

# **AGENT BASED INFORMATION RETRIEVAL IN GOVERNMENT SECTOR WEBSITES OF PAKISTAN**



**MCS**

By

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## SUPERVISOR CERTIFICATE

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# **ABSTRACT**

## **AGENT BASED INFORMATION RETRIEVAL IN GOVERNMENT SECTOR WEBSITES OF PAKISTAN**

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**Mutahira Naseem Tahir**

In this era of information technology, technology becomes an inseparable entity in human lives. The information technology and information and communication technology is diversely affecting the human lives both in positive and negative aspects. The new trends in these technologies and their impact on the human race enforces researchers and developers to come across new better techniques. E-Government is initiated with the aim to use the information technology, information and communication technology and wide variety of web-services to encourage involvement of the different stakeholders and enhance the performance of the government. The E-Government directorate under the supervision of ministry of information, approves a strategic plan for e-government. As part of the strategic planning, ministries are developing and launching their websites. This thesis attempts to bring attention towards the importance of search feature in the websites and quality of these websites are evaluated on the basis of an ISO/IEC25010-11 standard. This thesis will highlight the importance of search functionality in e-government. Moreover, an agent based information retrieval system GOWAIR is proposed and implemented to handle the issue of search functionality. At the end, an evaluation is carried out and mention results obtained.

## **DEDICATION**

In the name of Allah, the most Gracious, the Most Merciful. All praise to Allah almighty, for the strength, His blessings and mercy in completing this thesis. Guide us through the right path of those to whom you have bestowed your blessings.

This research work is dedicated to my beloved parents, friends, teachers and siblings who had always been so kind, encouraging, loving and helpful. They always provided me with their utmost support in every field of my life. Their encouragement had been a great source of determination for me to achieve my goals in life.

## **DECLARATION**

I hereby declare that this research, neither as a whole nor as a part has been copied out from any source. It is further declared that I have completed this work entirely on the basis of my personal efforts made under the sincere guidance of my supervisor. If any part of this project is proved to be copied out or found to be reported, I shall stand by the consequences. No portion of the work presented in this project has been submitted in support of any application for any other degree or qualification of this or any other university or institute of learning.

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# ABBREVIATIONS

<b>Definition</b>	<b>Abbreviations</b>
International Organization for Standardization	ISO
International Electro-technical Commission	IEC
E-Government	Electronic Government
Information Technology	IT
Information and Communication Technologies	ICT
Quality, quality in use, actual usability and user experience	2Q2U
Strategy to improve quality in use	SIQinU
Mobile Application	MobileApp
Government sector Website's Information Retrieval system	GOWAIR
Web application	WebApp
Website quality Assessment model	WQAM
Subject specific information retrieval and Viewing system	SIRViS
Medical Literature Search Agent	MELISA
Document ranking optimization technique	DROPT
Health Agent domain Ontology Model	HADOM
Federal Board of Revenue	FBR
Ministry of Defence	MOD
Federal Education Institute Directorate	FGEI-CG
Ministry of Finance	MOF
Ministry of Professional and Technical training	MOT
Ministry of Planning, Development and Reform	MOP
Official Gate to Government of Pakistan	GOP
Ministry of Science and Technology	MOST

## **1 INTRODUCTION**

### **1.1 BACKGROUND**

The basic definition of an E-Government is "The employment of the Internet and the world-wide-web for delivering government information and services to the citizens" [1]. Electronic government can also be stated as "The utilization of Information Technology (IT), Information and Communication Technologies (ICT s), and other web-based telecommunication technologies to improve and/or enhance on the efficiency and effectiveness of service delivery in the public sector" [2]. E-government encourages the involvement of different stakeholders in the development of state and community as well as develops the governance process better [3].

Network society theorists' states in various studies that activities and social structures in societies are increasingly centers around network largely on information and communication technologies (ICTs) [4] [5] [6]. However governments lag behind in taking up the new technologies. Current public administrations have become progressively more multifaceted, have to harmonize activities with evolving actors in the public domain, and management and processing of large amount of data looks like a silo, insular culture, slow policy-making and knowledge dissemination of the aged model appears to be ill-suited for the improve information flow and corporation, legality and trust as perceived by the citizens and ultimately efficiency and proficiency [7].

Taking this scenario into consideration, e-government and ICT seems to be ideal solution to contemporary public administration problems since the middle of 1990s. Researchers are arguing that could the intensive use of technology increase efficiency of public administration operational rules, simplifies administrative processes [8], involvement of the citizens increases [9] and transparent and accountable government activities could be legislate [10]. Due to high expectations, an exploration is required to evaluate the extent to which public administration and procedures can incorporate ICTs in their basic

activities. It is fascinating to validate whether governments are becoming supplier, transparent and considers citizen's preferences, and transition towards new form of administrative organization might be considered as a virtual state [11] or as a network administration [12].

The government of Pakistan announced its first e-government strategy in 2005 for five years. The E-Government Directorate revised the strategic planning based on the consideration of past years, new realities and current conditions. The E-Government strategic plan is approved for three years in July 2012 [13]. Salient feature of this strategic plan is human resource development, top-level ownership, comprehensive planning, priority on high impact projects, interoperability of applications, security of government information, timely availability of funds and software development.

According to internet live stats [14], there are 1,025,413,487 websites in the world. The number of these websites continuously increasing with each passage of time. The total number of websites registered under the domain ".pk" are approximately 30,000 according to ISPAK 2014 [15].

According to August 21, 2016 United States estimation, population of Pakistan is 193,337,071 [16] with literacy rate of 57% [17] having 69% males and 45% females respectively literate. The internet users in Pakistan are 25 million with 15.9%.

Websites are information systems (IS), organized to collect, store, organize and communicate information. Information retrieval and search is the integral part in the world of websites

The Government of Pakistan aims to spend Rs.4.6 billion on the information technology in the form of e-government, infrastructure and human resource development. The e-government is gaining fame in recent years. It is observed that over the past few years, almost every ministry is moving towards the e-government. This allows the citizens of Pakistan to have an easy access to rules, regulations, legislations and laws.

The e-government sector is in its initial stages having many shortcomings. Apart from many other limitations, these government sector websites do not address the issue of intelligent information retrieval.

## **1.2 PROBLEM STATEMENT**

The literacy rate of Pakistan is 57% including the individuals having the basic education who can read or write their names. The access to information especially the related to legal procedures is the right of every human. In the era of technology, the government of Pakistan is paying attention to the e-government sector. Different ministries develop their websites with the aim to provide the information to the citizens of Pakistan. The e-government is in the initial stages in Pakistan, it lacks different aspects which can benefit the general users. One of the aspects is the search facility in these websites. The thought is to provide a technique to facilitate the users while using these websites.

## **1.3 OBJECTIVES**

- Analyze the existing government sector websites
- Study the ISO/IEC 25010 standard to evaluate the quality of government sector websites.
- Study the impact of search feature on the overall quality of the website.
- Propose a solution that overcomes the challenges faced due to lack of search feature in the government sector websites
- Develop an abstract application which will facilitate in the search process
- Test the effectiveness of the developed application

## **1.4 ADVANTAGES**

This research provides the opportunity to explore this domain of study, which will greatly serve to improve the lives of people of Pakistan.

- Primarily an in-depth research pertaining the quality of government sector website has been carried out.
- This research provides the opportunity to study the importance of ISO standard and adherence of the websites with the ISO quality standard.
- An agent based information retrieval system is developed.
- The system provides with a single screen to surf the government sector websites.
- This will allow users to search the required information from any websites.

## **1.5 AREAS OF APPLICATION**

- Quality engineering
- Study the adherence of ISO standards in the e-government
- Study the impact of search feature on the quality in use of e-government
- Develop an application tackle the issue of search facility

## **1.6 THESIS ORGANIZATION**

The thesis is organised in the following manner. Chapter 2 provides the literature review; research methodology is presented in Chapter 3, Chapter 4 presents the analysis of existing government sector websites and impact of search feature on the quality of these websites; Chapter 5 presents the proposed solution and implementation of the proposed solution; Chapter 6 presents the survey results of the proposed solution and Chapter 7 concludes the thesis with concluding remarks.



## 2 LITERATURE REVIEW

### 2.1 ISO STANDARD

The traditional web applications do not address the features and usage context of mobile applications. In the paper [18], authors highlight the issues of user interface operability and their impact on the evaluation on the mobile applications usability. An ISO 25010 based quality model called 2Q2U is offered to assess and improve the MobileApp usability. 2Q2U addresses the quality attribute 1)quality, 2)quality in use, 3)actual usability and 4)user experience) They looked as the mobile app usage context and impact on app design. In combination with 2Q2U a new framework for the quality is proposed in [19]. SIQinU (strategy to improve quality in use) aims to improve the quality. The propose strategy is used for the evaluation of radio WebApps for user's hedonic and pragmatic needs.

A framework is presented [20] to evaluate Hindi and Punjabi websites on the basis of external quality attributes based on ISO/IEC 25010-11 standard. The proposed framework includes visual and automated observations. In their research proposal, 290 websites from academic, newspaper and government domains will be selected to evaluate on the basis of designed framework.

Abbasi et.al in [21] presents the ISO 25010 user interface aesthetics (UIA) from product quality (PQ) and quality in use (QIU) perspectives. In the said ISO standard, aesthetics is categorized as sub-characteristics of usability. While designing, it is important to design and evaluate aesthetics from user's perspective as well as from the product design perspective. The proposed approached is used to evaluate local Chinese websites.

The web portals as discussed in [22] provide wide range of applications, information and services. The quality in use, as important perspective of ISO/IEC 25010 standard is used as base to define a quality model for the web portals.

Stefani in [23] defines the B2C-specific quality assessment model for web metrics. Three dimensions based on end-user interaction categories, internal specifications of metrics and sub-characteristics of quality in light of ISO9126.

Jayakumar [24] evaluates the websites quality on the basis of accuracy, feasibility, usability and Website quality Assessment model (WQAM). The quality metrics are evaluated through the questionnaire sample. The feedback is used to identify the areas in the website requires improvement. On the basis of the feedback, new e-learning framework is proposed to incorporate the findings. High-level structure based on characteristics, sub-characteristics and main three dimensions attributes (content, service and technical quality) is suggested for the comparison, evaluation and improvement of websites [25].

The independency between the six quality attributes of ISO/IEC9126 is confirmed in the paper [26]. Customer satisfaction is quantitatively measured on the basis of these quality attributes. A prediction model is presented to assess the total customer satisfaction based on the inherit characteristics of the product. Based on these quality attributes “three dimensional integrated value model [27]” model is proposed to display the total quality of the system visually. The entire quality of the system can be measured and compared using integration meter of the evaluation of the system presented through solid volume cubic vectors of the characteristics.

## **2.2 INFORMATION RETRIEVAL TECHNIQUES**

Vimes is architecture for the information retrieval on the web [28]. This architecture is based on the description of relevance. The broader relevance used not only the relevant weight but also consider constrains 1) form, 2) format, 3) price and quality. Profiles are stored as mean to store user preferences. The basics of this model lie on the heterogeneity of information flow: different resources deliver the same information having attributes like price and quantity. The relevance of the resource to the query depend on constrains including price, quantity, format or form. Vimes is a broker aiming to assist in the query process. The architecture is composed of three components; 1) stores user profiles in

open formats, 2) transformation broker to transform resources, 3) user interface for communication between the two components.

Many search engines use keywords for the searching mechanism. Most of the time users find noisy results in their search results due to ambiguity of semantics and usage of keywords. Intelligent Search Bot is proposed by Gupta [29] to facilitate users by filtering relevant results. The system continuously learns user preferences and enhances the efficiency over time. The main concern is to identify user search intentions from the search query and extraction of relevant results. The system is trained according to user intentions by doing classification of the results. After training, knowledge representation and extraction, reasoning and analysis of search results is carried out for relevance. Decision trees are used as the foundation of this technique.

### **2.3 AGENT BASED INFORMATION RETRIEVAL SYSTEM**

Legal and technical aspects for the use of software agents to help access the ScienceDirect digital library are discussed in [30]. The case study presents the contract between VUA and ScienceDirect. They study the aspect of difference made by introducing software agents at VUA. Different scenarios are described for humans where they interact with or without software agents to access the digital library. The use of software agents do not change the human use of the library but provide more geographical independence to the users.

Yew et al in [31] introduces the concept of customizable Web-browsing service using mobile software agents. Server side multi-agent architecture is presented with the aim of increasing the efficiency of internet browsing. The user profile is used by the software agents to monitor the user's favorite websites. Later on agents construct customized views of the sites and inform the user using a web interface.

BASAR prototype is presented by [32], embeds the intelligent agents and modeling techniques into domain oriented systems. They investigated the conceptual issues like control of initiative, intervention and focus of attention with BASAR. They addressed the issues of new role distribution between user and agents.

Williams et al [33] presents SIRViS for multiple users of local computer system to access information stored distinctly on a wide area network. The SIRViS (subject specific information retrieval and Viewing system) consists of control panel and a content viewer. The control panel is used to enable user define a unique set of rules for locating information stored in one or databases across the network. Any user with the help of content viewer can access and display information about particular subject area or particular user. For displaying information in different subject area, local processing may require multiple VIRViS.

The ability of mobile agents for controlling and managing information on distributed systems is used to search technical research paper across the network [34]. The mobile agents roams from host to different locations, execute data processing and appropriate data is send back to the host. Htoon et.al uses the java-programming agent Aglets. They achieved bandwidth savings and overcome the problem of network latency.

The profile information filtering using agents is presented by Wondergem et.al in [35]. The engine is implemented as multi-agent system, comprising of different types of active agents. They used noun phrases for the basis of querying and description of languages. The method to identify the similarity has to support these languages. Depending on the identification process, related documents to be presented.

The technology of agents and genetic algorithms used to manage the information retrieval [36]. The main focus of this paper is to establish a relation between genetic algorithm and its importance for the information retrieval. This paper discusses the genetic algorithm as a proposed solution. It also analysis the dynamic and static proposed solutions.

Fault tolerance technique for the agents is presented by Hans's et.al [37]. Agent may stop the operation in the route on any server. This paper proposes the usage of partial results, check points and last visited host's address to save before agents' movement to the next host in the route. If fault occurs, the affect is masked by sending the replica of the original host to the instantaneous check point before the faulty server. This technique shows good results by refining the round trip time of the agents. The replica agent needs not to roll back after the incident of fault.

Møller et.al [38] explores the usage of descriptive logics (DLs) for retrieving information in multi-agent set-up. Two DLs and their relevant reasoning facilities are discussed for information retrieval. They checked the scenarios of instance example-based instance retrieval, retrieval and instance checking. A broker based multi-agent for information retrieval is presented to make use of knowledge bases. The purpose behind is to transfer queries to individual agents and their conglomerated result use as a correct but need not to be complete set of results. Multi-agent information retrieval systems are further enhanced using the intelligent evolution [39]. Based on user's query history, the system rectifies users' preferences constantly coming with more accurate results. The experimental results show an accuracy of 81.6% and continue to improve with constant use of the system.

Document ranking optimization (DROPT) technique is presented for context aware health care systems [40]. This technique measures retrieve information to validate the effectiveness of the results. They [40] presented architecture for the information retrieval system comprising of context aware agents expertise. Researchers while establishing solutions for the medical health care systems, ubiquitous computing medical system with main focus on context aware agents is presented [41]. The aim is to attain an autonomous data organization for the user. This system helps physicians' decisions by retrieving and recommending links to former case studies and digital medical libraries.

The mobile agents route across different servers and study image databases performing feature extraction, collect similar images at as each respective node to speed up the processing [42]. The benefit of the proposed technique is increase in computational time while reducing bandwidth by avoiding transferring of enormous data.

Selective information retrieval using agents is proposed by [43]. They use the cooperation model to articulate the process of agent communication and association. Different hosts collaborate with each other in a distributed environment for improving proficiency. User gets more relevant pages through effective indexing and searching approach. Higher performance is achieved using the concept of topical crawling founded on anchor words notion.

A three layer architecture for agent based web-document search system [44]. The proposed architecture is modular based; enable the inclusion of new search modules, personalized selection of retrieved documents and security methodologies like encryption / authentication handle.

Zhang et.al [45] presented the multi-slot WebIE system based on the agents' technology. The proposed system comprises of different agents which co-ordinate with one another to carry out the goal. To handle the issue of adaptability, extraction rule learning and repair is proposed.

## **2.4 SEMANTIC AGENT BASED INFORMATION RETRIEVAL SYSTEMS**

Medical Literature Search Agent (MELISA), a prototype is presented in [46]. Information retrieval agent can easily be adapted to any medical literature sources or professional domains. Abasolo et.al presented a three layer architecture consist of separated ontologies, query models and aggregation operators for combing results from separate queries.

Chang et.al in [47] presents a prototype of agent based information retrieval in cloud environment. The proposed framework automatically generates mobile agents for the retrieval of preferred data without the interference of the user. Reasoning Agent (RA) deduced the user's request based on the ontologies and translated to a Mobile Information Retrieving Agent Description File based on Mobile Agent Description Language to define the behavior of IR agents. MIRA – GA a generating agent is used to generate MIRA in accordance with MIRADF.

The problems of retrieving data from heterogeneous sources using a specific application to distributed Earth Science data annals and prediction of world event at multiple stages of abstraction are addressed [48]. Solution is presented by developing an engine as an interface agent with consistent data source based on ontologies. They [48] addressed their second problem by analyzing events over a period of time to generate sequential patterns.

Application of semantic agents in the field of industrial automation is presented [49]. An agent-based approach with an integrated access to distributed heterogeneous data sources. In the proposed approach, ontologies store terms, attributes and their relationships in a specific domain of usage. Query processing is supported by the agents and helps users in querying information. To identify the possible bottlenecks in the query can be handled using different architectural modules and optimizing query.

Taveter et.al in [50] presents the problem of information source concepts and the inner-concepts between the domain relationships. It is observed that queries are expressed in the form of concepts about the actual object. There lies a problem in the form that is single object can be distinguish and classified differently by different information sources. This can be solved by defining ontologies from taxonomic perspective [50]. SARI an agent based semantic information retrieval system is used by [50]. They contributed to the research by elaborating and clarifying distinction and connection between ontology and taxonomy, viewpoint and bridge in information retrieval, one-way and two-way bridges, use of bridges to connect ontology classed to its taxonomy, query extension and generation for databases and their conceptual structures, query expansion for textual databases and query development for WWW.

A prototype for the information on the internet in presented [51]. They presented the concept that web search should be both syntactically and semantically. An innovative methodology based on semantic network and ontology using the intelligent agent model is proposed.

HealthAgent domain Ontology (HADOM) [52] theorizes the HealthAgent information and describes the source knowledge using conceptual graphs (CGs). Using this method, conceptual graphs build on the existing ontologies allowing flexibility and modularity. The advantage of the proposed methodology is that CGs can be placed above other formalism and optimize query and retrieval process.

A distributed AI and information mining technique is presented [53]. A multi-agent system comprises of ontologies from taxonomies of terms is designed. Currently present available web resources are represented in a structural way using these ontologies.

The integrated retrieval system framework of heterogeneous information in Digital Libraries is presented in [54]. The proposed solution consists of user interface agent, wrapper agent, mediator agent, knowledge retrieval agent and knowledge based search agent. These agents communicate with each other and collaborate to perform cohesive retrieval function of diverse information in Digital Libraries.

Wang et.al [55] presents the multi-agent system based on ontologies and multi-agents. The proposed system can effectively make information retrieval from syntax level to semantic level, saves user searching cost and searching efficiency increases. The main problem associated with this method is practical employment of ontologies in information retrieval.

Architecture is proposed to process ontology-based queries for the XML annotated documents [56]. InfoSlueth an agent based system is used to carry processing on data from heterogeneous sources allowing introduction of new agents at any time. They [56] introduce two query strategies: 1) simple strategy and 2) semi-join strategy. Ontological Agent-based retrieval system “KnowledgeSeeker” is to retrieve and analyze Chinese news article from the internet [57]. The usage of different ontologies makes it easier to fathom the context of the article more precisely. To find the required web services due to lack of search mechanism of UDDI and increase in web services is handled using Semantic Search Agent (SSA) [58].

The lack of semantics hinders the automatic processing of web data. The problem is tackled by proposing a solution comprises of semantic web and intelligent agents with the use of other technologies such as knowledge modeling, information retrieval and ontology construction [59]. The proposed framework consists of collecting agent, storing agent, reasoning agent and querying agent. The problem of “difficult to feedback useful information to users” is handled by Junwei et.al [60]. They presented a technique to retrieve relevant documents or information by the analysis of semantics in the queries and documents. Semantic Agent Based Search (SOAS) [61] is proposed to handle the problem of Meta data extraction, modeling and retrieval of information over the internet. User search preferences and intentions can be improved by specifying the user’s search



and retrieval preference, filtering and rating web pages. This approach is highlighted using the agent-based system “Websiffer II” [62]. E-learning uses the digital content present in the form of text or multimedia elements over different search engines. Currently search engines uses basic search by the word matching algorithms. The meaningfulness of the search results can be increased using the domain ontologies and multi-agent systems [63].

### **3 RESEARCH METHODOLOGY**

This chapter describes the methodology used to evaluate the e-government websites. The quality in use measures are used in the study are effectiveness in use, efficiency in use and satisfaction in use. Quality in use do not depend only on the system/software, but also on the specified context in which the system is being used. Quality in use context is determined by the users, tasks, objectives and environmental factors.

This chapter discusses the research methodology to evaluate the quality in use. The quality in use of e-government websites are evaluated using the usability study, observations and retrospective think aloud techniques. The steps used to carry the quality in use evaluation are defined in [70] given below:

- Establish purpose of evaluation
- Define context of use
- Specify the context of evaluation
- Specify the quality in Use Requirements
- Design an evaluation and collect data
- Analyze and interpret the data
- Present the result

#### **3.1 ESTABLISH PURPOSE OF EVALUATION**

The purpose of evaluation is to study the impact of search feature on the quality of the website when perceived from the user perspective. The main research questions in study are:

- 1 Is the quality of existing e-government facilities are in conformance to the ISO quality standard?
- 2 Is the quality in use of the websites enable users to provide productive results?
- 3 Are the quality in use measures appropriate to evaluate the quality of e-government websites in a define context of use?
- 4 Is lack of one feature or another in the e-government websites affect the quality from user perspective?
- 5 Is lack of search functionality in the e-government websites impact on the efficiency, effectiveness and satisfaction of the users?

### **3.1.1 Identify types of products**

The websites analyzed in the study are the e-government websites belongs to different ministries. The websites considered for the research belongs to the e-government domain. There are dozens of websites available on the internet belongs to e-government, education, entertainment and e-commerce. The e-government websites are developed with the aim to provide an easy access to the information and rule and regulations. Simple observation shows that most e-government websites of Pakistan lacks one feature or another which affect the quality in use. Therefore, existing eight e-government websites are selected for the research are as follows:

- Federal Board of Revenue
- Ministry of Defence
- Federal Education Institute Directorate
- Ministry of Finance
- Ministry of Professional and Technical training
- Ministry of Planning, Development and Reform
- Official Gate to Government of Pakistan
- Ministry of Science and Technology

## A. Federal Board of Revenue

Federal board of revenue websites provides information about the income tax, sales tax, customs and federal excise duty and electronic system of FBR as shown in the figure.

The website is available at <http://www.fbr.gov.pk/>

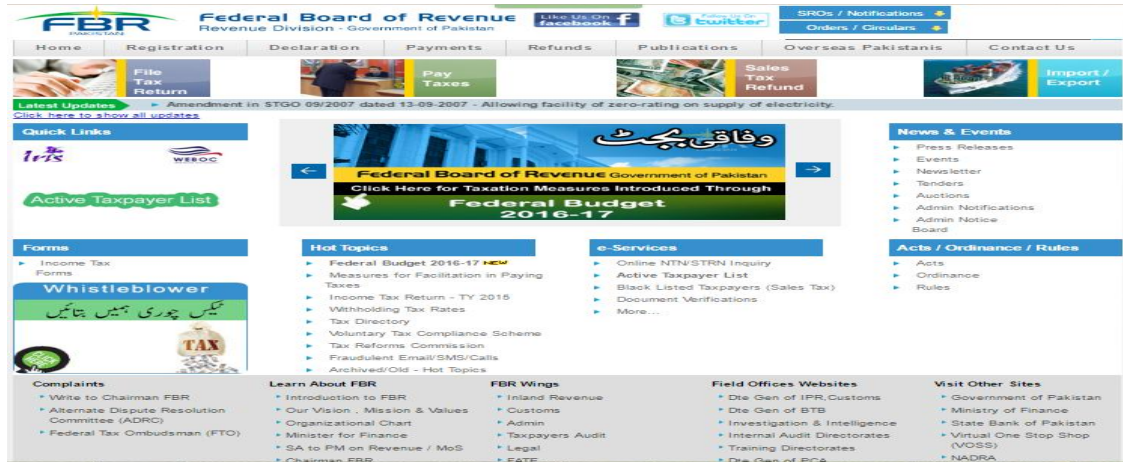


Figure 3-1 – Federal Board of Revenue

## B. Ministry of Defence

Ministry of Defence deals with the administrative matters and policies pertaining to Defence of the Federation and three Armed forces as shown in figure. The ministry website provides information relating to policies, publications, and jobs, Information and Services, News & Press Releases. The websites is available at <http://www.mod.gov.pk/gop/index.php?q=aHR0cDovLzE5Mi4xNjguNzAuMTM2L21vZC9kZWZhdWx0LmFzcHg%3D>



Figure 3-2 – Ministry of Defence

### C. Federal Education Institute Directorate

FG Educational Institutions (C/G) Directorate Rawalpindi provides users with information about academics, institutions, rules and functions and policies as shown in the figure. The website is available at <http://www.fgei-cg.gov.pk/>



Figure 3-3 – FG Educational Institutions Directorate Rawalpindi

### D. Ministry of Finance

The Ministry of Finance deals with the subjects related to financial matters of Federal Government and that are affecting the country. The ministry is responsible for the preparation of annual budget, supplementary/excess budget statements. The e-government services provided by the ministry are access to Federal Budget, Pakistan

Economic Survey, MTBF Secretariat, PRSP Secretariat, and Debt Policy Coordination Office, NFC Secretariat, Press Releases, Regulations, Other Publications, Quality Assurance Program, Career Opportunities, Tenders, Trainings, HR Notifications/Office Orders and Public Notices as shown in the figure. The website is present at <http://www.finance.gov.pk/>.

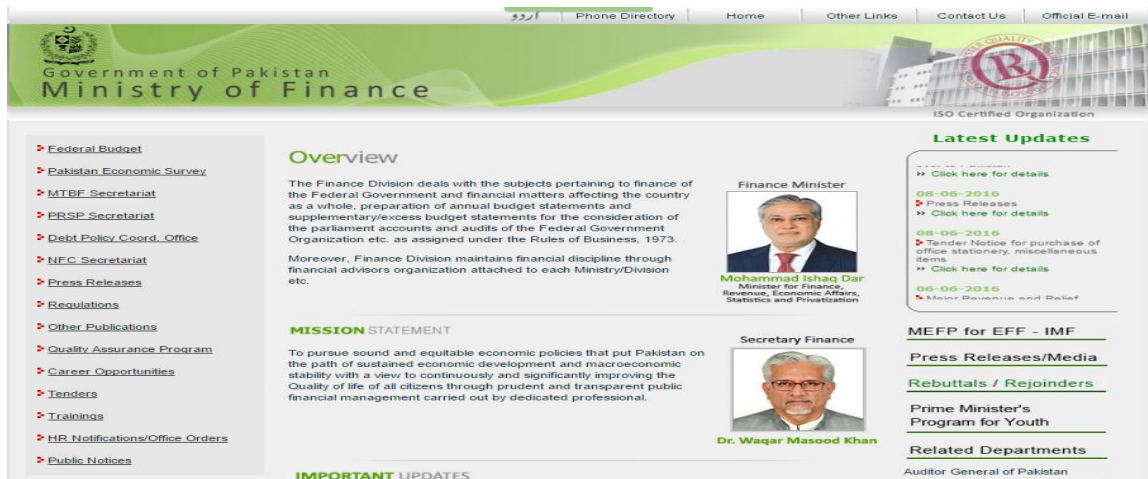


Figure 3-4 - Ministry of Finance

### E. Ministry of Professional and Technical training

Ministry of Professional and Technical Training was established in July 2011. The ministry is striving to provide equal opportunities to all citizens enabling them to acquire knowledge through Primary, Secondary, and Higher Education including Technical and Professional training; creating a knowledge society leading to knowledge economy. The website provides the functionalities as information about news/events, policies, publications, media, different organizations under its umbrella and contact information shown in figure. The website is available at <http://moent.gov.pk/gop/index.php?q=aHR0cDovLzE5Mi4xNjguNzAuMTM2L21vcHR0bS9kZWZhdWx0LmFzcHg%3D>



Figure 3-5 – Ministry of Federal Education and Professional Training

#### F. Ministry of Planning, Development and Reform

Ministry of Planning, Development and Reforms website provides an insight into the ministry functionalities, organizations, mission statement, history, vision 2025, development projects, different resources, media resources and contact information as shown in figure. The website link is <http://www.pc.gov.pk/>.



Figure 3-6 – Ministry of Planning, Development and Reform

#### G. Official Gateway to Government of Pakistan

The website of Official Gateway to Government of Pakistan facilitates the access to all

the websites administrated by different departments. This website provide a comprehensive information about different topics like visa policy, passport issues, immigration rules, economy, education, ministries, employment, tourism, holidays and many more. The website screenshot is shown in the figure and available at <http://www.pakistan.gov.pk/>.



Figure 3-7 – Official Gateway to the Government of Pakistan

#### H. Ministry of Science and Technology

This ministry is enabling Government of Pakistan to take steps in the way to plan, coordinate and direct efforts; initialize and promote scientific and technological plans for the socio-economic development. The website provides functionalities in the form of news, information about policies, easy access to publications, projects information and contact information as shown in the figure. The website link is <http://www.most.gov.pk/>.





Figure 3-8 – Ministry Of Science and Technology

### 3.1.2 Specify quality model

The ISO/IEC 9126 standard used for the quality evaluation is replaced by ISO/IEC 25010 standard. This standard perceives usability as a component of quality in use and as a software quality attribute as defined in ISO 9241-11 standard composed of three characteristics but main focus on quality in use. The characteristic measures are: effectiveness in use, flexibility in use and satisfaction in use. This standard further defines the satisfaction in use as pleasure, comfort, likeability and trust [15]. It also defines flexibility in use as context conformity in use, context extendibility in use, and accessibility in use [15]. Quality in use define in ISO/IEC 25010-11 model overcomes the deficiencies present in ISO 9141-11 and ISO/IEC 9126-1. The narrow definition of usability defined in ISO/IEC 9126 [10] is broadens in ISO/IEC 25010-11. The quality of a system as the extent to which the system satisfies the stated and implied needs of various stakeholders [8]. Quality in use as defined in ISO/IEC 25010-11 “the degree to which a product used by specific users meets their needs to achieve specific goals with effectiveness, efficiency, safety and satisfaction in specific contexts of use” [3].

### 3.2 IDENTIFY CONTEXT OF USE

In order to measure quality in use, it is important to identify each component of the context of use; the users/participants, intended user groups, skills and cognitive and physical capabilities of the users [1]. This section presents the selection of participants for the quality in use evaluation. A demographic survey is conducted to collect the information about the user, the job, experience in job and technology experience. For the demographic survey, questionnaire is used to collect the information about the potential users in Islamabad/Rawalpindi Pakistan.

### 3.3 SPECIFY THE CONTEXT OF EVALUATION

The evaluation has to be carried in the conditions as close to the real world in which the product is to be used [70].

#### 3.3.1 Tasks:

Intended context of use: interviews are conducted with the potential users suggests that using e-government websites become troublesome sometime due to lack of search facility. The task list is formulated to evaluate the impact of search functionality on the quality in use. The tasks are organize to measure learnability, cognitive load, and interactivity, ease of use, helpfulness, attractiveness and functional completeness of these websites.

Table 3-1 – Task List

<b>Task List</b>
T1.Task to check the learnability
T2.Task to check the cognitive load
T3. Task to check the interactivity
T4. Task to check ease of use
T5. Task to check helpfulness
T6. Task to check attractiveness

T7. Task to check the functional suitability

### **3.4 SPECIFY THE QUALITY IN USE REQUIREMENTS**

The ISO/IEC 25010-11 quality in use measures used for the evaluation are as:

#### **3.4.1 Effectiveness**

*Completion Rate:* Percentage of participants who completed each task correctly.

*Mean goal achievement:* Mean extent to which each task was completely and correctly achieved, scored as a percentage.

*Errors:* Errors were not measured.

*Assists:* The participants were given no assistance.

#### **3.4.2 Efficiency**

*Task time:* mean time taken to complete each task (for correctly completed tasks).

*Completion rate efficiency:* mean completion rate/mean task time.

*Goal achievement efficiency:* mean goal achievement/mean task time.

*No of references to the manual/evaluator:* number of separate references made to the manual.

#### **3.4.3 Satisfaction in use**

Satisfaction in use was evaluated by providing users with the post evaluation satisfaction questionnaire.

### **3.5 DESIGN THE TEST AND COLLECT THE DATA**

Usability evaluation was conducted to evaluate the existing e-government websites with the actual users. The participants were told to use the websites and told that purpose of evaluation was to judge their abilities. The participants were asked to use the e-

government website for 15-20 minutes prior to assignment of tasks. This step was taken to make users familiarize with the websites. The participants were asked at the end of 20 minutes time period as they were ready for the test. After 20 minutes, participants were asked to use the websites and perform the tasks assigned by the evaluator. User based usability test, retrospective think aloud (RTA) and observation methods were used for the evaluation of the e-government websites. Retrospective think aloud method was used to evaluate the severe issues faced while using the website. At the end of the evaluation session, participants were asked to fill the post evaluation satisfaction questionnaire.

### **3.6 ANALYZE AND INTERPRET THE DATA**

The data obtained using the usability test with the participants is analyzed by reviewing the selected quality metrics and notes taken during evaluation process. The statistical analysis is carried out using the mean score, median and mode for the analysis of existing e-government websites.

### **3.7 PRESENT THE RESULT**

Data obtained from the usability test, results were generated. The results of the quality in use evaluation is presented in the next chapter.

### **3.8 SUMMARY**

In this chapter research methodology used for the evaluation of quality in use of existing e-government websites is presented. The survey was conducted among people who belonged to different group of ages having diverse experience and information technology knowledge. The results obtained from the survey are discussed in detail in the next chapter.

# **4 ANALYSIS OF EXISTING WEBSITES WITH REFERENCE TO SEARCH FUNCTIONALITY**

The last chapter discusses the research methodology adopted to carry out the quality in use evaluation of e-government websites of Pakistan. This chapter presents the results obtained from the quality in use evaluation. A comparative analysis of the existing e-government websites selected for the evaluation is presented. Results are presented for the effectiveness in use, efficiency in use and satisfaction in use separately for each website. The results presented in this section are as follows:

- Context of use survey results (participants demographic results)
- Effectiveness in use results
- Efficiency in use results
- Satisfaction in use results

The data collected for the evaluation through the usability test, observations, retrospective think aloud and post evaluation satisfaction questionnaire. The data analysis is carried out using the measures described in chapter 3 and statistical mean for satisfaction in use.

### **4.1 CONTEXT OF USE**

The intended context of use of the e-government websites is describe in this section. This section describes the participants who took part in the quality in use evaluation process. Users demographics, professional experience, computing experience and if have any special needs are described.

### 4.1.1 Participants Age

This section presents the users information who participated in the survey. A total of 240 users within the age range between 20 years to above 50 years participated in the evaluation survey. The information in the figure 4.1 is explained as follows:

- Among users 10% belonged to age group between 20-30 years
- 28% of users belonged to 31-40 years age group
- 36% of users had age between 41-50 years
- 26% of the participant's age was above 50 years

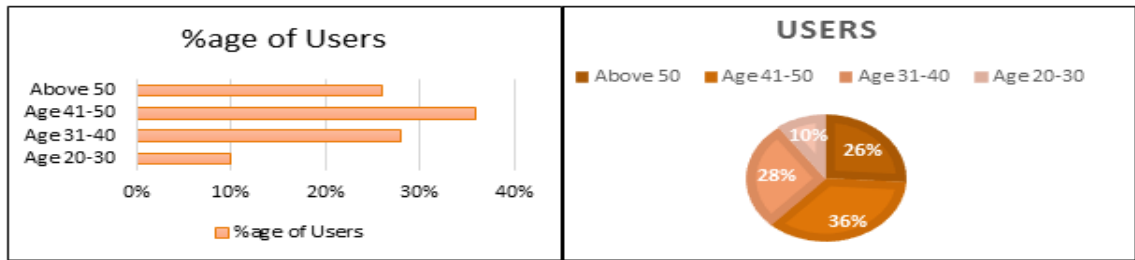


Figure 4-1 - %age Participants with respect to Age Group

The number of participants varied in different age groups. Among the users, 63 participants were above 50 years. Among 240 users 86 belonged to age group of 41-50 years, 67 participated users had age between 31-40year and 24 users fitted into the age group of 20-30 years. The information of the users with respect to the age groups are presented in the figure 4.2.

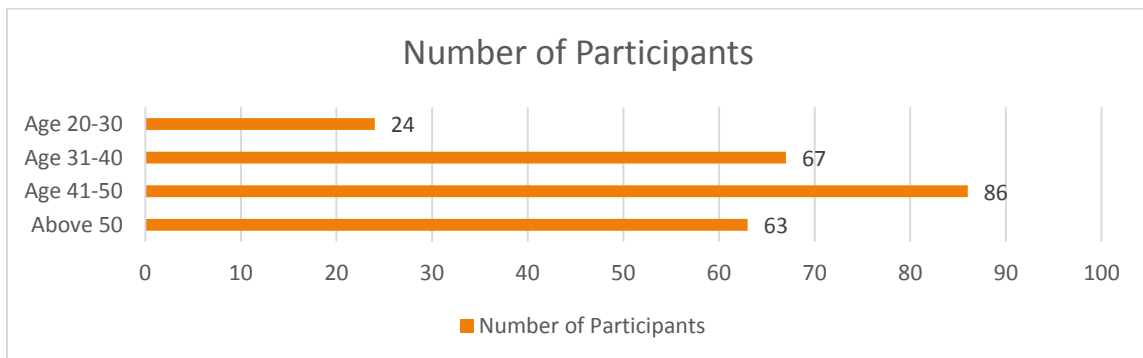


Figure 4-2 – Number of Participants

### 4.1.2 Participants Occupation

To achieve the desired goals of the quality in use evaluation in the specified context, it was ensured participants belonged to different areas of life. The results from the survey are shown in the figure 4.3. From the results it is shown that 4% of the participants were students, 4% were doctors, and 30% were government servants, 27% participant's worked in private sector or owns businesses and 35% belonged to engineers or IT profession.

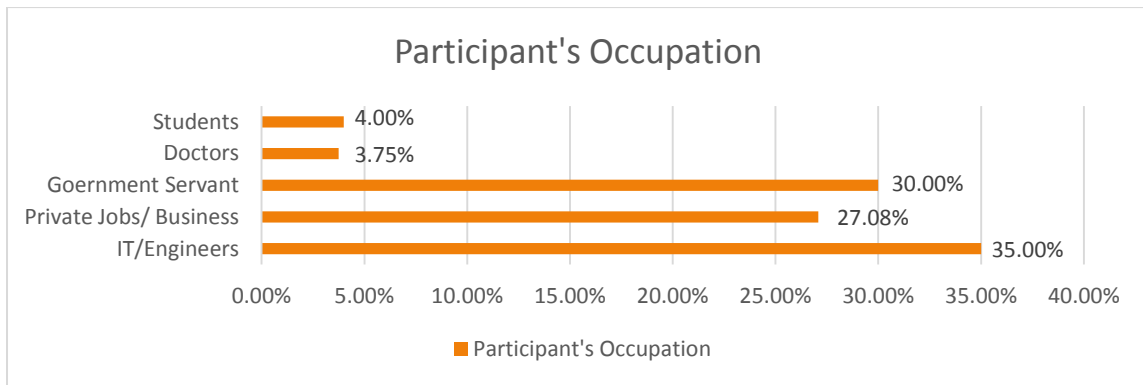


Figure 4-3 – Participant's Occupation

Among 240 participants, 84 participants worked as engineers/IT professionals and users who had private jobs or own businesses were 65. In the survey, 72 participants told they work in the government sector. Due to hectic routine of doctors, only 9 were available for the survey. The nature of information in the selected websites was not the subject directly related to the students, total of 10 students were asked to participate in the survey.

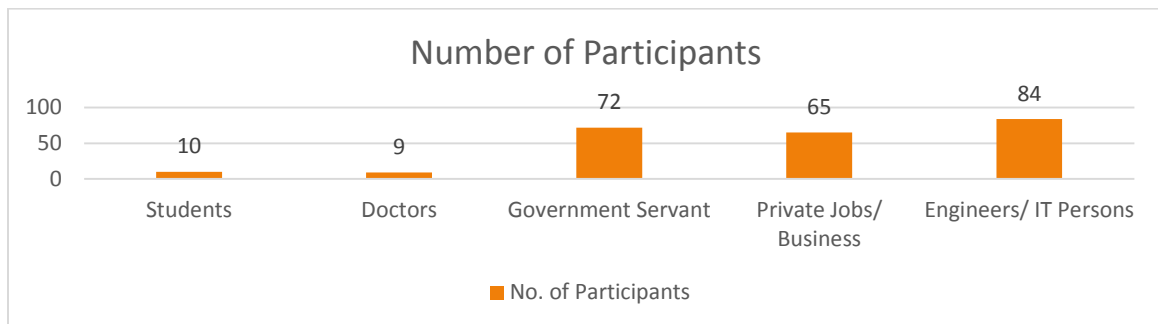


Figure 4-4 – Number of Participants With Respect to Occupation

### 4.1.3 Professional Experience

Professional experience broadens the horizons of the person. This helps in understanding the cognitive behavior of the users and their attitude towards the e-government. For the users experience average mean value is used to determine the participant's job experience with respect to their profession. User's professional experience is shown in figure 4.5. The information about the participants experience is explained as follows:

- IT professional/ Engineers had an average of 7.5 years of experience in their respective fields.
- Users having jobs in the private sector had mean 5.5 years of experience.
- Government sector users had an average mean of 15 years job experience
- Doctors were working for the 9 years in the field.

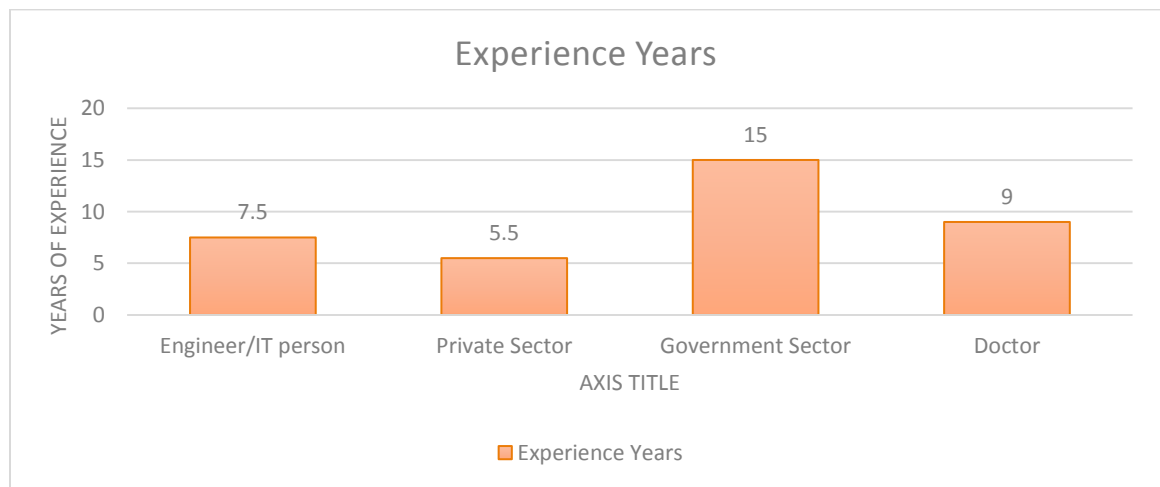


Figure 4-5 – Professional Experience

## 4.2 EFFECTIVENESS IN USE

The data for the Effectiveness in use was collected using the usability test, observations, retrospective think aloud (RTA) and post evaluation questionnaire. The effectiveness was measured using the definition used in Chapter 3 section 3.4.1. The results for effectiveness were recorded for all the eight websites during the task performance phase. The mean, median and mode values for each websites is shown in Table 4.1.



Table 4-1 – Results for Effective in Use

Sr. No	Websites	Mean %age Completion Rate			User Response		
		Mean	Median	Mode	Mean	Median	Mode
1.	FBR	70%	67%	60%	2.355	2	2
2.	Ministry of Defence	56.66%	49%	50%	2.5	1	2
3.	Federal education Institute Directorate	46.66%	35%	40%	1.3	1	1
4.	Ministry of Finance	63.33%	55%	50%	2	2	2
5.	Ministry of Professional and Technical Training	53.33%	60%	45%	2.3	1	2
6.	Ministry of Planning, Development and reform	46.67%	38%	48%	3	1	2
7.	Official Gateway to Government of Pakistan	40%	25%	35%	1.3	2	1
8.	Ministry of Science and Technology	54%	56%	45%	2	2	2

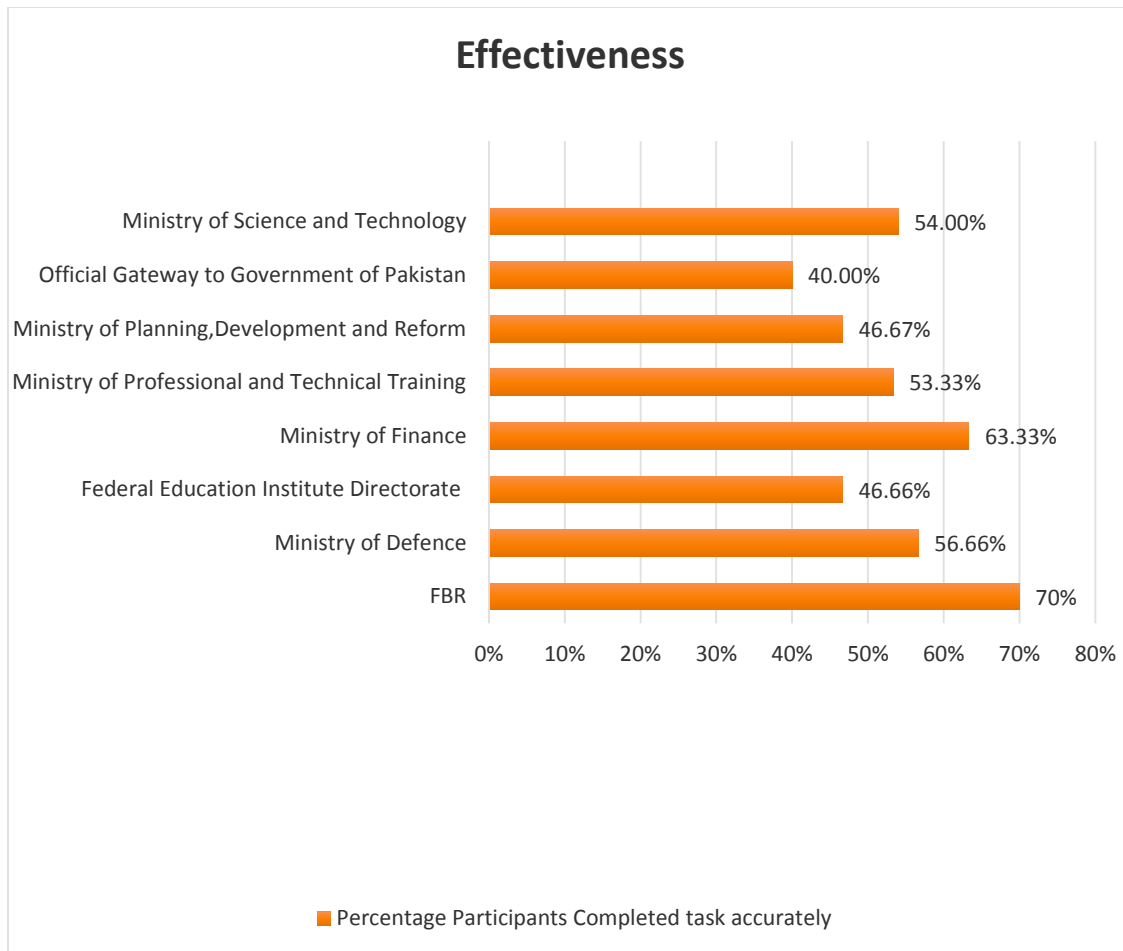
**Note:** all task complete = 100%, each task with error = 10% deduction, help from evaluator = 5% deduction

**User Response:** 1 strongly not agree, 2= disagree, 3 = neutral / somewhat agree, 4 = agree, 5 = strongly agree

In the above table results are organized in two ways 1) mean %age completion rate obtained from usability test and RTA and 2) user response from the questionnaire

#### 4.2.1 Analysis of Effectiveness in Use

The performance of the selected websites are compared using the data presented in above Table 4.1. For the comparative analysis mean values for percentage of task completion rate while analyzing the mistakes, errors and help from the evaluator. The figure 4.6 shows the comparative analysis of the websites selected for the research study.



**Figure 4-6 - Comparative Analysis of Effectiveness in Use for the Websites**

The analysis of the figure 4.6 showed that measures for the website of FBR are greater than all other websites. This showed that users find it easy to complete the assigned tasks with less errors and least help from the evaluator. The results indicated that users had more difficulty in completing the tasks, made mistakes and required frequent help from the evaluator while using other websites. The figure above show that users faced great difficulty in finding the desired results while using the Official Gateway to Government of Pakistan.

The figure 4.7 shows the comparative analysis of user response obtained from the post evaluation questionnaire at the end of task completion. The results shows the attitude of the users towards the websites. The results measures using the 5 point Likert scale. The results in the graph shows the average mean values of the user response obtained from

the questionnaire. The lower scores show poor performance of the users. The user response for Official Gateway to Government of Pakistan and Federal Education Institute Directorate is least. The analysis of the results shows users were not or somewhat satisfied with their task performance.

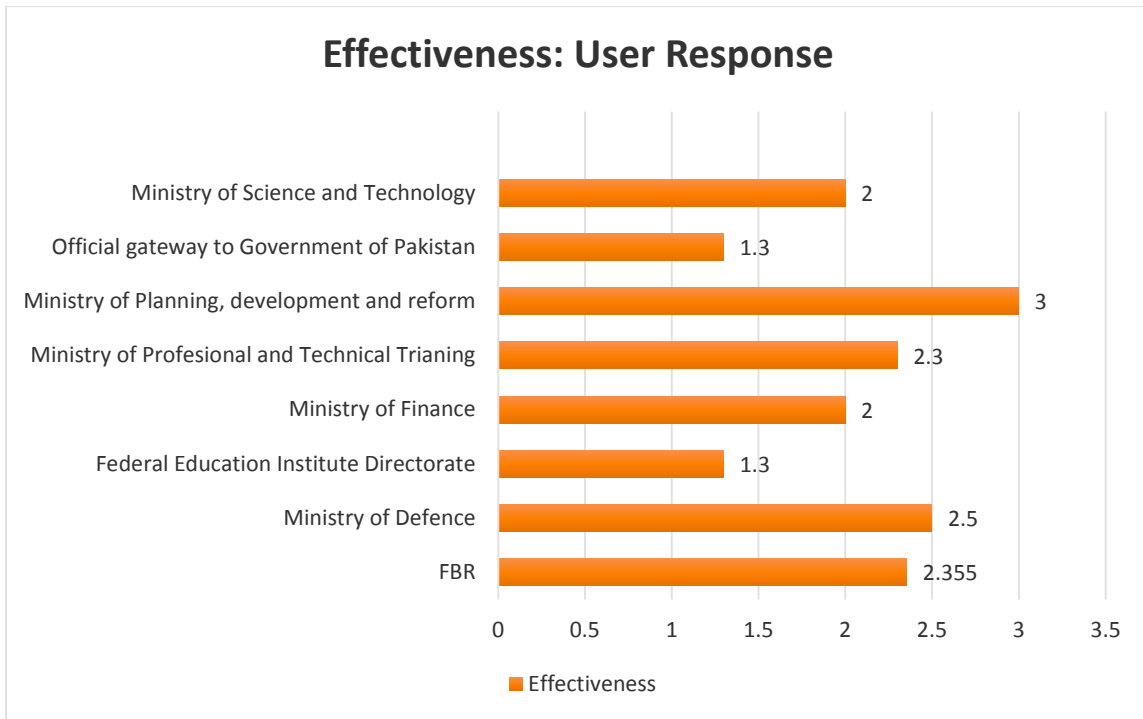


Figure 4-7 – Effective in Use: User Response

### 4.3 EFFICIENCY IN USE

The data for the Efficiency in use was collected using the usability test, observations, retrospective think aloud (RTA) and post evaluation questionnaire. The effectiveness was measured using the definition used in Chapter 3 section 3.4.2. The results for efficiency were recorded for all the eight websites during the task performance phase. The mean time taken to complete the accurately completed task is measures using the usability test and observations. The mean, median and mode values measures through the post evaluation satisfaction questionnaire for each websites is shown in Table4.2.

Table 4-2 – Efficiency in Use

Sr. No	Websites	Mean Efficiency			User Response		
		Mean %age Task Rate (%age)	Time	%age / Time	Mean	Median	Mode
1.	FBR	70%	1.25m	56%	2.473	1	2
2.	Ministry of Defence	56.66%	1.5m	37.77%	2.7	2	2
3.	Federal education Institute Directorate	46.66%	2.5m	19%	1	1	1
4.	Ministry of Finance	63.33%	2.5m	25.33%	2.1	1	2
5.	Ministry of Professional and Technical Training	53.33%	1.25m	42.66%	1	2	1
6.	Ministry of Planning, Development and reform	46.67%	1.5m	31.11%	2	2	2
7.	Official Gateway to Government of Pakistan	40%	2.5m	16%	2.3	1	2
8.	Ministry of Science and Technology	54%	1.12m	48.21%	1	1	1

**Note:** Mean %age task rate (%age) is used from the Table 4.1, Time is calculated in minutes using stop watch, **User Response:** 1 strongly not agree, 2= disagree, 3 = neutral / somewhat agree, 4 = agree, 5 = strongly agree

#### 4.3.1 Analysis of Efficiency in use

The comparative analysis of the results shown as bar graph in figure 4.8. The results in the graph is plotted using the mean values presented in the Table 4.2. The analysis of the results shows that the efficiency rate of the selected websites were not high. These websites do not provide functions that access users in finding the desired results within specified time. Other factors that affect the efficiency were organization of the data on these websites. Users found it difficult to memorize these websites for later use. The website of FBR presented the partial search functionality helped in achieving high efficiency rate. On the other hand Official Gateway to Government of Pakistan and Federal Education Institute Directorate had the least efficiency rates.

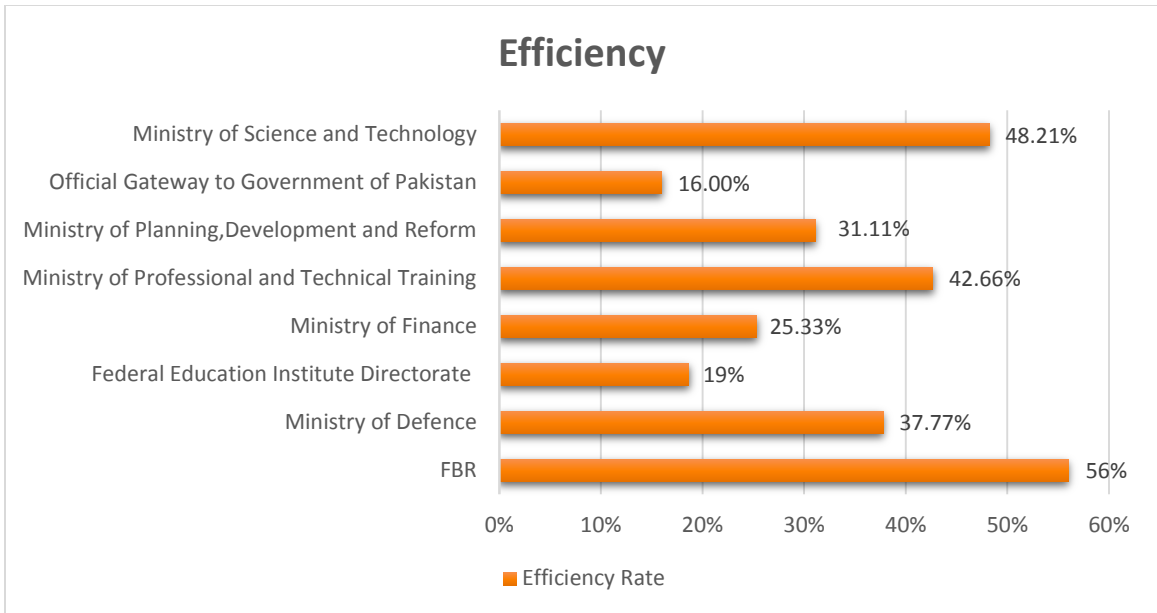


Figure 4-8 – Efficiency

User response obtained using the post evaluation satisfaction questionnaire is shown in figure 4.9. The 5 point Likert scale is used to measure the survey results. The high scale indicate the greater satisfaction achieved obtained by completing tasks in limited/ minimum time. The users did not feel satisfied after achieving the goals.

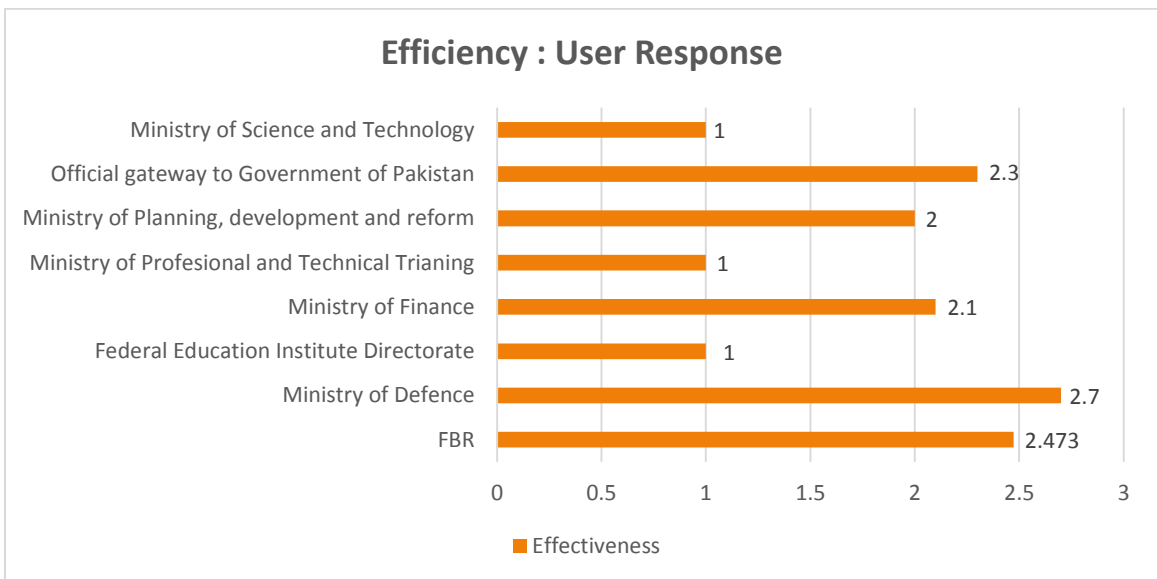


Figure 4-9 – Efficiency: User Response

#### 4.4 SATISFACTION IN USE

Satisfaction is accomplished by the achieving the pragmatic goals. Satisfaction in use is measured in terms of satisfaction, likability, trust, pleasure and comfort obtained while using the system. The user opinion about satisfaction, likability, pleasure, trust and comfort was recoded using the satisfaction questionnaire. The results were measured using the Likert scale. The mean values for satisfaction in use in shown in graph in the figure 4.10. The response showed users were not felt accomplished after achieving the tasks. The pragmatic goal did fulfilled and users faced number of difficulties in achieving the goals.

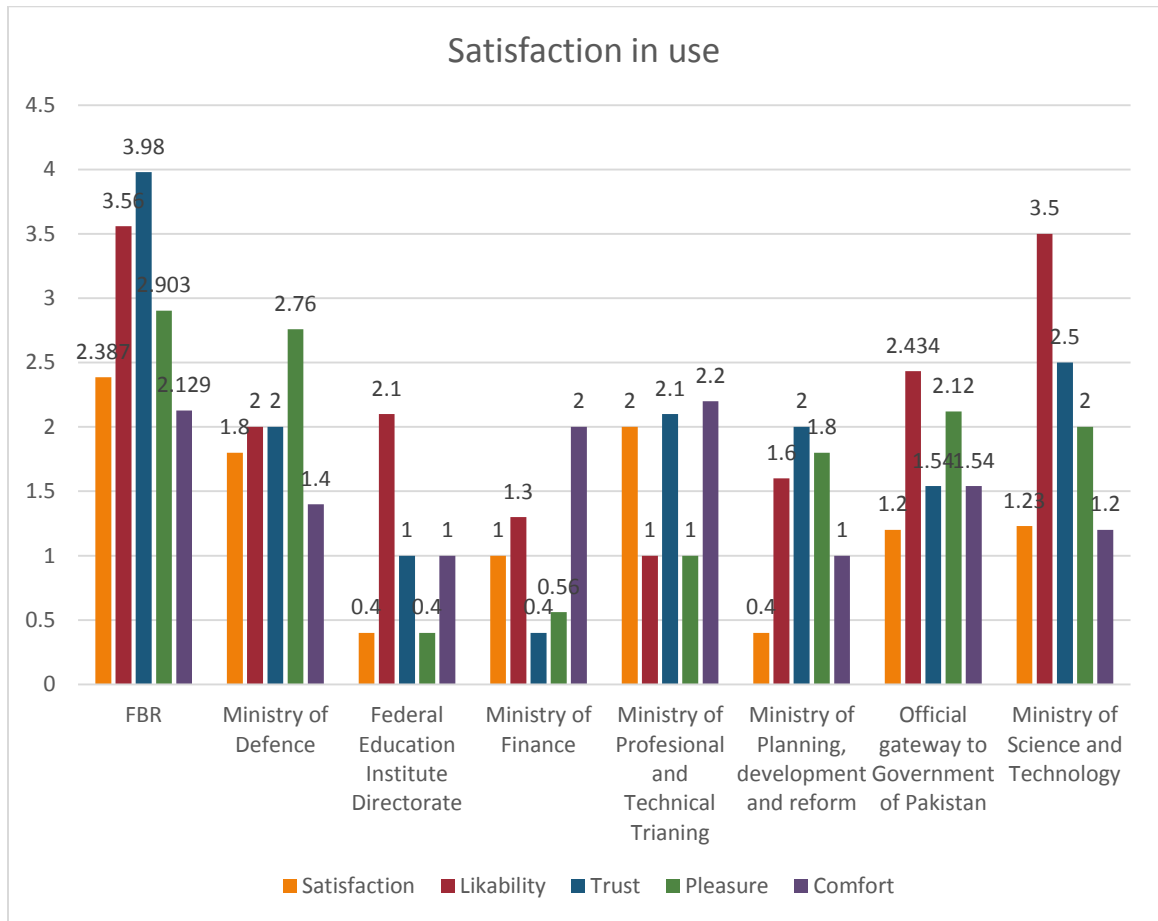


Figure 4-10 – Satisfaction in Use

## **4.5 CONCLUSION**

An important factor that contribute to poor performance is lack of search feature in those websites. The tasks for the survey was organized in such a way that participants were asked to use the websites for 20-30 minutes to get familiar with the features of the websites. After the said time period, different tasks were assigned to them. Most tasks were designed to find a particular data present on these websites. Due to lack of search feature, user's performance degraded. The participants did not perform their tasks with effectiveness and efficiently. Once the tasks not completed effectively and efficiently, user satisfaction, trust, comfort and pleasure had not achieved.

# **5 PROPOSED SOLUTION AND IMPLEMENTATION**

In the Chapter 4, analysis of websites is presented selected for the research study. The analysis shows users face difficulty in achieving the tasks due to lack of search functions in those websites. The lack of search function impacts on the effective and efficiency of these websites. The user's sense of satisfaction was not achieved by not fulfilling the pragmatic goals. A search functionality should be provided in the websites to achieve high effectiveness, efficiency and satisfaction scores. This chapter provides an information retrieval framework. An agent based GOWAIR system is proposed.

## **5.1 INFORMATION RETRIEVAL MODEL**

It requires fetching data from distributed information resources through the information searching process. The agent-based information retrieval system should have the features of intelligence and adaptability. Using the sovereign, learning and synergic properties of the agent, Government sector Website's Information Retrieval (GOWAIR) system is presented based on the ontology and multi-agent theories. Agents have an autonomous property which enables them to control their own actions without the assistance of the human factor. In a multi-agent environment. Agents arrange and cooperate using the agent's synergic property. The learning property of the agents enables them to acquire knowledge while interacting with the human beings or other agents.

## **5.2 MULTI-AGENT SYSTEMS**

An agent is an encapsulated software entity with predefined set of objectives. An agent wants to achieve its goals through sovereign actions. While performing its actions, it interacts with its environment and other agents though maintains a persistent state. The agent-based archetype supports ways to abstract solution for a given problem. Agents interact in a supple way by using the concepts of autonomy, reactivity, interaction, goal-



orientation, persistency and proactivity. The concept of agents allows analyzing and designing system having distributed information, decision processed and functionalities [67]. Adaptive and flexible systems are developed by the researchers on the foundation of agent-based architecture. These software systems handle different views, distributed task nature or contradicting ideas emerges from the problem area [49].

### **5.3 ONTOLOGIES AND AGENT COMMUNICATION**

The computer system requires representation of the concepts, relationships among them and their related context for communication and decision tasks.

- Description of the terms in the problem domain is presented by the ontologies.
- Ontologies are used to represent the syntax and the content of messages communicated between the agents.
- According to W3C [68], ontology is set of entities, properties, classes and relationships to describe a standardized terminology.
- Ontologies are useful for the users, database systems or any application sharing the knowledge specific to the domain.
- Communication between the agents is possible if they share a common ontology or having an association between rationally parted ontologies [69].
- Random agents communicate reliably by exchanging the desired content.

### **5.4 PROPOSED SYSTEM**

The proposed solution consist of the following steps shown in figure 5.1.

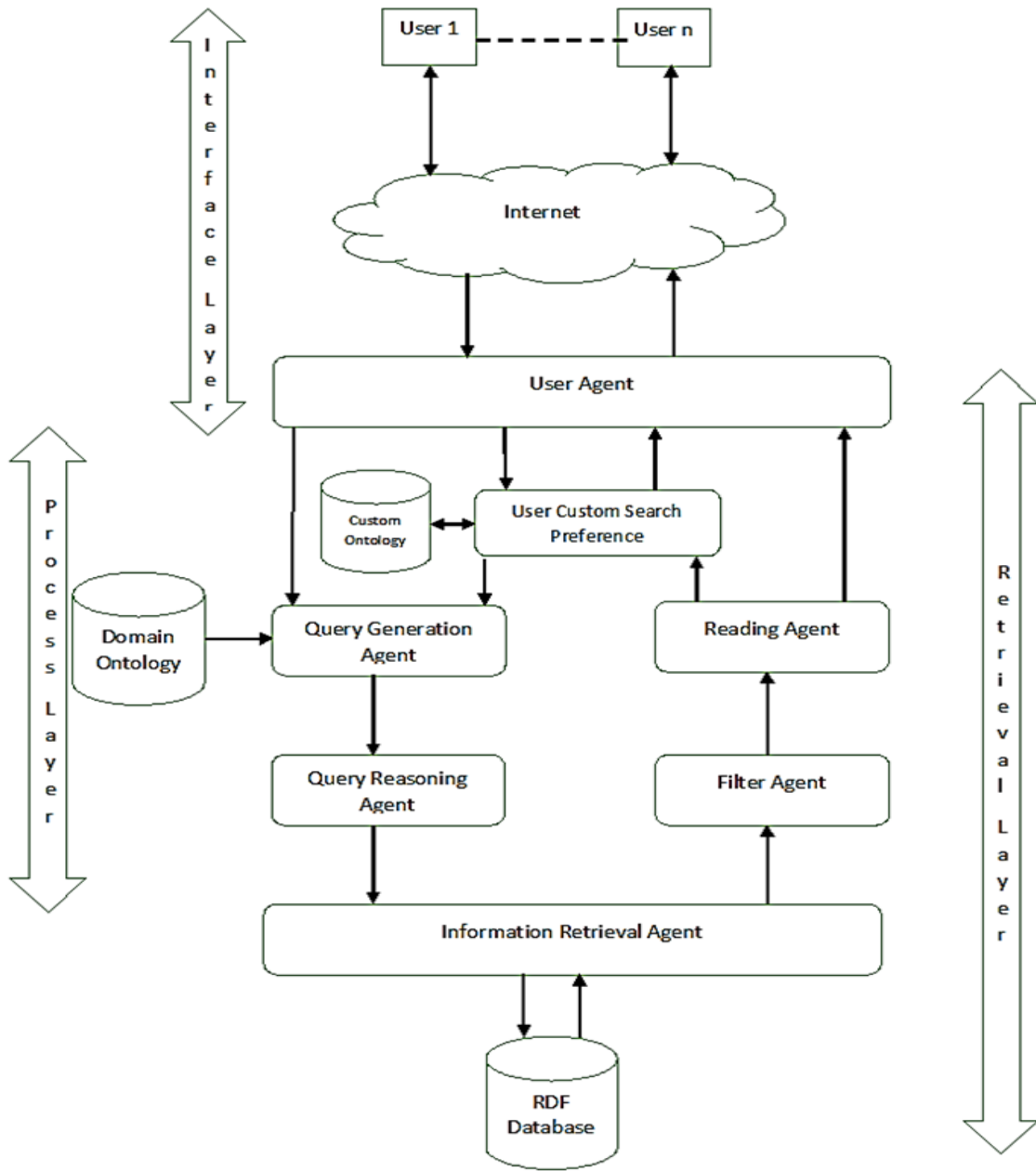


Figure 5-1 – GOWAIR

#### 5.4.1 Interface Layer

The intercommunication between the user and the user agent over the internet is communicated through the interface agent.

#### **5.4.2 Process Layer**

The process layer is the building block of the system. This layer is responsible for handling complex and uncertain demands of the users. This layer helps users in the intelligent compilation of search queries.

#### **5.4.3 Retrieval Layer**

Retrieval layer accomplishes the task of information retrieval, filtering relevant information and analysis of the retrieved results according to the user demands.

#### **5.4.4 Custom Ontology**

User custom information and search patterns are stored in the custom ontology. There is a need to store user's information and interests to work in an efficient way. With the user's first time interaction with the system, users provide useful information to the system in the form of search terms. With the user's continuous interaction with system, the custom ontology develops. The user's feedback and searching demand is used as the entry point. With the custom ontology, user will eventually have personalized searching services. This will help the user by saving search cost and search efficiency improves.

#### **5.4.5 Domain Ontology**

Domain Ontology presents field specific knowledge. It is used to represent the content and data sources in a specified pattern. It provides a vocabulary which is readable by the computer machines and interpreted by humans. The domain ontology contains the vocabulary specific to the government sector websites.

#### **5.4.6 User Interface Agent**

The communication channel between humans and computer on the foundation of custom ontology and domain ontology is provided by the user interface agent. The custom ontology is called by user agent after every search demand. The empirical information related to the search query is found out and sends to the user agent for approval and

selection. If there is no pattern similar with the user search request in the custom ontology, search demands directly forwards to the query generation agent.

#### **5.4.7 Query Generation Agent**

User queries are forwarded to query generation agent. User agent makes pretreatment to the user search query presented in natural language, all keywords are brought forward to the query generation agent. Query generation agent analyzes the keywords on the basis of domain ontology. The result of analysis is listed down in the form of synonymous with the user's keywords for approval and selection. If keyword is not a term of domain ontology, users are provided with possible relational concepts in the domain ontology. This assists users to express their searching demands in an efficient way with constant guidance of domain ontology.

#### **5.4.8 Query Reasoning Agent**

It facilitates the formatting of searching needs that are relevant and similar to user's demand in accordance with domain ontology. The reasoning agent undertakes the responsibility of semantic matching and semantic relevance matching. The impact of semantic matching is accurate reasoning of user search needs in accord with the domain ontology concepts; circumvents the issue of one word multiple meanings. The semantic relevance matching implies the inference rules over the domain ontology. This provides the co-relation between the domain ontology concepts in relation to the search terminology. Using this, the problem of secluded information in a pool is solved.

#### **5.4.9 Information Retrieval Agent**

This agent has control over the data sources. The data sources are managed in the form of resource description framework (RDF) database. These files contain the intensive description of the websites. These provides the information about the content of the websites. Information Retrieval Agent starts with the refined query from the query agent and delivers the corresponding search results to the filter agent.

#### 5.4.10 Filter Agent

Filter agent receives results from the Information Retrieval Agent. The Filter Agent is responsible for eliminating blind links and redundant results. The results are sorted out according to their relevance degree and returned in uniform format.

#### 5.4.11 Reading Agent

Reading Agent will filter off the unwanted results according to the user preference.

### 5.5 “GOWAIR” SYSTEM SCREENSHOTS

- The main screen of the GOWAIR is presented in the figure 5.2.
- Main screen is the entry point into the GOWAIR system.



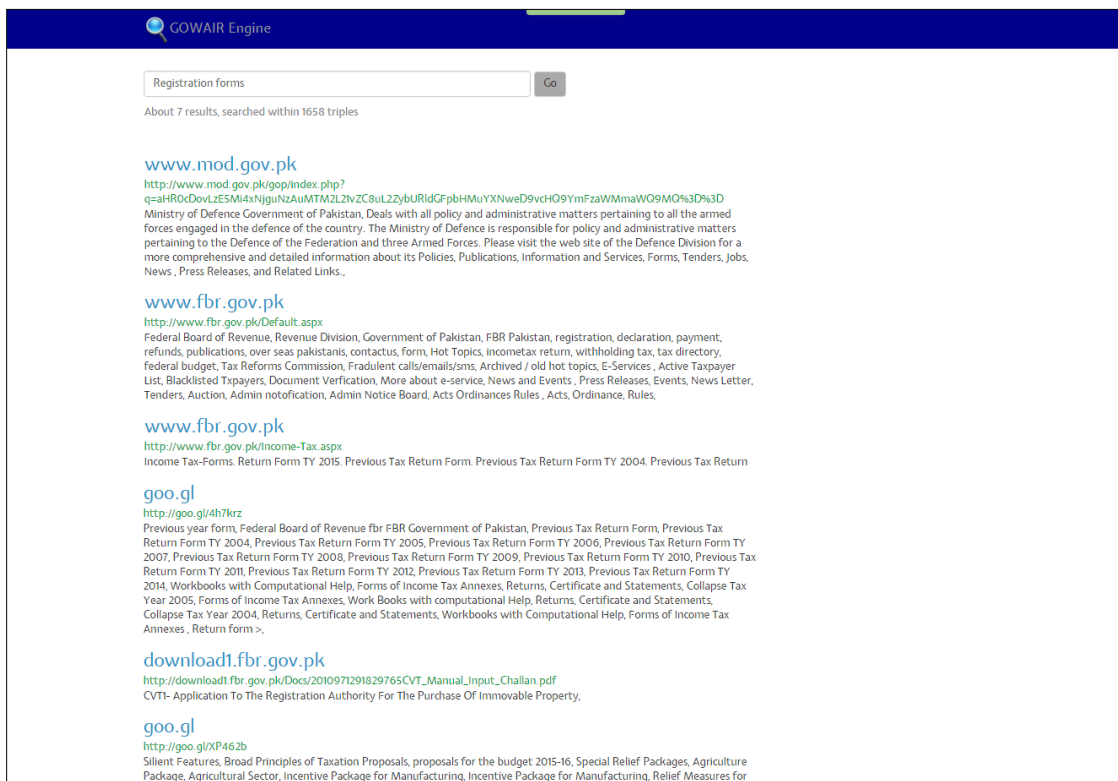
Figure 5-2 – Main Page of GOWAIR

- The system allows users to search the results in an efficient manner by predicting queries.



**Figure 5-3 - Query Prediction/ Autocomplete Query**

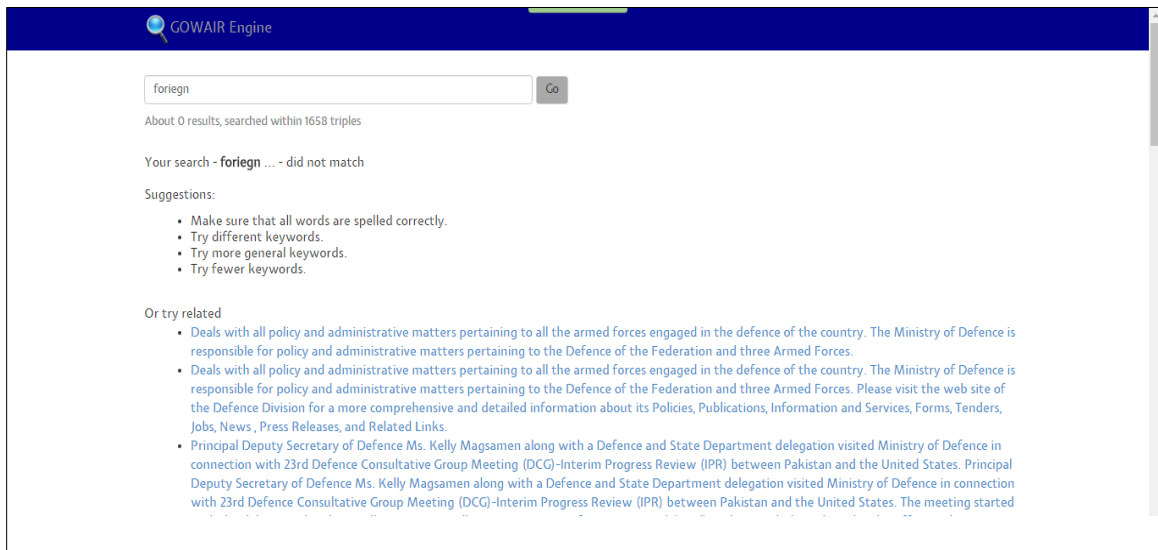
- Search results are shown in the figure.



**Figure 5-4 - Search Results**

- The figure 5.5 shows the search query do not match
- If search query do not match, provides reasons for not showing the desired results.

- It also provides the users with possible options for the search.



**Figure 5-5- Search Query Not Matched**

### **6 RESULTS**

The software testing is considered an important phase of software development life cycle. An activity handles the whole development and maintenance of the software is called as software testing. The purpose of software testing is to highlight the shortcomings in the developed software.

The evaluation of the developed application is carried out with the aim to ensure the purpose of the application development. The purpose of the testing phase is to ensure all the requirements of the user considered. The application is developed after highlighting the problems faced by the users due to lack or inefficient search functionality in the websites. The testing procedure is carried out to ensure the developed application satisfied the user needs.

The evaluation is carried out on the basis of ISO/IEC25010-11[64] Quality in Use. Quality in use states the software usage in a defined context. The measurement of Quality in use characteristics is carried out on the basis of ISO/IEC 25022 Systems and software engineering - Systems and software Quality Requirements and Evaluation (SQuaRE) [70] standard. Based on the ISO/IEC 25010-11; following quality in use characteristics are used for the evaluation

- Effectiveness in Use
- Efficiency in Use
- Satisfaction in Use

For the evaluation 25 participants were contacted. Initially participants were briefed about the system, later asked to use the system. The questionnaire used for the evaluation in presented in Appendix B. The survey was conducted in Rawalpindi/Islamabad.



## 6.1 EFFECTIVENESS

The effectiveness of the system is evaluated using set of question asked. The Table 6.1 presents the questions asked about the system effectiveness and results measured using five point Likert scale. In the table mean, mode and median values of the user results are shown.

Table 6-1 – Effectiveness Evaluation

Sr. No	Questions	Mean	Median	Mode
1.	Software helped in finding the required information?	4.3	4	4
2.	Completed the tasks with accuracy?	4.5	3	4
3.	Do you find the desire information with accuracy and completeness?	4.65	4	4
4.	While using the system do not required help from the evaluator?	4.231	5	4

Note: User Response: 1 strongly not agree, 2= disagree, 3 = neutral / somewhat agree, 4 = agree, 5 = strongly agree

The graph in the figure 6.1 shows the user response about the system effectiveness. From the survey, it was observed that 54% users were of opinion that “GOWAIR” provides results with accuracy and completeness.

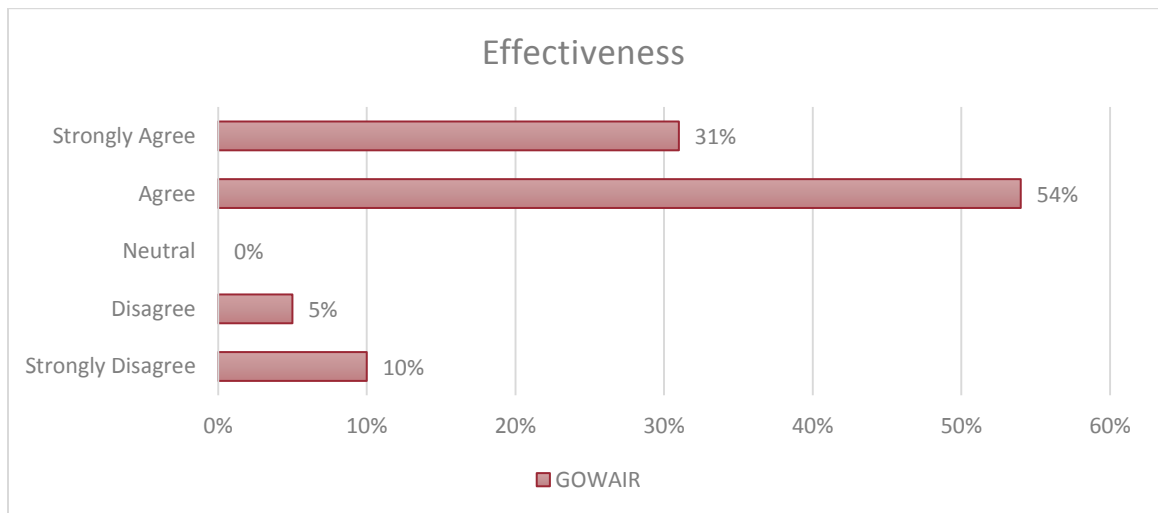


Figure 6-1 – Effectiveness

## 6.2 EFFICIENCY

The Table 6.2 shows user response about the efficiency of the system. The data for efficiency is collected using the evaluation questionnaire filled by the user at the end of the test session. The mean, median and mode scores were calculated using the Likert scale. The high indicates better efficiency of the system as shown in table.

Table 6-2 - -Efficiency Evaluation

Sr. No	Questions	Question Number	Mean	Median	Mode
1.	Do you achieve your goals while spending minimum time resource?	Q5	4.7	5	4
2.	I completed the tasks in time	Q6	0.67m	0.898m	0.56m
3.	Do you find the information in less time?	Q7.	4.23	3	4
4.	System helps in finding the information in minimum time?	Q8.	4.87	4	4

Note: User Response: 1 strongly not agree, 2= disagree, 3 = neutral / somewhat agree, 4 = agree, 5 = strongly agree

The participant's opinion is shown as bar graph in figure 6.2. About 60% of the participants thought system responded to the input in minimum time.

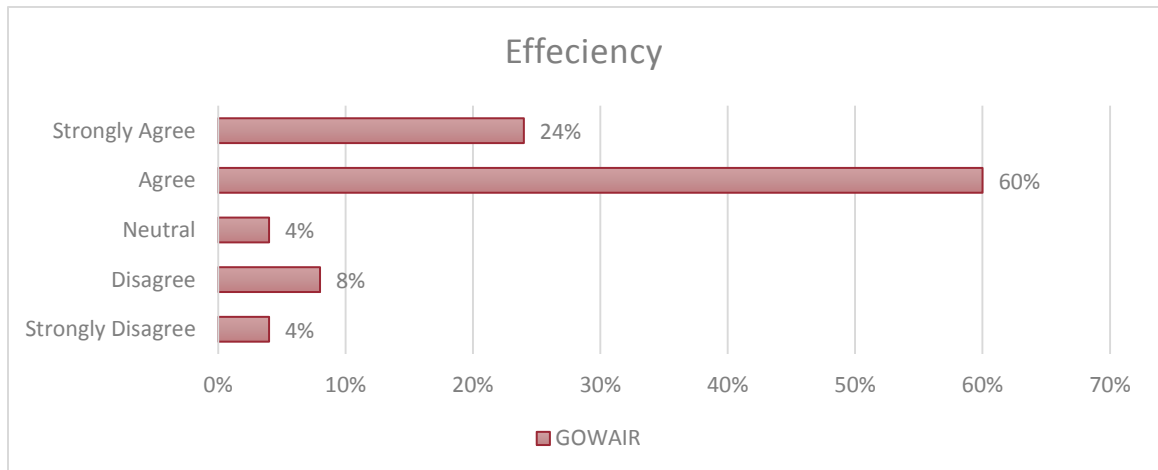


Figure 6-2 - Efficiency

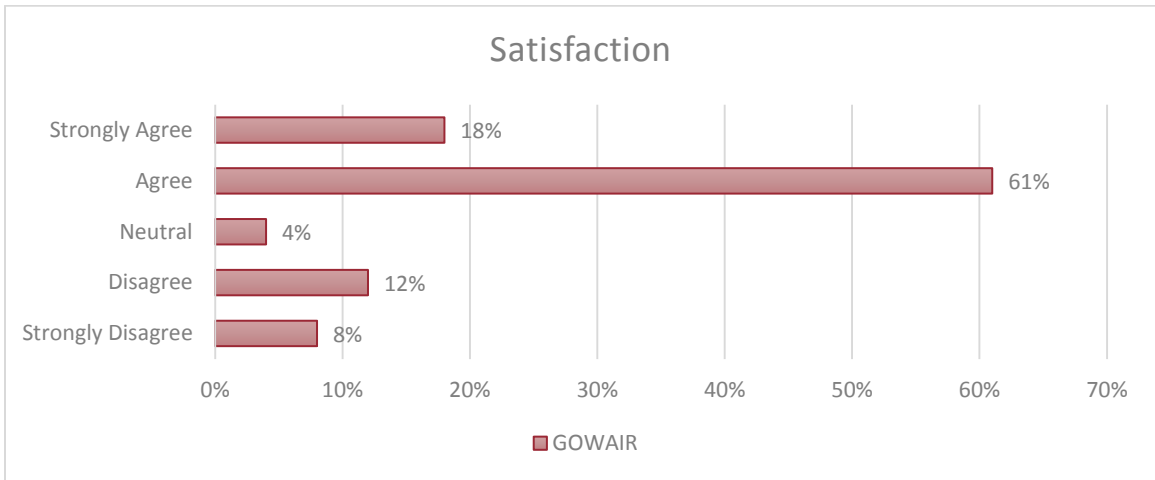
### 6.3 SATISFACTION IN USE

User's pragmatic needs are evaluated using satisfaction questionnaire. The questions were about satisfaction, pleasure, likeability, comfort and trust of users towards the system. Table 6.3 is used to show the mean, median and mode values measured using the data collected from the survey

Table 6-3 – Satisfaction in Use

Sr. No.	Questions	Mean	Median	Mode
1.	Are you satisfied with the system?	4.3	4	4
2.	Do you find the system useful while searching for specific target?	4.67	4	5
3.	Do system behave the same while showing the results?	3.98	5	4
4.	Do you feel pleasure when you find the information in one click?	4.123	3	4
5.	Do you feel comfortable while using the system?	4.43	5	4
6.	Do you find the system trustworthy?	3.89	3	4
7.	Do you like the system?	4.21	4	4
8.	Did system satisfies your requirements?	4.34	3	4
9.	Do you feel accomplished after the results in minimum time?	4.76	4	4

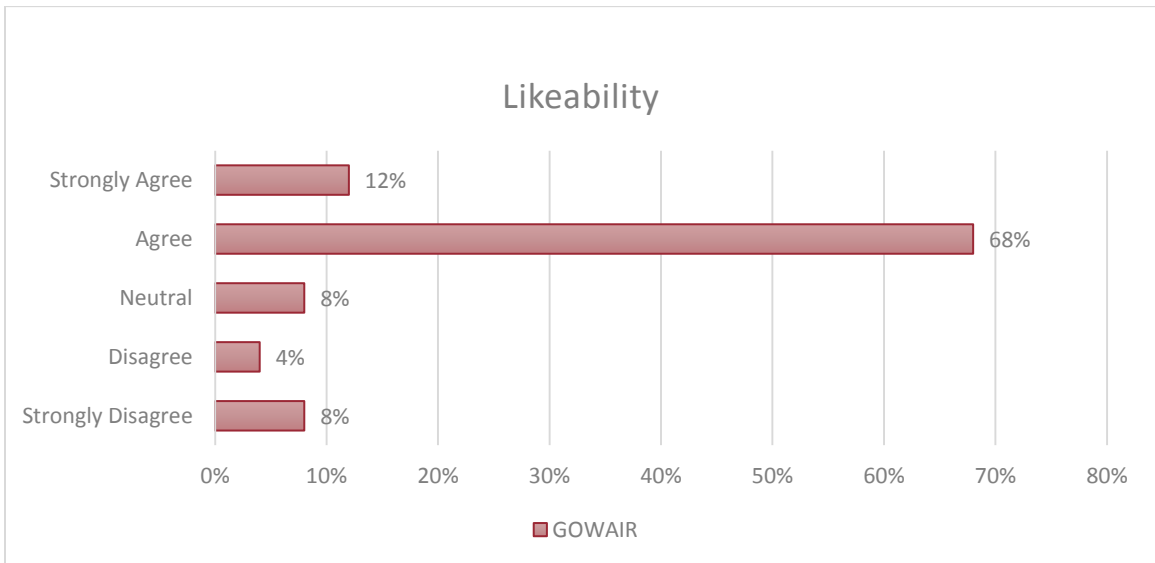
In figure 6.3 user satisfaction results are shown. From the figure it observed that 61% users felt satisfied while using the system while 18% users felt very satisfied.



**Figure 6-3 - Satisfaction**

### 6.3.1 Likeability

The user attitude towards the system; users found the system likeable is shown in figure 6.4. The 55% users of “GOWAIR” found the system useful while 10% users thought to be very useful.



**Figure 6-4 – Likeability**

### 6.3.2 Trust

The graph in the figure 6.4 shows the user response when asked about the users' confidence on the system. 64% users showed trust in the GOWAIR system.

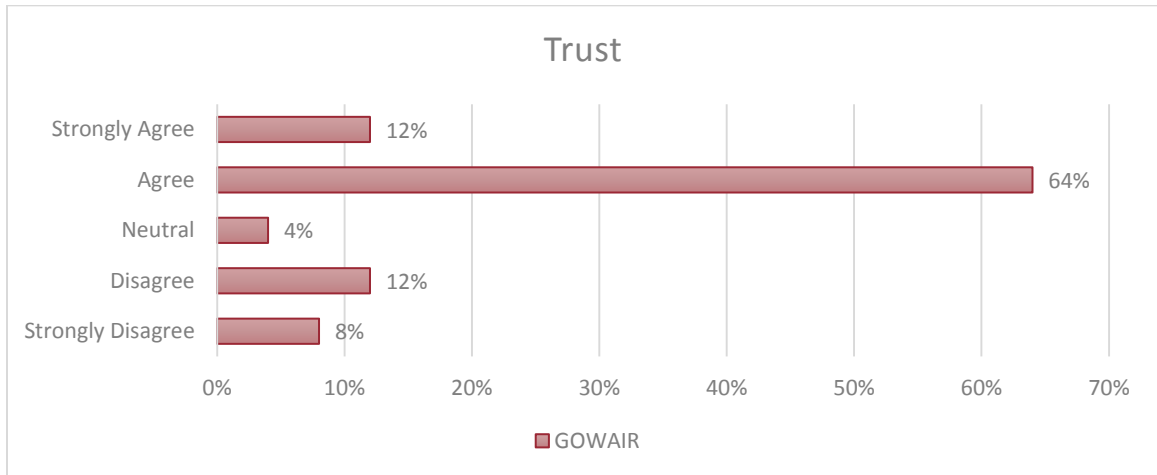


Figure 6-5– Trust

### 6.3.3 Pleasure

The pleasure users felt while fulfilling the personal needs is shown through the graph in the figure 6.6. 40% users of GOWAIR system felt pleasure while using the system while 15% felt extreme pleasure in the usage of the system.

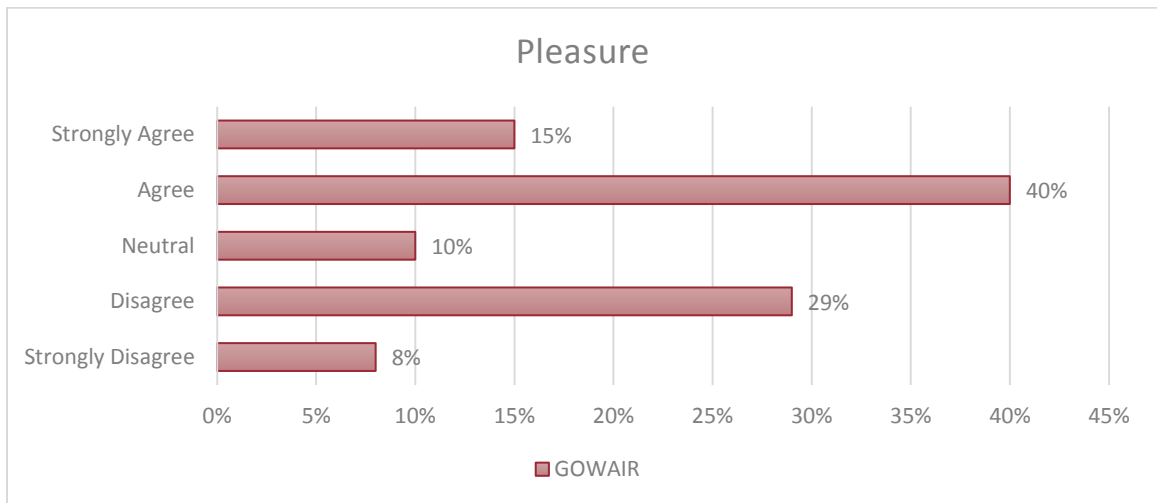


Figure 6-6 - Pleasure

### 6.3.4 Comfort

User's physical comfort is analyzed using the questionnaire method. Users comfort is important for the usage of the system, it provides an insight that system is usable for persons with mild disorders of vision or old age persons etc. the user comfort level towards the system is shown in the figure 6.7.

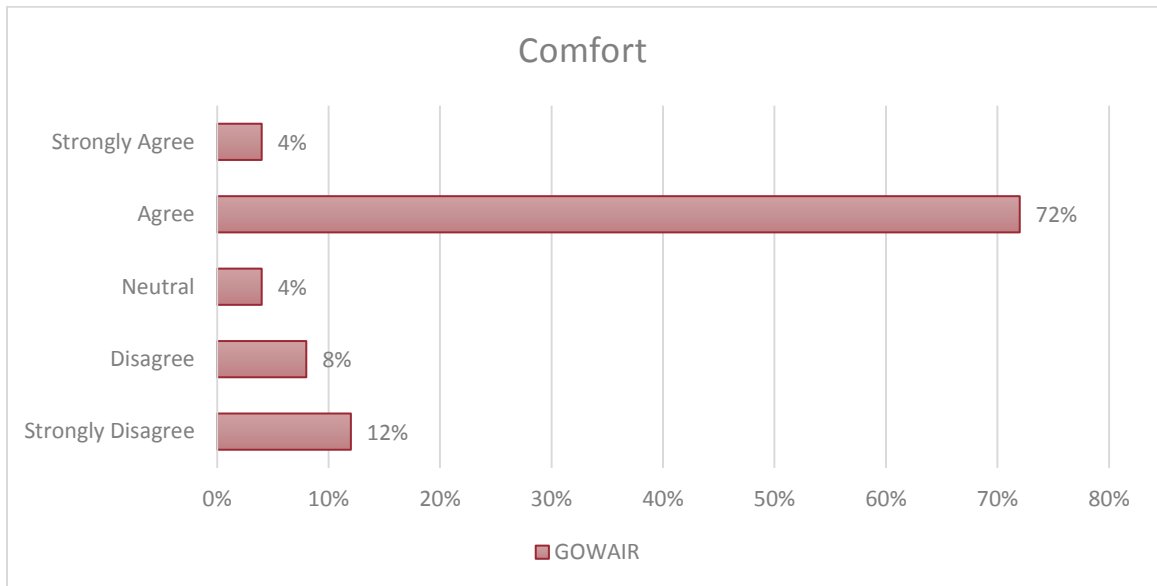


Figure 6-7 - Comfort

## 6.4 CONCLUSION

The evaluation of the system is carried out using satisfaction questionnaire. The participants were briefed about the working of the system and asked to use the system. The system is the prototype of the proposed model. The analysis of the initial prototype shows better effectiveness, efficiency and high levels of user satisfaction.

## *CHAPTER 7*

### **7 CONCLUSION**

The era of information technology is used for delivering government facts and figures and facilities to the citizens. The use of information technology is seen in every phase of our life. Governments tend to use this information technology, information and communication technology and different web-based technologies to improve the effectiveness and efficiency of the public sector services. Electronic government or e-government is initiated to encourage direct involvement of different stakeholders in the development process and timely delivery of information to the citizens.

In Pakistan, e-government plan was initiated in 2005 with five years planning. The E-Government Directorate approves a new strategic plan for three years in 2012. The strategic planning mainly includes the human resource development and software development. On the initiative of E-Government Directorate, different ministries starts to develop websites with aim to provide basic information to the citizens.

The aim of this thesis is to analyze websites of different ministries who had taken initiative in providing e-services to the citizens of Pakistan. In the first phase of the thesis, eight websites are analyzed using the ISO/IEC25010-11 as a standard. Using the survey it is studies that search functionality impacts the overall quality of the websites. Most tasks were designed to find a particular data present on these websites. The users found it hard to memorize the provided information leads to poor performance in completing the task accurately within the allocated time period. The satisfaction in use directly associated with the effectiveness in use and efficiency in use. If the user fails to complete the tasks accurately without external help within the specified time leads to poor satisfaction results. The trust, comfort, pleasure, likability and satisfaction are associated with the pragmatic goals of the users. The users faced difficulty in using these websites, find it hard to achieve the desired goals. The results shows that users had to explore the websites multiple times before reaching to the destination. Due to lack of

search feature, user's performance degraded. The participants did not perform their tasks with effectiveness and efficiently. Once the tasks not completed effectively and efficiently, user satisfaction, trust, comfort and pleasure had not achieved. The users faced difficulty in using these websites, find it hard to achieve the desired goals. The results shows that users had to explore the websites multiple times before reaching to the destination.

On the basis of these results, an information retrieval system is proposed. The GOWAIR system facilitates the users in their search. Using the system, users will able to find their desire information in an efficient manner.



## **APPENDICES**

# APPENDIX A

## QUESTIONNAIRE FOR QUALITY IN USE

**Name:**

**Occupation:**

**Age:**

**Job Experience:**

Kindly fill the questionnaire after completing the set of tasks.

Likert scale is use for the response.

The format of a typical five-level Likert item, for example, could be:

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

**Q1. I completed the tasks with accuracy. Do you think search feature increases effectiveness?**

- 1) 1
- 2) 2
- 3) 3
- 4) 4
- 5) 5

**Q2. I achieved the goals specified**

- 1) 1
- 2) 2

- 3) 3
- 4) 4
- 5) 5

**Q4. Given tasks achieved with accuracy and completeness**

- 1) 1
- 2) 2
- 3) 3
- 4) 4
- 5) 5

**Q5. To increase the efficiency of the site search feature helps?**

- 1) 1
- 2) 2
- 3) 3
- 4) 4
- 5) 5

**Q6. It was easy to complete tasks within given time period without search feature**

- 1) 1
- 2) 2
- 3) 3
- 4) 4
- 5) 5

**Q7. Do you think using search feature satisfaction level boosts?**

- 1) 2
- 2) 3
- 3) 4
- 4) 5

**Q8. I find the site useful for achieving tasks easily. Is provided feature useful?**

- 1) 1
- 2) 2
- 3) 3
- 4) 4
- 5) 5

**Q9. After repetitive use, I find the site behavior same**

- 1) 1
- 2) 2
- 3) 3
- 4) 4
- 5) 5

**Q10. My trust level for the site is**

- 1) 1
- 2) 2
- 3) 3
- 4) 4
- 5) 5

**Q11. Do trust level increases through search features?**

- 1) 1
- 2) 2
- 3) 3
- 4) 4
- 5) 5

**Q12. I feel pleasure while fulfilling the tasks**

- 1) 1
- 2) 2
- 3) 3

4) 4

5) 5

**Q13. I am satisfied with physical comfort (eye strains etc.) while using the site**

1) 1

2) 2

3) 3

4) 4

5) 5

**Q14. Do you feel comfortable if goals completed in lesser period of time?**

1) 1

2) 2

3) 3

4) 4

5) 5

**Q15. Do search feature provide pleasure while achieving your goals?**

6) 1

7) 2

8) 3

9) 4

10) 5

**Q16. System mitigates the risk to economic status, human life, health, or the environment**

1) 1

2) 2

3) 3

4) 4

5) 5

**Q17. Does websites consider potential financial risks while designing the site?**

- 1) 1
- 2) 2
- 3) 3
- 4) 4
- 5) 5

**Q18. Should search feature covers all aspects of the site?**

- 1) 1
- 2) 2
- 3) 3
- 4) 4
- 5) 5

**Q19. Do you think change in design frequently is financial loss?**

- 1) 1
- 2) 2
- 3) 3
- 4) 4
- 5) 5

**Q20. I think the context covered by the site is according to user requirement in the search feature?**

- 1) 1
- 2) 2
- 3) 3
- 4) 4
- 5) 5

**Q21. Does search provide flexibility while using the site?**

- 1) 2

2) 3

3) 4

4) 5

**Q22. I think site can be used beyond initial requirement**

1) 1

2) 2

3) 3

4) 4

5) 5

# APPENDIX B

## EVALUATION QUESTIONNAIRE

**Note:** this survey is to evaluate the GOWAIR system according to the ISO/IEC25010-11 Quality in Use standard.

The format of a typical five-level Likert item, for example, could be:

1. Strongly disagree
2. Disagree
3. Neither agree nor disagree
4. Agree
5. Strongly agree

### **Q1. Software helped in finding the required information?**

- 1) 1
- 2) 2
- 3) 3
- 4) 4
- 5) 5

### **Q2. Completed the tasks with accuracy?**

- 1) 1
- 2) 2
- 3) 3
- 4) 4
- 5) 5

### **Q3. While using the system do not required help from the evaluator?**

- 1) 1
- 2) 2



- 3) 3
- 4) 4
- 5) 5

**Q4- Do you find the desire information with accuracy and completeness?**

- 1) 1
- 2) 2
- 3) 3
- 4) 4
- 5) 5

**Q5- Do you achieve your goals while spending minimum time resource?**

- 1) 1
- 2) 2
- 3) 3
- 4) 4
- 5) 5

**Q6. I completed the tasks in time**

**Q7. Do you find the information in less time?**

- 1) 1
- 2) 2
- 3) 3
- 4) 4
- 5) 5

**Q8. System helps in finding the information in minimum time?**

- 1) 1
- 2) 2
- 3) 3

4) 4

5) 5

**Q9. Are you satisfied with the system after retrieving the desired results?**

1) 1

2) 2

3) 3

4) 4

5) 5

**Q10- Do you find the system useful while searching for specific target?**

1) 1

2) 2

3) 3

4) 4

5) 5

**Q11 - Do system behave the same while showing the results?**

1) 1

2) 2

3) 3

4) 4

5) 5

**Q12 - Do you feel pleasure when you find the information in click?**

1) 1

2) 2

3) 3

4) 4

5) 5

**Q13 - Do you feel comfortable while using the system?**

- 1) 1
- 2) 2
- 3) 3
- 4) 4
- 5) 5

**Q14 - Do you find the system trustworthy?**

- 1) 1
- 2) 2
- 3) 3
- 4) 4
- 5) 5

**Q15 - Do you like the system?**

- 1) 1
- 2) 2
- 3) 3
- 4) 4
- 5) 5

**Q16 - Did system satisfies your requirements?**

- 1) 1
- 2) 2
- 3) 3
- 4) 4
- 5) 5

**Q17 - Do you feel accomplished after the results in minimum time?**

- 1) 1
- 2) 2
- 3) 3

4) 4

5) 5

## **REFERENCES**

## REFERENCES

- [1] *United Nations E-Government Survey 2014*, United Nations Department of Economic and Social Affairs, UN, Retrieved 2014-09-16.
- [2] J. C. Hai, Ibrahim, *Fundamental of development administration. Selangor*, Scholar Press, ISBN 978-967-5-04508-0, 2007
- [3] Alenezi, Hussain, Tarhini, Ali, Sharma and S. Kumar, "Development of quantitative model to investigate the strategic relationship between information quality and e-government benefits", in *Transforming Government: People, Process and Policy*, vol. 9 ver. 3, pp. 324–351, doi: 10.1108/TG01-2015-0004, Retrieved 5 January 2016.
- [4] M. Castells, "La Era de la Información (trilogy) (The Information Age)", in *Economy, society and culture Mexico XXI century 1996 Alianza*, vol. 1. Madrid, 1996-2000
- [5] J. V. Dijk, "The Network Society: Social aspects of new media", SAGE Publications Ltd., December 21, 1999
- [6] M. Wall-Smith, *The Network Society: A Shift in Cognitive Ecologies? First Monday*, 2002
- [7] A.Schellong, "Crossing the boundary - Why putting the e in Government is the easy part", in *PNG Working paper N. PNG07-002*, John F. Kennedy-Harvard School of Government, 2007
- [8] J. Fountain, "Challenges to organizational change: multi-level integrated information structures (MIIS)", in *D. Lazer, V.Mayer-Schoenberger, (eds.): Governance and Information Technology: From Electronic Government to Information Governmen., MIT Press. Cambridge, MA, 2007*
- [9] B. N. Hague and B. D Loader, *Digital democracy: discourse and decision making in the information age*, Routledge, London, 1999
- [10] S. Bhatnagar, "Access to information: E-Government", in *Hodess, Inowlocki, Wolfe (eds.) Global Corruption Report*, Profile Books Ltd. London, 2003

- [11] J. Fountain, *Building the virtual state: information technology and institutional change*, Brookings Institution Press, Washington DC, 2001
- [12] M. Castells, & E. Ollé, “El model Barcelona II: L’Ajuntament de Barcelona a la societat xarxa, model II Barcelona: Barcelona city council in the network society in Catalonia (2002-2004)”, Barcelona: Universitat Oberta de Catalunya, 2004
- [13] *E-Government strategic plan for the federal government*, Electronic Government Directorate - Ministry of Information Technology, July, 2012
- [14] “Internet live stats”, <http://www.internetlvestats.com/total-number-ofwebsites/>, 10th May, 2016
- [15] Internet service providers association of Pakistan”, <http://www.ispak.pk/index.php>, 20th May, 2016
- [16] “Worldometers Population of Pakistan”, <http://www.worldometers.info/world-population/pakistan-population/>, 21<sup>st</sup> August, 2016
- [17] “Education”, [http://finance.gov.pk/survey/chapter\\_10/10\\_Education.pdf](http://finance.gov.pk/survey/chapter_10/10_Education.pdf), 10th May, 2016
- [18] P. Lew and L. Olsina, “Towards understanding and improving mobile user experience”, in *PNSQC Proceedings*, 2013
- [19] P. Lew , M. Q. Abbasi , I. Rafique , X. Wang and L. Olsina, “Using web quality models and questionnaires for web applications understanding and evaluation”, in *Proceedings of the 2012 Eighth International Conference on the Quality of Information and Communications Technology*, pp. 2029, September 02-06, 2012
- [20] R. Kaur, V. Goyal and G. Kaur, “Web quality model for websites developed in Punjabi and Hindi”, in *The International Journal of Soft Computing and Software Engineering [JSCSE]*, Vol. 3, No. 3, *Special Issue: The Proceeding of International Conference on Soft Computing and Software Engineering 2013 [SCSE’13]*, San Francisco State University, CA, U.S.A., March 2013

- [21] M. Q. Abbasi, J. Weng, Y. Wang , I. Rafique, X. Wang and P. Lew, “Modeling and evaluating user interface aesthetics employing ISO 25010 quality standard”, in *Quality of Information and Communications Technology (QUATIC), 2012 Eighth International Conference*, pp: 303 - 306 , Lisbon,3-6 Sept. 2012
- [22] M. Herrera, M.Á Moraga, I. Caballero and C. Calero, “Quality in use model for web portals (QiUWeP)”, in *Daniel, F., Facca, F.M. (eds.) ICWE 2010. LNCS*, vol. 6385, pp. 91–101. Springer, Heidelberg, 2010
- [23] Stefani, Antonia, and B. Vassiliadis, "A web metrics quality evaluation framework for e-commerce systems", in *Proceedings of the ICWE'05 Conference*, pp. 110-123, 2005
- [24] R. Jayakumar and B. Mukhopadhyay, “Website quality assessment model (WQAM) for developing efficient e-learning framework-A novel approach”, in *International Journal of Engineering and Technology (IJET)*, 2013
- [25] A. Rocha,” Framework for a global quality evaluation of a website. Online information review”, in *The International Journal of Digital Information Research and Use*, pp. 374–382, 2012
- [26] K. Esaki, “ Prediction models for total customer satisfaction based on the ISO/IEC9126 System Quality Model”, in *American Journal of Operations Research*, vol.3, pp. 393-401, 2013,
- [27] K. Esaki, (2013) “Three dimensional integrated value models based on ISO/IEC9126 system quality model”, in *American Journal of Operations Research*, vol. 3, pp. 342-349, 2013
- [28] B.V. Gils, H.A. Proper, P.V. Bommel, and E.D. Schabell, “Profile-based retrieval on the World Wide Web”, In *Proceedings of the Conferentie Informatiewetenschap (INFWET2003)*, pp. 91–98, 2003.
- [29] V. Gupta, N. Garg, T. Gupta, “Search Bot: Search Intention Based Filtering Using Decision Tree Based Technique”, in *Third International Conference on Intelligent Systems Modelling and Simulation*, pp. 49-54, 8-10 Feb. 2012



- [30] F.M.T. Brazier, D.R.A. de Groot, A. Oskamp, and N.J.E. Wijngaards, "Agent-based information retrieval: Legal and technical considerations in a simple case", June 2004.
- [31] A. Yew and G. Pavlou, "Customisable off-line Web browsing with mobile software agents", in *Service Portability and Virtual Customer Environments*, IEEE, pp. 102-108). IEEE. 2000
- [32] Thomas, G. Christoph, and R. Oppermann, "Supporting information consumers by search agents in the World-Wide Web", in *Proceedings ERCIM Workshop on User Interfaces for All. Heraklion, Kreta*, 1995.
- [33] Jr Williams and R. Henry, U.S. Patent No. 6,108,686, 22 Aug. 2000."Agent-based on-line information retrieval and viewing system"
- [34] Brewington, Brian, R. Gray, K. Moizumi, D. Kotz, G. Cybenko, and D. Rus, "Mobile agents for distributed information retrieval", in *Intelligent Information Agents*, Springer Berlin Heidelberg, pp. 355-395, 1999.
- [35] Wondergem, B. C. Martijn, P. V. Bommel, T. W. C. Huibers, and T. P. V. D. Weide, "Towards an agent based retrieval engine: profile information filtering project." in *Proceedings of the 19th Annual BCS-IRSG conference on Information Retrieval Research*, British Computer Society, pp. 13-13, 1997.
- [36] Nastase, Floarea, and R. Mogos. "An agent-based framework for E-Commerce information retrieval management using genetic algorithms", in *Informatica Economica*, vol. 13, ver. 4, pp. 148, 2009
- [37] Hans, Rahul, and Ramandeep Kaur. "Fault tolerance approach in mobile agents for information retrieval applications using check points", in *International Journal of Computer Science & Communication Networks*, vol. 2, ver. 3, 2012
- [38] Möller, Ralf, V. Haarslev and B. Neumann, "Expressive description logics for agent-based information retrieval", in *Knowledge Engineering and Agent Technology*, vol. 52, pp. 139, 2004

- [39] Xue, Bin, and G. Yan, "Research on multi-agents information retrieval system based on intelligent evolution", in *2nd International Conference on Computer Science and Network Technology (ICCSNT)*, IEEE, pp. 1042-1045, 2012.
- [40] Agbele, K. Kehinde, A. O. Adesina, E. Daniel, and D Seluwa. "Agent-based context-aware healthcare information retrieval using DROPT approach", in *IJIR*, vol. 5, ver. 2, pp. 109–118, July-December 2012
- [41] Rodríguez, Marcela, and A. Preciado, "An agent based system for the contextual retrieval of medical information", in *Advances in Web Intelligence*, Springer Berlin Heidelberg, pp. 64-73, 2004.
- [42] El-Bakry, M. Hazem, A. M. Riad, A. Atwan, S. A. El-Ghany, and N. Mastorakis "A new automated information retrieval system by using intelligent mobile agent", in *Proceedings of the 9th WSEAS international conference on Artificial intelligence, knowledge engineering and data bases, World Scientific and Engineering Academy and Society (WSEAS)*, pp. 339-351, 2010.
- [43] Gao, Kai, and Y. Gu, "Analyzing an agent-based selective information retrieval", in *Services Computing (SCC), IEEE International Conference*, pp. 427-430, 2004.
- [44] Pogacnik, Matevz, and J. F. Tasic. "Agent based retrieval of information from Internet", in *Electrotechnical Conference, 2000. MELECON 2000. 10th Mediterranean*, vol. 1, pp. 399-402. IEEE, 2000.
- [45] Zhang, Shudong, Y. Qin, and N. Yao, "An agent-based system framework for multi-slot Web information extraction", in *2nd International Asia Conference on Informatics in Control, Automation and Robotics (CAR)*, vol. 3, pp. 200-203. IEEE, 2010.
- [46] Abasolo, J. Maria, and M. Gomez, "MELISA: An ontology-based agent for information retrieval in medicine", in *Proceedings of the first international workshop on the semantic web (SemWeb2000)*, pp. 73-82, 2000.
- [47] Chang, Y.S., Yang, C.T., Luo, Y.C.: "An Ontology based Agent Generation for Information Retrieval on Cloud Environment", in *Journal of Universal Computer Science*, vol,17, ver. 8 , pp. 1135-1160, 2011

- [48] Das, Subrata, K. Shuster, and C. Wu, "Ontologies for agent-based information retrieval and sequence mining", in *Proceedings of the Workshop on Ontologies in Agent Systems (OAS02), held at the 1st International Joint Conference on Autonomous Agents and Multi-Agent Systems Bologna*, Vol. 6, Italy, 2002
- [49] Dipl.-Ing, S. Pech, and H. C. P. Göhner, "An Agent-based approach to information retrieval in industrial automation systems", in *21st International Conference on System Research, Informatics & Cybernetics*, Baden-Baden, 07.08.2009
- [50] Taveter, Kuldar. "Intelligent information retrieval based on interconnected concepts and classes of retrieval domains", <http://www.ercim.org/publication/wsproceedings/DELOS8/taveter.pdf>, (1999).
- [51] Cesarano, Carmine, A. d'Acierno, and A. Picariello, "An intelligent search agent system for semantic information retrieval on the internet", in *Proceedings of the 5th ACM international workshop on Web information and data management*, pp. 111-117. ACM, 2003.
- [52] Croitoru, Madalina, B. Hu, S. Dasmahapatra, P. Lewis, D. Dupplaw, A. Gibb, M. Julia-Sape et al, "Conceptual graphs based information retrieval in HealthAgents", in *Twentieth IEEE International Symposium on Computer-Based Medical Systems, CBMS'07*, pp. 618-623. IEEE, 2007.
- [53] Sánchez, David, D. Isern, and A. Moreno, "An agent-based knowledge acquisition platform", in *Multiagent System Technologies*, Springer Berlin Heidelberg, pp. 118-129, 2005
- [54] Liu, Lizhen, M. Wu, L. Xiong, Z. Niu, and H. Song, "Cooperative Work for Agent-Based Heterogeneous Information Integrated Retrieval in Digital Libraries," In *IEEE 11th International Conference on Computer Supported Cooperative Work in Design, 2007. CSCWD 2007*, pp. 395-399, 2007.
- [55] Wang, J. Yan, and Z. Zhu, "Framework of multi-agent information retrieval system based on ontology and its application", in *IEEE International Conference on Machine Learning and Cybernetics*, vol. 3, pp. 1615-1620, 2008.

- [56] Bouramoul, Abdelkrim, M. K. Kholadi, and B. L. Doan, "An ontology-based approach for semantics ranking of the web search engines results", in *IEEE International Conference on Multimedia Computing and Systems (ICMCS)*, pp. 797-802, 2012.
- [57] Lim, H.Y. Edward, S.T. L. Raymond, and N.K. L. James, "KnowledgeSeeker—an ontological agent-based system for retrieving and analyzing Chinese web articles." In *IEEE International Conference on Fuzzy Systems, FUZZ-IEEE (IEEE World Congress on Computational Intelligence)*, pp. 1034-1041, 2008.
- [58] Celik, Duygu, and A. Elgi, "A semantic search agent approach: finding appropriate semantic Web services based on user request term (s)", in *IEEE 3rd International Conference on Information and Communications Technology, 2005. Enabling Technologies for the New Knowledge Society: ITI*, pp. 675-687, 2005.
- [59] Xiao, Yi, M. Xiao, and F. Zhang, "Agents-based intelligent retrieval framework for the Semantic web", in *IEEE International Conference on Wireless Communications, Networking and Mobile Computing (WiCom)*, pp. 5357-5360, 2007.
- [60] Junwei, Luo, and X. Xiao, "Research on Information Retrieval System Based on Semantic Web and Multi-Agent", in *IEEE International Conference on Intelligent Computing and Cognitive Informatics (ICICCI)*, pp. 207-209, 2010.
- [61] Ahmed, Zeeshan, and D. Gerhard, "Designing a Dynamic Components and Agent based Approach for Semantic Information Retrieval", *arXiv preprint arXiv: 1008.1335* 2010.
- [62] Kerschberg, Larry, W. Kim, and A. Scime, "A semantic taxonomy-based personalizable meta-search agent", in *Proceedings of the IEEE Second International Conference on Web Information Systems Engineering*, vol. 1, pp. 41-50, 2001
- [63] Hosam, Al-Samarraie, M. Abbas, and I. Naufal. "The design and development of exceptional representation based on domain ontology and multi-agent systems for e-learning purposes", in *IEEE Fourth Asia International Conference on Mathematical/Analytical Modelling and Computer Simulation (AMS)*, 2010, pp. 517-520, 2010.

- [64] “ISO/IEC 25010:2011; Systems and software engineering -- Systems and software Quality Requirements and Evaluation (SQuaRE) -- System and software quality models”, ISO/IEC JTC 1/SC 7, 2011-03-01
- [65] “The ISO/IEC 25000 series of standards”, <http://iso25000.com/index.php/en/iso-25000-standards>
- [66] Lew, Philip, L. Olsina, and L. Zhang, “Quality, quality in use, actual usability and user experience as key drivers for web application evaluation”, In *International Conference on Web Engineering*, Springer Berlin Heidelberg, pp. 218-232, 2010.
- [67] N. Jennings, M. Wooldridge, “Agent-Oriented Software Engineering”, London, pp. 5-6, 2000
- [68] “W3C World Wide Web Consortium; Web Standards”, [www.w3.org](http://www.w3.org), 2009
- [69] “FIPA - Foundation for Intelligent Physical Agents, FIPA Ontology Service Specification”, Geneva, Switzerland, 2000;
- [70] “ISO/IEC 25022; Systems and software engineering -- Systems and software quality requirements and evaluation (SQuaRE) -- Measurement of quality in use, ISO/IEC JTC 1/SC 7”,