THE USE OF WEB-BASED SURVEYS FOR ACADEMIC RESEARCH IN THE FIELD OF ENGINEERING

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Abstract
This paper presents a research project-in-progress which investigates the use of Web-based surveys as tools for academic data collection. A brief review of existing literature on this topic is included. Details of a survey, which evaluates current attitudes toward Web-based surveys as opposed to the traditional paper-and-pencil format, are also provided. The result section discusses a preliminary assessment of the attitudes of researches from Engineering as compared to other fields. Finally, this paper concludes with recommendations for future research.

Keywords: Academic Research, Electronic Surveys, Internet Based Surveys, Web-Based Data Collection, Web-Based Surveys

Introduction
Survey research methodology is a well-accepted practice for collecting data in many fields of research particularly in the social sciences (i.e., psychology, marketing, organizational behavior, etc.). The typical purpose of survey research is to advance scientific knowledge or develop theory (Malhotra and Grover, 1998).

The technology available today to conduct survey research offers many opportunities. Researchers are no longer limited to the traditional paper-and-pencil method of eliciting responses from a target population. Some of the technologies that have been utilized as an alternative to the traditional approach include: (1) phone, (2) fax, (3) PC disk-by-mail, (4) electronic mail, and (5) the Internet. The latter is beginning to receive increased attention as the general acceptance and increased usage of personal computers and the popularity of the Internet continue.

In fact, given that there are many well-documented drawbacks of using paper-and-pencil surveys, it is not surprising that many researchers are looking to take advantage of emerging technologies to conduct survey research (Klassen and Jacobs, 2001). The growing quantity of papers in the open literature suggests that the number of researchers investigating the use of the Internet to conduct survey research is increasing. Researchers continue to conduct studies to better characterize the advantages and disadvantages of using Web-based technology for data collection. Much of the research has indicated that Web-based surveys offer the ability to overcome many of the shortcomings of traditional paper-and-pencil surveys. The most pronounced advantages using Web-based survey technology are listed below.

- Lower costs (Schmidt, 1997; Sackmary, 1998; Couper, 2000; Roztocki, 2001)
- Wider distribution (Schmidt, 1997)
- Automated data entry (Boyer et al., 2002)
- Faster turnaround times (Sackmary, 1998; Truran, 2000)

These advantages are certainly expected to increase the attractiveness of conducting survey research and potentially expand the number of disciplines that turn to survey research to collect data. Some researchers are taking the extra step and exploring the potential benefits of technical fields that traditionally do not widely utilize survey research to adopt, improve, and develop customized applications of proven survey research techniques where appropriate in their own fields (Boyer et. al., 2002).

This exploratory paper focuses on the potential impact that Web-based survey technology might have on the number of non-traditional disciplines opting to conduct field-based/survey research. Specifically, we conduct a preliminary investigation to explore the perceptions that engineers versus non-engineers hold in terms of field-based research within the context of Web-based data collection technology. Due to the fact that this research project is ongoing, many of the results are in their infancy. Nevertheless, we feel that our findings are important as an initial step to characterize the potential wider use of electronic surveys in engineering-related research questions.

Motivation
The focus of education and research in technological fields is changing. This transition is particularly apparent within engineering. Over the last several decades, engineering schools have been criticized for their lack of relevance in their instructional methodologies and within their research agendas (Lang et. al., 1999). The practices of such schools are skilled at equipping students with a solid working knowledge of engineering "fundamentals" but tend to produce graduates with no or little experience in many of the issues encountered in engineering practice.

In addition, much of traditional engineering research has focused on engineering research and development as opposed to engineering practice (Lang et. al., 1999). While this certainly has advanced our technological expertise, it has created a gap between the focus of faculty research and that of industry needs. Researchers in the social sciences, business, organizational behavior, etc. have long used survey-research techniques to capture many of the contemporary issues faced by practitioners in the field and to maintain relevance for theory building within their respective disciplines.

Survey research is not typically a common method of data collection for engineers. In fact, most engineering curriculums do not offer a survey methodology course as a degree requirement. Thus, most engineers are unfamiliar with systematic survey-based work. Does this lack of introduction to survey research methodology exclude researchers in engineering from utilizing an approach, which has been so important in knowledge building in other disciplines? We do not know the answer to such a question but we are interested in initiating a preliminary characterization of the interest of engineers to conduct survey research given the onset of several alternative technologies to facilitate this activity. Engineers are generally characterized as having a strong acceptance of various technologies. They are often willing to step into the void to test and implement new and different technologies given the nature of their work and often enter the field of engineering because of their aptitude in technology-related subjects.

The emergence of new technologies persists today. Advances in computing, information and communications technology will continue to alter how we do our work and also the work that we undertake (Koelling et. al., 1996). In addition, work has been done that indicates that attitudes towards a particular technology in terms of its perceived ease of use and perceived usefulness can predict the usage of that technology (Lederer et. al., 2000). With the continued high usage of the Internet and the development of Web-based surveys (i.e., e-surveys) engineers may be more open to explore field-based research given their current wide-use and tendency to embrace various technologies.

Organization. This paper is organized in several sections. We first provide a brief characterization of the existing literature to position our investigation within the context of the existing literature. Next we articulate our research hypotheses and briefly explain the insight behind them. The next section describes our data collection process. Finally we present preliminary results and discuss the implications of our findings. We conclude the paper with directions for future research.

Research Hypotheses

The hypotheses that we test in this paper all center on differences between engineers and non-engineers in using Web-based survey instruments as tools for academic research. Support for these hypotheses might be interpreted as a sign that Web-based data collection may gain wider acceptance by engineering-related disciplines.

> HYPOTHESIS 1 (H1): Researchers in engineering fields prefer Web-based surveys to paper-and-pencil more then researchers in non-engineering fields.

Engineers must adapt to new and emerging technology to stay relevant in their respective fields. Becoming attached to the "old way" of doing business is highly dangerous given the pace for which technology changes the method and meaning of engineering work. Often new technologies clearly outperform existing technologies. We submit that this phenomenon contributes to the enthusiasm for which engineering researcher embrace technology.

> HYPOTHESIS 2 (H2): Researchers in engineering fields are less aware of the limitations of Web-based surveys than researchers in non-engineering fields.

> HYPOTHESIS 3 (H3): Researchers in engineering fields support the use of Web-based surveys for serious academic research more than researchers in non-engineering fields.

Clearly, engineering researchers do not benefit from a long history of survey research with test-standards for conducting such work within their field as researchers in the social sciences. This lack of awareness may create a gap between engineering and non-engineering researchers in understanding the usefulness of Web survey instruments.

Research Methodology

This section describes our methodology for collecting data with the goal of testing the above hypothesis.

Web-Based Survey Design. To obtain the necessary data to test our hypotheses, we developed a survey questionnaire. The goal of the questionnaire was to elicit information about attitudes toward Web-based surveys, from researchers in academic environments.

The questionnaire contained two major sections. The first section contained nine statements about Web-Based Surveys, as presented in Exhibit 1. The objective of the statements was to measure respondents' attitudes toward Web-Based Surveys as compared to the "paper-and-pencil" format. We

applied a five-grade Likert scale with possible responses: strongly agree, agree, neutral, disagree, and strongly disagree. The second section included demographic questions, as shown in Exhibit 2.

In addition to demographic questions and statements, the questionnaire contained a text box. The main objective of this text box was to elicit "open" feedback from the respondents.

The survey also indicated that participation was voluntary. Survey participants were provided with an explanation of the intent of the survey and its potential outcomes. Incorporating these elements has been show to enhance response rates (Dillman, 2000). Finally, we should mention that additional questions were included on the survey that do not pertain to the focus of this paper and thus are not discussed.

Exhibit 1. Statements about the Attitudes toward Web-Based Surveys

Number	Survey Statement
S1	Overall, the quality of responses for Web-based surveys is at least as high as it is with traditional paper-and-pencil surveys
S2	Web-based surveys have more advantages than disadvantages
S3	Web-based surveys will eventually replace traditional paper-and-pencil surveys as a means of academic research.
S4	Web-based surveys are more appropriate than paper-and-pencil surveys when collecting data on highly sensitive topics
S5	Web-based surveys are only appropriate for research in a highly limited number of fields
S6	Overall, Web-based data collection is not useful for serious academic research.
S7	Overall, Web-based surveys are more efficient than paper-and-pencil surveys
S8	Overall, Web-based surveys ensure more anonymity than paper-and-pencil surveys.
S9	Participants consider the presence of rewards and incentives when answering any type of survey.

Exhibit 2. Demographic Questions

Question
Which field most describes your primary professional affiliation?
What is your primary role in academia?
Where is your primary professional affiliation?

Survey Posting. After the survey was tested and up-loaded to the server, participants from the fields of Engineering, Business, Management and Marketing were contacted by sending a call for participation to five selected professional e-mail lists. Subscribers to the lists are primarily faculty and graduate students. In addition, the Web address of our study was submitted to four major Internet search engines to increase the dissemination effort of the survey instrument.

Data Analysis

During approximately one month of data collection, 302 responses were collected. Three submissions contained mainly empty spaces and were therefore discounted. The remaining 299 responses were considered usable.

The demographic profiles of the useable responses are summarized in Exhibit 3. Most of our respondents indicated that they are faculty, researchers, or graduate students and are affiliated with a college or university. These results suggest that we were able to reach a group representative of our target population.

Exhibit 3. Demographic Information

Primary Professional Affiliation:	
Engineering	43
Business/Management	163
Education	53
Psychology	7
Other	33
No response	0
Primary Role in Academia:	
Faculty	195
Graduate Student	56
Researcher	34
Other	14
Not specified	0
Primary Professional Affiliation:	
Research University	176
Teaching University/College	97
Private Company	8
Self-employed	4
Other	9
Not specified	2

Attitudes toward Web-Based Surveys. We coded all responses to the nine statements in Exhibit 1 with numbers ranging from 5 (for strongly agree) to 1 (for strongly disagree). Descriptive statistics were calculated for each of the nine statements for both engineering and non-engineering populations. Exhibit 4 summarizes the results.

Exhibit 4. Comparison of Sample Means Engineering versus Non-Engineering Responses

Statement Number	Mean Eng.	Mean Non-Eng	Mean Diff.
S1	4.05	3.92	0.13
S2	4.07	3.78	0.29
S3	3.65	3.14	0.51
S4	3.17	2.82	0.35
S5	2.47	2.54	-0.08
S6	2.02	1.75	0.28
S7	4.21	4.04	0.17
S8	3.00	2.61	0.39
S9	3.60	3.69	-0.09

To test our set of hypotheses, a *t*-test was used to determine whether or not the means of the two populations (engineering and non-engineering) could be assumed to be different. A difference in means would suggest different attitudes.

The results of the *F*-test suggest that all statements (see Exhibit 1), with the exception of S2, did not provide enough statistical evidence for unequal variances. As a result, a pooled-variance *t*-test for differences in two means (assuming equal variances) is conducted. The results of the *t*-test are summarized in Exhibit 5.

Exhibit 5. *t*-Test on Engineering versus Non-Engineering Responses

Question	Df	T value	P value
S1	296	0.77	0.441
S2	NA	NA	NA
S3	297	2.68	0.008
S4	292	2.10	0.037
S5	293	-0.47	0.641
S6	296	1.93	0.054
S7	297	1.13	0.258
S8	296	2.40	0.017
S9	297	-0.57	0.569

Discussion. Our findings suggest that engineers do have different attitudes about Web-based survey technology. Based on the results of our analysis it appears that researchers from engineering believe more strongly that Web-based surveys will eventually replace the "paper-and-pencil" format than researchers in non-engineering fields (S3).

Furthermore S4 and S8, show a significant difference (this time at a 0.05 level of significance) in the mean responses. It appears that researchers from engineering disciplines believe that Web-based interaction ensures a higher level of anonymity and may be a more appropriate medium for conveying sensitive information. At first glance, this result seems surprising since much research has been done on security issues surrounding the use of the Internet. One might expect that those in engineering would be highly aware of many of the security problems, particularly those that could be encountered with Web-based survey instruments to identify the respondent, such as cookies and hidden fields (Schmidt, 1997).

However, a deeper look may indicate that engineers perhaps prefer non-human interactions for tasks of this nature. Research does suggest that respondents may avoid or tone-down responses when anonymity is not guaranteed (Knapp and Kirk, 2002). Thus, engineers seem to feel that computers offer the potential to collect sensitive information without the discomfort of revealing personal or private information face-to-face.

For the remaining six statements (S1, S2, S5, S6, S7, and S9) our statistical analysis of the sample data did not detect any significant differences between the two groups of respondents. It is particularly interesting to note that no significant difference could be detected for S7. Both engineering and non-engineering researchers seems to think that Web-based surveys are more efficient than the paper-and-pencil method (Exhibit 4). This may be related to the fact that all respondents (engineering and non-engineering) that participated in this study are comfortable using computers and understand the benefits computers offer in increasing efficiency.

From our analysis, we appear to have empirical evidence to support H1. The collected data suggest that Web-based surveys enjoy higher support from engineering versus non-engineering researchers. Advances in technology often create obsolescence in current technologies. The more technology-dependent disciplines may experience a more frequent replacement of existing technologies with new technologies. The emergence of such a powerful survey research tool whose benefits appear to outweigh drawbacks is likely to replace existing more antiquated techniques.

It also appears that H2 is supported by our analysis of the sample data. It appears that respondents from the field of engineering are less aware of privacy and anonymity issues when collecting data on sensitive topics via the Internet. Finally, our analysis indicates that there is not enough evidence to support H3. This is contrary to our initial belief and it is interesting to note

that individuals who, on average (not substantially), strongly disagreed with S6 were outside the engineering field. However, this may be more of an indication of the fact that survey research is not as mature in engineering related research as it is in fields like business, psychology, marketing, etc.

Because this paper describes a research project in progress, these findings are still preliminary in nature and need to be treated as such. Our next step would be to validate our preliminary results.

Conclusions and Future Research

There are a large number of research opportunities in the area of Web-based surveys. Researchers seeking to ensure that their ideas and research efforts are relevant by surveying managers and/or other key informants on discipline related issues have a new tool to do so that avoids may of the pitfalls on conventional surveying methods. Given the tremendous opportunities that exist to tailor survey features and to reach people with specific interests Web-based surveys may begin to be embraced by researchers outside of the traditional fields (i.e., psychology, marketing, organizational behavior, sociology, etc.) that are mature in survey methodology and implementation. This preliminary investigation aimed to increase our understanding of the perceptions of engineers versus non-engineers in using Web-survey technology as a data collection tool in conducting academic research.

The results did offer insights into the perceptions of the researchers within the two categories that are in academic environments toward Web-based survey technology. Our future research will involve additional improvements to better characterize these perceptions. We plan to refine our dissemination of the survey by targeting lists that have a larger percentage of engineering researchers. Of the 299 useable responses, 43 of them (i.e., 14%) indicated that their primary work was in engineering. This is easy to do given the capability to target engineers via an engineering-specific newsgroup or distribution list.

It would also be worthwhile to better characterize the use of survey research activity being undertaken by engineering researchers. One method in which we will attempt to gain insight on survey research activity in engineering is to expand our search of papers published in engineering-related journals. This will serve as a gauge of the current activity in the engineering community in survey research methodology.

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