**University of Nevada, Reno**

**VIVA: A Survey Management Toolkit**

A thesis submitted in partial fulfillment of the

requirements for the degree of Master of Science in

Computer Science

by

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August, 2011

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We recommend that the thesis
prepared under our supervision by

**VICTOR VLADIMIROVICH IVANOV**

entitled

**VIVA: A Survey Management Toolkit**

be accepted in partial fulfillment of the
requirements for the degree of

**MASTER OF SCIENCE**

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August, 2011

# Abstract

Web-based electronic surveys constitute an established and indispensable method of gathering voluntary contributions to research data from population samples of variable sizes. Recent research suggests that electronic surveys can be more effective, as compared to traditional forms of surveying, in terms of flexibility, cost, and several other factors. These facts are confirmed by the industry in the form of an abundance of commercial survey management packages and of highly adopted commercial use of web-based electronic surveys.

The VIVA Survey Management Toolkit presented in this thesis is a web-based electronic survey management system designed to be integrated in the Nevada Climate Change Data Portal that is being built at the University of Nevada, Reno as a part of the NSF EPSCoR funded project Nevada Infrastructure for Climate Change Science, Education and Outreach. Besides the integration requirement, a major emphasis in designing VIVA was placed on exploring technologies and techniques that would expand or otherwise enhance the current state-of-the-art of survey management tools.

The thesis presents the detailed software requirements, use case modeling, and software design of VIVA and illustrates the toolkit in action through a step-by-step example of creating and distributing a survey and analyzing the results obtained. A comparison with related work and a set of possible directions of future exploration are also included in the thesis.

# Acknowledgements

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# 1  INTRODUCTION

Electronic surveys are commonly accepted as one of the standard tools to facilitate the research process, both in academic and commercial environments, where they tend to replace traditional media. The reasons for the success of electronic surveys lie in both the gaining momentum of computing technology and the increase in the number of technically proficient users that are able to take advantage of it (Walt, Atwood, & Mann, 2009) (Yun & Trumbo, 2000) (and thus might simply be prone to favor electronic medium (Shannon, Johnson, Searcy, & Lott, 2011)). Despite response rates of electronic surveys being generally lower (Gunn, 2011) (Kaplowitz, Hadlock, & Levine, 2004) (Klassen & Jacobs, 2001), factors like cost, flexibility, comparative easiness of computerized evaluations, broader reach possibilities (Andrews, Nonnecke, & Preece, 2003) and even more obscure metrics such as researcher's safety (Andrews, Nonnecke, & Preece, 2003) also make electronic surveys highly advantageous over their traditional counterpart. It is also pertinent to note that most of the research suggesting lower response rates for electronic surveys as compared to more traditional types, tends to be rather dated and itself suggests the reason being in the lower technological capabilities of the responders (Klassen & Jacobs, 2001), which in itself has become much less of an issue in the latest decade.

Work presented in this thesis resulted from the research done for the Nevada Infrastructure for Climate Change Science, Education and Outreach project under an NSF EPSCoR grant to the state of Nevada. The Cyberinfrastructure component of the project was assigned several tasks, one of which consisting of architecting, implementing, deploying and supporting the Nevada Climate Change Data Portal that is intended to

encompass many aspects of computing, aggregating and displaying data pertinent to the climate research. VIVA Survey Management System was originated and further developed as a subsystem of the Nevada Climate Change Data Portal.

In the scope of the Nevada Climate Change Data Portal, VIVA intends to fulfill a set of objectives that include: to facilitate communication between researchers and administrators of the portal with regard to the technical aspects of its organization, to allow researchers to easily perform electronic surveying to facilitate scientific research and, as an integral part of the Data Portal, to serve as a foundation for future developments on its software base.

In a broader scope, VIVA intends to be a research project that explores the current state-of-the-art in technology and methods of web-based electronic survey solutions and builds upon the findings by providing innovative solutions to problems commonly encountered.

The remaining chapters of this thesis are organized as follows: Chapter 2 provides a background study of existing electronic survey solutions as well as an overview of technologies used in contemporary climate change data portals; Chapter 3 explains the motivations for this work; Chapter 4 details the specification and requirements of VIVA; building on those, Chapter 5 provides the details of the design for VIVA; Chapter 6 then walks through the implemented prototype's functionality; Chapter 7 provides a comparisons between VIVA and existing electronic survey management solutions; and, finally, Chapter 8 outlines possible areas of future work and exploration and provides the conclusions of the thesis.

# 2  BACKGROUND

## 2.1  Electronic Survey Tools

This section provides an overview of some of the commercial electronic survey software packages available on the market. This overview is, of course, not exhaustive, but the packages for review were specifically selected to compose a diverse set of popular software tools representative of the current state of the technologies that are used in electronic survey management systems. The overview will proceed as follows. First, current availability and pricing of the software will be investigated. Second, it will be indicated whether the given software package possesses which of the following set of features:

1. Question types (an ability to create multiple choice, scale or other questions)

2. Results export

3. Multi-page surveys

4. Drag and drop interface for reordering

5. Correspondence overview

6. Custom greetings

7. Basic statistics

8. Advanced statistics

9. Internationalization

A few items might need some clarification. Custom greeting designates any functionality that allows the software to tailor email (or other type of) invitations, greetings inside surveys or any other of verbal interaction towards specific users (e.g. by

greeting a user by name). Correspondence overview designates functionality to allow reviewing any of such automated interaction outputs by an administrator at a later time. After going over this basic checklist, the software will be considered from a more informal, unrestrained perspective to reveal the most interesting features.

Please note that the following reflect only this thesis author's knowledge and opinion at this time, and some information about the products surveyed might have been unintentionally missed or misinterpreted. In addition, some related information may have changed or may have been unavailable.

**Survey Monkey** (http://www.surveymonkey.com/) is a hosted electronic survey tool that is especially popular in the academic and educational environments due to the software's feature set and pricing options. The software license is subscription-based and includes three plans: the very limited but free Basic as well as a Pro and Unlimited that differ slightly in billing options (the Unlimited license requires to pay $200/year while the Pro license costs $19.95 monthly) and a Pro's limitation of a maximum of 1000 responses per month (as the name suggests, Unlimited plan does not have this limitation) (Survey Monkey, 2010). For the purpose of this survey, the Unlimited plan will be considered. Table 2.1 presents a brief overview of selected features of Survey Monkey.

Survey Monkey presents a rather exhaustive set of basic features including a diverse set of question types (15 in total), the possibility to reorder questions, and a toolset for changing the visual appearance of the survey. A Survey Monkey license also includes a set of survey templates that can assist in quicker creation of new surveys (50 templates are provided). The software also includes a feature to export survey responses to a spreadsheet and functionality that allows creating custom graphs and charts to

illustrate those responses. Sharing of results is supported by creating a special URL through which others will be able to view survey results.

**Table 2.1:** Survey Monkey overview

| Question types | Yes, 15 types |
|---|---|
| Results export | Yes, spreadsheet |
| Multi-page surveys | Yes |
| Drag and drop interface | No |
| Correspondence overview | No |
| Custom greetings | Yes (no user-specific greeting options in survey) |
| Basic statistics | Yes |
| Advanced statistics | Yes |
| Internationalization | Yes |

The progress bar is a good addition to survey taking that indicates progress of the user through a multi-page survey. This feature is viewed to be helpful in increasing the completion rate of surveys.

Lack of question reuse might be a downside for some users (each question is created in place while editing the survey), although it is alleviated somewhat by a possibility to clone any survey (which is in itself an effective feature) and by the possibility of using pre-installed templates. Survey Monkey documentation lacks any indication of functionality that would allow a user to save partial progress for future completion. Deadline enforcement is not mentioned in the documentation, so it is assumed to be absent.

With regard to advanced features, Survey Monkey allows a user to download a printable PDF version of a survey (this is of questionable value, however, since submissions are only accepted electronically). Dynamism in the surveys is supported though use of skip logic (so that some questions are only shown to users who respond in a certain way to previous questions). Another interesting and non-trivial feature of Survey Monkey that may increase communication quality between the survey publishing entity and the users is the possibility to allow users to enter a comment on any of their answers. Lastly, results filtering, a function provided by Survey Monkey, is a worthy addition to reporting module that allows to quickly locate data of particular interest. Survey Monkey developers specify that the survey interfaces generated by the package are accessible by visually impaired users, more so, the application is specified to be compliant with Section 508 of the Rehabilitation Act (a document that describes the requirements for accessibility of electronic and information technologies for people with disabilities).

**Inquisite Survey** (http://www.inquisite.com/Survey/default.aspx) is a commercial package with extensive functionality. A brief overview of its basic features is provided in Table 2.2. The price of the package is not disclosed on the official web site, which might indicate that it is higher than average, which would make Inquisite Survey mostly suitable for large business entities. Another indication for this domain of applicability of this survey is supported by the documentation, which most of the time deals with terms such as "customers", "sales", etc. (Inquisite Survey, 2010). Being an enterprise commercial application, Inquisite Survey includes all of the basic functionality that is commonly expected from a survey management suite. Features that deserve especial

mention are the WYSIWYG editor for easy editing of survey presentation including drag-and-drop question ordering, and an automated invitation management system which supports periodic reminders.

**Table 2.2:** Inquisite Survey overview

| Question types | Yes, 15 types |
|---|---|
| Results export | Yes; CSV, MDB, SPSS, more with plugins |
| Multi-page surveys | Yes |
| Drag and drop interface | n/a |
| Correspondence overview | No |
| Custom greeting | n/a |
| Basic statistics | Yes |
| Advanced statistics | Yes |
| Internationalization | Yes |

Inquisite Survey also supports similar template and survey cloning functionality as Survey Monkey. Question reuse is, unlike in Survey Monkey, explicit and is implemented using a share question library. As well as the previously reviewed software, Inquisite Survey is claimed to be compliant with Section 508 of the Rehabilitation Act, built-in text voicing is provided.

As mentioned previously, Inquisite Survey is primarily positioned towards the corporate market, which facilitates certain distinguishing qualities found in the software. One of such qualities is the software's tools for tracking and managing the users (in contrast to HTTP client details storage only or a wholly anonymous approach). A second such quality is that Inquisite Survey includes four administrative user roles: analyst,

reviewer, administrator and a system administrator to facilitate a more controlled access to potentially sensitive information. Inquisite Survey is an extensible platform which allows integration of custom software though a provided SDK and is accessible in multiple languages. The analysis module of Inquisite Survey is quite extensive as well and includes charting, filtering, exporting functionality and more.

**Magic Survey Tool** (http://www.magicsurveytool.com/) is an electronic surveying tool that is primarily positioned towards corporate clients (e.g., the developing company claims that the software helps understanding demand), but it seems to be quite generic and applicable in any environment. Also, Magic Survey Tool can be more appropriately compared to Survey Monkey rather than to Inquisite Survey due to functionality and pricing. The licenses are available for both hosted and self-hosted solutions in MS SQL (more expensive) and MySQL versions, ranging from a single to unlimited installation; also, an option of having a readable source code is available for a premium. This variety is represented by 16 different licenses with prices ranging from $499 to $2,699 (installation and hosting fees may apply also) (Magic Survey Tool, 2010). Table 2.3 provides a brief overview of selected features of Magic Survey Tool.

A feature that distinguishes Magic Survey Tool from many competitors is the presence, granularity and flexibility of controlling access to survey reports. The software employs user groups and roles to achieve this and allows restricting access even on an individual survey basis. The package includes a similar approach for achieving dynamic content as Survey Monkey: both packages employ skip logic. Also, Magic Survey Tool relies on cloning surveys to achieve a form of question reuse and provides an option of a progress bar for surveys.

**Table 2.3:** Magic Survey Tool overview

| Question types | Yes, 23 types |
|---|---|
| Results export | Yes; Excel, CSV, PDF |
| Multipage surveys | Yes |
| Drag and drop interface | No |
| Correspondence overview | No |
| Custom greetings | No |
| Basic statistics | Yes |
| Advanced statistics | No |
| Internationalization | Yes |

Differently from Survey Monkey, however, the software provides only a limited set of interface customization options (e.g., changing button titles is allowed as well as a company logo insertion, but not much more). Only some user information is collected and can be analyzed (e.g. geographic location of respondents can be extracted), which is similarly limited to Survey Monkey. As in the other reviewed software packages, Magic Survey Tool provides reporting functionality with graphical charting tools.

**Zoomerang** (http://www.zoomerang.com/) is a subscription-based service that provides three feature/pricing options: the free Basic, $199/year Pro and $599/year for Premium. For the purpose of this overview, the Premium version is considered. Table 2.4 provides a brief of overview of select features.

An interesting feature of Zoomerang that is not advertised by most of the competitors is integration with social media for sending out survey invitations. More precisely, Zoomerang can automatically post an entry URL on Twitter or Facebook. Documentation lacks details on any further integration with those sites, but even though

this integration is limited, it provides a very useful complement to traditional emailing of survey invitations. Another notable feature of the Zoomerang invitation distribution function is that an opt-out link is including in every email for easy unsubscribing.

**Table 2.4:** Zoomerang overview

| Question types | Yes, 15 types |
|---|---|
| Results export | Yes; Excel, CSV, PowerPoint, PDF, Word |
| Multi-page surveys | Yes |
| Drag and drop interface | Yes (for questions only) |
| Correspondence overview | No |
| Custom greetings | Email only |
| Basic statistics | Yes |
| Advanced statistics | Yes |
| Internationalization | No |

Zoomerang provides an unusually powerful mechanism for importing (users can be imported from Outlook, CSV, Gmail, Hotmail, Yahoo and more) and managing users. Dynamic survey qualities in this software are achieved though both skip logic and branching logic (contrasting with the common reliance on skip logic alone). The reporting module is another significant advantage of the system: as Table 2.5 shows, results can be exported in various formats, and filtering, frequency and statistical analysis can be performed on the data. Of particular interest is the amount of processing Zoomerang can perform on open-ended question (free-text) answers: analysis such as term frequency and tag-cloud can be performed (Zoomerang, 2010).

Zoomerang documentation only mentions a limited set of ways to customize the survey interface including company logo addition and changing button titles (contrasting to Survey Monkey or Inquisite Survey powerful WISIWYG editor).

**Hosted Survey** (http://www.hostedsurvey.com/) is, as the name suggests, a purely hosted solution to electronic survey management. The clients are charged on a per-response basis. The rates depend on the total number of responses and range from $.50/response at 50 responses to $.20 at 20,000 responses. The official web site claims that Hosted Survey is used in many areas including academic research and business (Hosted Survey, 2010). Table 2.5 provides a brief overview of selected features of this package.

**Table 2.5:** Hosted Survey overview

| Question types | Yes, 16 types |
|---|---|
| Results export | Yes; Excel, Access, XML |
| Multi-page surveys | Yes |
| Drag and drop interface | No (manual row # input) |
| Correspondence overview | No |
| Custom greetings | No |
| Basic statistics | Yes |
| Advanced statistics | Yes |
| Internationalization | No |

As any other software in this overview, Hosted Survey provides quite a solid set of basic features: multiple types of questions (although, some of those "questions" are only formatting elements such as page breaks, which comprise an interesting and unique

way of formatting pages), multiple data formats for exporting response data, a response analysis module with graphical charts, etc. What is notable for Hosted Survey is that the software provides both a survey template functionality and a shared question bank which results in a great potential of flexible reuse of both surveys and individual questions. The package provides a possibility to fully customize the layout of a survey, which is a considerable advantage. Dynamic functionality is achieved though using both branching and skip logic. Another advantage of the software is its ability to deliver personalized invitations though email (compare it with a bulk email with the same text for each recipient) that brings in an element of social presence which is considered to increase the quality of responses (Couper, Tourangeau, & Steiger, 2001). User-defined question constraints make up another distinguishing feature of Hosted Survey: e.g., a user is able to impose custom constraints on the number range in a "rate on a scale" question answer.

**QuestionPro** (http://www.questionpro.com/) is a purely hosted solution for electronic survey management. Three licenses are offered: Free Basic, Professional ($15/month) and Corporate ($99/month), the latter being considered here for the purposes of this overview. Table 2.6 provides a brief overview of selected features of QuestionPro. QuestionPro software fosters good reuse of questions and surveys by using both survey templates and a shared question library. An interesting feature that might boost usability of the system and productivity for instances that deal with a large amount of surveys, is the ability to assign surveys to user-defined folders for easier navigation. Another feature that was not found in other reviewed software packages is the comparison of the user's answers to the rest of the answers right after the completion of the survey. This might be

of a limited use to corporate entities, but is expected to be effective in an academic environment.

**Table 2.6:** QuestionPro overview

| Question types | Yes, 13 types |
|---|---|
| Results export | Yes; CSV, Excel, PowerPoint |
| Multi-page surveys | Yes |
| Drag and drop interface | No |
| Correspondence overview | No |
| Custom greetings | Email only |
| Basic statistics | Yes |
| Advanced statistics | Yes |
| Internationalization | Yes |

Questions in the survey can be randomized; this feature was found in many of the packages reviewed, but it is first mentioned here as the developers of QuestionPro provided a good application for this technology, reducing any possible bias due to ordering. In QuestionPro, a file attachment can be used a part of an answer to some of the questions; this is considered to be especially useful in academic environments as electronic surveys might so gain another dimension of usefulness as devices for sharing scientific data. Dynamic presentation is supported by branching logic and can be effective on a question-basis, not just survey-page basis (Question Pro, 2010).

## 2.2 Data Portal Technologies

Since the VIVA Survey Management Toolkit is intended to be integrated into the Nevada Climate Change Data Portal, it is possible to enhance such integrability by taking

into account the existing experience in the construction of data portals. Another important intention of this section is to provide a list of common downsides of the techniques employed on the web systems pertinent to climate research to avoid those in VIVA specifications. This section provides a brief overview of selected data portals that are dedicated to the topic of climate change. The overview will mainly focus on the distinguishing features of those portals, but will also provide a sense of what is common among such portals, a set of beneficial features and a list of possible disadvantages are also provided for each of the portals.

**EPA's Climate Change Portal:** http://www.epa.gov/climatechange/

This portal is a rather comprehensive source of information on climate change. It contains a lot of general (as opposed to region-specific) information on climate change. They have an excellent kids' section. It is very interactive and appealing. Another great feature of this site is a very powerful and flexible search. Among the limitations of this portal can be considered: poor navigation (examples: unstable main navigation section, deemphasized breadcrubms (hindering findability of a major navigation element (Kalbach, 2007) (Heim, 2007)), anchors that are not distinguished from links ("Contact us" link was detached from the navigation), unclear presentation (examples: cluttered layout, confusing link duplication, news are deemphasized, news leads to external websites, inconsistent layout, "Related links" and "Regional Information" use the same box as "News"), outdated design (especially in contrast with the parent portal, www.epa.gov), obscure search errors (dealing with "violation of security policy"), absence of syndication, semantic deficiencies of markup (e.g. no use of <acronym>, duplicated CSS).

The most beneficial features of the portal were found to be: very feature-rich and effective search, good content, kids' section (although, design needs improvements, e.g. too color-restricted gif images, inconsistent illustrations, semantically incorrect illustrations, pop-ups open in the top-left corner); excellent "Calculate your impact" application, informative interactive animations, "Share" menu that makes site seem less government- and more human-oriented, possibility to share and promote the website, related links, lack of unnecessary internationalization.

**California Climate Change Portal:** http://www.climatechange.ca.gov/

California Climate Change Portal is a web-site that contains articles mainly regarding climate change in the state of California, but it also has some general information on the topic (such as articles explaining what the "greenhouse effect" is). In addition to articles, the portal has many links to executive orders of the Govenror that have to deal with the environment.

Among the downsides of the portal the following were identified: layout does not fit into 1024 pixels in width, which is the case for around 20% of users as of January 2010 (W3CSchools, 2010);  occasional poor illustrations (e.g. Figure 2.1); "CA Climate Change Agencies" and "Key Federal Agencies, Academic & Nonprofit Groups" seem to only be accessible from all sections under "home", not from the main navigation (hindering user experience by obstructed findability of content (Heim, 2007) (Morville & Rosenfeld, 2006)); title page is not syndicated (a suggestion would be to use the calendar's CSS which the portal does provide).

The most beneficial features of the portal that are: a generally friendly and readable layout (see above for exceptions); introduction on the title page; quality

contents; well-structured and presented navigation, related links section; mostly semantic (and thus maintainable) client-side code that is properly indented and documented (though it validates with a lot of errors).



**Figure 2.1:** Unreadable text in images, California Climate Change Portal

**Georgia Coastal Ecosystems LTER**: http://gce-lter.marsci.uga.edu/

This portal's main purpose seems to be that of communicating the progress of Georgia's Coastal Ecosystems research to the world. The contents are quite dry and appear to be intended for scientists and researchers only. The site is, however, nicely

organized and presents information in a variety of ways: from on-site photos to text reports.

Among the most beneficial features of this portal the following were identified: excellent page layouts, very readable page structure; excellent navigation; good images (no unreadable details on thumbnails, details on full images); powerful search abilities (although the results page is cluttered). No sufficient downsides were identified for Georgia Coastal Ecosystems LTER portal.

**Department of Energy homepage:** http://www.energy.gov/

This one includes information that mainly regards energy concerns: there are articles on sources of energy, on how consumption affects environment, on energy statistics, etc. In addition to general and nation-level information, there are brief notes on each of the states. Among the most beneficial features of this portal the following were identified: accessible navigation, readable page structure, clickable US map serving as location selector.

**Tiempo Climate Portal:** http://www.tiempocyberclimate.org/portal/index.htm

This site contains mainly general information on climate change, global warming and such topics. There is also news that cover world events and a lot of external links to relevant web-sites. The navigation is rather obscure, as well as the site as a whole: there is no introduction or description page. This portal is hosted by University of East Anglia (UEA). The following specific downsides were identified: obscure navigation, and lack of introduction or about page.

**UN Climate Portal:** http://www.un.org/climatechange/

The UN Climate Portal contains articles, news, links and even videos from conferences (webcasts) that mainly regard climate change from the global perspective. As EPA's portal, this one has a kids' section ("Youth" link in the navigation), which is also quite appealing: it uses named animal/children avatars as speakers for more "personal" and appealing communication of ideas.

The most beneficial features of this portal were identified as follows: well-designed kids' section, and the use of icons in links to denote contents nature. The specific downsides of the portal were identified to be: fixed layout structure, navigation is easily mistaken with external links; use of capitalization of every letter in word as means of making emphasis; insufficient navigation options in calendar (e.g., it seems impossible to navigate between years).

**NASA Hurricane Portal:** http://disc.gsfc.nasa.gov/hurricane/index.shtml

The NASA Hurricane Portal is a web-site on hurricanes in Atlantic region. It contains a lot of visual information (such as satellite photos), as well as an interactive Hurricane Viewer, which allows users to visually track most of the past significant hurricanes. The site feels very well-structured overall. The most beneficial features of the portal were considered to be: very elaborate interactive hurricane viewer, and very good presentation of statistics and hurricane data.

**Washington State Department of Ecology:** http://www.ecy.wa.gov/

This site contains a lot of information that regards local (to Washington state) ecology topics: laws, lists of various facilities, calendar of local events, etc. However, there are also articles that are applicable to any location, e.g., articles that describe how

one could contribute to protecting the environment. The most beneficial features of the portal were identified to be: very comprehensive and well-structured navigation; very good page layouts, with each section stylized to topic. The two downsides identified were fixed layout and use of fully capitalized sentences as means of emphasis in the layout.

# 3 WORK MOTIVATION

Surveys constitute one of the most flexible and inexpensive instruments for collecting feedback from any audience including commercial establishment customers, website users, society members, etc. The aspect of inexpensiveness becomes an especially sensible advantage in situations where the audience is particularly large and/or diverse. The concept of electronic surveys allows one to lower the cost of research even more and addresses some complications associated with the diversity of the audience. For example, the factor of variation of geographical locations of the members of the audience could be neglected in a sense that it is irrelevant with regard to the cost of delivery of individual surveys (where a necessity to send physical copies of surveys would dramatically raise costs and complicate the process in cases where respondents are located in geographically remote locations from both each other and the organizer of the survey).

Flexibility is also a particularly advantageous trait of electronic surveys. Simply the fact that data is much more (in most cases infinitely) malleable when stored in a digital electronic format (as compared to physical storage options), allows us to make certain conclusions on the benefits of implementing surveys electronically. Indeed, any kind of change is possible on the survey, regardless of existing survey forms inventory, printing limitations (e.g., paper or manufacturing process limitations), etc.

Due to their obvious usefulness and wide acceptance, electronic surveys comprise a large segment in the software market with many companies and organizations around the globe offering a diverse set of options. The set of choices of electronic surveys is truly vast: there are freeware and commercial offerings, enterprise and small standalone

packages, hosted and local solutions, open-source and closed source code software, etc. In circumstances of such a rich choice space, most organizations are able to find reasonably fitting solutions for their needs, both in terms of functionality and pricing/licensing options. However, there is still room for software that is targeted to particular system configurations, such the proposed software, the VIVA Survey Management Toolkit (VIVA SMTK), which is intended to be integrated into the Nevada Climate Change Data Portal. On the other hand, there are also a number of possibilities to improve the user experience (of being a respondent to electronic surveys) that are not found in the contemporary electronic survey management software.

The proposed VIVA Survey Management Toolkit (VIVA SMTK) is an electronic survey solution designed with a goal of providing functionality and feature sets for the creation and distribution of electronic surveys as well as for the collection, storage and analysis of survey data. There are two major points that distinguish the proposed software from those already available on the market. First, VIVA SMTK is intended to seamlessly integrate with the Nevada Climate Change Data Portal. Seamless integration encompasses full visual integration of user interfaces and user interaction paradigms of VIVA SMTK and the Nevada Climate Change Data Portal and reuse of data whenever possible. Integration of user interface and interaction paradigms denotes the requirement of having a similar visual appearance of the interfaces and reusing the major navigational elements (or other elements that facilitate user interaction) or their parts as well as any interaction patterns to maintain consistent user experience (consistency is a critically important factor of a user experience with any interactive interface (Heim, 2007)) across the Data Portal and VIVA SMTK. Reuse of data encompasses the usage of common data

without a need to reenter any information to VIVA SMTK if it already exists in the Data Portal data stores and without a need for any explicit synchronization of data stores between the systems. Examples of such data reuse include incorporating any user information (such as names, email addresses, mailing addresses, etc.) that might exist in the Data Portal's data store (for functions such as facilitation of restricted access to parts of the web site) into VIVA SMTK for usage in survey distribution process.

Another major motivation for designing VIVA was to expand the existing pool of functionality of the modern survey management software by providing innovative features not found in any of the existing packages. Some of this functionality is briefly described in the remaining paragraphs of this section.

One  of the possibilities to improve the user experience for the survey administrators and generally improve the reach of the system that is not currently implemented in any of the available software packages, is the ability to perform the import of user data using a flexible mechanism that does not firmly restrict the format of the imported file. All of the applications reviewed that allow importing user data in bulk impose specific and explicit requirements upon the file that is fed into the application that concern the number of data columns and their order. Most solutions accept comma-separated values (CSV) as the most basic format and this was used in VIVA to demonstrate the custom import functionality. This functionality could be further extrapolated to other formats. Custom import is described and demonstrated in later sections.

None of the solutions reviewed fully incorporate the drag-and-drop metaphor for reordering questions. This is rather surprising as this metaphor is widely accepted in

general computing (Rekimoto, 1997) (Brewster, 1995) and is the one that most closely matches the real world interaction analogy (e.g., compared to clicking arrows which is more rarely found in the real world) and thus is often preferred by the users, though it is harder to implement in a web environment (which is apparently the reason for its underuse). Only Zoomerang had some implementation of this metaphor, but it was not covering transferring surveys between pages. VIVA incorporates this metaphor fully, as applied to questions.

# 4  SOFTWARE SPECIFICATION

The VIVA Survey Management Toolkit (VIVA SMTK) is the proposed software solution for facilitating electronic survey management with specific goals of being integrated into the Nevada Climate Change Data Portal, facilitating custom user import functionality, providing full coverage of the drag-and-drop metaphor in the scope of survey questions, and offering functionality for automated correspondence overview.

Custom user import is a feature that would allow an administrator to supply a file with user records, in which particular fields (such as fields containing last name, first name, email, etc.) are designated and ordered in an arbitrary fashion, and still be able to import it into the system's database. In VIVA this is achieved by the system prompting the administrator for explicit mappings of the supplied file field names and the database fields. The particular file format and file's internal representation of data (e.g. CSV, XLS) is irrelevant to this feature. CSV is used as an example format. Coverage of multiple formats pertains to more breadth-focused enterprise functionality than depth-focused innovations relevant to this research and is thus not included in the following specifications (as further discussed in Chapter 7).

The drag-and-drop metaphor coverage circumscribes a set of VIVA functions that would allow an administrator to reorder questions in or between pages of the survey by dragging and dropping them around pages using a mouse. Even though drag-and-drop is a widely accepted (Rekimoto, 1997) (Brewster, 1995) and powerful metaphor because it corresponds so well to the tangible world, it is very important to understand the context of its intended application to make sure the context is well suited for it (because many of such contexts are naturally not (Fountain, Huxtable, Ferguson, & Heller, 2001)). The

particular application of reordering is, however, one of the most obvious applications for this metaphor (i.e. reordering items on a surface is natural by dragging items across the surface) and thus poses no concerns of non-applicability.

Another feature that is included in VIVA specifications, but is rather often overlooked in existing survey management solutions, is the presence of custom greetings that are automatically tailored towards specific users (i.e. by using their names in email invitations or in greetings on survey pages). Tailoring communication towards specific users and endowing surveys with any elements of social presence tend to decrease the non-response rates (Couper, Tourangeau, & Steiger, 2001) (Fowler, 2009), while the opposite (the undesirability of impersonalized surveys) also holds true (Zhang, 2000).

The basic requirements of the proposed solution are outlined below with the help of functional (prioritized on 3 levels) and non-functional requirements, use cases and the traceability matrix that ties those together. The following specifications are intended to be comprehensive (or nearly so) and thus also cover the very basic functionality that is not intended to be a part of the innovative component of VIVA. An example of such is the ability to break the surveys down into several pages which is very beneficial because of how this functionality alleviates the tiring effects of long surveys (Reynolds, Woods, & Baker, 2007). Note that some of the requirements are derived from the research done on reviewing existing climate change data portals, specifically those that try to impose techniques that rule out common downsides (e.g. FR1.21).

## 4.1 Functional Requirements

The functional requirements were structured into three levels based on their importance to the system, level one being the most important (shown in Table 4.1), level

two being less important and not mandatory for prototype implementation (shown in Table 4.2) and level three requirements being the least important and not mandatory for the implementation of prototype (shown in Table 4.3). The requirements that are deemed to cover the most innovative functionality are FR1.17-19.

**Table 4.1:** Level 1 functional requirements

| FR1.1 | The system shall provide functionality for survey creation |
|---|---|
| FR1.2 | The system shall allow saving surveys for future use |
| FR1.3 | The system shall allow to modify any previously saved survey |
| FR1.4 | The system shall allow to permanently remove any of the previously saved surveys |
| FR1.5 | The system shall provide a set of pre-installed survey templates |
| FR1.6 | The system shall allow saving questions for future use, independently of the surveys |
| FR1.7 | The system shall allow using any question in its database in several surveys |
| FR1.8 | The system shall allow editing any of the saved questions |
| FR1.9 | The system shall allow creating questions of several types |
| FR1.9.1 | The system shall allow creating questions of type "free text" |
| FR1.9.2 | The system shall allow creating questions of type "multiple choice" |
| FR1.9.3 | The system shall allow creating questions of type "rate on a scale" |
| FR1.9.4 | The system shall allow creating questions of type "true or false" |
| FR1.9.5 | The system shall allow creating questions of type "multitple choice with multiple answers" |
| FR1.10 | The system shall provide functionality for viewing and submitting surveys |
| FR1.11 | The system shall provide functionality for email survey distribution |
| FR1.12 | The system shall provide a reporting tool with a briefing of submitted surveys |
| FR1.13.1 | The reporting tool shall show averages for reports |
| FR1.12.2 | The reporting tool shall show number of surveys that were submitted, per survey |
| FR1.12.3 | The reporting tool shall show the total number of surveys submitted |
| FR1.13 | The system shall support deadlines for survey submission |
| FR1.14 | The system shall allow to add a person to survey receivers |
| FR1.15 | The system shall allow to remove a person from survey receivers |
| FR1.16 | The system shall save partial survey progress of a registered responder |
| FR1.16.1 | The system shall save any fully answered questions |
| FR1.16.2 | The system shall save any text entered into a free-text question answer |
| FR1.17 | The system shall allow for import of custom CSV files, regardless of the field names, order or number |
| FR1.18 | The system shall provide a way to review the particular emails that were sent to each of the users |
| FR1.19 | The system shall allow the questions to be re-ordered both in and between pages using the drag-and-drop metaphor |
| FR1.20 | The system shall provides customized greeting using user's first names |
| FR1.21 | The system shall provide global navigation that is consistent across all pages of the interface |

**Table 4.2:** Level 2 functional requirements

| FR2.1 | The system might allow making any question required on a per-question basis |
|-------|------------------------------------------------------------------------------|
| FR2.2 | The system might allow making any question required on a per-survey basis |
| FR2.3 | The system might allow adding a possibility of "prefer not to respond" option to any question on a per-survey basis |

**Table 4.3:** Level 3 functional requirements

| FR3.1 | The system might allow creating dynamic surveys (so the content of the survey depends on the previous responses) |
|-------|------------------------------------------------------------------------------|
| FR3.1.1 | The system might allow dynamicity on a per-question basis |
| FR3.2 | The system might provide functionality for automatic event-driven survey distribution |
| FR3.3 | The system might provide functionality for automatic recurring survey distribution |
| FR3.4 | The system might provide a statistical analysis module to analyze the submitted surveys |
| FR3.5 | The system might provide a graphical to represent submitted survey data and analysis results as charts |
| FR3.6 | The system might provide functionality for delayed survey distribution |
| FR3.7 | The system might support reminders to users that have not submitted the survey yet |
| FR3.8 | The system might allow users to save a partially completed survey |
| FR3.9 | The system might allow bulk import of users via CSV/XLS/XML files |

## 4.2 Non-Functional Requirements

**Table 4.4:** Non-functional requirements

| NFR1.1 | The system shall be implemented in ASP.net 4.0 |
|--------|-------------------------------------------------|
| NFR1.2 | The system shall be written in C# |
| NFR1.3 | The system shall store data using MS SQL Server |
| NFR1.4 | The system shall integrate with Nevada Climate Change Data Portal |
| NFR1.5 | The system shall include only interfaces in valid XHTML |
| NFR1.6 | The system's interfaces shall include only valid CSS styles |
| NFR1.7 | The system shall be cross-browser compatible |
| NFR1.7.1 | The system shall support Firefox 3.0 and up |
| NFR1.7.2 | The system shall support MS IE 7 and up |
| NFR1.7.3 | The system shall support Opera 10 and up |
| NFR1.7.4 | The system shall support Safari 4 and up |

## 4.3  Use Case Diagram

Several use cases are provided in Figure 4.1 to illustrate some of the functionality of the VIVA SMTK. Please note that the diagram is not exhaustive and only shows the most important use cases.
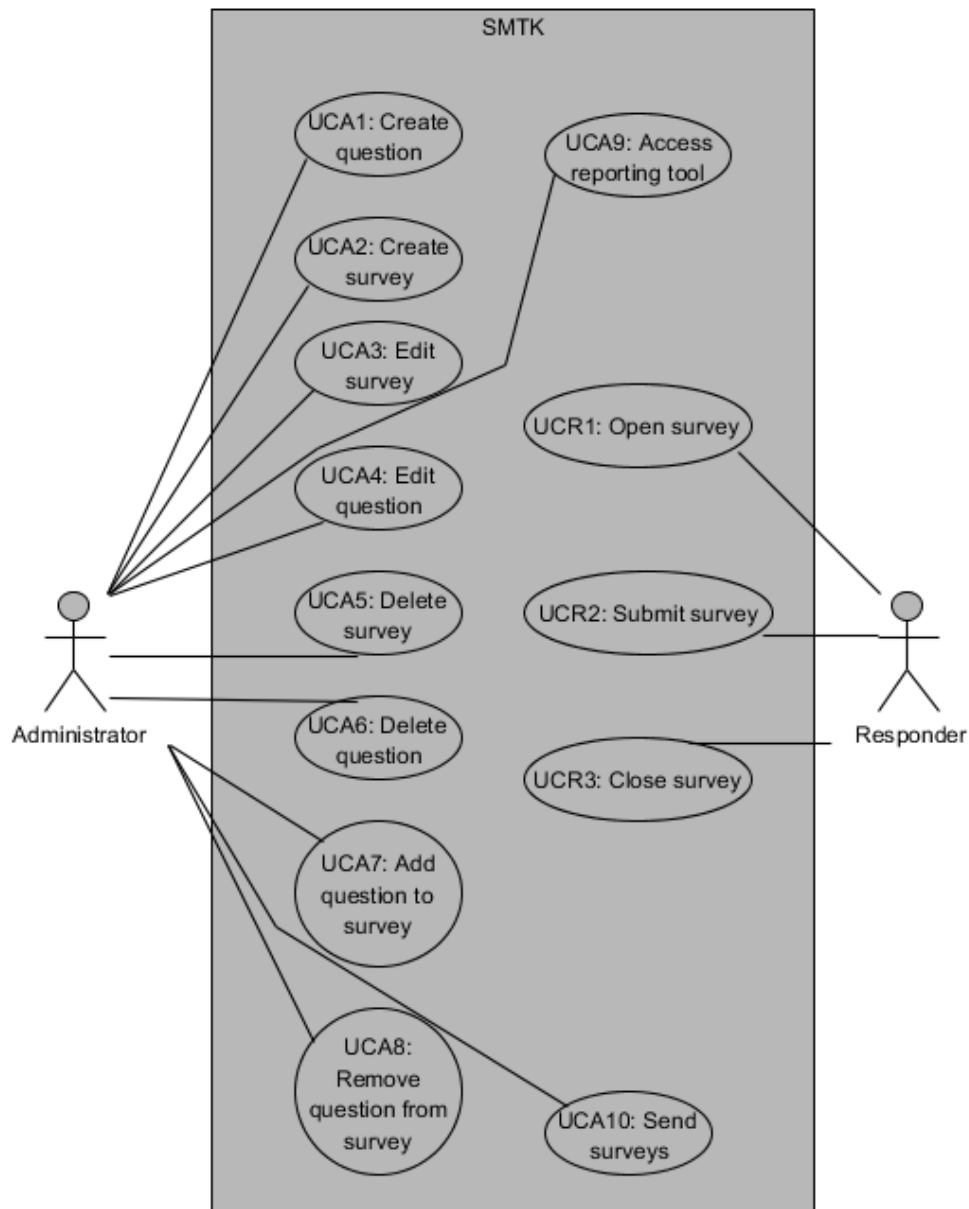


**Figure 4.1:** Use case diagram

## 4.4  Use Case Descriptions and Requirements Traceability Matrix

Use case descriptions (Table 4.5) are listed to provide a better understanding of the use cases (Figure 4.1). A requirements traceability matrix is then provided (Table 4.6) to specify how the functional requirements fit into (or fulfill) provided use cases.

**Table 4.5:** Use case descriptions

| | |
|---|---|
| **UCA1:** Create question | Create a question of one the several types for future addition to one of the surveys. |
| **UCA2:** Create survey | Create a new blank survey which will be further developed by changing its properties or adding questions to it. |
| **UCA3:** Edit survey | Open one of the previously saved surveys (or preinstalled templates) for editing.The process of editing might include adding/deleting questions or changing other properties of the survey inlcuding order of the questions. |
| **UCA4:** Edit question | Open one of the previously saved questions for editing. Editing a question might include changing its type or question. |
| **UCA5:** Delete survey | Permanently remove a survey from a database. The questions that composed the survey are not deleted. |
| **UCA6:** Delete question | Permanently remove a previously saved question from the database. The question will not be accesible for inclusion in any surveys afterwards and will be removed from existing surveys. Thus in case the question is already included in surveys, a confirmation will be required to delete it. |
| **UCA7:** Add question to survey | Associate an existing question with an existing survey and position this questions among the other ones (if any). |
| **UCA8:** Remove question from survey | Disassociate an existing question from a given survey. Note that the question is not deleted from the database (as it is in UCA6) and is still available for inclusion in other surveys and stills stays associated with all surveys it was associated with previously. |
| **UCA9:** Access reporting tool | Access a section of the website, which provides reporting and statistics information |
| **UCA10:** Send surveys | Distribute the surveys among associated users |
| **UCR1:** Open survey | Navigate to the URL of the survey using a web-browser, landing on the first survey page. The URL might be received through email or other means to be supported by the system. |
| **UCR2:** Submit survey | Submit the last page of the survey, thus sending the provided data back to the deployment server for storage and analysis. |
| **UCR3:** Close survey | Close the browser window before submitting a completed survey. This process is preceded by automatically saving any partial progress. |

**Table 4.6:** Requirements traceability matrix

| Req./ Use case | UCA1 | UCA2 | UCA3 | UCA4 | UCA5 | UCA6 | UCA7 | UCA8 | UCA9 | UCA10 | UCR1 | UCR2 | UCR3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FR1.1 | | X | | | | | | | | | | | |
| FR1.2 | | | | | | | | | | | | | |
| FR1.3 | | | X | | | | | X | | | | | |
| FR1.4 | | | | | X | | | | | | | | |
| FR1.5 | | | | | | | | | | | | | |
| FR1.6 | | | | | | | X | | | | | | |
| FR1.7 | | | | | | | X | | | | | | |
| FR1.8 | | | | X | | X | | X | | | | | |
| FR1.9 | X | | | | | | | | | | | | |
| FR1.9.1 | X | | | | | | | | | | | | |
| FR1.9.2 | X | | | | | | | | | | | | |
| FR1.9.3 | X | | | | | | | | | | | | |
| FR1.9.4 | X | | | | | | | | | | | | |
| FR1.9.5 | X | | | | | | | | | | | | |
| FR1.10 | | | | | | | | | | | X | | |
| FR1.11 | | | | | | | | | | X | | | |
| FR1.12 | | | | | | | | | X | | | | |
| FR1.12.1 | | | | | | | | | X | | | | |
| FR1.12.2 | | | | | | | | | X | | | | |
| FR1.12.3 | | | | | | | | | X | | | | |
| FR1.13 | | | X | | | | | | | | | | |
| FR1.14 | | | X | | | | | | | | | | |
| FR1.15 | | | X | | | | | | | | | | |
| FR1.16 | | | | | | | | | | | | | X |
| FR1.16.1 | | | | | | | | | | | | | X |
| FR1.16.2 | | | | | | | | | | | | | X |
| FR1.17 | X | | | | | | | | | | | | |
| FR1.18 | X | | | | | | | | | | | | |
| FR1.19 | | | | | | | X | | | | | | |
| FR1.20 | | | | | | | | | | | X | | |
| FR1.21 | X | X | X | X | X | X | X | X | X | X | X | X | X |

# 5  SOFTWARE MODEL

Having the requirements specified in the previous chapter, design work was performed accordingly. VIVA SMTK was designed to incorporate most of the basic features that are included in comparable contemporary software so that it is able to perform the functions of constructing, storing and sending out surveys as well as providing some statistics. Along with those features, VIVA SMTK was designed to allow the responders to save any partial progress through the survey to have a possibility to restore it later, without submitting it to the system. The following section goes over the design of VIVA SMTK in several subsections.

## 5.1  High-level Design

VIVA SMTK's administrator section sitemap is illustrated in Figure 5.1. The sitemap was chosen to be the descriptive tool for the high-level design part of this section, as VIVA SMTK, as a web application, can be most easily broken down into high-level structural elements by providing the overview of its views (or pages). As seen in the diagram, the administrator interface deals with constructing a survey and its components (Questions and Surveys pages), managing survey audience (Users page), as well as accessing reports and data (Reports page) and the help files (Help page). As shown in Figure 5.1, the Reports page is broken down into two subsections: Global snapshot and Survey submission. This breakdown explains the VIVA SMTK's approach to statistics, which encompasses two areas: general data on all submissions (information such as global averages) and detailed data on each individual survey submission.
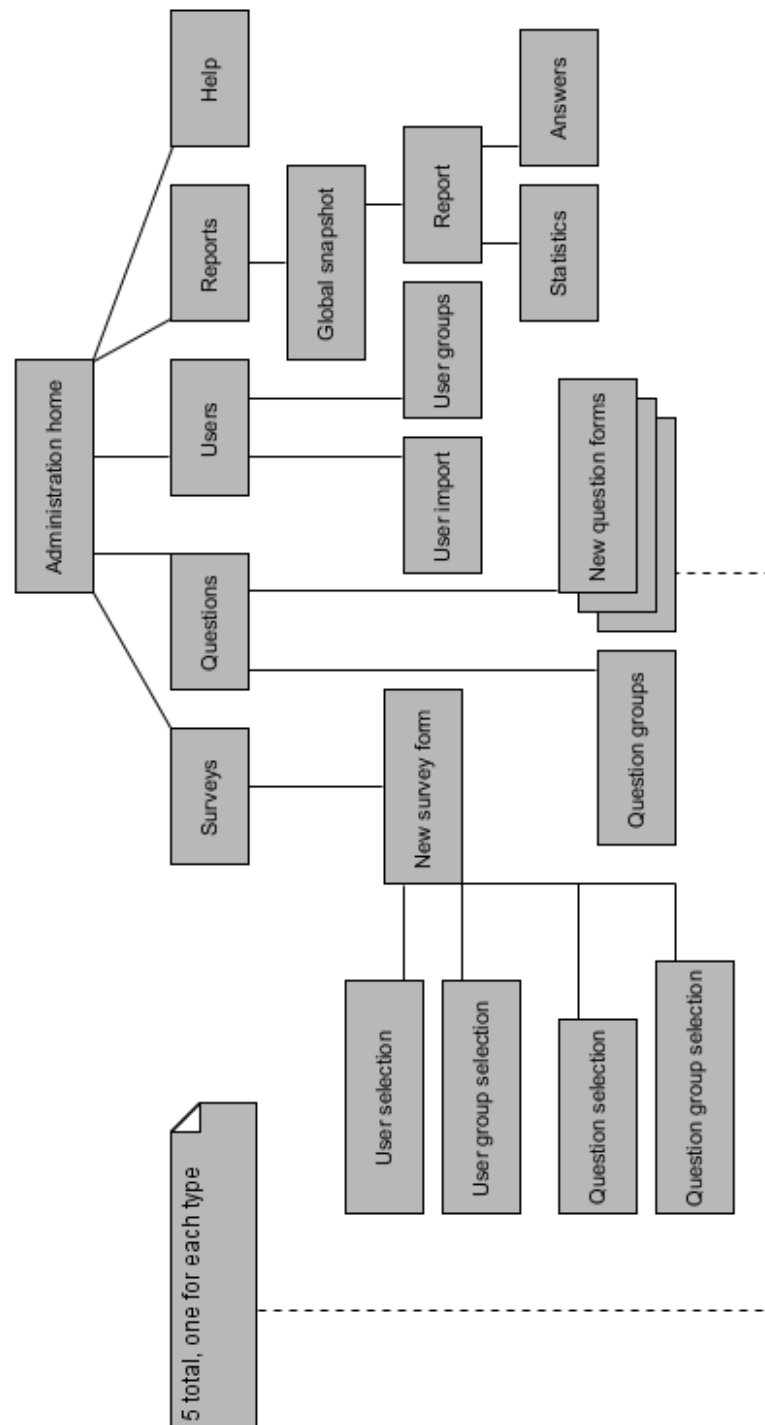
**Figure 5.1:** Administrator section sitemap

Figure 5.2, on the other hand, concerns itself with depicting the design of the responder part of the system. It illustrates an activity diagram for a process of responding to a survey. Along with illustrating the basic procedures of opening, submitting and discarding a survey, the diagram also depicts the processes of saving partial progress in a survey and restoring a previously saved survey. Figure 5.3 illustrates the three-tiered architectural pattern that VIVA SMTK is built upon.
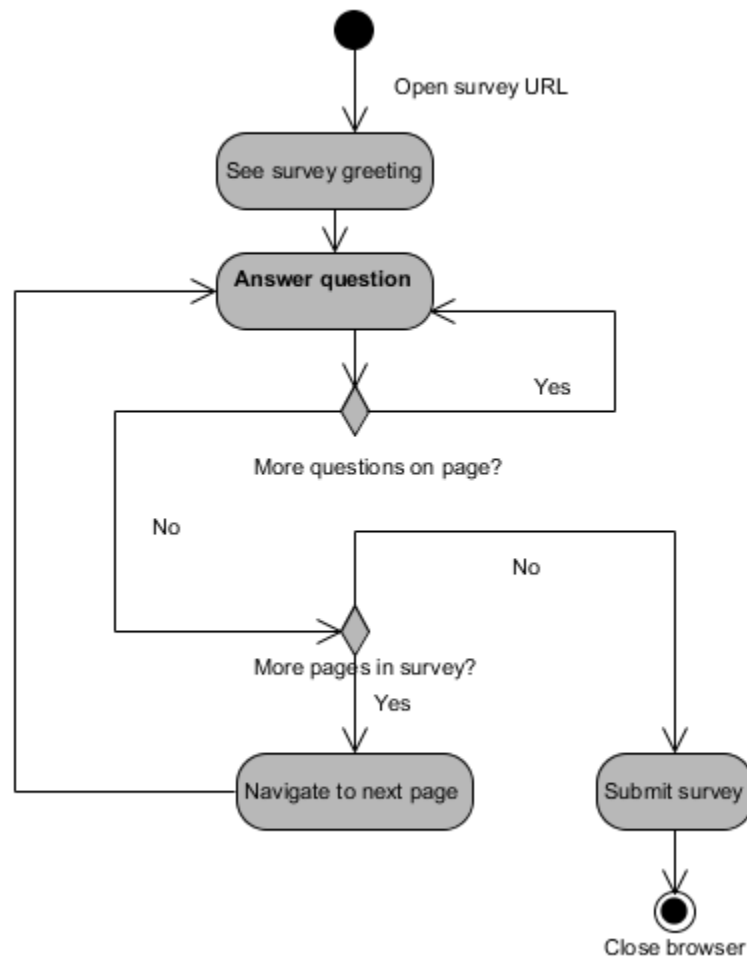
**Figure 5.2:** Responder user activity diagram
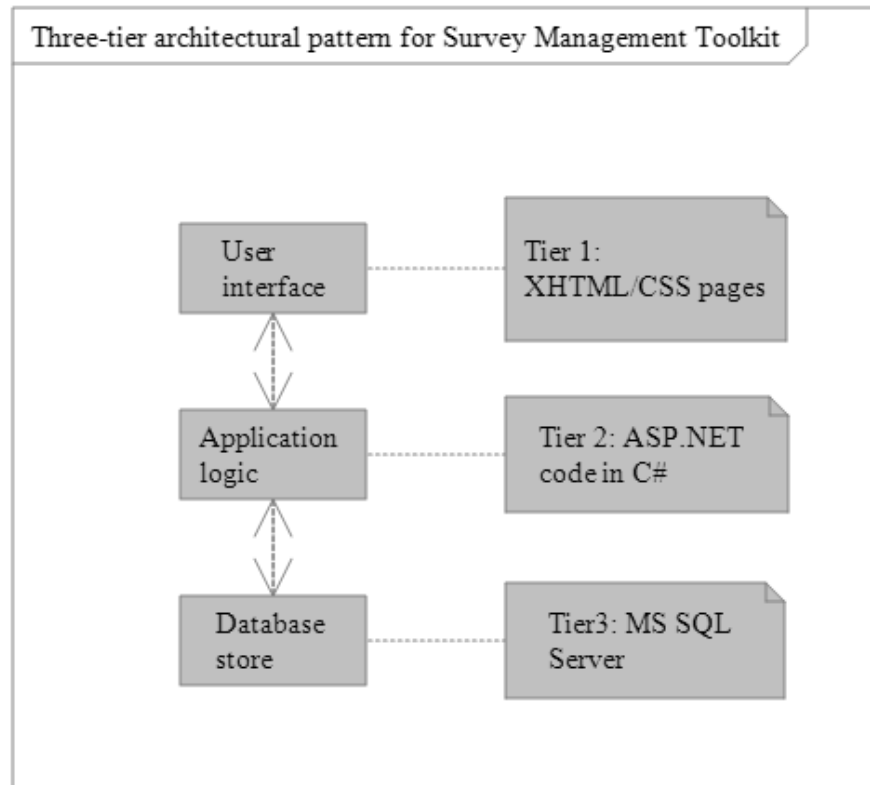
**Figure 5.3:** Three-tier architectural pattern

As a web-based application, VIVA SMTK also uses a client-server architecture, depicted in Figure 5.4. This is, of course, an obvious choice for any web based application, but the diagram was still considered to be a worthy addition to this design description as it displays the possibility of concurrency of the responders' actions.
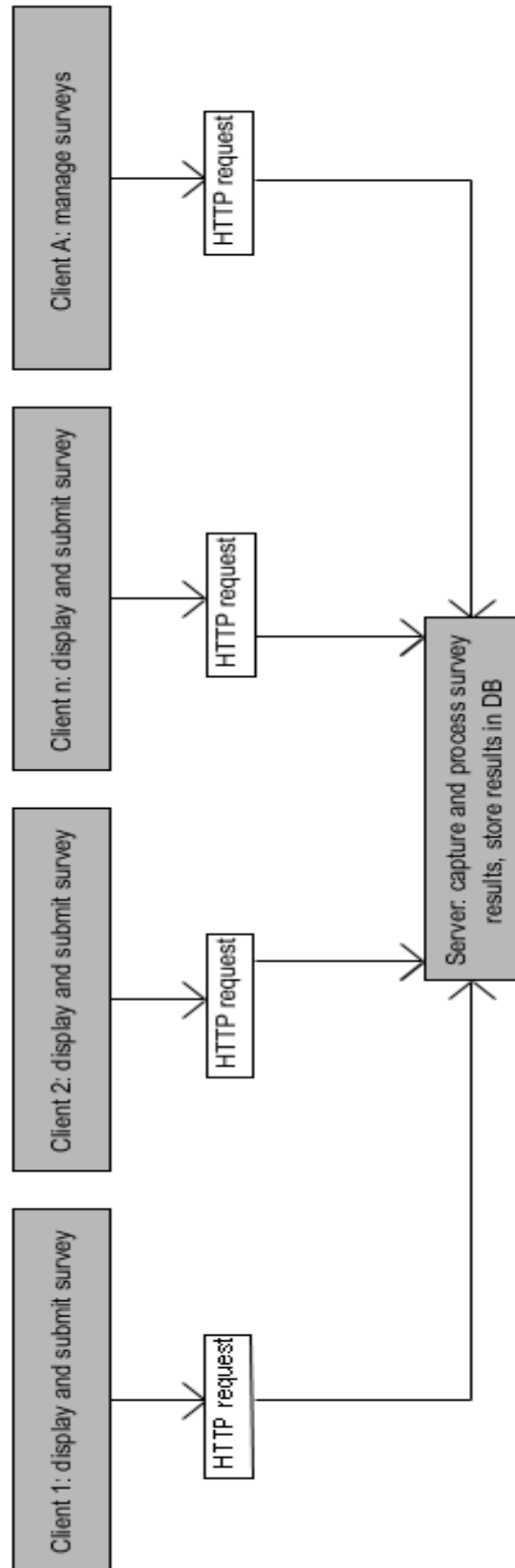
**Figure 5.4:** Client-server architectural pattern

## 5.2  Class Diagram

VIVA SMTK is designed as object-oriented software, which means providing a class diagram is essential for its design specification. Figure 5.5 shows such a diagram, displaying the core classes of the application.
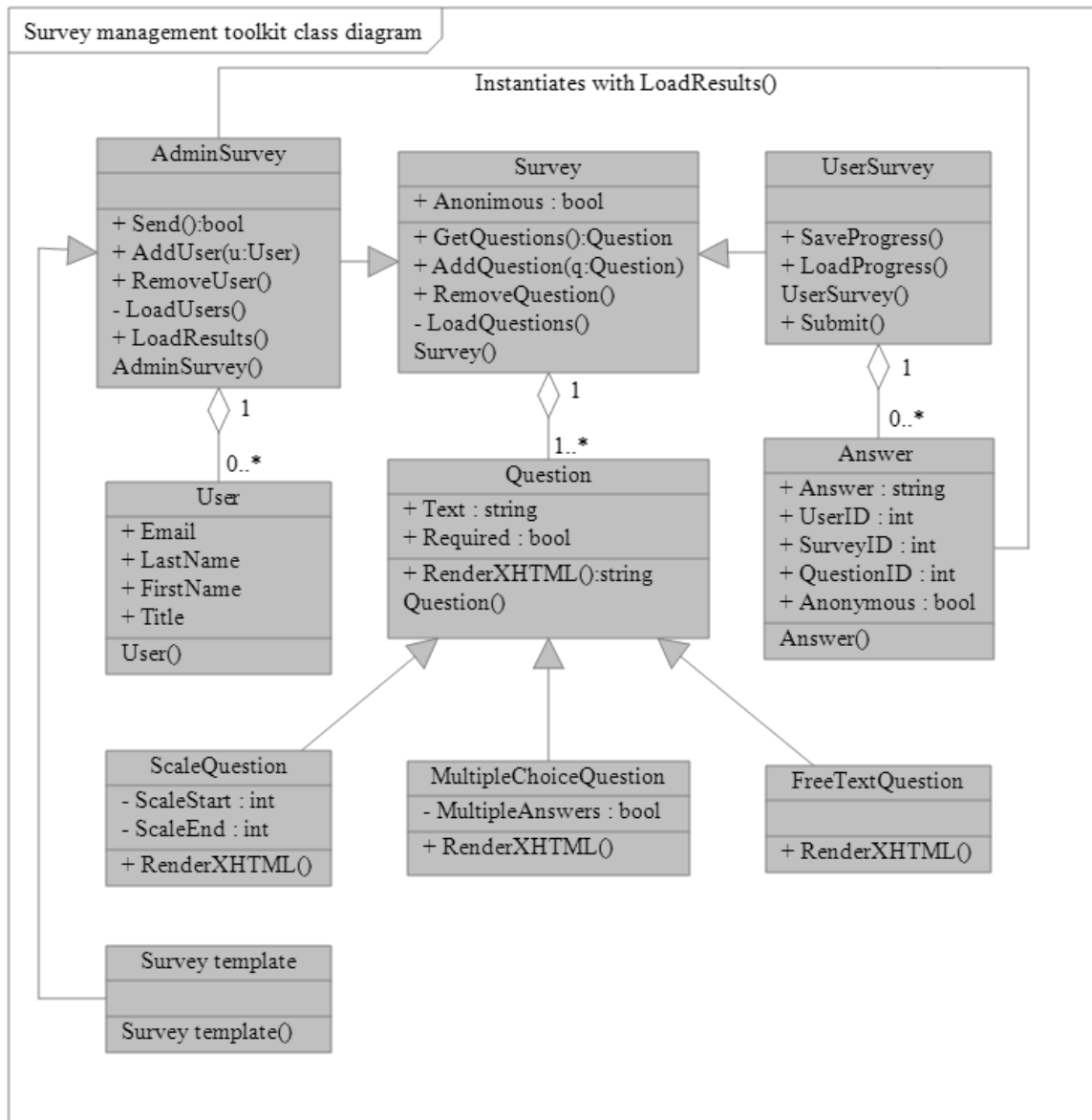
**Figure 5.5:** Class diagram

As it can be seen from the diagram, the responder's survey class and the administrator's survey class both derive from a single entity, and this decision was made to support and maintain behavioral and interface consistency. The following section provides a more thorough description of the depicted classes along with descriptions of their methods. Please note that this object model was not used in the prototype implementation, which instead relies on ASP.net forms for logical grouping of logic.

## 5.3  State Machine Diagrams

This section presents two state machine diagrams that correspond to the experiences of the responder and the administrator within VIVA SMTK, respectively. The responder machine diagram shown in Figure 5.6 covers the basic functions such as submitting the survey along with save/load functionality. Its administrator's counterpart displayed in Figure 5.7 covers only a slice of the of administrator's activities within VIVA, it particularly depicts those that have to do with the process of constructing and sending a survey.

## 5.4  Data Design

Figure 5.8 depicts the database design diagram for VIVA. As seen from the diagram, multiple-to-multiple relationships are employed for most tasks to maintain flexibility. Also, as it is stated on the diagram, all question types rely on the same table for storing the replies. To avoid cluttering the database schema and make further expansion of question types set easier, all replies are stored as ASCII text and are only further converted to their respective formats.
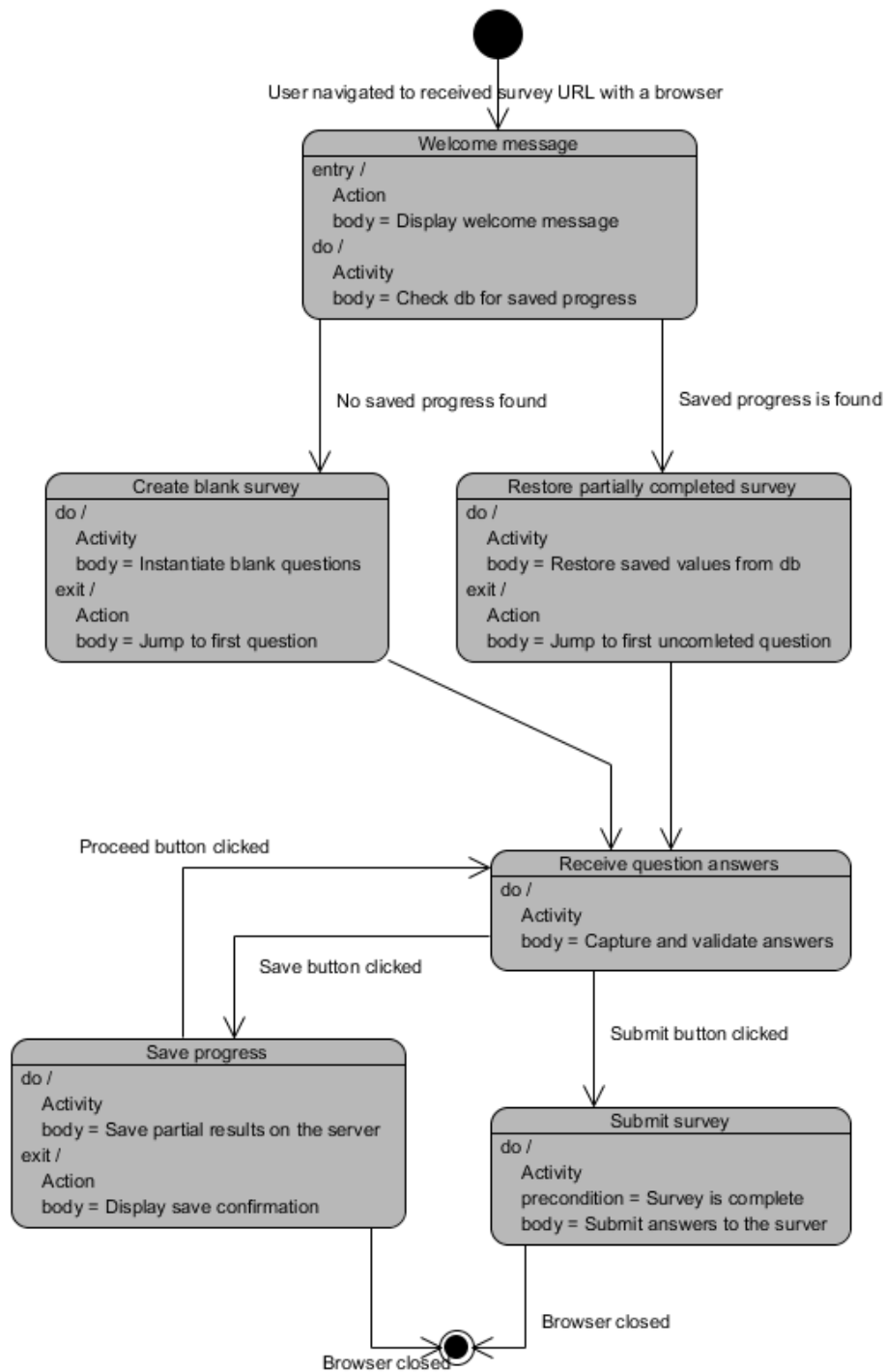
**Figure 5.6:** Responder state machine diagram
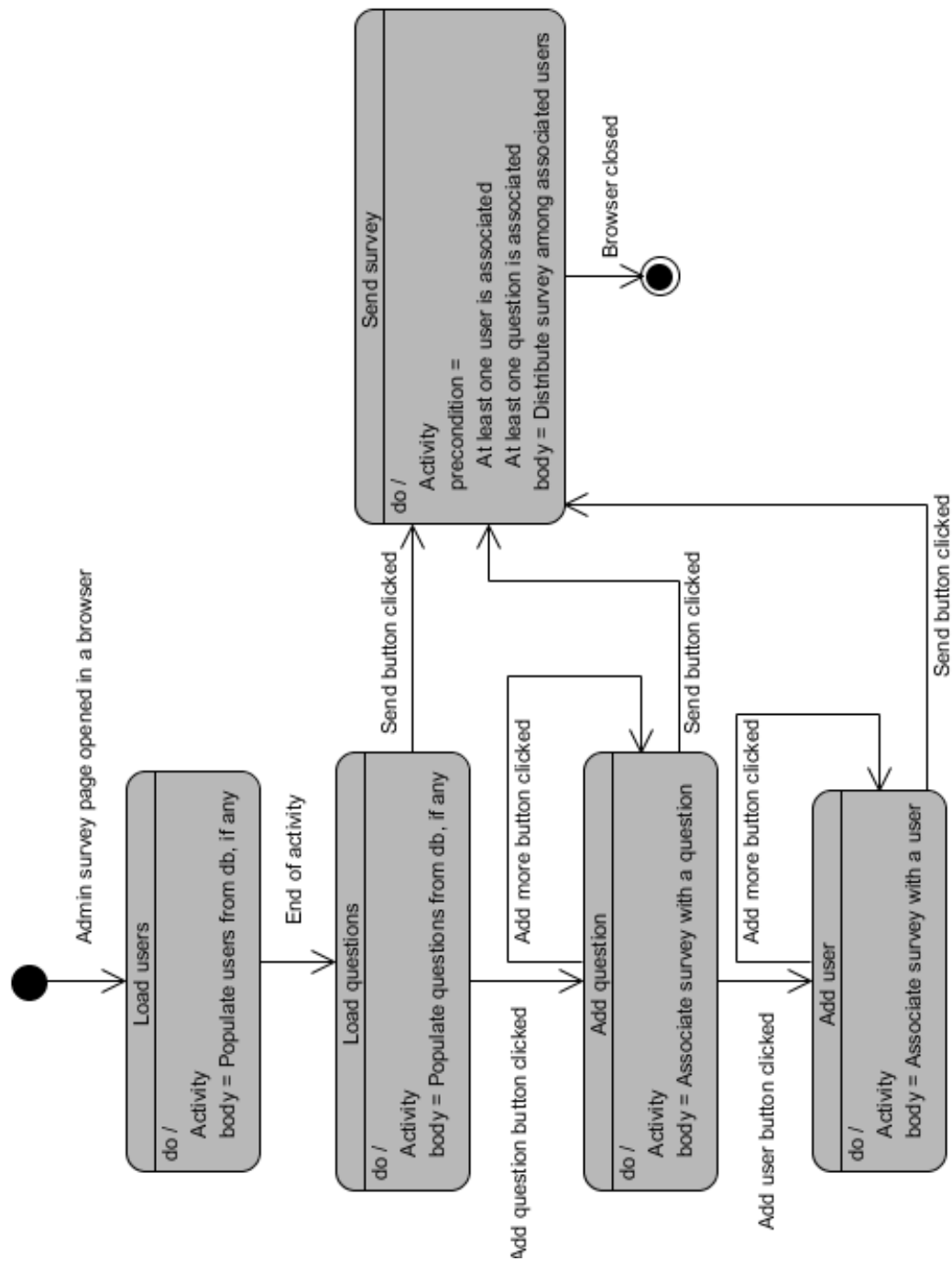
**Figure 5.7:** Administrator state machine diagram
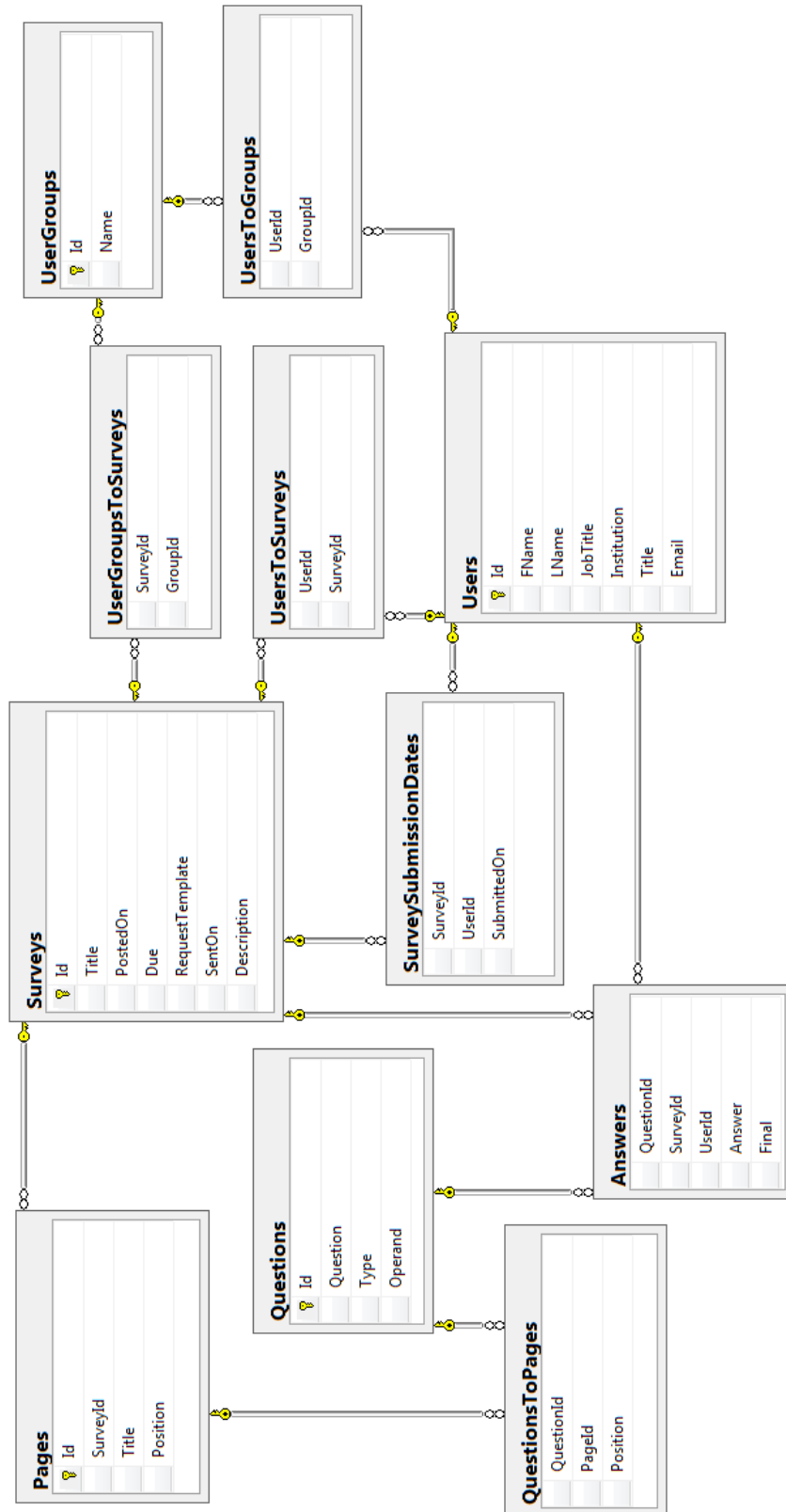
**Figure 5.8:** Database diagram

# 6  VIVA PROTOTYPE DETAILS

This chapter provides an overview of the software prototype based on the design provided in the previous chapter. The following overview is illustrated by a general introduction to VIVA's interface (Section 6.1) followed by an example of user interaction with VIVA demonstrating the usage of the most important features of the toolkit (Section 6.2). In this example, a new survey will be created, sent and its related statistics collected.

## 6.1 General Overview

A screenshot of the application's title page is provided in Figure 6.1. This high-level view of the page is then decomposed into smaller and more detailed highlights of the features. The top section of the page consists of a logo and the main navigation bar. The body of the page contains a sidebar (which is global to the administrative interface) and the main section, which provides interfaces for business logic. The title page of the toolkit's adminitrative interface directs to the list of surveys, also accessible via the "Surveys" entry in the main navigation bar (Figure 6.2).

Figure 6.2 shows the main navigation bar located on top right of every page of the application (including both administrative and survey-taking interfaces). In this figure, Administrative navigation is displayed. It includes the links to the survey, questions and user management interfaces as well as links to the reporting interface and to a help file.

Figure 6.3 and Figure 6.4 show an enlarged view of the sidebar that appears on all of the survey administration pages. The purpose of the sidebar is to provide a brief and concise overview of the latest activity within the system, thus only the most basic and pertinent information is displayed.

**Figure 6.1:** VIVA administrative interface title page



**Figure 6.2:** Main navigation bar

Latest submissions table (Figure 6.3) provides information on the four last survey submissions (ordered by submission date with the latest ones on top). It includes the title of the submitted survey, the name of the submitting user and the date/time on which the survey has been completed. The due surveys table is shown in Figure 6.4. Its function is

to show the surveys that are expiring the soonest, in descending order by date of expiration.



**Figure 6.3:** Latest submissions



**Figure 6.4:** Due surveys

## 6.2  Example

This section provides an example of using the VIVA SMTK. In this example a survey is created, sent and taken. After that results are reviewed and analyzed.

Figure 6.5 shows the table that is displayed on the default entry point of the administrative interface. This table includes a list of the surveys that are currently available to the system. The following set of data is included is this view: survey title, the date and time the survey was posted, the date and time the survey was sent to the users on (in case the survey has not been sent yet this field is displayed blank), the date of survey expiration (if set by administrator) and a brief description of the survey (if any). The titles of the surveys are clickable and lead to the editing/administration pages for the respective surveys. The VIVA toolkit provides paging functionality for all of the grid data including the list of surveys. Figure 6.5 shows the paging interface right below the table data (for demonstration purposes the amount of entries is set to 6 per page but it is configurable).

The VIVA toolkit also provides sorting functionality for most of the grid data including the list of surveys. By default, the surveys in the application administrative title page are sorted by the dates in descending order (the most recently submitted ones on the top). It is easy to re-sort the table by clicking on one of the column titles.

| Title | PostedOn | SentOn | Due | Description |
|-------|----------|--------|-----|-------------|
| Policy ammendments survey | 7/9/2011 5:42:00 PM | 7/9/2011 5:43:00 PM | | On the new additions to project generalpolicy |
| Personal attitude survey | 7/7/2011 2:47:00 PM | | | |
| Sensor calibration methods survey | 7/7/2011 2:41:00 PM | | | |
| User experience survey | 12/7/2010 12:06:00 PM | 6/5/2011 1:19:00 PM | | |
| Works relevance survey | 12/5/2010 6:57:00 PM | 1/1/2011 1:08:00 PM | 1/1/2011 5:08:00 PM | |
| Climate change survey | 12/4/2010 5:09:00 PM | 12/7/2010 12:15:00 PM | | EPSCoR milestones, etc. |

1 2

Add new survey:

Title:

Add

**Figure 6.5:** List of surveys

Figure 6.6 show the result of this action, which is a table, sorted according to a user-chosen data element. In the figure Figure 6.6, the "SentOn" table header was clicked and the table is now shown sorted by the dates on which the surveys were sent to the users. As seen in Figure 6.6, the row according to which the table is sorted is highlighted. It is also possible to alternate between ascending and descending sorting order by repeatedly clicking on the column title.

**Figure 6.6:** Re-sorted survey list

Figure 6.7 shows the completed new survey form (also shown uncompleted in Figure 6.5 and Figure 6.6). The form is very simple and only accepts the title of the survey to be created. After submission of the form (by clicking the "Add" button), the administrator is redirected to the edit/administration page of the newly created survey, as shown on Figure 6.8. In this example we create a survey title "Data portal survey".



**Figure 6.7:** Adding new survey form

## Basic survey info

| | |
|---|---|
| Title | Data portal survey |
| PostedOn | 7/23/2011 12:33:00 PM |
| Due | |
| RequestTemplate | Hello, <# NAME #>! Please complete the following survey: <# SURVEY_URL #> |
| Description | |
| Edit Delete New | |

## Questions/Pages

Drag and drop to reorder in/between pages

**Page 1** [add question to this page]

Add new page

## Individual users

Add User

## User groups

Add User Group

Send

**Figure 6.8:** Newly created survey

As displayed in Figure 6.8, a survey administration page includes several sections. The top-most section entitled "Basic survey info" includes the following data: Survey title, survey posting date and time, survey expiration (due) date, an email invitation template and description. Each of those fields except survey posting date is editable by clicking the "Edit" link at the bottom of the "Basic survey info section". Figure 6.9 below

shows and example of basic survey information editing. As the figure shows, a simple description was added using the corresponding field at the bottom. This information was then saved by clicking the "Update" link at the bottom of the "Basic survey info" section.



**Figure 6.9:** Editing basic survey data

The "Questions/Pages" section which is located right below the "Basic survey info" section is the part of the survey administration page that includes the interface for managing survey composition (questions and their correspondence/ordering within pages). As Figure 6.8 shows, a newly created survey contains a single empty page by default. A question can be added to any page by clicking the "add question to this page" link that corresponds to the desired page. In VIVA, questions are added through the

existing library, so before adding questions to a survey, the process of adding a question to a library is illustrated.

Figure 6.10 displays the question management interface that results from clicking the "Questions" link under the main administrative navigation bar. The question management interface contains several elements, including: a link to question group management interface, a list of existing questions in the library and the new question creation links at the bottom.

Clicking the "Manage question groups" link leads to a simple interface that allows managing question groups, as shown in Figure 6.11. For the purposes of this demonstration, groups called "Technical questions" and "Content questions" were created using the form right below the list of question groups (similar to the new survey creation form in Figure 6.7), resulting in a table that includes the new entries (shown in Figure 6.12). These groups will help navigating through the library of questions and more easily selecting the desired ones.

Manage question groups

| Questions |
| --- |
| Test |
| test |
| Multiple choice |
| MCMA |
| Please answer yes or no |
| FreeText |
| Likert 1-10 |
| YesNo |
| MultipleChoice |
| MC Multiple Answers |
| test |
| test |
| 123123123 |
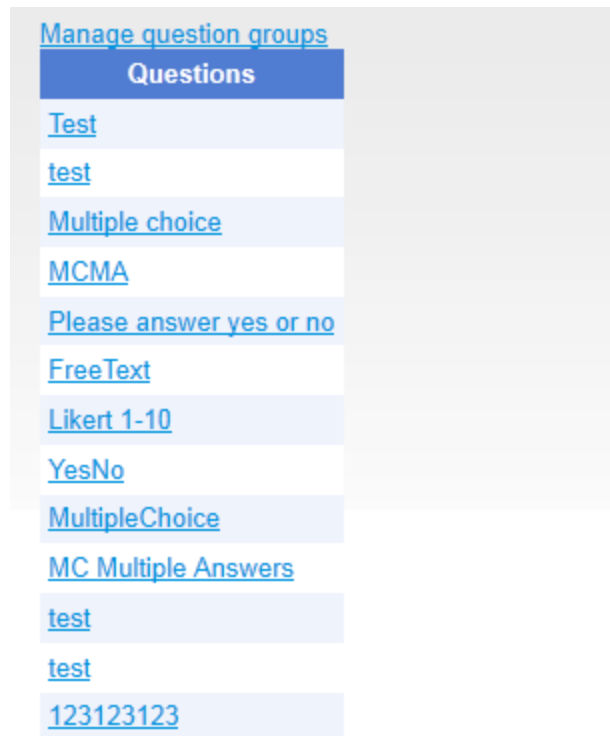
# Create new question:

FreeText
Likert
YesNo
MultipleChoice
MultipleChoiceMultipleAnswers

**Figure 6.10:** Question list

| | Id | Name |
| --- | --- | --- |
| Edit Delete | 1 | EPSCoR |
| Edit Delete | 2 | Hydrology |
| Edit Delete | 3 | Geology |

Add new question group:

Name: [          ] Add
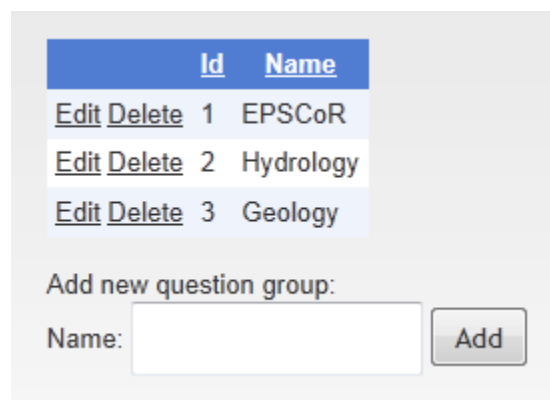
**Figure 6.11:** Question groups

**Figure 6.12:** Question groups with new items

Next the process of creating questions and associating them with groups is illustrated. Getting back to the question administration page, it is possible to create a new question by clicking on one of the available question type links ("Free text", "Likert", "YesNo", "Multiple Choice" and "Multiple Choice with Multiple Answers") in the "Create new question" section. For the purpose of this demonstration, questions of all types will be created.

The first question to be created in this example is of free text type. The interface for creating questions of this type is shown in Figure 6.13. Any question creation interface consists of two major parts: details of the question which vary from type to type and group assignment which is the same for every question type. The free text question type is the simplest one and only contains the question text field in the question details part. In this example it is set to "How would you describe the most positive and most negative aspects of your experience with the data portal?" Note that the list of suggested groups includes the newly created "Technical questions" and "Content questions". No groups were selected for this question.
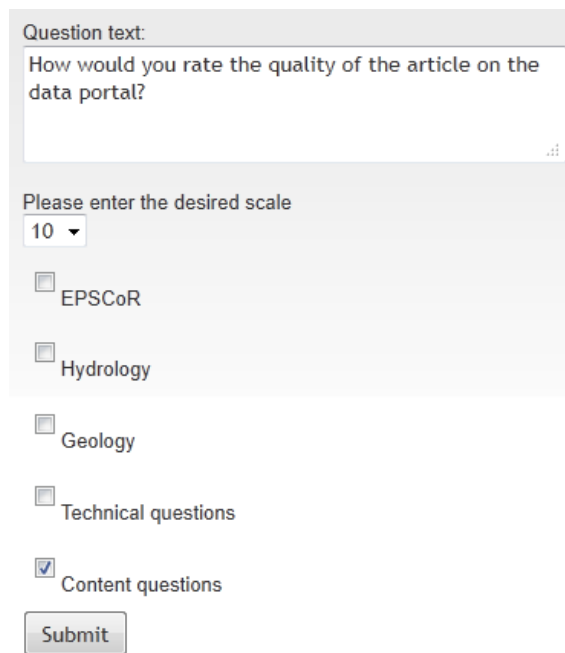
**Figure 6.13:** Free text question creation

Next, a Likert-scale question was created. The form is demonstrated in Figure 6.14. As seen from the figure, a form for creating Likert questions includes an additional element in the question details part, which is the top limit of the scale to use (can be set to an integer between 3 and 15). In this example the scale is left at the default value, 10. The question text was set to "How would you rate the quality of the articles on the data portal?" As the figure shows, this question was assigned to group "Content questions".

The next question created was of the type Yes/No, as seen in Figure 6.15. As the free text, this type of questions is not parameterized, only the question text field is present in the question details part of the form (set to "Are you contributing articles to the date portal?"). As seen from the figure, the question is assigned to a single group "content

questions". Following that, a multiple choice question was created, as shown in Figure

6.16.
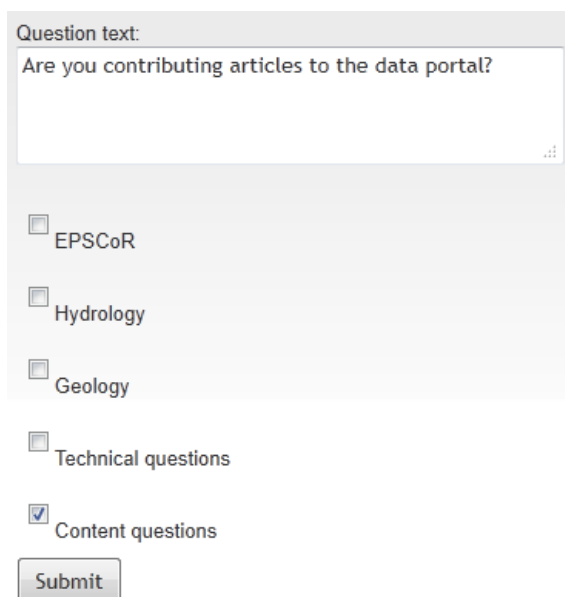


**Figure 6.14:** Likert scale question creation



**Figure 6.15:** Yes/No question creation
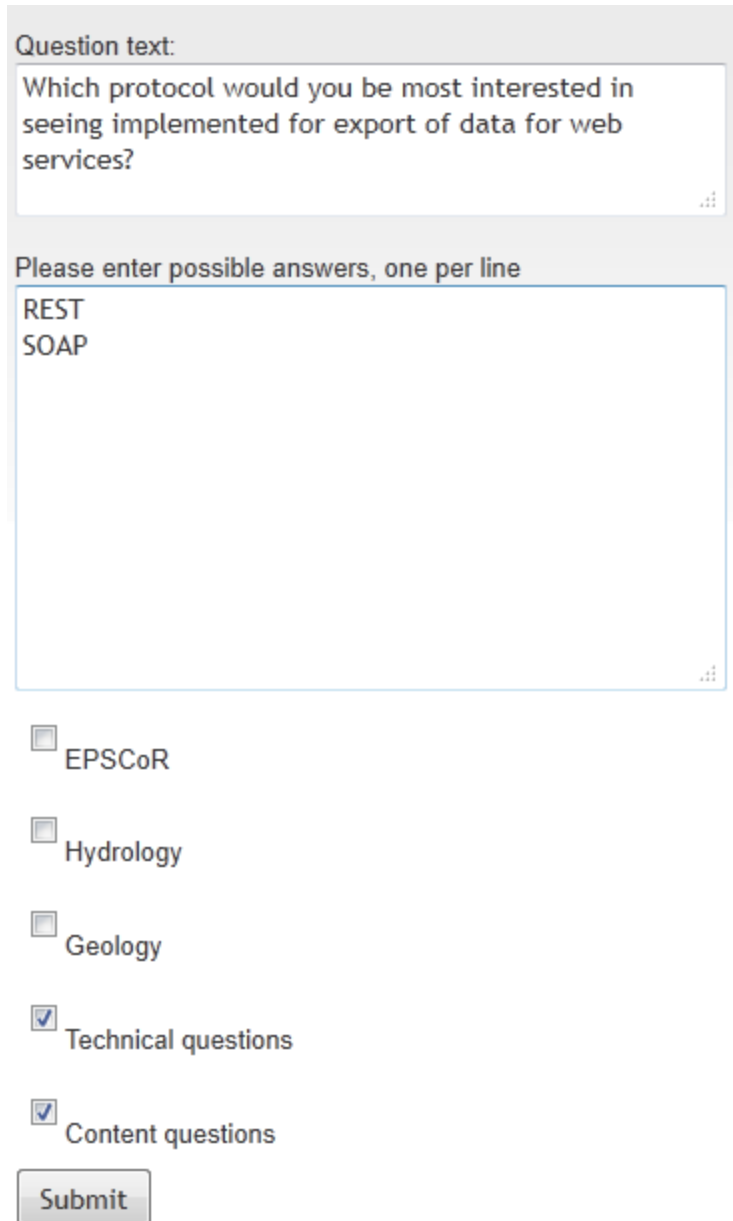
**Figure 6.16:** Multiple choice question creation

In addition to the question text field which was set to "Which protocol would you be most interested in seeing implemented for export of data for web services?", a field for entering the choices is present. In the following example, the two choices that were entered were "REST" and "SOAP". As shown in the figure, this question was assigned to two groups: "Technical questions" and "Content questions".

Finally, a question of type multiple choice/ multiple answers is created. As seen in Figure 6.17, the form layout is similar to that of the simple multiple choice one. The question was titled "Which data sensors are you most interested in?", assigned four choices and assigned to two groups.



**Figure 6.17:** Multiple choice with multiple answers question creation

After the questions are added to the toolkit's library, it is possible to add them to the survey. Clicking on the "add question to this page link" next to a desired page (as seen in Figure 6.8) leads to an interface of adding questions to surveys, as shown in Figure 6.18 below. By default, all questions in the library are displayed for choosing, broken down into pages.



**Figure 6.18:** Adding a question to a page

To facilitate the process of finding the desired questions, it is possible to filter them by group by selecting one of the values from the dropdown list at the top of the questions table. Figure 6.19 shows the result of filtering, after selecting the type "Technical questions". As seen from the figure, the newly displayed table now only includes questions that were previously assigned to that group (Figure 6.16 and Figure 6.17).

**Figure 6.19:** Filtering questions by group

After spotting the desired question, it is added by clicking the corresponding "Select" link. The browser is then redirected back to the survey administration page. Figure 6.20 shows the result of adding several questions to the survey.



**Figure 6.20:** Survey page with added questions

Adding pages to surveys is accomplished by clicking the "Add new page" button under the "Questions/Pages" section of the survey editing/administration page (Figure 6.8, Figure 6.34). Figure 6.21 shows a result of creating a new page. As seen from the figure, new pages are appended at the bottom (at the end) of the survey. Note that "remove whole page" links have appeared and it is now possible to remove any single

page. A survey cannot have less than one page, so this functionality is only available in surveys that contain two or more pages. A confirmation that is issued every time a page deletion process is initiated is shown in Figure 6.22.



**Figure 6.21:** Adding a new page to survey
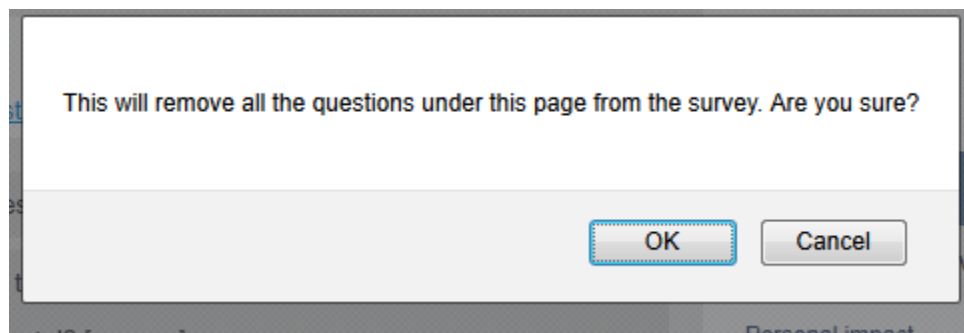


**Figure 6.22:** Page deletion warning

VIVA allows reordering questions in or between pages by dragging and dropping. Figure 6.23 shows the second page populated with questions and illustrates the dragging

of a question from the second position of the first page to the third position of the second page.



**Figure 6.23:** Process of reordering questions

After the survey has been populated with questions, it is necessary to associate it with users that will receive it. It is possible to add users individually or though user groups. Both methods are demonstrated below. First, two users were added individually. To add users individually it is necessary to click the "Add User" link under the "Individual users" section of the survey edit/administration page (Figure 6.8, Figure

6.34). Figure 6.24 shows the user selection page that is the result of this action. Just as with questions, it is possible to filter the individual users by groups to facilitate the process of locating the desired user. Figure 6.25 shows the resulting table after adding two users to the survey.



**Figure 6.24:** Adding an individual user to survey
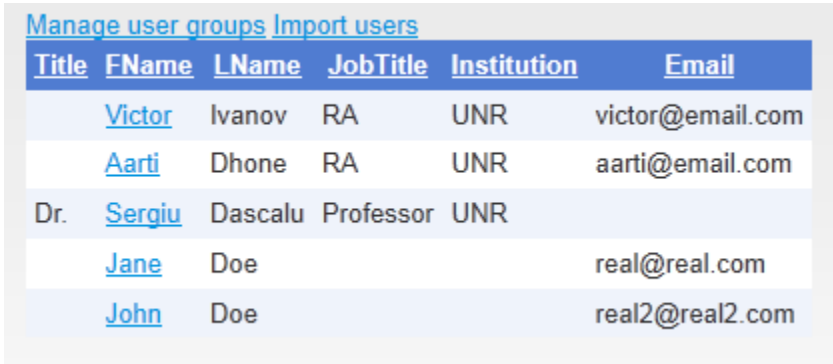


**Figure 6.25:** Added individual users

One of the key features of VIVA SMTK is the custom user import functionality that allows the administrator to supply a CSV file (with the data of the users being imported) that is not restricted on the order of the columns or on the names of the columns. The process of a custom user import is demonstrated next.

To initiate the import, it is necessary to first navigate to the user management interface (shown in Figure 6.26) by clicking on the "Users" item of the main
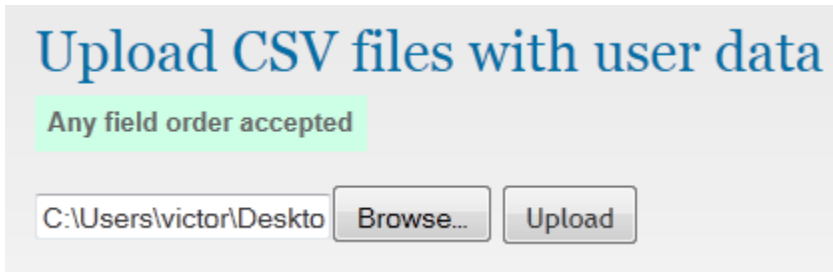
administrative navigation menu (Figure 6.2). After that, it is necessary to click on the "Import users" link at the top of the users table. Figure 6.27 shows the user import interface in its initial state which consists of a file upload field and the button that initiates the upload. Figure 6.28 shows the CSV file that is used for the import.
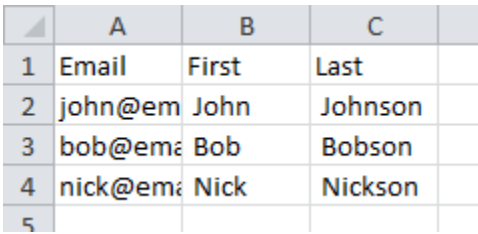


**Figure 6.26:** User management



**Figure 6.27:** User import interface



**Figure 6.28:** CSV file with user data in custom format

After the file is uploaded, it is analyzed and the interface changes to facilitate the process of matching the fields of the uploaded CSV to the entries in the VIVA's database.

Figure 6.29 shows the updated interface after the appropriate selections have been made. Note that it is possible to assign the imported users to one or more groups. In this example, the imported users are assigned to "Students" and "UNR" groups (pre-created). After the users are imported, the browser is redirected to VIVA's user page. As shown in Figure 6.30, the users were appropriately inserted into the database.



**Figure 6.29:** Matching data from CSV with the database

**Figure 6.30:** Imported users

Figure 6.31 shows the edit page for a particular user, which results from clicking on the corresponding last name. In this example the user was removed from the "Students" group and assigned to "Instructors" group, while "UNR" membership was left intact. The group memberships were then updated by clicking on the "Update Membership" button.

It is also possible to modify any of the user account details including name, title, etc. To access the editing interface, it is necessary to click on the "Edit" link on the user's page (Figure 6.31). Figure 6.32 displays the editing interface. For this example, a "Dr." title and "Professor" job title were added. The changes were then saved by clicking the "Update" link at the bottom.

**Figure 6.31:** User edit page



**Figure 6.32:** Editing user data

The second way to associate a survey with users is by adding an entire user group to a survey. This can be done by clicking the "Add User Group" under the "User groups" section of the survey editing/administrative interface (Figure 6.8, Figure 6.34). The process of adding user groups is very similar to adding questions and individual users. Figure 6.33 below shows the result of adding two user groups ("Students" and "Instructors", pre-created) to the survey.
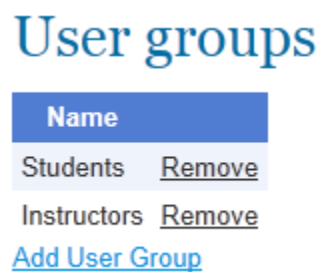


**Figure 6.33:** Users added to survey

After a survey is composed with questions and associated with one or more users via associating it with individual users and/or user groups, a survey can be distributed among the users by sending them emails with the URL to the survey on a VIVA server according to the survey's email template. Figure 6.34 shows the entire survey editing/administration page after sending the survey by clicking the "Send" button at the bottom of the page (Figure 6.8). After the survey is sent, the editing/administration page transforms. First, as Figure 6.35 shows, the "Send" button becomes inactive and is greyed-out. Also, a report on the emails that have been sent appears, shown in Figure 6.36. By default, it shows the template of the email, but it is possible to select any of the users that have received this survey via the table at the bottom (by clicking the corresponding "Select" link).

**Figure 6.34:** Survey management interface after sending the survey

**Figure 6.35:** Sent condition indication



**Figure 6.36:** Sent emails

Figure 6.37 shows the same table after the administrator selected to review the email that was sent to Dr. Nick Nickson. As shown in the figure, the selected row gets highlighted and the template variables get substituted to match the actual user data. An actual URL is also provided and for the purposes of this demonstration it will be used to simulate the actual user experience.

After Dr. Nickson receives his email with the invitation and after he navigates to the URL of the survey, he sees the survey taking interface, as shown in Figure 6.38. As it can be seen in the figure, the survey taking interface is similar to the administrative one,

the differences being in the title of the page (reading "Electronic survey") and in the stripped-down navigation that only includes the "Help" entry.



**Figure 6.37:** Concrete sent email

Figure 6.39 presents the first page of the survey, as seen by a user that takes it (in this case – Dr. Nick Nickson). As it can be seen in the figure, the first page includes the title of the survey, the indicator of the page position and a simple greeting. Note that question positions match the ordering that was previously established in the administrative interface. The answers are completed and submitted by clicking the "Next page" button at the bottom of the page.
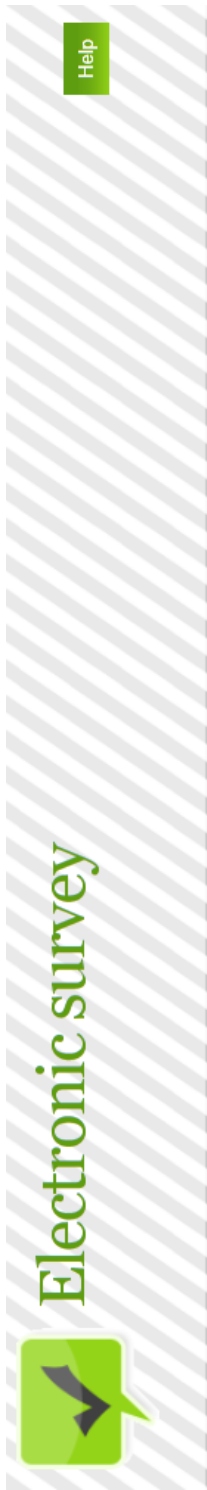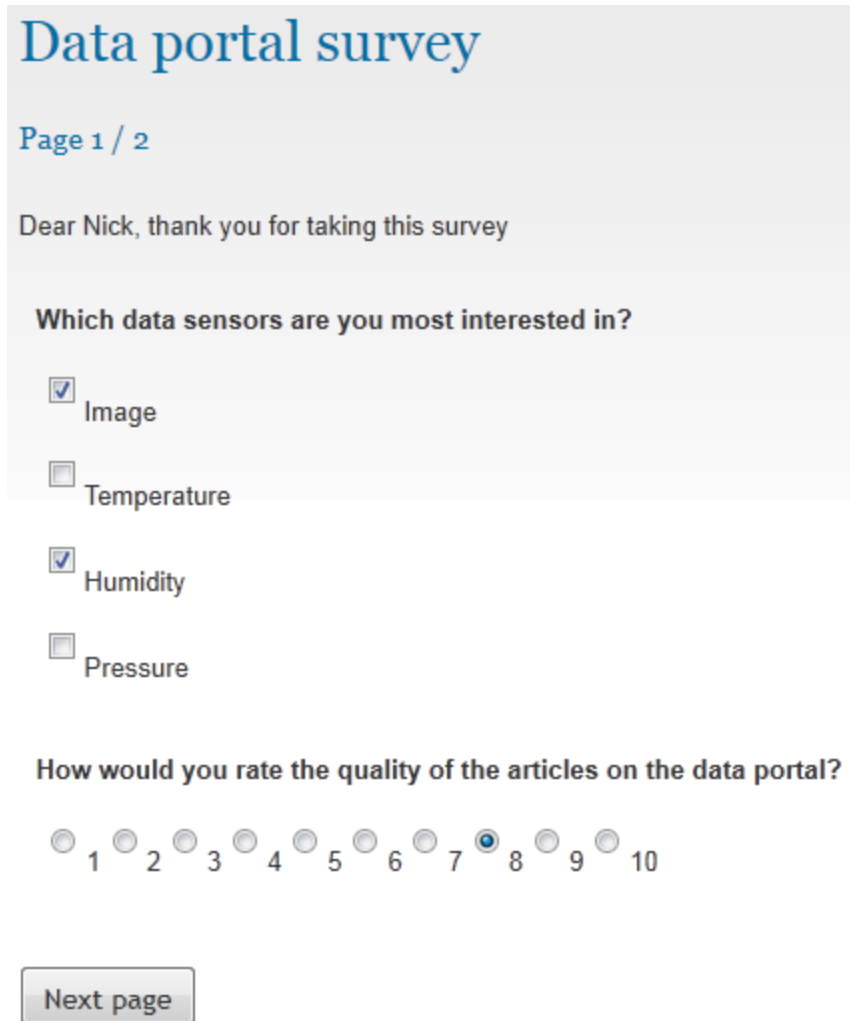
**Figure 6.38:** Taking the survey

**Figure 6.39:** Taking the survey, page 1

The layout of the second page of the survey, as seen by the survey taking user, is shown in Figure 6.40. Note that the page still has the survey title and page position indicator, but not the greeting. Also note that question positions match the ordering that was previously established in the administrative interface. The page is completed and the survey is submitted by clicking the "Submit survey" button that appears at the bottom of the last page of the survey.

# Data portal survey

Page 2 / 2

**Are you contributing articles to the data portal?**

No ▾

**How would you describe the most positive and most negative aspects of your experience with the data portal?**

I especially liked the portal navigation, but I would appreciate more data sources

**Which protocol would you be most interested in seeing implemented for export of data for web services?**

○ REST

● SOAP

Submit survey

**Figure 6.40:** Taking the survey, page 2

After submitting the final page of the survey, it is marked as done and is not available to be re-taken by the same user. Figure 6.41 shows the message that the user sees after completing the survey and any time after, when the user navigates to the survey URL from the email.

**Figure 6.41:** Survey submitted

Any time after the survey has been sent to the user, the administrator can access reports and statistics for that survey. Figure 6.42 shows the entry page of the administrative reports interface, accessible through the "Reports" item of the main administrative navigation bar (Figure 6.2). This entry page lists all active surveys as URLs leading to their respective report pages. Also, as seen in Figure 6.42, a count of total submissions is displayed next to the title of each survey. This demonstration's survey ("Data portal survey") shows six submissions in total, which match the number of users associated with it directly and via group (for the purposes of this demonstration every user's survey completion was simulated).
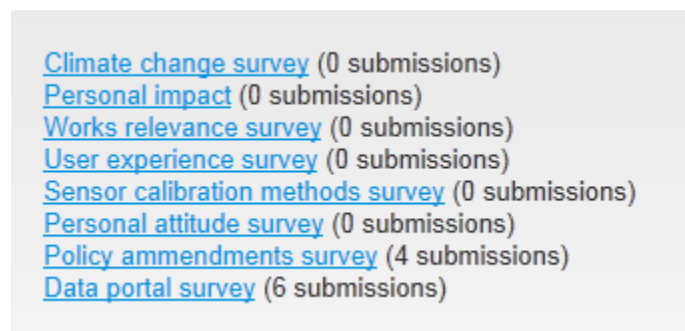


**Figure 6.42:** Collective reports page

Figure 6.43 shows the reports page for the "Data portal survey". As shown in the figure, there are two main sections in this page: "All submission" that aggregates data and statistics that includes all submissions, and "Submissions by group" which provides the same data, only individually filtered by every group that was associated with the survey.

**Figure 6.43:** Survey report page

The CSV files include the actual data that each user submitted, as shown in Figure 6.44 (global report) and Figure 6.45 (group-filtered report, for the "Instructors" group). The Statistics pages provide some basic analysis of this data, as shown in Figure 6.46 (global report) and Figure 6.47 (group-filtered report, for the "Students" group).

| A | B | C | D | E | F |
|---|---|---|---|---|---|
| User | Which data sensors are you most interested in? | How wou | How would you rate the quality of | Are you contribut | Which protocol would y |
| Aarti Dhone | Humidity | I would li | 8 | Yes | REST |
| Dr. Sergiu Dascalu | Image / Temperature | I find the | 6 | Yes | SOAP |
| Jane Doe | Image / Temperature / Humidity / Pressure | I like eve | 8 | Yes | REST |
| John Johnson | Temperature / Humidity / Pressure | I would a | 5 | Yes | REST |
| Bob Bobson | Image / Temperature | I like eve | 10 | Yes | REST |
| Dr. Nick Nickson | Image / Humidity | I especial | 8 | No | SOAP |

**Figure 6.44:** Global CSV report

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | User | Which data sensors are you most interested in? | How would you describe the most po | How would you rate th | Are you contri | Which pro |
| 2 | Dr. Sergiu Dascalu | Image / Temperature | I find the portal great overall I would | 6 | Yes | SOAP |
| 3 | Dr. Nick Nickson | Image / Humidity | I especially liked the portal navigatio | 8 | No | SOAP |

**Figure 6.45:** CSV report for the instructors group

# Data portal survey

## Statistics for all submissions

| Question | Statistics |
|---|---|
| Are you contributing articles to the data portal? | Yes: 83.33% \| No: 16.67% |
| How would you describe the most positive and most negative aspects of your experience with the data portal? | N/A |

| | Question | Percentage | Total |
|---|---|---|---|
| Which protocol would you be most interested in seeing implemented for export of data for web services? | REST | 66.7% | 4 |
| | SOAP | 33.3% | 2 |

| | Question | Percentage | Total |
|---|---|---|---|
| | Image | 66.7% | 4 |
| Which data sensors are you most interested in? | Temperature | 66.7% | 4 |
| | Humidity | 66.7% | 4 |
| | Pressure | 33.3% | 2 |

| Question | Statistics |
|---|---|
| How would you rate the quality of the articles on the data portal? | Average: 7.5 \| Max: 10 \| Min: 5 |

**Figure 6.46:** Global statistics for survey

# Data portal survey

## Statistics for Students

| Question | Statistics |
|---|---|
| Are you contributing articles to the data portal? | Yes: 100% \| No: 0% |
| How would you describe the most positive and most negative aspects of your experience with the data portal? | N/A |

Which protocol would you be most interested in seeing implemented for export of data for web services?

| Question | Percentage | Total |
|---|---|---|
| REST | 100% | 3 |

Which data sensors are you most interested in?

| Question | Percentage | Total |
|---|---|---|
| Image | 33.3% | 1 |
| Temperature | 66.7% | 2 |
| Humidity | 66.7% | 2 |
| Pressure | 33.3% | 1 |

How would you rate the quality of the articles on the data portal? Average: 7.7 | Max: 10 | Min: 5

**Figure 6.47: Statistics for a particular group**

# 7  COMPARISON WITH RELATED WORK

Comparison of the VIVA prototype with six independent web-based software solutions was performed using the metrics introduced in Section 2.1, to which the "custom user import" feature was also added:

1. Question types (an ability to create multiple choice, scale or other questions)

2. Results export

3. Multi-page surveys

4. Drag and drop interface

5. Custom user import

6. Correspondence overview

7. Custom greetings

8. Basic statistics

9. Advanced statistics

10. Internationalization

By comparing the design and prototype of VIVA to the existing software as shown in Table 7.1, it can be seen that VIVA does include what is considered to be the essential electronic survey software functionality (providing multiple question types, allowing the results to be exported, providing functionality to break surveys down into pages and providing some basic statistics) and it is successful in offering certain functionality that is not found in other packages.

One of VIVA's innovative functions is that of providing the custom import feature that allows using a file with an arbitrary order and naming the field designators

for collections of user data (note that this feature is not concerned with the particular representation of data on disk, and CVS was used only as an example). This decoupling of data formatting from its meaning is viewed as an important feature that is relevant not only to the particular case of a survey management toolkit, but also to a general class of applications that might deal with importing data in bulk. The concept of decoupling data format from meaning also corresponds well to commonly accepted good practices of engineering and might be further developed to facilitate an even broader scope of applications. There is a trade-off of a necessary user intervention during the process of matching the data field names to the data meanings, but it is viewed as reasonable, especially considering the possibility of automating the process in the future (as described in the following section). Other functions that can be considered innovative based on this comparison are the full coverage of the drag-and drop metaphor for the reordering of questions and the possibility to review the automated correspondence items (such as email invitations). A VIVA feature that was also present in some, but not all of the reviewed systems, is that of custom greetings (e.g. in emails or in surveys) that are tailored towards specific users (e.g., by using their names in greetings). Such functionality is favorable as endowing communication with elements that are tailored towards specific individuals tends to reduce the non-response rates (Fowler, 2009).

The comparison also reveals that even though the VIVA prototype introduces unique and innovative functionality, it is not yet as extensive with regard to enterprise functionality including internationalization, advanced statistics or the number of question types. Note that much of this breadth-focused functionality was intentionally omitted from VIVA's software specifications for the purposes of leaving more space for depth-

focused functionality in this thesis. Nevertheless, addition of such functionality in the future, as strongly believed by this thesis' author and as discussed in the following section, might be one of the most effective ways of enhancing VIVA (although such functionality specification needs to be consolidated with the researchers using the system as VIVA is designed to be an integral part of the Nevada Climate Change Data Portal).

Note also that the comparison shown in Table 7.1 is not meant to be comprehensive and other criteria might be considered as well. Also, some information regarding the software packages involved may have been missed or misinterpreted by the author of this thesis, or may have not been available.

**Table 7.1:** Comparison with related work

| Feature/ Software | VIVA | Survey Monkey | Inquisite Survey | Magic Survey Tool | Zoome rang | Hosted Survey | Question Pro |
|---|---|---|---|---|---|---|---|
| Question types | 5 | 15 | 15 | 23 | 15 | 16 | 13 |
| Results export | CSV | PDF, XLS, XML, CSV, SPSS | CSV, MDB, SPSS | Excel, CSV, PDF | Excel, CSV, PPT, PDF, Word | Excel, Access, XML | CSV, Excel, PPT |
| Multi-page surveys | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Drag and drop interface | Yes | No | n/a | No | Yes (question only) | No | No |
| Custom user import | Yes | No | n/a | No | No | No | No |
| Correspondence overview | Yes | No | No | No | No | No | No |
| Custom greetings | Yes | Yes | n/a | Yes | Email only | No | Email only |
| Basic statistics | Yes | Yes | Yes | No | Yes | Yes | Yes |
| Advanced statistics | No | Yes | Yes | Yes | Yes | Yes | Yes |
| Internationalization | No | Yes | Yes | Yes | No | No | Yes |

# 8 FUTURE WORK AND CONCLUSIONS

Even though, as stated in the previous chapter, the VIVA Survey Management Toolkit prototype is not as extensive as some of the currently available software packages, particularly with respect to the coverage of enterprise-level features, it is able to effectively perform the functions of an electronic survey management system and fulfills its objective as a research project aimed at introducing innovative functionality to the class of software tools that deal with web-based electronic survey management. There is, of course, plenty of room for improvement of the presented prototype, as outlined next.

One of the possibilities for extending functionality VIVA's functionality is to upgrade the major features that comprise the innovative aspects of this software tool. First, it is possible to further develop the concept of custom (user) input, for which there are two ways to approach: breadth-focused and depth-focused. A depth-focused approach would consist of further developing the capabilities of importing CSV files with the user data, which can include a feature such as auto suggestions for field pairings based on the column names in the CSV file. Such suggestion engine might be very simple and rely on an algorithm that simply compares the titles of the CSV columns to a set of pre-defined strings (e.g. determine if the CSV column name contains strings "First", "Name" or "Given", if so – suggest it is a field containing first name) or it could be more elaborate, maintaining and referencing a thesaurus or even interfacing to a third-party string analysis engine. The second, breadth-focused approach to enhancing the custom import functionality can be centered on broadening the set of formats accepted (the current design of VIVA only accepts CSV just to set the example) or on allowing custom

importing of not just users, but also other data such as questions or serialized surveys, and maybe even auto-recognizing the exact type of data being imported without manually specifying it.

Finally, perhaps the most obvious class of possible improvements consist of endowing VIVA with more enterprise-level features such as internationalization of the interface, providing advanced statistics with graphing options, expanding the set of export formats, integration with social media applications (e.g. some of the reviewed software packages are able to integrate with Facebook for purposes of sending invitations to participants), expanding the number of question formats offered, etc. Another item that can be prioritized as particularly important in the efforts of solidifying VIVA as an enterprise-level application is in the reconsideration of portions of the user interface that would allow VIVA to handle larger amounts of data (e.g. more surveys with more questions or a very large library of questions). Even though VIVA provides a set of features that allow it to scale content-wise such as on question and user groups, the interface can sometimes be a bottleneck. An example is the questions display panels which can grow large in extended surveys and contribute to a complex interface. A possible solution to this issue can consist of the interface to collapse survey pages into smaller entities that take less space and contribute less to the overall interface complexity, and to expand them back, when needed.

However, since VIVA is not a commercial project but a research project that originated as a component of the Nevada Climate Change Data Portal, the most important aspect of evaluating its features should not be its commercial viability, but its applicability and usefulness to research pertinent to the Nevada Infrastructure for Climate

Change Science, Education and Outreach project. Identifying features under this criterion could be performed through matching data obtained from surveying available software packages with data collected through elicitation of requirements and other types of feedback from the researchers working on the project (the surveys themselves can be conducted using VIVA). In this way the industry standards and generally accepted metrics of reliability, availability and scalability can be combined with the actual needs of the researchers using VIVA and the Nevada Climate Change Data Portal.

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