schemes are semantic networks, rules, frames, logics and case base [28].

Semantic network: In this scheme, knowledge is represented in terms of objects and relationships between objects. The objects are denoted as the nodes of graphs. The relationships between two objects are denoted as a link between the corresponding two nodes. The most common form of semantic networks uses between nodes to represent is-a and has relationships between objects [33].

Rules: A rule is a conditional statement that links given conditions to actions or outcomes. A rule-based system consists of if-then rules, a group of facts, and an interpreter controlling the application of the rules, given the facts.

These if-then rule statements are used to formulate the conditional statements that contain the complete knowledge base. A single if-then rule assumes the form if *x* is *A* then *y* is *B*' and the if-part of the rule '*x* is *A*' is called the antecedent or premise, while the then-part of the rule '*y* is *B*' is called the consequent or conclusion.

There are two broad kinds of inference engines used in rule-based systems:

Forward chaining starts with the facts and works forward to the conclusions. In a *forward chaining* system, the initial facts are processed first, and keep using the rules to draw new conclusions given those facts. In a *backward chaining* system, the hypothesis (or solution/goal) we are trying to reach is processed first, and keep looking for rules that would allow concluding that hypothesis. As the processing progresses, new sub goals are also set for validation. Forward chaining systems are primarily data-driven. Consider an example with the following set of *if-then* rules

Rule 1: *If A and C then Y*
Rule 2: *If A and X then Z*
Rule 3: *If B then X*
Rule 4: *If Z then D*
If the task is to prove that *D* is true, given *A* and *B* are true. According to *forward chaining*, start with Rule 1 and go on downward till a rule that fires is found. Rule 3 is the only one that fires in the first iteration. After the first iteration, it can be concluded that *A,B,* and *X* are true.

The second iteration uses this valuable information. After the second iteration, Rule 2 fires adding *Z* is true, which in turn helps Rule 4 to fire, proving that *D* is true.

Backward chaining is the process of starting with conclusions and working backward to the supporting facts. In the backward chaining method, processing starts with the desired goal, and then attempts to find evidence for proving the goal. Returning to the same example, the task to prove that *D* is true would be initiated by first finding a rule that proves *D*. Rule 4 does so, which also provides a sub goal to prove that *Z* is true. Now Rule 2 comes into play, and as it is already known that *A* is true, the new sub goal is to show that *X* is true. Rule 3 provides the next sub goal of proving that *B* is true. But that *B* is true is one of the given assertions. Therefore, it could be concluded that *X* is true, which implies that *Z* is true, which in turn also implies that *D* is true. Backward chaining systems are primarily goal-driven [34].

Frames: In this technique, knowledge is decomposed in to highly modular pieces called frames which are generalized record structures. Knowledge consists of concepts, situations, attributes of concepts, relationships between concepts, and procedures to handle relationships as well as attribute values [33].

Logics: Logic is a formal and declarative language in which knowledge can be represented such that conclusions can easily be drawn. It contains syntaxes and semantics. The logical representation of first-order predicate calculus was an obvious candidate for knowledge representation, since it was developed to provide a clear and unambiguous way of representing natural-language statements [13].

Case base: case based reasoning means using old experiences to understand and solve new problems. In a case based reasoning, a reasoner remembers the previous situation similar to the current one and uses that to solve new problems. case based reasoning can mean adapting old solution to meet new demands; using old cases to explain new situations; using old cases to critique new solutions; or reasoning from precedent to interpret new situations or create an equitable solution to a new problem [35].

3.4. Knowledge Modeling

Knowledge modeling is the second step next to knowledge acquisition. After the needed knowledge is gained from different sources, the knowledge is represented in a knowledge modeling. Therefore knowledge modeling is a structured representation of knowledge. According to [36] the knowledge modeling involves organizing and structuring of the knowledge acquired during knowledge acquisition. This activity provides an implementation independent specification of the knowledge to be represented in the knowledge base. Knowledge Modeling is the concept of representing information and the logic for purpose of capturing, sharing and processing knowledge to simulate intelligence. Here, the basic concepts that expose the main activities and decisions that are made to solve cases in the domain are modeled.

Knowledge acquired via various knowledge acquisition methods can be modeled such as decision tree and hierarchical tree structure. Decision trees are produced by algorithms that identify different methods of splitting a data set into branch like segments. These segments form an inverted decision tree that originates with a root node at the top of the tree. Another technique to model knowledge is hierarchical tree structure. The hierarchical tree diagram provides the analyst with an effective visual compression of the clustering results. The hierarchical tree diagram is one of the most commonly used methods of determining the number of clusters. It is also useful in identifying outliers, as these will appear as one member clusters that are joined later in the clustering process. The numbers at the top and bottom of the hierarchical tree diagram represent equally spaced values of the criterion function. It gives a pictorial representation of the criterion function information [20]. Therefore, as compared two models, the researcher used hierarchical tree model in this study to represent the knowledge

As indicated ESIC incorporates all business activities carried on in the country and hence once incorporated it is mandatory that any business should go through the procedures of the business licensing system. Based on the level of Ethiopia’s particular economic development there are total of 10 sectors. Each sector is sub-divided in to major divisions, divisions, major groups, groups and sub-groups.

3.5. Hierarchical Structure of Cases

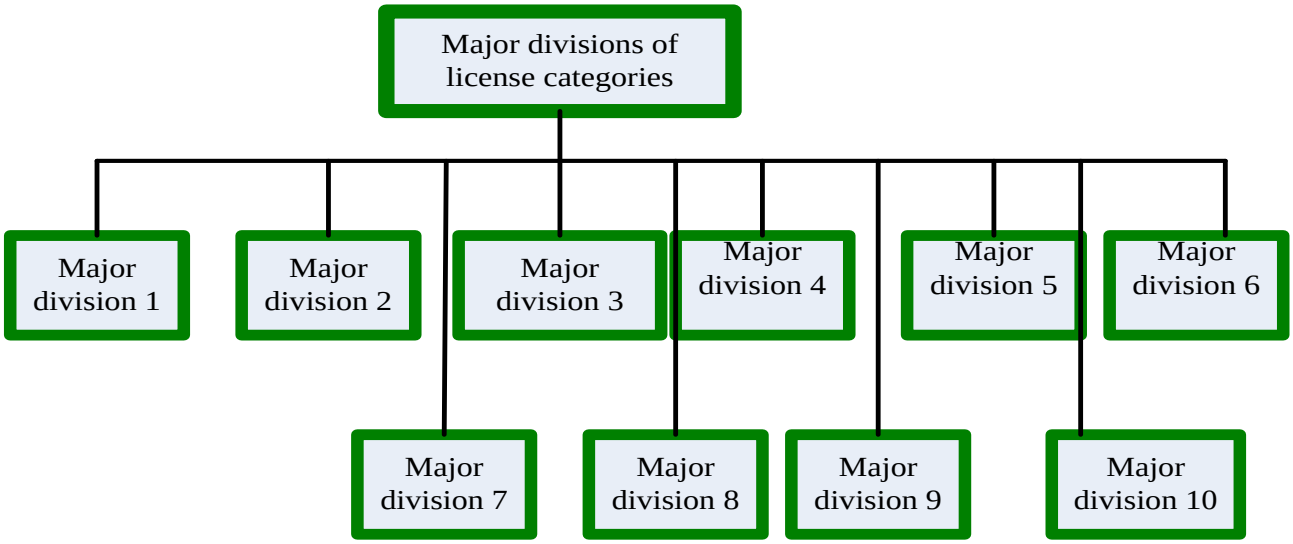

Figure 3.2 Major structure of license categories

The following listed are major divisions of Ethiopian license categories and this major divisions are represented by single digits.

1. Agriculture, hunting, forestry and fishing
2. Mining and quarrying
3. Manufacturing
4. Electricity, gas and water supply
5. Construction
6. Wholesale and retail trade; repair of motor vehicles, motor cycles and personal and household goods; hotels and restaurants; import & export
7. Transport, storage and communication
8. Financial intermediation, insurance, real estate and business services
9. Community, social and personal services
10. Private household exterritorial non-governmental organizations, representatives of foreign governments and other activities not adequately define

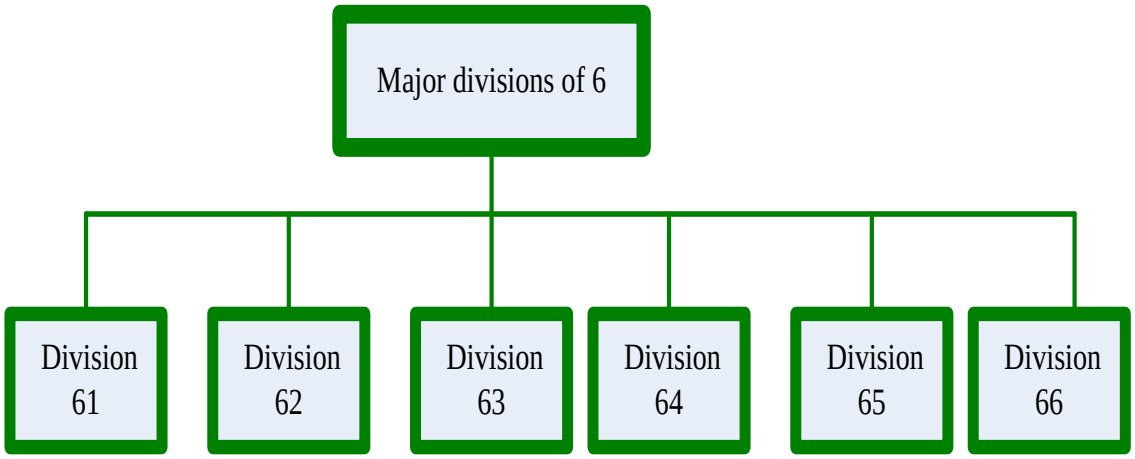

Figure 3.3 Hierarchical structure of sub division license categories

As described in the first diagram the major divisions are represented by single digit but divisions are represented by two digits. Therefore divisions are described as follows.

- Wholesale and commission division represented by **61**
- Retail trade, of motor vehicles and motor cycles; repair of personal and household goods division is represented by **62**.
- Maintenance and repair service is represented by **63**
- Hotel and restaurant is represented by **64**
- Import trade and export trade is represented by **65** and **66** digits respectively.

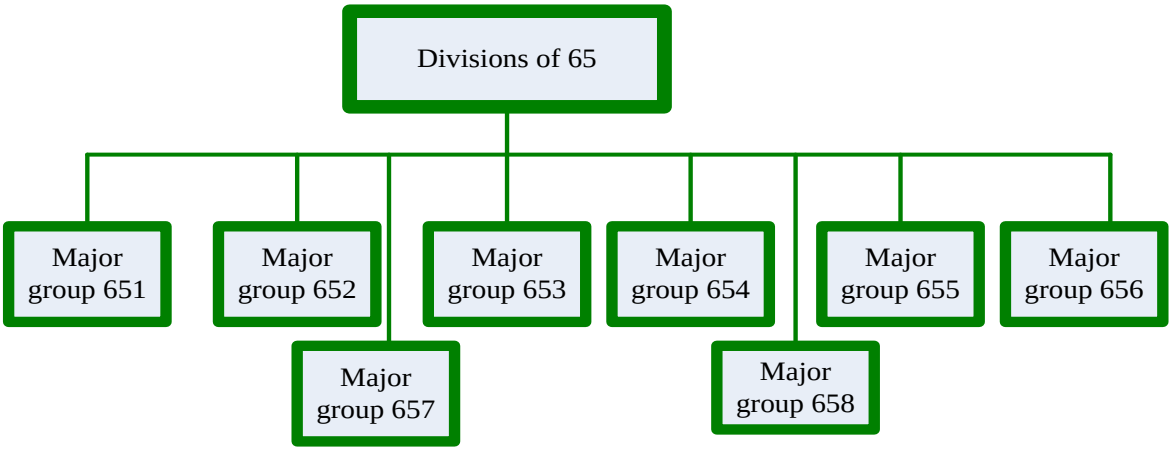

Figure 3.4 Hierarchical structure of import major groups

The above figure 3.4 depicted that division 65 is represented by import trade and under this division there are various major groups. So, each major group is represented by three digits. The following are list of major groups and their representation in digits.

- 651 import trade on a fee or contract basis
- 652 import trade in agricultural raw materials, livestock, food, beverages tobacco and tobacco products
- 653 import trade in household and office goods
- 654 import trade in solid, liquid and gaseous fuels and related products, industrial products, chemicals and chemical products, construction materials, explosives pyrotechnic product intermediate products, waste and scrap
- 655 import trade in machinery, equipment and supplies
- 656 import of vehicles and spare parts
- 657 is represented import trade in processed agricultural products
- 658 this digit represented Import trade in other machinery and equipments

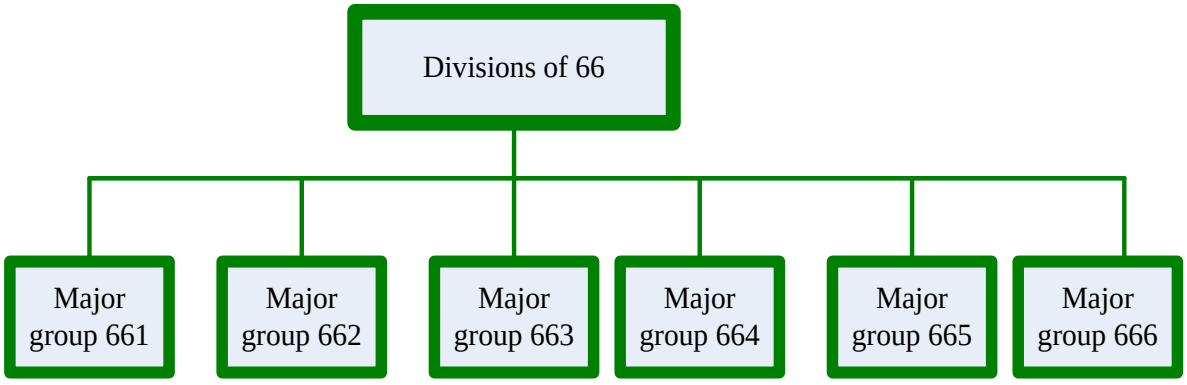

Figure 3.5 Hierarchical structure of export major groups

The above figure 3.5 depicted that division 66 is represented by export trade and under this division there are various major groups. So, each major group is represented by three digits. The following are list of major groups and their representation in digits.

- 661 this digit represented export trade in agricultural raw materials, livestock, and food, beverages and tobacco and tobacco products.
- 662 is represented export trade in household goods.
- 663 is represented export trade in solid, liquid and gaseous fuels and related products, industrial products, chemicals and chemical products, construction materials, explosive pyrotechnic product intermediate products, waste and scrap.
- 664 represented machinery, equipment and supplies.
- 665 this digit is represented export trade in other factory products.
- 666 are represented vehicles and spare parts export.

Table 3.1 List of groups under each major group

Major groups	***Representation in digits***	***Groups***
661	6611	Export trade in agricultural raw materials
	6612	Export trade in livestock and livestock products
	6613	Export trade in food
	6614	Export trade in beverages
	6615	Export trade in processed agricultural product
	6616	export trade in other agricultural products
	6617	Export trade in Plant Seeds
	6618	Export trade in flour products
652	6521	Import trade in agricultural raw materials
	6522	Import trade in livestock and livestock products
	6523	Import trade in food
	6524	Import trade in beverages
663	6631	export trade in solid, liquid and gaseous fuels and related products
	6632	export trade in metal ,non-metals, metal ores and scraps
	6633	export trade in construction materials, hardware, plumbing and heating equipment and supplies
	6634	export of chemicals and chemical products
	6635	export of explosives pyrotechnic products
	6636	export of medicines and other related chemicals
664	6641	export trade in industrial, agricultural, construction and related machinery and equipment
	6642	export trade in telecom and computers and accessories
	6643	export trade in electrical equipment
	6644	export trade in machinery and equipment n.e.c
665	6651	export trade in other factory products
	6652	other machinery and equipment
655	6551	Import trade in Industrial, Agricultural, Construction and other Machinery and Equipment

	6552	Import trade in Telecom, computers equipment and accessories
	6553	Import trade in electrical equipment
	6559	Import trade in Machinery and Equipment n.e.c
656	6561	Import of motor vehicles
	6562	Import of Bicycles

As described above in figure 3.4 each major group is represented by three digits and under each major group there are a lot of groups which were represented through four digits as depicted in table 3.1.

According to the first revision of Ethiopian Standard Classification no two business activities can be issued a license under a single license category. There shall be a minimum of one and a maximum of nine categories under a given group. A person/business man can have as many as up to nine categories under a single license. But categories under different groups cannot be entertained under a single business license.

Table 3.2 Sample list of subgroups (product types)

Groups in digits	***Subgroups representation in digits***	***Subgroups***
6611	66111	Export of cereals
	66112	Export of oilseeds
6612	66121	Export trade in livestock
	66122	Export of wool, raw hides, and skins
6621	66211	Export trade in textile Fibers and Yarn
	66212	Export trade in textiles
6622	66221	Export of household and office furniture, requzite, boards, appliances
	66222	Export of households (including mattresses, cushions, blanket etc)
6631	66311	Export Coal, coke and briquettes
	66312	Export Petroleum, petroleum products & related materials
6632	66321	Export trade in Iron and steel
	66322	Export trade in Non -ferrous Metals
6641	66411	Export trade in industrial machinery and equipment

	66412	Export trade in agricultural machinery and equipment
6642	66423	Export trade in computer and computer peripheral equipment.
	66424	Export trade in Telecom and Computers and Accessories n.e.c
6541	65411	Import trade in Coal, coke and briquettes
	65414	Import of electricity
6542	65421	Import of in Iron and steel
	65423	Import trade in scraps
6544	65442	Import trade in chemical fertilizers
	65448	Import trade in pesticides and agrochemicals
6553	65533	Import of lighting and lighting accessories
	65535	Import trade in wiring and cables accessories

Finally, under each group there are large amount of subgroups (product types) and each subgroup is represented by five digits. Therefore exporters could export from these subgroups based on their interest, and capital. The above table 3.2 depicted that sample subgroups under each group.

CHAPTER FOUR

4. Methodology

In the previous chapter, literature review and related works was performed to get adequate knowledge about case based recommender system. Therefore, in this study the researcher tried to discuss the methodology in detail. The researcher used various data collection techniques to gather data with different domain experts, importers, exporters and other concerned bodies. The next activity after acquired the relevant data is selecting the best tools to design the proposed architecture and to implement its prototype of case based recommender system for import export product selection.

According to this step, design of case based recommender system for import/export product selection and its prototype was developed to solve the problem.

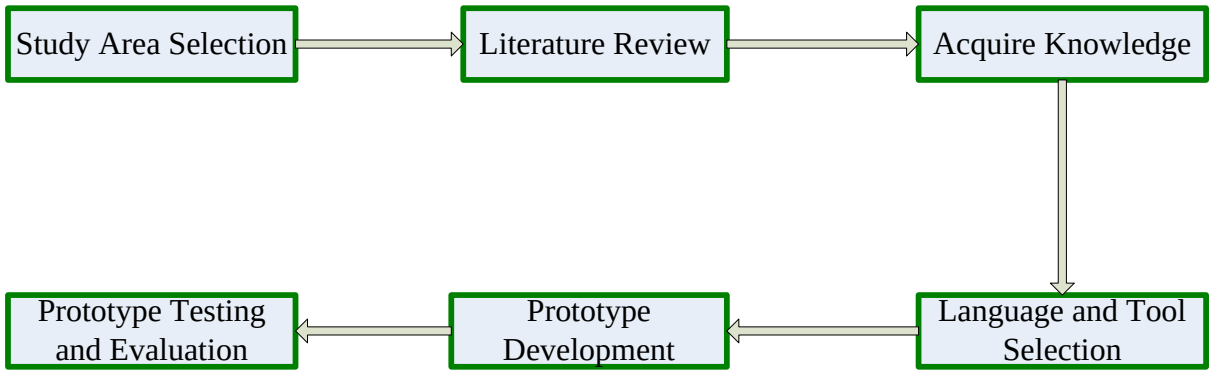

Figure 4.1 Research methodology process

The above figure 4.1 depicts that the research methodology process. In this study, the research process goes through at these six steps. Steps are described as follows:

Study area selection (identifying problem) the researcher begins a study by identifying a research problem to address. The research problem is clearly defined in statement of the problem and impact of studying the problem also defines.

Literature review is a written summary of journal articles, books, and other documents that describes the past and current state of information on the topic of the selected study. In this study literature review is the second step.

So in order to have broad knowledge of the domain, the researcher reviewed various journal articles, books, and other relevant documents that are particularly to the selected area.

Knowledge acquire is the process of collecting data from various sources through using various data collection techniques. During knowledge acquire tacit and explicit knowledge is acquired from domain experts, importers and exporters and other relevant sources.

Language and tool selection in this step best programming language and various programming tools selected in order to write the program and develop the prototype. The selected tools are described in detail in section 4.7.2

Prototype development after best languages and programming tools selected IECBRS prototype developed.

Prototype testing and evaluation is the process of checking the system retrieval performance and user acceptance of the prototype. To check the users need satisfaction the developed prototype is evaluated by domain experts and users (importers and exporters). In addition to this the developed system is evaluated its retrieval performance through using recall and precision.

4.1. Research Design

The research design is the conceptual structure within which the research is conducted; it constitutes the blueprint for the collection, measurement and analysis of data. As such the design includes an outline of what the researcher will do from writing the hypothesis and its operational implications to the final analysis of data. So the research design can be defined as a plan, structure and strategy of a research to find out alternative tools to solve the problems and to minimize the variances [37].

There are different approaches which are commonly used for all types of research. The common approaches are quantitative, qualitative; design oriented and mixed method approaches [38].

Quantitative research type is concerned on phenomena that are expressed in terms of quantity or number which is numerical values, standardized measurable data, have large sample size and using statistical analysis. Quantitative research approach is used to hypothesize validation of hypothesis of the research [37].

Qualitative research is concerned on qualitative phenomena i-e quality or kind. It is interpretive and descriptive, no-numerical and has smaller sample size [37]. A mixed method research approach is a type of research which combines both qualitative and quantitative approach elements to collect data, analyze data for the purpose of breadth and depth of understanding [39]. Mixed method is used while it is not sufficient to address the research problem or answer research questions and to provide alternative perspective in a study [40]. Design oriented research creates artifacts by artificial objects and its objective is innovating purposeful artifacts and produce new knowledge during this process. Design science focused on some steps that are problem awareness, development, evaluation and conclusion to get an output [41]. On the other hand, constructive research method commonly used in computer science and which develops solutions to the existing problem (improves solution or adding some value). The new contribution has being developed, such as algorithm, model, software or framework [42].

Selecting an appropriate research method for the development of knowledge in a given study is a fundamental task. So in this study the researcher both qualitative and constructive research methods were used. Qualitative research method was used for data collection. Qualitative data collection is focused on sample of specific group. Qualitative research method was useful in this study to identify participant using purposive sampling technique. Additionally the researcher was used semi-structured interview to collect data and qualitative research method is appropriate for this type of interview method. Constructive research method is the second method that the researcher was used in this study. This type of method is crucial for understanding of research process and knowledge production. So this method was used to create knowledge in the selected domain. Based on the above described reason the researcher has been selected qualitative and constructive research method.

4.2. Process Model

Process model is the description of sequence of activities that carried out in the software project and other sub-phases of activities. There are various types of process models in software development process but for this study the researcher used prototyping process model to achieve this study objective.

Prototype is a process model which provides a solution to the problem and it is a practice of building an early version of a system that describes some part of working version of the system. There are two types of prototyping for user interface design. **In throwaway prototyping** different parts of the system are built and then thrown away. Throwaway prototype might be written very quickly to demonstrate the essential functions that a system will carry out. In **evolutionary prototyping** the prototype is part of the final system. Evolutionary prototype shows the main features of the system and it is part of final deliverable system [43].

4.3. Data Sources

For the development of prototype relevant data is crucial in order to increase the performance and validity of the system. Relevant literature such as books, websites, documents, journal articles and other resources from the internet were reviewed. The main sources of data for this study are:

- Domain experts from ministry of trade. In this organization domain experts were selected and the required data is acquired from experts.
- Private exporters and importers also another sources of data.
- Ministry of trade website, documents and manuals are also sources of data for this study. The federal democratic republic of Ethiopia ministry of trade Ethiopian standard industrial classification revision one 2007 document was the main source in this study.

4.4. Data Collection Techniques

After the research problem has been defined and research design selected the next task is collecting data through various data collection techniques. While conducting the research after deciding the method for data collection to be used for the study and the researcher should consider two types of data both primary and secondary. To acquire tacit and explicit knowledge the researcher analyzed various sources of knowledge.

For the purpose of this study both primary and secondary sources of data are the means of sources of knowledge. For this qualitative data collection method, non-probability sampling technique which called purposive sampling technique was used for interviewee groups.

Because a few group of domain experts and importers and exporters selected for the interview since they are the targeted group. The interviewed professionals' were domain experts from ministry of trade, private importers, and exporters. The primary sources of data are domain experts from ministry of trade, private exporters and importers, and other concerned bodies were interviewed to collect the relevant cases regarding to import export case. Secondary sources of data collection were made carefully. Because secondary sources of data are not original as primary data. So, the researcher checked the reliability, suitability and adequacy of data for this study. Documents, guidelines, manuals and organizations' website has been analyzed to gather the relevant data.

There are various data collection techniques which were used to collect data. Interview, observations and document analysis are the most common data collection methods for this study. The researcher prepared interview questions for the targeted group of people (**see appendix A**). **Interview** was common and most widely used in this study. This technique was a direct (face-to-face) communication between the researcher and domain experts and other concerned bodies. To identify attributes the researcher has been conducted with 5 domain experts from ministry of trade. During data collection process through interview all relevant cases were collected. Specifically, interview with domain experts was crucial in this study to collect the whole attributes. After collecting attributes the researcher selected 7 most important attributes with the help of domain experts. The researcher has been conducted with various 15 successful importers and exporters through interview. For this study the interview was performed in two city of the country Addis Ababa and Adama. 13 importers and exporters were interviewed at Addis Ababa city and 2 importers and exporters at Adama city. Another technique during data collection process was **document analysis**. As described above documents are secondary sources of data and they are not prepared by the researcher instead they are prepared by others. Therefore during document analysis relevant documents with import export were analyzed.

The documents which were published and unpublished such as books, journal articles, brochures of MoT, manuals, guidelines, etc. related to export import cases and ministry of trade website's. The researcher acquired knowledge through document analysis. **Observation** was one method to gather data.

The researcher observed the working environment and focused on some activities like how to start the license procedures, how the domain experts provide advice to new exporters and importers etc.

4.5. Issues of Reliability and Validity

Relevant data and methodology of the research used have a great influence for reliability and validity of this study. The reliability and validity of the research depends on the relevant data collected, the tools used and capability of the researcher knowledge. However, to achieve the reliability and validity of case based recommender system previously described factors has been taken in to consideration.

4.6. Sampling Techniques

Sampling involves the selection of individuals, units, and/or settings from a defined study area. There are different sampling techniques in qualitative research to sample the research participants. This includes purposive sampling, snowball sampling, quota sampling, typical case sampling, convenience sampling and others [38]. Therefore, in this study, non-probability technique which is called purposive sampling technique was used to gather qualitative data. In this research, the researcher was selected deliberately domain experts, importers and exporters based on some parameters as described below. Only few groups of people have been selected for the interview in this study. Groups of people were selected from ministry of trade, private exporters and importers. Domain experts were selected from ministry of trade based on their relevant working experience and their educational status. The selected group is representative of the entire group because they are information enrich. Private importers and exporters were selected based on their interest and successful importers and exporters.

4.7. Design and Development of the Prototype

4.7.1. Architecture of IECBR System

Architecture of the CBR system for import and export has various steps as shown from figure 4.2. A knowledge engineer is collected cases from various sources. This knowledge is processed and represented in appropriate form and modeled using hierarchical structure model. Successful importer and exporter cases were represented in the case base.

A new importer and exporter who need advice or recommendations entered new query in to the system. The existing case in the case base and the new query is loaded in to the working memory. Then the k-nearest neighbor algorithm computes similarity of the new cases with existing cases (solved cases) in the case base through using similarity computation function. If relevant cases are found in the case base the system ranks the relevant retrieved cases based on their local similarity and average similarity computation then the prototype of the system proposes solution.

After retrieve the next step is reuse or adaptation. The reuse step adapts the retrieved cases to the requirement of the query. After adapting the cases, the system proposes the recommended solution of the problem. The proposed solution is derived directly from the retrieved cases that is exactly matches or partially matches to the problem of new cases. Partially match of retrieved cases means all attribute values of existing cases are not similar with the new case attribute values but some attribute values are the same. Using the proposed solution directly may have risk because some attribute values may need editing (changing) based on different situations. As a result the user of the system should have made an adaptation on the proposed solution having differences between the proposed case and the new case.

The next task next to reuse is revising. This step is domain expert dependent. In the revise step the proposed solution is tested or evaluated by domain experts. If the recommended solution is not accepted by domain experts, other alternatives might recommend. Cases contradictions are revised where previous importer exporter case attribute values are not similar with the new case (query) attribute values. There is no similarity between the existing case and new case means there is no previously stored importer exporter cases in the case base similarity with the new case attribute values. Finally, the new case which means the revised cases is retained in the case base for future use. In this step the system learned new experience.

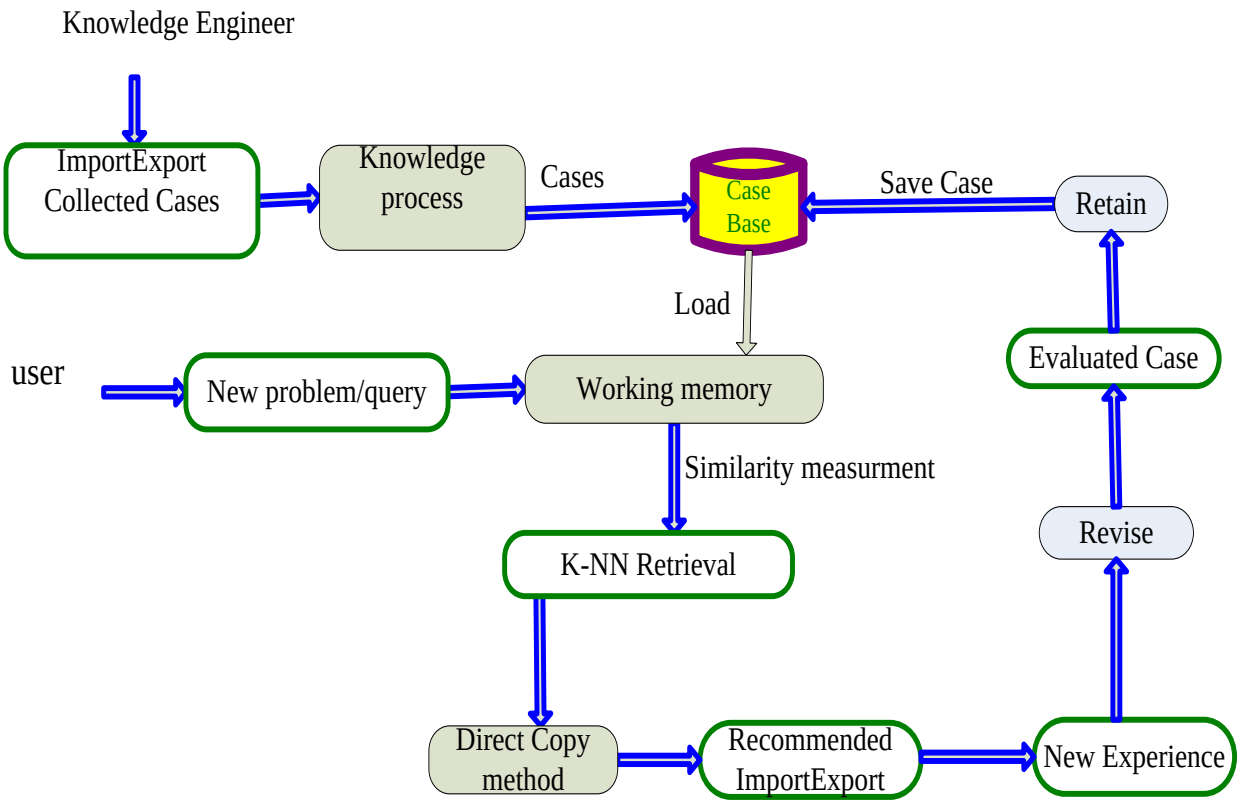

Figure 4.2 Architecture of IECBR system

4.7.2. Programming Technique and Tools

Currently, there are various crucial CBR implementation tools for teaching and research academic purposes. SWI-prolog, myCBR and JCOLIBRI tools are the most popular tools. Each has its own strength and weakness. But for this study the researcher selected JCOLIBRI2 tool due to its feature and ability.

According to [48] JCOLIBRI2 tool has unique features than other types of tools. The unique features of these tools are listed below as follows.

- JCOLIBRI supports the full CBR cycles (Retrieval, Reuse, Revise and Retain).
- JCOLIBRI is extensible, reusable, different types of users and different purposes (development, research and/or teaching), compatible with commercial applications and, supporting different types of CBR systems, since it is just a .jar file suitable for web applications.
- It is suitable for developing large scale applications.

- JCOLIBRI works well in external database.
- In JCOLIBRI Knowledge representation logic is based on local and real past cases rather than generalized rules/guidelines, so it is not complex and time consuming.
- JCOLIBRI is more user friendly

Regarding to the above described features JColibri framework is selected for this study. JColibri framework is compatible with most different database engine. But the researcher selected MySQL database engine. Because MySQL is an open-source and it handles powerful database packages. In addition it works on many different operating systems and with many programming languages. To develop graphical user interface (GUI) JavaFx was used. Because JavaFx is an open source and it is rich in different features. JavaFx supports different features in a single library such as media, UI controls, web, 2D and 3D. In addition application written using JavaFx can run consistently across multiple platforms and can run on various devices.

4.7.3. Case Representation

A case in case-based reasoning is a contextualized piece of experience, an experience that teaches a lesson fundamental to achieving the goals of the reasoner which can be represented in various forms. Case representation in case-based reasoning (CBR) makes use of familiar knowledge representation formalisms from AI to represent the experience contained in the cases for reasoning purposes. A large variety of representation formalisms have been proposed. However, three major types of case representation have arisen: feature vector (or propositional) cases, structured (or relational) cases, and textual (or semi-structured) cases [44].

Feature-vector approaches represent a case as a vector of attribute-value pairs, similar to the propositional representations used in Machine Learning (ML), that support k-nearest neighbor matching and instance-based learning [44]. Case representation has been expressed in the way which easily represented in JCOLIBRI. Case structure designing supports to describe features accessible in the cases and used to compute the similarity between the existing cases and new cases. The collections of cases were structured to make efficient in retrieval process. This is done through case indexing process. Indexing refers to assigning indexes to cases for retrieval and comparisons of query to the case in the case-base [45].

Generally, the purpose of this application is retrieve similar cases from the case base that can show future reasoning, problem solving, transforming retrieved solution in to a solution appropriate to the current problems that means retrieve similar cases to the new cases from the case base and offering recommendations in import export process.

4.7.4. Selection of Case Attributes

Cases were collected via various data collection techniques from various primary and secondary sources. Domain experts were the main source for this study to collect relevant cases. After collected the cases from different sources the next procedure was identifying the most significant attributes through the help of domain experts. The most significant attributes were identified and selected. The selected attributes are listed based on their significance as follows as given weights from table 4.1 Subgroups, Groups, Location, Legal-status and nationality. Of course, some attributes has given the same weights and have equal significance.

Some of the attributes were selected by the researcher as attribute description such as nationality, legal-status, location, groups and subgroups and weights given to each attribute based on their significance. Some of selected as a solution attributes are description and capital. The following are list of attributes:

Nationality: is the country you come from. In this attribute nationality is any businessperson who import or export products to/from Ethiopia any country.

Legal status: in this attribute there are different legal status types that form to start the business. It is a type of ownership to start the business. Values of this attribute are individual merchant, PLC, shared company, cooperative union, commercial representative and governmental organization.

Location: is a place where the businessperson wants to start the business. The values of this attribute are Addis Ababa, Oromia, Amhara, Tigray, Benishangulgumuz, Hareri, Dire Dawa, Gambella, SSNPR, Afar, and Somalia.

Capital: is the total amount of money which is needed to start the business.

Group: is a collection of products classed together in one unit. So this attribute type contains one up to nine different subgroups (products) which have some similar characteristics.

Description: this attribute indicates a type of business which is the business person wants to start. The values of this attribute are importer, exporter or both.

Subgroup: is a single type of product which is an importer and exporter imports and exports.

4.7.5. Description of Selected Attributes and Their Weight

In this study 5 attribute descriptions are used for users to input in to the system for the purpose of requesting the system and 2 attributes are selected to present a solution to users depending on the attribute description input. The following table contains both attribute description and attribute solution with their data type, weight and similarity function.

Table 4.1 Description and solution attributes with data type and weight

Attributes Description			
Attributes Name	***Data Type***	***Weight***	***Similarity***
Nationality	String	0.8	Equal
Legal status	String	0.9	Equal
Location	String	1.0	Equal
Group	String	1.0	Max String
Subgroup	String	1.0	Max String
Solution Attributes			
Capital	Integer		
Description	String		

The above table contains the general description of attributes consisting of attribute name, data type, weight and local similarity. As shown from the above table the most significant attributes to the problem domain has the highest weight value. The local similarity of three description attributes is equal and two description attributes is maximum string.

JCOLIBRI programming tool uses both local and global similarity measures. The following are definition and of appropriate similarity measures in JCOLIBRI and various local and global similarities used in this study.

A. **Local Similarity:** this kind of similarity measure divides the similarity definition in to a set of local similarity of each attribute. There are different types of local similarity measurement used:
   - **Equal:** if equal local similarity function returns 1 the query and the case in the case base exactly matches and the system gives recommendation unless returns 0 and have no solution.
   - **Max String:** if the max string local similarity selected, the system matches with the maximum string length.
   - **Interval:** this function returns the amount of similarity within the range if we selected interval local similarity.
   - **Threshold:** These functions returns 1 if the query and the case are in the given threshold and the threshold have to set as an interval.

B. **Global Similarity:** it is associated with compound attributes and used to get similarity of collected attributes in unique value. Global similarity computes the final similarity measure. Average similarity is a type of global similarity that considers the average of all attribute of local similarity values. The global similarity of all case attributes has any data type have average similarity value.

4.8. JCOLIBRI2 Architecture Framework

JCOLIBRI2 is the result of the experience acquired during the development of the first version. It solves many drawbacks like case representation, management of metadata, development problems, etc. But the architecture of this new version is very different (although compatible) as is based on a complete revision of CBR systems and frameworks. A framework is a set of classes that embodies an abstract design for solutions to a family of related problems. In other words, a framework is a partial design and implementation for an application in a given problem domain [46].

For classifying a framework we can distinguish two types. A white-box framework is reused mostly by sub classing and a black-box framework is reused through parameterization. The usual development of a framework begins with a design as a white-box architecture that evolves into a black-box one.

The resulting black-box framework has an associated builder that will generate the application's code. The visual builder allows the software designer to connect the framework objects and activate them. The first version of JCOLIBRI is closer to a black-box framework with visual builder and lacks of a clear white- box structure. The new design of JCOLIBRI2 attempts to remodel the architecture into a clear white box system oriented to programmers, and a black-box with builder layer that is oriented to designers. The key idea in the new design consists of separating core classes and user interface. That separation will give us the two layers architecture shown in the following figure [46]:

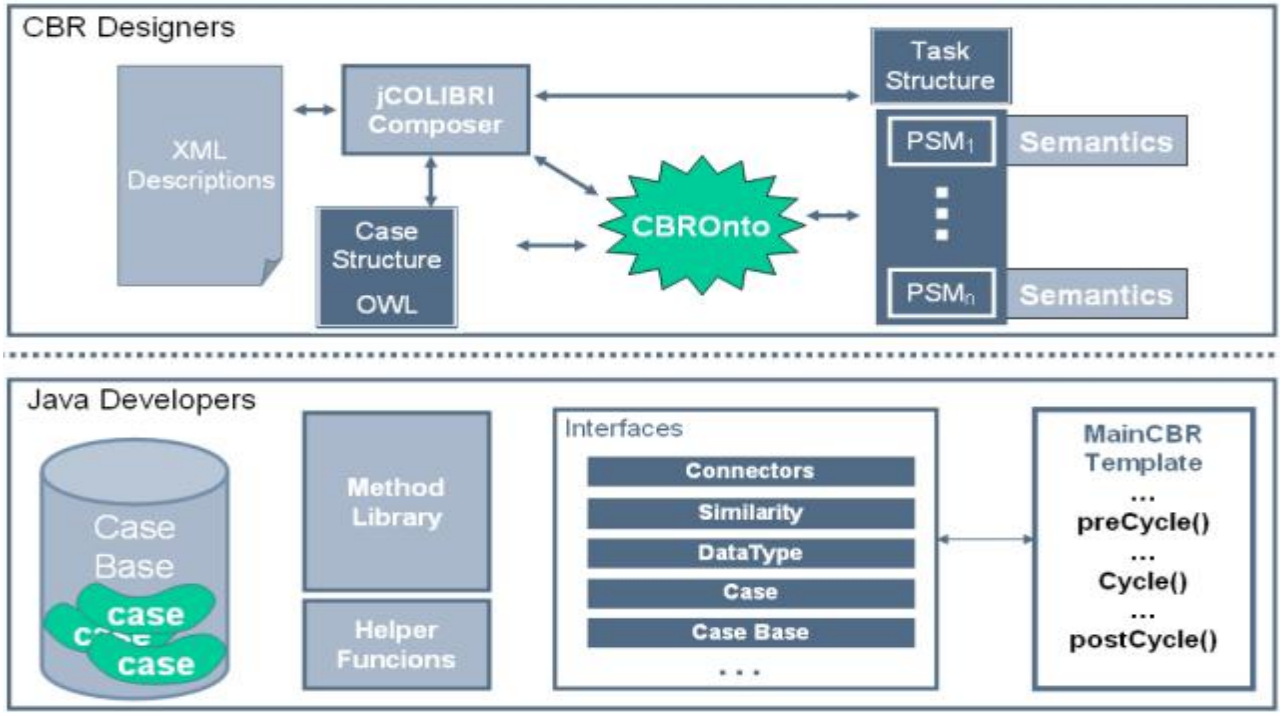

Figure 4.3 Two layer architecture of jcolibri2 (source [46])

4.9. Prototype Implementation Using Jcolibri2

JCOLIBRI case based reasoning framework was used to develop case based recommender system. JCOLIBRI has been constructed as core modules to offer basic functionality of case based reasoning as well as case base recommender system.

4.9.1. Building Case Base

Cases represented in a feature value representation means each attribute have its own value in column and row format. Cases are stored in a case base as plain text file format. A case base representing C columns for each attribute (A1, A2, A3…….AC) and each R row representing individual cases (C1, C2, C3……..CR) and each attribute have a sequence of possible K values associated to each attribute A(V1, V2, V3……..VK) [47].

Cases has been collected from previous importer exporter cases from ministry of trade (MoT) and this cases has been organized and structured to build the case base recommender system. As described in chapter one, one of the main objectives of case based recommender system was building case base regarding to importer exporter process. Cases are the most crucial input for case based recommender system product selection for importers and exporters. So, to provide the best similar case to importers and exporters the relevant cases were collected carefully.

4.9.2. Case Structure Configuration

One of the basic features of JCOLIBRI tool that defining the case structure of the system in a case structure. In a case structure configuration each attribute is created in a case structure and the data type is assigned for each attribute. Case is composed of from four components such as case description, solution and result. **Case description**: describes the problem using various attribute. **Solution**: contains solution of the problem. **Justification**: how the solution drive. **Result**: is an outcome of applying the problem to real situation.

Description and solution are sets of attributes and there are two types of attributes simple and compound attributes. Simple attributes are described by Name, Type, Weight and Local similarity function. Compound attributes collect other simple attributes, allowing complex case structure. When two cases are compared, the local similarity functions are used to simple attribute values. Global similarity functions are linked to compound attributes and are used to combine similarities of the collected attributes in a unique similarity value. Finally the similarity value of two cases is computed as the similarity of their description concept.

4.9.3. Managing Connector

JCOLIBRI manages the case base management in two mechanisms: in persistency mechanism and in-memory organization. Once the case structure configured properly, CBR system must access the case in an efficient way from the case base. JCOLIBRI supports both MYSQL and plain text file to store its case base. Therefore to load case base in to the storage media the connectors must be configured.

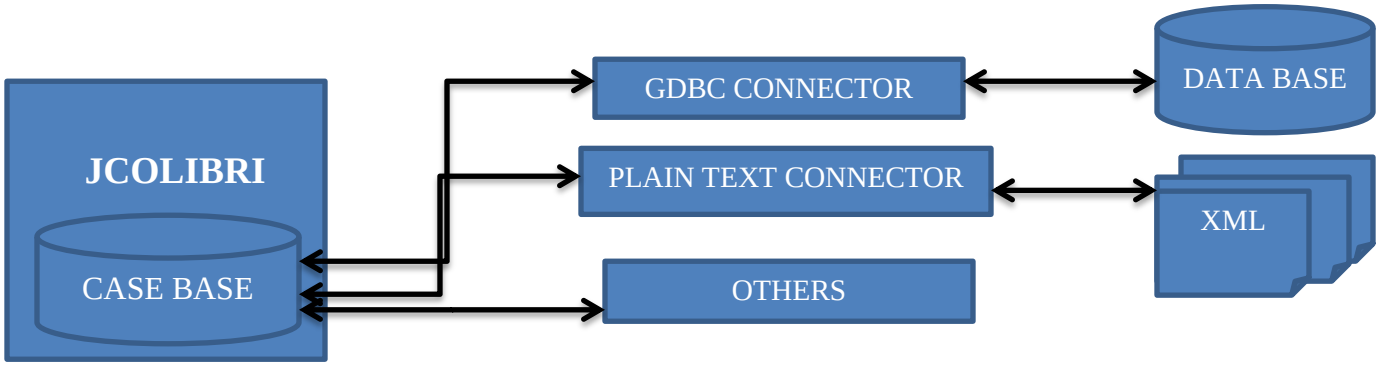

Figure 4.4 JCOLIBRI2 case base schemas

Persistence is built around the connectors. A connector represents the first layer of JCOLIBRI on top of the physical storage and it allows users to load the cases from different storage sources. Connectors are objects that know how to access and retrieve cases from the storage media and return cases in to the CBR system in a uniform way. JCOLIBRI supports different connectors. But for this research plain text connector was used, because the cases are stored in a plain text file format.

The second layer case base management is the data structure used to organize the cases once loaded in to memory. The organization of the case base is (linear, k-trees, case retrieval nets, etc.) may have influence on the CBR process, so the framework leaves open the election of the data structure that is going to be used. JCOLIBRI2 contains the following case bases:

- jcolibri.casebase.LinealCaseBase: Basic Lineal Case Base that stores cases into a list.
- jcolibri.casebase.CachedLinealCaseBase: Cached case base that only persists cases when closing the application.
- jcolibri.casebase.IDIndexedLinealCaseBase: Extension of LinealCaseBase that also keeps an index of cases using their IDs.

In the prototype system the database connector which is partly implemented with hibernate (Object-Relational Mapping tool) was used and lineal case base is selected for in memory organization of the cases. To connect and load the case base, the Configure and Precycle functions of the CBR application were coded. Databaseconfig.xml is used to initialize the connector. The content of databaseconfig.xml is shown in the following figure.

```
<DataBaseConfiguration>

<HibernateConfigFile>hibernate.cfg.xml</HibernateConfigFile>
<DescriptionMappingFile>IECaseDescription.hbm.xml</DescriptionMappingFile>
<DescriptionClassName>IECaseDescription</DescriptionClassName>
<SolutionMappingFile>IECaseSolution.hbm.xml</SolutionMappingFile>
<SolutionClassName>IECaseSolution</SolutionClassName>

</DataBaseConfiguration>
```

Figure 4.5 Database configuration mapping

4.9.4. Tasks/Methods

Generally CBR application can be described by four cycles at the highest level of generality: **Retrieve** the best similar cases, **Reuse** the knowledge to solve the problem, **Revise** the proposed solution and **retain** the experience for future problem solving [46].

As it can be seen in the main function of the CBR application below, after configure () and Precycle () the next step is loading the query dialog.

```
public void start(Stage primaryStage) throws Exception {
            Parent root =
FXMLLoader.load(getClass().getResource("Main.fxml"));
            Scene scene = new Scene(root);
            primaryStage.setScene(scene);
            primaryStage.setTitle("CBR");
            primaryStage.setMaxWidth(1200);
            primaryStage.setMaxHeight(600);
            primaryStage.show();
      }
      public void cycleButtonClicked(ActionEvent ev)
      {
            try {
```

```
                if(ev.getSource().equals(btnRetrieve))
                {
                      FXMLLoader loader = new
FXMLLoader(getClass().getResource("query.fxml"));
                      Pane retrieval = (Pane)loader.load();
                      ancPaneContent.getChildren().clear();
                    queryController =loader.getController();
                      ancPaneContent.getChildren().add(retrieval);
                      }

                else if(ev.getSource().equals(btnReuse))

                {
                      FXMLLoader loader = new
FXMLLoader(getClass().getResource("reuse.fxml"));
                      Pane reuse = (Pane)loader.load();
                      ancPaneContent.getChildren().clear();
                    reuseController =loader.getController();
                      ancPaneContent.getChildren().add(reuse);
                }
                else if(ev.getSource().equals(btnRevise))
                {
                      FXMLLoader loader = new
FXMLLoader(getClass().getResource("revise.fxml"));
                      Pane revise = (Pane)loader.load();
                      ancPaneContent.getChildren().clear();
                    reviseController =loader.getController();
                      ancPaneContent.getChildren().add(revise);
                }

                else if(ev.getSource().equals(btnRetain))
                {
                      FXMLLoader loader = new
FXMLLoader(getClass().getResource("retain.fxml"));
                      Pane retain = (Pane)loader.load();
                      ancPaneContent.getChildren().clear();
                    retainController =loader.getController();
                      ancPaneContent.getChildren().add(retain);
                }

          } catch (IOException e) {
                // TODO Auto-generated catch block
                e.printStackTrace();
          }

     }
```

```
	public static void main(String[] args) {
		Start s = new Start();
		try {
			s.configure();
			_theCases = s.preCycle();

		} catch (ExecutionException e) {
			e.printStackTrace();
		}
		launch(args);
	}
}
```

Figure 4.6 Main function of CBR Application

When the system starts the following screen is displayed then the first query dialog displays.

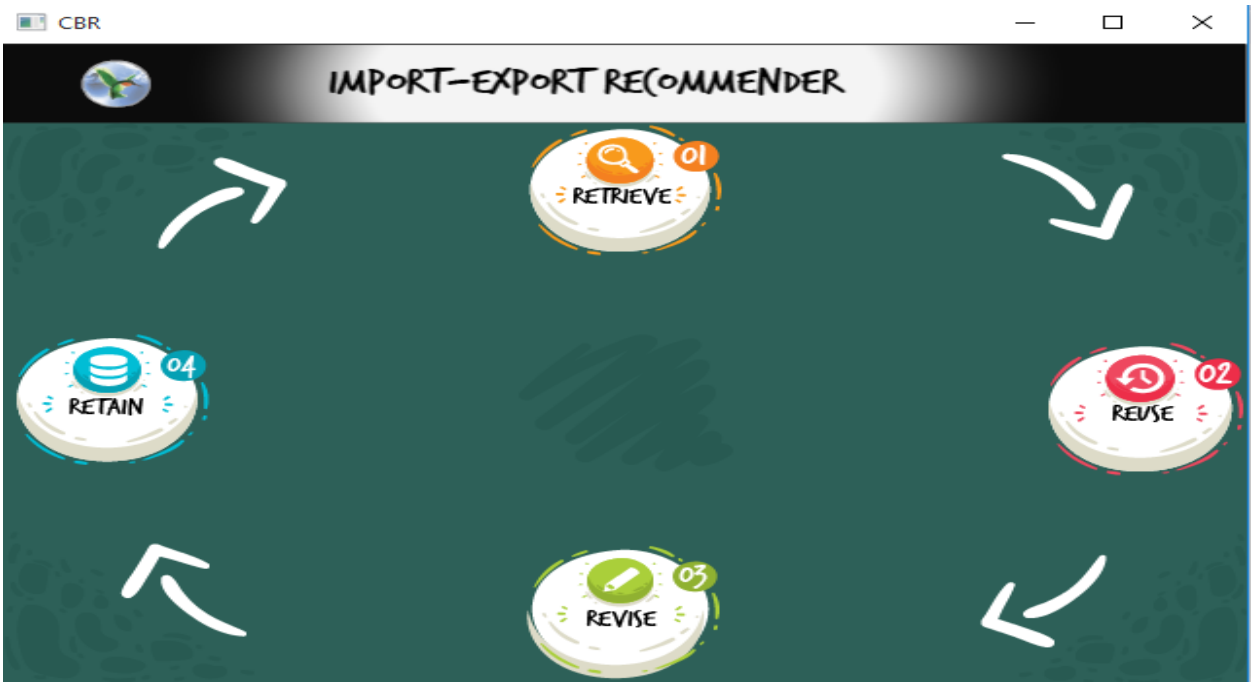

Figure 4.7 Initial screen

CHAPTER FIVE

5. Presentation, Analysis and Interpretation of Data

The data collection techniques are discussed in the previous chapter. In this chapter challenges how the data is collected to develop the prototype of case based recommender system has been discussed. As described from previous chapter dataset is the main source of data. Development and implementation of the prototype is described briefly from previous chapter. Testing and evaluation process of the prototype has been discussed here. The system has been tested through different CBR cycles and user acceptance testing also performed.

5.1. Description of Data Collected

The main challenge faced during data collection was getting relevant data or sources of data. As the researcher described from chapter three the data is collected from primary and secondary sources of data. Getting these sources is one of the challenges faced while conducting the study. Another challenge in this research was willingness of professionals to give the dataset. For the purpose of this study the researcher used the dataset which is organized by ministry of trade in an excel format. In addition to the data set Ethiopian Standard Industrial Classification (ESIC) Rev.1 from ministry of trade (MoT) is another source of data to identify major divisions, divisions, major groups, groups, subgroups and codes represented for each product. The dataset contains past importer and exporter cases in column row format. In this study the researcher collected the data from different importers and exporters and different data collection techniques were applied to get relevant data.

5.2. Data Preparation

Data preparation is manipulation of data in to a form that is suitable for further analysis and processing. Data preparation is an essential step to get correct and reliable result. In this study different relevant data were used. For instance, as described from chapter three hierarchical structure of case was described in text format and these data is prepared in a hierarchical structure to clearly explain the concepts.

To develop case based recommender system for import export product selection with their appropriate capital, the researcher used the dataset from ministry of trade. The dataset is organized in an excel form but it was not appropriate to convert in to the case base (database). Because there was a blank space in some part of row and some column part was written in Amharic and the remaining column was written in English language. This type of data is not appropriate to develop the case based recommender system. Then the blank space was filled with appropriate case and the column which is written in Amharic was discarded to make similar. After prepared excel data which appropriate for the developed prototype it is converted in to the data base.

5.3. Experimentation and Prototype Performance Evaluation

5.3.1. Experimental Testing

To develop the case base recommender system constructing the case base is the most crucial step and to develop the case base most important attributes were selected and their weight and similarity function given to each attributes. As described from previous chapter the attributes were selected via support of domain experts. Seven attributes were selected to represent the case of import export. The case based recommender system calculates local similarity and average or global similarity function between the new case and cases in the case base and then retrieved the most similar case using KNN algorithm. In this study the researcher used 1516 cases to build the case base. These cases are representing most import export products and it is crucial to importers and exporters in product selection.

5.3.2. Testing the Main Cycles and Evaluating System Performance

To check the validity and performance of the case based recommender system the main CBR cycles and the effectiveness of the prototype is tested in this section.

5.3.2.1. Testing Configure and Precycle

In the case based recommender system the first two functions are executed configure and precycle. During configure, a database connection is created and initialized using an xml file.

Since Jcolibri needs the case base to be loaded in to memory prior to other tasks, an object for in-memory organization of cases is also created during configuration.

To check whether the above tasks are done successfully first Jcolibri uses an error logging mechanism and all codes are surrounded by a try-catch block. If any problem occurs, the catch block will throw an exception and the right message is displayed to the user. During testing the following problem initially occurred. The system was unable to connect the database (contains the case base). This was basically due to invalid mapping of attributes to the database. Such problems are missing attributes, mapping non-existent attribute and so forth were occurred. Finally, all the above problems were and to confirm that, the database connector object and the loaded cases and other information are displayed on the console output of the IDE as shown below.

```
public void configure() throws ExecutionException {
		try {
			_connector = new DataBaseConnector();
	_connector.initFromXMLfile(jcolibri.util.FileIO.findFile("databaseconfig.xml")
)
			_caseBase = new LinealCaseBase();

		} catch (Exception e) {
			e.printStackTrace();
			throw new ExecutionException(e);
		}
	}
	public CBRCaseBase preCycle() throws ExecutionException {
		_caseBase.init(_connector);
		java.util.Collection<CBRCase> cases = _caseBase.getCases();
		for (CBRCase c : cases)
			System.out.println(c);
		return _caseBase;
	}
```

After every problem was fixed which is described above the following dialog box or console displayed based on the above code. After testing of configure and precycle the first initial screen box displayed.

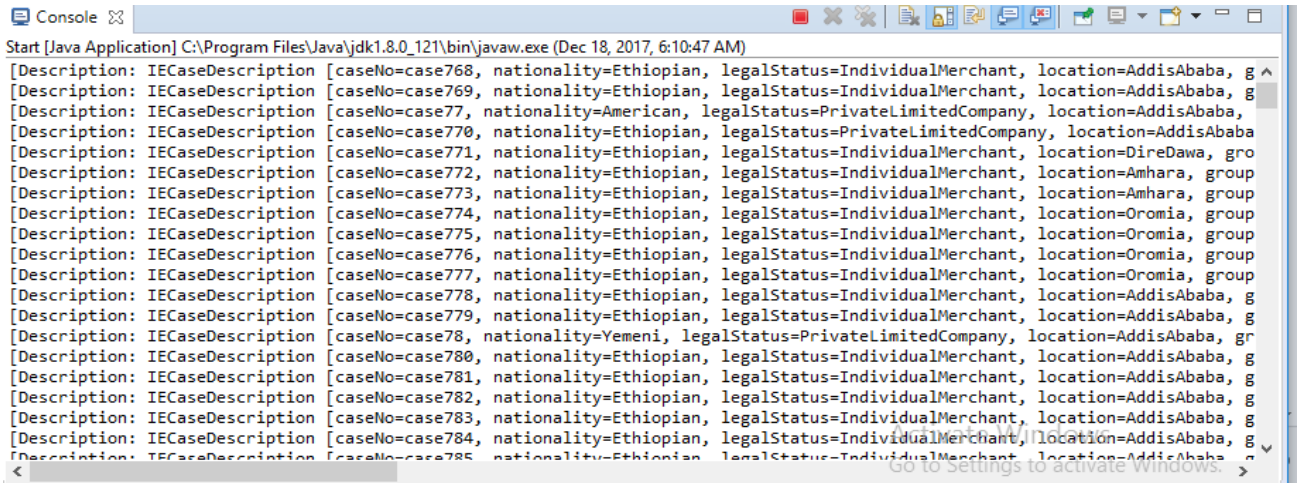

Figure 5.1 Testing configure and precycle

5.3.2.2. Testing the Query Dialog

The following dialog box which is the query dialog displayed at the first time while the system runs. These dialog box or query dialog used for users to enter a new query or new case.

Figure 5.2 Testing query dialog

The above query dialog box enables the users to enter the cases. After the user enters the cases the system computes the cases on their similarity function and attributes weight they have given. In this study 1516 cases were collected from ministry of trade and these cases stored in the case base. The system computes similarity between new cases and old cases or cases which is stored in case base based on their similarity function and weight and retrieves the best top 10 cases from the case base. The following dialog box depicts the top 10 retrieved cases.

5.3.2.3. Testing Case Retrieval

In case based recommender system case retrieval is the first step. Case retrieval is retrieving the most similar cases from the existing cases using k nearest neighbor algorithm. JCOLIBI is an implementation tool and uses this algorithm to retrieve cases.

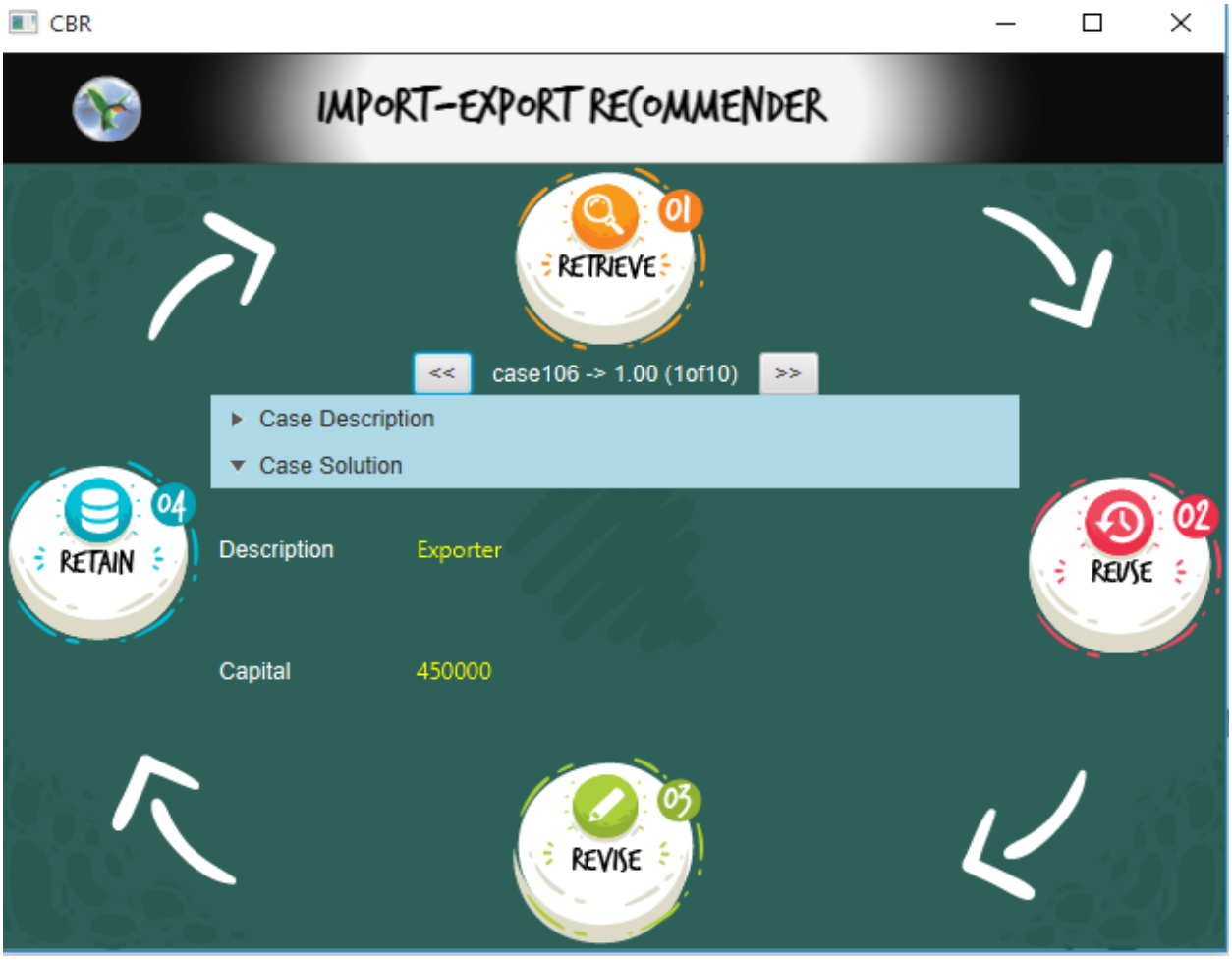

Figure 5.3 Testing Case Retrieval

The above dialog box depicts the retrieved similar cases with appropriate ranking order. The system recommends the users (importers and exporters) as displayed above. The system computes the similarity between the new case which is entered in the query dialog and old cases which is stored in the case base. After computing the similarity the system retrieved case 106 first as described in the above figure 5.3

Precision and recall are common methods of measuring the performance of the retrieval process. Precision is the fraction of the retrieved cases which is relevant to the query. Recall is the fraction of the relevant cases which has been retrieved to a given new query from the case base.

$$\text{Precision} = \frac{\#of\ relevant\ cases\ retrieved}{Total\ \#of\ \ cases\ retrieved}$$

$$\text{Recall} = \frac{\#of\ relevant\ cases\ retrieved}{\#of\ \ relevant\ cases\ in\ the\ case\ base}$$

To commence the evaluation process for each test case all relevant importer and exporter cases should be identified from the case base. Test cases are given to domain experts in order to assign the relevant cases from the case base for each test case. The domain experts use the value of recommendation attributes of importer and exporter cases to assign the relevant cases to the queries that have similar solution (recommendation) are relevant to each other. After assigned the relevant cases for each test case as shown in the following table 5.1 then precision and recall are calculated.

Table 5.1 shows sample test case and relevant cases assigned by domain experts

Test Cases	***Relevant cases from the case base***
Case1003	Case202, case1004, case1046, case1090, case1233, case1293, case1333,case1365,case272
Case102	Case111, case5, case54, case602, case67,case759, case84, case879,case88
Case1153	Case1096, case479, case1051, case1183, case324, case452
Case118	Case124, case15, case178, case214, case24, case25, case724, case834
Case867	Case868, case652, case653, case792, case850
Case871	Case11, case47, case148, case152, case155, case197, case729, case734, case750
Case909	Case908, case368, case891, case134, case65, case25

To calculate the precision and recall value of the retrieval performance of the CBR system various researchers used various standard threshold's i-e means there is no standard threshold's for degree of similarity that has been used for retrieving relevant cases to measure the performance of their system. In this study, the threshold is set by the researcher and used threshold value [1.0, 0.8]. The researcher was conducting sixty experiments to measure precision and recall by using a leave-one-out cross validation testing proportion and [1.0, 0.8] threshold interval.

Table 5.2 performance measurement of the system using precision and recall

Test cases	***Recall***	***Precision***
Case1003	0.78	0.7
Case102	0.89	0.57
Case1153	1.0	0.6
Case118	0.6	0.5
Case867	0.8	0.4
Case871	0.89	0.8
Case909	1.0	0.6
Average	.85	0.59

To calculate the recall of each test case as depicted in the above table 5.2 dividing the number of relevant retrieved cases with total relevant cases. For instance, case1003 seven relevant cases are retrieved out of nine relevant cases. So the result of recall is 7/9 will be 0.78 (78%). The remaining test cases calculated in the same way as the first one. To calculate the precision value of the system dividing the relevant number of cases retrieved with the total number of retrieved cases. For instance, case1003 seven relevant cases are retrieved and total fourteen cases retrieved. So the result of precision value of the system is 7/10 will be 0.7 (70%). The precision value of the remaining cases also calculated in the same way. The average recall and precision value of the system is 85% and 59% respectively. The higher recall values depicts that the system obtains most of the relevant cases from the case base.

So, this recommender system can retrieve the relevant cases that enable importers and exporters to make right decision easily in product selection process with their appropriate capital. In terms of capital this study achieved a very good result. But precision is lower average result regarding to recall average result.

5.3.2.4. Testing of solution and adaptation process

The purpose of testing solution adaptation is to evaluate the system capability to reuse the existing cases from the case base. The system loads the case base at the PreCycle stage of JCOLIBRI framework and then selects working cases from the case base. This working case always stored in to current context at the retrieval stage. The next stage is reusing the cases that are stored in the working memory and this reuse stage can be used by the next user of the system at another time. The adaptation process of case based recommender system is successful as the case features of the previous and new case have similar or less contradiction attribute values. Adaptation process will not be performed as the attribute values of the previous and the new cases have more dissimilarity or totally different from the previous cases. In such cases adaptation process has to be edited and performed manually by domain experts in the revision stage.

Figure 5.4 Testing Case Reuse and Solution Adaptation

As depicted in the above figure 5.4 the system adapts the recommended solution with a direct copy method. The previous step retrieves top 10 cases from the case base in the ranked order. So in this step the most similar case from top 10 cases adapted through a direct copy method.

5.3.2.5. Testing of Case Revision

In the retrieval stage top 10 cases were retrieved in the ranking order. Then the retrieved cases proposed for recommended solution in the reuse stage. Therefore the next task is after solution adaptation step is revision of cases. In this step, domain experts should be able to edit (change) the cases. In the revision step both the description cases that was entered in the query dialog and the recommended solution incorporated to create new experience.

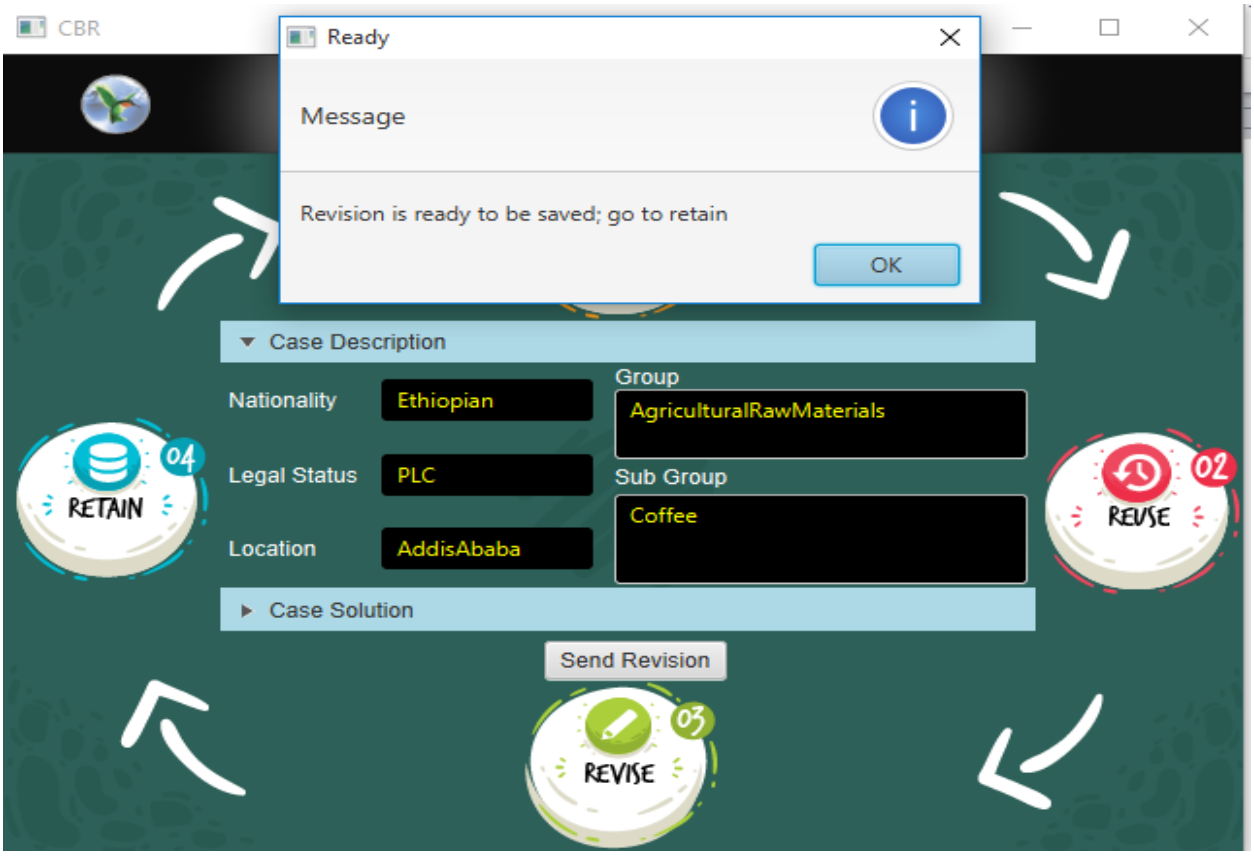

Figure 5.5 Testing Case Revision

As the above figure 5.5 depicted the cases was revised and ready to send the revised case to the next step after evaluated by domain experts.

5.3.2.6. Testing of Case Retaining

The last cycle in JCOLIBRI framework is retaining which is an important step to present the revised case to domain experts and store new cases together with the existing case. The domain experts select and retain the required case and these new cases are used as an input for future use and the case base is updated by a new learned cases.

Figure 5.6 Testing Case Retaining

The retain step has a save dialog box that enables the domain experts to save any case that is required by domain experts after revised case. Therefore to check whether the retained case is presented successfully in the case base check saved case in the case base. This saved case is used for future.

5.3.3. User Acceptance Testing

To check the user satisfaction of the case based recommender system user acceptance testing is an essential step. So the system is tested and evaluated the performance of the CBRS of import export to address the user acceptance questions, clarity and accuracy of the prototype. During the system testing and evaluation process was done by domain experts and importers and exporters were selected. Each domain experts and importers and exporters has been used their own methods or queries to test the system and they gave a value in terms of user interaction of the system and accuracy of the existing case and recommendations based on their queries. User acceptance testing helps to ensure the performance of the developed prototype by assessing the feedback obtained from domain experts and importers and exporters. To assess the user acceptance the developed prototype, the researcher has been prepared questionnaires and distributed to five domain experts and five importers and exporters. All the questions assigned by very high, high, medium, low, and very low these five alternatives described in terms of numeric value to analyze the system performance easily.

The following table 5.1 depicts that evaluation criteria and performance value given by domain experts. Five domain experts selected to evaluate the system. The alternatives and its value respectively Very high= 5, High= 4, Medium= 3, Low= 2, Very low= 1. The following Table 5.1 depicts the result of domain expert acceptance**.**

Table 5.3 depicts the result of domain expert acceptance

No	***Evaluation criteria***	***Performance value***					
		Very low	***Low***	***Medium***	***High***	***Very high***	***Average***
1	User interface prototype interactivity			1	3	1	4.0
2	Easy to use the system			1	2	2	4.2
3	Adequacy and clarity of the system in recommendation process			1	3	1	4.0
4	Relevancy of attributes representing			1	1	3	4.4
5	Relevancy of retrieved cases			1	1	3	4.4
6	System efficiency in time				1	4	4.8

7	Fitness of the final solution to the new problem			1	2	2	4.2
8	Significance of the system in the domain area				1	4	4.8
9	Total Average						4.35

The above table depicts that user interface prototype interactivity of the system is rated 20% very high, 60% high and 20% medium. Easy to use the system is rated 40% very high, 40% high and 20% medium. Adequacy and clarity of the system in a recommendation process is rated as 20% very high, 60% high and 20% medium. Relevancy of attribute representation is rated 60% very high, 20% high and 20% medium. Relevancy of retrieved cases of the system is rated 60% very high, 20% high and 20% medium of respondents. System efficiency in time is rated 80% very high, 20% high. Fitness of the final solution to the new problem is rated 40% very high, 40% high and medium 20%. Significance of the system in the domain area is rated 80% very high and 20% high of domain expert respondents.

The following table 5.2 depicts that evaluation criteria and performance value given by importers and exporters. Five importers and exporters selected to evaluate the system. The alternatives and its value respectively Very high= 5, High= 4, Medium= 3, Low= 2, Very low= 1.

Table 5.4 depicts the result of importers and exporters acceptance

No	***Evaluation criteria***	***Performance value***					
		Very low	***Low***	***Medium***	***High***	***Very high***	***Average***
1	User interface prototype interactivity			2	2	1	3.8
2	Easy to use the system			1	2	2	4.2
3	Adequacy and clarity of the system in recommendation process			2	2	1	3.8
4	Relevancy of attributes representing			1	3	1	4.0
5	Relevancy of retrieved cases		1	1	2	1	3.6
6	System efficiency in time			1	1	3	4.4

7	Fitness of the final solution to the new problem			1	3	1	4.0
8	Significance of the system in the domain area			1	2	2	4.2
9	Total Average						4.0

As depicted that from the above table 5.2 row number 1 indicates user interface prototype interactivity of the system is given 3 value by two respondents, 4 by two respondents and 5 by one respondents and the respondent is rated 20% very high, 40% high and 40% medium of respondents. Easy to use the system is rated 40% very high, 40% high and medium 20% of respondents. Adequacy and clarity of the system in a recommendation process is rated as 20% very high and 40% high and 40% of respondents. Relevancy of attribute representation is rated 80% very high, 20% high. Relevancy of retrieved cases of the system is rated 20% very high, 40% high, 20% medium and 20% low of respondents. System efficiency in time is rated 60% very high, 20% high and 20% medium. Fitness of the final solution to the new problem is rated 40% very high, 40% high and medium 20% of respondents. Significance of the system in the domain area is rated 80% very high and 20% high.

As described from the above two table 5.1 and 5.2 the system performance is evaluated by the domain experts and importers and exporters. So the result of system performance as evaluated by both domain experts and customers 87% and 80% respectively.

CHAPTER SIX

6. Conclusion, Contribution and Recommendation

Short and precise description of previous chapters are discussed here, contribution of the study and future work recommendations are incorporated in this chapter.

6.1. Conclusion

The objective of this study is to develop a prototype case based recommender system which can support new importers and exporters in product selection to prepare capital. Recommender system have proven system by providing response to the information overload problem to the users with proactive and personalized information services where people to find items of interest from huge information spaces. There are various products which imported from different countries to Ethiopia and exported from Ethiopia to different countries. But there are lot of problems for new importers and exporters to prepare capital based on their interest of product selection to import and export products. The developed IE case based recommender system has a great significance for new importers and exporters. The system was developed by selecting most crucial attributes to give successful recommendation. The selected attributes to recommend importers and exporters are nationality, legal-status, location, group and subgroups as description attributes and capital and description attributes as solution was used by the researcher to develop IE case based recommender system. So, the developed IE recommender system recommends how much capital they should prepare based on their product selection. To develop the best prototype IE recommender system various documents, journal articles, MoT websites were reviewed in detail for better understanding. After reviewed IE recommender system architecture were designed and prototype of IE recommender system developed.

Knowledge was acquired from various relevant sources and the knowledge was modeled using hierarchical tree structure model to represent concepts and clearly explain concepts. Qualitative data collection method was used. To acquire the knowledge the researcher used various data collection techniques such as interview, document analysis and observation. In this study the most determinant attributes were identified and 1516 cases were collected from ministry of trade.

The cases are the previous importer and exporter cases and organized in to the case base properly. Case based recommender system uses previous cases as the domain knowledge to provide recommendation to new importers and exporters. JCOLIBRI programming tool has been applied to develop the prototype case based recommender system. One of the main reason for applying case based recommender system for import and export product selection process is adaptation of new experience or new cases. Case based recommender system uses past cases as domain knowledge to provide recommendation. If new cases adapted to the case base it uses as a solution for next time. Therefore, case based recommender system change and updates itself by adapting new cases. For instance, rule based recommender system doesn't change and update itself. It is restricted based their given specific rules and facts.

The developed prototype case based recommender system is mainly retrieve the best similar cases in a ranking order by computing the new problem with the previously solved cases which is stored in the case base and adapting (reusing) the solution. In a case based recommender system the user in this case importers and exporters enter the new query or cases and the system computes similarity between new query and previous importer exporter cases which has been found in the case base using nearest neighbor algorithm. After computing similarity between cases if the new case is exactly matching with the existing cases the system provides the solution. But if the user is not satisfied through the solution the user can revise the cases to get the best solution. Finally, the system stored the final solution in the case base for later use. The developed IE case based recommender system is evaluated by five domain experts and five users of the system. Recall and precision is a standardized methodology for information retrieval of system performance measurement. Therefore, the developed IE case based recommender system is evaluated similarity retrieval and relevant cases from the retrieved cases through recall and precision.

6.2. Contribution of the study

This research has contributed a significant understanding on case based recommender system related to import export cases. The case base contains 1516 previously recorded importer exporter cases that can be used to recommend new importers and exporters aspiring to select the right product.

The prototype recommender system support by comparing their cases with the cases stored in the case base. In this study the researcher used the latest tools and best similarity algorithm methods. Knowledge representation of import export with different attributes and cases is the basic contribution of this work. Knowledge representation of import export enables further study for other researchers related to import export. In addition to this; the study shows the possibility of solving a problem of searching of the right product with their appropriate capital they have.

6.3. Recommendation

There are number of problems which needs further investigation and further future work. Therefore the researcher recommends some points that need future work for the sake of system performance increment.

- The case based recommenders system recommends only description and capital in this study. The researcher recommends for future work by adding additional attributes and the system recommends the products accessible area.
- The researcher used a case based recommender system to recommend the solution. To improve the performance of the system the researcher recommends future works to hybrid with rule based and ontology based recommender system added.
- The system retrieves only one case at a time even more than one cases displayed in a ranking order. So the researcher recommends other researchers to use template retrieval algorithm to retrieve all case.
- The system is developed in English language, so this language is difficult to understand by some importers and exporters. So the researcher recommends for future work is developing the case based recommender system using Amharic language to easily communicate with the system.
- In this study the researcher collected 1516 cases from ministry of trade. So the researcher recommends for other researchers add additional cases to improve the performance of the system.

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APPENDIX A

Interview Questions for domain experts

1. Full name

   _____

2. Sex

   Male ☐ Female ☐

3. Age

   20-30 ☐ 31-40 ☐ 41-50 ☐ Above 50 ☐

4. Educational level

   Diploma ☐ Degree ☐ MSC ☐ PHD ☐

5. Work experience in years

   1-5 ☐ 6-10 ☐ 11-20 ☐ 21-30 ☐ Above 30 ☐

6. What are the pre requirements to be importer/exporter?
7. What are the most determinant attributes consider being importer/exporter?
8. How much capital is needed to start importing/exporting products?
9. In which products are there more importers and exporters?
10. What type of advice is given to new importers and exporters?
11. Is there any system that gives recommendation to new importers and exporters?

APPENDIX B

Interview questions for importers and exporters

1. How do you get advice from domain experts?
2. How to select products to import or export products?
3. How do you know the beginning capital to start the business?
4. Which type of product is more preferable to import or export to be successful according to your initial capital?

APPENDIX C

Sample Cases of Importer and Export

CaseNo	Nationality	LegalStatus	Location	Group	SubGroup	Description	Capital
case1	Ethiopian	IndividualMerchant	AddisAbaba	AgriculturalRawMaterials	Coffee	Exporter	4000000
case10	Ethiopian	PrivateLimitedCompany	AddisAbaba	OtherAgriculturalProducts	BeverageCropsExceptTeaAn	Exporter	300000
case100	Ethiopian	IndividualMerchant	Hareri	SolidLiquidAndGaseousFuel	SolidLiquidAndGaseousFuel	Exporter	3000
case1000	Ethiopian	IndividualMerchant	AddisAbaba	TextilesTextileFibersClothing	BagsLuggageHandBagsAnd	Importer	1000000
case1001	Ethiopian	IndividualMerchant	Tigray	ConstructionMaterialsHardv	ConstructionMaterials	Importer	398950
case1002	Ethiopian	PrivateLimitedCompany	AddisAbaba	MachineryAndEquipment	MedicalEquipments	Importer	1000000
case1003	British	IndividualMerchant	DireDawa	ChemicalsAndChemicalPro	PlasticsInPrimaryAndNonPri	Importer	500000
case1004	Ethiopian	IndividualMerchant	AddisAbaba	ChemicalsAndChemicalPro	PlasticsInPrimaryAndNonPri	Importer	50000
case1005	American	IndividualMerchant	AddisAbaba	MotorVehicles	UsedMotorVehicles	Importer	50000
case1006	Ethiopian	IndividualMerchant	AddisAbaba	FurnitureHomeAndOfficeFu	pliesDishDecoderSetTopBox	Importer	3000000
case1007	Ethiopian	IndividualMerchant	Tigray	IndustrialAgriculturalConstr	ConstructionEquipmentsLik	Importer	600000
case1008	Ethiopian	PrivateLimitedCompany	AddisAbaba	MetalNonMetalsMetalOresA	GlassAndGlassProducts	Importer	500000
case1009	Ethiopian	IndividualMerchant	AddisAbaba	FurnitureHomeAndOfficeFu	HouseholdAndOfficeFurnitu	Importer	500000
case101	Ethiopian	IndividualMerchant	Tigray	LivestockAndLivestockProd	Livestock	Exporter	1350702
case1010	Ethiopian	PrivateLimitedCompany	AddisAbaba	TelecomAndComputersAnd	ComputerAndComputerAcc	Importer	1000000
case1011	Ethiopian	IndividualMerchant	AddisAbaba	SparePartsExceptCarBattery/	MotorVehicleSpareParts	Importer	574344
case1012	Ethiopian	PrivateLimitedCompany	AddisAbaba	FurnitureHomeAndOfficeFu	FurnitureHomeAndOfficeFu	Importer	1000000
case1013	Ethiopian	IndividualMerchant	AddisAbaba	ConstructionMaterialsHardv	ConstructionMaterials	Importer	270000
case1014	Ethiopian	PrivateLimitedCompany	Tigray	ChemicalsAndChemicalPro	SoapsDetergentsToiletriesCl	Importer	250000
case1015	Ethiopian	IndividualMerchant	AddisAbaba	MetalNonMetalsMetalOresA	GlassAndGlassProducts	Importer	100000
case1016	Ethiopian	IndividualMerchant	Amhara	PaperAndCellophaneProduc	PackagingMaterialsMadeFrc	Importer	500000
case1017	Ethiopian	IndividualMerchant	AddisAbaba	TextilesTextileFibersClothing	FootwearAndLeatherGoods	Importer	1500000
case1018	Ethiopian	PrivateLimitedCompany	Amhara	PaperAndCellophaneProduc	PaperAndPaperProducts	Importer	150000
case1019	Ethiopian	IndividualMerchant	AddisAbaba	PaperAndCellophaneProduc	PaperPaperAndCellophaneP	Importer	100000
case102	Ethiopian	IndividualMerchant	Oromia	AgriculturalRawMaterials	Pulses	Exporter	500000

:ase1020	Brazilian	CommercialRepresentative	AddisAbaba	CommercialRepresentative	CommercialRepresentative	Importer	100000
:ase1021	American	IndividualMerchant	AddisAbaba	FurnitureHomeAndOfficeFu	SanitaryAndSanitaryAccesso	Importer	200000
:ase1022	Ethiopian	PrivateLimitedCompany	AddisAbaba	TextilesTextileFibersClothing	BagsLuggageHandBagsAnd	Importer	20000
:ase1023	Ethiopian	IndividualMerchant	AddisAbaba	MetalNonMetalsMetalOresA	IronAndSteel	Importer	50000
:ase1024	Ethiopian	PrivateLimitedCompany	AddisAbaba	IndustrialAgriculturalConstr	ConstructionEquipmentsLik	Importer	50000
:ase1025	Ethiopian	PrivateLimitedCompany	AddisAbaba	SparePartsExceptCarBattery/	MotorVehicleSpareParts	Importer	250000
:ase1026	Ethiopian	PrivateLimitedCompany	AddisAbaba	MotorVehicles	UsedMotorVehicles	Importer	300000
:ase1027	Ethiopian	PrivateLimitedCompany	AddisAbaba	IndustrialAgriculturalConstr	LiftsEscalatorsAndIndustrial/	Importer	100000
:ase1028	Ethiopian	IndividualMerchant	AddisAbaba	TextilesTextileFibersClothing	Textiles	Importer	500000
:ase1029	Ethiopian	IndividualMerchant	Tigray	IndustrialAgriculturalConstr	ConstructionEquipmentsLik	Importer	51510
:ase103	Ethiopian	IndividualMerchant	Tigray	AgriculturalRawMaterials	Cereals	Exporter	907440
:ase1030	Ethiopian	PrivateLimitedCompany	AddisAbaba	TextilesTextileFibersClothing	Textiles	Importer	1000000