



ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
FACULTY OF INFORMATICS
DEPARTMENT OF COMPUTER SCIENCE

Design and Implementation of SMS Based Public Opinion Polling System

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A Project paper submitted to the School of Graduate Studies of Addis
Ababa University in partial fulfillment of the requirements for the
Degree of Master of Science in Computer Science

June, 2010

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Acknowledgement

Glory be to God, the most gracious, most merciful, the guidance and support of whom I rely on. My warm and special gratitude goes to my advisor, Dr. Dejene Ejigu for his constructive and heart full suggestions, comments and encouragements.

I am also indebted to all family members and loved ones who have been supporting me in everything. Love you all for your prayers, support and encouragements.

My Special thanks also go to members of the Faculty of Informatics for their valuable support and sharing ideas during the development of the project.

Finally, I wish to express my sincere respect for the staffs of ERTA (Public relations office) for their feedback and discussion on the functional requirements of the system. Similarly, I also thank marketing officers and Mobile Technology officers of ETC for their valuable information regarding SMS technology.

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Acronyms and Terms

API	Application Programming Interface
AT	ATtention
BLMT	Broadband Local Money Transfer
CDMA	Code Division Multiple Access
CSV	Comma Separated Values
DBMS	Database Management System
DLL	Dynamic Link Library
ECX	Ethiopian Commodity Exchange
ERTA	Ethiopian Radio and Television Agency
ETC	Ethiopian Telecommunication Corporation
GPRS	General Packer Radio Service
GSM	Global System for Mobile Communication
HEP	Health Extension Program
ICT	Information and Communication Technology
IFOP	French Institute of Public Opinion (English)
Ipsos	A global market research company headquartered in Paris, France.
ITU	International Telecommunication Union
IVR	Interactive Voice Response
MFAF	Media Focus on Africa Foundation
M-PESA	Mobile-PESA (Money)
MSSQL	Microsoft SQL.
MTN	Mobile Telephone Network
PIN	Personal Identification Number
SMPP	Short Message peer –to-Peer Protocol
SMS	Short Message Service
SMSC	Short Message Service Center
SQL	Structured Query Language
UML	Unified Modeling Language
WIZZIT	-a cell phone-based banking in South Africa

Abstract

The collection, analysis, and interpretation of public opinion play invaluable role in the development of socio-economic and political situations of a society.

Different techniques can be used to collect public opinion polls including personal interview, voice call, Internet, post etc.

However, most of the techniques stated above have a combination of one or more the following short comings: limited area coverage, high cost, difficulty of use, availability, homogeneous social strata, very high response time etc.

On the contrary, the newly emerging and rapidly expanding mobile wireless technology enables anytime anywhere communication. Recently, there is the high expansion in the use of SMS technology, reduction in the cost of bulk SMS, and reduction in the cost of mobile subscription fee (high penetration). These make the use of mobile phones to collect public opinion an optimal solution and create an enabling environment for the widespread development of SMS bases applications and services.

In this project work, we made use of the SMS technology to develop a SMS based Public Opinion Polling System (SMSPPoll). The system uses a GSM modem attached to a computer to send and receive messages to and from respondents. Since the GSM modem is considered as one of the communication ports in the computer system, the technique utilize the I/O port APIs provided by the .NET framework.

SMSPPoll is capable of composing questions, sending questions as SMS messages to respondents, accepting SMS responses from respondents, summarizing poll results and presenting the results in tabular and graphical formats. The application also enables to print/export results as appropriate.

Keywords: Mobile phone based opinion polling; SMS based opinion polling

1. Introduction

1.1. Background

Public opinion polls are the measurements of public opinions on specific issues through different medium from a sample of the group whose views are to be described. The most common topics in polls are voting intentions and political party support, views on the government of the day and its policies, and views on major current public issues, economic conditions, etc.

The history of using public opinion polls dates back to 1824, when a local straw poll was conducted by the Harrisburg Pennsylvanian in the contest for the United States Presidency [1]. The most impressive scientific attempt at public opinion polling was the Literary Digest poll, a national-scale poll conducted by the now-defunct *Literary Digest* magazine as a means for forecasting U.S. presidential election results. Its first run in 1916 correctly predicted Woodrow Wilson's re-election based on a simple tabulation of the returns of millions of postcard questionnaires that had been sent to Americans listed in telephone directories and state automobile registries [3]. Since then, there have been new emerging public opinion polling organizations that conduct polls nationally and even internationally. Examples of such organizations include the Gallup (International), Harris poll (International), Ipsos (International), IFOP (France) and most television networks and public media in most countries [2]. In the case of our country, Ethiopia, public opinion is gathered on some issues through private and public radio stations.

With advancements in information and communication technologies (ICT), online public opinion polling applications are developed. As a result, there are a number of national and international companies involved in conducting online public opinion polls through the Internet for different purposes on different subjects (e.g. Gallup)[2].

Results of public opinion polls and the respective opinion questionnaires databases are made available through different poll report publishers via the Internet. Availability of such data can be useful for different institutions and individuals (like government bodies, researchers,

industries, business and service organizations, etc.). A framework for digital preservation of public opinion polls has also been developed in [9].

SMS (Short Messaging Service) was developed as part of Global System for Mobile Communication (GSM) network in 2G mobile system [22]. These days, SMS based data collection methods are common place, like in health extension programs (HEP) and Healthcare [8].

In this project, SMS based public opinion polling system is proposed that enables different organizations to collect public opinion, analyze and present poll results.

1.2. Motivation

The motivation to work on this project is based on own observation of needs for such kind of applications when the different state owned and private radio stations in Ethiopia initiate different issues on which they want to obtain public opinion. However, almost all the media expect respondents only to make a telephone call to express their views. With the current economic condition, making a call to express one's opinion about an issue is not feasible for the majority of individuals. This might affect the quality of the opinion gathered. In addition, the opinion collected via phone calls is not seen to have been analyzed, summarized and communicated back to the public in any form.

SMS based data collection methods may have their own disadvantages [3]. However, obtaining public attitudes on social, economic and political issues using SMS based applications for decision making or utilizing public opinion as a research input (for public opinion based research groups) will give quality output. This is because it encompasses a wider range of subjects of interest than can be achieved with alternative surveying mechanisms.

Therefore, it is reasonably feasible that the development of SMS based public opinion polling applications to get the public opinion for different situations. The authors in [4] have also indicated that the major reasons to setup and promote SMS-based e-government applications relates to characteristics of the SMS medium which are; easy to use, very cheap in cost, an

anywhere anytime communication channel, high penetration, and excessive infrastructure. Moreover, such applications will be used in different domains. For example, in politics, opinion polls can be used to predict election outcomes, conducting large surveys on government policies, deciding on different public issues. In academics, the application can be used to obtain students' opinion on different academic issues, decisions, plans, etc. In addition, the application can also be used to obtain public opinion as an input for different socio-economic researches as well. In business, it can be used to obtain customers' opinion on services and products.

1.3. Statement of the Problem

In the previous two sections, it has been indicated that there is a greater need in different organizations/institutions to get the public opinion on different issues for different purposes. It has also been clearly seen that, for developing countries like Ethiopia, conducting online opinion poll currently is not applicable due to the limited wired Internet connectivity. On the other hand, about 5% [11] of the Ethiopian population has subscribed to the mobile phone as compared to 0.7% [5] of the country's population who has access to the wired Internet connectivity - a wide gap. In addition, mobile phone subscription in Ethiopia [6] and generally in Africa [7] has high rate of penetration than wire line internet subscription. High reduction of subscription fee (about 85 ETB) is an indication of high penetration plan by ETC. In support of mobile services, the corporation has recently introduced the group SMS service with very low price (as low as one cent per recipient – depending on the number of recipients).

Hence, in order to reach out that portion of the society that has no wired connectivity to the Internet, developing such SMS based public opinion polling applications is of paramount importance because it easily enables to reach expected respondents through the existing wireless mobile phone network and simple device (apparatus) with SMS texting capability. The approach has also a lower cost than what is currently practiced in Ethiopia to collect public opinion - making phone call.

1.4. Objective of the Project

1.4.1. General Objective

The general objective of this project is to develop a system that helps organizations to conduct SMS based public opinion poll and summarize and present poll results.

1.4.2. Specific Objective

In order to achieve the aforementioned general objective, the following specific objectives are set

- Studying existing public opinion polling systems within and outside Ethiopia.
- Study technologies behind SMS, opinion polling, and analysis.
- Elicitation of requirements for SMS based public opinion polling applications.
- Developing the design specification of the system.
- Implementing the system as per the design specification.
- Testing the system.

1.5. Scope and Limitation

Scope

The SMS based public opinion polling application enables organizations to prepare polls on a central sever and dispatch the polls as SMS messages to the intended respondents via their mobile numbers, accept responses from respondents and analyze and present results. Up on the end of the poll period, the poll results can be communicated back to the public as appropriate.

Limitation

Since processing and summarization and of open-ended polls needs to handles responses with unconstrained length of characters, which may be beyond the capacity of existing SMS technology (Maximum 160 characters), the project to be developed does not include public opinion polls with open-ended questions.

1.6. Methodology

The methodology to be followed to conduct this project will be based on object oriented software engineering principles. Therefore, the development methodology includes thorough study of existing SMS based application, clearly understanding the requirements for such systems and developing requirement specification, designing and implementing the system and finally testing it with demonstration data. In all the phases of the project development, there will be appropriate report document which will be compiled in to the final project report.

Development Tools and Languages

In this project development, Visual C#.NET is used as the front-end programming language as it is easy to use and have experience at it. MSSQL Database Server is used as the back-end persistent data infrastructure. The development environment used is Microsoft Visual Studio 2008 Team Edition.

Equipments Needed for Deployment

The following equipments are needed for the successful deployment of the software to be developed.

- Personal Computer,
- GSM/GPRS modem with GSM/GPRS SIM card.
- A Cell phone with GSM/GPRS SIM card.

1.7. Application of the Project

The outcome of this project can be used in different problem areas. Since the application is of general nature, it can easily be adapted for any organization interested to collect public opinion on different issues for quality decision making, understanding public needs or conducting researches. More specifically, the following are potential application areas of the project output:

- E-Government: Government can listen to the public using SMS based polls on different policy issues [4]. Specifically, mobile governance is getting momentum in developing countries [10].
- Research institutes: Those which conduct public survey for socio-economic and political researches.
- Business/Service providers: To obtain customers opinion on their products or services and also provide services to customers.
- Private and public media agencies: To obtain public opinion on some current issue
- Educational institutions: Obtaining the view of the institution's community on different issues

2. Literature Review

2.1. Overview

Often for a number of reasons, there is a need to collect data from a number of different sources. One of such sources is the general public. Public opinion polling is one of the methods for data collections from the general public.

Public opinion polls, from among other benefits, provide the opportunity to predict election outcomes, obtain the public attitude on different government policies, conduct opinion based researches, obtain views of the society on different current socio-economic and political events etc.

Different media are available to conduct public opinion polling; personal interview, telephone calls, websites, snail mail (post). However, the medium through which such information is gathered from the public has an impact on the diversity of the responses, the area of coverage, the response time and ultimately on the conclusion of the final results.

With the introduction of the mobile technology, a number of organizations are embarking on using the wireless mobile network as a means of collecting data from the remote areas. Using such technology for data collection is promising since it has a lesser cost, better response time, and greater area coverage than what can be achieved by other media.

2.2. Public Opinion Polling

A poll is a type of survey or inquiry into public opinion conducted by interviewing a random sample of people. A random sample is the result of a process whereby a selection of participants is made from a larger population and each subject is chosen entirely by chance [18].

The history of using public opinion polls dates back to 1824, when a local straw poll was conducted by the Harrisburg Pennsylvanian in the contest for the United States Presidency [1]. Public opinion polls have two important influences on the respondents; the *Bandwagon* effect

where in respondents favor the candidate having the majority vote and the *Underdog* effect where in respondents, out of sympathy, vote for the candidate perceived to be losing [17].

2.2.1. Design and Administration

While conducting public opinion polls, there are three important phases: Registration of participants, voting and finally tallying. In any public opinion survey, the design and administration of questions has a paramount effect on the success of the survey. Therefore, the models of the questions (being close-ended or open-ended), the method of questioning (clarity and non-ambiguity), the sampling techniques used and the procedure of administering the surveys (open-ended pilot and close-ended surveys) are issues to be considered for a successful opinion survey [20]. In addition, issues like saliency of the topic raised and identity of the sponsor are important in influencing participation of respondents [26].

2.2.2. Major Opinion Polling Organizations

In this section, a brief review of major online public opinion polling organizations is presented [19].

- **Gallup Brain:** This online site provides access to more than 70 years of Gallup polling data, while the analysis articles go back to 1997. Users can search by basic keyword or an advanced search with limits by date and data type, or browse by decade, topics, and trends. While a subscription to Gallup's On-Demand service is required to access detailed data through Gallup's main site, there is limited free access to recently published analysis articles and selected recent questionnaires.
- **Harris Interactive:** This online site provides access to the well-known Harris polls on its homepage back to 1998. Users can search the site by keyword or date. Results are mostly presented in the form of news releases, analysis articles, and individual questions with responses.
- **National Opinion Research Center (NORC):** Since 1941, NORC has been conducting specialized surveys on local, national, and international public opinion based in USA. Current major research areas are economics and population; education and child

development; health survey, program and policy research; substance abuse, mental health, and criminal justice; and statistics and methodology. NORC has conducted the General Social Survey since 1972. Depending upon the study, users can view questionnaires, datasets, frequencies, or analyses.

- **Zogby:** An international polling firm established in 1984, Zogby provides current news releases and articles from third-party sources that feature data from Zogby polls, and “Trends over Time” providing users with time-series data relating to current topics in the media. Registered users are allowed to view survey results.

In addition, most of the well known internal media and new magazines conduct public opinion polls. Moreover, there are a number of professional associations in the field of public opinion research that cooperate on the development of standards and ethics in the field.

2.2.3. Multinational and Foreign Polls

In this section, some of multinational and foreign opinion polling organizations are described [19].

- **Afrobarometer–Africa Public Opinion Research.** Founded in 1993, this non-partisan research project conducts regular surveys of African opinions from more than a dozen nations on a wide range of topics. Surveys, survey results, briefing papers, and working papers are available online.
- **Mansfield Asian Opinion Poll Database.** This organization offers opinion polls on key policy-related issues from major media organizations and other agencies in Japan and South Korea.
- **European Public Opinion Analysis:** This is the website for the Public Opinion Analysis sector of the European Commission. Since 1973, the European Commission has been monitoring the evolution of public opinion in the member states. The surveys and studies address major topics concerning European citizenship: enlargement, social situation, health, culture, information technology, environment, the Euro, defense, etc [14].

- **Latinobarometro.** Latinobarómetro is an annual survey of public opinion in 18 countries in Latin America produced by Latinobarómetro Corporation, a non-profit organization based in Santiago, Chile.

2.2.4. Poll Data Archives and Searchable Databases

This section provides a review of renowned online poll data archives and searchable databases [19].

- **World Public Opinion (WPO).** The Program on International Policy Attitudes launched WorldPublicOpinion.org in January 2006 to provide a source of in-depth information and analysis on public opinion from around the world on international issues. The database covers national, cross-national, and international surveys, summary reports of survey results. The database also includes Americans & the World, a source on U.S. public opinion on international issues and “The Digest”, which provides analyses of polling on various international topics.
- **Public Opinion Poll Question Database.** Produced by the Odum Institute for Research in Social Science at the University of North Carolina. Coverage includes Harris, southern poll, state polls, the knight foundation community polls from before 1970 to present, depending upon the topic. The database is searchable by keyword to obtain survey question text. Results for specific questions are available by displaying “all question information”.

2.3. *SMS-Based Services and Applications*

SMS was first introduced in the GSM mobile network. Later, in the CDMA network SMS was also implemented but in a different way [12]. The difference between the two is on the implementation of binary messages. SMS based services are common-place in different countries for different purposes. SMS is the most reliable and popular message communication on mobile phones today. According to ITU (International Telecommunication Union), in China alone, SMS usage totaled to 250 billion in 2005[21].

Basically, SMS messages are handled via a Short Message Service Center (SMSC) that the cellular provider maintains for the end devices. The SMSC can send SMS messages to the end device using a maximum payload of 140 octets (160 characters) [22].

In most of SMS based applications, there are commonly accepted SMS- application architectures. Two of the most widely used architectures are seen here. Figure1 shows the architecture where the SMS application directly interacts with the respondents via a GSM modem attached to the computer on which the SMS application runs.

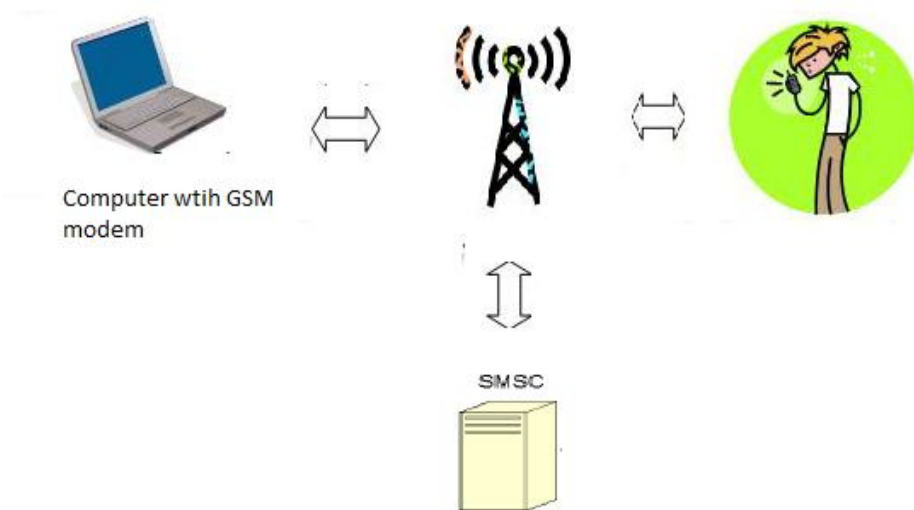


Figure 1 SMS Applications using GSM modem

Alternatively, SMS messages can be sent to the mobile network operator’s SMSC using SMPP (Short Message Peer-to-Peer Protocol). SMPP is an open industry standard messaging protocol designed to simplify integration of data applications with wireless mobile networks [22] as shown in figure 2. The content providers can be given a short code by the service provider. A short code is an abbreviated number (four, five, or six digits) that is used as an “address” for text messages. Individual carriers can use short codes that are valid only on their network or are interoperable across network carriers (known as a common short code) [22].

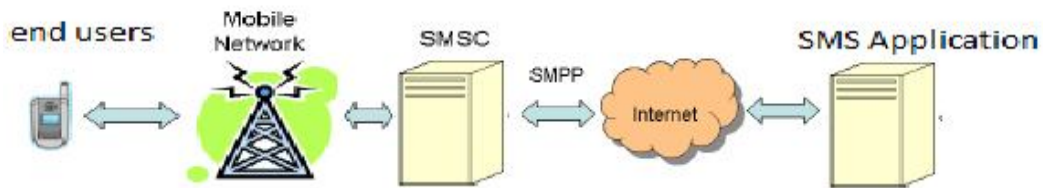


Figure 2 SMPP based SMS application

If the SMS application uses the GSM modem to connect to the wireless mobile network, then there are two modem options to select from; GSM/GPRS Modems and Cell phones. Currently, “Fully Type Approved” GSM/GPRS modem, with GSM 07.05 and 07.07 AT commands are available in the international market. The well known GSM modems are those of WAVECOM. Alternatively, in cases when GSM/GPRS modem is not available, cell phones can be used as a GSM modem. However, it should be noted that not all cell phones support the full set AT commands. Hence, programmers should select cell phone modems carefully.

Another important issue in SMS based services is the cost of using SMS services. Recently Ethiopian Telecommunication Corporation (ETC) has reduced the cost of bulk SMS to as low as one cent per recipient (depending on the number of recipients). Moreover, Telecom providers can facilitate the transfer of SMS cost from respondents to the pollsters which reduces the reluctance of respondents to respond to questions. Additionally, pollsters can provide some rewards like free (bonus) air time or some other prizes for randomly selected respondents. These conditions prove the possibility and applicability of SMS based application and services in Ethiopia.

2.4. Application of SMS based Services

The fast explosion in the use of mobile phones in Africa and the fact that SMS technology is cheap and an easy-to-use is a good opportunity for the wide spread development of SMS based services (applications). As a result there have been a number of SMS based applications developed in a number of countries. For example, a good lesson can be learnt from the

experience of Philippines [24]. In the subsequent sections, a review of some SMS based applications is presented.

2.4.1. RapidSMS- UNICEF- Ethiopia

UNICEF Ethiopia launched a massive food distribution program to supply the high-protein food Plumpy'nut to under-nourished children using mobile phones for monitoring and delivering supplies more than 18,000 feeding centers in the country. To coordinate the distribution and maintain appropriate stocks, field monitors report on supplies and number of children fed through an SMS reporting system using a UNICEF-built mobile data collection and monitoring software, RapidSMS.

RapidSMS - is a flexible distribution monitoring package - which can be reconfigured to any supply or situation (e.g. drug supply, bed-net distribution, etc), and deployed at short notice. A GSM modem attached to a web server receives the incoming SMS messages, replies with a confirmation message, and automatically saves the entry into a database.

RapidSMS can be accessed from anywhere on the Internet (with proper login credentials) to monitor reporting activity, send custom messages to field monitors, generate reports, and export data to Excel. Field monitors are able to send any additional information in the form of “alerts” which are forwarded by email or SMS to UNICEF staff, so action is taken immediately. Reported data can be automatically plotted on a map to show a visual summary of field conditions [13].

2.4.2. Mobile Banking- Zambia

There are m-Banking services, or “pilots,” in African countries such as the Democratic Republic of the Congo (Celpay), Kenya (M-PESA), South Africa (MTN Mobile Banking and WIZZIT) and Zambia (Celpay) [24]. However, these are not the only SMS based banking applications in Africa. More than 150 mobile payments initiatives worldwide have been discussed in [25]. The case of CelPay is presented here.

Celpay enables citizens of Zambia, Tanzania and Democratic Republic of Congo to make person-to-person payments via SMS i.e. Celpay is a SMS based secured (using a 4 digit pin) mobile remittance service. Customers can load their wallet by paying a Celpay agent and can send it to beneficiaries, who can retrieve the money in cash from Celpay agents. In Zambia, Celpay has an independent distribution network which comprises of 100 agents, 6 major banks and recently launched a partnership with Zambia Postal Services Corporation which has over 200 post offices and postal agents. This makes Celpay the single biggest distribution network available in Zambia.

Celpay is currently handling and processing transactions worth a 100 billion Kenyan Shilling (or 25 million USD) per month from payments made by individuals and corporate for goods and services. Celpay is tried and tested and 500 million USD worth of transactions were processed in the last five years (2006 - 2010). Celpay Zambia expects to reach 1 billion USD mark by 2010. The future plans of Celpay include expansion into Zimbabwe and Kenya [25].

2.4.3. Poll Monitoring System-India

The information and communication platform using the mobile phone was used in a very significant way for the first time for poll-day-monitoring of 3008 polling stations in Tripura during the General Election 2009 in India. Using the mobile phone, a SMS-based web application Software with GSM/GPRS modem interface was deployed to collect poll day statistics on the 23rd April 2009, the day of the poll in the two parliamentary constituencies in Tripura.

The application gave an idea of the average voting percentage and the progress of poll, and also generated voter turnout report (polling station, assembly segment and parliamentary constituency wise). All the stakeholders like the assistant returning officers, returning officers, Observers and the chief electoral officer could directly monitor progress of poll and address any problems immediately.

The format and syntax of the SMS messages were suitably designed so that the message received by the system through the GSM modem could be automatically interpreted and updated into the

database and made available to all the stakeholders for monitoring the polling stations online [15].

2.4.4. Media Focus on Africa Foundation (MFAF) Polls-Kenya

Media Focus on Africa Foundation (MFAF) has conducted opinion polls prior to the Kenyan elections in December, 2007. The poll project was part of MFAF's Election Assistance Campaign, which sought to promote civic participation and discussion of political issues prior to the December 2007 Kenyan elections. The polls were produced in collaboration with Butterfly Works [16].

The goal of the campaign was both to engage participants in the questions, to gauge public opinion in Kenya, and to build a list of phone numbers to continue mobile campaigns in the future.

The questions were advertised on television, radio shows, and newspaper advertisements. Thousands of Kenyans responded to the polls via SMS on their mobile phones, helping to bring issues of voting and civic participation into the national conversation. People would send SMS messages in response to the questions asked on the various media. The group asked users to give letter responses (like A or B) because MFAF only had one short code, and would sometimes ask multiple questions during the course of a television or radio show. This allowed for "A" to mean yes for the first questions and "C" to mean yes for the second. Because the answers people sent were inconsistent (some people would respond with "yes" instead of letters and others would send wordier responses), MFAF had manually filtered and sorted the responses.

MFAF originally tried to use home-made software and a modem to send and receive the polling messages, but found that the modem wasn't able to receive large amounts of SMS at one time. They eventually used a polling platform and short code from Kenyan mobile vendor-Interactive Media Services. A short code number in Kenya costs about 100 Euros each month for use on one of the networks.

Each poll received between three and four thousand responses per question, with most responses coming from newspaper advertising and the viewers of the drama series. The results of the polls were published in newspapers, on the MFAF website, and in some talk shows. Overall, the group estimates that it had about 30,000 unique users respond to the poll [13].

2.4.5. SMS-Based Teaching and Learning System-Hong Kong

Developed in Hong Kong Institute of Education, the SMS-based teaching and learning system is capable of providing such support of sending individual or group SMS messages. Teachers can login to the system to send individual SMS messages. They can also retrieve any student's mobile number from a database and send a quick SMS message to the student. The SMS system is also capable of sending a message to a group (e.g., a class of students) retrieved from the database. In fact, this capability was proved very effective to deliver an urgent message of canceling a lesson due to sickness to his students. Furthermore, a teacher can also send group messages such as marks and grades to each student of a class. The messages are conveniently stored in Microsoft Excel and XML files to help the teacher to compose the messages easily [21].

2.4.6. SMS based commodity exchange service -Ethiopia

The Ethiopia Commodity Exchange (ECX) is a new initiative for Ethiopia and the first of its kind in Africa. The vision of ECX is to revolutionize Ethiopia's tradition bound agriculture through creating a new marketplace that serves all market actors; from farmers to traders, processors, exporters and consumers [29]. ECX is planning to provide two types of mobile based commodity market data exchange services starting July 2010. The first one is Short Message Service (SMS) based market information dissemination and the second one is Interactive Voice Response (IVR) that provides commodity information, trading schedule, and member services.

2.4.7. SMS based banking service – United Bank, Ethiopia

One of the rapidly expanding banks in Ethiopia, United Bank, has earlier launched Telephone Banking, Internet Banking and Broadband Local Money Transfer (BLMT) services to its customers. It introduced SMS Banking service in September 2008. Like telephone banking, Internet banking

and BLMT services, United Bank is a pioneer to introduce SMS banking. SMS banking is a service that enables customers to get banking services using their mobile telephone by just sending a text message to the Bank's system [28]. Currently, SMS is used for simple account to account money transfer, account information inquiry, mini bank statement request, reminder services and stopping payment orders. The services are secured by a personal identification number (PIN) provided by the bank. The customers are provided with asset of commands (SMS syntaxes) to initiate these mobile SMS based bank transactions.

2.5. Existing Systems in Ethiopia

To the best of our knowledge, currently there is no organization that conducts public opinion polls in Ethiopia. However, there are few government and private media agencies that conduct public discussion on different socio-economic and political affairs and events. In addition, as per the interview conducted with the Ethiopian Television and Radio Agency (ERTA), there is a need to conduct public opinion polls at least monthly on major current affairs and the agency is preparing a plan accordingly. In these systems, the most extensively used medium is either voice call or personal interview.

However, since the use of voice call or personal interview as a medium of collecting public opinion has an associated financial cost, limited area coverage, limited social strata etc, the use of SMS based public opinion polling applications to collect public opinion is feasibly important.

3. Requirement Analysis

3.1. Overview

Public opinion polls play an important role in increasing the public participation in vital and current issues.

In this chapter, the functional and non-functional requirement of an SMS based public opinion polling system (SMSPPoll), which is a standalone windows form based application, is defined. In order to have a complete picture of the requirements for such systems, the different analysis models are produced.

3.2. Functional Requirements

Functional requirements capture the intended behavior of the system or what the system will do. This behavior may be expressed as services, tasks or functions the system is required to perform. Hence, the functional requirements for SMSPPoll are stated as follows;

- **Composition of Questions**

The system enables to compose questions under a given category with a set of options. Since the question is sent via the wireless mobile network, the users of the system should design the questions carefully so that they communicate with respondents within the constraint (Maximum of 160 characters).

- **Importing Respondents' Telephone Numbers from an Excel or Text File**

Since this system is supposed to work in a closed set of respondents, the system enables the users to import bulk respondent data from an excel file (saved as .csv format) and a text file where the phone numbers are entered one per line.

- **Format and Send Opinion Polls as SMS to Respondents**

SMSPPoll enables users to select a specific question, select respondents, and send the question as SMS to respondents. While selecting respondents, the user is given the flexibility to select from different sources: from database (with category and area code), from own source (individual entry or importing from file – as in 3.2.3 above.).

- **Accept responses from Respondents and Tally Poll Results**

Once a poll has been sent to respondents, the system queries the GSM modem to grab any new response messages. When the system finds messages destined to the modem, it checks the validity of the responses and then tally the poll result depending the response given. Since, the senders phone number s masked the moment the message is received, the anonymity of respondents is maintained.

- **Produce Different Types of Reports for Poll Results Including Graphs**

SMSPoll enables to produce summarized poll results automatically and plots the graph for poll results. The poll result can be viewed in two types of graphs; bar chart and pie chart on demand.

- **Searching of Poll Questions.**

Sometimes users may be interested to know what questions are there in the database under a given category. This may be done either for adding new questions or viewing poll results. Hence the system provides simple key word search in to the poll question database within a specified category.

- **Sending of final poll results via SMS as appropriate.**

When poll period for a question has ended and the poll is completed, the system enables the users to send poll results as SMS to intended recipients as appropriate. The SMS is composed of the question and its options (choices) with corresponding tally marks.

- **Printing and Exporting of Poll and survey Results.**

SMSPoll enables to print or export results to some compatible file formats like portable document format (.pdf), Microsoft excel (.xls), Microsoft word (.doc), Rich text format (.rtf) for future analyses and consumption. Collecting public opinion by itself may not be an end.

3.3. Non Functional Requirements

The Non functional requirements of SMSPPoll define the qualitative aspects of the system. These Non- functional requirements describe the system with respect to security, usability, flexibility, robustness, etc. Accordingly, the following sub sections describe the Non-functional requirements for SMSPPoll.

- **User Interface**

The system should have user-friendly interface. The system should be easy to navigate by the use of menus that link to the different module of the system. Besides, descriptive and user friendly messages should be provided for any failure. Completion/Confirmation messages should also be displayed when the application processes the data successfully. In addition, appropriate progress information should be displayed for some background processes.

- **Security**

Since such application can be used to collect and store very sensitive data, the system should have a well defined and strong security mechanism that enables to limit access to the system by unauthorized personnel. In order to achieve such a secured system, account management module should be implemented with an encryption technology. In addition, to protect any network related attack via the GSM modem, the opening and closing of the communication port has to be managed carefully.

- **Message Filtering (Message Pre-processing)**

SMSPPoll will be used to collect data from the public for further analysis and decision making. Therefore, the SMSPPoll should be able to truncate duplicate messages, reject invalid message, and clean noisy messages. In order to achieve this requirement, SMSPPoll should have a module for message pre-processing and validation.

- **Performance**

The performance of the system is the other important issue that needs to be considered. The performance of the system with respect to sending and receiving SMS messages will depend on the type of modem used. GPRS modems have better performance than GSM modems [27].

Regarding the performance of the application, efficient codes will be used in the implementation. The most important performance metric in data centric applications is the management of the connection between the application and the persistent data store. Hence, this issue is managed efficiently.

3.4. System Models

3.4.1. Introduction

System models enable us to capture the system requirements from three different aspects: Functional (usage), structural and interaction. The following sub sections are used to capture the system requirements from these aspects.

3.4.2. Use case Model

A use case in software engineering and systems engineering is a description of a system's behavior as it responds to a request that originates from outside of that system. The use case technique is used to capture the functional requirements of a system. Use case modeling is composed of a use case diagram and the accompanying documentation describing the use cases, actors and their associations [23].

3.4.2.1. Actors

The Actors of a system are the roles that operate on the system. The following are the actors identified in SMSPPoll.

- Administrator- who has access to the whole system
- Clerk- who is deprived of some administrative tasks.
- Respondent- individual to whom a poll is sent

3.4.2.2. Use cases

The following are the use cases identified.

- Compose question
- Register respondent
- Poll (Send Question)
- Accept Response
- View poll result

- View survey result
- Monitor poll status
- Send poll result
- Register user
- Authenticate user

3.4.2.3. Use case Diagram

The use case diagram shows the association between actors and use cases. Figure 3 shows the use case diagram for SMSPPoll

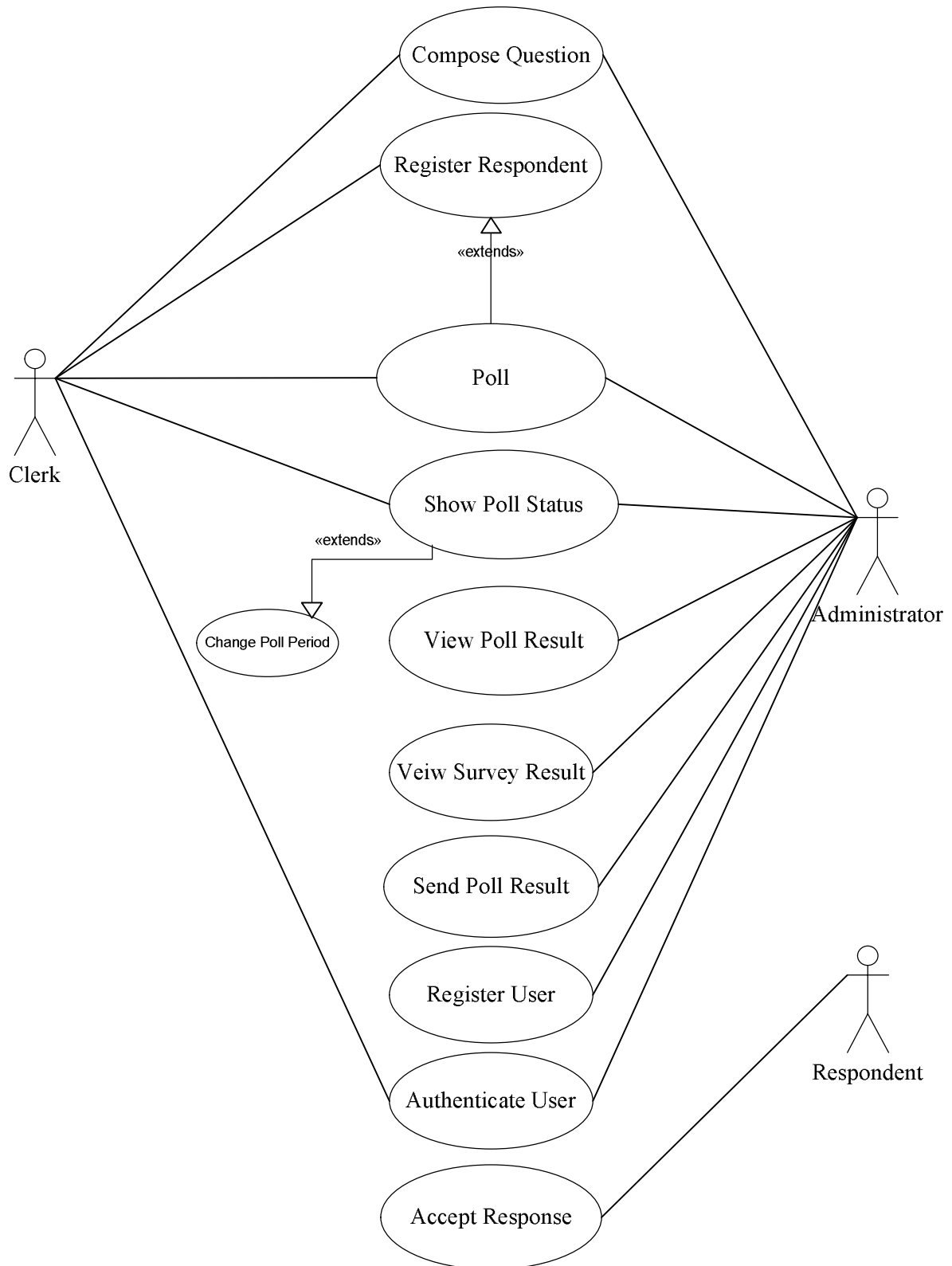


Figure 3 Use case diagram for SMSPoll

3.4.2.4. Use case Description

In this section, the description of the use cases is presented.

Name: Compose Question

Actors: Clerk, Administrator (user)

Description: enables the clerk or the administrator to compose a poll questionnaire.

Pre-condition: The user has successfully logged in to the system.

Flow of events:

1. The user wants to compose a question for a poll.
2. The user clicks on the “Compose Question” menu.
3. The system displays the “Compose Question” form.
4. The user fills in the form and clicks on the save button.
5. The system verifies that the data entered is correct.
6. The system saves the question in the database.
7. The use case ends

Alternative course A: The system finds that the entered data is invalid

- A.5. The system finds that the data entered is invalid.
- A.6. The system informs the user that the entered data is invalid and prompts the user to re-enter the invalid values.
- A.7. The system resumes at step 5 of the basic course of action.

Post-condition: The question will be stored in the database

Name: Register Respondent

Actors: Clerk, Administrator (user)

Description: enables the clerk or the administrator to Register Respondents.

Pre-condition: The user has successfully logged in to the system.

Flow of events:

1. The user wants to register a respondent for a question under a given category.
2. The user clicks on the “New Respondent” menu.
3. The system displays the “Register Respondent” form.
4. The user fills in the form and clicks on the save button.

5. The system verifies that the data entered is correct.
6. The system registers the respondent under a given category.
7. The use case ends

Alternative course A: The system finds that the entered data is invalid

- A.5. The system finds that the data entered is invalid.
- A.6. The system informs the user that the entered data is invalid and prompts the user to re-enter the invalid values.
- A.7. The system resumes at step 5 of the basic course of action.

Post-condition: The Respondent information will be stored in the database

Name: Poll

Actors: Clerk, Administrator (user)

Description: enables a user to initiate an opinion poll by sending questions to respondents.

Precondition: The user has successfully logged into the system.

Flow of events:

1. The user wants to send a question to respondents.
2. The user clicks on the “New Poll” menu.
3. The system displays the “send question via SMS” form.
4. The user selects the question category.
5. The system displays the list of questions under the selected category.
6. The user selects the question to be polled
7. The user selects respondents to whom the poll is to be sent [**Extension: Register Respondent**].
8. The system prepares the SMS message.
9. The user clicks on the “send” button.
10. The system verifies that there is no missing information.
11. The system sends the SMS message to the respondents and displays a confirmation message.
12. The use case ends

Alternate Course A: There is missing information

- A.10. The system finds that there is missing information.

A.11.The system informs the user that there is missing information.

A.12. The user re-enters the missing information.

A.13.The use case resumes at step 10 of the basic flow events

Post condition: The question is sent to the respondents.

Name: Accept response

Actors: Respondent

Description: enables to accept a response from a respondent.

Precondition: the respondent must have been polled.

Flow of events:

1. The respondent wants to send a response to a poll.
2. The respondent presses the “reply” menu of his/her mobile phone on the received poll message.
3. The respondent enters the question code and the option code (selected) separated by a comma.
4. The respondent presses the “send” menu of his mobile phone.
5. The system queries the GSM modem attached to the computer for new incoming messages.
6. The system reads any new message.
7. The system verifies that the received message is in the correct format.
8. The system verifies that the respondent was polled.
9. The system marks a tally for the question against the selected option.
10. The system deletes the message from the GSM modem.
11. The use case ends

Alternate Course A: The message sent is not the correct format

A.7.The system finds that the received message is not in the correct format.

A.8.The use case resumes at step 10 of the basic flow events.

Alternate course B: The respondent was not polled.

B:8. The system finds that the respondent was not polled.

B:9. The use case resumes at step 10 of the basic flow events.

Post condition: a response from the respondent is accepted

Name: Show Poll Status

Actors: Clerk, Administrator (user)

Description: enables a user to monitor the status of an opinion poll in progress.

Precondition: The user has successfully logged into the system and the opinion poll has been made.

Flow of events:

1. The user wants to show the status of a poll in progress.
2. The user clicks on the “Poll Status” menu.
3. The system displays the “Show Poll Status” form.
4. The user selects the question category.
5. The system displays the list of questions under the selected category.
6. The user selects the question the status of which s/he needs to monitor.
7. The user clicks on the “Show Status” button.
8. The system verifies that there is no missing information.
9. The system displays the poll status information for the selected question [**Extension: Change Poll Period**].
10. The use case ends.

Post condition: The poll status for the selected question will be shown.

Name: Change Poll Period

Actors: Clerk, Administrator (user)

Description: enables a user to change the duration of a poll.

Precondition: The user has successfully logged into the system and the opinion poll has been made.

Flow of events:

1. The user wants to change the poll period for a selected question

2. The user clicks on the “change” button next to “End Date”.
3. The user selects a new end date for the poll.
4. The user clicks on the “Save” button.
5. The system changes the poll period as specified by the user.
6. The use case ends

Alternate Course A: The user selects an earlier end date.

- A.4. The user selects an earlier end date.
- A.5. The system informs the user that the new end date is an earlier date and informs the user to select a later date.
- A.6. The use case resumes at step 4 of the basic flow events

Post condition: The poll period will be changed.

Name: View Poll Result

Actors: Administrator

Description: enables the administrator to view poll result.

Pre-condition: The administrator has successfully logged in and the question for the poll must have been sent.

Flow of events:

1. The administrator wants to view results for a poll.
2. The administrator clicks on the “View Poll Result” menu.
3. The system displays the “View Poll Result” form.
4. The administrator selects the question category.
5. The system displays the list of questions which have been polled in the selected category.
6. The administrator selects the question for which s/he wants to view the result.
7. The system calculates the total number of tallies against each option in the question based on responses.
8. The system calculates the percentages of respondents who voted for an option.
9. The system displays the poll results along with illustrative graphs.
10. The use case ends.

Post-condition: The poll result will be displayed for the administrator.

Name: View Survey Result

Actors: Administrator

Description: enables the administrator to view survey result under a given category.

Pre-condition: The administrator has successfully logged in and there should be a polled question in the category.

Flow of events:

1. The administrator wants to view results for a survey.
2. The administrator clicks on the “View Survey Result” menu.
3. The system displays the “View Survey Result” form.
4. The administrator selects the question category.
5. The system calculates the total number of tallies against each option for each question under the category based on responses from respondents.
6. The system displays the survey results.
7. The use case ends.

Post-condition: The poll result will be displayed for the administrator.

Name: Send Poll Result

Actors: Administrator

Description: enables the administrator to send poll result for a question to respondents or concerned parties.

Precondition: The administrator has successfully logged into the system and the poll period for the selected question has ended.

Flow of events:

1. The administrator wants to send poll results to stakeholders.
2. The administrator clicks on the “Send Poll Result” menu.
3. The system displays the “Send Poll Result” form.
4. The administrator selects the question group.

5. The system displays the list of questions under the selected category.
6. The administrator selects the question the result of which is to be sent for stakeholders.
7. The administrator enters the phone numbers of stakeholder(s) to whom the poll result is to be sent.
8. The administrator clicks on the “send” button.
9. The system checks there is no missing information.
10. The system sends the poll result to the stakeholders and displays a confirmation message.
11. The use case ends

Alternate Course A: There is missing information

- A.9. The system finds that there is missing information.
- A.10. The system informs the administrator that there is missing information.
- A.11. The administrator re-enters the missing information.
- A.12. The use case resumes at step 9 of the basic flow events

Post-condition: The poll result will be sent for the stakeholders.

Name: Authenticate User

Actors: User (Administrator, Clerk)

Description: enables to authenticate a user who wants to access the system

Precondition: the user has a valid account of the SMSPPoll system

Flow of events:

1. The user wants to login to the system
2. The user clicks on the start icon of SMSPPoll system
3. The system displays the login screen of the system
4. The user provides her/his username and password
5. The user clicks on the “Login” button
6. The system checks that the entered information is correct
7. The system verifies that the login information is valid
8. The system displays the main screen of the SMSPPoll System
9. The use case ends

Alternate Course A: The entered information is incorrect

- A.6. the system verifies that the entered information is incorrect.
- A.7. The system informs the user to re-enter the incorrect information.
- A.8. The user enters the information and clicks on the “login” button.
- A.9. The use case resumes at step 6 of the basic flow of events

Alternate Course B: The login information is invalid

- B.7. The system determines that the login information is invalid.
- B.8. The system informs that no such user exists
- B.9. The system informs the user to try again
- B.10. The use case resumes at step 3 of the basic flow of events

Post condition: The user is granted access to the systems

Name: Register User

Actors: Administrator

Description: enables administrator to create a new user account for the users of the system

Precondition: The administrator has successfully logged into the system

Flow of events:

1. The administrator wants to create a user account
2. The administrator clicks on the “Register New User” menu.
3. The system displays the “Register New User” form.
4. The administrator enters the user account information and clicks on the “Register” button.
5. The system checks that the entered information is correct.
6. The system checks that the user name is not in use by another user
7. The system creates the user account and displays a confirmation to the administrator.
8. The use case ends.

Alternate Course A: The entered information is incorrect.

- A.5. The system finds that the entered information is incorrect.
- A.6. The system informs the administrator to re-enter the incorrect information.
- A.7. The administrator enters the information and clicks the “Register” button.
- A.8. The use case resumes at step 5 of the basic flow of events.

Alternate Course B: User name is in use by another user.

B.6. The system finds that the user name is already in use by another user.

B.7. The system informs the administrator to try another user name.

B.8. The use case resumes at step 5 of the basic flow of events

Post condition: A new user account is registered in the system.

3.4.3. Object Model

The object models help the application programmer to understand the structural elements of the system. This is depicted using class diagrams and a data dictionary of the classes. Since the classes in this application are few in number and clear enough to understand easily, only class diagram is presented.

3.4.3.1. Class Diagram

The class diagram is one of the ways for depicting the structural component of a system.

The class diagram for SMSPPoll is given in figure 4.

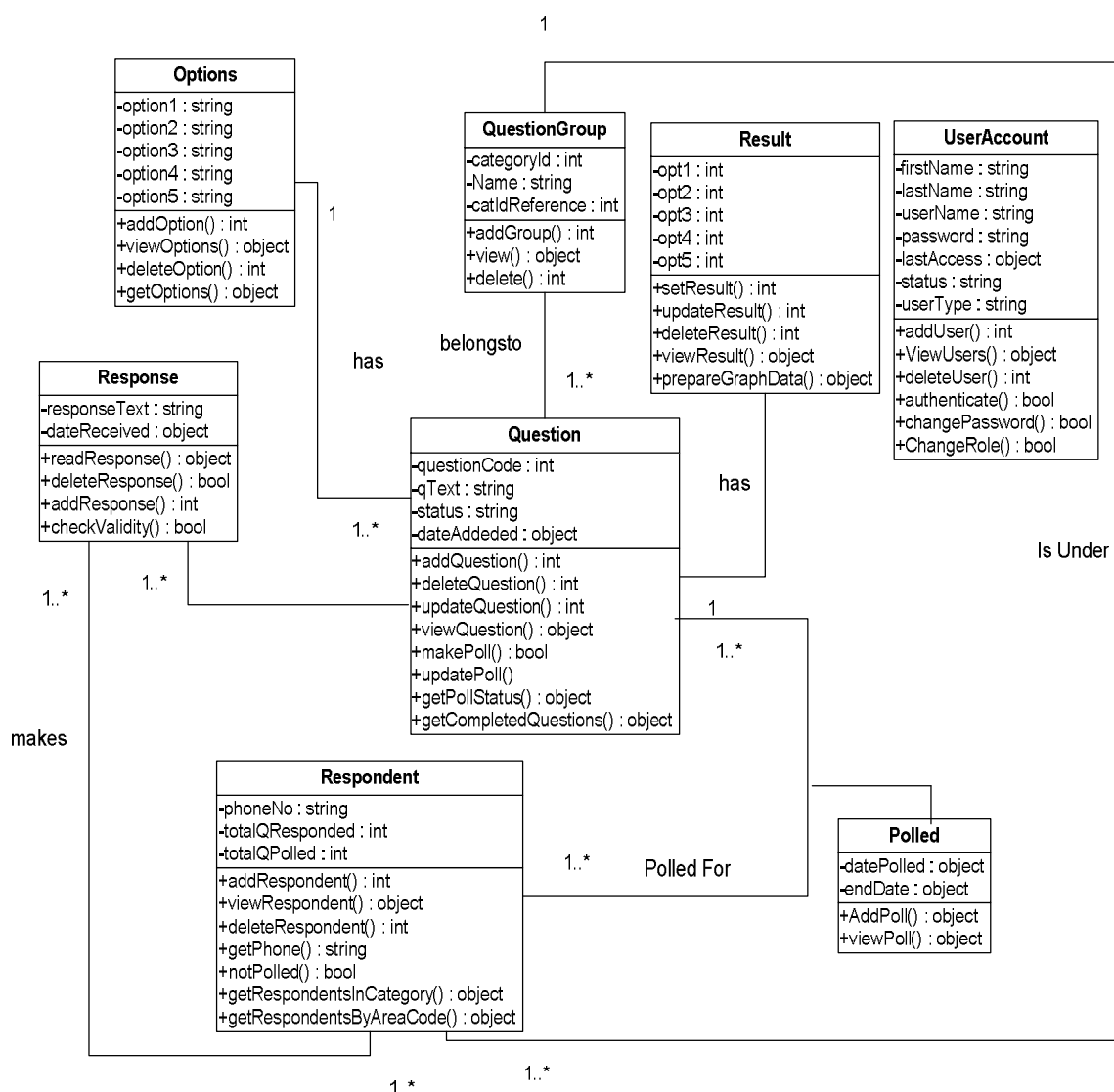


Figure 4 Class diagram for SMSPPoll

3.4.4. Dynamic Model

3.4.4.1. Sequence Diagram

A sequence diagram is a kind of interaction diagram in UML that shows how processes inter-operate with one another and in what order. It is a construct of a Message Sequence Chart. The following are sequence diagrams of the basic flow of events in the system presented to show the interaction of the system's processes and the order of interaction. Figure 5,6 and 7 show the sequence diagram for registering a new user, authenticating a user and composing a question respectively.

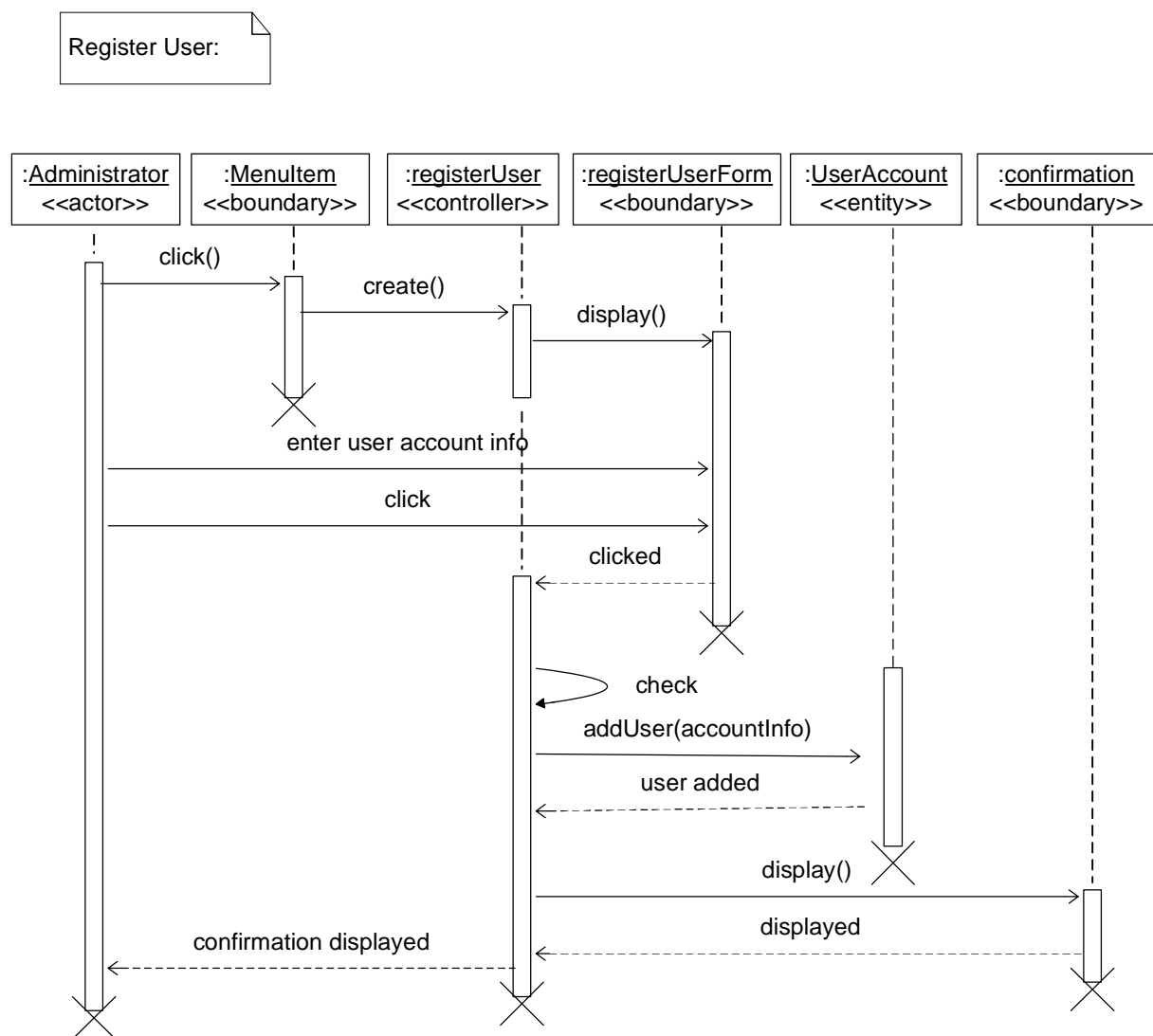


Figure 5 Sequence diagram for registering new user

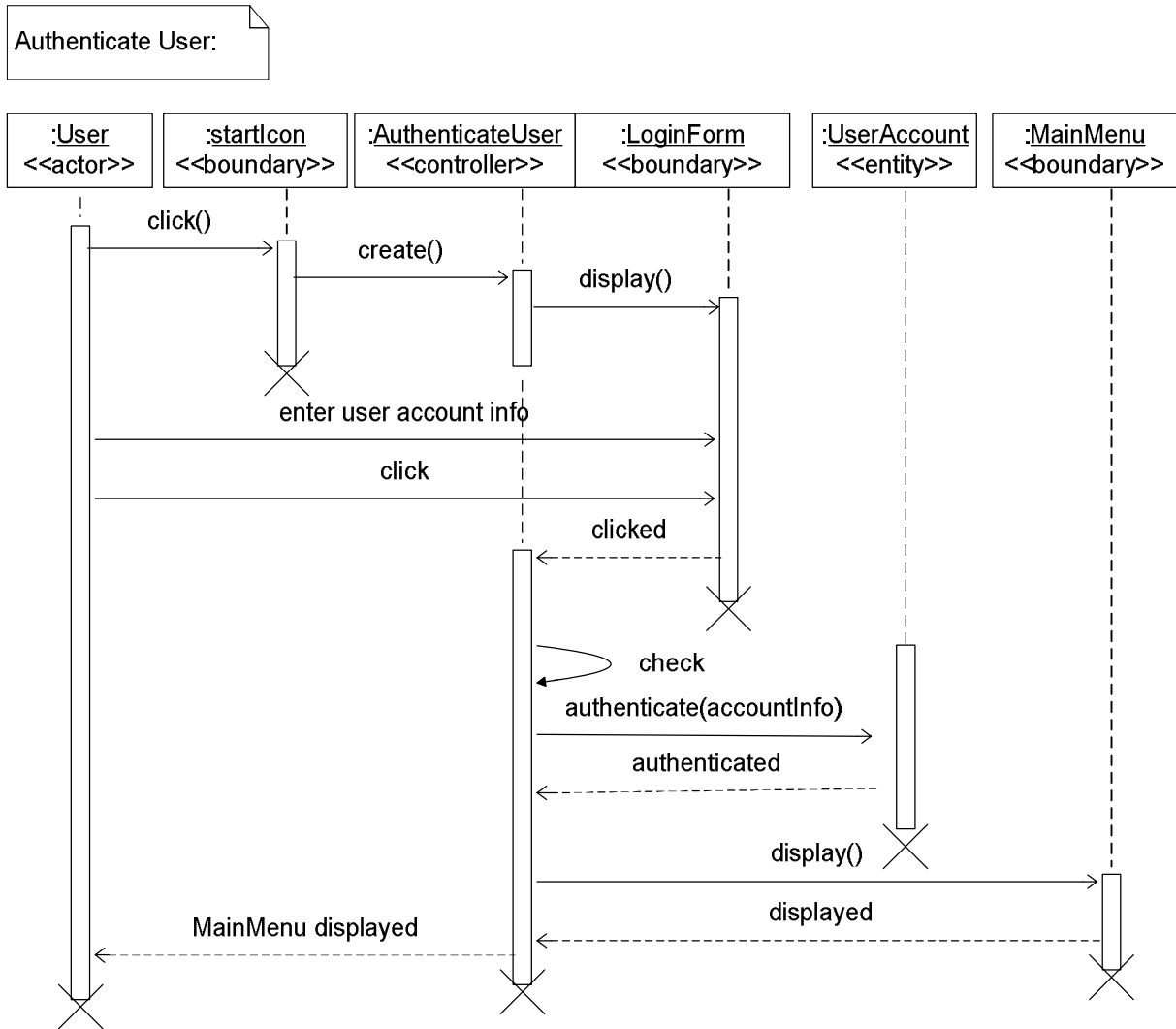


Figure 6 Sequence diagram for authenticating user

Compose Question:

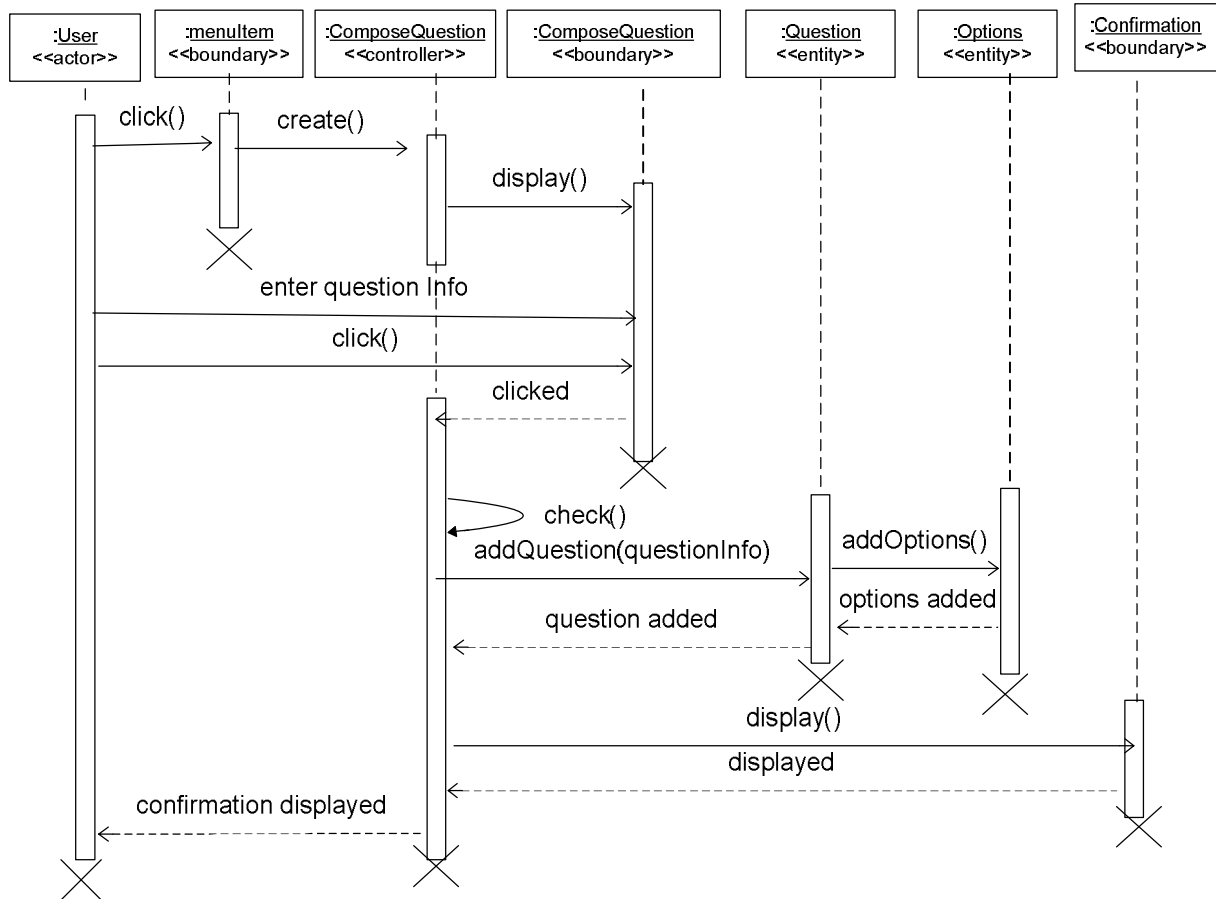


Figure 7 Sequence diagram for composing a question

Interested readers can have a look at more sequence diagrams at Annex A.

4. System Design

4.1. Overview

Requirement analysis models, although effective for identifying what will be built, do not contain sufficient information to define how the system will be built. Object oriented design is used to bridge the gap between analysis and implementation [23].

During system design, developers define the design goals of the system and decompose it into smaller subsystems that can be realized by an individual team. Developers also select strategies for building the system such as the hardware/software platforms, and persistence data management.

In this document, the different system design models are present in order to determine how to build the system.

4.2. Purpose of the System Design

The purpose of design is to determine how the system is to be built and to obtain the information needed to drive the actual implementation of the system. The following are the specific purposes of system design:

- To decompose the system to manageable parts and understand the complexity
- To select strategies for building the system
 - To determine the hardware/software platform on which the system will run
 - To determine the persistent data management strategy.

4.3. Design Goals

Design goals identify the qualities that the SMSPPoll system should focus on. The following are the qualities of the SMSPPoll system that should be considered in designing the system.

- **Availability:** The system should be available during the poll period.
- **Robustness:** the system should be able to filter out invalid messages, duplicate messages, and clean noisy response formats.

- **Security:** The system should be secured from unauthorized access, modification or destruction.
- **Usability:** The system should be easy to understand and use (attractive user interface).
- **Performance:** The system should have an acceptable performance level.

4.4. System Design Models

System design is the process or art of defining the architecture, components, modules, interfaces, and data for a system to satisfy specified requirements. In this section, subsystem decomposition, hardware/software mapping, and persistent data management of the proposed new system are presented.

4.4.1. Subsystem Decomposition

Subsystem decomposition is the process of synthesizing new subsystems (or identifying existing subsystems) from the analysis model of the proposed system. The goal of subsystem decomposition is to distribute the classes of the system into larger-scale, cohesive components. In addition, it also reduces the complexity of the design model. Figure 8 shows the layer 1 subsystem decomposition of the SMSPPoll system. As is depicted in the figure, the application is composed of three main components; an interface component, an application logic component and a persistence data store component.

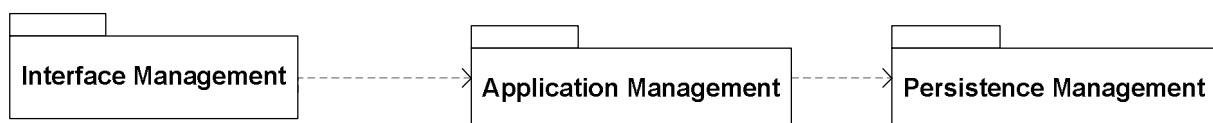


Figure 8 Layer 1 subsystem decomposition of SMSPPoll

Figure 9 shows the layer 2 subsystem decomposition of SMSPPoll. In this layer the layer 1 subsystems of SMSPPoll are presented in a bit detailed structure indicating what sub components are there in the layer 1 components.

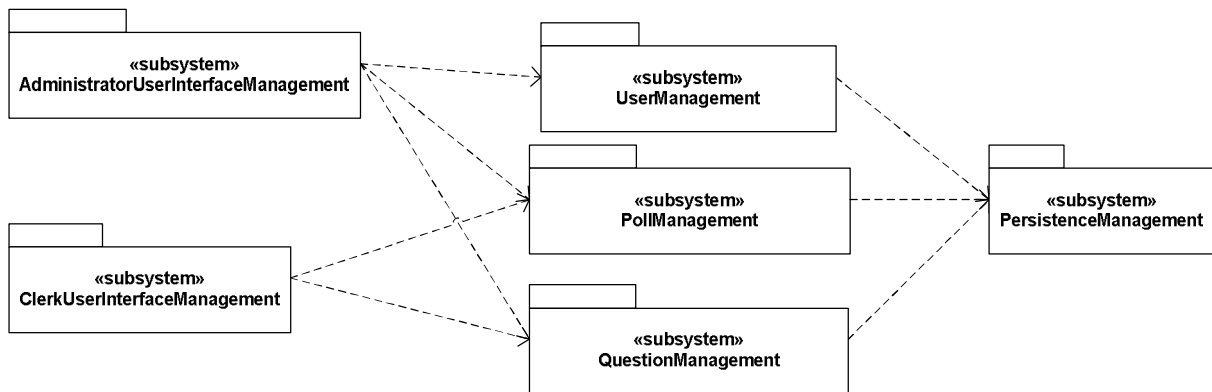


Figure 9 Layer 2 subsystem decomposition of SMSPPoll

The detailed layer 2 subsystem decomposition for SMSPPoll is given in figure 10. This detailed layer 2 subsystem decomposition indicates which classes are to be implemented together in the specific sub components of layer 2.

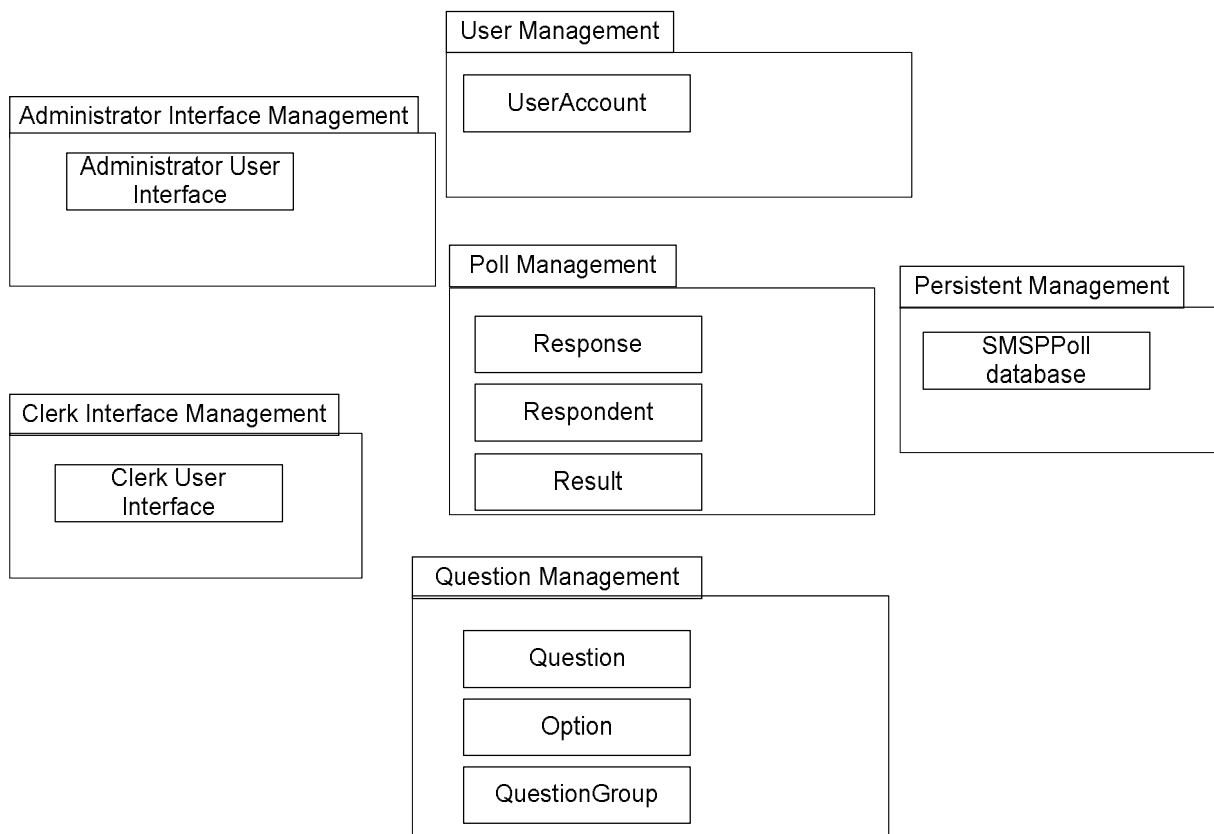


Figure 10 Detailed layer 2 subsystem decomposition.

4.4.2. Hardware/Software Mapping

Hardware/Software mapping is done in order to show the hardware for the system and the software that is installed on that hardware. This mapping, also called the deployment model, is used to show the run time configuration arrangement of processing elements. The hardware /software mapping for SMSPPoll is given in figure 11.

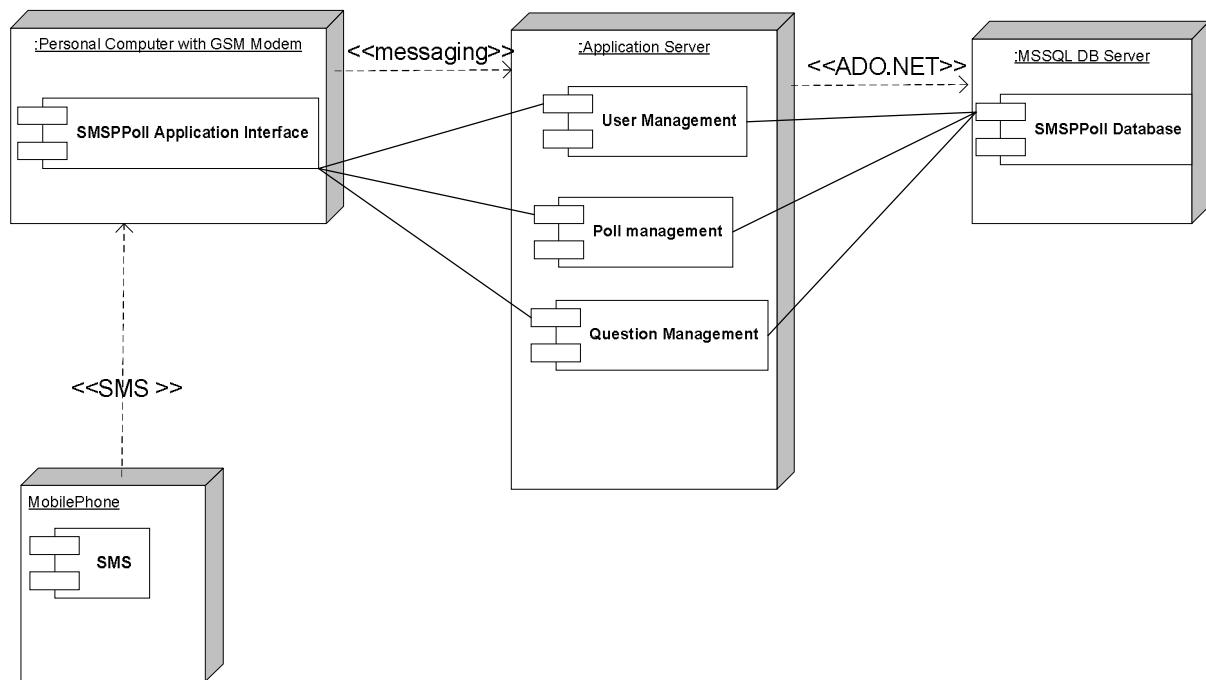


Figure 11 Hardware/Software mapping for SMSPPoll

4.4.3. Persistent Data management

In building object-oriented applications which access relational data, there are technical issues that should be addressed. Since the application data is stored on Microsoft SQL Database Server, which is a relational database management system, we need to address the issues of converting objects to relational tables. In persistence data management, the issues of mapping object model into relational data model has to be addressed so that data to be stored permanently in the SMSPPoll database can easily be determined. The following are the activities to be carried out to convert class hierarchy to relational tables:

- Mapping attributes to columns

- Mapping classes to tables
- Mapping relationships to foreign keys

In the course of these actions, figure 12 shows the persistent data tables that are mapped from the SMSPPoll class diagram to relational schema.

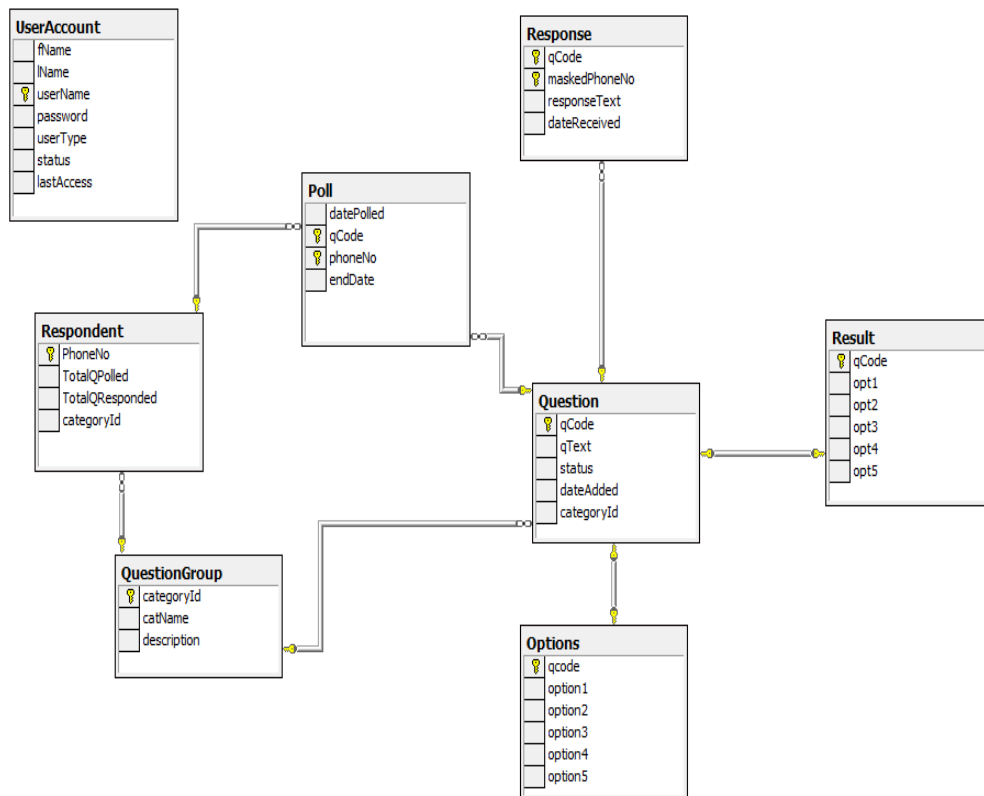


Figure 12 Persistent data model

5. Implementation

5.1. Overview

SMSPoll is windows form based desktop application developed on .NET framework 3.5. The prototype is developed using Visual studio 2008 Team Edition integrated development environment. The application is programmed using C# programming with MSSQL Database Server as the back-end database infrastructure. The application is developed in three tier architecture. The first tier is the interface layer which is a collection of windows form based user interfaces. The second layer (the Middle tier) is the collection of classes in to which the business (Application logic) is implemented. For ease of development and use, the application logic is compiled in to a Dynamic Link Library (DLL) which then is imported in the interface layer. It is in this layer that the AT Commands, which are used to instruct the GSM modem to send, receive and delete SMS, are embedded. In the third layer is the persistence layer in to which the persistent data is stored. In this layer, since the DBMS used is MSSQL Server Database-a relational DBMS, the normalized set of relational schema is implemented so that SMSPoll data is stored in an integrated and consistent manner.

5.2. The SMSPoll System

As per the design specification of the SMSPoll, the desk top application is developed. A screen shot of major system functionalities along with their description is provided in this section.

Users of the SMSPoll have to be authenticated to get access to the system. In addition, the system provides different privileges depending on the user type.

A screen shot of the SMSPoll authentication interface is shown in figure 13.

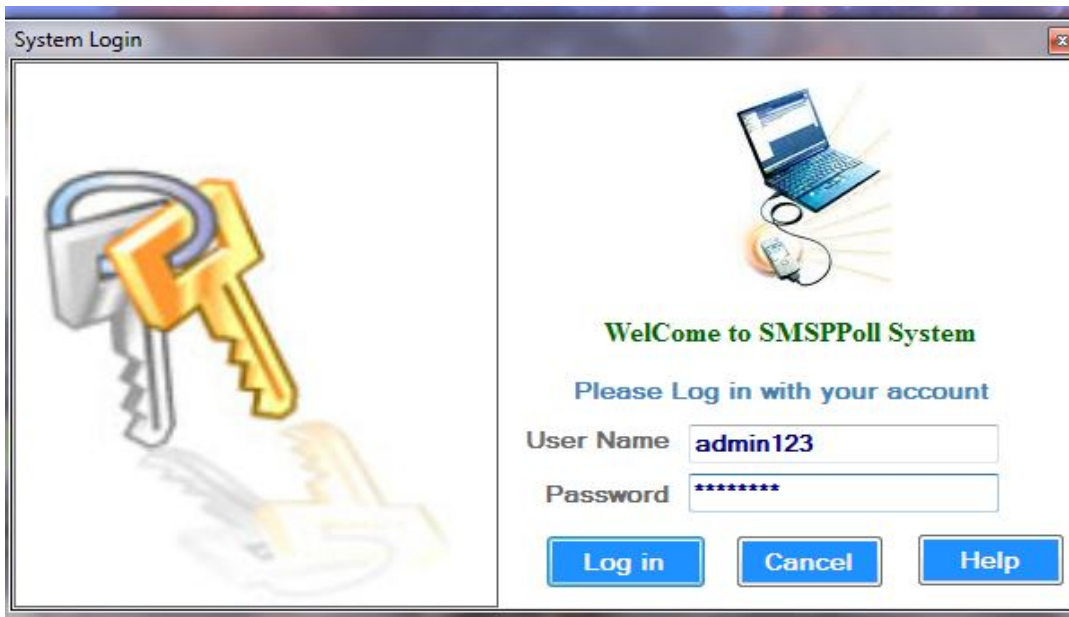


Figure 13 SMSPPoll system login

If users fail to get access to system and do not know why, they can click on the help button to get general help on system security and database configuration as shown in fig 14 below.



Figure 14 SMSPPoll local help -case of system account and security

The main menu for the SMSPPoll is shown in figure 15. This screen has a menu bar, a tool bar, and a shorthand side bar menu that enables the user to have an ease of access to the system functionalities.

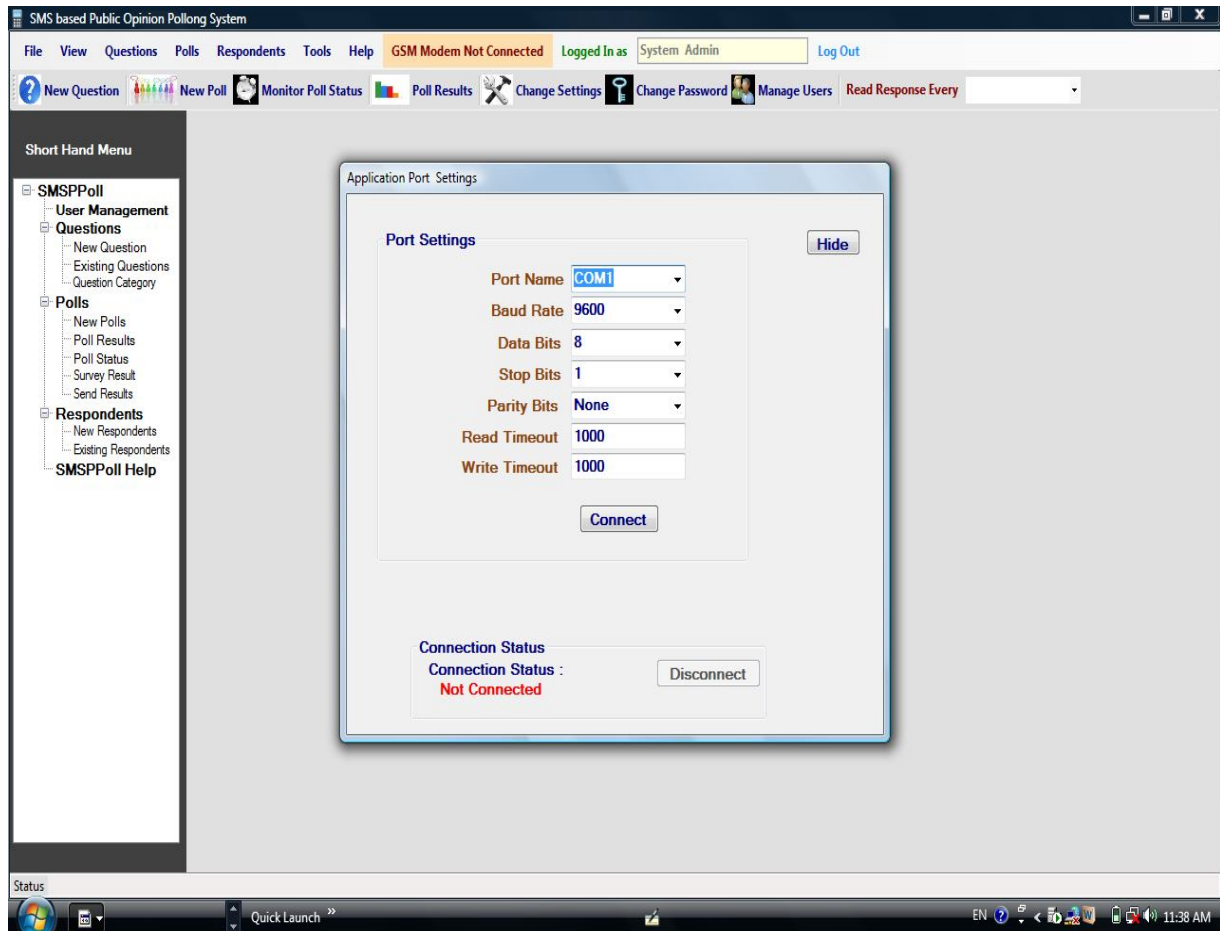


Figure 15 SMSPPoll main menu.

When the main menu loads, it prompts the user to configure the GSM modem as shown in figure 15. Once the GSM modem configuration is done, the SMSPPoll will be able to send and receive SMS messages to and from respondents. The user can also further configure how often to query the GSM modem for new responses from respondents using the tool bar drop down list.

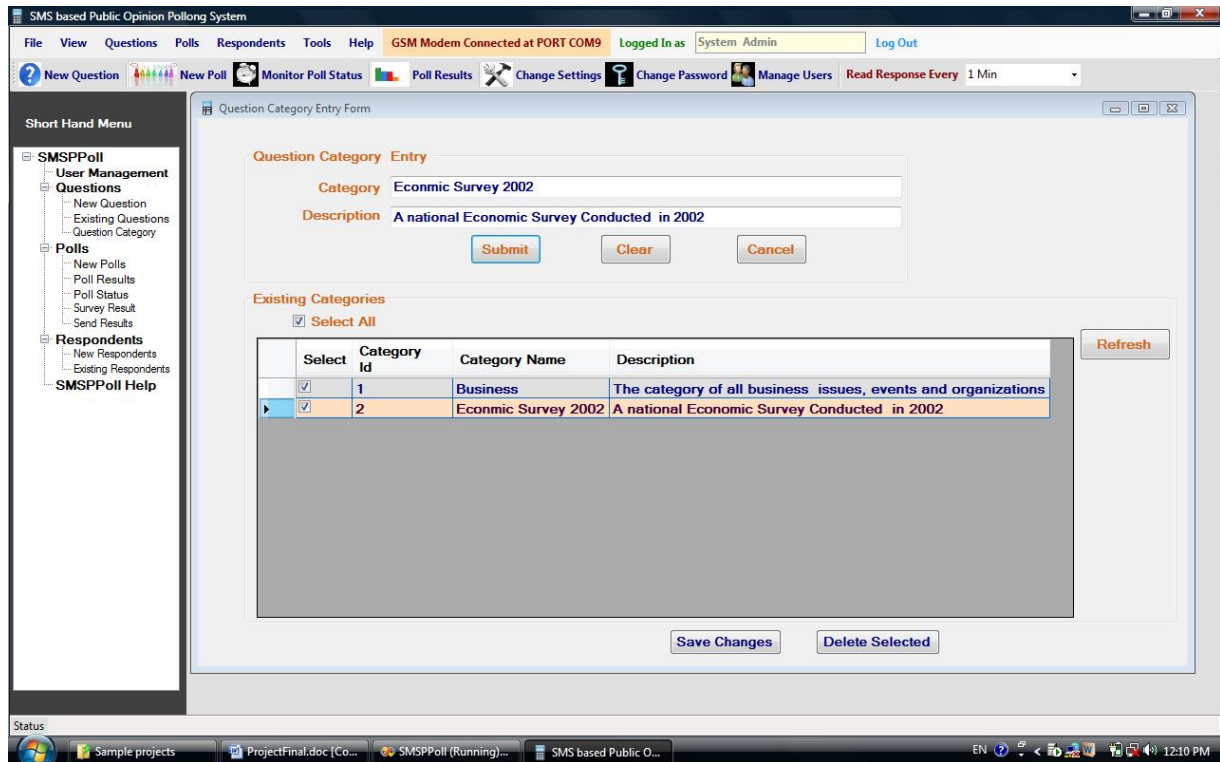


Figure 16 Question category entry.

In order to conduct a poll, the user has to create the category of the survey to conduct as shown in figure 16. In the same way, the user has to add the questions of interest under the category as shown in figure 17.

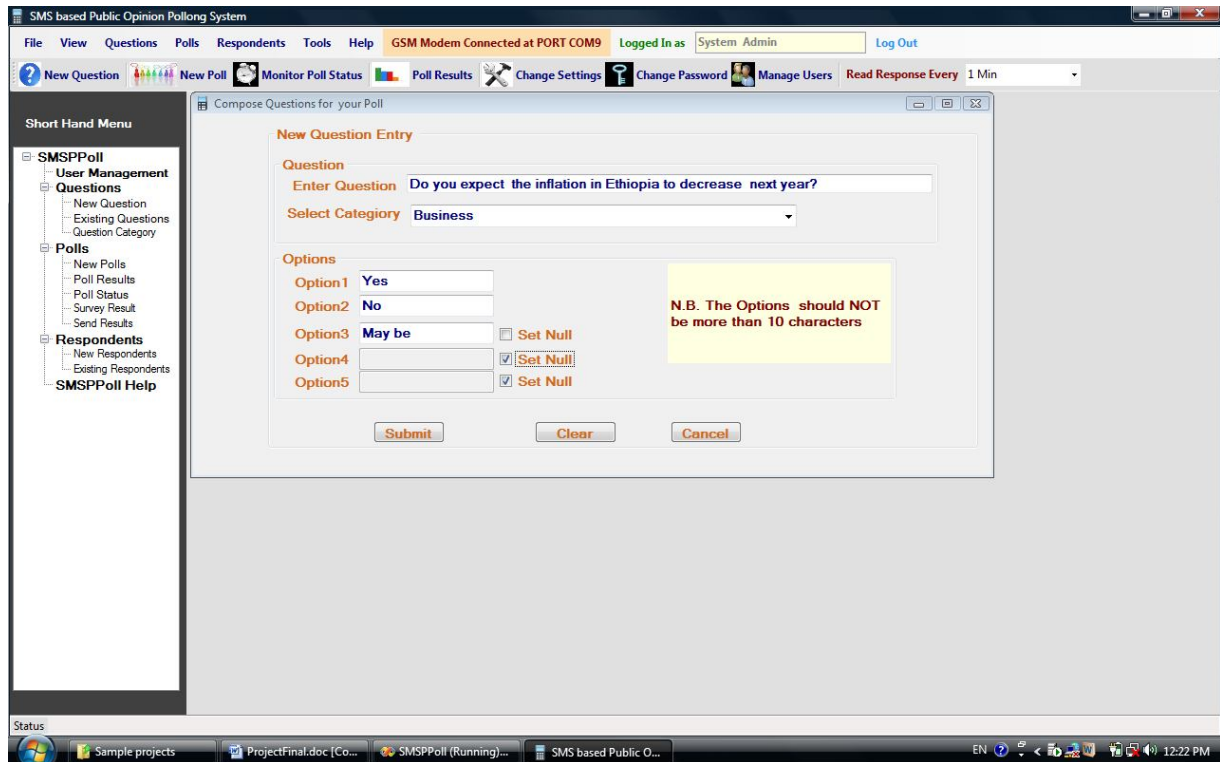


Figure 17 New question entry.

Once the question is composed the user then plans the intended respondents and enters respondents' information (Mobile phone numbers) in to the database under the intended category as shown in figure 18.

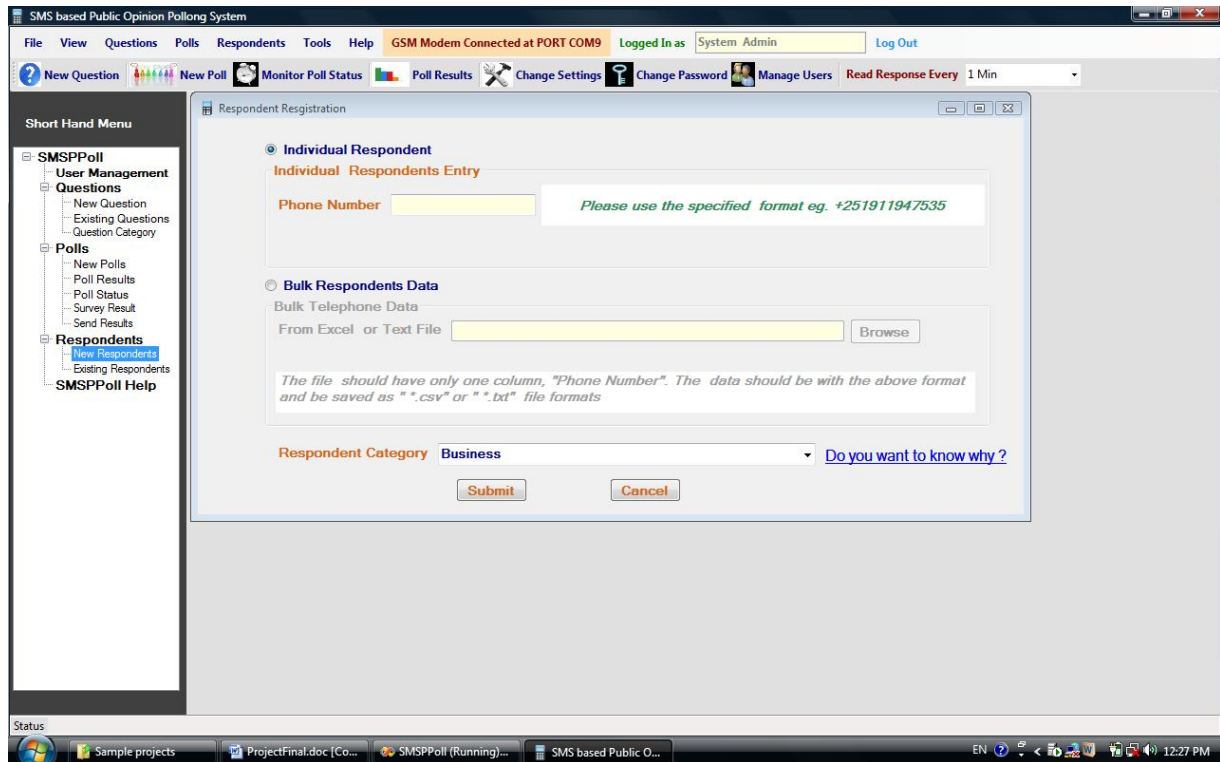


Figure 18 Respondents entry

The respondents data can be entered on individual basis or can be imported from an excel file saved as CSV file format or from a text file where one phone number is entered per line. However, a user can also enter respondents' information at the time of polling as is shown in figure 19.

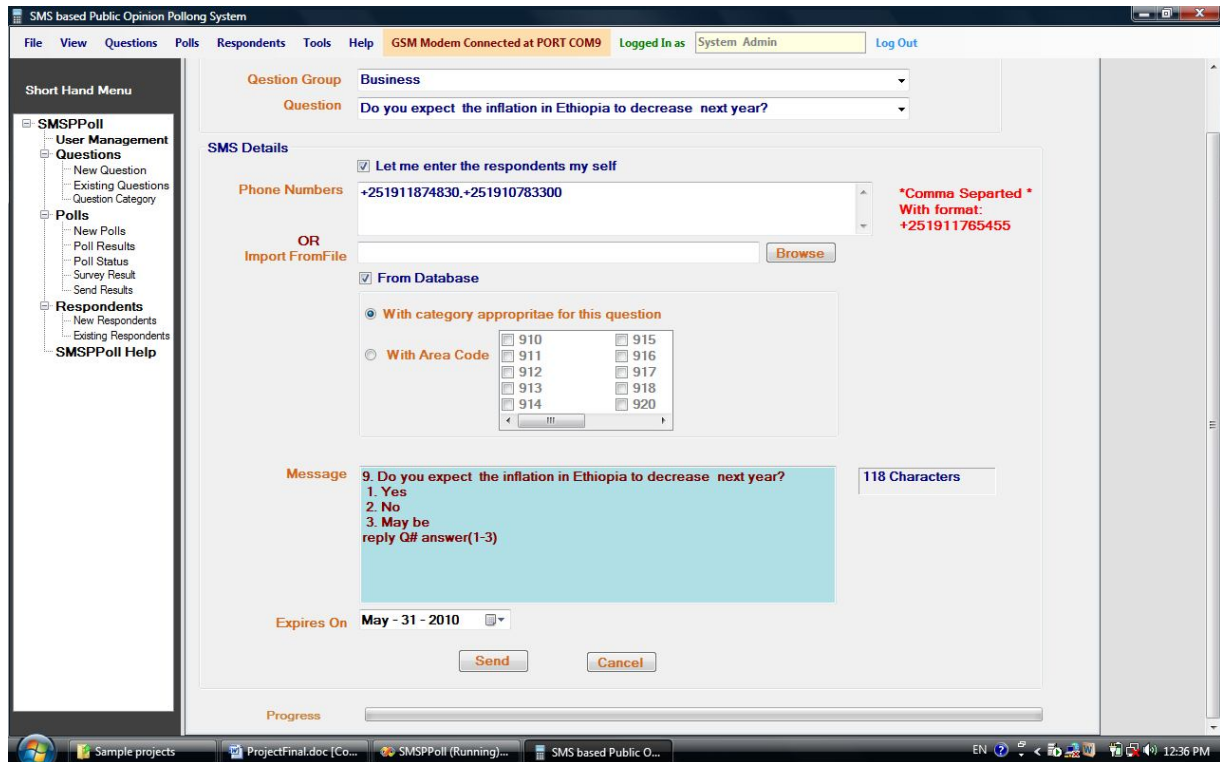


Figure 19 Making a new poll

Once the user has composed the questions and has prepared the intended respondents, s/he initiates a new poll as shown in figure 19. Respondents receive the poll as SMS message in their inbox as shown in figure 20. Respondents decide on their choice and send a reply SMS message with a restricted format <Question# Choice#>. For example, a reply of “7 3” implies the user has selected the third option for the seventh question. The reply will then be automatically added to the database for further processing.

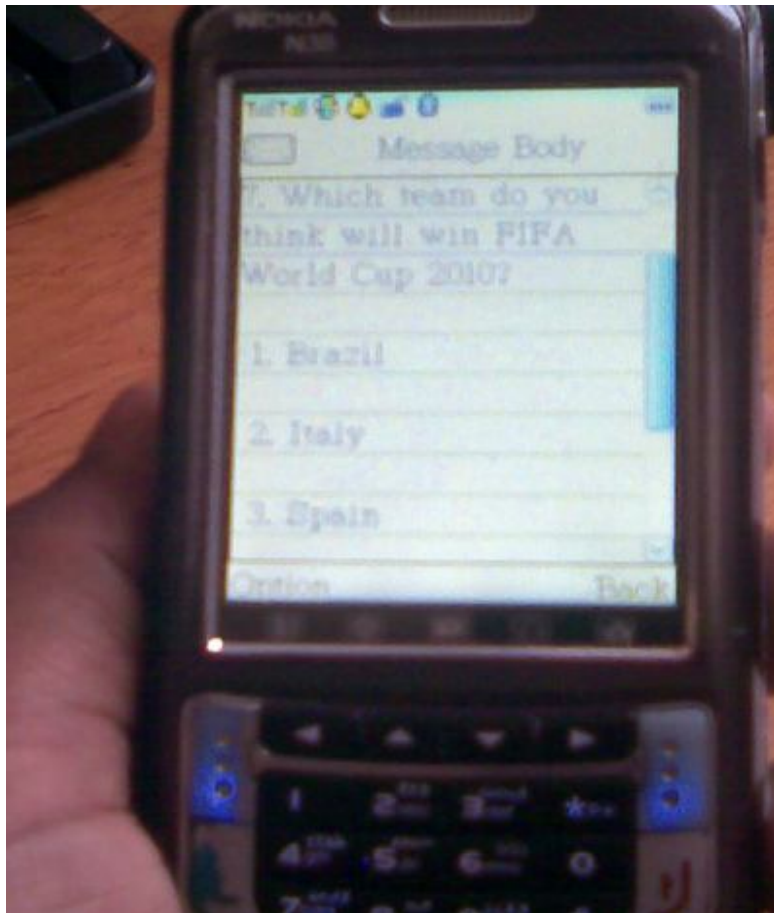


Figure 20 A question sent as SMS message to respondents- on a mobile phone

Once a poll is made, respondents can respond to the poll in a specified period of time. Since respondents respond out of their will, they are not enforced by the deadline and therefore, they are not aware of the deadline. However, the users of the system have the flexibility to monitor the poll status that shows expected respondents those who respond and therefore adjust poll period accordingly as shown in figure 21.

SMS Based Public Opinion Polling System

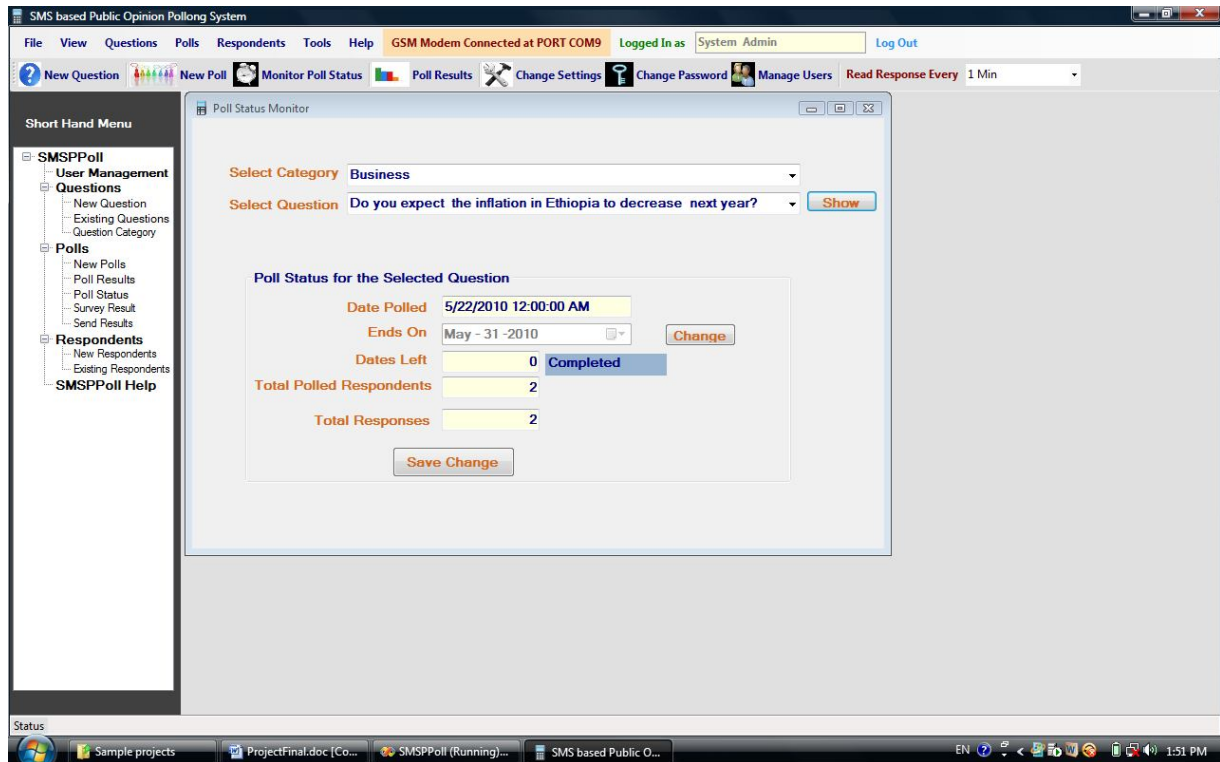


Figure 21 Poll status monitoring

Poll results can be view in either bar char or pie chart as shown in figure 22 and 23.

SMS Based Public Opinion Polling System

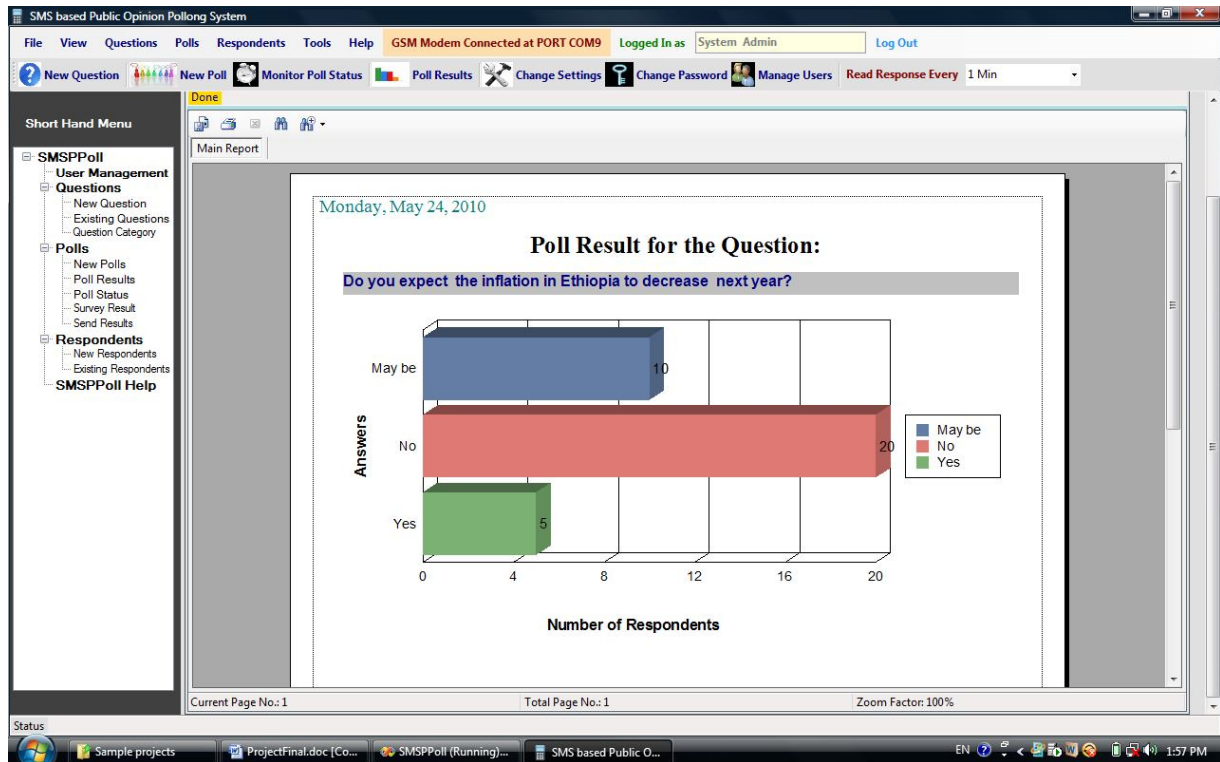


Figure 22 Poll result with bar chart

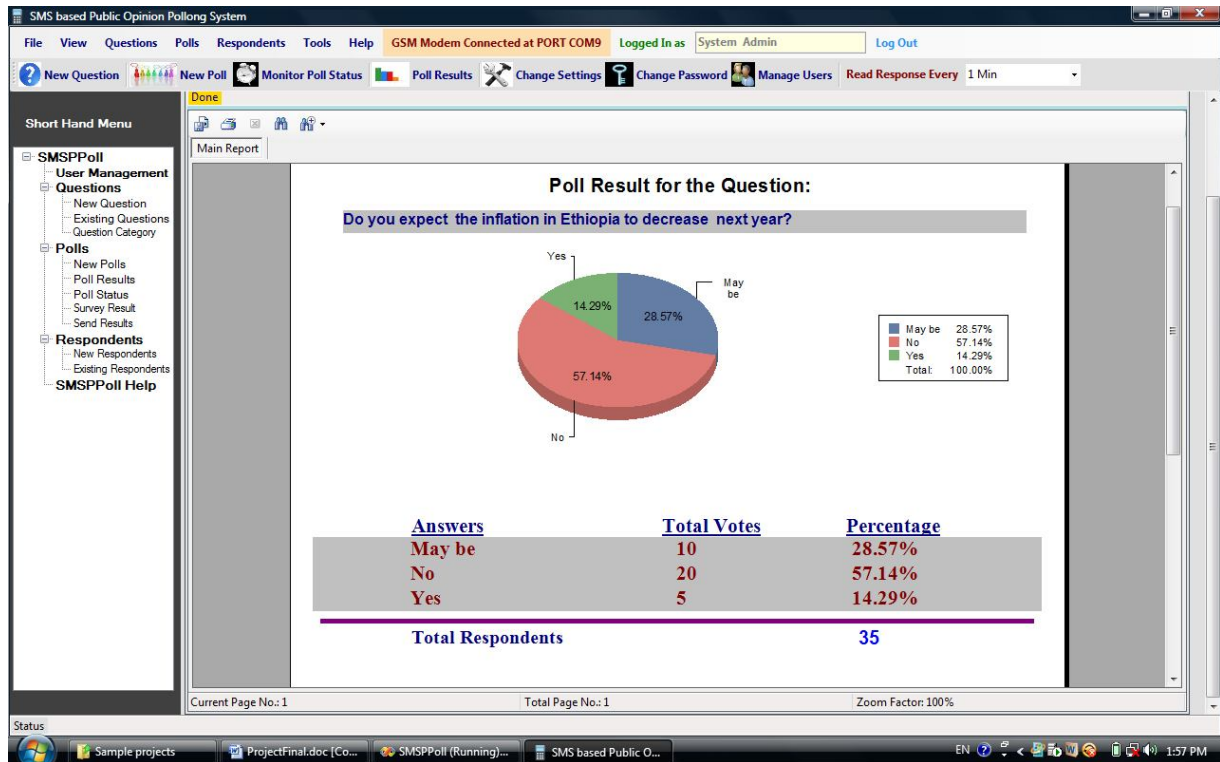


Figure 23 Poll result with pie chart.

Moreover, the survey results conducted under a given category can also be viewed as shown in figure 24.

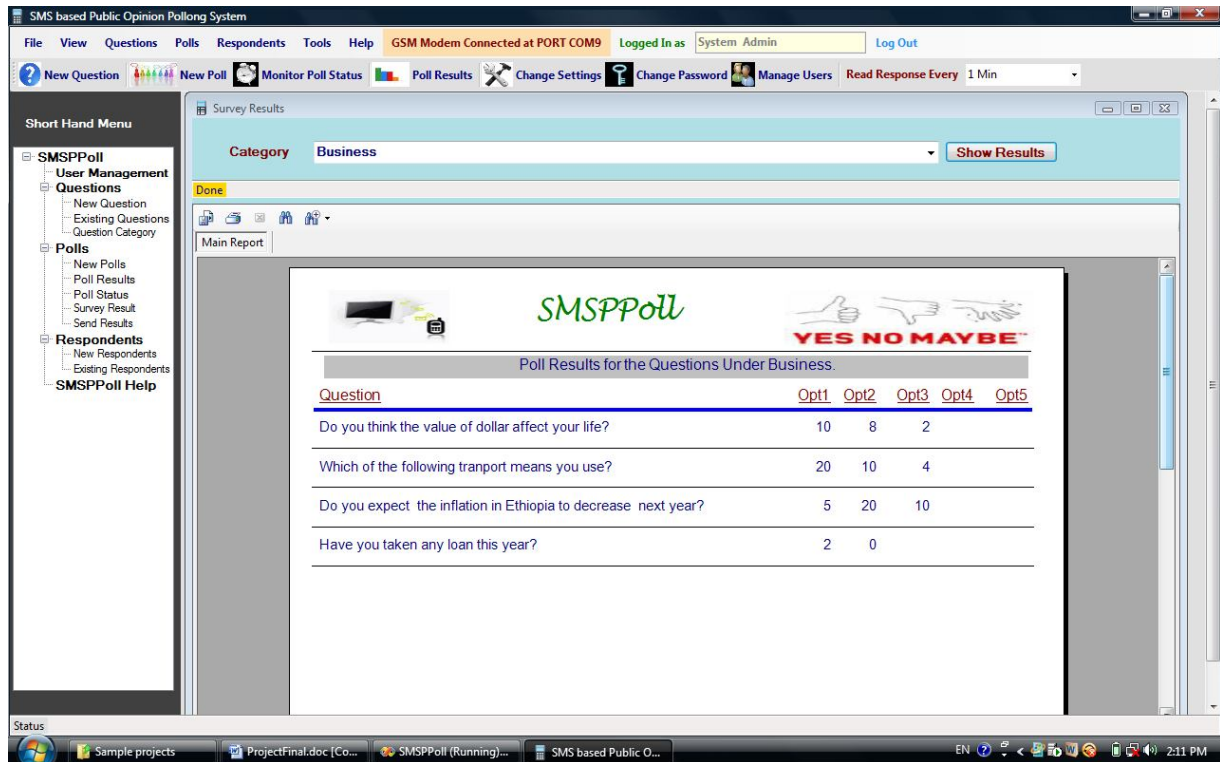


Figure 24 Survey results for a given category

Poll results can be printed or exported to some file formats.

5.3. Testing

Software testing is done to measure the gap between expected system behavior and the actual system behavior observed. SMSPPoll system testing is done at different levels.

- Unit testing: at this level of testing, the different classes in the system have been individually tested.
- Integrated testing: at this level of testing, the different classes are tested together to ensure that the different classes interoperate together.
- System Testing: at this level of testing, the whole system components are tested together to ensure that the different system components interoperate together to provide the intended system functionality services.

6. Conclusion and Recommendations

Conclusion

The development of SMSPPoll- a public opinion polling application is accomplished in the context of a close-ended question with restricted set of response. The system basically makes use of the AT –commands of the GSM modem to instruct the modem to send questions as SMS messages and receive responses from respondents as SMS messages. Since the GSM modem is considered as one of the communication ports in the computer system, the technique utilize the I/O port APIs provided by the .NET framework.

In order to achieve the objective set out, the following specific tasks were accomplished.

- We have studied the technologies behind SMS, Opinion polling, and their analyses.
- We have identified the GSM modem option to use for our application. Initially, since we could not find a GSM modem in local markets, we assumed to use CDMA1x as a GSM modem. But later we learnt that the AT commands are not supported on this proprietary device. Hence, finally, we found a cell phone that is fit for our purpose.
- We have developed the SMSPPoll system with the selected technologies.
The system is developed with all its features that enable organizations to conduct public opinion poll with a set of close-ended questions and for known respondents.
- We have tested the system at three different levels: Unit testing- to test each class individually, integration testing- to test the integration and communication of the different classes together and finally the system testing- to ensure that the system fulfils the requirements set out in the design specification. Accordingly, the system is confirmed to be fully functional.

The current developments in the mobile technology like the reduced price of bulk SMS messages, the possibility of transferring the costs from respondents to pollsters and the use of the provider's SMS gateway with a short code from the provider are enabling environments for development of the SMS based applications and services in Ethiopia.

Recommendations

This application is developed with restricted (close-ended) questions and for known (registered) set of respondents; further work can be considered to include open-ended question in public opinion polls. The handling of unregistered voters is in fact as sub task of this project and hence, this system can be easily customized to handle the case of unregistered respondents.

A more advanced applications can also be considered in Ethiopia, like in mobile payment, mobile governance, mobile learning, etc which can be implemented by utilizing the mobile SMS technology.

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Annex A: Sequence Diagrams

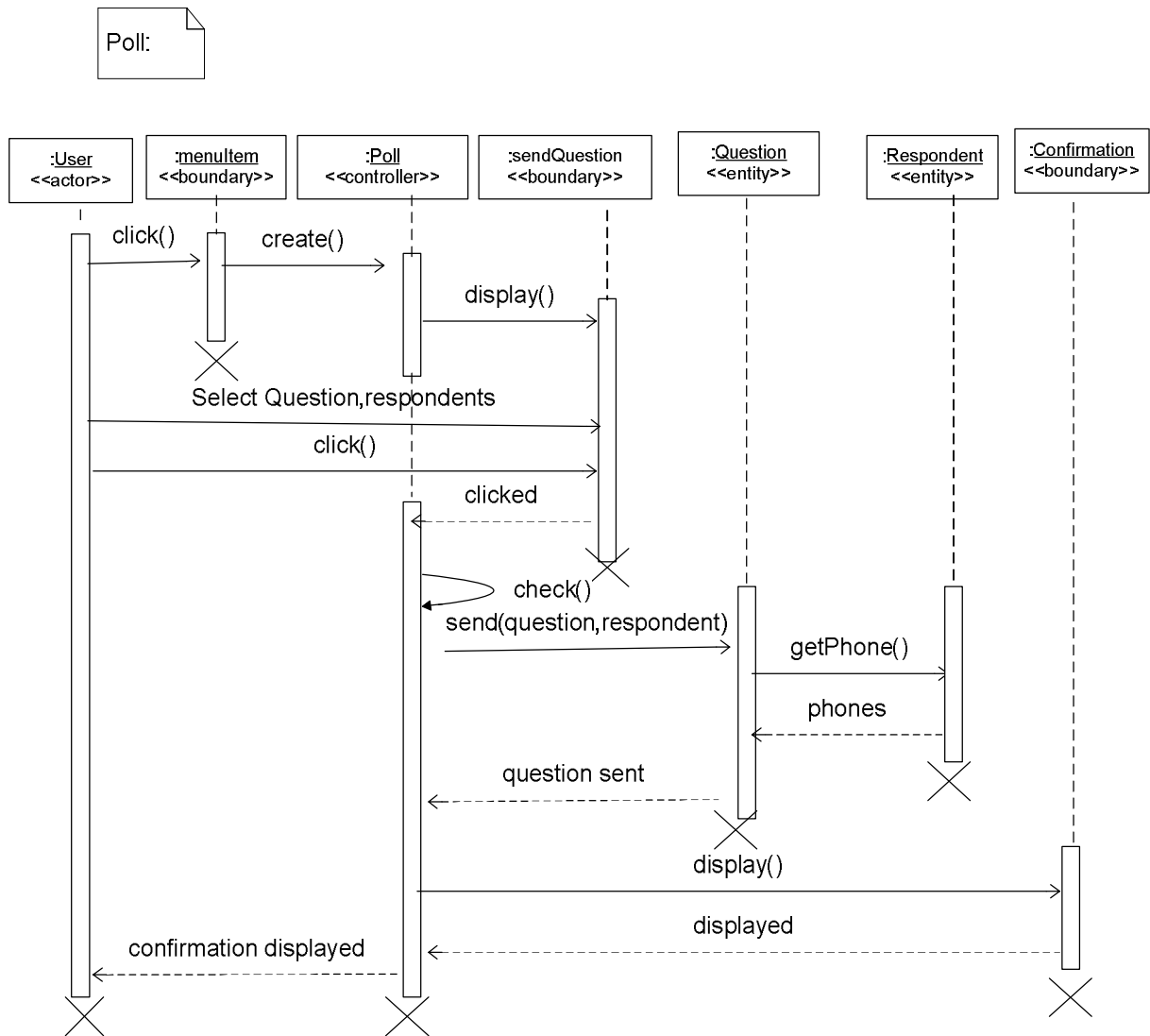


Figure 25 Sequence diagram for polling respondents

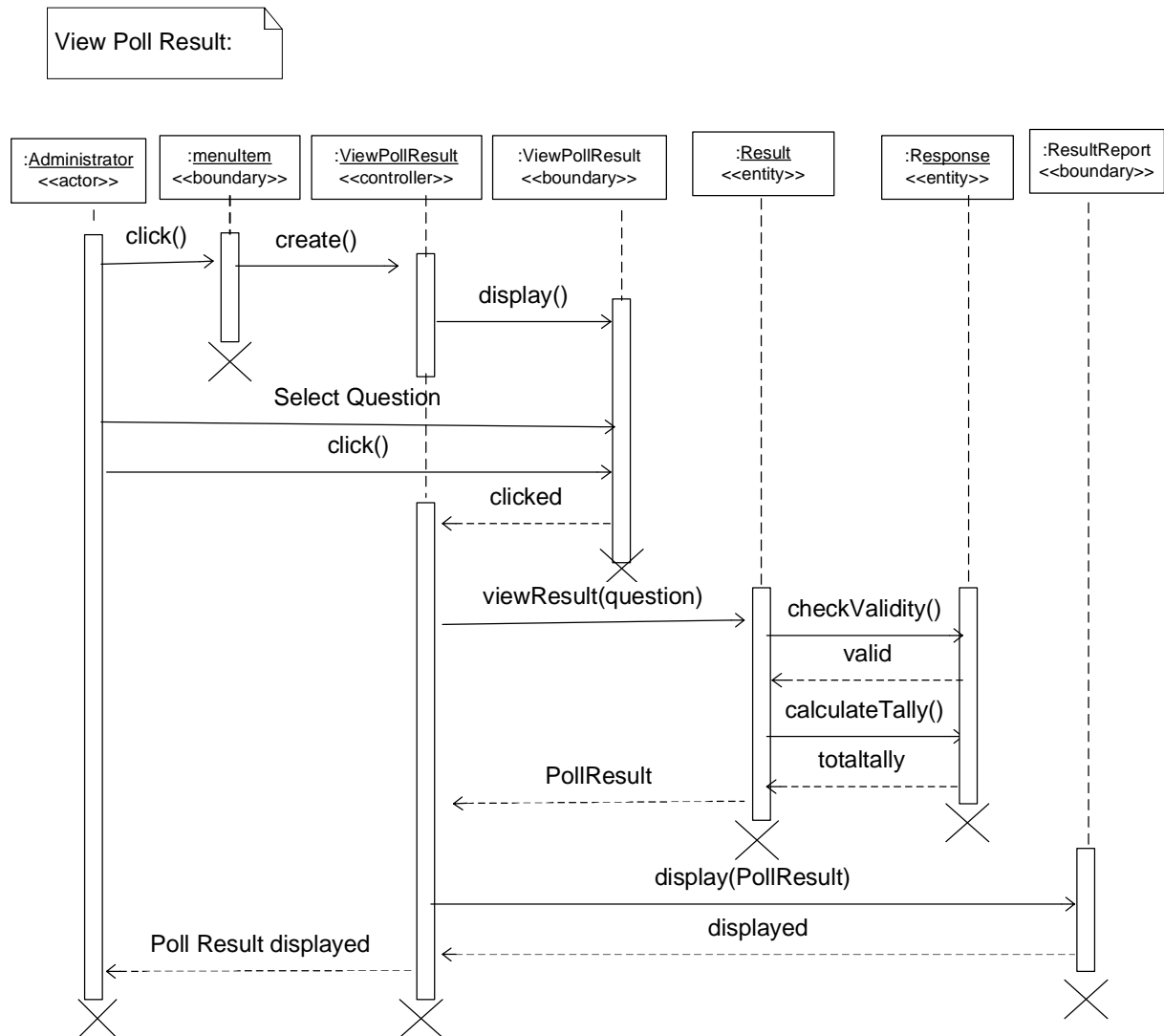


Figure 26 Sequence diagram for viewing poll result

Send Poll Result:

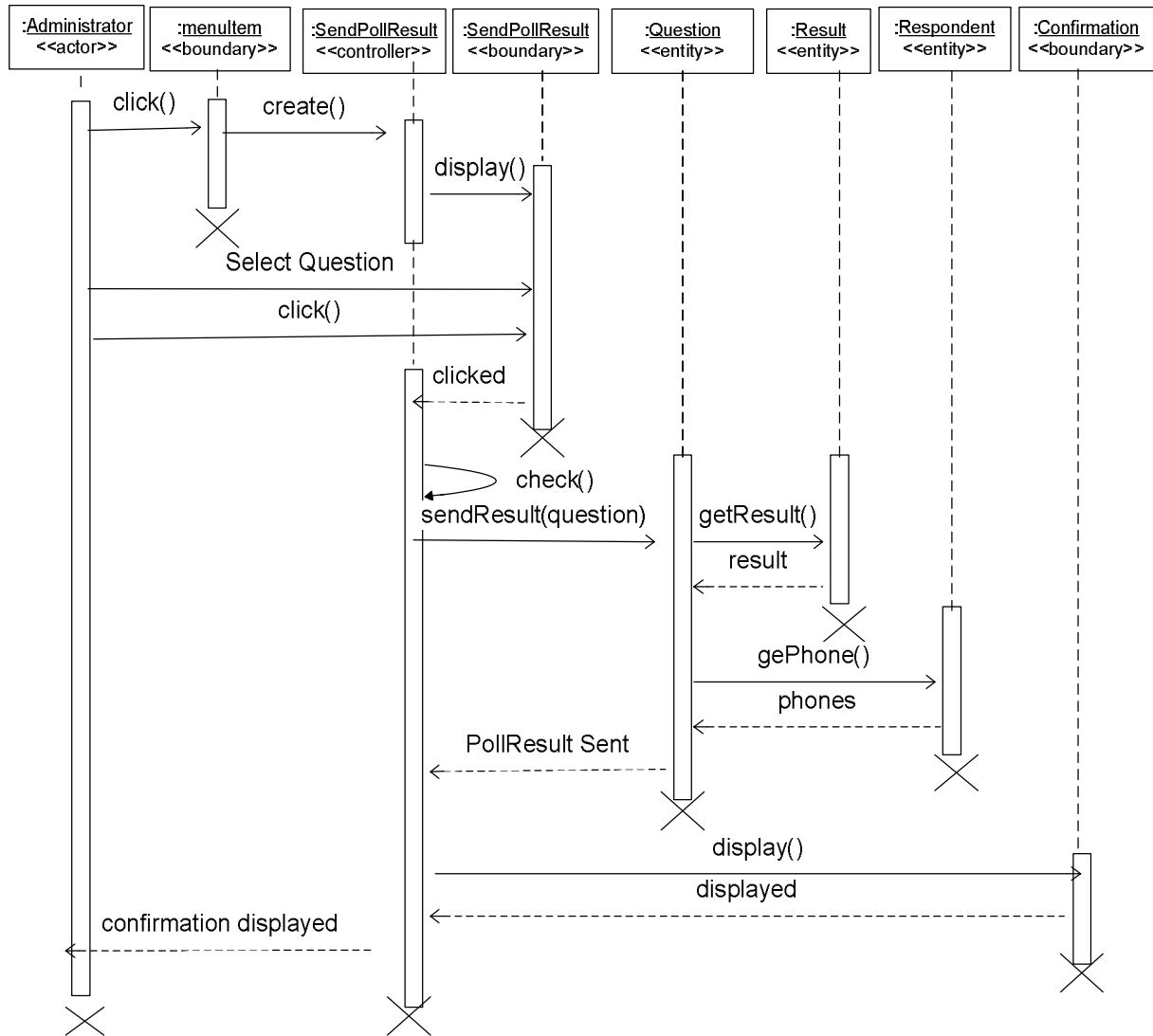


Figure 27 Sequence diagram for sending poll result

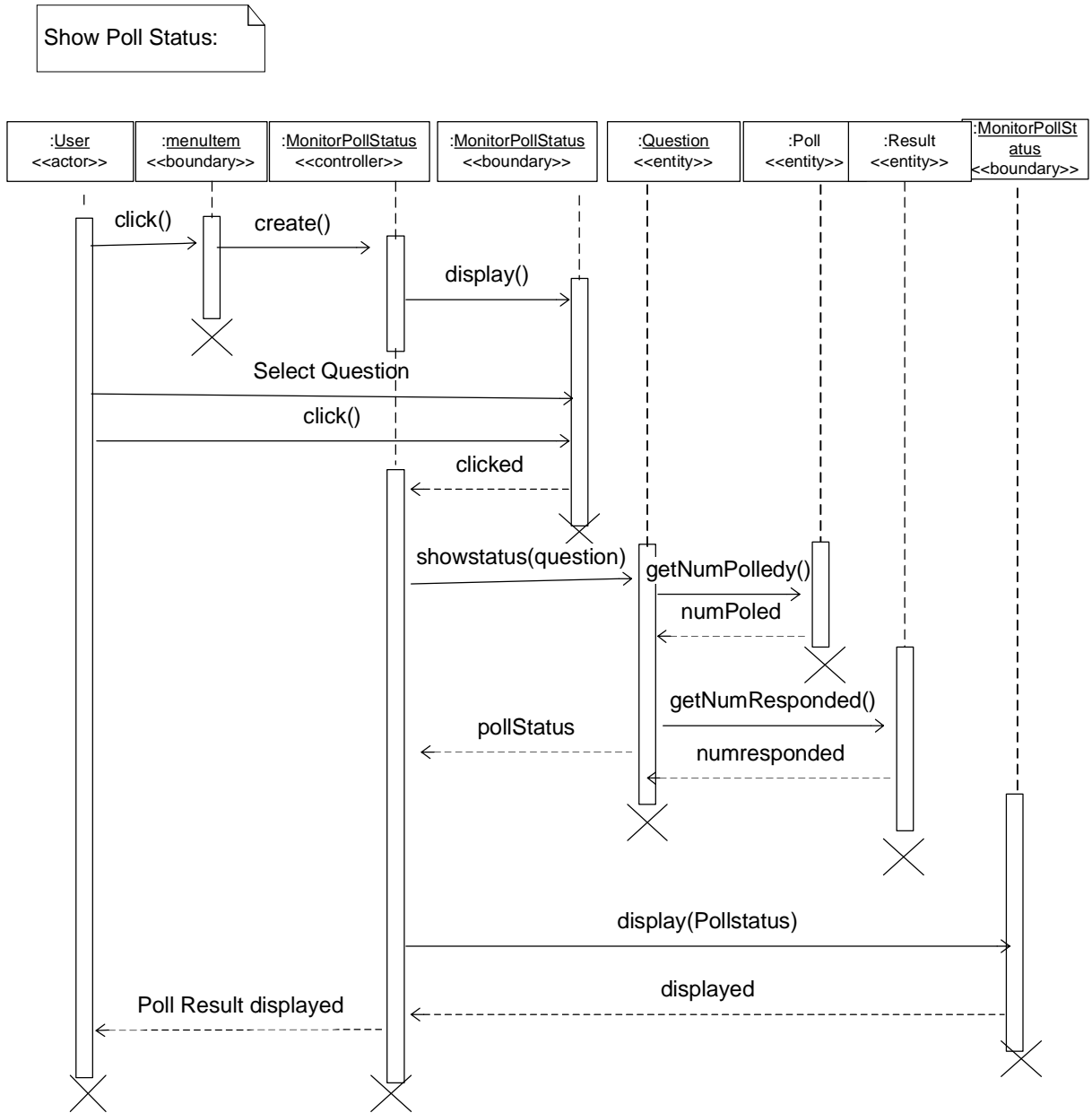


Figure 28 Sequence diagram for showing poll status

Annex B: Sample of the Implementation of Classes

C# Class implementation for the Question class

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Data;
using System.Data.SqlClient;

namespace SMSPPoll
{
    public class Question
    {
        private string qText;
        private string status;
        private DateTime dateAdded;
        private int categoryId;

        SqlDataAdapter da = new SqlDataAdapter();
        DataTable dt = new DataTable();

        #region "properties"

        public string QText
        {
            get
            {
                return qText;
            }
            set
            {
                qText = value;
            }
        }

        public string Status
        {
            get
            {
                return status;
            }
            set
            {
                status = value;
            }
        }

        public DateTime DateAdded
```

```
{
    get
    {
        return dateAdded;
    }
    set
    {
        dateAdded = value;
    }
}
public int CategoryId
{
    get
    {
        return categoryId;
    }
    set
    {
        categoryId = value;
    }
}

#endregion

#region "Constructors"
public Question()
{
}

public Question(string qText, string status, DateTime dateAdded, int
categoryId)
{
    this.qText = qText;
    this.status = status;
    this.dateAdded = dateAdded;
    this.categoryId = categoryId;
}

#endregion

#region "methods"

public void addQuestion()
{
    try
    {
        SqlCommand cmd = new SqlCommand("addQuestion", Connection.conn);
        cmd.CommandType = CommandType.StoredProcedure;
        cmd.Parameters.AddWithValue("@qText", this.qText);
        cmd.Parameters.AddWithValue("@status", this.status);
        cmd.Parameters.AddWithValue("@dateAdded", this.dateAdded);
        cmd.Parameters.AddWithValue("@categoryId", this.categoryId);
        cmd.ExecuteNonQuery();
    }
}
```

```
        catch
        {
        }
    }

    public void updateQuestion(int qCode)
    {
        try
        {
            SqlCommand cmd = new SqlCommand("updateQuestion", Connection.conn);
            cmd.CommandType = CommandType.StoredProcedure;
            cmd.Parameters.AddWithValue("@qCode", qCode);
            cmd.Parameters.AddWithValue("@qText", this.qText);
            cmd.Parameters.AddWithValue("@status", this.status);
            cmd.Parameters.AddWithValue("@dateAdded", this.dateAdded);
            cmd.Parameters.AddWithValue("@categoryId", this.categoryId);
            cmd.ExecuteNonQuery();

        }

        catch
        {
        }

    }

    public void makePoll(int qCode, string phonNo, DateTime endDate)
    {
        try
        {
            DateTime polled= new
            DateTime(DateTime.Now.Year,DateTime.Now.Month,DateTime.Now.Day,0,0,0,0);
            DateTime endsOn = new DateTime(endDate.Year, endDate.Month, endDate.Day, 0,
            0, 0, 0);

            SqlCommand cmd = new SqlCommand("makePoll", Connection.conn);
            cmd.CommandType = CommandType.StoredProcedure;
            cmd.Parameters.AddWithValue("@qCode", qCode);
            cmd.Parameters.AddWithValue("@phoneNo", phonNo);
            cmd.Parameters.AddWithValue("@datePolled", polled);
            cmd.Parameters.AddWithValue("@endDate", endsOn);
            cmd.ExecuteNonQuery();

        }

        catch
        {
        }

    }

    public void updatePoll(int qCode, DateTime datePolled, DateTime endDate)
    {
        try
        {

```

```
        SqlCommand cmd = new SqlCommand("updatePoll", Connection.conn);
        cmd.CommandType = CommandType.StoredProcedure;
        cmd.Parameters.AddWithValue("@qCode", qCode);
        cmd.Parameters.AddWithValue("@datePolled", datePolled);
        cmd.Parameters.AddWithValue("@endDate", endDate);
        cmd.ExecuteNonQuery();
    }

    catch
    {
    }
}

public void updateQStatus(int qCode, string status)
{

    try
    {

        SqlCommand cmd = new SqlCommand("updateQStatus", Connection.conn);
        cmd.CommandType = CommandType.StoredProcedure;
        cmd.Parameters.AddWithValue("@qCode", qCode);
        cmd.Parameters.AddWithValue("@status", status);
        cmd.ExecuteNonQuery();
    }

    catch
    {
    }

}

public void updateQStatus()
{
    try
    {

        SqlCommand cmd = new SqlCommand("updateQState", Connection.conn);
        cmd.CommandType = CommandType.StoredProcedure;
        cmd.ExecuteNonQuery();
    }

    catch
    {
    }

}

public DataTable getQuestionsIncategory(int catId)
{
    try
    {

        SqlCommand cmd = new SqlCommand("getQuestionsInCategory",
Connection.conn);
```

```
        cmd.CommandType = CommandType.StoredProcedure;
        cmd.Parameters.AddWithValue("@categoryId", catId);
        da.SelectCommand = cmd;
        da.Fill(dt);
    }
    catch
    {
    }
    return dt;
}
public void deleteQuestion (int qCode)
{
    try
    {

        SqlCommand cmd = new SqlCommand("deleteQuestion", Connection.conn);
        cmd.CommandType = CommandType.StoredProcedure;
        cmd.Parameters.AddWithValue("@qCode", qCode);
        cmd.ExecuteNonQuery();
    }
    catch
    {
    }

}

public DataTable getPolledQuestionsIncategory(int catId)
{
    try
    {
        SqlCommand cmd = new SqlCommand("getPolledQuestionsInCategory",
        Connection.conn);
        cmd.CommandType = CommandType.StoredProcedure;
        cmd.Parameters.AddWithValue("@categoryId", catId);
        da.SelectCommand = cmd;
        da.Fill(dt);
    }
    catch
    {
    }
    return dt;
}
public DataTable searchQuestionsIncategory(int catId, string searchKey)
{
    try
    {

        SqlCommand cmd = new SqlCommand("searchQuestionsInCategory",
        Connection.conn);
        cmd.CommandType = CommandType.StoredProcedure;
        cmd.Parameters.AddWithValue("@categoryId", catId);
```

```
        cmd.Parameters.AddWithValue("@searchKey", searchKey);
        da.SelectCommand = cmd;
        da.Fill(dt);
    }
    catch
    {
    }
    return dt;
}
public DataTable getCompletedPollsIncategory(int catId)
{
    try
    {
        SqlCommand cmd = new SqlCommand("getCompletedPollsInCategory",
Connection.conn);
        cmd.CommandType = CommandType.StoredProcedure;
        cmd.Parameters.AddWithValue("@categoryId", catId);
        da.SelectCommand = cmd;
        da.Fill(dt);
    }
    catch
    {
    }
    return dt;
}
public DataTable getPollStatusIncategory(int qCode)
{
    try
    {
        SqlCommand cmd = new SqlCommand("getPollStatusInCategory",
Connection.conn);
        cmd.CommandType = CommandType.StoredProcedure;
        cmd.Parameters.AddWithValue("@qCode", qCode);
        da.SelectCommand = cmd;
        da.Fill(dt);
    }
    catch
    {
    }
    return dt;
}
}
```

```
        #endregion
    }
}
```

Annex C: Sample of the Database Scripts

```
Create Proc setResult @qCode int ,@option varchar(10)
```

```
As
```

```
declare @opt varchar(10)
```

```
if( @option='1' OR @option='a' or @option='A')
set @opt='opt1'
else if( @option='2' or @option= 'b' or @option='B')
set @opt='opt2'
else if( @option='3' or @option='c' or @option='C')
set @opt='opt3'
else if( @option='4' or @option= 'd' or @option= 'D')
set @opt='opt4'
else if( @option='5' or @option='e' or @option='E')
set @opt='opt5'
else
set @opt='invalid'
```

```
if(exists(select * from Result where qcode=@qCode))
```

```
begin
```

```
/* tally marks being done*/
```

```
if(@opt='opt1')
```

```
update result set opt1=
```

```
case
```

```
when opt1 is null then
```

```
1
```

```
else
```

```
opt1+1
```

```
end
```

```
where qcode=@qCode
```

```
else if(@opt='opt2')
```

```
update result set opt2=
```

```
case
```

```
when opt2 is null then
```

```
1
```

```
else
```

```
opt2+1
```

```
end
```

```
where qcode=@qCode
```

```
else if(@opt='opt3')
```

```
update result set opt3=
```

```
case
```

```
when opt3 is null then
```

```
1
```

```
else
```

```
opt3+1
```

```
end
```

```
where qcode=@qCode
```

```
else if(@opt='opt4')
update result set opt4=
case
when opt4 is null then
1
else
opt4+1
end
where qcode=@qCode
else if(@opt='opt5')
update result set opt5=
case
when opt5 is null then
1
else
opt5+1
end
where qcode=@qCode
else
print 'invalid option'
END

else
Begin
if(@opt='opt1')
insert result(qCode,opt1) values (@qcode, 1)
else if(@opt='opt2')
insert result(qCode,opt2) values (@qcode, 1)
else if(@opt='opt3')
insert result(qCode,opt3) values (@qcode, 1)
else if(@opt='opt4')
insert result(qCode,opt4) values (@qcode, 1)
else if(@opt='opt5')
insert result(qCode,opt5) values (@qcode, 1)
else
print 'invalid option'
END

Go

Create proc setgraph @qcode int
as
if(exists(select * from graph ))
delete graph

declare @i int
set @i=1
declare @val int
declare @opt varchar(10)
while @i<6
begin
-- get the exact option
if(@i=1 and exists(select opt1 from result where qcode=@qcode and opt1
is not null ))
begin
set @val=(select opt1 from result where qcode=@qcode)
```

```
set @opt=(select option1 from options where qcode=@qcode)
insert graph values(@opt,@val,null)
end
else if(@i=2 and exists(select opt2 from result where qcode=@qcode and
opt2 is not null ))
begin
set @val=(select opt2 from result where qcode=@qcode)
set @opt=(select option2 from options where qcode=@qcode)
insert graph values(@opt,@val,null)
end
else if(@i=3)
begin
if(exists(select opt3 from result where qcode=@qcode and opt3 is not
null))
begin
set @val=(select opt3 from result where qcode=@qcode)
set @opt=(select option3 from options where qcode=@qcode)
insert graph values(@opt,@val,null)

end
else
begin
if(exists(select option3 from options where qCode=@qCode
and option3 != ''))
begin
set @opt=(select option3 from options where qcode=@qcode)
insert graph values(@opt,0,null)

end
end
end
else if(@i=4)
begin
if(exists(select opt4 from result where qcode=@qcode and opt4 is not
null))
begin
set @val=(select opt4 from result where qcode=@qcode)
set @opt=(select option4 from options where qcode=@qcode)
insert graph values(@opt,@val,null)

end
else
begin
if(exists(select option4 from options where qCode=@qCode
and option4!= ''))
begin
set @opt=(select option4 from options where qcode=@qcode)
insert graph values(@opt,0,null)

end
end
end
else if(@i=5)
begin
```

```
        if(exists(select opt5 from result where qcode=@qcode and opt5 is not
null))
            begin
                set @val=(select opt5 from result where qcode=@qcode)
                set @opt=(select option5 from options where qcode=@qcode)
                insert graph values(@opt,@val,null)
            end
        else
            Begin
                if(exists(select option5 from options where qCode=@qCode
and option5!=''))
                    begin
                        set @opt=(select option5 from options where qcode=@qcode)
                        insert graph values(@opt,0,null)
                    end
                end
            end
        end

--increment counter
print 'record ' + cast (@i as varchar) + ' inserted'
set @i= @i+1

end
--Update percentage
update graph
set percentage= cast (round((cast (value as float)/cast( (select sum(value)
from graph) as float))*100,2) as varchar) + '%'

Go
```

Annex D: Sample of the Code behind the User Interfaces

C# code for the code behind file of the compose question form.

```
using System;
using System.Collections.Generic;
using System.ComponentModel;
using System.Data;
using System.Drawing;
using System.Linq;
using System.Text;
using System.Windows.Forms;

namespace SMSPPoll
{
    public partial class ComposeQuestions : Form
    {
        public ComposeQuestions()
        {
            InitializeComponent();
        }
    }
}
```

```
private void chkOption4_CheckedChanged(object sender, EventArgs e)
{
    if (chkOption4.Checked)
    {
        txtOption4.Enabled = false;
        txtOption5.Enabled = false;
        txtOption4.Text = "";
        txtOption5.Text = "";
        chkOption5.Checked = true;
    }
    else
    {
        txtOption3.Enabled = true;
        txtOption4.Enabled = true;
        chkOption3.Checked = false;
    }
}

private void chkOption5_CheckedChanged(object sender, EventArgs e)
{
    if (chkOption5.Checked)
    {
        txtOption5.Enabled = false;
        txtOption5.Text = "";
    }
    else
    {
        txtOption5.Enabled = true;
        txtOption4.Enabled = true;
        chkOption4.Checked = false;
    }
}

private void ComposeQuestions_Load(object sender, EventArgs e)
{
    try
    {
        Category c = new Category();
        DataTable dt = new DataTable();
        dt = c.getCategories();
        cmbCategory.DataSource = dt;
        cmbCategory.DisplayMember =
dt.Columns[1].ColumnName.ToString();
        cmbCategory.ValueMember =
dt.Columns[0].ColumnName.ToString();
    }
    catch (Exception ex)
    {
        MessageBox.Show("Problem populating categories:" +
ex.Message.ToString(), "SMSPPoll");
    }
}

private void btnSubmit_Click(object sender, EventArgs e)
{
```

```

        if(txtQuestion.Text.Length==0)
        {
            MessageBox.Show("Please Enter Question", "Question Missing",
MessageBoxButtons.OK, MessageBoxIcon.Exclamation);
            return;
        }
        if ( cmbCategory.SelectedIndex<0)
        {
            MessageBox.Show("Please Select Category", "SMSPPoll",
MessageBoxButtons.OK, MessageBoxIcon.Exclamation);
            return;
        }
        if (txtOption1.Text.Length == 0)
        {
            MessageBox.Show("Please Enter Option1", "SMSPPoll",
MessageBoxButtons.OK, MessageBoxIcon.Exclamation);
            return;
        }
        if (txtOption2.Text.Length == 0)
        {
            MessageBox.Show("Please Enter Option2", "SMSPPoll",
MessageBoxButtons.OK, MessageBoxIcon.Exclamation);
            return;
        }

        try
        {
            Question q = new Question(txtQuestion.Text, "New",
DateTime.Now, Convert.ToInt32(cmbCategory.SelectedValue));
            q.addQuestion();

            Options o = new Options(txtOption1.Text, txtOption2.Text,
txtOption3.Text, txtOption4.Text, txtOption5.Text);
            o.addOptions(txtQuestion.Text);
            DialogResult dr = new DialogResult();
            clearContent();
            dr= MessageBox.Show("Question added to the database
successfully! \n Do you want to add the respondents for this question?",
"SMSPPoll", MessageBoxButtons.YesNo, MessageBoxIcon.Question);
            if (dr == DialogResult.Yes)
            {
                Respondent rs = new Respondent();
                rs.TopLevel = false;
                rs.Parent = this.Parent;
                rs.BringToFront();
                rs.Show();
            }
        }
        catch (Exception ex)
        {
            MessageBox.Show("problem Inserting question to the database "
+ ex.Message.ToString(), "SMSPPoll", MessageBoxButtons.OK,
MessageBoxIcon.Error);
        }
    }

    private void clearContent()

```

```
{
    txtOption1.Clear();
    txtOption2.Clear();
    txtOption3.Clear();
    txtOption4.Clear();
    txtOption5.Clear();
    txtQuestion.Clear();
    cmbCategory.SelectedIndex = -1;
}

private void btnCancel_Click(object sender, EventArgs e)
{
    this.Close();
}

private void button1_Click(object sender, EventArgs e)
{
    clearContent();
}

private void chkOption3_CheckedChanged(object sender, EventArgs e)
{
    if (chkOption3.Checked)
    {
        txtOption3.Enabled = false;
        txtOption3.Text = "";
        chkOption4.Checked = true;
    }
    else
    {
        txtOption3.Enabled = true;
    }
}
}
```

Declaration

I, the undersigned, declare that this project is my original work and has not been presented for a degree in any other University, and that all the sources of materials for the project have been duly acknowledged.

AMINU MOHAMMED

This project has been submitted for examination with my approval as an advisor.

DEJENE EJIGU (PhD)

Addis Ababa Ethiopia

June, 2010