Adama Science and Technology University

School of Graduate Studies

Department of Computing

APPLICATION OF CASEBASED RECOMMENDER SYSTEM IN TOURISM SITE SELECTION

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By

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Names and Signature of Members of the Examining Board

Chair Person, Examining Board	Signature
Tbebe Beshah (PhD)	
Advisor	Signature
Examiner	Signature

Acknowledgment

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Table of Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS AND ABRIVATIONS

ACT.....Amhara Culture and Tourism

AI……Artificial Intelligence

CBR.....Case based reasoning

CBRTSS……case based reasoning for tourism site selection

CRS…….Computer Reservation system

CSV.....Comma Separated Values

ES…….Expert System

GAIA.....Group of Artificial Intelligence for Applications

GUI.....Graphical User Interface

JCOLIBRI……java Cases and Ontology Libraries Integration for Building Reasoning Infrastructure

KBS.....Knowledge Based System

ML…….Machine Learning

PROLOG.....Programming in Logic

PSM.....Problem Solving method

WTO.....World Tourism Organization

ABSTRACT

Tourism is the business of providing tours and services for tourists. Each and every tourist can be specifically differentiated on various parameters in tourism site selection decision. But tourism advice in developing countries like Ethiopia has different problems such as no sufficient and knowledgeable experts to give advice to tourists. Because of this majority of tourists are not satisfied in their tour. To address such problems, this study attempts to design and develop a prototype case based recommender system for tourism site selection decision that can provide advice for domain experts and tourists to make right decision at the right time. To develop the prototype system relevant knowledge was acquired through interview from domain experts and tourists and also document analysis was employed. Then, the acquired knowledge was modeled using hierarchical structure and represented using feature value case base representation and finally implemented using jCOLIBRI programming tool.

The main data source used to develop the case based recommender system for tourism site selection is previous tourist cases from ACT office. Nearest neighbor retrieval algorithm is used to measure the similarity of new case (query) with cases in the case base.Moreover, in testing and evaluating the prototype system domain experts and tourists were participated. Thus, the average performance of the prototype system through user acceptance testing is 83% and 84% by domain experts and tourists respectively. And also the performance of the prototype system is measured using recall, precision and accuracy measures and it achieves 86% of recall, 65% of precision and 87.5% of accuracy.

CHAPTER ONE

1. INTRODUCTION

1.1. Background

Sometimes we take decisions unaware of the existence of other alternatives. This may be the reason why many people nowadays trust in third parties recommendations rather than in themselves to take decisions. But these suggestions are not enough in this digital age [1]. The recent appearance of recommender system is lending a hand to tackle this matter in a more effective way. 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 [2].

Recommender systems enable people to share their opinions and benefit from each other's experience. They can be defined as "any system that produces individualized recommendations as output or has the effect of guiding the user in a personalized way to interesting or useful objects in a large space of possible options" [3].

Recommender systems can be also described as an information filtering technology that is used to present information on items to the user that are in line with the users tastes. Recommender systems are used to support users in their decision-making in daily life situations in terms of pre-selecting information that might be of interest to them, where they confronted situations without sufficient experience in the available alternatives. These systems involve predictive models, heuristic search, data collection, user interaction and model maintenance [3].

Recommendation process is a step by step process. The recommender system makes a decision about the item/items at each point. This decision should take into account the sequential process involved and the optimization criteria suitable for the recommender system. Then they suggest items to the user who can then accept one of it. A new list of recommended items is calculated and presented to the user at the next stage. This step by step nature of the recommendation process, where at each stage a new list is calculated based on

the user's past ratings, will lead us naturally to our reformulation of the recommendation process as a step by step optimization process [2].

Case based recommender system is a part of knowledge based recommender system that depends on case based reasoning to generate personalized recommendations for exploiting the knowledge contained in past recommendation cases. In these systems the quality of a new suggestion depends on the quality of past recorded recommendation cases [4].

The Ethiopian Ministry of Culture and Tourism is a government agency responsible for developing and promoting the tourist products of Ethiopia both inside the country and internationally. In doing so the Ministry closely works together with different national and international stakeholders. It publicizes the country's resources of tourist attractions and encourages the development of tourist facilities [5].

Tourism is the sum of the phenomena and relationships arising from interaction among tourist, business suppliers, host governments, host communities, origin government, Universities, Community colleges, Nongovernmental organization in the process of attracting, ,transporting, hosting, managing the tourists and others Visitors [6] . And Tourists are people who travel to and stay in places outside their environment for more than twenty-four hours and but not more than one consecutive year for leisure, business and others purpose but not related to the exercise of an activity remunerated from within the place visited [7].

Tourism is one of the largest income generating Business sectors which contributes multidirectional benefits for a country's economic development. Tourism has both direct and indirect impacts through enhancing the total economic growth of the country. Now a day, Tourism sector is getting attention by developing countries since it is becoming a backup for their economy stability with the fact that their economic background mainly depends on exporting Agricultural products which has little contribution for earning hard currency [8].

According to [9] the Amhara National Regional State, home of age-old monuments and other heritages situated on the "Historic Route" has the Lion's Share of the country's tourist attractions. Three of the seven world heritage sites of Ethiopia (the medieval castles of Gonder, the Simien Mountains National Park and the Rock Hewn Churches of Lalibela i.e.one of the eight wonders of the world) are housed here. The thunderous Blue Nile Falls, Ethiopia's largest lake, Lake Tana dotted with island monasteries, the endemic wild lives like

Walia Ibex, Gelada Baboon, Simien Fox, etc. still adorn this gracious region. Since this region has historical and natural tourist attractions it is the destination of tourists.

Therefore, the researcher imitates to develop recommender system for foreign as well as domestic new tourists.

Usually, users or travelers starts from an elementary knowledge of the place to visit and of the places that can be of interest for them, either for the artistic, social or leisure value they may have. Besides this, each person can adopt different profiles depending on the trip they want to do or the circumstances that surround them; therefore, several profiles can be distinguished, such as cultural, gastronomic, or family profile, among others [1].

Users can have access to a huge deal of data and information related to a specific place, but surely they will prefer to filter that information and get those elements or activities that match their profile or particular interests. Each of these profiles determines the different places to visit or the different ways to plan a trip. Hence the goals of this research is to develop a recommender systems to give tourism site selection recommendation to new tourists that is most successful in the future based on considering their demographic and socio economic characteristics and match these characteristics with the previous tourist's characteristics.

1.2. Statement of the problem

Tourism is one of the fastest growing industries that provide services and sales of goods for visitors who came from outside of the destination area for a period of more than 24 hours and less than one year [10]. Designing a travel plan is the most crucial tourism service for users. This service requires an intelligence system in form of the recommendation to assist travellers with their travel plans. Presently, most of the current travel recommendation systems focus on producing recommendations at the destination selection stage [11]. Since, Ethiopia is the destination of tourists it has its own advising system to tourists, but in its tourism advising system there are a number of problems faced by domain experts to provide service to travellers. The first problem faced by experts in tourism advising system is lack of appropriate, relevant and understandable information to give advice and guidance to tourists. This is because of unavailability of information system that is developed to enable proper collection, organization and dissemination of information in the Amhara Culture and Tourism bureau [9].

The other problem in tourism advising system is collaboration among different domain experts. In other word, one expert may have awareness about religious tourist attraction areas but has no more idea about natural tourist attraction areas the other expert has, hence integration among domain expert is the problem in the advising system. These shows experts advice is limited only with the one most familiar with them [12]

The other critical problem in tourism advice system is, the advising services given takes long time to get the required tourist attraction areas[13].As stated by [14] difficulty of getting appropriate advice is a critical issue for tourists since knowing the right tourist attraction area and the right time to visit are the factors to consider to new tourists.

According to the interview made with Amhara Culture and Tourism Bureau experts, tourists have a few criterias to consider when looking for the right place to visit such as age, nationality, gender, and attraction type preference. The experts further comments that due to lack of knowledgeable domain experts to give appropriate advice in Amhara culture and tourism, visitors are confused about where to visit, which route they should follow, which time is good to visit, which hotel services good and which tourist attraction area is good to them to be satisfied in their tour.

Finally, in the context of visiting," success depends on ensuring that your visiting strategy fits your personal characteristics" [14]. Though visitors are trying to get satisfaction, each one comes from a diverse background and has different needs and capabilities. It follows that specific visiting vehicles and methods are suitable for certain types of visitors. Even though there is a recommendation system that is made by other researcher this recommender system did not include the main factors that should be included in recommendation process such as marital status, profession and interested attraction site type; the researcher system recommends only two recommendations i.e. attraction site and visiting time; and also the research that was made did not include explanation facility [15]. Since the sector also uses traditional advisory system of tourists and the traditional nature of the existing advisory system make it interesting to undertake the study.

So to fill the above stated problems, this research aims to design case based recommender system that assists tourists by providing fast and consistent advisory service and hence they can identify the tourism site that satisfy their needs.

To this end, the study attempts to explore and find solutions for the following research questions:

1. How to acquire, model, represent, and implement the required knowledge for a recommender system?
2. How to develop an effective prototype model for tourism site selection recommender system?

1.3. Objective of the study

To address the problems in section 1.2 above, the study has the following specific and general objectives:

1.3.1. General Objective

The main objective of this study is to develop case based recommender system that can give recommendation on tourism site selection in Ethiopia particularly, Amhara regional state to foreign and domestic new tourists.

1.3.2. Specific Objectives

To attain the general objective the following specific objectives are set:

- To understand the concept of case based recommender system and how it is designed.
- To identify and collect the previous cases, facts, insights and rules that new tourists need to know in order to select tourism sites.
- To identify the main attributes that influence in tourism site selection process.
- To acquire, model, and represent the required knowledge for a recommender system
- To develop a prototype recommendation system to tourists on tourism site selection that best matches with their personal characteristics.
- To forward recommendations for further work.

1.4. Scope and Limitation of the Study

The scope of this research is to develop a prototype case based recommender system for tourism site selection based on previous solved cases. Nevertheless it did not include other activities of the culture and tourism office such as licencing and supervising, setting standards, etc. In addition, the aim of this research is to develop a prototype of the system since it is difficult to develop a full-fledged system within the given time and resources available for the research.

The main limitation in this developed system is the explanation facility is not user interactive. Another limitation of the system is since the main data sources are previous tourist cases which are collected from ACT office. Because of this attributes like number of tourists, annual income of tourists which should be considered in tourism site selection are not included in the case structure for the development of the prototype system since they are not available in the recorded file.

1.5. Significance and Application of the Study

The study primarily benefits Amhara culture and tourism office experts and tourists, especially the inexperienced tourism expert professionals are the immediate beneficiaries to improve their working habits. Hence tourism experts can use the system in recommending tourism sites to new tourists which fulfills their needs based on their personal or economical characteristics where highly qualified tourism expert professionals are unavailable in the sector. The developed prototype case based recommender system is used to give advising services for both foreign and local tourists. The case based recommender system is developed using the knowledge of different tourism experts and documentary sources which is used as organizational memory. Therefore, it gives better recommendation services where highly qualified tourism expert professionals are not found.

1.6. Organization of the thesis

The thesis is organized in to six chapters: **Chapter one** discussed about the introduction part of the study, background of the study, problem statement, objective of the study, scope and limitation of the study and significance of the study. **Chapter two** provides an overview of literature review on the recommender system, review on tourism, and related research works. **Chapter three** discussed about the methodology used to carry out the study. **Chapter four** focus on knowledge acquisition, representation and conceptual modeling procedures. **Chapter five** deals with design, implementation and presents the results found in the evaluation and testing process of the prototype case based recommender system and lastly **Chapter six** focus on final conclusions of the research and the recommendations forwarded for future studies.

Chapter Two

2. Literature Review

2.1. Recommender System

Recommender Systems are software tools and techniques providing suggestions for items to be of use to a user. The suggestions provided are aimed at supporting their users in various decision-making processes, such as what items to buy, what music to listen, or what news to read. Recommender systems have proven to be valuable means for online users to cope with the information overload and have become one of the most powerful and popular tool in electronic commerce [16].

In any Recommender system there are two basic entities which appear the user / customer and the item / product. A user is a person who utilizes the Recommender System providing his opinion about various items and receives recommendations about new items from the system [15].

Recommender systems have arisen to provide convenient suggestions to the users. These systems can be used for different purposes in several domains from offering papers to researchers to helping consumers in e-commerce. There are recommendation systems in different domains such as films, television programs, video, music, books, news, images, and web pages [17].So we can state that recommender systems are basically aim to overcome the difficulty of finding proper information from large amount of information. For Example, Amazon recommends books in book domain; Last.fm helps users to find the songs that they want to listen; and Movie Lens tries to guide users to reach the movies they might like.

2.2. Architecture of Recommender System

The main components of a recommender system make interaction to give recommendation for the user as shown in figure 2.1. 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 performs a recommendation algorithm that compares and/or combines user profiles and item descriptions. Then item with a maximum gain to the user is recommended [18].

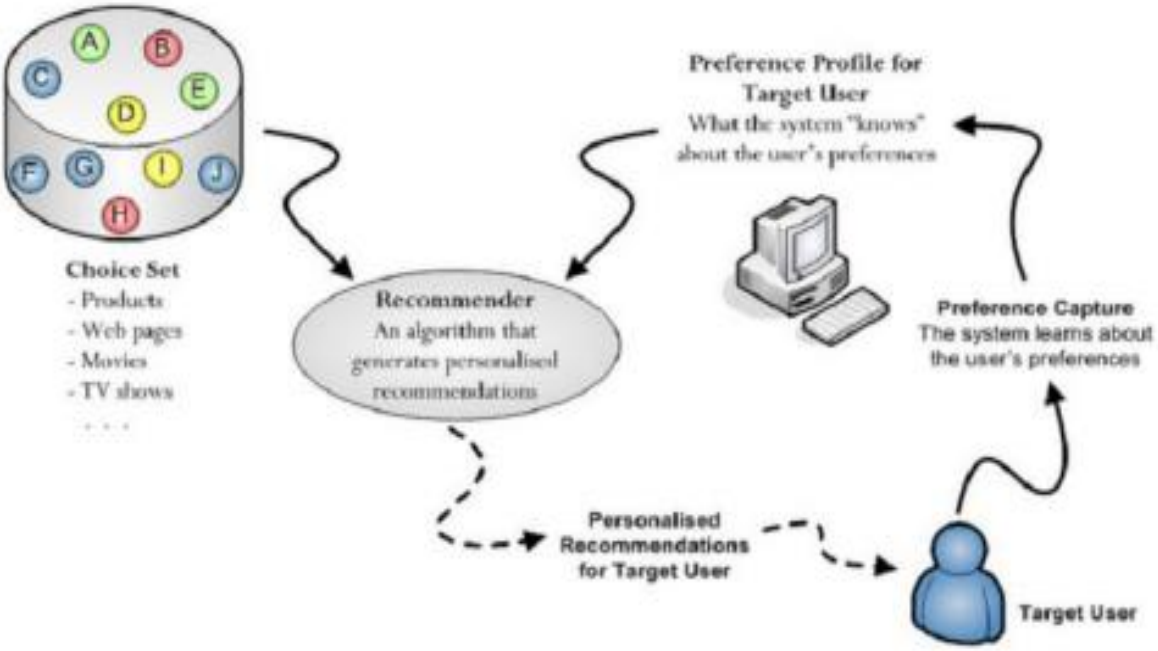

Figure 2.1 : Architecture of Recommender system [18]

2.3. Classification of Recommender Systems

Recommender systems are classified in to the following categories, depending on how they work [19]:

- ✓ **Content-based recommender system** is the one that provides recommendations taking into account the profile created from the content analysis of the items that the user has bought, used or visited in the past.
- ✓ **Collaborative filtering system**, in which recommendations only consider the similarity of terms between users. That is, collaborative systems recommend items that other users with similar interests like.
- ✓ **Knowledge based recommender systems:** Recommender systems based on knowledge consider the needs and preferences of each user to suggest recommendations.
- ✓ **Demographic Recommender Systems:** Demographic recommender systems have the objective of classifying the user according to his demographic information; therefore, recommendations are based on demographic categories.
- ✓ **Hybrid recommender system:** All of the recommender systems that have discussed about have their weak and strong points, so it is logical to try to maximize its profits and reduce its weaknesses by hybridizing two or more recommender techniques.

Since this study is concerned on knowledge based recommender system, the detail of knowledge based recommender system has discussed as follows:

2.3.1. Knowledge based recommender systems

Computer programs that try to solve problems in a human expert-like fashion by using knowledge about the application domain and problem solving techniques are known as Knowledge based system. Human experts use the knowledge they have about the domain and techniques that lead how to use the knowledge to solve problems. Knowledge based systems handle problems in the same way. They represent the knowledge about the application domain and they use one or more techniques that guides on how to use the knowledge to solve problems. Every knowledge based system has two building blocks which are known as knowledge base and inference engine [20].

Knowledge base contains all necessary knowledge about the domain that is required to handle problems. The knowledge can be acquired from experts, documents, books and/or other sources. It is formalized and organized with a technique called knowledge

representation. There are several ways to represent knowledge in the knowledge base. Two examples of such techniques are cases and rules. The second component of a knowledge base system is inference engine. After the system gets the required knowledge, it needs to be instructed how to use the knowledge in solving problems. Inference engine represents the reasoning technique that manipulates uses and controls the knowledge to solve the problems. Case based reasoning and rule based reasoning are two examples of reasoning techniques [21].

2.3.1.1. Architecture of Knowledge based systems

Figure 2.2 shows the building blocks of knowledge based system architecture [22].

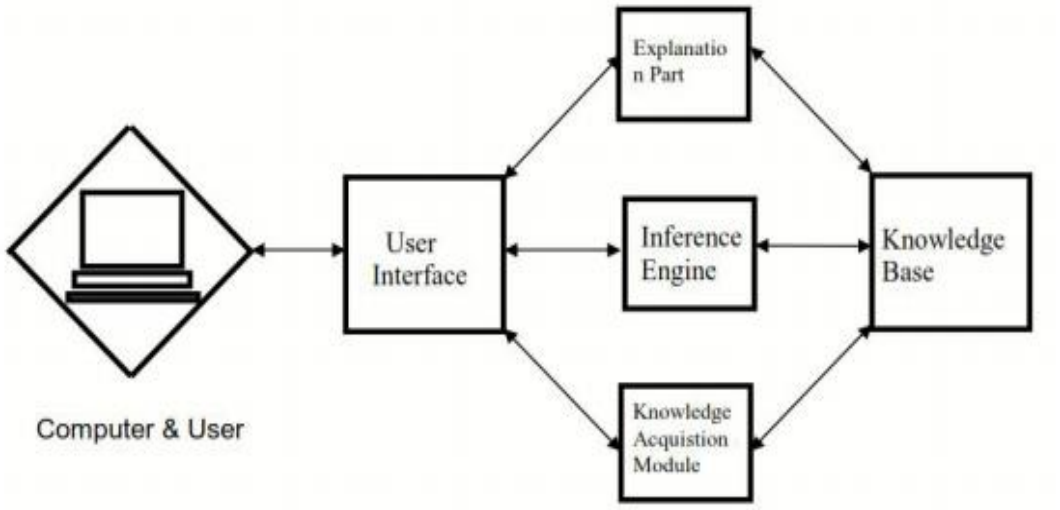

Figure 2.2: Architecture of Knowledge based system

As it is shown in the figure 2.2 the architecture of knowledge based system consists of different components such as Knowledge Base which contains all relevant knowledge acquired from domain experts including knowledge acquired from the user during their interaction with the system. The knowledge acquisition module helps in the collection process of knowledge from the set of human experts. The inference engines formulate questions and assert the answers provided by the user in a natural language form. It provides a mechanism for conveying recommendations to the end user. The explanation module provides a brief description to the user while the system arrived at a certain conclusion **[23]**

2.4. The Knowledge engineering process

The development of knowledge based system includes five major activities; knowledge acquisition, knowledge representation, knowledge validation, inferencing and explanation.

2.4.1. Knowledge acquisition

Knowledge acquisition is the process of acquiring relevant knowledge from human experts, books, documents, sensors, or computer files. The knowledge can be specific to the problem domain or to the problem-solving procedures, it can be general knowledge (e.g., knowledge about business) or it can be Meta knowledge (knowledge about knowledge). Knowledge acquisition is the bottleneck in knowledge based system development today. Because, the trustworthiness and the performance of the knowledge based system mainly depends upon the acquired knowledge [24].

The knowledge acquisition process incorporates different methods such as interviews, questionnaires, record reviews and observation to acquire factual and explicit knowledge [25].The performance of the expert systems depends upon the reliability, validity and accuracy of the elicited knowledge. The process of knowledge elicitation is affected by different contributing factors such as communication between the expert and ability of knowledge engineer. Therefore, effective elicitation techniques facilitate to acquire relevant knowledge form domain experts. The commonly used knowledge acquisition techniques are interview, document Analysis [25].

2.4.2. Knowledge Representation

It is the next task next to knowledge acquisition; this activity involves preparation of a knowledge map and encoding of knowledge in the knowledge base. It is discussed in detail in section 4.4.

2.4.3. Knowledge Validation

It involves validating and verifying the content of knowledge (e.g., by using test cases and confusion matrix) and user acceptance. It can be also described as checking the knowledge base of the Knowledge base system (KBS) for semantic faults that may occur during the KBS development. A validated KBS comprises the correct knowledge to perform like the domain expert in the domain area. Thus, validation searches for faults in the KBS behaviour when it attempts to find a solution for a certain domain problem.

2.4.4. Inference engine

Inference engine involves the design of software to enable the computer to make inferences based on the stored knowledge for the specific domain problem. In other word inference engine is a programs that reason over extensive knowledge bases. Or it can be described as the component that provides a methodology for reasoning and formulating conclusions. The

inference engine provides directions about how to use the system's knowledge to solve problems [26]. The purpose of the inference engine is to seek information and relationships from the knowledge base and to provide answers, predictions, and suggestions in the way a human expert would. The inference engine must find the right facts, interpretations, and rules and assembles them correctly.

2.4.5. Explanation

Explanation module involves the design and programming of an explanation capability (e.g., programming the ability to answer questions such as why a specific piece of information is needed by the computer or how a certain conclusion was derived by the computer). Explanation subsystem helps in justification of ES conclusions by tracing conclusions to their sources and showing how was a certain conclusion reached. One of the key characteristics of an expert system is the explanation facility. With this capability, an expert system can explain how it arrives at its conclusions. The user can ask questions dealing with the what, how, and why aspects of a problem. The expert system will then provide the user with a trace of the consultation process, pointing out the key reasoning paths followed during the consultation [26].

2.5. Knowledge based reasoning techniques

To build knowledge base, several knowledge based reasoning methods can be used. The most widely used knowledge representation techniques includes semantic network, fuzzy logics, rules, case base and frames. For the purpose of this research work case based reasoning approach is discussed.

2.5.1. Case based System

Case based systems are knowledge based systems that solve problems by remembering similar past situation and reusing its solution and lesson learned from it. Case based systems combine problem solving and learning from new experiences for future use [27]. The knowledge base of a case based system represents situations or domain knowledge in the form of cases and the inference engine uses case based reasoning method to solve new problems or to handle new situations.

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 [27] .Each case is constituted with three main parts: [28]

- **Situation/Problem description:** describes specific circumstances, states of a situation, and state of the environment when this particular case is recorded.
- **Solution:** provides how the problem described in the problem description was solved or treated in a particular instance.
- **Outcome:** describes the final result or consequence and feedback gained from following the proposed solution.

The structure of a CBR system is usually devised in a manner that reflects separate stages. However, at the highest level of abstraction, a CBR system can be viewed as a black box that incorporates the reasoning mechanism and the following external facets [29]:

- The input specification or problem situation
- The output that defines a suggested solution to the problem
- The memory of past cases, the case base, that are referenced by the reasoning mechanism

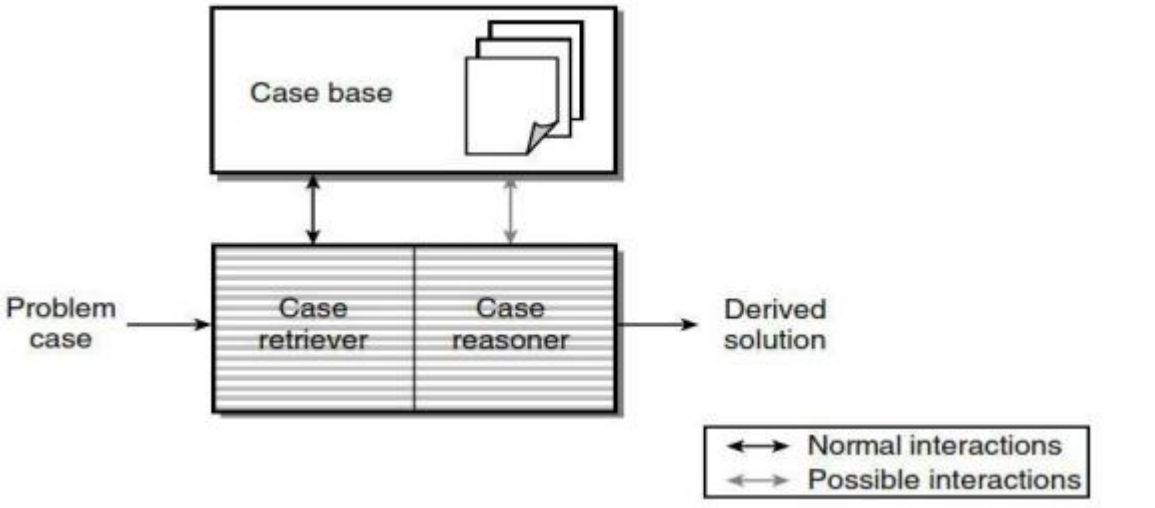

Figure 2.3 : The major components of CBR system [29]

In most CBR systems, the CBR mechanism, alternatively referred to as the problem solver or reasoner, has an internal structure divided into two major parts: the case retriever and the case reasoned [29]. The case retriever's task is to find the appropriate cases in the case base, while the case reasoner uses the cases retrieved to find a solution to the problem description given. This reasoning process generally involves both determining the differences between the cases

retrieved and the current case, and modifying the solution to reflect these differences appropriately. The reasoning process may or may not involve retrieving additional cases or portions of cases from the case base.

2.5.1.1. Case Based reasoning Cycle

Case based reasoning, as its name indicates, uses cases to reason about a given problem. In its problem solving process, it reuses old similar cases to understand the problem, suggest a solution, and/or to keep it from failure. A case based reasoning technique follows four processes; retrieve, reuse, revise and retain, to accomplish its reasoning task. Figure 2.4 shows sequence of the processes and each process is described below [27].

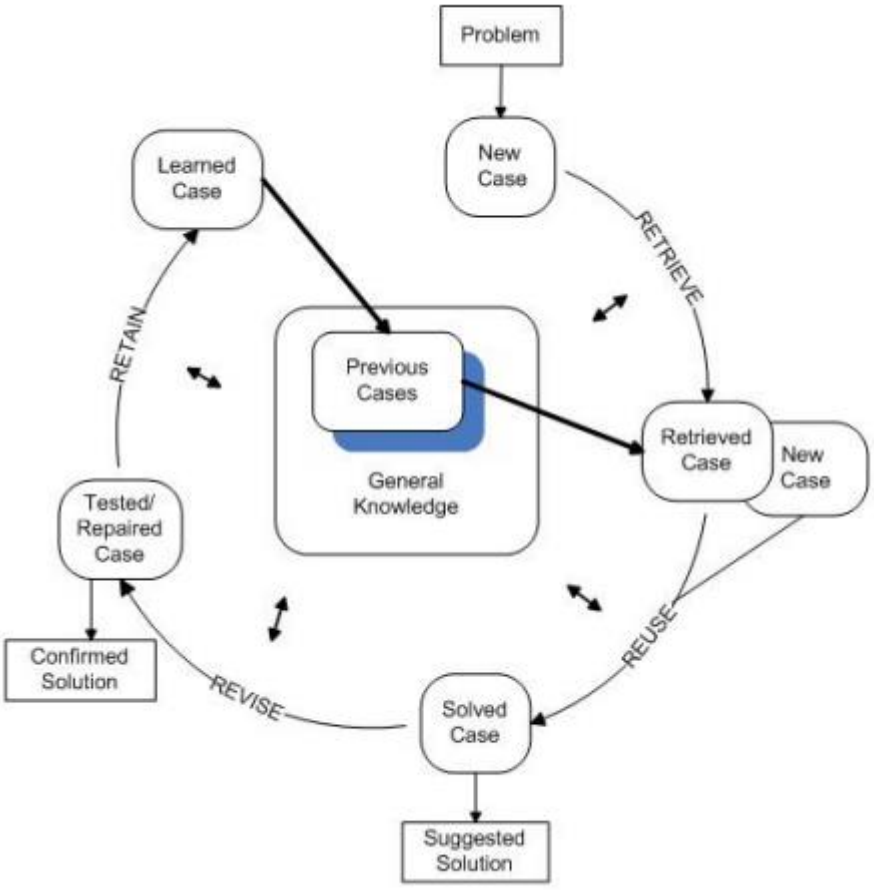

Figure 2.4: Case base reasoning cycle

2.5.1.1.1. Retrieval

When a new problem occurs, this process tries to identify the descriptive features of the new problem and searches previous cases that match with the new situation based on the identified features. Identifying descriptive features involves tasks of identifying properties that describe

the new problem, leave out those that don't describe it strongly and represent the descriptive features in a case format. There are algorithms that are capable of doing this task. For this research Nearest Neighbour Retrieval Algorithm is employed; and searching similar previous cases is performed by matching the new case with saved old cases from the knowledge base and it results in a collection of similar cases.

The final step of retrieval process is to select the best matched case or a set of cases from the collection of similar cases. To realize this retrieval task, CBR systems employ special similarity measures that allow the computation of the similarity between two problem descriptions. Because the interpretation of this similarity strongly depends on the particular domain, similarity measures are part of the general knowledge of the system. Different researchers describe the main tasks during retrieval of cases. For example [29] categorised case retrieval subtasks into three:

Identify features: which involves indexing the problem with the most descriptive feature in order to match it with indexed matched cases.

Initially match: searching previous cases that match with the problem at hand and it retrieves a set of plausible candidates.

Select: Selecting the best-matched case from the set of similar cases.

2.5.1.1.2. Reuse

The selected case in the retrieval process can be used to understand the new situation when it is not clear by itself, to propose a solution based on the solution taken on the selected case, or to prevent from following a wrong way of solving the problem based on the outcome of the selected case. Proposing a solution can be performed into two ways: reusing the solution as it is or by adapting it. When the selected case and the new case do not have significant difference, the solution in the selected case will be proposed as it is for the new problem. Whereas, if there is a significant difference between them, the solution in the selected case is adapted based on the unique feature of the new case, this process is known as adaptation.

2.5.1.1.3. Revise

In case based systems proposing a solution is not the only goal, it also aims to learn from the consequence of applying the proposed solution. This process evaluates how good the proposed solution is for the given problem. The evaluation is performed by using simulator,

by getting feedback from a human expert of the application domain or by applying it in the real world and see the result. This process may take hours; days or months until the result is being realized. The system learns from the result whatever it is: success or failure. If it is failure, the fault needs to be repaired and explanation of why the failure occurs should be given to prevent future similar problems from such kind of failures.

2.5.1.1.4. Retain

Case based systems upgrade their domain knowledge by learning from new experiences obtained while problems are solving. After the proposed solution for the given problem is evaluated in the revise process, the retain process identifies useful and worth remembering new experiences and decides how to merge with existing knowledge. This type of learning is known as incremental learning because it always adds knowledge that is new and useful in addition to the existing knowledge.

The new experience may be success or failure. If it is success, the retain process keeps how the problem is solved by modifying existing cases or by creating a new case if it has significant difference with the existing ones. The advantage of keeping failure processes is to prevent future similar problems from similar failure. The failure can be task failure where the solution is unsuccessful or expectation failure where the observed solution is different from the expected solution.

The bigger inner rounded rectangle in Figure 2.4 represents the knowledge base which is made up of cases and general knowledge. General knowledge of a case based system is domain-dependent knowledge that represents generalizations of cases, adaptation strategies and case matching procedures in order to support case based reasoning process [27].

2.6. Case based Reasoning Techniques

The basic Case-Based Reasoning techniques that are applied in any CBR research are:

2.6.1. Case Representation

A case is a contextualized piece of knowledge representing an experience that teaches a lesson fundamental to archiving the goal of the reasoner [30]. Typically, there are three major parts of a case as it is discussed in section 2.5.

Another way to describe case presentations is to visualize the structure in terms of the problem space and the solution space [31]. Figure 2.5 illustrates the structure. According to

this structure, the description of a problem resides in the problem space. The retrieval process identifies the features of the case with the most similar problem. When the best matching is found, the system uses similarity metrics to find the best matching case. In those processes, the solution of a case with the most similar problem may have to be adapted to solve the new problem.

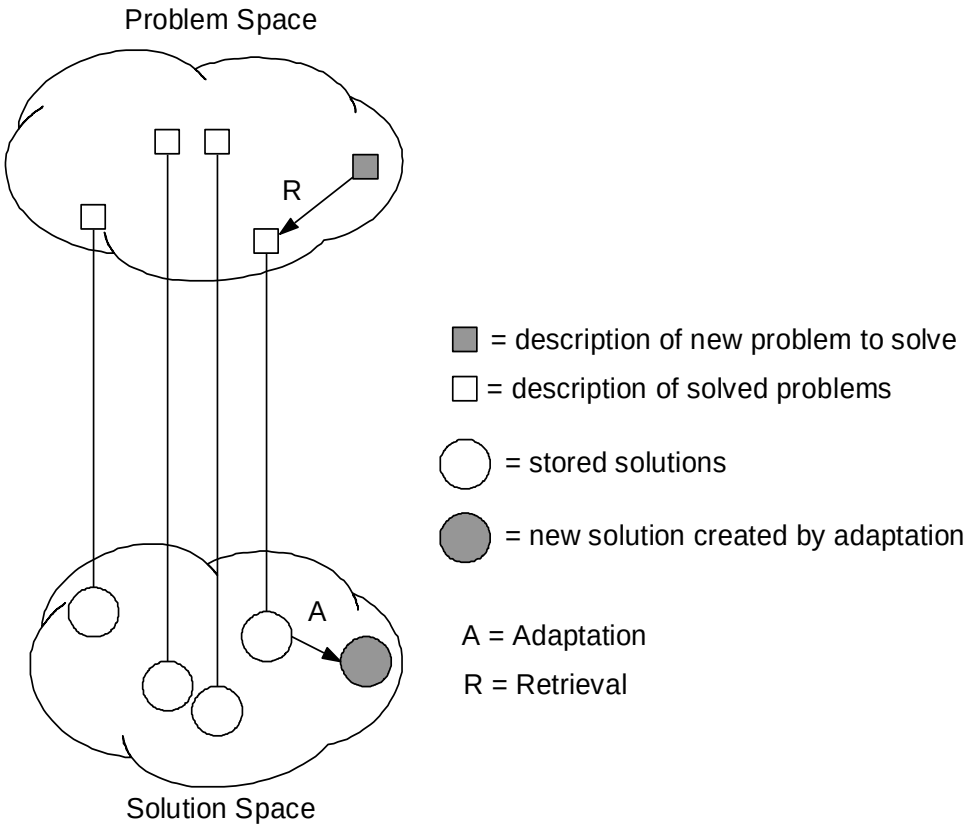

Figure 2.5 : Problem and solution space [31]

2.6.2. Case Indexing

An index is a computational data structure that can be stored in memory and searched quickly. Case indexing involves assigning indexes to cases to facilitate their retrieval [31]. The CBR community proposed several guidelines on indexing [30]:

- Indexes should be predictive.
- Predictions that can be made should be useful ones, that is, they should address the purposes the case will be used for.
- Indexes should be abstract enough to make a case useful for future cases.
- Indexes should be concrete enough to be recognized in the future.

Methodologies for choosing indexing include manual and automated methods. In some systems, cases are indexed by hand. For example, when the cases are complex and the knowledge needed to understand cases well enough to choose indexes accurately is not concretely available, hand indexing is needed [30]. On the other hand, if problem solving and understanding are already automated, it is advantageous to use automated indexing methods.

2.6.3. Case Retrieval

Case retrieval is a process that a retrieval algorithm retrieves the most similar cases to the current problem. Case retrieval requires a combination of search and matching. In general, two retrieval techniques are used by the major CBR applications: nearest neighbor retrieval algorithm and inductive retrieval algorithm.

2.6.4. Case Adaptation

It is a technique to alter retrieved case for reproducing new solution for new problem. It may be the most important step which adds intelligence. Case adaptation improves overall problem solving ability of CBR [32].

2.6.5. Storage

One important feature of a good CBR system is case storage [33]. It represents a logical view what is stored in case. For efficient retrieval, case base should be organized in a manageable way. These methods referred as a case-memory model. There are two best models these are Schank's and Kolodner's dynamic-memory model for organizing case base for efficient retrieval.

2.7. Advantages of Case based reasoning

A Case based reasoning approach has many advantages in developing knowledge base systems. Its main advantages are [34]:

- 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.
- 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.

- 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.
- 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.
- 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.

2.8. Disadvantages of case based reasoning

Even though case based reasoning approaches have number of advantages. But, due to lack of sufficient cases, the construction and inference mechanism of a case-based system loss the required objective. Some of the limitation issues in case-based reasoning are [34]:

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

2.9. CBR System Performance Evaluation Methods

The evaluation method for CBR includes both system performance (statistical analysis) and user acceptance [35]. The statistical analysis can be conducted for both retrieval and reuse process of CBR. The primary task of CBR is retrieving cases that are relevant to the problem from the case base [33]. The useful measures of retrieval performance in CBR are precision and recall. Recall is defined as the ratio of the number of relevant cases returned to the total number of relevant cases for the new case in case base. Whereas precision is the ratio of the number of relevant cases returned to the total number of cases for a give new case [36].

$$Recall = \frac{\text{Number of relevant cases retrieved}}{\text{Total number of relevant cases}}$$

$$Precion = \frac{\text{Number of relevant cases retrieved}}{\text{Total number of cases retrieved}}$$

To assure the applicability of the system in the real life in addition to system performance evaluation based on statistical analysis the system is evaluated with user acceptance testing. Because of a system that achieves better system performance statistically may not be comfortable to the user in solving a particular problem [37].

2.10. Tourism in Amhara region

As compared to other places of Ethiopia, Amhara region is by far the richest region in natural, wild life and historical attractions. The region is situated at the heart of the historic route of Ethiopia. In Ethiopia there are two historic routes. The northern rout compares both Tigray and Amhara region and most of the tourism sites to this rout are situated in Amhara region.

According to [40], UNESCO has cited the following attraction in Amhara as world heritage sites, namely, the rock hewn church of Lalibela, the relate of Ethiopian emperors at Gondar, the Semen mountains National Park which is famous for its breath taking landscape and also shelter of world's rare and endemic animal species of Walia ibex, the red fox and Chelada baboon. Likewise, [41] affirmed that there are popular tourist attraction sites such as the Blue Nile falls locally called 'tiss esat' and the nearby bridge built by king Fasil 300 years ago, the ancient monasteries of lake Tana which are noted for their traditional music's, the mummified remains of Ethiopian kings and hand crafts, the replaces and treasures of the past Ethiopian emperors, numerous other historical church's and Tigray sites from early Christianity located throughout the region. The Bureau added that the region's endowments in different species of birds, pleasant climate, beautiful scenery and hospitable people.

2.10.1. Tourist Flow in Amhara Region

The viability of any enterprises depends more on the rate of patronage by consumers. Tourism industry and the associated enterprises are location specific and services oriented. The range of goods and services has influence on the threshold population required for the survival on any enterprises. Tourism as an international commodity has its range extend to the whole world where it draws its consumers and the consumers has to get to the tourist

destinations to enjoy the pleasure of tourism. In Amhara region threshold population to sustain tourism enterprises is guaranteed as it an all year round business. Tourism enterprises in Amhara region draw its consumer both from within the country as domestic tourists and from different parts of the world as international tourists [42].

In 2004 alone Amhara region received a total 119, 044 domestic and 44,502 international tourists at various tourists' destinations in the region, while in 2005 the record was 51,089 domestic and 45,428 international tourists. The reduction of the domestic tourist for 2005 was due to non-availability of data from Lalibela location for that period (see Tables 7 and 8). Looking at the trend from the two tables it indicated that the tourists flow is ever increasing from year to year, thus tourism enterprises would ever have the required threshold population to sustain its growth which is yet to reach its maturity stage in the region [42].

2.11. Categories of Tourist Attractions

As stated by [14] the categories of attractions, with most promising key opportunities for potential visitors exist in the country today are grouped in such a way:

2.11.1. Natural attractions

It is an attraction that has been created by nature. Many of these areas have been given a status to protect their environment and provide facilities so that the public are able to enjoy the sights.

2.11.2. Cultural attractions

Ethiopian culture is very multi-faced, reflecting the ethnic diversity of the country. In Ethiopia, the culture of almost all regions like Tigray, Amhara, Konso, Somali, Oromo, Harar, Afar, Gambela, SNNP, are quite different one from the other and fascinating one to visit. There are also various cultural attractions of Ethiopian festivals that must be visited by visitors. The most prominent one are: Epiphany (Timket) and finding of the True Cross (Meskal).

2.11.3. Religious Attractions

Ethiopia is also endowed with various religious attractions in different parts of the country. The well-known ones are: Axum Tsion, the rock hewan churches of lalibela, monastery of Debre damo, various monasteries that are found in islands of Lake Tana etc.

2.11.4.Historical attractions

Ethiopia is a landlocked country in Eastern Africa located on the Horn of Africa. It is bordered on the north and northeast by Eritrea, on the east by Djibouti and Somalia, on the south by Kenya, and on the west and southwest by Sudan. As Africa's oldest independent country, Ethiopia covers 1.13 million sq. km (437,794 sq. miles). The country has various historical sites which have a great potential of attracting visitors to it. The top historical tourist destinations of the country are: Bahirdar, Lalibela, Gondar, etc.

2.12. Related research work

There are limited researches done locally towards designing case based reasoning. Hence, some of the related works conducted by local researchers in the knowledge based (case based) recommender system have been reviewed as follows.

Biazen [43] has done research study on application of case based recommender system in field of study selection in the case of higher education in Ethiopia. The objective of the author was to develop a prototype case base recommender system that assists the students in their 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 uses 105 cases which are collected from successful students as case base. These cases are used as an input for the system to provide recommendation. After accepting the input 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. This recommendation enables students to make decision easily. In this study, the author used JCOLIBRI case base development tool to develop the prototype of case based recommender system. After developing the prototype of the system, testing of the prototype for case base recommender system was done to evaluate the performance of the system. Based on user acceptance of prototype testing, the average performance of the system was 77.2% and 80.2% by the domain experts and students respectively.

Getachew [37], has also done research study on application of case-based reasoning for anxiety disorder diagnosis. The main goal of this research was developing a prototype case-based reasoning system that can give decision support for anxiety disorder diagnosticians at a different level of expertise. Overcoming the limitations of a rule-based knowledge base system such as incremental learning and specific knowledge acquisition are the instigation of this research. For the implementation of the prototype, successfully solved cases was

acquired from Amanuel Mental Specialized Hospital. In addition, the main parameters was identified in consultation with anxiety disorder experts. Then, the implementation of the prototype using jCOLIBRI case-based reasoning framework was realized. Finally, testing of the prototype case-based reasoning system was done to evaluate the performance of the system. The testing of the prototype was performed from two sides. The first one was testing in terms of precision and recall and registered 71% and 82% respectively. In addition to this, the average solution similarity using methods Leave One Out evaluator and Hold Out evaluation achieved performance of 73% and 75.5% respectively. The second one was the performance of the system was evaluated by the potential users' of the system and achieved 83.2% performance.

Yibeltal [38] has done research study on application of recommender system in investment activity selection in the case of Ethiopia. The objective of the researcher was to develop Case Based Recommender System that can give recommendation on the selection of investment sectors and investment activity in Ethiopia to foreign and domestic investors. Here also the system provides recommendation to new investors based on previously solved cases and new query given by the investor. The author uses 1344 cases which are collected from successful investor as case base. In this study the author also used JCOLIBRI. After developing the prototype of the system, testing of the prototype for case base recommender system was done to evaluate the performance of the system. Finally Based on user acceptance of prototype testing, the average performance of the system was 82% and 84% by the domain experts and investors respectively. And also the performance of the prototype was measured using recall, precision and accuracy measures, where the system achieves 85% recall, 64% precision and 87% accuracy.

Tamir [15] has done research study on application of case based recommender system in the tourism sector for the selection of tourist attraction areas in the case of Ethiopia. The aim of this research was to develop a prototype of case based recommender system for tourist attraction area and visiting time selection that can assist experts and tourists to make timely decisions. The author uses 615 cases which was collected from successful visitors as case base. In this study the author used JCOLIBRI development tool to develop the prototype of case based recommender system. After developing the prototype of the system, testing of the prototype for case base recommender system was done to evaluate the performance of the system. Based on prototype user acceptance testing, the average performance of the system was 80% and 82% by domain experts and visitors respectively. The performance of the

system was 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.

To conclude, some studies have been developed using case based reasoning technique to reason out the solution of a particular problem and specifically one study was performed in the domain area as to the researcher knowledge. But, the researcher's system did not include the main factors that should be considered in recommendation process such as marital status, profession and interested site type; did not give explanation facility to the users; and also based on the researcher the system recommends two recommendations. In addition there is still a big limitation on the system that was developed in its functionality. The system that was developed by the previous researcher make the solution attribute i.e. tourism attraction area as description and solution attribute but one attribute cannot be description and solution attribute in CBR system and hence the work that was done did not recommend the tourism site correctly since the system suggests the tourism site that the users feed to the system. Hence to solve the limitation of the developed system the researcher proposed knowledge based system that recommends four recommendations and provides explanation facility to the users.

Table 2.1: Summary of Related works

Author/year	Objective/purpose	Methods/Approaches	key findings	Remark
Getachew W.(2012)	Developing a prototype case based reasoning system that give decision support for anxiety disorder diagnosticians	Successful solved cases are acquired from Amanuel Mental Specialized Hospital; JCOLIBRI is used as a case base reasoning development tool.	The final system provides recommendation for anxiety disorder diagnosticians	The system did not have user explanation facility
Biazen G.(2013)	Developing a prototype case based recommender system that assists students in their field of study selection, Ethiopia	Data is collected as a case base from successful students, JCOLIBRI case base development tool is used to develop the system.	The developed system provides recommendation to the students based on previously solved cases and new query given students	The system did not give explanation facility
Yibeltal Y.(2013)	To develop case based recommender system that can give recommendation for investors in investment sector selection	Used cases are collected from successful investors from EIA office, JCOLIBRI is used as a development tool	The developed system provides recommendation to investors based on their query.	The system asks users to feed interested investment activity and it suggests itself to the users
Tamir A.(2014)	To develop prototype of case bases recommender system for tourist attraction area	The author collected data from MoCT office and National Tour operation, JCOLIBRI is used for developing the implementation	The result of the researcher provides recommendation for tourists based on their input query	Did not have explanation facility. The system suggests the users input itself.

CHAPTER THREE

3. METHDOLOGY

3.1. Research Methodology

With the aim of achieving the objective through answering the research questions of this study, the following methods and techniques are employed.

3.1.1. .Literature review

To get clear insight about the problem related to this research work, to collect necessary information related to recommender system and for the successful completion of this study relevant literatures such as books, journal articles, conference papers and some other sources are consulted.

3.1.2. Data collection and preparation method

To acquire the needed knowledge for this study, both primary and secondary data collection methods have been used. As primary sources, Tourism experts from ACT office and tourists from different tourism sites have been interviewed. Purposive sampling technique has been used to select domain experts based on their educational qualification and their position in the tourism sector. Tourists are selected by random sampling from different tourism sites.

To acquire the required knowledge from the selected domain experts and tourists semi - structured interview techniques have been employed since it allows the interviewer to change the order and add new questions based on the interviewee response.

The main source of dataset used to undertake this research was previous visitor's case from ACT office. The dataset contains a total of 54,895 visitor cases recorded in a year from 2010-2014. The dataset of each year stored in different Microsoft excel file. The researcher used purposive data selection methods to select sample datasets for this research, since there are large amount of data. Therefore, the main objective is to select successful tourists in each tourism sites and the researcher selected visitors who are successful or satisfied in their recreational program for this research as a case base. In the recorded dataset there is a remark column filled by experts marked as satisfied and not satisfied. Of these, the researcher selects successful visitors which are marked as satisfied in their recreational program for the development of the system.

There are totally 21,450 successful visitors from the total of 54,895 visitors. But since the data set having different problems such as missing value of majority attributes, redundancy, etc., the researcher selects one thousand four hundred forty eight (1448) cases of visitors from total of 21,450 successful visitors. Finally these 1448 cases represented as case base in a CSV format that are used as previously solved cases. From 1448 cases used for this research 688 are from Rock Hewn Churches of Lalibela site, 599 are medieval castles of Gonder site, 41 from Bahirdar town site, and 120 from Blue Nile Fall site. The number of samples from each tourism site depends on the total number of cases in the case base so the researcher selects the case from each site proportionally.

3.1.3. Case Representation

After the required knowledge is gained, the next task is knowledge (case) representation**.** The case representation task is concerned with the selection of relevant attributes, the definition of indexes and structuring the knowledge in a specific case implementation.

For this study, the acquired cases are represented using one of the different case representation methods that are appropriate for the researcher. Among the different case representation methods, feature-value case representation method have been used. Other case representation methods like relational database case representation, predicate based representation and soft computing case representation methods have their own advantages and disadvantages. But, for this study feature-value representation method is appropriate. Feature-value case representation method is a process of represent a case as a vector of attribute-value pairs, similar to the propositional representations used in Machine Learning (ML), that support nearest neighbour matching and instance-based learning. The reason for representing cases using feature-value representation is that this approach supports nearest neighbour retrieval algorithm and it represents cases in an easy way [33] and [44].

3.1.4. Programming Tool

There are various programming tools to develop recommender systems among these SWI-prolog, myCBR, and jCOLIBRI are the most widely used and known frame works for teaching and academic research purpose.

- For this research JCOLIBRI Case base recommender system framework is used since it is most appropriate programming tool for case base systems .According to [45] JCOLIBRI has the following capabilities.
- Has the ability of learn new cases.

- Suitable for developing large scale applications.
- It supports the full CBR cycles.
- JCOLIBRI is user friendly and works well in external database.
- JCOLIBRI is extensible, reusable, different types of users and different purposes, compatible with commercial applications and, supporting different types of CBR systems, since it is just a .jar file suitable for web applications.

❖ WEKA

The researcher also used another programming tool for this research for data preprocessing and attribute/feature selection methods.

3.1.5. Evaluation/Testing Procedures

To meet the established objectives of this study, the prototype system is extensively tested and evaluated. The retrieval performance of the system, the reuse performance of the system, case similarity of the system and system's user acceptance of the prototype are the main focuses of the evaluation process. performance measurement determine if the system perform the required task successfully whereas user acceptance measurements are concerned with issues how well the system addresses the needs of the user.

To evaluate the acceptance of the system the researcher provide the evaluators closed ended questions when they interact visually with the system by using appropriate cases.

The performance of the prototype system is evaluated using the standard measures of relevance precision and recall. Since the main goal of the retrieval task of the case based reasoning retrieving relevant cases from the case base, and hence precision and recall are useful measures of retrieval performance in case based reasoning [36].Different threshold value is used to measure the similarity between the existing case and the new case to implement the test .In addition the reuse process and the learning testing of the prototype system are evaluated.

The retrieval performance of the prototype system i.e. recall and precision and the reuse process of the prototype used 56 sample cases that make up the case base as training and testing data. Both retrieval and reuse process used leave-one-out cross validation testing proportion .The researcher conducted 56 experiments for both retrieval and reuse evaluation of the system. The performance of the reuse task is measured by using accuracy. To know how new cases are matched with the cases from the case base the researcher also made an experiment on case similarity testing.

CHAPTER FOUR

4. KNOWLEDGE ACQUISITION AND MODELLING

4.1. Knowledge Acquisition

Knowledge acquisition is the process of collecting, structuring and organizing knowledge from different sources such as from human experts, books, and documents. The acquired knowledge may be specific to the problem domain or to the problem solving procedures. Knowledge acquisition is the crucial and determinant phase in building knowledge-based systems. But, it is too difficult and capable of making an error task that knowledge engineer does while developing a knowledge-based system [46].

Knowledge acquisition step of this research work contains basic activities such as collecting the required knowledge, analysing it and identifying important concepts focusing on tourism site selection. To get the required knowledge the researcher used both primary (from domain experts and tourists) and secondary (from relevant documents) sources.

4.1.1. Reviewing Relevant Documents

The researcher carried out document analysis to acquire explicit knowledge which is found in various secondary sources of knowledge which are related to tourism site selection such as books, articles that are published in different journals, research papers, manuals, internet websites, Guideline and forms that are used in the process of tourism site selection. Finally relevant and technical knowledge were extracted and structured for the next steps of this research work i.e. for knowledge modeling and representation. The main data source (case base) used for this research is previous tourist cases found from ACT office.

4.1.2. Interviewing Domain Experts

Since one of the specific objectives of this research is extracting tacit knowledge which is embedded and personalized in experts mind. Hence the researcher employed both structured and unstructured interviews to elicit tacit knowledge from domain experts. For this reason, knowledge are collected from domain experts from ACT bureau; seven (7) domain experts have been interviewed to obtain the required knowledge on the domain area. These experts were interviewed issues like, how the expert interact with tourists, what are the major criteria to be considered to assign tourists in different tourist attraction areas, and what are the

possible tourist attraction areas recommended to the tourists and appropriate visiting time(see full interview questions in Appendix 1).

The researcher tries to make an extensive discussion with the experts to acquire the relevant tacit knowledge which is significant to generate the proposed case. In addition, the domain experts are actively participated throughout the research work and they are consulted to confirm the correctness of the acquired knowledge. During face to face communication, the acquired knowledge from domain experts has been recorded manually by using pen and paper sheet.

According to some domain experts, the investigation of visiting application starts by collecting some relevant information such as gender, travel frequency, age, annual income, and type of Visitor (nationality) i.e. whether they are domestic or foreign, attraction preference, length of stay, etc. But even if these visitor's files are collected, mostly experts assign visitors in different tourist attraction area based on their interest. During the discussion, almost all domain experts provided the same information about tourist attraction area selection advising system and they said that since there is no clear and consistent tourism guideline or criteria to assign or recommend visitors in different tourist attraction area, they simply asks visitors about their interested attraction area then gives some explanation about the selected attraction area rather than use a guideline or criteria to suggest tourists in suitable attraction areas.

Since one of the main target of this research is to identify the factors that has a great impact on the selection of tourist attraction area, the researcher forwarded few questions to domain experts about "what are the main attributes having effect on tourist attraction area selection?". The researcher also asked the effect of some attributes that are found from different secondary sources to get confirmation from domain experts whether it has effect or not. Based on the above questions domain expert said that, considering some of the profile of visitors and other attributes are important to determine the type of tourist attraction area to visitors; because some tourism sectors and tourist attraction areas have unique associations with age factors, gender factor, travel frequency factor, type of visitor factor, travel purpose.

Finally, domain experts conclude that, considering the above factors to assign visitors in different tourist attraction area is a very important thing to facilitate the service. Since tourists mostly choose the attraction area based on the opinion of others or their interests without considering the suitable time period of visiting, and other factors. Hence, experienced and

knowledgeable experts can identify the best attraction area to each visitor by considering different demographic characteristics of visitors, socio-economic factors and other factors to make immediate decision.

4.1.3. Interviewing Tourists

The researcher also gathered Primary sources of knowledge from tourists. Here again to elicit the required knowledge semi structured interview has been used. Since one of the main goal of interviewing visitors is to elicit relevant tacit knowledge, about seven (7) visitors were selected using random sampling techniques and accordingly they have been interviewed.

The interview with tourists covered issues like, how to get advising systems from domain experts, what are the problems in advising systems of ACT office and how you select tourism sites that match with your interest (see the interview question in appendix II). Based on the questions raised, visitors responded that, there were no sufficient and experienced tourism experts that could provide advice for each queries. Tourists further comments that, the advising system is quite different from expert to expert due to these reason tourism experts mostly recommend visitors on the area which is always familiar with them. Visitors said that it must need well organized and consistent advising guidelines for travellers. Difficulty of getting appropriate advice is a critical issue for visitors since knowing the right attraction area is a key factor, knowing the length of the trip and also knowing the right time to visit is another key factor to consider to new tourists. Visitors tend to lose money by choosing wrong tourist attraction areas and coming in appropriate time.

4.2. Attribute Selection using data mining tool

Since the original data sets that are acquired from ACT office has number of problems such as attributes have so many missing values, some attributes hold the values of other attributes, and no common writing way of attribute values. Hence the researcher undertake series of activities to overcome these problems on the data set. These activities are discusses step by step as follows.

4.2.1. Data Gathering

The researcher collected the data set/previous tourist cases from ACT office in year 2010-2014.The original document consists of 54,895 records which include the required information focusing on tourists and the factors on tourism site selection.

4.2.2. Data Preparation and Cleaning

Pre-processing the data helps to fill some missing values; to detect some outliers that may put the data mining result at risk; and to remove or correct some noisy data. Moreover, data preparation comprises several subtasks: selection, integration, transformation, cleaning as well as reduction and/or discretization of data and hence these tasks need to be performed. Usually these tasks are very expensive. The data originally were available in Excel format. Hence, to use it in WEKA software it should be converted in to CSV or ARFF format. Then data pre-processing have been made for cleaning it using WEKA software. Then, attributes that have so many missing values can easily be detected and removed. Values that are not in WEKA compatible form are modified. For instance, Weka doesn't handle values with space unless they are in single quotation. Therefore, since it is difficult to put all such values in single quotation, the researchers preferred to put them as one token by using underscores (_) to fill spaces.

After going through the data cleaning, the data is saved as CSV file format in which the values are saved in comma delimited form in order to create an ARFF format file. Finally the data that were converted into ARFF file format has been used for the experimentation for attribute selection.

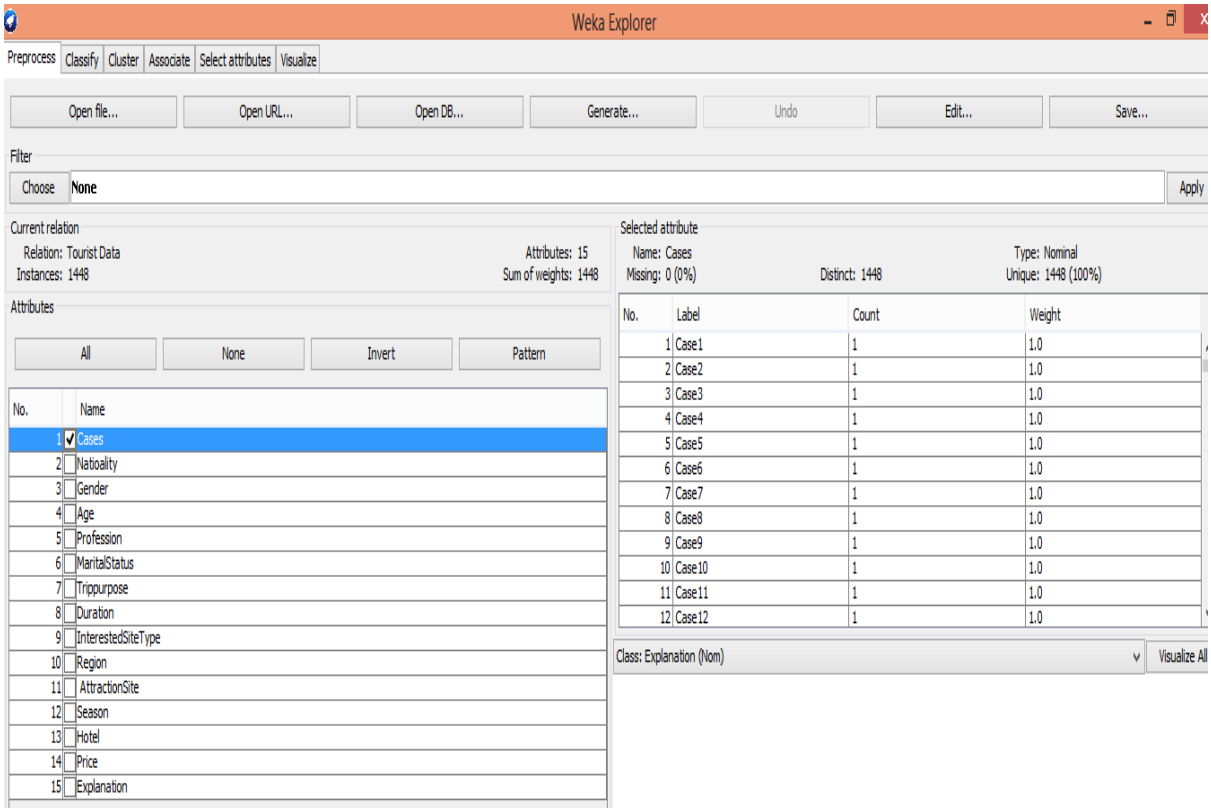

Figure 4.1: Data Cleaning using Data mining Technique

4.2.3. Feature/attribute selection

Attribute selection is a process of selecting a subset of relevant features for use in model construction from original features. The main idea of feature selection is to choose a subset of input variables by eliminating features with little or no predictive information. Feature selection can significantly improve the comprehensibility of the resulting classifier models and often build a model that generalizes better to unseen points. Attribute selection can be used to investigate which (subsets of) attributes are the most important ones. In data mining task, one can get some attribute that has little or no impact on the overall Tourism sector and tourist attraction area selection output. Feature selection reduces the number of features, removes irrelevant, redundant, or noisy data, and brings the immediate effects for applications: speeding up a data mining algorithm, improving mining performance such as predictive accuracy and result comprehensibility Therefore since there were several attributes in the recorded tourist data set, the researcher performs an attribute selection task using Weka attribute selection algorithm.

Attribute selection methods in Weka contain two parts: The first one is

A search method: such as ranking, best-first, forward selection, random, exhaustive, and genetic algorithmic.

An evaluation method: such as information gain, correlation-based, wrapper, chi-squared etc. For this research, the researcher uses a search method of ranking and an evaluation method of information gain attribute selection. The reasons for selecting information gain evaluation method and ranking search methods are: information gain attribute evaluation evaluates the worth of an attribute by measuring the information gain with respect to the class. Information gain evaluator is used to select the best attribute at each node in the tree. Such a measure is referred to as an attribute selection measure or a measure of the goodness of split. The attribute with the highest information gain (or greatest entropy reduction) is chosen as the test attribute for the current node. This attribute minimizes the information needed to classify the samples in the resulting partitions and reflects the least randomness or "impurity" in these partitions.

The attribute with the highest information gain is considered as the most discriminating attribute of the set under consideration. So, an attribute that yields maximum information gain will be chosen for data set partitioning. Then, a node is created and labelled with the chosen attribute, branches are formed for each value of the attribute, and the samples are

partitioned accordingly. The same criteria will then be applied to each split sample. The iterative divide and conquer process executes until no further split is required. Ranking search method is used to rank attributes by their individual evaluation from highest information gain value to lowest information gain value. The highest information gain value is the most important attribute for tourism site selection. Based on the experiment using information gain evaluation methods and ranking search methods the importance of attributes in ranking order are gender, age, nationality, interested site type, marital status, educational level, trip purpose, length of stay, and region.

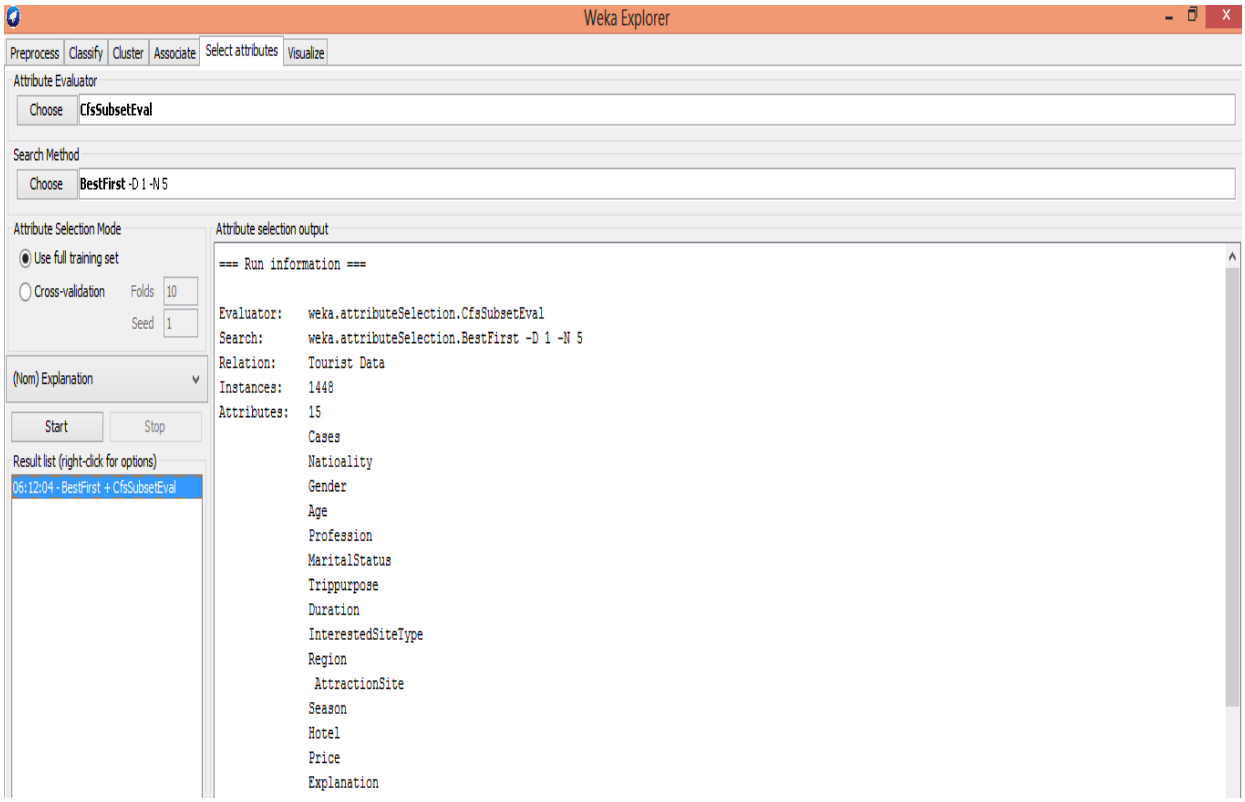

Figure 4.2: Attribute Selection using Data Mining Attribute Selection algorithm

After selecting attributes using attribute selection algorithm, the researcher consulted with domain experts for the purpose of validating the selected attributes which are useful in tourism site selection decision.

4.3. Conceptual Knowledge Modeling

During the knowledge modeling phase, the specialist's knowledge (elicited by various techniques) is represented in a knowledge model. A knowledge model is a structured representation of knowledge using symbols to represent pieces of knowledge and the relationships between them. Knowledge models include symbolic character based languages

such as logic, diagrammatic representations such as networks and ladders, tabular representation such as matrices and structured text such as hypertext. The generation and modification cycle of a knowledge model is an essential part of the knowledge modeling phase. The model helps to ensure that all stakeholders in a project understand the language and terminology being used and quickly conveys information for validation and modification where necessary. The knowledge models are also of great value during cross-validation with other specialists [47].

During the knowledge acquisition stage, most of the knowledge is unstructured and often in tacit form. The knowledge engineer will try to understand both the tacit and the explicit part of the knowledge and then use simple visual diagrams to stimulate discussion amongst users and knowledge experts. The knowledge engineer then has to construct the conceptual model from what has been discussed during the knowledge acquisition stage. This communicates the knowledge to the information specialist who will transform the model into workable computer programs or codes. This approach is similar to that of software engineering where models are used to represent user requirements. The main difference here is that in knowledge engineering, it is the modeling of knowledge and its related flows whereas software engineering models the information and process flow [48].

There are different conceptual modeling techniques and for this study hierarchical structure is used to model how tourism site selection is performed. To make the acquired knowledge reasonable for knowledge representation it is modeled using hierarchical structures. The context of this hierarchical structure is used to demonstrate clearly the tourism site selection which is implemented by using jCOLIBRI programming tool.

The model was built by the knowledge engineer after the core concepts are extracted from domain experts, visitors and secondary source of data (document analysis). After gathering the required knowledge, the knowledge engineer makes a discussion with domain experts to validate the knowledge that acquired from different source is correct for tourism site selection. In this study, the conceptual modeling technique is used to show how tourism site selection is held on.

Hierarchical structure was used to model the knowledge. The hierarchical structure as shown in figure 3.1 is derived from the knowledge acquired from in the consultations of experts, tourists and secondary sources. These hierarchical structures are the base for the prototype knowledge based system development. The prototype knowledge base system is developed

based on the model presented in these hierarchical structures. The prototype follows the procedures presented in the hierarchical structure to recommend tourists where and when travel. In the following hierarchical structure figure 3.1 the main factors of tourism site selection to reach a better decision and the fundamental procedures during the tourism site selection are structured.

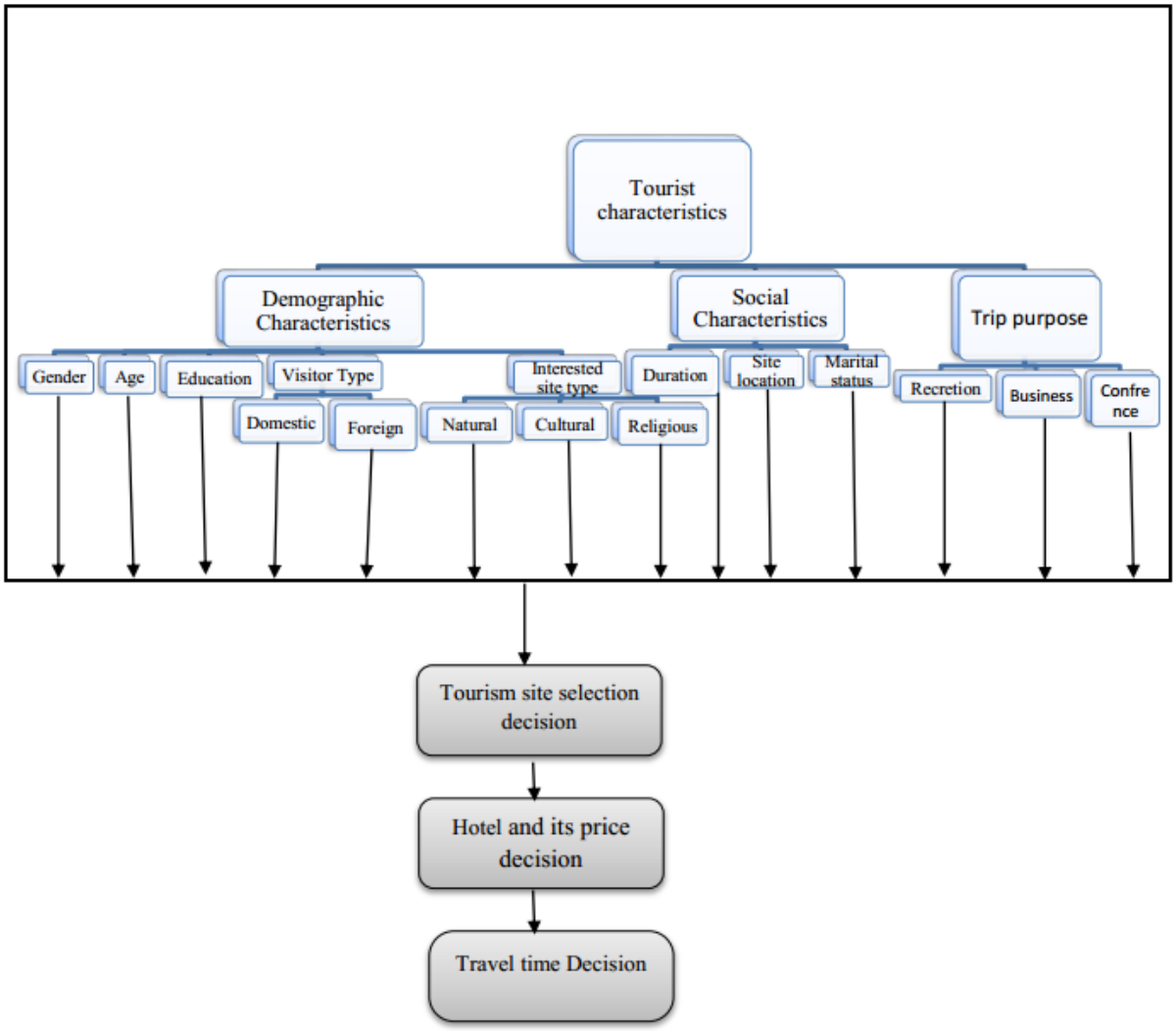

Figure 4.3: Hierarchical Structure of tourism site selection

4.3.1. Factors that influence Tourism site selection

Consumer behaviour is a highly important issue for all marketing activities which have the purpose to promote and sell tourism products.

The tourism consumer behaviour can be defined as the ensemble of its acts, attitudes and decisions regarding choosing, buying and consuming tourism products and services, and also its post-consuming reactions [49].

The discovery of the consumer's needs and decision processes is very important for the marketing activity because it allows the marketing manager to improve his own decision-making process, to forecast future behaviour and to have a real and objective of the consumer demand. Understanding consumer behaviour is important for developing new tourism products and services because it offers a clearer view of what consumers are looking for and the manager can reflect them in the development process.In order to develop effective and efficient advertising campaigns, it is required to comprehend consumer behaviour. The tourism consumer behaviour is influenced by many factors, the basic ones are: Demographic (personal) factors, social factors and economic factors. The detail of each factor is discussed below [49]:

4.3.1.1. Gender

The gender of the tourists can influence their choice. For example, women choose shopping holidays, or holidays that include beauty and body treatments, spa and men can opt for sports holidays such as golf tournaments, or participate in various sporting events (tennis championships, football games etc.). Studies have shown that women put more value on physical and emotional relaxation in a trip. Also males have been noted for travelling often as a result of work associated issues or businesses, while females on the other hand are noted for travelling more for recreational reasons. Therefore, decision on destinations to visit could be reflected in gender. Gender is related to personality, visitor‘s way of acting and their intentions to go towards attractions. Opposite views in socio- psychological intentions which represent push and pull factors that determine destination choices. These pull and push factors were analysed on leisure travellers from a gender point of view. There is also a difference in the gender decisions as concerns push and pull factors. Females were seen to make decision associated with culture, family bonding opportunities and ego while male's decisions were related to sports, and new experiences when planning on destinations to visit [50].

On the other hand, females are more risk averse in their choices of destinations to visit and consider educational opportunities while males are adventurous or risk taking in their decisions. In addition to that, males and females of the same age group could have different views as regards leisure destination choices. In business travels especially considering hotel choices and service delivery, women prioritized security, self-service and lower prices as

opposed to men who valued business services and things associated with more when making decisions.

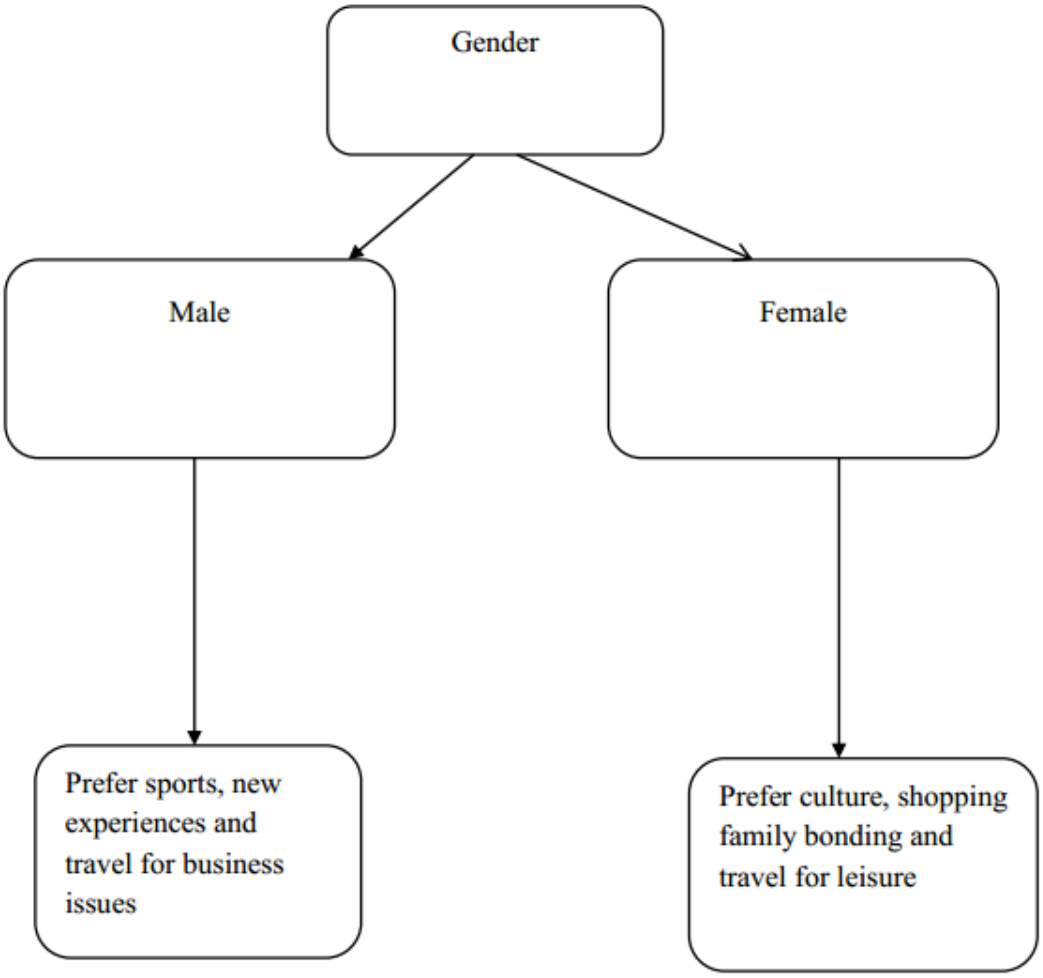

Figure 4.4: Gender factor in tourism site selection

4.3.1.2. Age

On cultural motivations and relaxation-based motivation the age of a tourist had a significant effect. For the cultural motivations factor, tourists in the oldest age categories were more likely than tourists in the youngest age category to travel to the destination based on the need to increase their knowledge of local places and to meet local people. For the relaxation-based motivations factor, tourists in the oldest age category (56 and over) were more likely to travel to the destination based on the need ‘‘to relax’’ and ‘‘to enjoy good weather,’’ compared with those in the youngest age category (18 to 35 years). Tourists in the 36 to 55 age group were more likely to travel to the destination based on the need ‘‘to be emotionally and physically refreshed,’’, compared with tourists in the youngest age category (18 to 35 years).Tourists in

the youngest age category were more likely to travel to the destination based on the need ‘‘to engage in sports, ’compared with tourists in the oldest age category (56 years and over) [50].

With respect to age differences, older tourists were more likely to travel for reasons based on cultural exploration and relaxation, whereas younger tourists were more likely to travel to engage in sports. Older tourists (who are likely to be retired and have more free time) tend to desire mental stimulation and prefer to visit countries to increase their knowledge and awareness, and learn new experiences. Younger tourists are more active and are more likely to seek a whole range of physical activities when visiting a destination [50]

Generally, Tourists in the age category (56 and over) desire to increase their knowledge of local places, to meet local people and ‘‘to relax’’ and ‘‘to enjoy good weather” whereas tourists in the age category (36-55) are more likely to travel to the destination based on the need to be emotionally and physically refreshed. And finally, tourists in the age category (18-35) are more likely to travel to the destination based on the need to engage in sports.

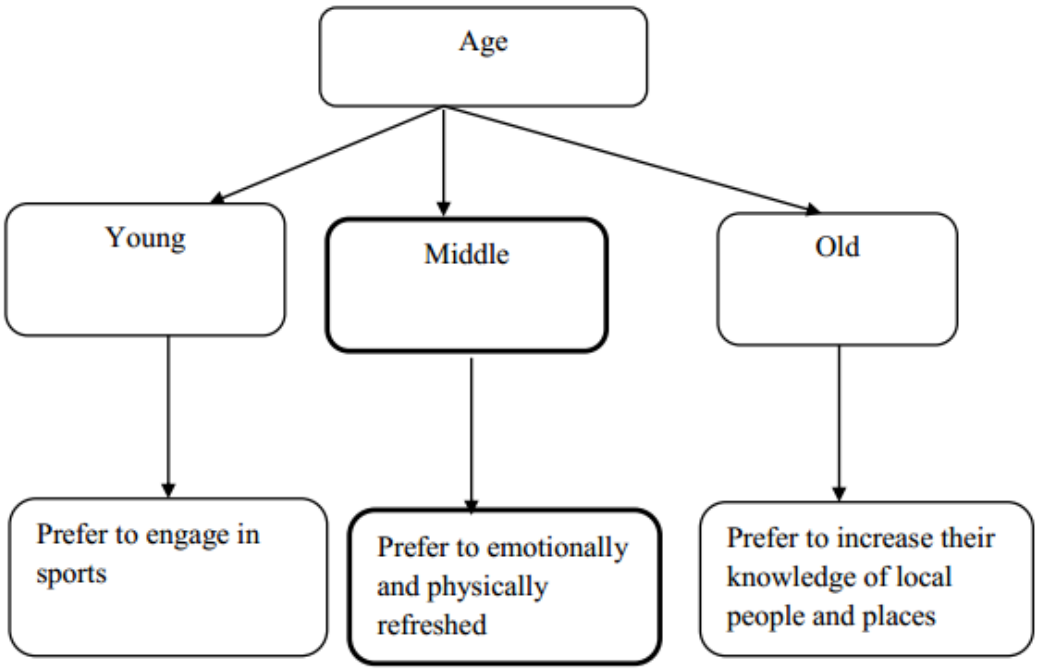

Figure 4.5: Age factor in tourism site selection

4.3.1.3. Type of Visitors

Visitor is any person travelling to a place other than that of his/her usual environment for a period not exceeding twelve months and whose main purpose of visit is other than the exercise of an activity remunerated from within the country visited. There are two types of visitors [7].

Domestic/Internal Visitor: A person who travels within his /her residential country and outside his/her usual environment. The maximum duration of the trip is twelve (12) consecutive months. These are visitors who have Ethiopian nationality or live in Ethiopia and participate in different attraction areas for visiting purpose.

Foreign /International Visitor: one who visits a country other than that in which he habitually lives for a period of at least 24 hours and a maximum of twelve consecutive

months. And hence these are visitors who have no Ethiopian nationality or nationality of other country. For the development of the tourism sector, getting more international tourists are better than the domestic ones because the revenue earning from them is by far interesting than the local tourists for the advancement of the sector. Therefore, there is no restriction to visit an area for both the domestic and the local tourists, as so long as they can accommodate all the necessary service including the entrance fee.

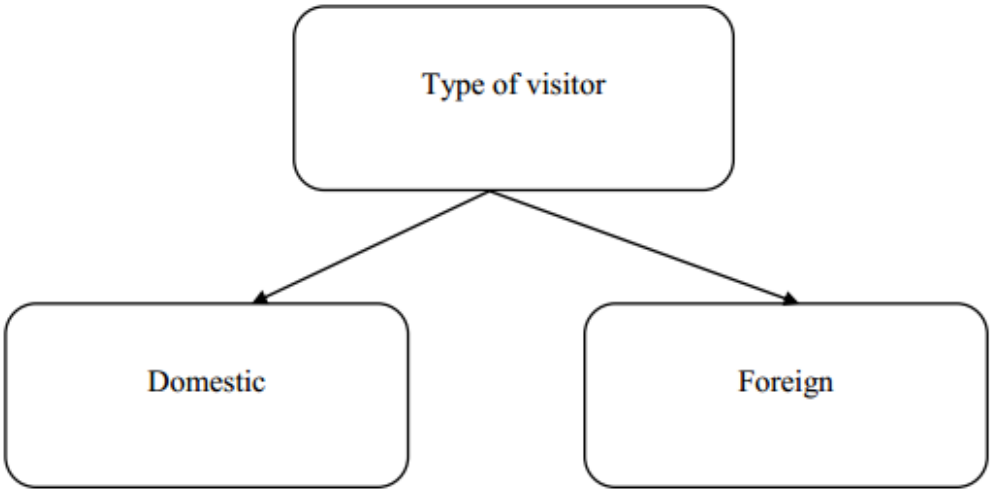

Figure 4.6: Type of Visitors

4.3.1.4. Profession

Profession also has a great impact on tourist tourism site selection. Elementary level tourists wants to visit attraction areas like that are good for playing whereas secondary level visitors more likely to visit areas which have sports activities and college or above level tourists more likely want to increase their knowledge of experience in their life [51].

4.3.1.5. Location of attraction areas

Tourism sites are located in different locations or regions in the Ethiopia and their location is a critical factor for success or to be satisfied in tourists visiting programme. A greater environmental awareness and a society that takes its health and fitness more seriously than it was in the past. This awareness has affected travel and tourism developments in the recent years. 'Green issues' such as the development of eco-tourism, green hotels and conservation of heritage sites are becoming more and more important which provide a basis for sustainable tourism development of a tourist destination. Travel and tourism has always been an industry that has made extensive use of new technological equipment. And hence, tourists should consider different facilities such as computerized reservation system (CRS), the use of computers and sophisticated databases for marketing purposes, latest developments in transportation make extensive use of new technology, etc. [12].

Generally there are factors to consider when establishing your tourism site location if it is manmade it is better to think about the availability of different services like transportation facility, communications, accommodation, etc. are key driver factors in strengthening the national economy and enhancing Ethiopian productivity. Service availability promotes both foreign and domestic visitors because service availability growths are associated with greater accessibility and reduction in transportation costs and maximization of profit [14].

Tourist Attraction locations in Amhara region

Amhara region is blessed more with abundance and diversify natural environment than other regions in Ethiopia. It has more of the tourist attraction locations within it boundary. The major tourist attraction locations have been grouped into four [40].

1. **Rock-Hewn Churches of Lalibela**

This is another fascinating historical spots found in small town called Lalibela six hundred-kilo meters north of Addis Ababa the capital city of Ethiopia. The 11 medieval monolithic

cave churches (Bete Medihane Alem, Bete Mariam, Bete Amanuel, Bete Merkorios, Bete Abba Libanos, Bete Gebrael - Rufael, Bete Meskel, Bete Denagil, Bete Debre Sina, Bete Golgota, and Bete Giyorgis) of the 13th century of referred as ´´ New Jerusalem`` constricted around 12 century attributed to King Lalibela who set out to construct the church after Muslim conquests and bring to an end the Christian holy land Jerusalem. It considered as Africans New Jerusalem, it is one of spectacular and extraordinary historical site.

From the top of view the churches is simply the sign of Cross but when you enter under the cave you will experience the amazing and complex design of the churches in the current era nobody seemed to figure out how from one huge rock could be made eleven different huge churches without using no modern technologies. All the eleven churches represent a unique artistic achievement, in their execution, size and the variety and boldness of their form. The whole of Lalibela offers an exceptional testimony to the medieval and post-medieval civilization of Ethiopia.

Rock-Hewn Churches, Lalibela is registered UNESCO world heritage site and attracts thousands of tourists, it recommendable to go during the great celebration of Genna (Ethiopian x-mass) and Timket (Epiphany) is particularly rewarding. It is such colourful and unique beautiful holiday celebration

2. Fassil-Gebbi Castles of Gondar

Fasil Ghebbi is a palace is located in Gondar, Ethiopia. Gonder was the 17th century's capital of Ethiopia and it is notable for its Medieval Castles and Churches. The city's unique imperial compound contains a number of Castles built between 1632 and 1855. It served as the home of Ethiopian's emperor Fasiledes and various Emperors who ruled during this period in the 17th and 18th centuries. This is only one of its kind architecture shows diverse influences including Nubian, Arab, and Baroque styles. The site was inscribed as a UNESCO world heritage site in 1979.

In this compound there are fascinating historic sites such as the Bath of Fasiledes famous for the celebration of Ethiopian Epiphany holiday, Fasiledes castle, lyasu's Palace, Queen Mentewab's Castle and three churches. The main castle which is very incredible and notable was built in 16130s and early 1640s on the orders of King Fasiledes, who was the founder of the city of Gonder as a capital and responsible for the constriction of most of spectacular architectural castles during his era. "With its huge towers and looming battlemented walls, it

resembles a piece of Europe transposed to Ethiopia. This is also the main tourist attraction in historical route. Ethiopian Airlines has a daily flight to this destination from the capital Addis Ababa mainly for the convenience of tourist´s.

3. **Bahir Dar**

Bahir Dar, the capital city of Amhara regional state serve as the gateway to the main attraction location in the region with several tourist sites which include: Lake Tana , Islands and Peninsular Monasteries, Wanzaye Hot spring, Orthodox churches, cultural activities, Souvenirs and artefacts of silver, brass and gold.

4. **Blue Nile Fall**

Blue Nile, the Grand River in Africa is one of the natural wonders of Ethiopia especially for its breath taking falls. The Blue Nile Falls near Tis Abay town, 35 Kilometres South East of Bahir Dar has been drawing the attention of tourists from different corners of the world. That is why thousands of visitors are seen streaming to this most spectacular scene.

The Blue Nile Falls locally known as "Tis Isat" or "Smoke of Fire" that the water stretched on 400 metres wide surface and plunging dramatically 45 metres deep creates drizzly plethora that in turn produces brilliant rainbows across the gorges of the river. The mistydeluges drive the onlookers up to a kilometres away. The curtains of the spray enthral any visitor and will not ever vanish from memory .Specially, a morning visit rewards tourists with the astounding rainbows. Environ of these falls is endowed with marvellous landscapes, natural forests and multi-coloured birds.

4.3.1.6. Duration of Stay

Duration of stay is the time period that tourists have, to visit a certain attraction. It can be for 2 weeks, a month, or a maximum of 12 months. Here visitors have to put the exact time that they have, to make a tour while visiting because if one tourist want to stay in a certain area for about a month, that specific attraction area may not have sufficient facilities like accommodation, food and beverage to stay more and the tourist may get suffer in such a situation.

4.3.1.7. Marital Status

Marital status also has a factor on the selection of tourism site. Single visitors are more likely want to visit areas like religious attraction sites, married visitors more likely to visit areas which have good environment like natural attraction sites whereas visitors who are in the status of retirement want to visit cultural tourism sites to increase their knowledge of experience [51].

4.3.1.8. Trip purpose

Travel purpose refers to the reason that, the entrance of tourists in the country. It might be for business, visiting relatives or friends, for leisure, for education etc. Therefore, visitors should specify the motive that initiates to make a tour in a certain attraction area before they start their visiting activity because some places may not give sense for some visitors if it didn't match with his/her motive.

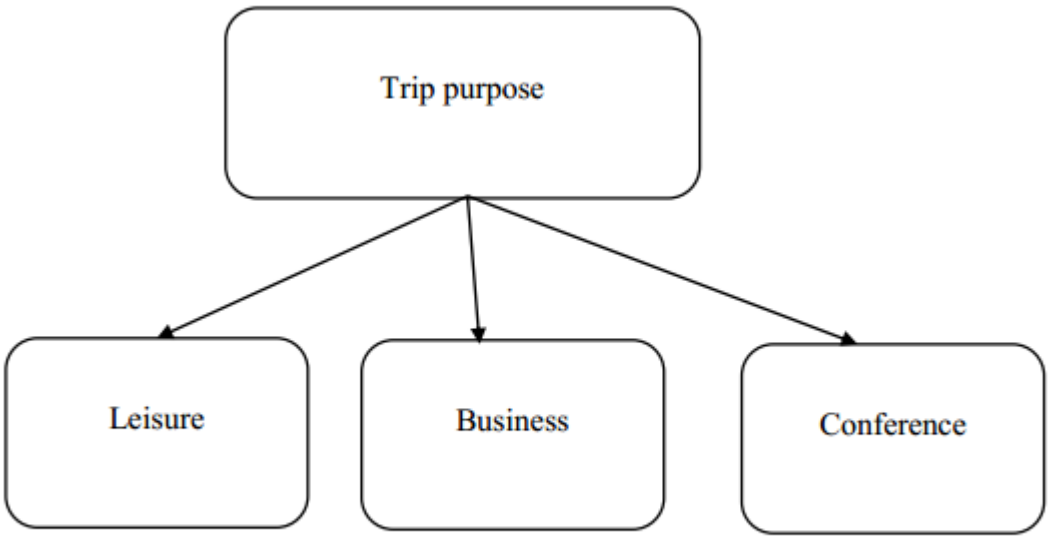

Figure 4.7: Trip Purpose

4.4. Knowledge Representation

Once the knowledge has been acquired and modeled, the next step is knowledge representation using appropriate format that is both understandable by end-users, experts and inference engine.

Knowledge representation is a means of encoding the human experts' knowledge in an appropriate medium. It is the dedication to a vocabulary, data structures, and programs that

let domain knowledge usable. In other word Knowledge representation is the process of interpreting domain knowledge into computer understandable form using knowledge representation methods. Knowledge representation techniques include semantic network, logics, rules, case base and frames [35]. From these, the researcher used case based representation method for this research.

The acquired cases are represented using one of the different case base representation methods that are appropriate for the researcher. Case base representation methods include feature-value case representation, database case representation; predicate based case representation and soft computing case representation methods [52].

For this research the researcher used feature-value case base representation method. The reason for representing cases using feature-value case based representation is that this approach uses old experiences to understand and solve new problems. It also reuses its solutions and lessons learned for future use. And also it represents cases in an easy way by using attribute and value pair representation [44].For this study nearest neighbor retrieval algorithm has been used to calculate the similarity of cases in a case base representation. The similarity function of nearest neighbor retrieval algorithm involves in computing the similarity between the stored cases in the case base and the new query. Finally, it selects the most similar stored cases to the query.

Nearest Neighbour Retrieval Algorithm

Nearest neighbour retrieval technique is used to measure similarity between the source case and the case which we are searching [29]. The nearest neighbour algorithm measures the similarity of stored cases with a new input case, based on matching a weighted sum of features [33]. 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 [53]. But the retrieval time of this algorithm increases linearly as the case in the case base increases. The algorithm for nearest neighbour is as follows [44]:

- For each feature in the input case
- Find the corresponding feature in the stored case base
- Compare the two values to each other and compute the degree of match
- Multiply by a coefficient representing the importance of the feature to the match
- Add the results to drive an average match score

- This number represents the degree of match of the old case to the input.

4.5. Case Structure of Tourism site selection

Tourism site selection case structure has two parts. The first part is the input specification (tourist case)/or problem case descriptions or situation and the second one is the output suggested solution.

Query description/Situation: Part of tourism site selection case structure which consists of attributes that describes about tourist.

Output suggested solution: It is the second part of tourism site selection case structure and provides the recommended tourist attraction site, appropriate time to visit the area and services based on the problem description.

Hence, to accomplish this study the researcher identified different description/situations and solution attributes with the help of tourism expert and from recorded data set of previous tourist's cases. However, there were different problems during identification and representation of case structure. One of the first challenge was the attributes (the tourist's information in this case) registered in the ACT bureau was so enormous, so the researchers selects the most important attribute which used to determine tourism site selection using data mining feature/attribute selection algorithm by using Weka software. Then the researcher selects nine (9) significant attributes from the total of 16 ones. The other challenge was the previous tourist cases were recorded in different formats such as in hard copy, word and Excel; and the researcher lost a lot of time to encode them in electronically meaning converting the word format and hard copy to excel format for the development of recommender system. The most significant attributes that affects tourism site selection decision are shown below:

Table 4.1: The case structure for tourism site selection

Attribute Name	Parameter
Gender	Description
Age	Description
Nationality	Description
Profession	Description
Marital status	Description
Duration of trip	Description
Trip purpose	Description
Interested site type	Description
Region	Description
Recommended attraction site	Solution
Recommended Visiting time	Solution
Recommended Hotel and its price	Solution
Explanation facility	Solution

The brief descriptions of attribute which are used for making the case structure are presented below:

Gender: is one of the attribute that represents a tourist sex as male or female. The value of this attribute is either male or female.

Age: is the length of time that a tourist lived and its value is a number.

Nationality: is the term used to refer to the status of belonging to a particular nation. The value of nationality is either Domestic or foreign. Domestic means visitors who have Ethiopian nationality and foreign means visitors who have other nationality (a visitor who has not Ethiopia nationality).

Profession: refers to the highest level of schooling that a person has reached. The value of Educational level can be either of the three values such as elementary, high school or College or above.

Marital Status: One's situation with regard to whether one is single, married, separate. The value of marital status can be any of the three values such as single, married or separate.

Trip Duration: it is the time period that tourists have to visit a certain attraction. It can be for a week, a month, or a maximum of 12 months.

Trip purpose: it is the reason that, the entrance of tourists in the country. It might be for business, leisure or conference etc.

Region: is the location of tourist attraction site that specifically facilitates service to visitors. So a tourist feeds a region to the system.

Interested site type: is the visitor's interest of attraction site type such as cultural, religious, etc. that they want to visit. Hence, tourists fill (enter) their own interest of attraction type as a query.

Recommended attraction site: it is a suggested solution and provides a recommended attraction area based on the similarity of cases.

Recommended visiting time: it is also a suggested solution and provides recommended time to make a tour and visit a certain attraction so that visitors can easily identify the right time to visit.

Recommended Hotel and its price: It is also another suggested solution that provides tourist standard hotel and its price based on a query of a tourist.

Explanation Facility: is used to provide explanation and description about the recommended tourism attraction site.

CHAPTER FIVE

5. IMPLEMENTATION AND EVALUATION

5.1. Introduction

The implementation and performance evaluation part of this research involves the actual development of a prototype case based recommender system for tourism site selection for new tourists; and testing and performance evaluation of the prototype. Hence, after having all the necessary previous tourist's cases from ACT office and the knowledge from the domain experts and different relevant documents, the next task is coding the knowledge into computer using appropriate and efficient knowledge representation methods. To develop the CBR system of this research the researcher used JCOLIBRI 1.1 to design and implement the prototype of recommender system. Since JCOLIBRI uses nearest neighbor retrieval algorithm for retrieval task and also nearest neighbor retrieval algorithm is suitable when there are attributes which have numeric (continuous) value [54]. Therefore the researcher used nearest neighbour retrieval algorithm for retrieval task.

5.2. Designing the Architecture

An architecture is a blueprint showing how the components of the prototype case based recommender system for tourism site selection interacts and interrelates. Figure 5.1 illustrates the architecture of the CBRTSS system.

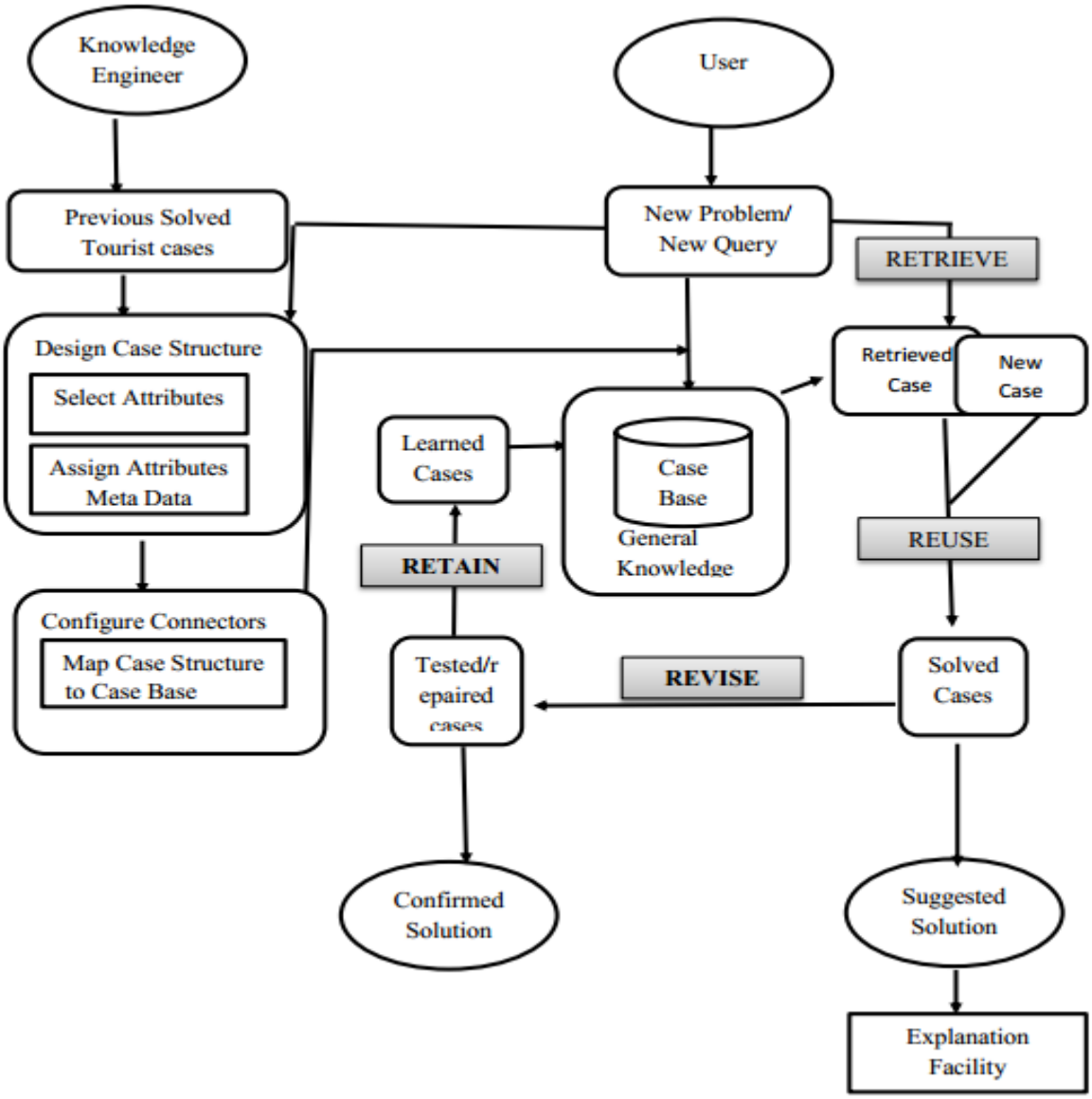

Figure 5.1: Architecture of the prototype

As shown in figure 5.1 the architecture of CBRTSS shows how the prototype works during tourism site selection. The prototype of CBR system for tourism site selection functions by getting the new query or problem or users are required to put/enter their problem description and then the system retrieves similar previous solved cases from the case base. After retrieving cases then it ranks cases based on the similarity measurement then the most similar one proposed as a solution to the user. If there is exact matching between the query and previous cases in the case base, the system recommends the most matched tourism site, visiting time and hotel and its price for tourists. If the similarity between query and existing case is approximate, the proposed solution needs modification (adoption of solution) to fit the new case (query). At the end, the best modified solution should be stored into the case base

for future use. The case base updates incrementally when the system learns from new case used by the user. In addition case contradictions are revised if there are situations where previous tourist's cases attribute values are not similar with the new case (query) attribute values. If there is no similarity between the existing case and new case it indicates that there are no previous stored cases having similarity with the new case (query) in all attribute values. Therefore if there is no similarity between the existing and new case, the proposed system cannot give recommendation to new cases. So during this time, this new case or problem of tourist can be revised and stored in the case base. Finally, the revised solution or stored cases is retained in the case base for future problem solving.

5.3. Implementation

For the development of case based recommender system for tourism site selection the researcher used the main features of jCOLIBRI to deliver the actual prototype. According to [45] JCOLIBRI has been constructed as a core module to offer the basic functionality for developing CBR application. Implementing a CBR application from scratch remains a time consuming software engineering process and requires a lot of specific experience beyond pure programming skills.

JCOLIBRI helps one to create new CBR application with predefined task and methods. These predefined tasks and methods are represented in XML files that describe the tasks supported by the framework (tasks.xml) along with the methods for solving these tasks (methods.xml).The predefined tasks and methods stored in the framework of jCOLIBRI GUI for the purpose of configure the new system using (reusing) the tasks and methods that are predefined in the framework tasks.xml and methods.xml. Building a CBR system is a configuration process where the system developer selects the tasks the system must fulfil and for every task assigns the method that will do the task [45].

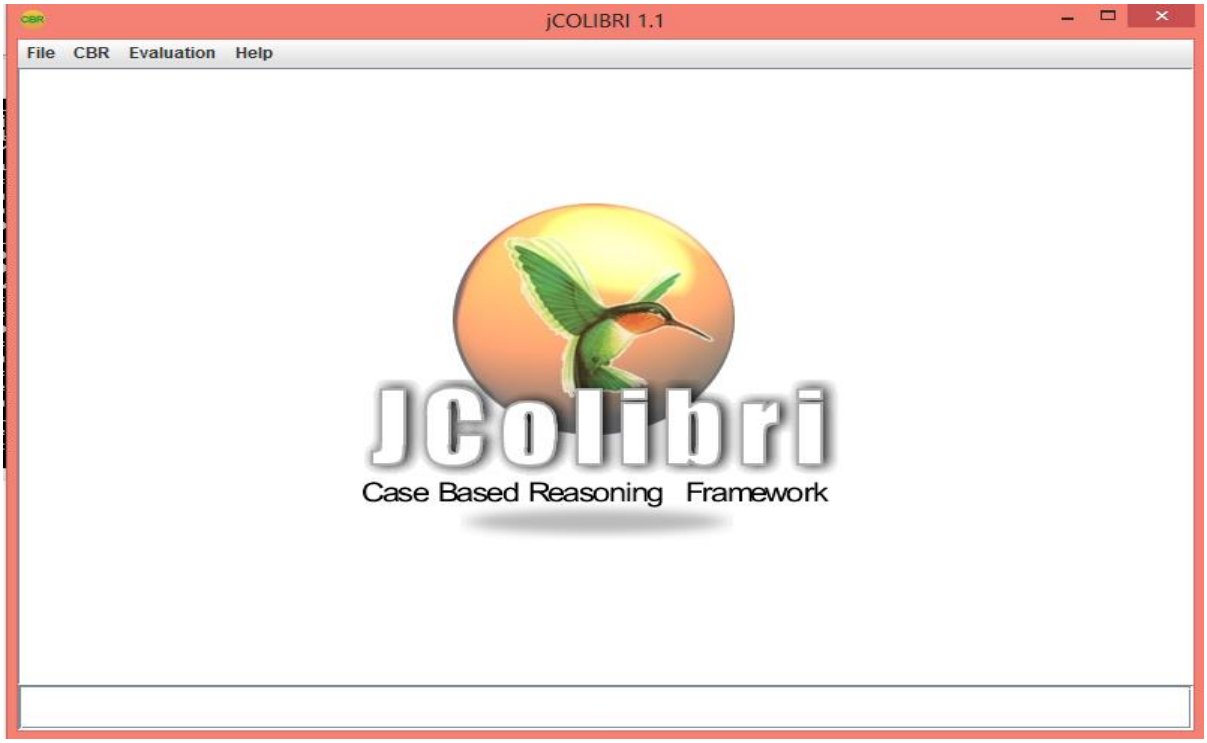

Figure 5.2: The main window of JCOLIBRI

After running jCOLIBRI GUI as shown in fig 4.2, the next task was creating new CBR applications. Figure 5.2, Shows the main window of jCOLIBRI with upper toolbar consisting of 4 menu lists, namely, file, CBR, Evaluation and Help. New CBR application can be developed step by step through this GUI. To develop new CBR application select "new CBR system" on the CBR toolbar. After that the box of entering new application name are displayed as shown figure 5.3.

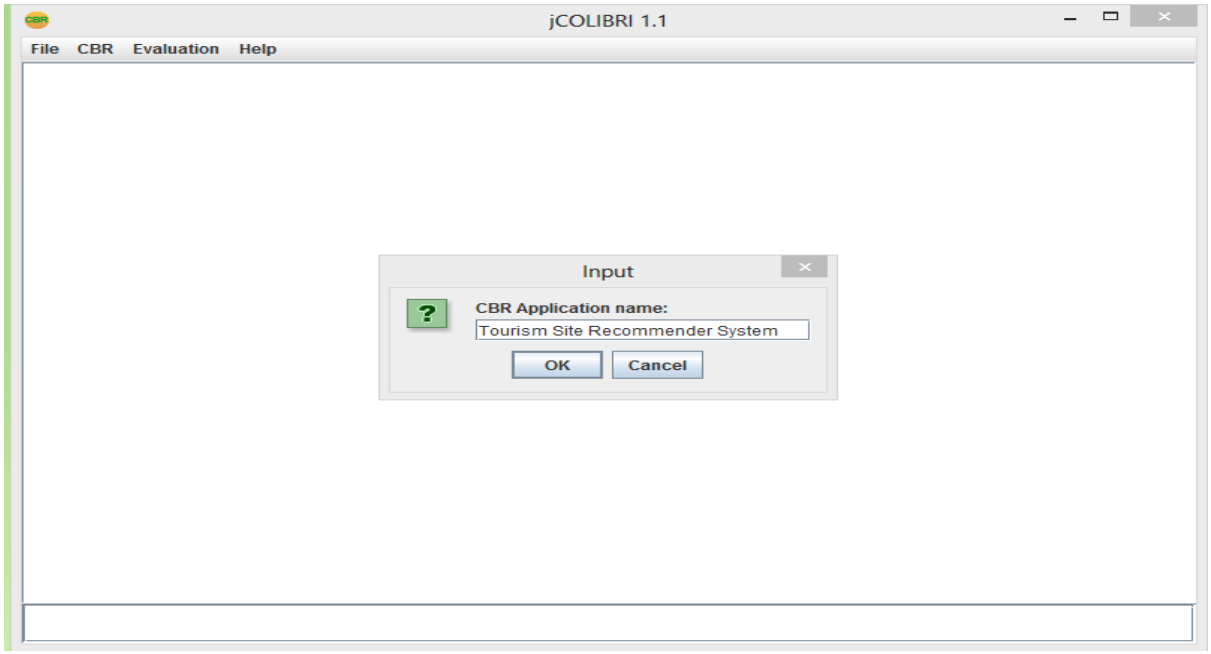

Figure 5.3: Creating New CBRTSS System

Then, a new window will appear to select one extension out of five as shown in fig 5.4. The five extensions are [45]: Core extension, Case Retrieval Nets Extension, Description Logic Extension, Textual Extension. And User Components Extension.

Core extension contains basic components of jCOLIBRI. Case Retrieval Nets Extension support case retrieval nets. In Description logic extension, description logic of jCOLIBRI is supported. Textual base CBR components are supported in textual extension. If user wants to define his/her own components he/she can use User components Extension. For this research the researcher used core extension because it contains all basic components of jCOLIBRI that are needed to make case based recommender system.

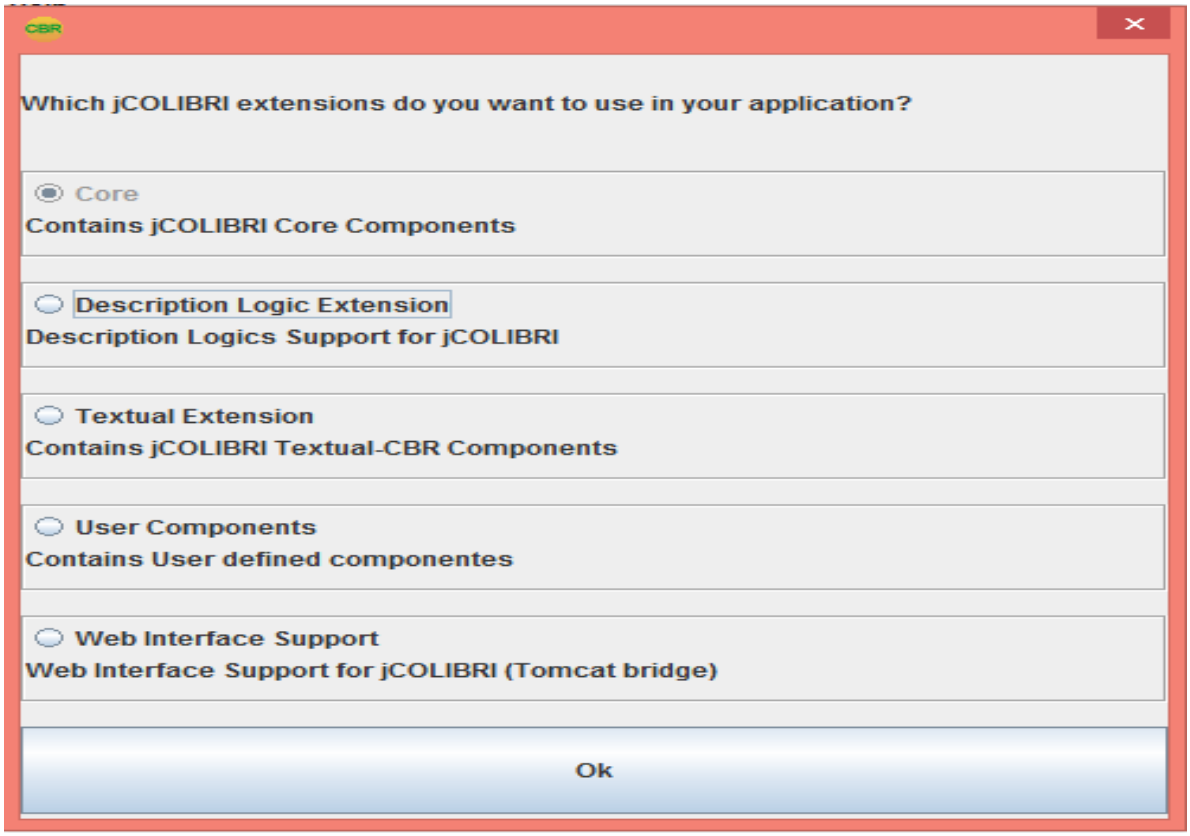

Figure 5.4: JCOLIBRI Extensions

After selecting the core extension as shown in fig 5.4, the main CBR application window that contains PreCycle, CBR cycle and post Cycle applications are displayed as shown fig 5.5.

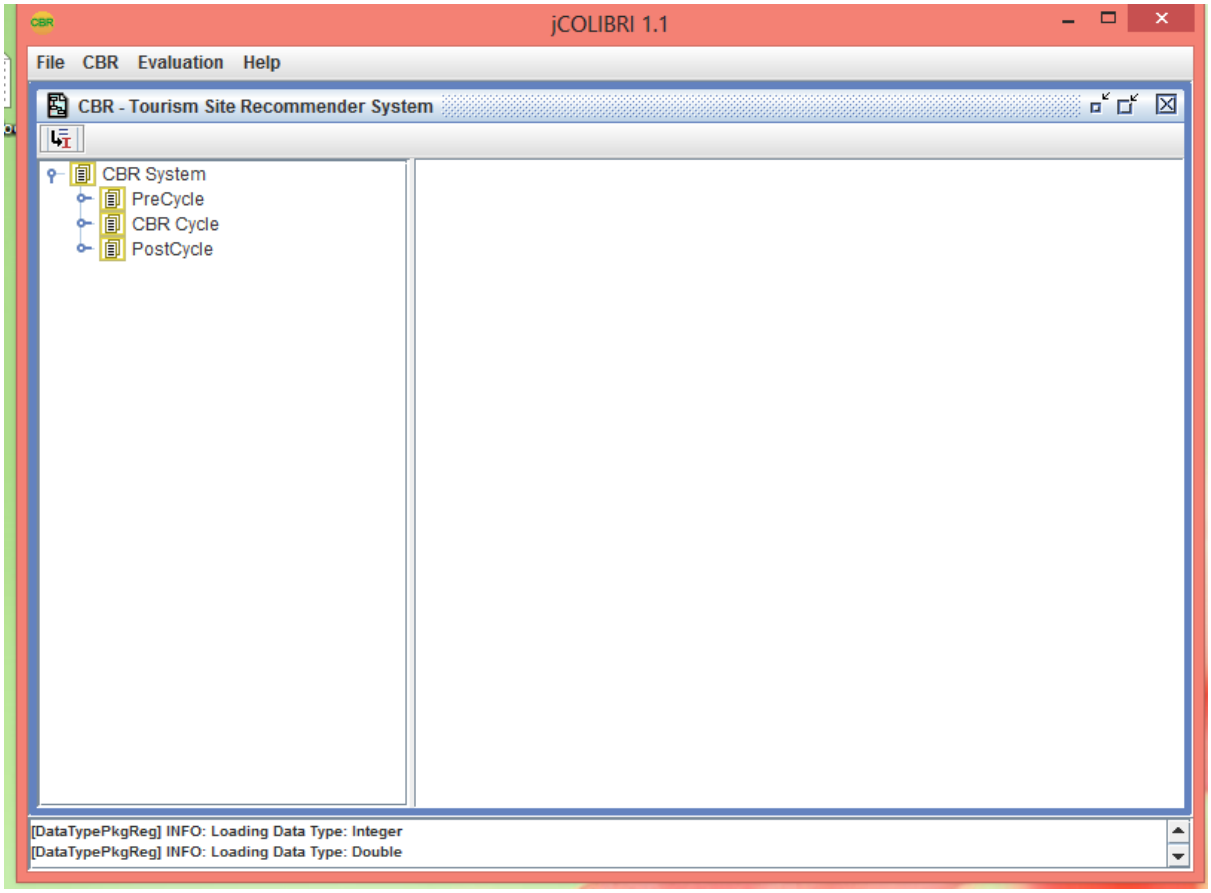

Figure 5.5: CBR applications

After displaying of the main CBR application, since the development of CBR system is very complex, the development of the CBR system for tourism site selection for this research is divided into the following subsections which enable to achieve the objectives of this research.

5.3.1. Building the Case Base

One of the objectives on building the case base is collecting previous tourists' cases in order to build a case base and represent the cases using the appropriate case representation method. So, the researcher collected previous tourists' cases from ACT office. The acquired cases are used to build tourism site selection CBR system that can offer decision support to domain experts and tourists.

The case base is represented as a plaintext feature value representation comprising of n columns representing case attributes (A1, A2, A3... An) and each m rows representing individual cases C ({C1, C2, C3, ..., Cm}). Each attribute has a sequence of possible k values associated to each column attribute A= {V1, V2, V3… Vk} [44].

5.3.2. Case Representation

A case-based reasoner is heavily dependent on the structure and content of its collection of cases often referred to as its case memory. Since a problem is solved by recalling a previous experience suitable for solving the new problem, the case search and matching processes need to be both effective and reasonably time efficient. Further, since the experience from a problem just solved has to be retained in some way, these requirements also apply to the method of integrating a new case into the memory. The representation problem in CBR is primarily the problem of deciding what to store in a case, finding an appropriate structure for describing case contents, and deciding how the case memory should be organized and indexed for effective retrieval and reuse [4].

Designing a case structure helps to define easily the features available in the case and to measure the similarity between existing case and new cases (query). Hence, the overall application of this research is to retrieve similar cases from the case base that can show future reasoning, problem solving, transforming a solution retrieved into a solution appropriate to the current problems (i.e. to retrieve similar cases to the query from the case base that guide investors), and making a recommendation in investment sector and investment activity selection process.

The collections of cases are represented in the feature-value representation to make efficient retrieval process. This is done through case indexing process in the jCOLIBRI programming tool. Indexing refers to assigning index to cases for retrieval by comparing the existing case and the query given by the user [55].

5.3.3. Description of the selected attributes

Figure 5.6 shows a visual tool provided with jCOLIBRI that can be used to define case structures easily. As you can see, the window is divided in two regions. The left panel displays the structure of the case as a tree, and the right panel shows the property values of the selected attributes. A Case has a Description (Describes the problem), a Solution (represents a possible solution approach) and a Result (shows if the proposed solution is able to solve the problem). Description and Solution are sets of Attributes, and there are two types of attributes: simple and compound that allows to make hierarchical case structure.

To make the CBR application functional first the researcher configured the case structure. In the figure 5.6, the left side's options are case structure description, solution and result. And when selecting one of description attributes, for instance Nationality, then its properties will

appear on the right side. Name, type, weight and case similarity are properties of description attribute. “Apply changes” button used to change the properties of description attribute Local similarity is used for computing the similarity of each attributes. After defining the case structure it is saved in xml file. During configuration of case structures, jCOLIBRI creates codes automatically and saves in xml file format.

The case structure consists of nine description attributes (nationality, gender, Age, Profession, Marital status, Trip Purpose, Duration, Interested site type and region) and five solution attributes: attraction site, visiting time, hotel and price and explanation facility. These Solution attributes are assigned to the new case after the user entered the values of all description attributes and the system measured the similarity between the existing cases attribute value and new cases attribute value.

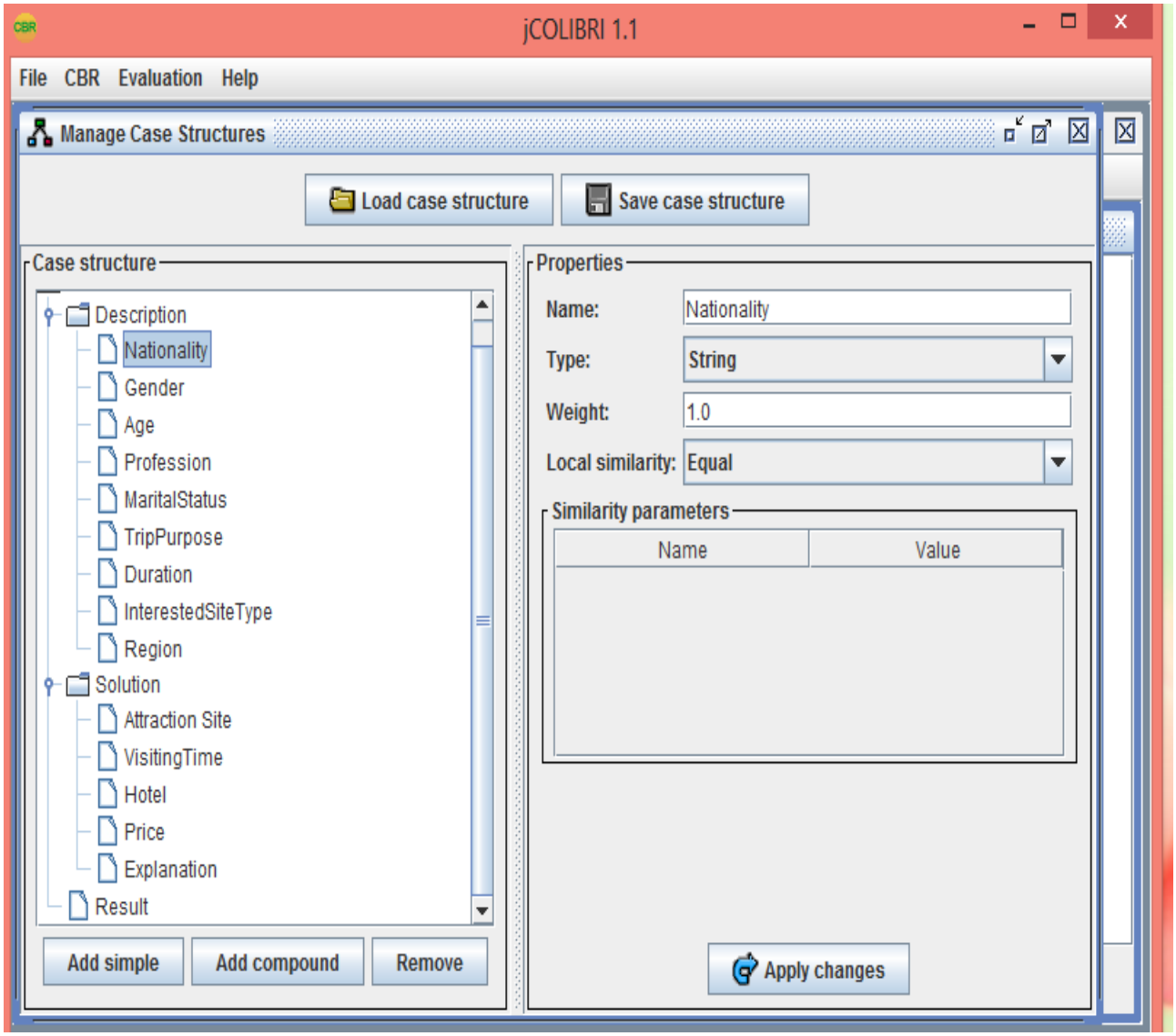

Figure 5.6: Creating the Case Structure

Table 5.1 shows the description of significant attributes with their name, data type, Weight and local similarity. The most significant attributes to the problem domain such as Nationality, Gender, Age, interested site type have the highest weight value of 1.0. These attributes are the most relevant to the tourists to select attraction site type visiting time hotel and price. Next to these, attributes like profession, marital status, trip purpose, duration and region have the weight value of 0.95, 0.95, 0.9, 0.9 and 0.7 respectively. The weight of each attribute has been assigned its value by a data mining tool, information gain attribute selection algorithm and domain experts at the time of attribute selection. The weights of each attribute indicates that attributes having high weight value is the most relevant to the user in the tourism site selection process.

Next to selecting significant attributes of the case then definition of appropriate similarity measure in JCOLIBRI was made. JCOLIBRI follows both local and global similarity measures. Local similarity measure divides the similarity definition into a set of local similarity of each attribute whereas global similarity calculates the final similarity measure.

- **Local similarity**: divides the similarity definition into a set of local similarity of each attribute. The local similarity of all case attributes which have string data type have either equal or Max String similarity value. JCOLIBRI provides many types of local similarity measurement but for this research the researcher used the following local similarity measurements:
  - Equal: Here the input case and value of case base must be exact match, in this case the new problem or case will have a solution or the system will provide the solution to the user. If there is no match the new case/query will not have any solution or recommendation.
  - Interval: in this local similarity measurement exact match is not compulsory rather the system reminds this interval value in the searching from the case base to get the similarity.
  - Max string: here the system matches by using the maximum string length.
- **Global Similarity**: it is linked with compound attributes and used to get similarity of collected attributes in unique similarity value. Global similarity calculates the final similarity measure. The type of global similarity measurement used in this research is average similarity measurement for all case attributes that have any data type that considers the average of all attribute of local similarity values.

Table 5.1: Attributes and their Meta data of CBRTSS

Description Attributes			
Name	Data Type	Weight	Local Similarity
Nationality	String	1.0	Equal
Gender	String	1.0	Equal
Age	Integer	1.0	Interval
Profession	String	0.95	Max String
Marital Status	String	0.95	Max String
Trip Purpose	String	0.9	Max String
Duration	String	0.85	Max String
Interested Site Type	String	1.0	Max String
Region	String	0.7	Max String
Solution Attributes			
Attraction site	String	1.0	Equal
Visiting time	String	1.0	Equal
Hotel	String	1.0	Equal
Price	Integer	1.0	Equal
Explanation	String	1.0	Equal

5.3.4. Managing Connectors

Connectors are objects that know how to access and retrieve cases from the storage media and return those cases to the CBR system in a uniform way. Therefore connectors provide an abstraction mechanism that allows users to load cases from different storage sources in a transparent way. JCOLIBRI includes connectors that work with plain text files, XML files, relational data bases and Description Logic systems. Other connectors can be included depending on the specific application requirements by means of the jcolibri.cbrcase .Connector java interface [39]. Once case structures are configured in jCOLIBRI, CBR systems must access the stored cases in an efficient way from the case base. So, managing connector performs the task of configuring the connector that is going to load the case base. JCOLIBRI supports both SQL database and plain text file to store its cases base.

For the implementation CBRTSS prototype, the researcher used plaintext connector since tourists' cases are stored in plaintext file format. Plaintext file case base connector is used for persistence of cases. In this connector, the researcher has to specify the path of case structure

and also path of text file. All the attributes of a case should be mapped. The case structure path is used to access and match attributes from case structure and file path is used to specify the .txt file that contains the case base. Delimiter of this connector uses comma (,) to separate value of each attribute in the case. This is connector's responsibility to retrieve data from case base and return it back to GUI. Like that of case structure, connector is also saved saved/loaded in/from XML file.

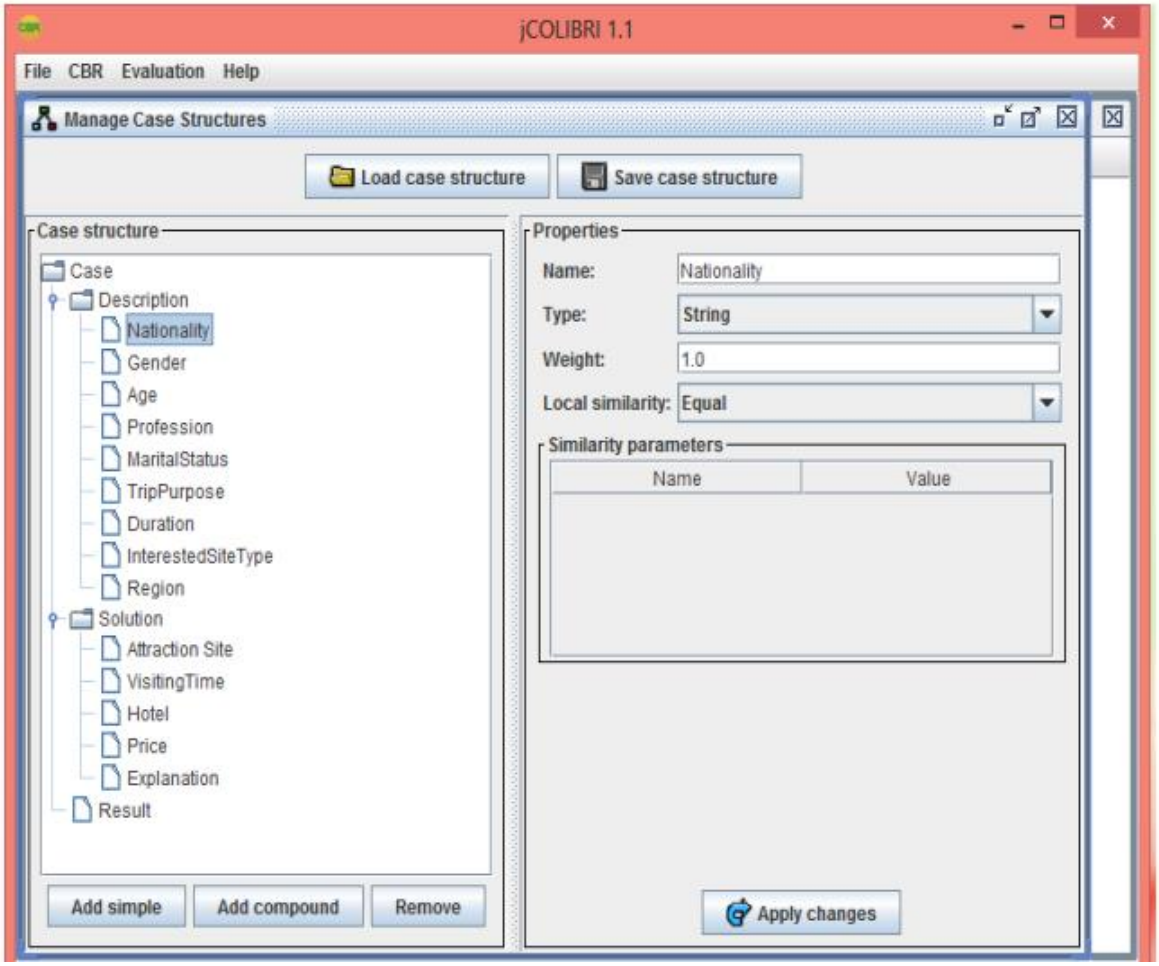

Figure 5.7: Configuring the connector with the case base

5.3.5. Managing Tasks and Methods

5.3.5.1. Managing Tasks

Next to case structure configuration, the next task is selecting tasks and methods of application. Core packages and User defined package tasks are the two types of JCOLIBRI task packages. The researcher used core package tasks for the development of the Case Based Reasoning for tourism site selection prototype. Core packages have predefined tasks and methods that used to configure new system by reusing the tasks rather than using tasks or

methods defined by the system developer itself like user defined packages, because defined tasks and methods by user itself for every system is time taking and complex And also it contains all classes that represent core functionality of a CBR application such as the domain model, case bases, similarity functions and retrieval algorithms. Various core packages are available in JCOLIBRI. The main components of Core packages which are used in the development of CBR tourism site selection prototype PreCycle, main CBR cycle and Post Cycle. Configuring tasks and methods is the final and important step for creating a new application where the CBR application is configured. The left side of Figure 5.8 shows the main components of Core packages that are used in the development of CBRTSS (PreCycle, CBR Cycle and Post Cycle) and the right side depicts tasks and methods used to perform or execute the tasks.

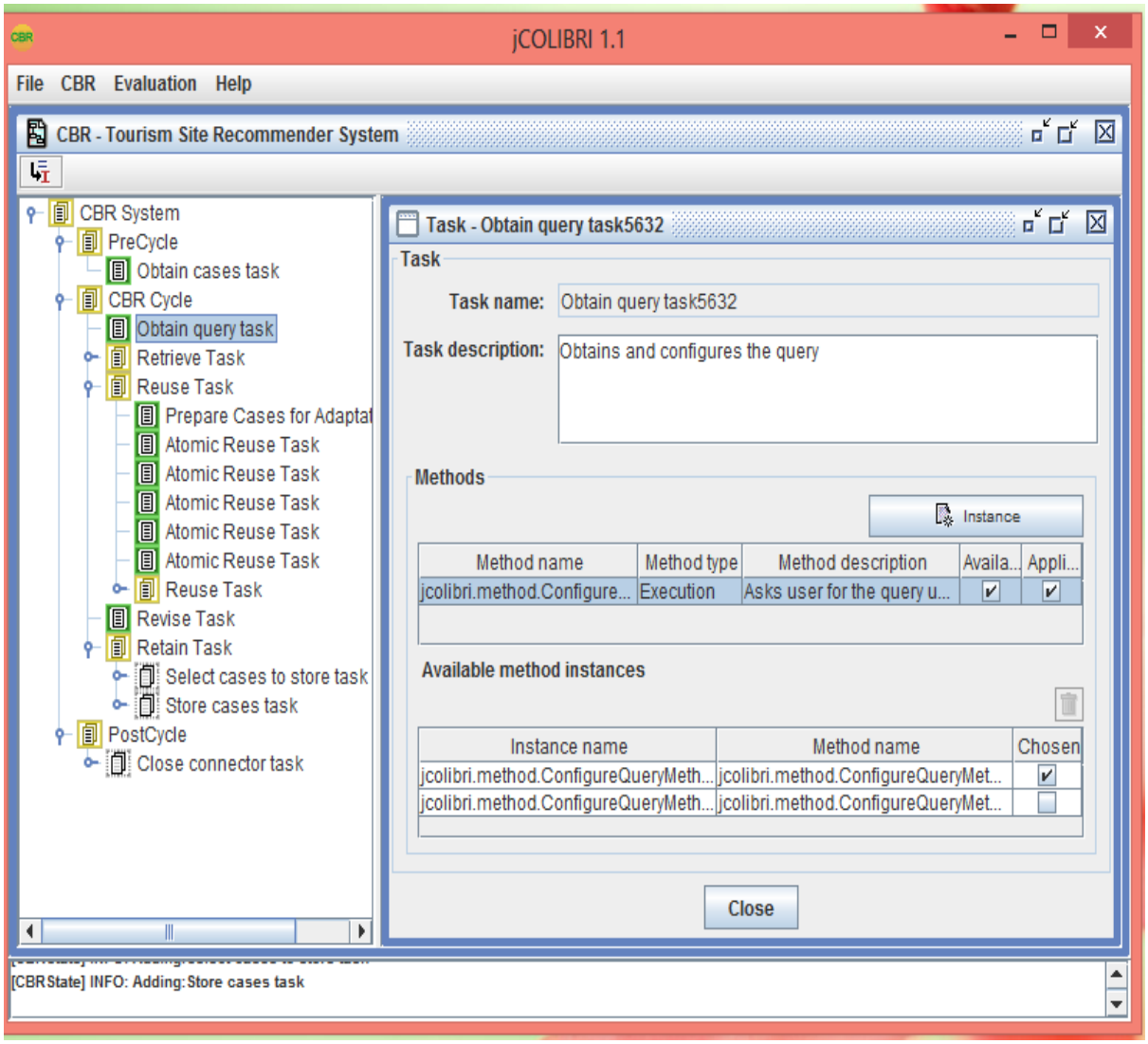

Figure 5.8: Configuring the CBR applications

From Figure 5.8 the main tasks and activates on each CBR systems or components of core packages can be discussed as follows:

I. PreCycle task

This is the first task that should be solved before the execution of the main CBR cycle .like computing the index structure or processing texts in textual CBR .PreCycle is used to load the cases from data sources (case base).In this component of core package there is only a subtask 'Obtain cases task'; here it is necessary to define the path of the connector which used to load the cases from the case base/from tourists' case base.

II. Main CBR cycle

After giving the path of the connector in the PreCycle now the next task of the researcher is giving the path of the case structure that is saved in xml format in Main CBR cycle sub task called "obtain query task" which is used to knows the number of tourists' case attributes that are available after the path is assigned. Besides obtaining query sub task, other subtasks are available in the main CBR cycle such as retrieve tasks, reuse tasks, revise task and retain tasks. These sub tasks are described as follows:

a. Retrieve task

This is the sub task of the main CBR cycle which used to retrieve case(s) from the stored case base. This task is also decomposed in to different subtasks such as select working cases task (selects cases from case base and stores them into current context), compute similarity task (compute similarity of the stored cases with the case entered by the user using the query window) and select the best case (shows the best matched case(s) after computing the similarity of stored cases against the new case.).

b. Reuse/Adaptation task

This sub tasks enable to reuse previously stored cases. It includes three subtasks the first one is "prepare cases for adaptation task" which is used to selects cases from the case base and stores them into context, here also the researcher should specify the path of the case structure. The second subtask is the "atomic reuse task" which should be resolved by reuse resolution method; and the third one is the "reuse task" generates the proposed solution for the problem based on similarity after the processed of the prepare case for adaptation task and atomic reuse task. However there are situations where previous cases are not similar with the new

case or the problem when this happened the new case or problem can be stored in the case base and will be reused by other users in this case tourists for the future. The system can learn at every entry of new case and new users adopt this knowledge for tourism site selection process.

c. Revise task

This is the evaluation step about the suggested solution in reuse phase. After selecting the most similar cases from the retrieved results, the solution for the problem should be confirmed and validated before the solution is stored for future use.

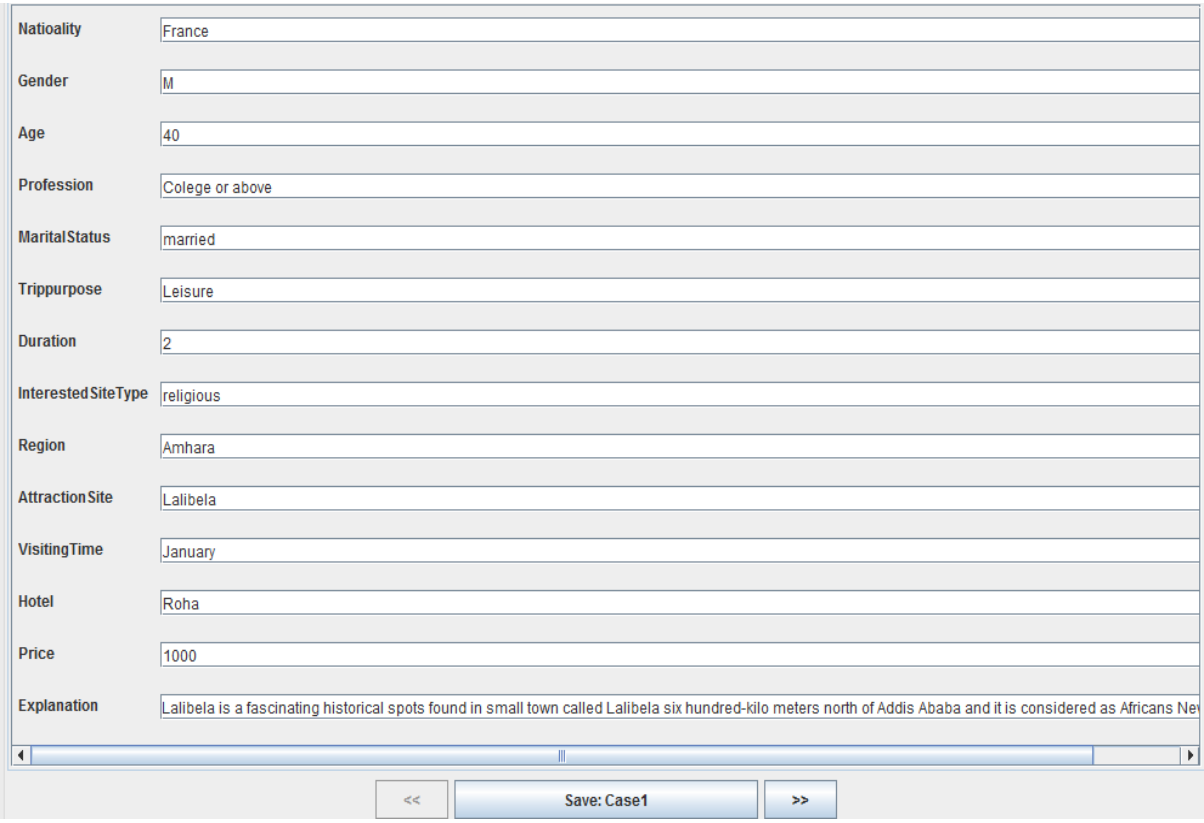

Figure 5.9: Revision Task

d. Retain task

Retain task is performed after having confirmation in revision phase. This sub task is used in CBR case retention on a persistence layer. It has subtasks such as “store cases task” used to type a new case name and “select cases to store task” which used to give authentication to the user for storing case. Then after the evaluation and correction of retrieved cases in revise task the problem together with its solution will be stored in case base.

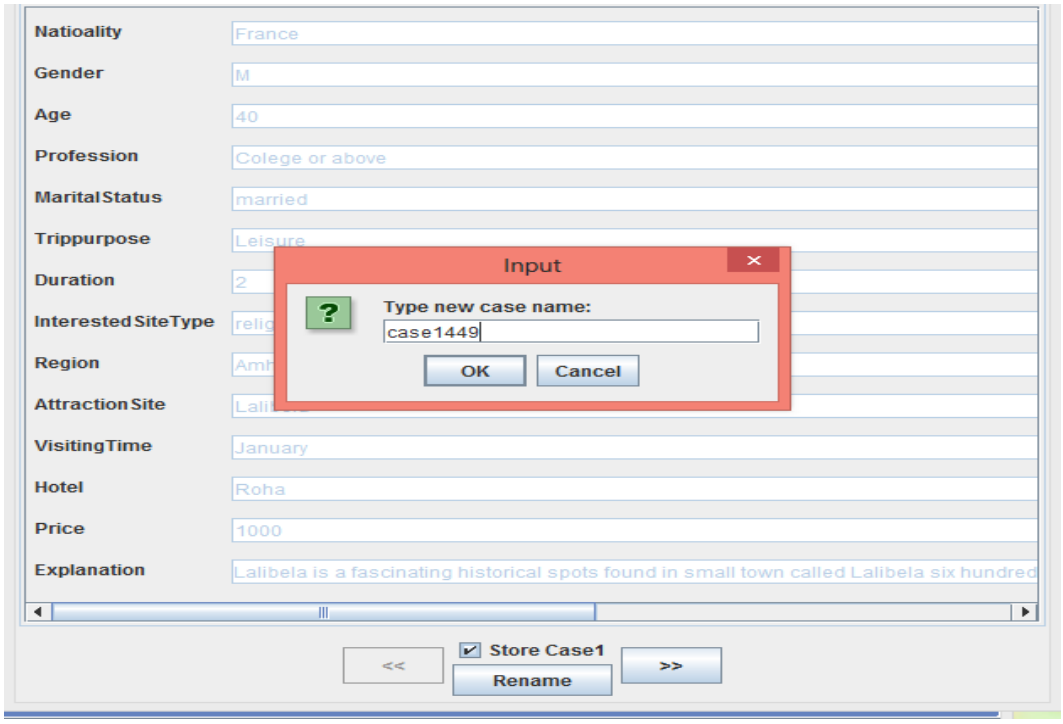

Figure 5.10: Retain Task

III. Post Cycle

This task contains sub tasks that executes after main CBR cycle. Case retrieve begins with case description and ends with best matching of the case with the new case. The subtask of post Cycle "close connector task" will close the connection between the case base and graphical user interface.

5.3.5.2. Managing Methods

There are many method packages available in JCOLIBRI method library it is the task of the knowledge engineer to choose the most appropriate methods during designing CBR application. For this research the researcher selects and used the following listed methods as it is shown in Table 5.2.The method packages store classes that resolve the task; and classes can resolve the CBR cycle using programming or using graphical user interface (GUI). All tasks in JCOLIBRI should have their own methods to be assigned in order to achieve its recommendation goal.

Table 5.2: Methods used to solve task

Method	Description
LoadCaseBaseMethod	Returns the whole available cases from the case base to designer and use connector as parameter to retrieve case base.
NumericSumComputationalMethod	Computes similarity tasks between cases and query
SelectSomeMethod	Select best of found cases and returns most similar value of the top best selected case.
ConfigureQueryMethod	Obtains and configures the query and displays the graphical user interface window by receiving case structures as an input to request query and to receive cases from the case base.
RetainChooserMethod:	Allows the user to choose the method. User can choose if he/she want this method to store in the case base.
SelectAllCaseMethod	Selects working cases from case base and store them into current Context. It allows displaying all the available cases from the case base to the result window.
ManualRevisonMethod	Enables users to modify cases in the query window.

Figure 5.11 shows the configuration of tasks and methods. The left side shows the tasks and subtask and the right side shows the methods.

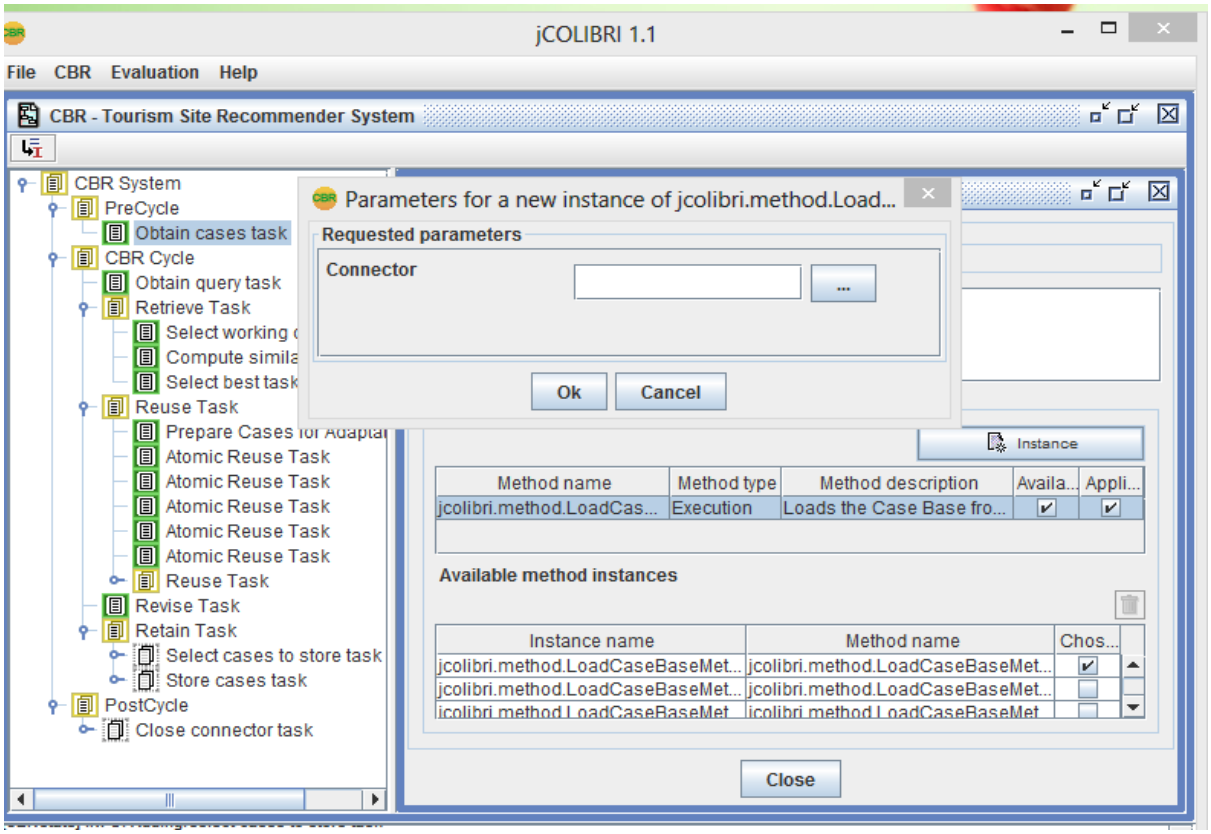

Figure 5.11: Configuring Tasks and Methods

5.3.6. Deploy the Case base Tourism Site selection recommender system

The next step after defining and configuring all the necessary steps required in designing case base recommender system in JCOLIBRI is new case (query) entry application for new tourists as it is shown in figure 5.12. In the figure tourists are required to enter the query to each requested parameters or attributes in the space provided. For example, in the "Nationality" box, tourists are required to enter query the country they came from, in the "Gender" box users/tourists are required to enter the query M or F ,in the "Age" box query tourists are required to enter their age, in the "Profession "query box tourists are required to put their educational level as either 'Secondary' or 'college or above', in the "Marital status" query box tourists are required to enter as 'single' or 'married', in the "Trip Purpose" box tourists are required its value as 'Leisure' or 'conference' ,in the "Duration" query box tourists are required to enter 1,2 3 or 4,in the "Interested Site type" tourists are required to enter as 'Natural', 'Religious 'or 'Cultural 'and finally tourists are required to enter the location of the site i.e. in the "Region" query box tourists are required to enter its value as 'Amhara'. After entering all the required the queries they will see the results of similar previous tourist cases at the bottom of the screen and the recommended tourist attraction site, visiting time, hotel and its price, and explanation facility.

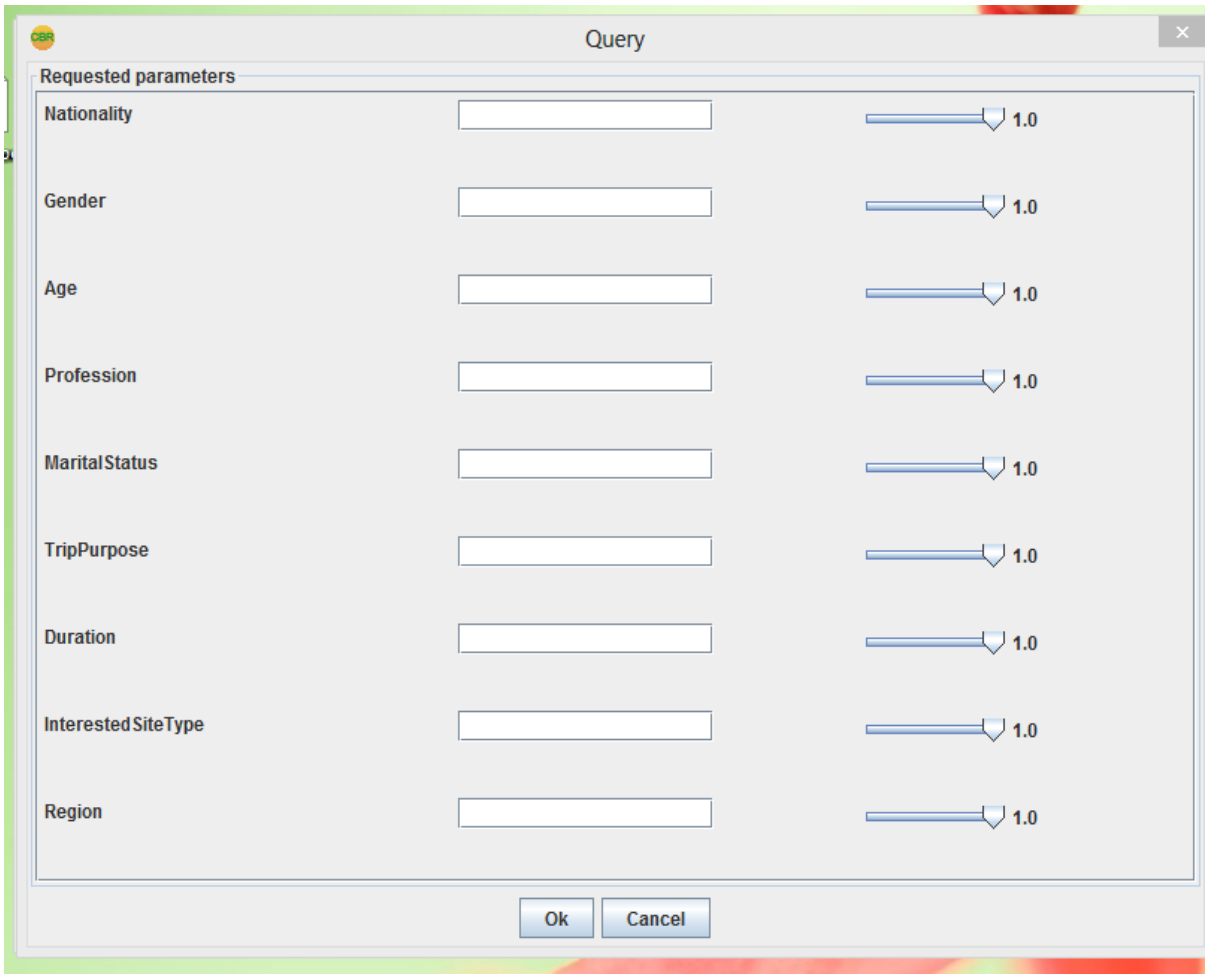

Figure 5.12: Case entry window to the case base

5.4. Explanation Facility

The ability to explain themselves is one of the more interesting features of knowledge based systems. Hence, for this study the explanation facility provides explanation about the recommended attraction site after decision or recommendation is made by the system. As shown in figure 5.9, once the system reaches final decision on the recommendation of tourism site selection, the user may not understand the recommended attraction site; in this case the system gives explanation facility about it in addition to recommended visiting time, Hotel and its price. Then the system gives more descriptions about recommended attraction site such as the location, distance from Addis Ababa, etc. For example figure 5.9.shows the system recommends to see the attraction site Lalibela and it gives explanation about where lalibela is located, its distance from Addis Ababa and also as it is considered as African New Jerusalem.

5.5. Testing and Performance Evaluation of the Prototype

In this sub section of the chapter the functionality of the prototype system is tested and verified weather it works correctly or not. Evaluations have conducted to check the performance of the system retrieval, reuse performance of the system, retaining and its user acceptance.

5.5.1. Similarity Testing

To know how new cases are matched with the cases from case base an experiment has made. The researcher used three experimental groups for this experiment. These experimental groups are presented to the system individually to evaluate the performance of the similarity measures. As it is shown in table 5.3 the first experimental group consists of cases with attribute values the same/equal to the cases with in the case base, the second one consists of cases with attribute values equal/the same except one attribute value to the cases with in the case base and the third group is consists of case with two different attribute values with the case with in the case base.

Table 5.3: Sample Queries with their values

Attribute	Problem/Query 1	Problem/Query 2	Problem/Query 3
Nationality	Italy 7	Switzerland 1021	United Kingdom 320
Gender	M	F	M
Age	55	23	35
Profession	College or above	Secondary	College or above
Marital Status	Married	Single	Married
Trip Purpose	Leisure	Leisure	Leisure
Duration	3 weeks	2 weeks	2 weeks
Interested Site Type	Religious	Historical	Natural
Region	Amhara	Amhara	Amhara

After making the problem/query the next step selecting the cases from the case base in this case the number of cases used to check the experiment are three and the researcher make three queries with each selected cases. Next to selecting the cases and making quarries the next task is providing the query to the system. Then after as it is shown in table 5.4 the system generated the similarity of the query with respect to the case.

As it is shown in the table below the when the problem/new case or test case has the same or equal attribute value with the selected case which is in the case base the degree of similarity becomes 1.0 like in problem/query 1, 4, and 7. Whereas when there is a change in one attribute value the degree of similarity decrease as compared to when all the problem/query attributes are equal/the same to the selected case. Similarly when there is a change in two problem/query attribute values the degree of similarity also decreases as compared to the degree of similarity that is found when one attribute value is changed. Finally one important indicator in the result is that when attribute values with higher weight value is changed the degree of similarity decreases as compared to changing attribute value which has less weight value.

Table 5.4: problem/query similarity with the corresponding cases

Problem/query	Description	With respect to	Degree of similarity
Problem1	Equal value for all attributes	Case 7	1.0
Problem 2	Attribute value of profession changed	Case 7	0.85
Problem 3	Attribute values of profession and marital status changed	Case 7	0.78
Problem 4	Equal value for all attributes	Case 1021	1.0
Problem 5	Attribute value of Nationality changed	Case 1021	0.85
Problem 6	Attribute values of Nationality and Gender changed	Case 1021	0.78
Problem 7	Equal value for all attributes	Case 1320	1.0
Problem 8	Attribute value of Duration changed	Case 1320	0.91
Problem 9	Attribute values of duration and trip purpose changed	Case 1320	0.86

5.5.2. Evaluation of retrieval and reuse process

The researcher used statistical analysis method which used 56 sample cases that make up the case base as training and testing data to evaluate the retrieval and reuse process of the system. The researcher used leave-one-out cross validation testing and it needs experimentation for each case, which is time consuming and hence the researcher selected this sample case for

testing. The statistical evaluation uses a leave-one-out cross validation testing proportion, where each case in turn is left out, and the learning method is trained on all the remaining cases, i.e. the evaluation is done for all cases by making one of the cases as a testing data and the rest of the cases as a training data(case base). The main reason that the researcher used leave-one-out cross validation is that it is common evaluation strategy in case based reasoning [56]and it provides almost unbiased estimate of generalization performance. The researcher conduct 56 experiments for both retrieval and reuse task of the case based reasoning system. The retrieval performance of the case based reasoning system is measured by using recall and precision, and the performance of the reuse task is measured by using accuracy.

5.5.2.1. Evaluation of the retrieval process

The primary task of CBR for tourism site selection is retrieving cases that are relevant to the new tourist cases, to enable users to manage new tourist case by analysing the retrieved case. To measure the effectiveness of the retrieval process of the prototype system the researcher used recall and precision. Recall measures the proportion of relevant cases to a given new cases (query) that have been retrieved from all the relevant cases in the case base. Precision on the other hand, measures the proportion of relevant cases to a given new case (query) from those that have been retrieved. Both recall and precision, being ratios, give values between 1 and 0.These two values are the most commonly used measures of the performance of the retrieval process in CBR system [56].

To perform the evaluation process, for each test case the relevant tourist cases from the case base should be identified. Then these selected test cases were given to domain experts to assign relevant cases to each test query. To assign relevant cases to test queries domain experts used the value of recommendation attribute of the tourists' cases as the main concept to assign the relevant cases to the queries, i.e. tourist cases that have similar solution are relevant to each other. Upon this concept recall and precision of the prototype system are calculated/evaluated as it is shown in the table below.

Table 5.5: Test cases with their relevant cases assigned by domain experts

Test case	Relevant cases
Case 21	Case1342, Case753, Case17, Case300, Case569
Case 107	Case 652, Case1214, Case145, Case86, Case487
Case 235	Case456, Case295, Case198
Case 356	Case59,Case698
Case 465	Case1377, Case1266, Case358, Case1245, Case305
Case 496	Case497,Case562
Case 668	Case304, Case842, Case390, Case605, Case1405, Case258, Case488,Case677
Case 789	Case 788,Case1034,Case1046
Case 965	Case902, Case542, Case1218, Case760, Case589, Case62, Case1231, Case306
Case 1225	Case1236,Case 546,Case1223

Following relevant cases are identified and assigned to the test cases then calculating the recall and precision value of the retrieval performance of the CBR system with a threshold interval is performed.

As [38] and [15], indicated in their research, there is no standard threshold for the degree of similarity that has been used for retrieving relevant cases in CBR. Different CBR researchers use different case similarity threshold. Both [38]and [15] used a threshold level of [1.0, 0.8) i.e. cases with global similarity score greater than 80% are retrieved. For this research, since the two researchers are satisfied in the threshold value of [1.0, 0.8] hence the threshold value of this research is set by the researcher which is [1.0, 0.8] .To measure recall and precision by using a leave-one-out cross validation testing proportion and [1.0, 0.8] threshold interval the researcher conducted Fifty six (56) experiments.

Table 5.6: Performance measurement of the prototype system using recall and precision

Test Case	Recall	Precision
Case 21	0.80	0.7
Case 107	0.80	0.7
Case235	0.67	0.6
Case 356	1.00	0.5
Case 465	0.60	0.7
Case 496	1.00	0.5
Case 668	0.88	0.8
Case 789	1.00	0.6
Case 965	0.88	0.8
Case 1225	1.00	0.6
Average	0.86	0.65

As it is shown in the table above the average results for both recall and precision of the prototype system are 86% and 65% respectively which is a good result since it is above average. Based on the table above for every test case more than average is registered for the two performance measurements i.e. recall and precision. Upon the recall result of this research a good result is achieved. While the precision result of the research is somewhat lower compared to the average recall; this is because of the trade-off between precision and recall.

5.5.2.2. Evaluation of the reuse process

The reuse process in this research is used to evaluate the proposed system whether it suggests /recommend convenient tourism sites correctly for new tourists cases or problems or not. The performance of the reuse process is measured by using accuracy. Accuracy is one of the useful measurements in case based reasoning [56]. Accuracy is defined by the percentage of the number of correctly recommended cases [36].

As it is described above the researcher used a leave-one-out cross validation testing proportion, hence 56 experiments are conducted to evaluate the performance of reuse process of the prototype system. The result in the table below shows the reuse process of the system registers above average, which is a good result.

Table 5.7: Accuracy of the prototype system

Total number of tested case query	Total number of correctly recommended cases	Accuracy
56	49	87.5

5.5.2.3. Comparison of the performance of the prototype system with previous systems

In this sub section the researcher compared the performance of the prototype system i.e. the retrieval task and the reuse task of the system with the previously conducted thesis researches. Hence, the performance of the prototype system using recall and precision value of the system is compared with previously done researches as it is shown in the table below.

Table 5.8: Comparison of the system with previous CBR systems

Domain area	Programming tool used	Retrieval task		Reuse task
		Recall	Precision	Accuracy
Mental Health Getachew(2012)	JCOLIBRI	82	61	Not evaluated
Field of study selection Biazen(2013)	JCOLIBRI	85	55	Not evaluated
Investment Yibeltal(2013)	JCOLIBRI	85	64	87
Tourism Tamir(2014)	JCOLIBRI	83	61	85.4
Tourism	JCOLIBRI	86	65	87.5

As it is shown in the table above, the result of both the recall and precision value of the system shows an improvement from the recall value of Getachew [37] , Biazen [43] , Yibeltal [38] and Tamir [15].When we see the accuracy of the reuse performance of the prototype system it is also better than the other researchers which are stated in the table below.

Based on the researcher knowledge since there is a research work that was done previously, so the researcher used a thesis work that was done by Tamir [15] on the title of case based recommender system for tourism attraction area selection to compare the performance of this

research. Based on the comparison some of the problems of [15] research are overcome by this research. The main differences of this research work from [15] research are summarized as follows.

- ✓ The prototype developed system in this research has the capability of giving explanation facility about the recommended tourism site. But in Tamir [15] research, the developed prototype system did not give explanation facility about the recommended tourism attraction area.
- ✓ The prototype system of this research recommends four recommendations tourism site, Visiting time, Hotel and its price. But in [15] research it recommends only two recommendations tourism attraction area and visiting time.
- ✓ To develop the prototype system of this research the researcher used basic attributes such as interested site type, Profession and Marital status. But in [15] research these basic attributes did not included to develop the prototype.
- ✓ In Tamir [15] research work to recommend the tourism attraction area the prototype asked the users through the query window to enter their interested tourism attraction area but it should be a solution attribute it cannot be a description attribute. This is the big problem in [15] research because the researcher make a single attribute i.e. tourism attraction area as description and solution attribute and hence the research work did not recommend the tourism attraction area correctly. But in this research work to recommend the correct tourism site the prototype system asked the users through the query window to feed the tourism site type instead of tourism site and then it recommends the tourism site.
- ✓ The performance of the prototype is also better than the research that was done

5.5.3. Testing the learning Mechanism

Learning Mechanism part of the prototype is tested with cases that are collected from new tourists in ACT office. The main aim of testing of the performance is to test the learning performance of the prototype from solved tourist cases for future use. To check the learning performance the system the researcher fed a new tourist case to the system as it is shown in the table below.

Table 5.9: Sample new tourist case

Nationality	France
Gender	M
Age	40
Profession	College or above
Marital Status	Married
Trip Purpose	Leisure
Duration	2 weeks
Interested Site Type	Religious
Region	Amhara

The prototype retrieves and computes the similarity of the new case with the previous cases from the case base and put them in ranking order after the problem description of the above new tourist case is entered for the system. Then after the suggested solution is delivered for the problem description from the retrieved relevant cases. The suggested solution for the new tourist case is “Lalibela” as an attraction site, “January” as a visiting time, “Roha” as a hotel and “1000” as a price. The revise process of the prototype proposes the new solved tourist case to be verified by domain experts since this solved tourist case is new for the system as it is shown in the figure below.

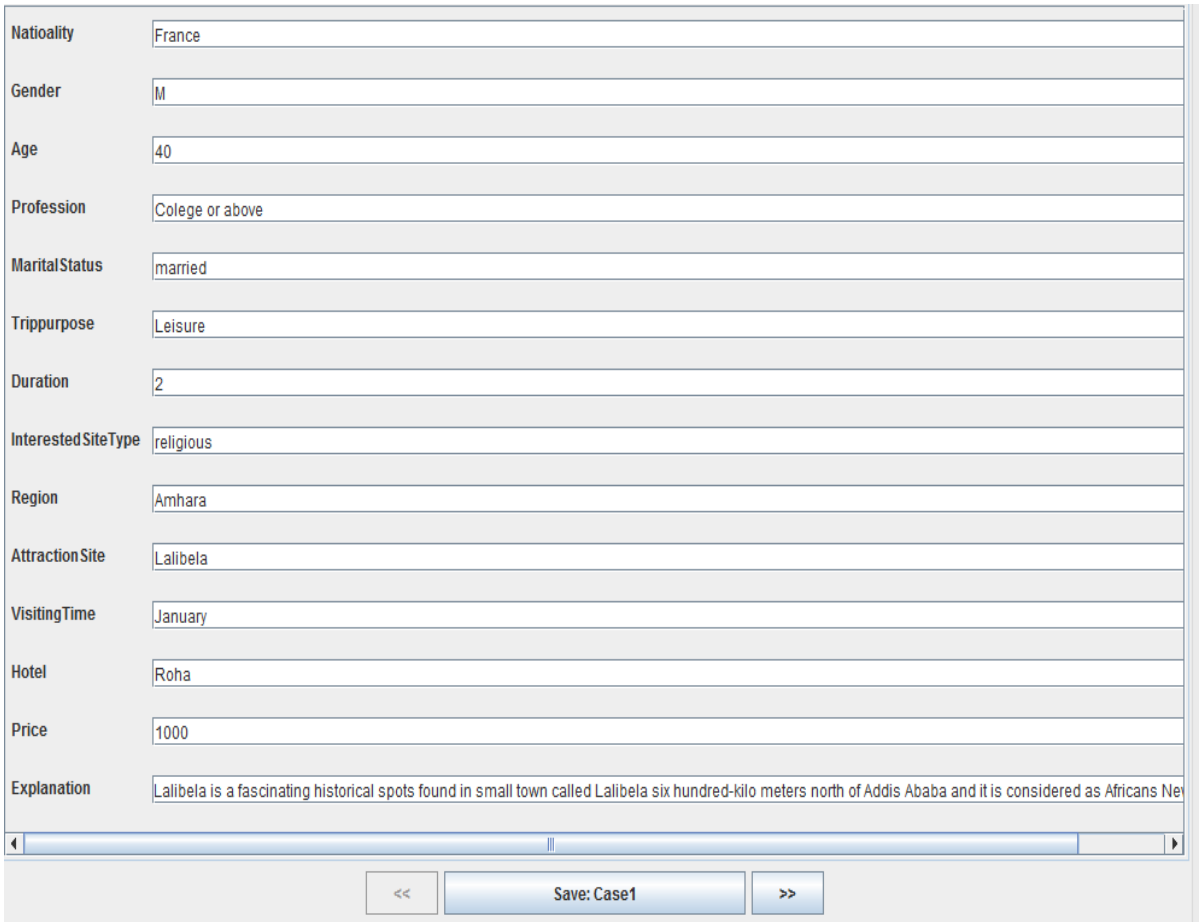

Figure 5.13: Revise process for the newly solved cases

After the validity of the suggested solution is proved by the domain experts then the new solved tourist case is retained for future use. Hence the new cases are stored in the existing case base for future use by the retain process of the prototype as it is shown in the figure below.

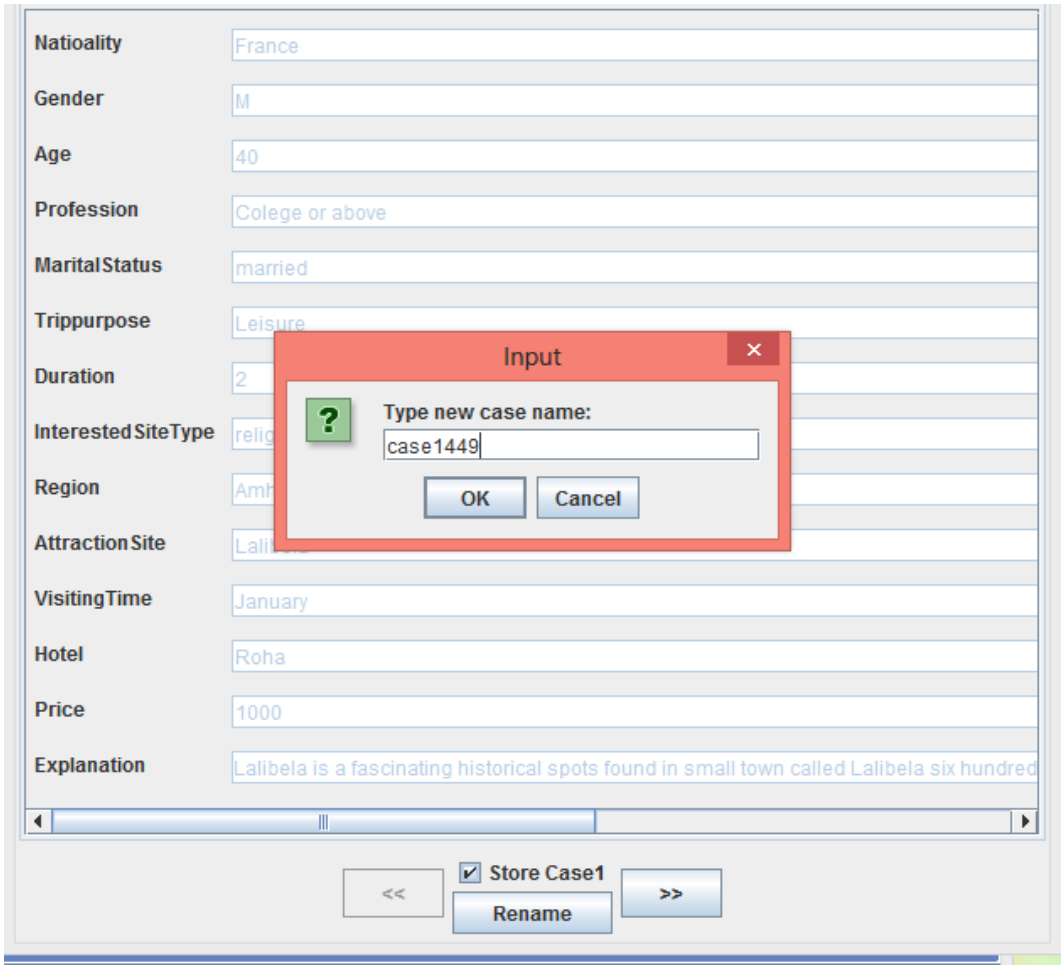

Figure 5.14: Retaining process of the newly solved for the future use

Again to test the learning mechanism of the prototype, the problem description of the above tourist case is again fed to the prototype as it performs regularly it proposes a solution for the case, but the revise task doesn't propose the solved tourist case to be verified. This shows that the case based recommender system for tourism site selection system has learnt from successfully solved tourist cases and used it in solving other tourist cases.

5.5.4. User acceptance Testing

User acceptance testing helps to ensure the performance of the prototype by assessing the feedback acquired from the users (tourists and domain experts) towards the developed prototype system.

Case based system user acceptance evaluation method allows users to directly interact with the system and evaluate the performance of the case based system from the users' point of view.

During the development of the case based recommender system there were 7 domain experts from ACT office that actively involved in the different stages of the study including knowledge acquisition and prototype development and these domain experts are also participated to evaluate the acceptance of the system. In addition to these domain experts to evaluate the acceptance of the prototype system by the users 7 tourists were randomly selected.

Before starting the evaluation process of the system using the questionnaire which is close-ended and nine in number and these questionnaire were adapted from [43], [38] and [15]. The first three questions are on the user interface design aspect such as easy to use, attractiveness and time efficiency of the system .The rest of the questions are used to evaluate the prototype's adequacy and clarity, relevancy of retrieved cases, relevance of the attributes used, clarity of the explanation facility, problem solving ability and significance of the prototype knowledge based system in tourism site selection recommendation system. All the nine closed ended questions answered as excellent, very good, good, fair and poor and the researcher assigned numeric values to the five options 5, 4,3,2,1 respectively.

Then after, the domain experts and tourists were allowed to interact with the system by running number of cases having similar parameter with the facts incorporated in the case base. After the consultation of the system, to assess the user acceptance of the prototype system tourists and domain experts assign value for each closed ended questions.

As it is shown in the table below domain experts rate the easiness of the system as very good 57.1 % and as excellent 42.9 %.Whereas the efficiency of the system in time is rated as very good 42.9 % and excellent 57.1 %.Similarly respondents/ domain experts rated the interactivity of the user interface as good 28.5 %, very good 43 % and excellent 28.5 %. On the other hand when we see their rating of the adequacy and clarity of the decision support they rate as good 43 %, very good 28.5 % and excellent 28.5 %.The usefulness/relevant of the retrieved cases in the decision making process is rated as good 14 %, very good 72 % and the remaining 14 % as excellent. Similarly the fitness of the final solution to the problem/new case is rated as good 29%, very good 57 and the remaining one 14 % as excellent. Similarly respondents/domain experts rated the relevancy of the attributes as good 28.5 %, very good 43 % and the rest one 28.5 % as excellent. Whereas the explanation facility is rated as good 14 %, very good 72% and excellent 14 %.Lastly the significance of the system in the domain area is rated as very good 28.5 % and 71 % as excellent by the domain experts.

Table 5.10: Performance evaluation of the prototype by domain experts

No.	Evaluation criteria	Performance value						
		1	2	3	4	5	average	Percentage
1	Easy to use of the recommender system				4	3	4.4	88
2	System efficiency in time				3	4	4.57	91
3	User interface interactivity			2	3	2	4	80
4	Adequacy and clarity of decision support			3	2	2	3.85	77
5	Usefulness of the retrieved case in the decision making process			1	5	1	4	80
6	Fitness of the final solution to the new case			2	4	1	3.85	77
7	Relevancy of the attributes in representing tourists case			2	3	2	4	80
8	The explanation facility to give description about the suggested attraction site			1	5	1	4	80
9	the significance of the system in the domain area			2	5		4.7	94
		Total average					4.15	83

As it is shown in the table below users/tourists rate the easiness of the system as good 14%, 72 very good 57.1 % and the remaining as excellent 14 %.Whereas the efficiency of the system in time is rated as very good 57 % and excellent 43 %.Similarly respondents/ tourists rated the interactivity of the user interface as good 28.5 %, very good 28.5 % and excellent 43 %. On the other hand when we see their rating of the adequacy and clarity of the decision support they rate as good 14 %, very good 57 % and excellent 29 %.The usefulness/relevant of the retrieved cases in the decision making process is rated as good 14%, very good 29 % and the remaining 57 % as excellent. Similarly the fitness of the final solution to the problem/new case is rated as good 14%, very good 57 and the remaining one 29 % as excellent. Similarly respondents/domain experts rated the relevancy of the attributes as good 14%, very good 72 % and the rest one 14 % as excellent. Whereas the explanation facility is rated as good 28.5 %, very good 28.5% and excellent 43 %.Lastly the significance of the system in the domain area is rated as very good 29 % and 71 % as excellent by tourists.

Table 5.11: Performance evaluation of the prototype by tourists

No.	Evaluation criteria	Performance value						
		1	2	3	4	5	average	Percentage
1	Easy to use of the recommender system			1	5	1	4	80
2	System efficiency in time				4	3	4.4	88
3	User interface interactivity			2	2	3	4.1	82
4	Adequacy and clarity of decision support			1	4	2	4.1	82
5	Usefulness of the retrieved case in the decision making process			1	2	4	4.4	88
6	Fitness of the final solution to the new case			1	4	2	4.1	82
7	Relevancy of the attributes in representing tourists case			1	5	1	4	80
8	The explanation facility to give description about the suggested attraction site			2	2	3	4.1	82
9	The significance of the system in the domain Area				2	5	4.7	94
		Total average					4.2	84

5.5.5. Discussion on user acceptance and system performance using recall and precision, case similarity and reuse process

The question of user acceptance and accuracy of the CBRTSS prototype can be address by the evaluation and testing procedures. To assess user acceptance issues and applicability of the prototype system visual interaction and questionnaire methods are used. The results obtained on close ended questions are summarized in table.

As shown in the table below none of the evaluators (domain experts and tourists) respond as poor or fair. Whereas the rate of the prototype by domain experts and tourists as very good is thirty four times (53.98 %) and thirty times (47.62%) respectively. Similarly domain experts and tourists reply as Excellent sixteen times (25.39%) and twenty four times (38.09%) respectively. Lowest value of responses is rated by domain experts and tourists as the prototype is good thirteen times (20.63%) and nine times (14.29%) respectively. Also as shown in the table the overall average user acceptance evaluation of the prototype system is 83% and 84% by domain experts and tourists respectively. Therefore, above 83% of domain experts and 84% of tourists are satisfied with the easiness, attractiveness, speed, adequacy

and clarity of problem solving ability, explanation facility about the recommended tourism site and the significance of the prototype case based recommender system in the domain area. This implies that the prototype modeled relevance and satisfactory domain knowledge in useful way and it performs well in making right decisions on the recommendation of investment sectors and investment activity.

Therefore ,when the researcher compares the results responded by domain experts and tourists, the performance of the prototype system responded by tourists 84% (4.2) and domain experts 83% (4.15) which is above average in acceptance of the system in users. This shows that the developed Case based recommender system for tourism site selection system is more acceptable and applicable in the domain area.

Table 5.12: Summary of Domain experts and tourists feedback

Respondents who respond as	Total number of respondents for each question		Percentage (%)	
	Domain expert	Tourist	Domain expert	Tourist
Poor	-	-	-	-
Fair	-	-	-	-
Good	13	9	20.63%	14.29%
Very good	34	30	53.98%	47.62%
Excellent	16	24	25.39%	38.09%
Total average	4.15	4.2	83%	84%

In addition to the user acceptance testing to analyse the performance of the prototype knowledge based system the researcher used test cases. Based on this tests the result indicates that the prototype system has recall performance of 86% and precision performance of 65%. Similarly also the accuracy of the prototype system for reuse process achieves 87.5%, which is above average. Recommending correctly for tourist cases is the goal of reuse process of the research meaning to make sure the problem is solved correctly, the performance of the reuse process of the prototype is measured by using accuracy. Based on the result of the reuse process/accuracy of the developed prototype system one can say that the prototype system has the capability to advise and recommend tourism site selection properly.

When one see the experiment result of case similarity test it shows that the degree of similarity (global similarity) becomes exact match /1.0 when the test case has attributes value the same as a case stored in the case base. Whereas, when there is a change in one or more attributes value of the test case as compared to a case from the case base the degree of similarity drop down/decreases.

Based on the above evaluations the main strength of the system and its applicability in the domain area are:

- Solve problems in the domain area where experienced and skilled tourism experts are unavailable.
- Have a learning capacity when the new cases coming,
- Provides consistent answers for repetitive decisions, processes and tasks,
- More accurate and easy to use,
- Applicable anywhere, even at home we can advise ourselves by having the software
- The prototype provides explanation facility which gives brief explanation about the recommended attraction site.
- Encourage self-advising

Generally, the testing and evaluation results of this research opened a door for further research work to fully implement and apply case based recommender systems technology in the tourism domain to provide recommendation for tourism site selection in Ethiopia particularly Amhara region.

CHAPTER SIX

6. CONCLUSION AND RECOMMENDATION

6.1. Conclusion

Case Based Reasoning is a methodology for solving problems by utilizing previous experiences. It involves retaining a memory of previous problems and their solutions and, by referencing these, solve new problems. Unlike rule based reasoning which cannot solve a problem that doesn't exactly match with the rule of the system, Case based reasoning can work with new cases that match partially to the case from the case base.

The advising system on tourism is at lower stage in developing countries like Ethiopia this is because of different factors such as lack of criteria to assign tourists in different tourism sites, lack of skilled manpower in the tourism sector, absence of collaboration among domain experts and lack of awareness of tourists about the purpose of advising systems for tourism site selection. To overcome these problems this research has conducted with the main goal of developing a prototype CBRTSS system that assists domain experts and tourists to select tourism site, visiting time and hotel available in the area.

For the development of the prototype system the researcher acquired relevant knowledge from domain experts, tourist and document analysis and also previous tourist cases are gathered from ACT office. Hierarchical structure Conceptual modeling method is used to conceptually model the relevant knowledge acquired from primary and secondary sources. To represent the knowledge before it has been codified using the jCOLIBRI 1.1 tool feature value case representation method is applied.

To accomplish its task CBRTSS system uses the main CBR cycles. The first task of the prototype system is retrieval of cases using Nearest Neighbor retrieval algorithm when the user entered a new query through the query window. After retrieval of cases similarity computation is performed and retrieves most similar cases. Then, reusing the previously solved cases from the case base is performed and followed by manual revision of cases to fit the problem at hand by tourism experts. Storing the revised case in the case base for future is the last task of the prototype system.

The retrieval performance of CBRTSS prototype system as it is shown in the evaluation result registers an average value of 86% and 65% recall and precision respectively. On the

other hand reuse performance of the prototype system registers an average value of 87.5% accuracy. The average user acceptance evaluation achieved 83% by domain experts and 84 % by tourists, since it is above average it is a promising result.

With regard to research questions the following conclusions are also drawn from the finding:

- ✓ The major attributes that have more influence in tourism site selection are nationality, age, gender, educational level, marital status, trip purpose, length of stay and interested site type.
- ✓ The type of tourism sites open to for both foreign and domestic tourists are cultural, historical and religious.
- ✓ The result of the system performance indicates that users are satisfied with proposed system and the validation result shows the system recommends highly acceptable tourism sites to tourists.
- ✓ The developed prototype case based recommender system learn new cases by dynamically updating the existing case base for the purpose of future use as a case base.
- ✓ The CBRTSS contribute in the selection or recommendation of tourism site selection by assisting tourism experts and tourists in the tourism sector. The proposed prototype system actually contributes a lot, especially for those less experienced domain experts.

6.2. Recommendation

From the presentations of the findings of the study, the researcher recommends the following issues as a future research direction for future study.

- ✓ To improve the performance of the system it is better to use hybrid approach by combining case based reasoning with rule based reasoning. The inclusion of rule based reasoning in this research helps the proposed system to give explanation facility when the user wants explanation and used to represented fact and rules extracted from the domain expert.
- ✓ Further investigation can be conducted by developing a CBRTSS system in different local languages which helps the system to be easily understandable by tourists since the proposed system was developed in English language and it is difficult to some tourists.
- ✓ Since the proposed system provides explanation facility about the recommended tourism site only when it provides recommendation and hence further research can be conducted to make the explanation facility user interactive which provides explanation any time the user wants.
- ✓ The attributes used for this research are collected from the previous tourist cases from ACT. These attributes are not enough for the selection of tourism site decision. So further research can be conducted by adding other important attributes for tourism site selection such as number of tourists, annual income and environmental factor by making a direct survey of successful tourists.

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Appendices

Appendix 1

Interview questions to Domain Experts

To perform the study the researcher selected the respondents and present the following questions to them.

1. What criterions are considered to assigning Tourists in different tourism sites?
2. How tourists get advising in your system when they come to visit?
3. What are the possible tourist attraction areas recommended to tourists?
4. What type of tourism sites as are favourable by male tourist and which one is by females?
5. Which attributes are more considered to make tourists satisfied with their tour?
6. What are the main reasons that makes many tourists unsatisfied in their tour?
7. What should be done for the future to solve the problems?

Appendix 2

Interview Questions to tourists

To perform the study the researcher selected the respondents and present the following questions to them.

1. Is the ACT bureau has enough tourism experts that provide advice to tourists?
2. How you get advising from the experts available?
3. Do you think that the advice which you get from experts is enough to select tourism sites?
4. How you select tourism sites that match with your interest?
5. What should be done to overcome the problems?

Appendix 3

This is an evaluation form to be filled by tourism experts and tourists in order to evaluate the applicability of the case-based reasoning system in tourism site selection. I thank you in advance for your willingness and valuable time.

Description of the parameter values are as follows.

Performance value	1	2	3	4	5
Description	Poor	Fair	Good	Very good	Excellent

Instruction: Please assign (X) on the appropriate value for the corresponding parameter of evaluation questions of the case based recommender system in tourism site selection.

No.	Evaluation criteria	Performance value				
		1	2	3	4	5
1	Easy to use of the recommender system					
2	System efficiency in time					
3	User interface interactivity					
4	Adequacy and clarity of decision support					
5	Usefulness of the retrieved case in the decision making process					
6	Fitness of the final solution to the new case					
7	Relevancy of the attributes in representing tourists case					
8	The explanation facility to give description about the suggested attraction site					
9	The significance of the system in the domain area					