Design of Delphi technique integrated with social media to make consensus based on experts' opinion

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Abstract

Delphi technique is the structure communication process to collect and analyse the experts' opinions with controlled feedback in an iterative manner to build consensus. Social media is an open and unstructured communication platform with flexibility to generate the contents at anytime from anywhere. Integration of the Delphi technique with social media provides an opportunity to utilize the social media users as experts and leverages the experts to participate in the Delphi communication process from anywhere and at anytime. The purpose of this research is to study the feasibility to integrate the Delphi technique with social media.

To examine the feasibility of integrating the Delphi technique with social media, the design science research method is chosen as a research approach. From the literature review of the Delphi technique and social media, the design guidelines were identified to develop the prototype system and to conduct the experiment as a proof of concept.

The university course feedback is selected as the context area to conduct the experiment with the prototype system. A pre survey is conducted to study the background information of technological knowledge of the participants and to know the opinions of the participants towards the context area. In the experiment, four questions were asked to the participants in each Delphi round to measure the group consensus and ideas convergence. The participants in the experiment were free to provide response to the questions from anywhere at any time using the Twitter account.

The results show that the experiment has been successful and the experts are able to make consensus on their opinions. In addition, this study also shows that the Delphi technique can be integrated with social media to build consensus. The results also support that Twitter may not be the ideal social media platform for such experiment. In the future studies, the design issues should be carefully considered for getting the better results.

Keywords
Delphi technique, Social media, Design Science Research

Foreword

I would like to express my great thanks to my supervisor Jouni Markkula and Sandun Dasanayake who gave me the guidance and valuable feedback on writing this thesis. Writing the thesis was a great learning opportunity for me and at the same time, it was a great experience to work along with my supervisors.

The thesis writing process went through lots of ups and downs and I am grateful to my supervisor who provided me valuable suggestion and motivation to progress with my thesis. To write the thesis in an academic way was itself a big challenge for me and also to conduct the experiment was a bit difficult since the idea was new. I am also thankful to the student of Research Method Course who participated in the experiment and made this experiment successful.

I am grateful to the University of Oulu who provided me an opportunity to learn in a diversified environment with the international education standard. Finally, I want to thank my family and friends who supported me to complete this thesis.

Deepak Lamichhane

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Abbreviations

DSR	Design Science Research
API	Application Programming Interface
HTTP	Hypertext Transfer Protocol
XML	Extensible Mark-up Language
JSON	JavaScript Object Notation
UI	User Interface

Contents

List of figures

List of tables

1. Introduction

Technologies, business activities and working procedure are growing with the pace of time in diverse fields. Within few decades, the IT industry has swiftly grown and at the same time, the increasing demands of software system, hardware, and internet have dramatically changed the people's attitude to adapt to the new technologies. Moreover, with the advent of expert and intelligent system, human activities have also changed and people seem to be depending more upon the expert system to make the decision for different situations and to do various daily activities. Even to make the system expert, there is a need for information and knowledge that can be obtained from different sources.

In recent times, the rise of web 2.0 and social media have played a significant role in making crucial decisions, marketing strategies, knowing the ideas of the customers and gathering public's opinion for making changes in the rules and regulations. Facebook, Twitter, MySpace, YouTube, Google+, Foursquare, and Pinterest are the most popular and extensively used social media. Each social media platform has its own value to different users. More or less, every social media platform has the same key features of the social phenomena as explained by Lyons et al. (2012). However, the evolution of social media has also changed the process of working, conducting research, making communication, and the availability of the information. In addition, the web 2.0 and social media have facilitated the people to create content and share these content in the group conveniently. These kind of social media platforms enable open and unstructured discussion. On the other hand, the decision concluded from such interaction might not be reliable. Nevertheless, aforementioned points lead social media as a tool for making the group discussion and decision in a collaborative way.

Rohrbaugh (1979) had stated that open and unstructured interactions lead to biased contribution by individual during group discussion. For example, an individual with his attributes and position may overshadow or bias the opinions of other individual in the group discussion. Moreover, these types of interactions may result in person dominant effect where the viewpoints of highly recognized people might overshadow lower profile person. Such biased contribution doesn't assure the decision's validity, reliability and credibility. In order to determine the validity, credibility and reliability of the information, either some scientific rigor methods should be followed or there should be pre-studies to support the information. Ideas generation and decision making are the cognitive abilities to select the appropriate solution for a problem. Some of the problems need high and sufficient knowledge, so individual cognitive abilities and judgments are not enough to provide the best solution. Hence, some structured and group decision methods like Delphi technique, Nominal Group Technique (NGT) etc., are utilized in making the group discussion and decision more effective.

Delphi technique is the structure communication process to gather the experts' opinions about certain problems in an iterative manner with controlled feedback on the opinions of experts. Brown (1968) explained Delphi as a technique for eliciting the opinions of the experts for getting the group response. Over here the term experts' means the personnel who have the broad sense of knowledge in different fields and can provide their point of view for different problems. According to Kuusi (1999), experts should have technical and scientific knowledge in various fields, and should be able to link different fields to provide the viewpoints and enthusiast for building new ideas.

There are many situations where Delphi technique can be used. For example, education sector is one of the areas where education technocrats, researchers, practitioners, stakeholders, governments, students and administrative staffs have to make crucial decision in different situations. The situations can be development of the program, change in administration, adaptation of technological innovation, improvement of the course structure, evaluation of courses, introduction of the new teaching methods using new technology, acquisition and adaptation of new technology, forecast of the university infrastructure based on financial investment after 30 years, design university education policy and many more. In a situation where there are many decision makers and people lack the sufficient knowledge for making a reference point to decide, the solution may be less effective as it will not be possible to talk to each individual in order to solve the problems. During such condition, the discussion might have conflicting ideas and the opinions of every decision makers might not be heard. Because of which decision might not be the unanimous decision due to dominant effect of the high personality. To overcome such problems, Delphi technique might be the suitable method which uses the experts' group responses and reduces the individual dominant effect through anonymity.

In recent years, there has been huge growth in the field of social network/media. Despite the existence of millions of users on different social media platform which can be used as an expert group and facilitator, the Delphi technique still lacks the use of social media for making the discussion and decision. Hence, social media can also provide new opportunities for making the group decision and making the consensus by utilizing the users as experts in the structured way like in Delphi technique.

Integration of Delphi technique with social media platform leverages the participants and motivates them for many reasons. For example, in this new era, people want to generate newer content in the social media rather than leeching the other's contents. Sharing ideas through blogs, wiki, micro blogging increases the participation level and communication. Regardless of the geographical location, the generated and shared content in social media are easily accessible within the group members in the same network.

In addition, social media platform is a ubiquitous system that adds flexibility to generate the contents anywhere and at any time. Ubiquitous system also increases the users' interaction with computing devices. Having limited cognitive abilities, individuals cannot generate more accurate contents when they are bound to the system within limited time. It is difficult to determine at what time span individuals are highly motivated. According to Fairbank and Williams (2001) "employees must be motivated to think creatively to participate in the suggestion system". It means that individuals are likely to provide more precise and accurate viewpoints when they are motivated. In that situation, ubiquitous system like social media helps the participant to participate actively and easily in the decision making process by providing their ideas without any limitations.

In the past few decades, numerous studies have been carried out on the Delphi technique and its derived form. Some of the studies were focused on improving the Delphi technique (e.g. Yang, Zeng and Zhang 2012; Hartman and Baldwin 1995;) while some other studies were focused on the use of the Delphi technique for generating the opinions from an expert group for making policy, finding software project risk, determining the impact of ICT in education (e.g. Rice 2009; Keil et al. 1998; Espinosa and Caro 2011). These studies have made significant contribution towards understanding of the Delphi technique, the guidelines to carry out the Delphi, the utilization of the statistical methods to get better results and many more. But there are only few research and studies done for combining the concept of social media with the

Delphi technique (Chang and Lo, 2012). Linstone and Turoff (2011) mentioned that Delphi technique will be done in the collaborative environment that will be asynchronous, scattered and continuous in the future.

The expected outcome of the research is to extend the use of social media in Delphi technique in order to make consensus. Moreover, the expected result of the research can contribute in the research area of Delphi technique with social media. As discussed in the previous section, the Delphi technique can be used in many situations, but in this thesis, course evaluation and feedback is selected as a context area to perform the Delphi technique.

This thesis will be based on design science research (DSR) method. In order to carry out the research, first the literature regarding the Delphi technique and social media will be done. This literature will be the basis for developing the conceptual framework and determining the system requirements. Based upon the requirements, a system will be designed and developed which will help to perform the Delphi technique with the use of social media. In the next step, observation and evaluation will be performed and findings will be discussed at the end.

2. Research Problems and Methodology

The prime focus of this thesis is to examine the role played by social media in Delphi technique and to analyse the requirements and challenges for integrating social media in Delphi technique.

2.1 Research problems

The study has developed two research questions to know the mechanism to integrate social media with the Delphi technique and to know the effect of such developed system on experts for providing their opinions. The main research questions are

1) What are the design requirements and challenges for integrating social media with the Delphi technique?

2) How does the Delphi technique integrated with social media affect the motivation of experts for expressing their opinions?

The answer to the first research question is provided by developing a prototype system as a proof of concept to perform the Delphi technique incorporated with social media. The second research question's answer is provided by comparing the results of the conducted experiment and the survey results.

2.2 Research methodology

With the problem stated above, design science research is selected as the research method for finding the answers to our research questions. Simon (1996) also pointed out that engineering and IS fields are mainly connected and appropriate to the design science research paradigm. March et al. (1995) mentioned that design science research focuses on the problem, design, development, and evaluation of the artifacts. It means that the problem domains are studied and understood and the applications are developed as artifact. Basically, DSR is the problem solving paradigm. Nunamaker, Chen and Purdin (1991) argued that there was no good IS research process for conducting the software development research. They proposed the multimethodological research approach which consists of four research strategies namely theory building, experimentation, observation, and systems development as a research process. Later Hevner et al. (2004) presented the new design science research framework suitable for all kinds of IS research methodologies.

It is always difficult to design an artifact with the advancement and need of technology in problem domains when existing knowledge is less. In this research, the artifact will be a software prototype which is designed, constructed after identifying the problems. According to Hevner et al. (2004), those constructed artifacts are evaluated and the results are either the final targeted artifacts or used to improve the artifacts. However, the "build and then evaluate" design science research approach initially proposed by March et al. (1995) was later extended and justified by the Hevner et al. (2004). The selected research methodological framework is a multimethodological research

approach (see Figure 1) provided by Nunamaker et al. (1991). Compare to Hevner et al. (2004) framework, Nunamaker et al. (1991) provides the structured way of system development in this study. In addition, it also adds the knowledge to a problem domain and acts as a proof-of concept. Figure 1 depicts the Nunamaker et al. (1991) research life cycle for system developments.

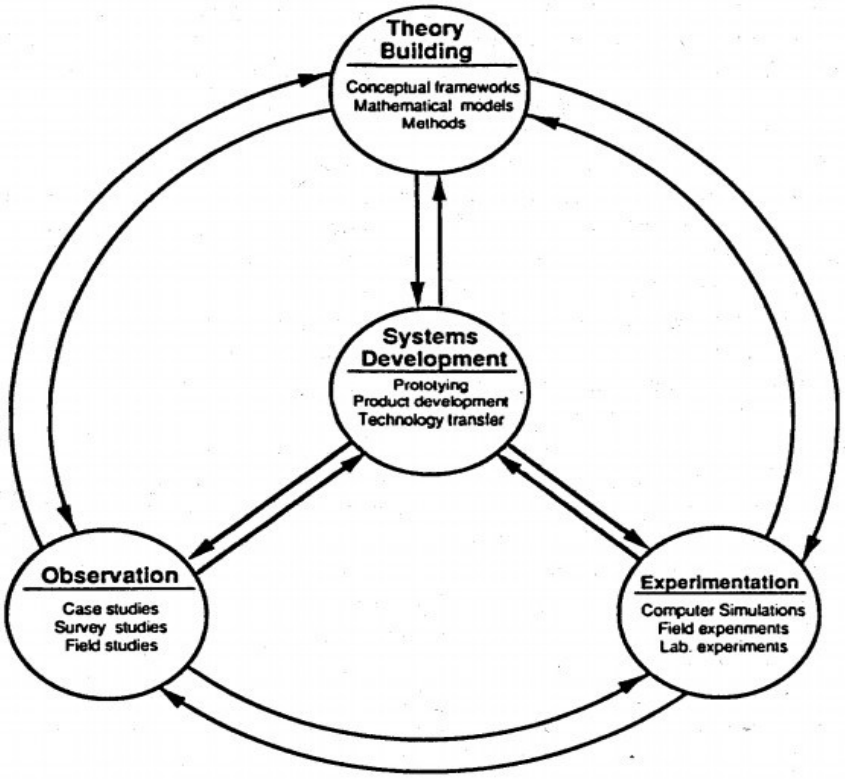

Figure 1. A multimethodological approach to IS research (Nunamaker, Chen, and Purdin, 1991).

New research ideas, concept design, models and frameworks are developed during the theory building. It also generates the knowledge for producing hypotheses, experimenting plans, and conducting observations. In this thesis, the literatures related to this research domain are studied. Literature review reveals the works that have been done in the past and also the problems that still exist to be solved. Regarding this study, it will help to know the pre-existing knowledge of the Delphi technique, the areas in which Delphi techniques are used, how Delphi technique is implemented through the web, what approaches have been made to integrate the Delphi technique with social media. Hence, ideas, problems, constraints and requirements for implementing the Delphi technique with social media will be obtained.

Laboratory, field experiments and computer simulation are performed on experimentation design strategy. Experiment design strategy lies between the theory building and the observation stage. A developed prototype system is analyzed for the experiments and the results from experiment design can be used to improvise its theories and practices. In this study, the field experiment is conducted to analyze the prototype system and assessed the feasibility to integrate the Delphi technique with social media.

Observation strategy is conducted for getting more knowledge of the problem domain when there is inadequate knowledge. It includes case studies, field studies and surveys. In addition, context and environment about the research should be precisely mentioned,

so that other researchers can also draw conclusions. In this study, pre-survey to gather the background information about the technological knowledge of the participants, providing the training presentation, examining the capacity of the participants to participate in the experiment through example questions, post survey questions included the observational stage of the research process.

According to Nunamaker et al. (1991), system development strategies incorporate conceptual design, construction of system architecture, system prototyping, product development, and technology transfer. It is the central hub for other research methodologies. Concept design is the process of converting theories and technology into practical applications. Prototyping provides the feasibility of system development and the initial development of prototype leads to the advancement of the complete product development with full functionality. Implementing the developed product in organizations leads the transfer of theories, concept, and systems. With consideration of the research problem and objective of this thesis, system development is the main component that will generate the artifacts. Table 1 explains Nunamaker et al. (1991) software development research process with the research problems of this thesis.

Table 1. Research process and problems for system development research (Nunamaker, Chen and Purdin, 1991).

System development research process	Research problems
Construct a conceptual framework	• Studying the relevant literature • Comparing the key features of Delphi technique with social media • Gathering the requirements for conceptual framework based upon the literature review • Developing the conceptual framework for developing the system with the requirements
Develop a system architecture	• Develop the system architecture based on conceptual framework and explain each modules
Analyze and design the system	• Analyzing the current solution for the different system module to provide the services • Select the suitable solution and design the system with requirements
Build the (prototype) system	• Implement the prototype based upon system design
Observe and evaluate the system	• Implement the developed prototype for field experiment • Observe the experiments and evaluate the developed system

According to the research process depicted in Table 1, first we will study the relevant literature review of the Delphi technique, and compare the Delphi technique key features with social media features. This review provides the groundwork to integrate the Delphi technique with social media and also provides requirements for developing the conceptual framework.

The conceptual framework provides the foundation for developing the high level system architecture. This system architecture helps to understand the services and relationship between different system modules.

In analysis and design, the current solutions for the system module services are analyzed and the system is designed using appropriate solution. The system design provides the base for developing the new prototype system.

Next step is the development of the working prototype. The problems are reported during the development and pilot implementation of the prototype. The issues during the development and implementation are fixed to enhance the system. In the final stage the developed system is implemented in the field and empirical data are collected to evaluate the system. In the end, it helps to provide the answers to our research questions.

3. Literature review

Literature review serves numerous purposes in the studies. In this thesis, literature review is the theory building process which helps to make the conceptual framework for software development research methodology.

The main sources of databases for gathering the publications are Scopus, ScienceDirect, IEEE, ACM, Google Scholar, and Springer Link because these selected databases contain appropriate publications for the study. "Delphi method, Delphi technique, and social media" are used as the main search terms in the aforementioned database to find the publication. In this thesis, the research since 1960s are included to study the Delphi technique because the Delphi technique is the old structured group discussion methodology and there are many derived versions of the Delphi technique and researchers have used this technique in various forms. From the database results, it can be said there are less work related to Delphi technique with social media and most of the studies are focused on Delphi technique used as methodological tool. Only few publications are found which discuss about the Delphi technique itself.

To limit our research, the study will not include the publications related to application areas of the Delphi and the Delphi technique implemented with other forms of group discussion methodology. Literature review have two sections in which the first section of the literature review deals with the Delphi technique and the second section of literature review explains the approaches for conducting Delphi through internet and how it can be integrated with social media. This immediate section provides the theoretical framework and literature reviews of the former studies of the Delphi technique.

3.1 What is Delphi?

Delphi technique was originally developed by Rand Corporation in between 1950s and 1960s (Ziglio, 1996) to forward the subjective ideas rather than objective ideas on subject matter where it lacks sufficient data. Brown (1968) explained Delphi is a technique to elicit the experts' opinions to make the group response in which expert opinions are kept anonymous and are allowed to criticize each other's opinion by proper reasoning in order to improve the group response. The clear definition of the Delphi technique is forwarded by Dalkey et al. (1969), they mentioned Delphi is a process to elicit and refine the group judgment in an iterative manner with controlled feedback in which expert opinions are kept anonymous and statistical tools are used to aggregate the appropriate opinions as group response. In general, Delphi technique is the systematic mechanism of the group communication process to gather heuristic opinions of experts in order to make consensus, forecast regarding problems in controlled iterative manner where it lacks factual information. Convergence of experts' heuristic opinions is handled through controlled iterative feedback, which helps experts to give greater insight into the problem's situation (Sackman, 1974).

3.2 Forms and Motives of Delphi

From 1960s to 2013, the Delphi techniques have been referred and utilized by different names and forms respectively. In the past, the word 'Delphi' was referred to the

traditional based Delphi technique. Nowadays, as per the use of the Delphi technique, researchers have named it as an eDelphi, real-time Delphi, internet-based Delphi (Espinosa and Caro, 2011; Cole, Donohoe and Stellefson, 2013; Lindqvist and Nordänger, 2007). This preludes, computers, internet, World Wide Web are used to perform the Delphi technique. Based on the above mentioned points, in this thesis, Delphi technique can be divided into two approaches. The first approach is a traditional Delphi technique where experts use the paper based communication channel to perform the surveys and the second approach is computer mediated Delphi technique in which experts uses the computer, internet and other related IT technologies to perform the surveys.

In early days of Delphi initiation, it was used for scientific and technological forecasting (Sackman, 1974; Ziglio, 1996); later on Delphi technique was more popular in finding historical data and events, budget allocations, urban and regional planning, curriculum development in universities (Linstone and Turoff, 1975), determining impact of ICT in education (Espinosa, and Caro, 2011), determining the software projects risk (Keil et al., 1998), policy making (Rice, 2009), health care services, business and many other areas. Table 2 presents motives and application of some of the selected studies of the Delphi techniques in the chronological order.

Table 2. Summary of Delphi techniques' motives and applications in the previous studies.

Authors	Year	Motive	Application
Dalkey and Helmer	1963	Identifying amount of A-bombs required for decreasing the war material.	Forecasting
Hartman and Baldwin	1995	Analyzing the opinions from diverse group for a new contracting process.	Solutions
Okoli and Pawlowski	2004	Identification of key factors to launch electronic commerce in Sub-Saharan Africa.	Identification
Taipale, Smolander, and Kälviäinen	2005	Identification of the research issues of software.	Identification
Gable, Stark and Smyth	2007	Identification of the key issues faced by the Information system researcher.	Identification
Rice	2009	Identifying the priorities in K-12 distance education.	Developmental plan
Mamaqi, Miguel and Olave	2010	Prioritizing the competence, capabilities and skills in lifelong learning.	Finding solutions
Espinosa and Caro	2011	Developing the ICT integration framework which support and examine ICT integration in schools.	Finding solutions
Wang et al.	2013	Making the standards for the green management.	Establishing standards

Concluding the summary from Table 2, forecasting, identification and solutions, establishing the standards and developmental plan are some of the applications where Delphi techniques have been utilized.

3.3 Delphi process

This section explains the process of carrying out the Delphi techniques even though there is no precise set of procedures and statistical measures that can be generalized and followed for all kinds of problems; however the essence of all Delphi techniques are same. This section also covers Delphi technique process, identifying and selecting the experts or respondent group, data collection and analyzing the results.

Despite the absence of predefined rigor Delphi technique process, many practitioners and researchers follow more or less the same Delphi process whether it is the traditional or derived Delphi technique. In the traditional Delphi technique, paper based surveys are used whereas in later one, different tools and mediums like computer, internet web surveys, social network, real-time system etc., are used. Whether it is traditional or derived Delphi techniques, the purpose of both methods is to elicit in-depth knowledge and exchange of information for the group decision. The derived Delphi techniques have some advantages over the traditional Delphi method such as it minimizes the slow communication and makes the real-time communications and it predefines communication characteristics set beforehand (Linstone and Turoff, 1975).

In general, Delphi technique is carried out on three rounds, but each round can be repeated or the number of rounds can be elongated by the researchers or facilitator depending upon the convergence of the opinions from the expert groups. In the first round, open-ended questions are prepared by the researchers about the problems and are provided it to the panel of expert groups and in return, responses are obtained. Open-ended questions leverage the expertise to cover and provide as many opinions as possible which ultimately provide the scope for the subsequent rounds. It is important to provide clear information about first round questions because experts might misinterpret the questions which might affect the end result. In the second round, the researchers compile all the responses and send back the questions for the next round. In addition, misinterpretations about empirical factors and theories assumptions should be clarified in successive rounds, which the respondent had missed in the first place (Dalkey and Helmer, 1963). The second round seeks the results in the quantifiable manner preferably through ratings and rankings and different statistical means are used for the consensus-building of the opinions. In the third round, experts are given a chance to review their opinions by defending their changes with appropriate arguments, after which the researchers compile all the gathered information and discloses the consensus opinions from experts.

In Delphi technique, selection of the appropriate experts and their numbers plays a major role in the knowledge building process. Generally, many researchers have selected experts who are highly ranked and are well known for having great knowledge in the context area, where the problem domain has to be solved, and a number of experts are based upon the scope of the study and availability of these experts. Experts' knowledge about subject matter is considered to be special factor which is uncontrollable. However, less knowledgeable experts can be used with the more knowledgeable one because they are likely to improve on the next iteration (Dalkey, Brown and Cochran, 1969). This idea was also supported by Sackman (1974) and mentioned that the opinions from experts and non-experts are inseparable. Lilja, Laakso and Palomki (2011) concluded that experts should have the technical/scientific expertise, interest on broad area, linking the knowledge in different fields, innovative, able to view the problem from different perspectives which was proposed by Kuusi (1999).

Delphi technique is itself the data collection mechanism for the consensus building. The data collection begins immediately when we start the Delphi process. It is difficult for the researchers to decide till which stage the data should be collected. Schmidt (1997) presented the framework for data collection and analysis mechanism for the ranking type Delphi. He also mentioned that no earlier researchers had previously used the common framework for presenting the results of ranking type Delphi.

3.4 Reliability and Validity

According to Ziglio (1996), the solution to a problem which lacks sufficient data is either to wait for the scientific knowledge and theory or to get the expert insight and their judgment of the problem in a systematic manner. The first option might not be suitable in a situation when immediate action and decision needs to be taken. So in such situation, methods like Delphi technique which elicits the experts' opinions are suitable, but until and unless we don't have the scientific knowledge and method, we cannot hold the truthfulness and validity of the solution. Thus, many researchers had concluded that the outcome from the Delphi process can't hold the total validity and therefore, it should not be used as a primary solution to particular problem rather it should be thought as the initial ideas, strategic planning about the problems. Moreover, Sackman (1974) also stated that the findings from Delphi may not be able to meet the validity, reliability, administration and interpretation of those findings for social use. In addition, Hasson et al. (2000) also doubted the reliability and validity of the results from the Delphi technique in the case when similar information is provided to two or more expert panels will have the same result or not. However, he suggested that the criterion (namely credibility, fitting, auditability and conformability) given by Lincoln and Guba (1985) for qualitative studies could be able to overcome this problem by ensuring the production of credible interpretation of the findings.

Despite the skepticism about Delphi's validity and reliability, Dalkey (1969), based on the experiments conducted in between 1960s and 1970s on the issue where the expert's opinions was the best accessible information, said that Delphi had benefits over the traditional methods such as group discussion, conference and many other interactive group tasks. The main reason behind this is a systematic process for analyzing the expert's opinions followed by the Delphi technique (Ziglio, 1996).

In the first round, open-ended questions are prepared by the researchers about the problems and are provided it to the panel of expert groups and in return, responses are obtained. Open-ended questions leverage the expertise to cover and provide as many opinions as possible which ultimately provide the scope for the subsequent rounds

Apparently, in the Delphi technique either open-ended questions or the closed-ended questions are used to elicit the experts' opinion. The term 'open-ended' questions means the questionnaire which seeks to find answers in qualitative form and the term 'close-ended' questions means the questionnaire which seeks to find answers in quantitative form. Thus, this technique's result can be the generation of quantitative estimates or qualitative evaluation (Sackman, 1974). Similarly Chen and Kung (1984) found that the combination of qualitative and quantitative methods in the forecasting has been more accurate compared to other methods. Hence, the results achieved from the Delphi techniques should be good enough than the normal survey based results. Rowe and Wright (1999) also supported that Delphi technique performs better than standard interacting group and statistical groups.

3.5 Key features to define Delphi technique

In the earlier section of this thesis, it is highlighted that anonymous, controlled iterative feedback, statistical group responses are the main key features that make the Delphi technique unique to other kinds of group discussion methodologies. Due to the lack of the generalizable structured way in a Delphi method, some of the researchers (Hartman and Baldwin, 1995) had agreed on anonymous and controlled iterative feedback as the key features in their modified Delphi technique experiment. However, the initial study done by Dalkey et al. (1963) and Dalkey et al. (1969) had mentioned anonymity, iterative controlled feedback and statistical group response as the main features of Delphi technique. Now, this section forwards more insights into the key features that define the Delphi technique.

Anonymity is referred as allowing different experts to express their responses to the questionnaires without exhibiting expert's identities with each other. Compared to other form of formal communication techniques like face-to-face communication, Delphi anonymity reduces the dominant effect within experts and social pressures to make the confirmation.

Controlled iterative feedback allows the experts to polish their opinions based upon the other experts' opinions as feedback in the iterative manner. The feedback can be the summary report, quantitative estimates of data based upon experts' opinions. In addition, Dalkey and Helmer (1963) mentioned that either the available data from previous experts or the critic provided by other remaining experts can also be provided as feedback. Thus, in the controlled iterative feedback, the iterative is maintained by re-evaluating the former phase results by the facilitators and then providing the results to the experts progressively until ideas are converged and consensus is build and which also reduces the untruth of the group opinions leading to the reliability and validity of results.

Statistical group response allows analyzing and interpreting the quantitative data. It serves many purposes such as reduction of the biasing effect of dominant, inappropriate communication, and group pressure toward conformity (Dalkey, Brown and Cochran, 1969). Experts' opinions are likely to scatter, so statistical group response tries to assure the convergence of the final results According to the results, different statistical measures like mean, median, standard deviation, intra-class correlation coefficients and other statistical method can be used to measure the group response. In the worst case, the final responses might not coincide and might fail to get final result (Dalkey, 1969).

Table 3 exemplifies the Delphi techniques' key features which are considered during the Delphi process as a methodological tool for research or Delphi technique design consideration studies. In Table 3, the word 'Delphi' will refer to denote the traditional Delphi technique otherwise its respective used name in their experiment will be used for the modified version of the Delphi technique.

Table 3. Key features considered in previous studies of Delphi technique.

Authors and Year	Method used	Anonymous	Controlled iterative feedback	Group response
Dalkey and Helmer (1963)	Delphi	Yes	Available data requested by some one of the experts or factors and considerations by one or other expert	Median
Brown (1968)	Delphi	Yes	Reconsider their estimate and revise the estimate and also the rationale that let them to change their original estimate	Median and interquartile range
Hartman and Baldwin (1995)	Modified Delphi method	Relationship between experts is anonymous but the researcher knew all the experts name to filter the conflicting views	Feedback was provided by allowing commentary on each other's comments during the time of making original comments.	n/a
Steinert (2009)	Adapted Delphi methodology	Experts name was revealed but anonymity was kept through link	Quantitative data and qualitative data were analyzed and provided as feedback	Synthesize by Ishikawa cause-effect diagram
Ogunseye et al. (2011)	Automated Delphi	Yes	The distinct views are presented to the knowledge source (experts) for further comments until there is convergence in views. For summarizing the experts' options, they had used the commercial document comparator Application programming interface (API) which does the natural language processing	n/a
Espinosa and Caro (2011)	Real time web-based Delphi	Yes	Comments of each experts were provided as feedback	Intra-class correlation coefficients, mean, median, and standard deviation
Dong et al. (2012)	Delphi-modified	Yes	Analyzed and summarized the experts ideas	n/a
Cole, Donohoe and Stellefson (2013)	e-Delphi	Anonymity was tracked through IP address	Analyzed and summarized the survey results and reported to the experts through emails and posted in the research portal	Mean and Standard deviation

From Table 3, it can be said that the key feature statistical group response, is not used in some of the studies for making the consensus in Delphi technique and controlled iterative feedback is also not followed in the same fashion. Despite the fact that direct communication contradicts with the controlled communication, in some studies the controlled iterative feedback was replaced by direct commenting on expert each other's comments while making original comments. However, anonymity was considered as the main key design feature of the Delphi technique in all studies.

Other than these key features, Ziglo (1996) have also mentioned asynchronous communication as a key feature that should be considered in Delphi technique. The author explained asynchronous communication as the right of experts to participate in the interesting problem at any time in the communication process with the places convenient for experts. In this scenario, places refer to the geographical location where they are physically located and tools they used for making the communication.

3.6 Delphi technique conducting approaches

In the previous section, the general process of conducting the Delphi process is discussed and now in this section different Delphi technique approaches and problems are studied. In order to understand the Delphi technique approaches and problems systematically, the study is divided in two sections: traditional and computer mediated Delphi technique. First section disclose the studies that are more focused on the Delphi Technique without computer intervention whereas the second section is focused on the studies carried out with the use of computer and its technology.

3.6.1 Traditional

Dalkey and Helmer (1963) performed the Delphi technique to forecast the bombs. In the experiment, the researcher selected the heterogeneous expert group from different fields with almanac type questionnaire and the interview session was done to remove the confusion in some rounds. It can be said that there was a decline in the response rate, but the factors responsible for decreasing the response rate were unclear. They predicted that due to the presence of some vague questions in the questionnaire, the result was poor in some Delphi rounds.

In order to make the vague questions more clear and understandable or to give some base information for predicting the answer, Brown (1968) proposed to provide the supplementary information with feedback during the Delphi round. The researcher performed the experiments by providing the supplementary information and feedback to the experts and greater consensus was observed in the experiment with feedback than without feedback; however the accuracy of the group estimates was not greater.

Hasson, Keeney and McKenna (2000) presented the guidance for identifying the research problems, searching the experts and presenting the data for the Delphi survey technique and also mentioned that there are few methodologies to collect the data. According to them, sometimes research problems for discussion can be chosen by the researchers themselves based upon the experts' competency level and the availability of the experts because all of the problems cannot be investigated by the Delphi technique. They outlined the information leading to differing judgments, opinions on topic from different perspectives and search for the information that might generate consensus can be the research objective of Delphi given by Turoff (1970).

In the study on Delphi as a powerful tool for strategic management, Loo (2002) mentioned that an appropriate problem should be considered under study and a heterogeneous expert group related to the subject matter of study should be selected. Moreover, Hasson et al. (2000) also suggested that experts with fair-mindset who will provide their own views, interest on the research objectives and are determined to complete the Delphi process should be chosen. According to them, a number of experts should be chosen based upon the criterion sampling and experts should be provided with all the required information regarding the experiments.

Furthermore, Loo (2002) mentioned that random procedure helps to reduce the biases during the selection of the experts and the number of the experts in a group depends upon the subject under investigation. Another important point the researcher explained was about the kind of questionnaire to be asked in the Delphi rounds. During the first round, open-ended or Likert scale type questions can be asked whereas in the successive round questions should be more specific and relative importance ratings, ranking order results and extraction of the group response can be provided as feedback. The author

also suggested the purposive sampling as a technique for the selection of experts and argued that large and random samples are not only the solution for expert's selection.

Similarly, Powell (2003) outlined the approaches to conduct the Delphi survey presented by different researchers. In general, three rounds of the Delphi are conducted where first round should be open-ended question with qualitative results and in subsequent rounds, questionnaires should quest towards the quantitative results by ranking or rating techniques. Rather than representing the experts' sample from various fields and making the heterogeneous experts group, it would be better to select the qualified experts with the credibility and appropriateness of study in the field of problem areas.

3.6.2 Computer mediated

The approaches to perform Delphi using computer was thought during the 1960s, where the computer can be utilized to provide the questionnaire, synthesize the group response and provide feedback results with relevant extra information (Brown, 1968). But the advancement of Delphi techniques through computer outperformed since 1990s. In this section, the Delphi technique carried out through computer and its related technology are studied.

Turoff and Hiltz (1996) reviewed the design of Delphi and its specific properties and methods to implement through the computer based environment. They commented that asynchronous interaction was left out in the traditional based Delphi technique due to limitation of time and space. Asynchronous interaction means letting individuals to provide personal judgment about any part of the problem and at any time so that experts can decide whether to take part in the judgment or not. Anonymity, another key feature of Delphi, can be maintained by using the pen names for the qualitative type statements, but it can be disclosed when the Delphi process reaches the final evaluation phase of group responses. The incorporation of the Delphi technique with the computer system provides better opportunities and intervention of facilitator can be replaced by making automated Delphi process.

A comparison study of paper and pencil with real-time Delphi conducted by Geist (2010) concluded that useful results were not extracted on both versions of the Delphi process. The reason behind this can be the unclear goal of the Delphi process and vague questions that might ultimately lead to the poor information for evaluation. And also response rate was observed only 55% in real-time Delphi and which is lower than paper based Delphi. The researcher stated that the low response rate was because of the tediousness to return to a web application to view the group results. In terms of expenses (e.g. time and cost), the real-time is more economical than paper and pencil, but the initial cost of web programming is high for real-time Delphi. The researcher mentioned that increasing the number of participant is easier to elicit feedback in the Delphi process.

Espinosa and Caro (2011) had developed the real time web-based Delphi to find out the ICT integration framework in basic education. They realized that the real time web-based Delphi saved time and enabled fast interaction. Selection of the participants was done from different sectors and each participant was invited through email. Despite the fact that the internet is ubiquitous, each participant was asked to gather virtually at a specific location for Delphi process. Each participant was assigned the random combination of names to maintain the anonymity. In the first round, each participant has to give percentage indicators based on the importance of ICT in education which would not exceed 100 percent and then in subsequent rounds, data visualizations through box

plots, percentage distributions were provided as well as participants' answer and ratings as feedback. They had used Intra-class correlation coefficients together with the mean, median, and standard deviation as a tool for convergence of the ideas.

The research conducted by Ogunseye et al. (2011) forwards the idea to integrate social media to generate the knowledge through Delphi technique. Researchers developed a prototype to test the Delphi process and they were successful to generate the knowledge. They claimed that they were able to automate the Delphi technique with the social network which was already foreseen by Turoff and Hiltz (1996). For summarizing the experts' options, they had used the commercial document comparator API which performed the natural language processing; however, they failed to implement the statistical group response for convergence of the opinions.

Dong et al. (2012) had implemented the Delphi techniques in the social network platform named SAP stream work. Anonymity and iterative feedback round, the key features of Delphi techniques were considered for implementing in SAP stream work. They had studied the feasibility of Delphi techniques on such social network platform and their study indicates that the Delphi technique can be implemented within the Social network. Nonetheless, it was difficult to maintain anonymity in a situation when experts requested for further clarifications regarding the questionnaire. For reducing the human intervention and organizing the information in a better way, the researcher had thought of using an advanced text analysis tool. Though they had feasibility in their study, the study had a few shortcomings. First, the study failed to compare the performance and user satisfaction with traditional Delphi approach; second, the expert group dynamics were small and homogeneous and lastly, the problem definition for discussion was poor.

Chang and Lo (2012) studied the Delphi techniques as the group decision model and developed the iGD system for aiding in group decision making process through the use of social networking. The results from iGD system were compared with the traditional Delphi techniques and results showed higher average accuracy. Despite the shortcomings of low decision quality when number of expert level increased, their study forwarded the ideas to use of collective intelligence from social media on Delphi techniques and also proposed iGD framework that would ensure the heterogeneous selection of experts to reduce the domination effect.

Cole, Donohoe and Stellefson (2013) studied the internet based Delphi technique and critiqued that e-Delphi is still under study; but it is noteworthy to mention Internet based Delphi technique has a wide range of benefit over traditional based Delphi technique. In the study, a research web portal was developed through which the purpose of the study, problem statement and consent information were provided to the participants. Qualified participants were chosen through the e-survey screening technique and participants were invited and reminded through emails. To reduce the biasing effect on selecting the participants, each participant were tracked through the IP address and allowed to submit the e-survey form once. In the first round, the open ended questions were asked and responses were summarized in the research web portal. In later rounds, statistical tools like standard deviations and mean scores were used for convergence of the ideas. They concluded that internet based Delphi overcomes geographical barriers, saves money and time, and provides ease by interactive web portal.

Many researchers experimented the Delphi technique according to the research objectives for generating ideas and making consensus. They modified the Delphi technique according to the suitability of research motives and different measurement scales were used to test validity and reliability of the results. But Hasson and Keeney

(2011) were worried about Delphi methodological rigor getting endangered due to the continual modifications of Delphi technique and different kinds of measurement scales used in the consensus.

In this phase, conducting approaches of the Delphi technique (i.e. traditional and computer mediated) in terms of preparation of the questions, selection of experts and their number, and feedback mechanism is studied. In the next section, traditional and computer mediated Delphi technique characteristics are studied. But the mechanism of convergence of ideas to build the consensus is left out and is studied in the system analysis section.

3.6.3 Traditional and computer-mediated approach comparison

In Table 4, Delphi methodological features are combined with other characteristics and traditional and computer-mediated approach is compared.

Table 4. Summary of the characteristics of Delphi technique in traditional and computer-mediated approach.

Characteristics	Traditional	Computer-mediated
Question type	Both structure and semi-structure	Both structure and semi-structure
Expert group type	Both homogeneous and heterogeneous	Both homogeneous and heterogeneous
Number of rounds	At least two round	Minimum one round
Mode of communication	Questionnaire through mail or direct interview	Questionnaire through email or real time process
Anonymous	Yes	Yes
Allowing feedback and modification	**Difficult**	**Easy**
Statistical group response presentation	Difficult and poor	Easy
Ease for facilitating asynchronous communication	**Low**	**High**
Clarity of information in rounds	Difficult and Poor	Easy and Good
Time and cost	High	Low
Decline in response rate	**High chance**	**Low chance**

From Table 4, it can be said that computer-mediated approach has ease and benefits over traditional approach of conducting the Delphi technique. And also earlier studies present that asynchronous computer-mediated communication provides the opportunities to generate the **innovative ideas** for making good decisions (Keil et al., 1998). In support, Cho et al. (2003) examined the Delphi technique in an asynchronous manner and found that structure asynchronous communication produced significant creative ideas compare to unstructured asynchronous communication.

Other than aforementioned Delphi key features, Ziglo (1996) have also mentioned asynchronous communication as a key feature that should be considered in Delphi technique. The author explained asynchronous communication as the right of experts to participate in the **interesting problem at any time in the communication process with the places convenient for experts**. In this scenario, places refer to the

geographical location where they are physically located and tools they used for making the communication.

Despite the benefits of asynchronous structure communication, it would take long duration for replying the questions and might **decrease in response rates** and **motivation**. This problem might arise due to the **untimely feedback**, **inappropriate time and place for providing opinions**, **tediousness to sit and provide the opinions using a dedicated computer-mediated Delphi application**, and many more. Geist (2010) stated low response rate in the real-time Delphi technique compared to paper and pencil Delphi technique because of the tediousness to return to web sites to view feedback and results.

These kinds of problems might be solved by integrating social media with the Delphi technique and which is one of the main research objectives of this thesis.

3.7 Social media

The social media system is a place where people come to create, share and exchange the information with each other through computing technologies. Moreover, people generate more content than some specific organizations (Comm, 2009), create user profiles and make groups to share their common interest in order to generate the content for appropriate and interested peoples. The generated contents in social media platform are in an open and unstructured manner and thus, it is difficult to execute, reuse to make a decision. It also supports collaborative decision making within the organization (Brzozowski, 2009). Despite social media platform enables collective intelligence, the decision from such type of unstructured communication is not valid and reliable and Rohrbaugh (1979) stated open and unstructured interaction lead in bias contribution for making decisions. Thus, a structured group communication process like Delphi technique is suitable to capture the explicit unstructured knowledge of the social media users.

At the first glance, it seems impossible to implement the Delphi technique through the use of social media because in order to carry out the structural communication for Delphi, anonymity, iterative feedback, statistical group responses and asynchronous communication are the main key features to be considered while social media is an open group with an unstructured interaction system where users have their own public profiles that contradict with the anonymity of Delphi process. Lyons and Lessard (2012) have purposed the social feature integration technique (S-FIT) which allows incorporating the social features with the information systems. The researcher had pointed out personal profiles, articulated networks, communities and groups which can be created and joined, comments on existing content, user generated content that can be created and shared as the main key social features of social media systems.

Table 5. Comparison of social media features (Lyons and Lessard, 2012) with the Delphi technique.

Features	**Social media**	**Delphi technique**
Profile	Public/Private	Private - Anonymous
Network	Follow/Friend request	No direct linked allowed but can use the following mechanism to clarify the misinterpretation of problems.
Communities	Direct – Homogeneous and Heterogeneous	Indirect – Preferably heterogeneous
User generated Content (UGC)	Anybody can generate the content and shared	Experts creates the content and facilitator shares the content
Comments	Users can comment in the generated content	Facilitator provides the comments to the experts as a group response in the form of statistical measure or other forms.

Profile

In order to implement the Delphi techniques through social media, the anonymity of the experts should hold true in social media system and pen names can be used for making expert anonymous. A pen name does not expose the experts' real status except certain attributes like viewpoints, confidence etc. (Yao and Liu, 2006). The social media system can have both the public and private user profiles, but in order to implement the Delphi techniques, the user's profile should be private.

Articulated network

In a social media application, the relationship between the users can be non-directed or directed. In directed relationship, a user is connected to another user but not necessarily the other way around whereas in non-directed relationship, both users are connected with each other (Lyons and Lessard, 2012). In Delphi technique, the numbers of experts are selected based upon the complexity of the problems and the experts are chosen by the researchers so there doesn't exist any non-directed or directed relationship among the expert groups; but there exists indirect communication among experts through facilitator by questionnaire and feedback response. In contrary to Delphi rigorous round structure, according to Yao and Liu (2006), the rigorous round structure can be broken through direct expert interactions to provide the sub-views while building the original main view and the direct interaction between experts can be maintained by the facilitator. Moreover, in order to prevent from biasing effect and social pressure, the facilitator can hold the right to maintain the non-directed or directed relationship. In maintaining the relationship among experts, there can also be the possibility of individual judgment leaking and it can decrease the Delphi performance when experts' opinions are affected by other experts' opinions.

Communities

In social media system, people come closer to make communities and share their ideas. Users of the communities have the rights to join certain communities and leave at their

own will. In social group users, compared to articulated network, there exists no direct relationship between individuals, but they are linked to each other indirectly (Lyons and Lessard, 2012). The size of the communities may vary from a few members to large members. Larger the members in the communities greater the user content generations. In Delphi technique, we can use those different social communities' single member or the communities as a whole as an expert or as the facilitator. But using the social communities as an expert panel or facilitator or choosing both as an expert panel and facilitator depends upon the research objectives and complexity of the problem. Murphy et al., (1998) mentioned that by increasing the number of participants, more reliable and better results of Delphi technique can be obtained. Hence it would be wise to consider the large number of users from the communities. Moreover, according to Delbecq et al. (1975), high quality and acceptable solutions will be produced by the heterogeneous experts rather than homogenous experts. Thus it would be better to select the heterogeneous users from social media communities; however the selection of the homogeneous and heterogeneous users depends upon the research objectives. Figure 2 shows the formation of the homogenous communities and heterogeneous communities in social media.

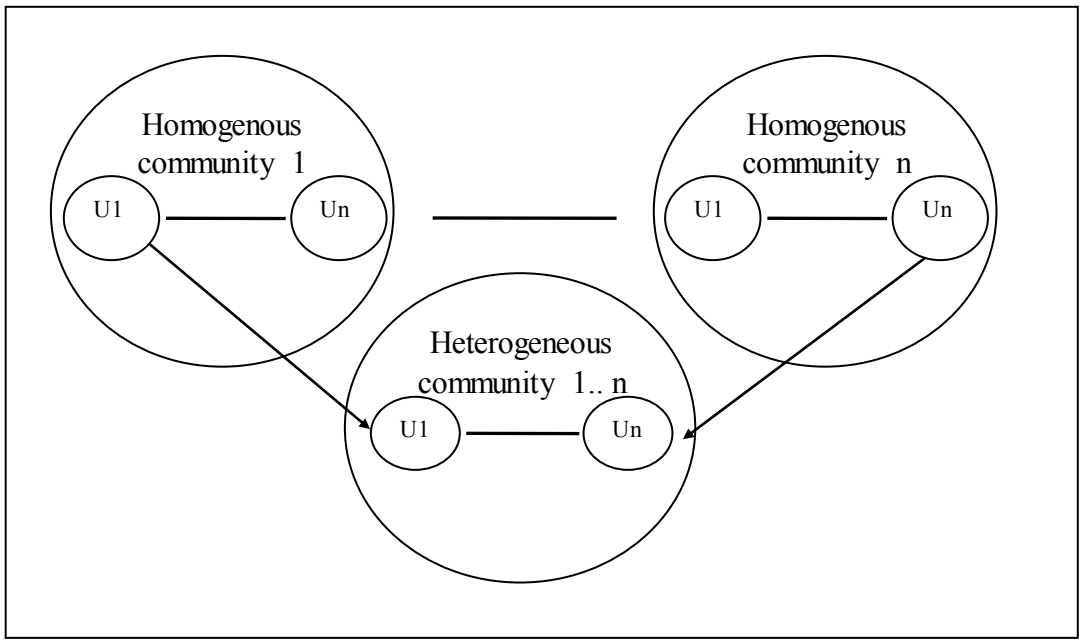

Figure 2. Formation of Heterogeneous communities from Homogeneous communities in social media

In social media platform, there are both homogenous communities and heterogeneous communities of users. Homogenous communities are formed through common interested user groups such as from school, workplace, organization and many more. On the same social platform, the heterogeneous communities are formed in the other way around when users start acting in a different way and so we have to choose each expert from different homogenous communities in order to make the heterogeneous group of experts from social media.

User generated content

In social media system, the contents are created and shared by the users themselves and made accessible to others. The privacy level of the generated content depends upon the user settings. Normally, the contents are shared by the user themselves, members of the communities or some other users. Since social media is an open unstructured

communication, the information is publicly available to the next users of the same social platform. But the Delphi technique is the structured asynchronous communication process where the generated contents are not made available directly to other users. The facility of user content generation can be utilized for providing the opinions of the experts for the Delphi technique. The generated content should not be made directly available to other users who are chosen as experts; but after each round, the facilitator can share the content for providing the group response.

Comments

In social media platform, commenting feature allows users to provide direct comments on articulated network and communities' group discussion. Direct commenting on the users' contents is contradicted with the controlled communication and decision coherence of Delphi techniques (Dong et al., 2012). On the contrary, Yao and Liu (2006) argued that experts can share the ideas within the interested experts group rather than rigorous round structure through the facilitator. In support they forwarded that the experts' confusion regarding the questionnaire and other assumptions can be improved from direct interaction between experts. In the design of Delphi methodological rigor, such direct interaction between experts can be valid when experts are not impacted by sub-views of other experts and they provide their own opinions. In the Delphi technique, the commenting feature can be used to provide the aggregated expert opinions and statistical measures of group response in each iterative round.

3.8 Summary of the literature review

In this section, we will summarize the literature review and find the design requirements and guidelines for developing the Delphi technique integrated with social media.

Concluding the literature review, it can be said that anonymity, controlled iterative feedback, statistical group responses and asynchronous communication hold the Delphi technique methodological rigor. Nonetheless, earlier studies of the Delphi technique carried out with social media **lacks to consider the statistical group response and asynchronous communication**. Seemingly using the Delphi technique through the internet or computer, participants may feel a compulsion to bind with the Delphi system in order to express their viewpoints, but using social media the experts are free to provide response from anywhere and at any time which means social media platform enables the asynchrony communication process in the Delphi technique and facilitators can track the questions, answers and provide timely feedback. We therefore, consider the statistical group response and asynchronous communication in design of the Delphi technique integrated with social media platform.

Our goal is to develop and conduct the Delphi technique integrated with social media. Based on the literature, it is possible to implement the Delphi technique within social media platform and also to integrate social media platform. It is not straight forward process to design and develop the Delphi technique with social media platform by considering the characteristics presented in Table 5, so we have to modify social media features to conduct the Delphi process. Integration of social media with the Delphi technique can be viewed in two approaches. The two approaches are

1. To embed the Delphi technique process within social media platform
2. To use social media platform as a tool to carry out the Delphi process

We are interested in the second approach in which Delphi technique utilizes the information available on social media and pre-processes social media's generated

content to use as expert opinions. We have summarized the problems and solutions that are found from the literature review for considering the methodological rigor of Delphi technique for designing the Delphi technique with social media platform.

Table 6. Summary of problems and solutions on designing the Delphi technique integrated with social media platform.

Problems	**Solutions**
Loosing Anonymity	Use of pen names for the experts
	Use of private profiles
Existing communication link between experts (Articulated network)	Pre-existing direct link between each experts should be destroyed and only communication link to the facilitator should be setup
Visibility of user generated contents	Setting up the privacy level of the generated contents
Direct interaction of experts by searching the users profile and making comments	

Now the conceptual framework for our system is developed based upon this groundwork.

4. Conceptual framework construction

From the above literature, groundwork for the thesis is made and which gives the base knowledge for conducting the Delphi technique. Moreover, it also provides the idea to conduct the Delphi technique through the internet. Figure 3 shows the process of conducting the Delphi technique through the internet.

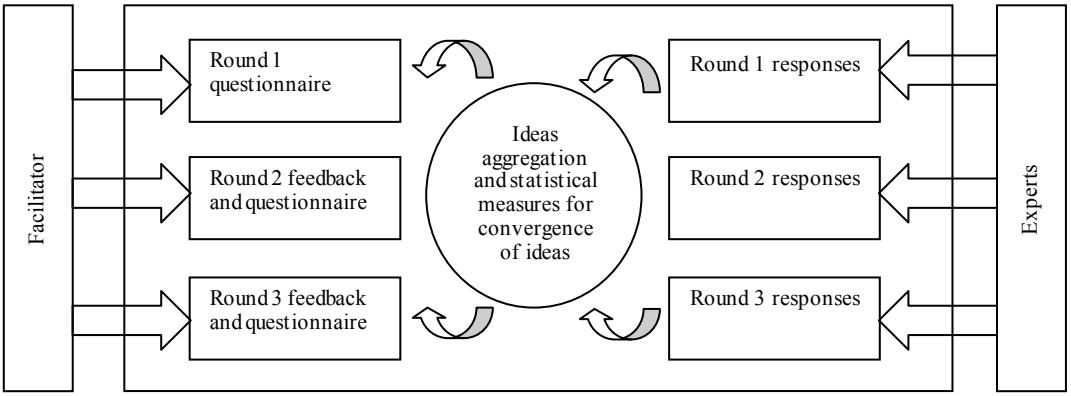

Figure 3. The basic conceptual framework for conducting Delphi approaches through internet.

The basic conceptual framework signifies that experts and facilitator interact through the web portal to provide their opinions and to manage the Delphi process respectively. In each round, questionnaires are provided to the experts and in return responses from the experts are collected as the experts' opinions. The generated opinions of experts are aggregated without changing its original meaning and the statistical measures are used to show the convergence of their opinions.

This conceptual groundwork is used as the basis for building the new conceptual framework for designing the Delphi technique integrated with social media platform. As stated in the previous section, in this thesis social media platform is utilized as a tool to carry out the Delphi process in which the Delphi technique utilizes the pre-processed users' generated content as expert's opinions which were created and available on social media platform during Delphi process. Moreover, the three characteristics were identified from the literature review as design guidelines to build the new conceptual framework.

1) Asynchronous communication
   Modeling of asynchronous communication is straight forward and for this process social media platform enables the asynchronous communication to participate in **any interesting problem at any time** in the communication process and also the **places convenient for experts**.

2) Statistical group response
   For this process, based upon the rank order scale type, different **statistical measuring tools** can be used to measure the **group response**. The detail explanation is performed in the system analysis phase.

3) Timely feedback
Timely feedback is defined as the mechanism **to calculate the statistical measure automatically and provide the feedback to the expert group after completion of each Delphi round** and the feedback is provided within the social media platform because of which experts don't need to go back and look through the web portal to view the feedback and group response. During this process statistical estimate are provided as feedback.

Using this Figure 3 conceptual framework and the three design guidelines, a new conceptual framework is constructed

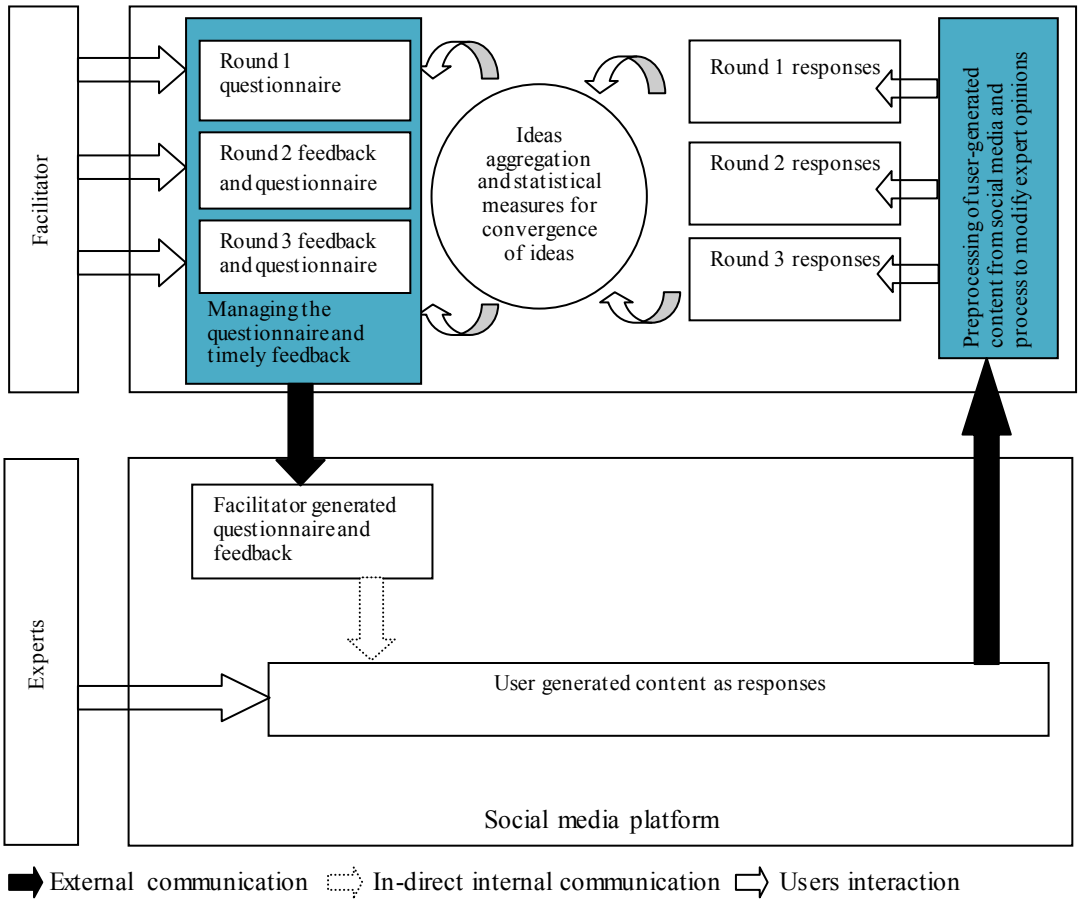

Figure 4. The conceptual framework

Based upon the groundwork (Figure 3 Basic Conceptual Framework), the design requirements and guidelines, we develop a new conceptual framework as shown in Figure 4. According to the new conceptual framework, the external communication between the web research portal and social media platform is in bidirectional order and the interaction of experts in this Delphi process is done through social media.

Managing the questionnaire and timely feedback facilitates the facilitator to provide the timely feedback in real-time and questionnaires to the social media platform.

Pre-processing of user generated content and process to modify experts' opinions is responsible to pre-process the responses that are created on social media. This module fetches and pre-processes the contents from social media platform which are generated by the expert groups and those pre-processed contents are delivered as expert opinions in the web research portal.

The developed conceptual framework provides the groundwork to design the Delphi technique process through social media and to study the feasibility of the Delphi process.

5. System architecture, analysis and design

In the previous sections, a conceptual framework was developed for guiding and designing the system. Moreover, the conceptual framework provides the base for developing the full functional software system. Following through high level system architecture design, a software system is analyzed and designed for the system implementation. In the system architecture, the functionality of each service in conceptual framework is represented by respective module and based upon the functionalities the possible solutions are analyzed to design the system.

5.1 System architecture

In the conceptual framework section, the interaction of the facilitator and experts with the system was explained and in this section, high level system architecture is designed and its related modules are explained. Figure 5 is the high level system architecture diagram which is a design based upon the conceptual framework. The system has two fold in which the facilitator interacts with the web portal and experts interact with social media platform.

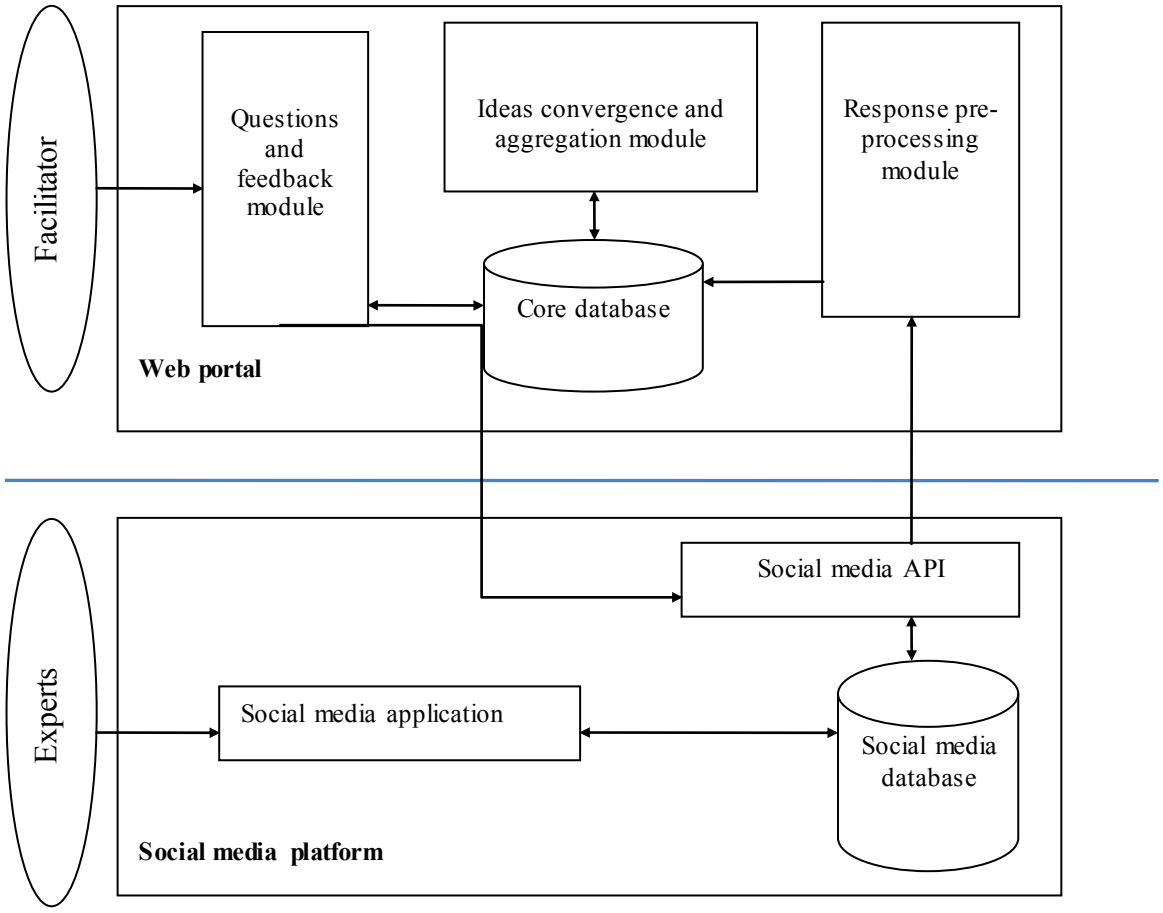

Figure 5. High level design of system architecture

The *facilitator* is a user who initiates the Delphi process and is responsible for providing the questionnaires and feedback to the experts group through the use of the web portal.

Experts are the group of users who interact with the web portal through a social media platform to provide the answers based upon the questionnaire asked by the facilitator.

A *web portal* is an application which is able to interact with social media application. It includes a different web page for providing the questionnaire, showing the statistical group response and other related functionalities. Inside a web portal, there are three core modules which provide different functionalities. The three core modules are questionnaire and feedback module, ideas convergence and aggregation module, and response pre-processing module.

Questionnaire and feedback module is responsible for providing the questions and feedback into a social media application. It is also responsible to stores the questions and feedback into the database. In each round of the Delphi process, the facilitator uses this module to provide the questions and feedback.

Ideas convergence and aggregation module is responsible to measure the convergence of the answers provided by the experts through statistical tool and the comments collected for changing their opinions are collected and aggregated.

The *response pre-processing* module is responsible to pre-process the unstructured content received from social media application.

The *database* is the data storage for storing the questionnaire, answers and a statistical measure of the experts' response.

Social media application is an application from where the experts interact to provide the answers to the questions.

Social media *API* is an application programming interface which helps to set up the external communication between the web portal and social media application. Specifically through the use of social media API, the facilitator can provide the questions and feedback to social media application and after that expert can provide their answers.

Social media database is the data storage for storing the user generated content. In this research, the user generated contents are the questionnaire, feedback and answers.

The above description of the high level system architecture presents the basic operation of each component and now in the system analysis phase; possible solution for the module is described and analyzed to develop the system.

5.2 System analysis

The purpose of this thesis is to design and develop the effective application for the Delphi technique which integrates with social media and to design the Delphi technique effectively proper requirement and possible solution should be analyzed. In this analysis phase, possible solutions are analyzed and examined based on the requirements for designing and implementing the system. In order to analyze the system, the system is separated into a questionnaire and feedback module, ideas convergence and aggregation module, response pre-processing module and social media application.

In this stage, questionnaire and feedback module is excluded for detail analysis because this module is not responsible to detect and analyze the simplicity and vagueness of the questionnaires but it is responsible for storing and providing the questions with or without feedback to the expert group from the web portal to social media application. To transfer the questions with or without feedback between social media application and web portal an appropriate social media API is needed and the selection of this API depends upon the kind of social media platform selected for this system. And also the detail analysis of the design of the questions to be used in the questionnaire and feedback module is not discuss, but it is clear the questionnaire to the expert group will be of rank order scale type questions and the maximum number of questions to be used in the experiment will be four and therefore, questionnaire and feedback module should be capable of handling rank order scale type questions and feedback for storing in the database and broadcasting in social media application.

In addition, response pre-processing module is also excluded from the detailed analysis because it is only responsible for detecting and synthesize the unstructured responses captured from social media and accordingly it provides the correct input format to the ideas convergence and aggregation module in different rounds of the Delphi process.

Hence ideas convergence and aggregation module and social media application are only considered for system analysis and to find the possible solutions.

5.2.1 Ideas convergence and aggregation module

This ideas convergence and aggregation module is responsible to analyze the responses of the expert group and to ensure whether the consensus of the experts had reached or not for making the final decisions. In general, the working mechanism of ideas convergence and aggregation module depends upon the kind of questionnaire asked in each round of the Delphi process and depending upon the questionnaire and its answer appropriate statistical measuring tools has to be chosen for analyzing the responses. To analyze and to make a better understanding of system properly ideas convergence and aggregation module are divided into two parts.

a) Ideas convergence

b) Ideas aggregations

Ideas convergence

The main objective of ideas convergence sub-module is to determine the convergence of the experts' opinions and to visualize whether experts' opinions lies in the group response or not. The convergence of the opinions can be determined by measuring the stability of the group responses in each Delphi round and this convergence of opinions will enable the consensus of opinions among experts. Therefore, **group stability** of the experts' responses is the necessary criterion for making the consensus among experts and an understanding of the measurement of convergence of opinions might be useful.

Measurement of the convergence of the opinions in the Delphi studies depends upon the types of data collected (i.e. the number of experts, the degree level of agreement, types of questions and many more) and therefore appropriate statistical tools should be chosen to measure the convergence of opinions. As in this experiment, we are only focusing on using the rank order scale type questionnaire in which the expert group response will be in the quantitative form. From Table 3, it can be said a statistical tool like central tendency (e.g. mean, median, and mode) and level of dispersion (e.g. standard

deviation, inter quartile range, variance and many more) is used to measure the group response. In addition, complex statistical tool like parametric and non- parametric are also used to measure the group response (Kalaian and Kasim, 2012), but in order to use those complex statistical tools some of the minimum criterion (e.g. normal distribution of data, skewness and many more) should also be fulfilled by the data.

In this thesis, we are only interested in selecting and using some of the statistical tools for measuring the ideas convergence rather than to compare and find the best possible statistical tool for measuring the ideas convergence. From this viewpoint, we have studied different statistical approaches used by researchers.

Analytical approach for measuring the consensus between Delphi rounds examined by Greatorex and Dexter (2000) used the mean and standard deviation for representing the group opinion and level of agreement and disagreement among experts. In their study, these two statistics tool i.e. mean and standard deviation, not only measured the consensus at the end of Delphi rounds, but also measured the consensus agreements and disagreements between each subsequent round. The researchers assumed that low standard deviation indicates high agreement among experts and high standard deviation means disagreement and a measuring value was fixed to determine the level of consensus agreement and disagreement for low and high standard deviation.

In support of evolution of agreements between Delphi rounds and measurement of group stability based upon agreement percentages, ranking importance and weighted Kappa values approached by Holey et al. (2007) also demonstrates the effective way to measure the consensus and group stability. In this approach, Colazzi's 7 stage thematic analysis was used to rephrase the appropriate opinions in the first Delphi round. In the subsequent rounds, Sim and Wright scaling method was used to find the agreement and the importance of the opinions and the agreement percentage level was calculated to compare agreement scale between rounds. In addition, in each round, Weighted Kappa (K) statistic was used to determine the agreement level on opinions based upon importance ranking in which high kappa value represents the group stability upon opinions and agreement level in between rounds.

Rice (2012) used the relative importance rankings on the statements presented by the experts and calculated mean and standard deviation to rank and to determine the consistency of statements in Delphi rounds. Rating scale from 1 to 5 was used to rate the statements in which 1 represented the statements of no importance and 5 represented the statements of high importance.

Kalaian and Kasim (2012) criticized the use of simple statistical tools (e.g. mean, calculation of responses percentage) and presented the parametric (e.g. coefficient of variation, F-ratio, Pearson correlation coefficient, Paired t-test) and non-parametric (e.g. McNemar Change Test, Spearman's Rank Correlation Coefficient, Wilcoxon paired Signed-Ranks T Test) statistical tools to check the stability and consensus of the responses and to determine when to terminate the Delphi rounds. In between Delphi rounds, these simple statistical tools can't better administer and present the collected data in an efficient manner because there is a slight change of mean values and percentages responses.

To forward some knowledge on using some complex statistical tool we have chosen Coefficient of variation (CV) as an example. In the experiment conducted by Kalaian and Kasim (2012), a CV value greater than 1 represented the responses of the experts are scattered and vice-versa. Moreover, the stability of the group responses is measured through absolute difference value of CV between two subsequent round in which

absolute difference of CV equal to zero or tends to zero signifies the group stability of responses and which implies there is no need of further Delphi rounds.

Shah and Kalaian (2009) used the 5-point Likert-type scale questions with 5 being of high importance and 1 being low importance and tested the best parametric tool for analyzing the Delphi data. Their study indicated that the CV is reliable for measuring the stability and consensus of responses among other complex statistical tool.

Ideas aggregation

The ideas aggregation sub-module is responsible to combines the individual opinions to make the group decision. In this experiment, the individual opinions refers to the comments written in natural language which are provided by the expert group to support their reason of changing individual viewpoints in the Delphi process.

Ideas aggregation is simple and easy when the information is in a structured format. For e.g. the answer from the questions (e.g. "How many users will be in the Facebook till 2025 A.D?") will be relatively easy and straightforward. But in this thesis, the comments from the expert group will be in non-quantitative form. In such non-quantitative information, there might be redundancy of the information. More specifically, the comments provided by the experts in each subsequent round of the Delphi technique may contain different terminologies used for the same terms and also can have a different sentence structure with similar themes. The solution to such condition is to use the single term by grouping different terms in the answer that have similar meaning and later uniting the answer description without changing the original meaning of experts answer (Schmidt, 1997).

The above solution can be done in two ways. First is the non-automatic procedure in which the facilitator can analyze all the sentence meaning and presents as a group summary and the second is the automatic procedure in which, natural language processing (NLP) tool can be used to analyze and synthesize the information, but in this phase we excluded to perform the detail analysis solution of using the NLP to extract the summary and also use of facilitator to analyze the sentence. Likewise the response pre-processing module, the idea aggregation sub-module is only responsible to collect the experts' comments and list all the comments as a summary report.

5.2.2 Social media application

In this thesis, we are using social media application as a tool to carry out the Delphi process and therefore selection and analysis of the appropriate social media application play a significant role to perform the Delphi experiment. The main role of social media application in this thesis is to facilitate the experts to view the questionnaire and feedback and allow some mechanism to provide answers to the questionnaire provided by the facilitator. Therefore, a communication channel is required to share and transfer the content from the web portal to the social media application.

A solution to establish the communication channel between web portal and social media application is to use the web Application Programming Interface (API). Before we analyzed social media application, a concept of web API is introduced. In terms of web, web API is a communication channel to interact with the web application by requesting and receiving response messages in structured format (e.g. XML, JSON) through Hypertext Transfer Protocol (HTTP). Normally, web API is also called web service.

In the earlier section of this thesis, it is described that social media application is developed with similar characteristics in different strategy with the vision to share the information on social networks. For e.g. Facebook, MySpace, Twitter LinkedIn, YouTube, Flicker and Google plus are the most popular media applications and the purpose of those kinds of social media are to share the content. But the types of content to be shared in such application might be different. Therefore, rather than analyzing different types of social media application individually, we had generalized social media application features or characteristics and compared with the Delphi technique in Table 5. Consequently, analysis done for social media application in the literature review will be used to design the system.

5.3 System design

This system design is based upon the system architecture and the analyzed solution for different module and sub-module of the system. Therefore, in the next section an appropriate solution is selected for the system module and fitted with the system architecture to design the system diagram.

5.3.1 Solutions for system module

Based upon the available solutions in the system analysis, we only select the appropriate solution for the ideas convergence and aggregation module and social media application. And as discussed in the system analysis, possible solutions for the questionnaire and feedback module and response pre-processing module is not studied and therefore, for those two modules a simple algorithm is developed and the algorithm is discussed in the implementation phase.

Ideas convergence and aggregation module

Regarding the ideas convergence process, a decision rules should be established to determine the consensus of the opinions through statistical tool like central tendency (e.g. mean, median, and mode) and level of dispersion (e.g. standard deviation, inter quartile range, variance and many more).

Among the possible approaches for the ideas convergence, we decide to use the mean and the coefficients of variation.

We adopted mean because the questionnaire is of rank order scale type and experts rank on each factor can be used to evaluate the average value for that factor and then the highest average value of the factor can be used to determine the relative importance.

In addition, we adopted coefficient of variation to determine the stability in the consensus of the group response. The stability of the group response can be calculated by the absolute difference value of the coefficient of the variation of two subsequent rounds. A smaller value or close to zero of absolute CV difference indicates the consensus is reached.

And for the ideas aggregation, a simple algorithm is developed and is discussed in the implementation phase.

Social media application

Among all social media platform, Twitter is selected as an appropriate social media application for the design. There are numerous reasons behind choosing the Twitter for the system design.

First, Twitter is a micro blogging social media application where users can type up to 140 characters to share the content. Moreover, the questionnaires are of rank order type scale questions and the total characters of the questions & feedback will be less than 140 characters.

Second, up to 2010, Twitter registered 41.7 million users as active users (Kwak et al., 2010) and at present, Twitter statistics (2013) reported 200 million users as active users. Due to the increasing trend of active user it is assumed that most of the participants (i.e. experts) will be familiar with the twitter feature in the experiment.

Third, hash tag or "#" symbol is the powerful tool to relate the content sharing in the Twitter because of which we can perform the long chain conversation.

Fourth, the Twitter provides the Web Service API because of which the communication channel between the web portal and social media application can be established.

5.3.2 The system design diagram

Based upon the selected system solution with the system architecture a system diagram is design in Figure 6.

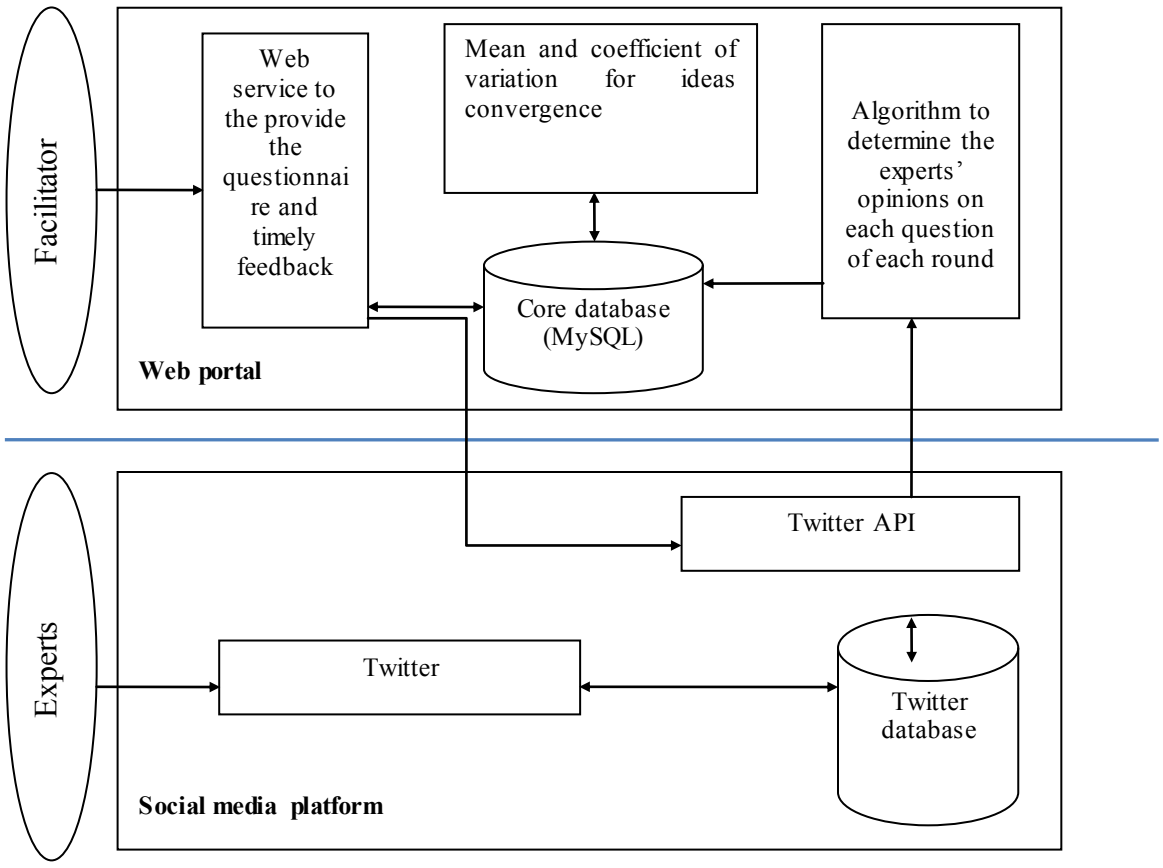

Figure 6. Diagram of system design

The system design diagram is constructed after identify the requirement in the conceptual framework and adding the functionality in system architecture. In the end, the solution for the functionality is analyzed and combined as shown in Figure 6.

According to the diagram, we used the simple algorithm for the questionnaire and feedback module, response pre-processing module and ideas aggregation module.

Regarding the ideas convergence sub-module we used the mean and coefficient of variation as a statistical tool for determining the relative importance of the factors and stability in the consensus.

Among the popular social media application, we selected Twitter and its API with HTTPs protocol. Twitter API is used to make the communication channel between the web portal and social media application.

And in order to store the data of the web portal, we selected and used the MySQL database. In the next section, the system is implemented and after which data is collected for the evaluation.

6. Implementation

In the previous chapters, three characteristics of Delphi technique are identified as the design guidelines to build the new conceptual framework, and the high level system architecture is developed. Based on the high level system architecture, the possible solutions are analyzed in the system analysis phase and appropriate solution is selected for designing the system.

Further based upon the system design diagram, a system is developed for conducting the experiment. To develop the system, PHP is selected as the programming language and MySQL is selected as the database to store the data. The overall purpose of the experiment is to study the feasibility of designing the Delphi technique using social media. In order to conduct the experiment, the course feedback evaluation is chosen as a context area and it is regarded as the first attempt of implementing social media using the Delphi technique principles for conducting the course evaluation.

In the academic sectors, there is always a challenge to improve the quality of education and standardization of the education process and this is the main reason behind choosing the university course feedback as a context area for the experiment so that ideas can be obtained from expert to maintain the good quality education There are different factors which directly or indirectly helped or hindered to learn and understand the university courses. (for example: lack of proper course contents, course schedule and so on). Moreover, in such institutions, it is difficult to know the individual problems. It is also a hectic and tedious to make the decision from the inappropriate information regarding the courses.

In this phase, the developed system comprised of two folds. The first one is the web portal and the second one is social media application and Twitter is selected as social media application. The web portal constitutes of three different modules and the detailed descriptions about the development of modules are explained in the following chapters. Moreover, the developed system only allows the authenticated users to access the system. Figure 7 shows the accessibility of the system to users after authentication.

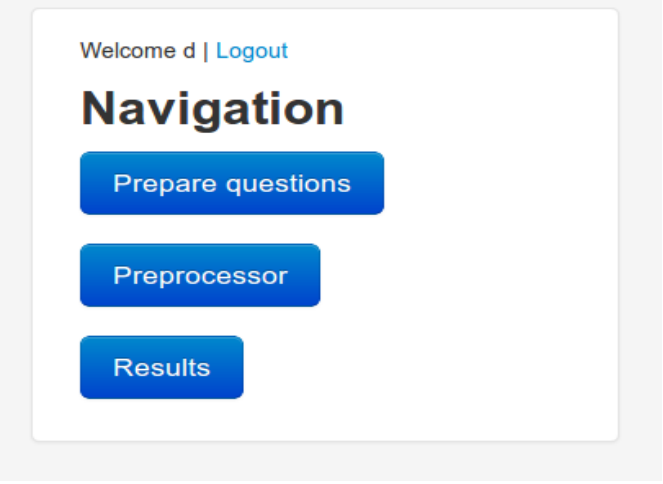

Figure 7. System access after authentication

6.1 Questions and feedback module

In the previous chapter, it is mentioned that the system is used for conducting the course evaluation in the university and the rank order scale type questions are used for the course evaluation. Therefore, the questions module is responsible to prepare the rank order scale type of questions. In addition, the mechanism to provide the feedback to the participants is also integrated with the questionnaire module. Figure 8 shows the interface for the facilitator to prepare the questions and to provide the feedback.

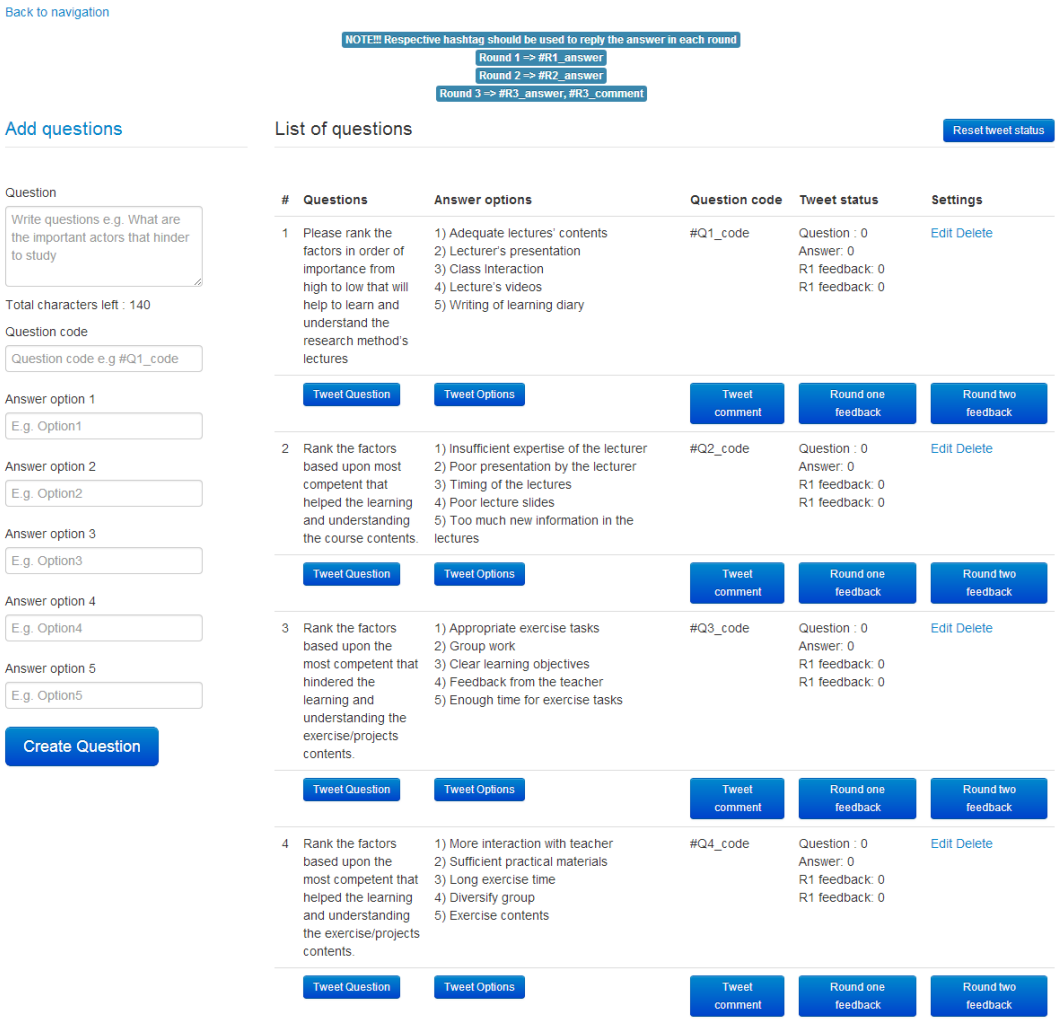

Figure 8. Questionnaires and Feedback module

As shown in Figure 8, the questions are prepared with the suitable options and stored in the database. In addition to the questions and options, the unique question code (for example: #Q1_code) is assigned to each question to differentiate each question and that unique question code is used as the hash tag (for example: #Q1_code) in Twitter to link the questions and options. Moreover within the same web page, the questions are listed and are allowed to edit or delete. The developed system allows to provide the suitable options to the questions; however, there is limited to provide only five options for each question.

Besides question preparation service, feedback providing mechanism is also added within the questionnaire and feedback module. The group response after the completion of each round is stored in the graphical format in the database and then it is provided to

the participants as a feedback. The detail description about the group response is done in the ideas convergence chapters.

When the questions and feedback are prepared, the facilitator is able to tweet the questions and their relative options sequentially and the feedback is tweeted only after the completion of each round along with the next round of questionnaires. A simple algorithm is developed to detect the size of the tweet messages because of the limitation of Twitter character size (i.e. 140 characters) to tweet. In the case of options, the total formatted options (see Figure 9) character size is detected and overflow options is tweeted as the next tweet messages with the same hash tags as questions. A tweet status section is designed for notifying the users about the total number of tweets made for each question, options and feedback.

Figure 9. Questions options format

6.2 Response pre-processing module

The response pre-processing module is responsible for detecting the responses of the participants in the Twitter and synthesizing the unstructured responses in the correct input format for determining the ideas convergence and aggregation in different rounds. Figure 10 shows the interface for the response pre-processing module.

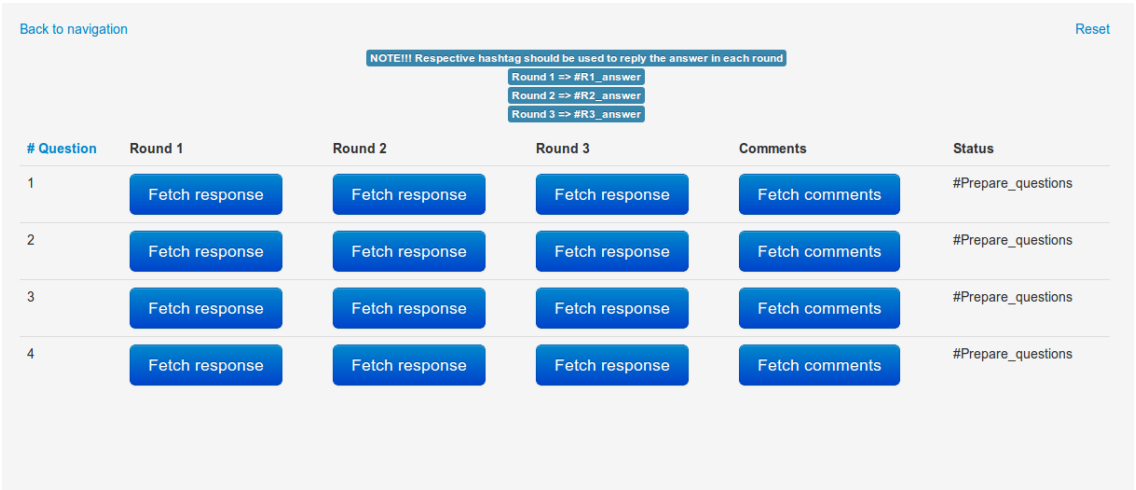

Figure 10. Response pre-processing interface

The interface is divided into round one section, round two section, round three section, and the comment round section for each question to fetch the respective round responses through Twitter. The mechanism of processing the response is described below.

The unstructured responses of each question to each round consist of the hash tags (see Appendix D) along with the answers. Appropriate hash tags are used to respond to the questions in each round by the participants. However, the format of providing the response to each question by the participants is pre-defined. For example, the pre-defined format of the response to the question number one of round one is "#Q1_code #R1_answer DACEB". In the response, "#Q1_code" represents the question number and "#R1_answer" represents the round number. Since, the questions are of rank order scale type and the options are represented by the alphabets and while providing the answer, the alphabets are used rather than the whole option making it simpler and better to understand, therefore "DACEB" is the answer to the questions. Moreover, the value for the option in the participants answer is given in descending order where the first choice has the highest value of 5 and the last choice has the least value which is 1 and is stored in the database for calculating the group response. Whereas, in the comment round, the hash tags are removed from the responses and the plain text is stored in the database. In addition, the pre-processing module is able to handle the modification of the expert's opinion.

6.3 Ideas convergence and aggregation module

The ideas convergence and aggregation module is responsible to determine the convergence of experts' opinions and to visualize whether experts' opinions lie in the group response or not. Figure 11 shows the interface for the ideas convergence and aggregation module. This interface is used by the facilitator to calculate the results after the completion of each round.

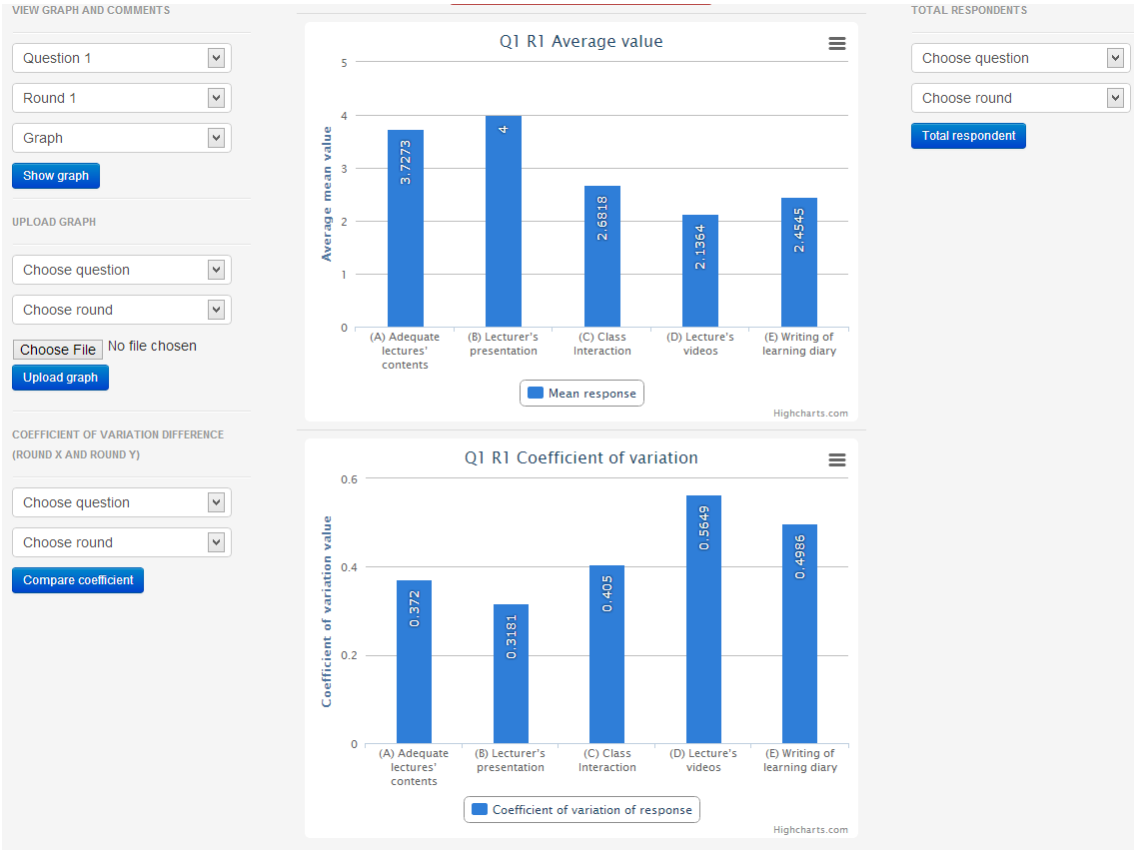

Figure 11. Ideas convergence and aggregation interface

The view graph and comments component are responsible to calculate the mean value and coefficient of variation of the question's options which are provided as the answer

by the participants. In addition, the graphical form of the mean value and the coefficient of variation of the options are presented.

The upload graph component is responsible to upload the graphical form of the mean value to provide as feedback.

The coefficient of variation difference component is used by the facilitator to view the coefficient of variation difference of the question's options between two rounds and this will helps facilitator to know the group stability of the experts' responses.

7. Evaluation with field experiment

The main purpose of this field experiment is to study the feasibility to conduct the Delphi technique with social media. The technological background survey is conducted to study the background information of technological knowledge of the participants and to know the detail consideration to be taken in order to perform the experiment and the participants' willingness to participate in the experiment. Next, to perform the field experiment, Research Methods course and exercise is selected as the experimental course for university course feedback. The collectable data from the field experiment were collected and stored for further analysis. In addition, the results from the post survey were included.

7.1 Technological background survey

The technological background survey was conducted from the 4th of November to 6th of November, 2013 in the Design Science Research (DSR) exercise and the DSR exercise is the part of the Research Methods exercises. There are two reasons to select DSR exercise group to conduct the technological background survey. First, this course is the compulsory course for the students to graduate and there will be a huge number of students to participate in the exercises. Second, my supervisor is the responsible teacher to conduct the DSR exercises. The questions in the survey comprised of questions related to the use of social media and the use of the course feedback system (see Appendix C). A Google form is used to make the survey and was available to every student through internet in the DSR exercises.

All the collectable data through survey is saved and backed up in order to support further research. In the survey, 67 students participated and provided their responses, among which most of the participants were of age group between 21 years and 30 years and had at least a high school degree. It confirms that the participants are able to understand the basic statistical measuring value through central tendency (for example: mean, median and mode).

Most of the participants (43%) use social media less than 1 hour or less (approximately) daily. 30 percent of the participants spend approximately 2 hours daily in social media while the only 4 percent of the participants use social media more than more hours daily. Among Facebook, Twitter, YouTube, and Google+ 35.5 percent of the participants used YouTube followed by Facebook (30.2%). Twitter is only used by 13.6 percent of the participants (see Figure 12).

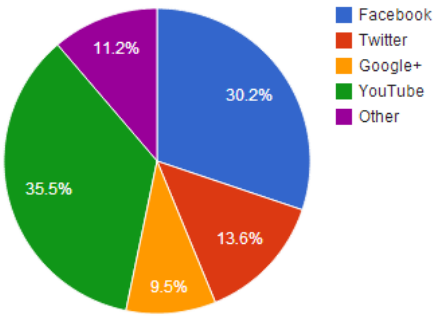

Figure 12. Frequently used social media by participants

Moreover, they would also like to recommend other participants to use YouTube (33%) followed by the Facebook (29%). When the participants were asked to select social media they used the most, Facebook is selected by the maximum participants approximately 46 percent followed by YouTube which is around 34 percent. The least used social media are Twitter and Google + with 3 percent.

More than half of the participants have the Twitter accounts approximately 60 percent. But only 15 percent of the participants are the active users of Twitter. The participants were also asked to select the level of the knowledge on the use of Twitter. 48 percent of the participants have the basic knowledge. 34 percent of the participants do not have any knowledge on using twitter while 15 percent of the participants have intermediate level of knowledge. Despite the fact most of the participants (85%) didn't use the Twitter actively, 70 percent of the participants were familiar with the use of hash tag (#) in the Twitter (see Figure 13).

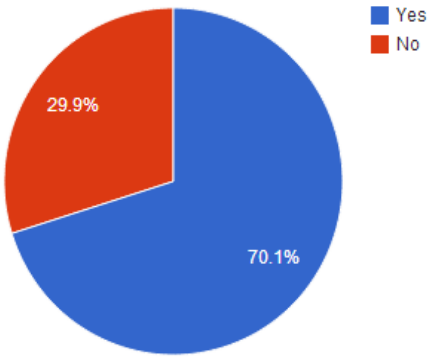

Figure 13. Participants' familiarity with the use of hash tag

In the survey, participants were asked about the frequency of use of twitter to tweet message and view other's message on a daily basis. Almost 97 percent of the participants selected the option "Not at all (0 times) or couple of times in a week". Only 1 percent of the participants tweet 1-3 times a day and same is the percentage of the participants who tweet 4-6 times daily. This result shows that the most of the participants are not using twitter so often in their daily life to tweet the message. However, in case of viewing the other's tweet message, the statistics is better than the tweeting their own message. 76.1 percent of the participants either view zero times or couple of times in a week. 14.5 percent of the participants view the tweet message 1-3

times daily and 4.5 percent of the participants each view 4-6 times and 10 or more times daily (see Figure 14).

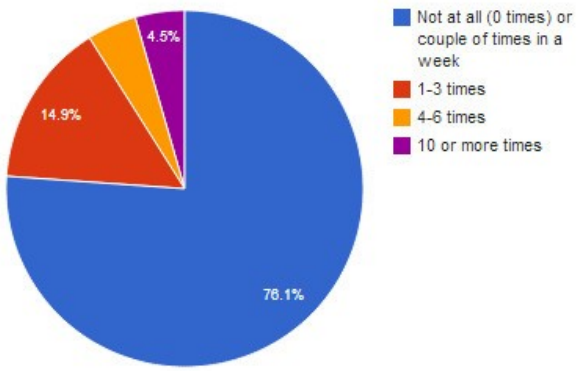

Figure 14. Frequency of participants viewing other's tweet message

The rest of the questions in the survey were focused on the use of social media on the course feedback system and to know the use current course feedback system. When the participants were asked about the course feedback system they were using in University of Oulu, 65 percent of the participants selected the University WebOodi feedback system while 25 % selected the paper based feedback form.

42 percent of the participants provided the course feedback in the University of Oulu. 18 percent participants mostly provide course feedback. Only 6 percent of the participants always provide course feedback. However, 28 percent of the participants never or almost never provided course feedback in the University of Oulu.

Furthermore, when the participants were asked about their motivation to provide the feedback on course, the result was positive. However when the participants were asked the level of motivation from the current feedback system, the response was mixed. Finally the participations were asked if they were interested on using social media to provide course feedback. More than half of the participants (55.2%) were willing to use social media to provide course feedback (see Figure 15).

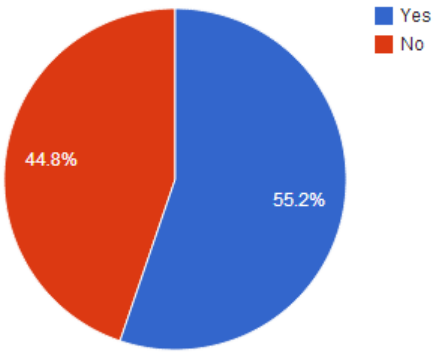

Figure 15. Motivation of the participants to use social media in course feedback

The statistical results of the technological background information reveal that participants are motivated to use social media to provide the course feedback and are

familiar with social media terms and technical competence. More specifically, in the experiment, participants are using the Twitter and Twitter hash tags (#) and the results confirm that most of the participants are familiar with the use of Twitter hash tags (#). In the experiment, different hash tags are used to represent the question number and the Delphi technique rounds (see Appendix D). In addition, the results also confirm that the participants are able to understand the basic statistical measuring values through central tendency (e.g. mean, median and mode) which are provided after the completion of first and second Delphi rounds. Most of the participants have their own Twitter accounts which can be utilized for the experimental purpose; however, when the participants were asked to provide free comments or ideas about the course feedback systems, they wanted to use social media for private purposes only and did not want social media to reveal their student life. Since the participants were not willing to use their personal account for the experiment, so for the experimental purpose, different new Twitter accounts for each participant have to be created.

In order to achieve the purpose of this experiment, the technological background survey provides the detail consideration to be taken to perform the experiment.

7.2 Experiment process

Before conducting the experiment, the participants were given the 15-20 minute training presentations from November 11, 2013 to November 13, 2013 in the course exercise group. From the technological background survey result, only 15 percent of the participants were the active users of Twitter and about half of the participants only had basic knowledge of Twitter. Misleading information and inappropriate problems to the participants in the experiment might lead to unwanted solution in Delphi technique and to make the clear understanding of the problems the participants should be provided with sufficient information beforehand. Therefore, the overall purpose of the presentation was to briefly describe the experiment purpose including the outcome of the research, to announce the start date and end date of the experiment round, and to check the capability of the participants to provide the accurate response. The example questions (see Appendix B) were presented to the participants with the example answer format, and the cheat sheet of hash tags (see Appendix D) to provide the response. Altogether 52 participants provided their response in which only 35 students provided the answer in the correct format. At the end of the training presentation, all the students of the course were notified about the free ticket of one cup of coffee and pulla as an appreciation for randomly selected 20 participants in the experiment.

7.2.1 Twitter account setup

From the technological background survey result, it seems that the participants may not be willing to use their personal account for the experiment so the new Twitter accounts for all the participants were created and the settings were setup. In addition to the participants Twitter account, the facilitator's account was also created and follow mechanism relationship was established between the participants and facilitator Twitter account. In order to maintain the anonymity of the participants, unique Twitter user name was used and to maintain the privacy level of the participants' generated contents, the tweets were made protected through setting. Moreover, the time zone in the Twitter setting was changed to fit the Finnish time zone.

7.2.2 Questions preparation

Altogether, the four questionnaires were prepared for the experimental purpose. The questionnaires were of rank order scale types (see Appendix A) in which two of the questions were related to the class lectures feedback and two of the questions were related to class exercises feedback. The questions were prepared with the help of the University of Oulu WebOodi course evaluation system questionnaires and the real feedback provided by the past students of the course. To prevent biasness during the questions' preparation, the past real feedback of the course were collected and provided as options to the questions.

7.2.3 Define experiment

After the experimental setup, questions preparation, and participants training, the experiment started from November 11, 2013 and ended on November 22, 2013. The total 12 days were divided into different four time frames to allocate the days for each Delphi round. Table 7 shows the time frame allocation for providing the response by the participants for each round.

Table 7. Time frame allocation for the Delphi rounds.

Delphi rounds	**Start date**	**End date**
Round 1	11.11.2013, Monday	15.11.2013, Friday
Round 2	15.11.2013, Friday	18.11.2013, Monday
Round 3	18.11.2013, Monday	21.11.2013, Thursday
Comment round	21.11.2013, Thursday	22. 11.2013, Friday

The students of the course had four exercise groups and the schedule for four exercise groups had different time and at different locations. Therefore, the time frame for the round one was allotted 5 days in which the first exercise group got 5 days to participate and the later two exercise groups got 3 days to participate.

Except comment round, in all round of the experiment, the four questions (see Appendix A) are sent to the participants at once whereas the comment round has only a single question that is "What are the reasons for changing opinion in between two rounds?" which is asked to the participant so that they could provide the opinion for changing their answers in between two subsequent rounds. The way to respond to the questions in each round is by creating a new tweet in their respective Twitter account. And the participants hold the right to provide answers to any number of questions in each round.

At the beginning of the first round, the participants were informed verbally and requested to answer the questions. After the completion of the first round, all the answer were used to calculate the mean value & coefficient of variation of each question options.

In the second round, the mean value of the group response was sent to the participants along with the questions. In this round, the participants were notified by email regarding

the start and end of the round and were asked to reconsider their answers. A similar process was repeated for the third round.

Later in the comment round, the participants were asked to critique and specify the reasons for changing the answers in between rounds.

7.3 Results

After the observation, the data were recorded and backed up for further analysis. In this section, the results of the observations are presented.

7.3.1 Participants

One important aspect of the experiment is the selection of the appropriate participants and their number. For the experiment, it is fair enough that course's students can be assumed as homogenous group type experts because in the experiments the questionnaires are related to the course's lectures and exercises feedback. Table 8 shows the number of participants in different rounds.

Table 8. Number of participants in experimental rounds.

Delphi round	Question one	Question two	Question three	Question four
Round 1	22	21	20	20
Round 2	12	12	12	12
Round 3	9	9	9	9

The experiment is the long process in an asynchronous manner in which participants have the right to participate in any kind of questions from anywhere and at any time because of which the number of participants in different questions is not same. However, the time frame to provide the response to the questions is set for each round.

7.3.2 Answer to Questions

In the experiment, the four questions were asked to check the group consensus and also the group ideas convergence was the key results of this experiment to be examined. The collected data in the experiment are presented as the summary of the results. In the later section, the results of each round are used for the analysis. Appendix E shows the symbolic representation of the statistical name used in Table 9, 10, 11 and 12. In these tables, the mean values in round one , round two and round three are represented by M_1,M_2 and M_3 respectively; similarly the coefficient of variations in round one, round two and round three are represented by CV_1, CV_2 and CV_3 respectively.

The first question in the experiment was "Please rank the factors in order of importance from high to low that helped to learn and understand the research methods' lectures". The question was designed to know the importance of each factor in the lectures. Table 9 shows the mean value and coefficient of variation of each factor in each round of the first question.

Table 9. Mean value and coefficient of variation for understanding the course.

Options	M_1	M_2	M_3	CV_1	CV_2	CV_3
Adequate lectures' contents	3.7273	3.25	3.2222	0.372	0.4462	0.3392
Lecturer's presentation	4	4.1667	4.2222	0.3181	0.2741	0.2588
Class interaction	2.6818	3	3.1111	0.405	0.252	0.408
Lecturer's videos	2.1364	1.6667	1.7778	0.5649	0.5411	0.5466
Writing of learning diary	2.4545	2.9167	2.6667	0.4986	0.4364	0.6219

After the end of the third round, participants ranked the "Lecturer's presentation" as the highest importance that will help in learning and understanding the research methods' lectures whereas the effectiveness of "Lecturer's videos" as less important. Despite the fact that the factors (options) have different mean value (M_1, M_2 and M_3) the rank order of the factors are same in all round of the experiment. The coefficient of variation (CV) in all the round of the experiment is less than 1. This shows the response of the participants are not scattered to the mean of the responses for each factor.

The second question in the experiment was "Please rank the factors in order of impact from high to low that hindered to learn and understand the research methods' lectures". This question is designed to know the impact of each factor in the lectures. Table 10 shows the mean value and coefficient of variation of each factor of the second question in each round.

Table 10. Mean value and coefficient of variation for hindering the course learning.

Options	M_1	M_2	M_3	CV_1	CV_2	CV_3
Inadequate lecturers contents	3.2857	3.1667	3.4444	0.3745	0.3054	0.3871
Less class interaction	3.0476	3.0833	3.4444	0.4695	0.434	0.2943
Poor lecture notes	3.619	3.4167	3.1111	0.269	0.3054	0.3388
Lectures timing	3.4286	4	3.6667	0.4478	0.4408	0.4724
Lecturers insufficient expertise	1.619	1.333	1.3333	0.6013	0.3703	0.375

At the end of the third round, the participants ranked the "Lecturer's timing" as the most hindering factor to learn and understand the lectures whereas "Lecturers insufficient expertise" was considered as the least hindering factor to learn and understand the lectures. The ranking order of the factors has varied in each round, but the "Lecturers insufficient expertise" is ranked as the factor that causes least hindrance to learn and understand the lecture in all rounds. Except in the first round, the coefficient of variation of all the factors is less than 0.5 and which shows the amount of variation of the participants' response in second question is low.

The third question in the experiment was "Please rank the factors in order of importance from high to low that helped to learn and understand the research methods' exercises". The question was designed to know the importance of each factor in the exercises.

Table 11 shows the mean value and coefficient of variation of each factor of the third question in each round.

Table 11. Mean value and coefficient of variation for understanding the exercise.

Options	M_1	M_2	M_3	CV_1	CV_2	CV_3
Appropriate exercise task	4.25	4.4167	4.3333	0.2517	0.2172	0.1999
Group work	3.6	2.9167	2.8889	0.3043	0.4174	0.5029
Teacher's feedback	2.6	2.5	2.6667	0.4735	0.4553	0.6219
Clear learning objectives	2.75	3	3	0.4066	0.3386	0.2887
Enough time for exercise tasks	1.8	2.1667	2.1111	0.7119	0.3795	0.6462

At the end of the third round, the participants ranked the "Appropriate exercise task" as the most important factors in the exercises whereas the "Enough time for exercise tasks" as the less important factors that support in learning and understanding the exercises. In all rounds, the mean value of the "Appropriate exercise task" and "Enough time for exercise tasks" is different, but those two factors are ranked first and last respectively. Also in the third question, the coefficient of variation of all the factors are less than 1 which indicates that the participants' response is not scattered; however the amount of variation of the participants' response in the third round is high compared to other rounds.

The fourth question in the experiment was "Please rank the factors in order of impact from high to low that hindered to learn and understand the research method's exercises". This question is designed to know the impact of each factor in the exercises. Table 12 shows the mean value and coefficient of variation of each factor in each round of the fourth question.

Table 12. Mean value and coefficient of variation for hindering the exercise learning.

Options	M_1	M_2	M_3	CV_1	CV_2	CV_3
Irrelevant exercise task	2.7	2.5833	2.7778	0.5649	0.3447	0.3934
Large exercise group	2.7	3.0833	3	0.5112	0.6088	0.6009
Inadequate lecturer feedback	3.1	2.4167	2.4444	0.3759	0.5657	0.5455
Tough exercise task	3.4	3.75	3.8889	0.4995	0.378	0.3736
Lack of joint discussion	3.1	3.1667	2.8889	0.4173	0.4714	0.4394

At the end of the third round, the participants ranked the "Tough exercise task" as the most hindering factors in the exercises whereas the factor "Inadequate lecturer feedback" has the less impact that hinder in the exercises. To this question, the ranking order of the factors in the second round and third round is almost similar. In addition, the coefficient of variation of the factors in all rounds is less than 1 and this indication signifies that the responses of the participants are not scattered.

7.4 Analysis

In the previous chapter the course feedback evaluation is selected as the context area to conduct the experiment and the results of the experiment are summarized. In this section, the results of the experiment and the developed prototype are analyzed.

7.4.1 Ideas convergence

Coefficient of variation (CV) determines the scatteredness of the data (Kalaian and Kasim, 2012). In this study, an absolute difference of CV in between two consecutive rounds is used to compare the stability in the results given by the participants. If the value of CV is less than 1, it means that the data are not scattered; but if the value of CV is greater than 1, it shows that the data is scattered. For the analysis of the result, the difference between the CV of each round for each question is taken which is presented in Table 13, 14, 15 and 16. Mathematically the difference can be written as:

$$\text{CV difference R2 and R1 } (CV_{R1\&R2}) = CV_{R2} - CV_{R1} \quad (1)$$

$$\text{CV difference R3 and R2 } (CV_{R2\&R3}) = CV_{R3} - CV_{R2} \quad (2)$$

Where, R1 refers to round 1, R2 refers to round 2 and R3 refers to round 3.

If the value of the CV difference is zero or close to zero for each option, it means that there is stability of responses among the experts but if the value is large , it means that the is no consensus among the experts' responses and further round should be executed to getter better result (Kalaian and Kasim, 2012). Table 13 shows the CV difference value of question one in between rounds.

Table 13. Coefficient of variation difference value of understanding the course.

Options	Adequate lectures' contents	Lecturer's presentation	Class interaction	Lecturer's videos	Writing of learning diary
$\mathbf{CV_{R1\&R2}}$	0.0742	0.044	0.153	0.0238	0.0622
$\mathbf{CV_{R2\&R3}}$	0.107	0.0153	0.156	0.0055	0.1855

In Table 13, the CV difference of R1 and R2 for the five options of question one ranges from 0.0238 to 0.153. The CV difference is highest for the third option which indicates that the experts have lower consensus for the third option compared to other options. The experts have the highest consensus for the fourth option which is Lecturer's videos. Similarly the CV difference of R2 and R3 for the five options ranges from 0.0055 to 0.185 which means that the consensus is higher for some option in the third round but at the same time, some option have lower consensus compared to R1 and R2. Only second and fourth options have better stability and consensus but for the rest options, the differences have increased. As a whole, the results show that there is consensus in the responses of the expert since all the values is close to zero.

Table 14. Coefficient of variation difference value of hindering the course learning.

Options	Inadequate lecturers contents	Less class interaction	Poor lecture notes	Lectures timing	Lecturers insufficient expertise
$\mathbf{CV_{R1\&R2}}$	0.0691	0.0355	0.0364	0.007	0.231
$\mathbf{CV_{R2\&R3}}$	0.0817	0.1397	0.0334	0.0316	0.0047

Table 14 presents the CV difference of R1 and R2 and CV difference of R2 and R3 for five options of the second question. The CV difference as a whole is close to zero ranging from 0.007 to 0.231 meaning that the experts have consensus and stability in their responses. The huge difference is seen in the last option (Lecturers insufficient expertise) which was 0.231 in $CV_{R1\&R2}$ and 0.0047 in $CV_{R2\&R3}$ which shows that there is better consensus in the third round. Similar huge differences are seen in the second and fourth options but in this case the difference has increased from 0.0355 to 0.1397 for the second option and for the fourth option the difference has risen from 0.007 to 0.0316 showing lower consensus among the expert. However, for the remaining options there is minor change which can be neglected. The results of the second question also determine that the consensus is achieved among the experts.

Table 15. Coefficient of variation difference value of understanding the exercise.

Options	Appropriate exercise task	Group work	Teacher's feedback	Clear learning objectives	Lecturers insufficient expertise
$\mathbf{CV_{R1\&R2}}$	0.0345	0.1671	0.0182	0.068	0.3324
$\mathbf{CV_{R2\&R3}}$	0.0173	0.0855	0.1666	0.0499	0.2667

In Table 15, the CV difference of R1 and R2 for the five options of the third question ranges from 0.0182 to 0.3324. The CV difference is highest for the fifth option which indicates that the experts have lowest consensus for the fifth option. The experts have the highest consensus for the third option (Teacher's Feedback) followed by first option (Appropriate exercise task) with the difference value of 0.0345. Similarly the CV difference of R2 and R3 for the five options ranges from 0.0173 to 0.2667. Overall the consensus is higher in third round except for the third option which is "Teacher's feedback". To summarize the whole table, the results show that there is consensus in the responses of the expert since all the values are very low and close to zero and have consistency as well.

Table 16. Coefficient of variation difference value of hindering the exercise learning.

Options	Irrelevant exercise task	Large exercise group	Inadequate lecturer feedback	Tough exercise task	Lack of joint discussion
$\mathbf{CV_{R1\&R2}}$	0.2202	0.0976	0.1898	0.1215	0.0541
$\mathbf{CV_{R2\&R3}}$	0.0487	0.0079	0.0202	0.0044	0.032

Table 16 presents the CV difference of R1 and R2 and CV difference of R2 and R3 for

five options of the fourth question. In Table 15, the CV difference of R1 and R2 for the five options ranges from 0.0541 to 0.2202. The CV difference is lowest for the fifth option (Lack of joint discussion) followed by the second option (Large exercise group) while the first option (Irrelevant exercise task) has the largest difference. Similarly the CV difference of R2 and R3 for the five options ranges from 0.0079 to 0.0487 and have better consensus for all the options and is the only question where $CV_{R2\&R3}$ has lower values for all the options compared the values of $CV_{R1\&R2}$. Overall, the results show that there is consensus in the responses of the expert since all the values are very low and close to zero and have consistency as well.

7.4.2 Ideas aggregation

The comment round question is more focused to know the opinion of the participants for changing the answers in between two rounds. The question asked was "*What are the reasons for changing opinion in between two rounds?"*. In this comment round, only four participants responded to the question and the responses from the participants were mixed. One of the participant mentioned "*I didn't. The graph had no influence on me due to it being too confusing*" whereas other participant mentioned "*Seeing what others had picked likely influenced decisions on later rounds*". Looking at this two participant's response, graphical group response as feedback might or might not change the individual opinions. While remaining two participants misinterpreted the question and provided the out of context reasons for changing their opinions.

7.4.3 Response rate

In the beginning of the experiment, 52 students were provided training presentation and among which only 23 students participated to provide their response for the first round which is 44.2 percent. The low number of participants was known beforehand because the participation in the experiment was in voluntarily basis because of which only interested participants joined the experiment. The results with the benchmark of 52 students show that response rates of the participants in round one, round two, and round three are 44.2 percent, 23 percent, and 17.3 percent respectively. However, the participants who participated in the round one could participate in round two. Only 12 students out of 23 participants participated in the round two which is 52.17 percent. The decrease in the response rate in the round two can be because of following reasons.

First, as mentioned earlier, the participants who participated in round one could participate in round two, so if the other students who did not participate in round one could not join the round two. Second, the questions for the second round were given on Friday and the deadline to submit the answers was on Monday and during the weekend participants might have other personal plans with friends, family or some trips which might have reduced the response rate.

Finally, the similarity of the questions in each round may have decreased the interest of participants to take part in round two. Similar was the case for round three where participants from round two can only took part in the next round and in the final round, 9 participants out of 12 participants answered the question which is 75 percent of participation. The drop in the number of participants from round two to round three is lower compared to the drop from round one to round two and the main reason can be the period when the round three was executed which was on weekdays.

7.4.4 Time consuming

In general, the time required to conduct the Delphi technique takes a long duration, but the real time Delphi technique might take lesser duration. In this chapter, the time consumed to conduct the experiment is analyzed.

Practically, in each round of the experiment, the participants can provide their responses to the four questions within 10 minutes. But Table 7 shows that the participants were provided at least 3 days to provide their responses for each round. 3 days of time are allocated to provide participants responses because all the participants are students and they might have lots of student work either in the university or at home. So, there was uncertainty on how fast the participants would act to participate in the experiment.

In other hand, if we look at the time provided to answer the question for each round, the time allocation is too long because of which experiment seems to be a bit time consuming.

7.4.5 Maintaining anonymity

The anonymity of the participants' response refers to how the system maintains the anonymity of the response without exhibiting participants' identities. During the experiment, all the selected participants were students; therefore there were few ways by which the participants could identify the participants and their responses.

First in the experiment, participants were provided with the unique Twitter username and the settings were made to protect the tweet. The configuration of the protected tweet in the Twitter account deprives the participants to share the response to other participants and to view other participants' response except the facilitator. But by intension if the participant had changed the twitter settings to make the tweet public and allow other participants to follow then the participants could break the anonymity. Second, the participants might also share their responses verbally if they know each other.

To address the first problem, the participants were asked not to change any configuration settings in their twitter account during the experiment. In addition, the facilitator had checked the participant's configuration settings during the experiment period. The second problem is a bit difficult to solve since the interaction between the participants cannot be controlled as they are in the same circle. However, rather than giving a presentation to all participants and asking them to participate, if invitation is sent to the selected participants individually and the list of participants is not disclosed, the possibility of the students discussing their responses with each other in the experiment might be reduced to large extend.

7.4.6 Post survey results and analysis

After the completion of the experiment, post survey was conducted among the participants who participated till the last round. The main purpose of the survey was to know the opinions of the participants regarding the experiment. Out of nine participants, seven participants took part in the survey. The questions of the post survey (see Appendix F) were focused on the understandability of question and motivation of participants during the field experiment. The questionnaire had Likert scale type questions, open ended question and multiple choice question type.

The participants were asked about the understandability of the question in twitter. 71.4 percent of the participants agreed that the questions were understandable and 14.3 percent of the participants strongly agreed on that. However, 14.3 percent of the participants remained neutral. Another question was focused on the feedback provided to each question after the completion of each round. 71.4 percent of the participants agreed that the feedback was understandable, 14.3 percent of the participants were neutral while remaining participants strongly disagreed.

The question was asked to know the opinion of the participants regarding the mechanism to answer the question on Twitter. 14.3 percent of the participants strongly agreed and 42.9 percent of the participants agreed that the question were easy to answer on twitter. 14.3 percent of participants remained neutral, disagreed and strongly disagreed on each.

The participants were asked how much they are motivated to provide answers on twitter. 14.3 percent of the participants were very highly motivated and same percent of the participants were highly motivated. 28.6 percent of the participant had medium level motivation and rest of the participants had low or very low motivation. The participants were asked to select social media apart from twitter in which they would be motivated to provide the answer to the question. 60 percent of the participants preferred Facebook and the rest selected Google+, YouTube and other social media.

Based on the above numerical values, it is clearly understood that the questions and the feedback provided to the participants were understandable, but the motivation of using Twitter to provide the answer is mixed.

On the open ended question, one participant mentioned "*Only hard thing was remembering the order of letters when tweeting the answer (here you can easily make mistake). So this should need to get around somehow in my opinion*". Another participant mentioned "*more questions and proper display of previous results and variation of self-comment*". These participants were focused on the user interface (UI) problem and future developments of such design issue. In addition, one participants was not able to understand the graph provide as a feedback and said "*The graphs provided at the end of the rounds were quite hard to understand*".

Another student mentioned "*Rather than using course related data, if the experiment was done with external data for instance games, I believe there would be more participation. I think people hesitated to answer about the course feedback in the survey*". This participant indicated that the participants might be more enthusiastic when the questions were not related to courses.

And another student mentioned that "*To me hypothesis is somewhat wrong. I don't change my opinions about something like school because of others in some*". This participants forwarded opinions based on psychological perspective.

The post-survey supported the research and help to identified some of the design issues for the future research for better developing the system and optimizing the results.

8. Discussion

In the above literature, the key features of the Delphi technique were identified and the design guidelines were considered to design and implement the system. In this research, the experiment is conducted as a proof of concept with the help of developed prototype system. Regardless, of the success of the experiment, there were certain limitations and issues which limit the study and are discussed in this section. The limitations should be taken into consideration in the future research for optimizing the results. The discussions are categorized in two fold in which the first one is the discussion about the prototype system and the second one is the discussion about the field experiment and results.

Twitter account creation and setup is one of the design problems. To conduct the experiment, all the participants have to be provided with the new Twitter account. Therefore, the configuration should be changed on those newly created Twitter accounts. The configuration settings mean establishing the follow mechanism relationship in between the participants' new Twitter account and the facilitator Twitter account, settings to protect the tweet from being visible to non-authenticated persons and many more. Beforehand the total number of students in the Research Methods course was known to be more than 100 among which around 70 to 80 students were present in the Research Methods exercise. Taking these figures into account, we plan to create at least 70 new Twitter accounts. When the bunch of Twitter accounts (approx. 70) were created within 2 days through the single internet protocol (IP) address and established the follow relationship in between the participants' new Twitter account and the facilitator Twitter account, the twitter administration suspended most of the those mass creation accounts. The suspension of the account was done on two bases. First one is the mass creation of the related accounts from a single IP address because of which the Twitter administration assumed as the created account was for the disruptive or abusive purposes. Second in the Twitter, when the large numbers of users follow or unfollow a single user in a short time period then the Twitter assumed the account as the spam and suspends all the related accounts. Besides these there are other twitter rules because of which the account can be suspended. This indicates that, it is difficult to create a bunch of specific Twitter accounts for a study case from a single IP and established the follow relationship between two users in a short period of time. To solve this issue, the Twitter account should be created from different IP address with not related twitter username and setup the follow relationship in timely basis.

The questionnaire in the Delphi technique plays an important role. In this experiment, the questions were of rank order scale type and only 5 options were provided to rank in each question. The questionnaire and its related options were prepared through the help of University WebOodi course evaluation system questionnaires and the real feedback provided by the past students. Looking into this scenario, there are two design problems with respect to the questions preparation. First, the relative options provided to each question were prepared only through analyzing the past student feedback. Second, the relative options provided to each question were only 5 in order to fit in a tweet message. In this sense the questions were not made perfectly for the experiment. In order to make the better questions, first the brainstorming among the students based on the question theme should be performed through which it will be easy to find the possible options for the questions. In addition, increasing the number of options to the question will help to cover the large problem context and might provide the better results.

Another key design problem is the used of lengthy Twitter hash tag. In the experiment, the participants had to use the question hash tag and the answer hash tag (see Appendix D) in order to provide the answer in each round. Hash tags for the experiment were selected based on availability and previously not used by other users in the Twitter and that signify the question and answer. From the experimental point of view, the size of two hash tags was lengthy and the use of two hash tags might not be self-instructed for the participants to understand. In the further study, the use of hash tags should be thoroughly analyzed for the better representation of the questions and the answers and also the character size of the hash tags can be minimized in order to save space.

Besides the prototype system design issues, the inability to include the large number of participants in the experiment is another issue from the observation perspective. From the technological background survey result it is clear that the participants are familiar regarding the use of hash tag (#) in the Twitter. In this respect, we assume that most of the participants are able to use Twitter. Because of this assumption, the training session was more focus on what the participants have to do rather than how to do it in the Twitter. In addition, question practice session was conducted with the paper and pencil rather than with the practice in the Twitter account. But in the end of the training session and during the experiment, it seems that half of the participants were not able to use Twitter in order to provide their responses. The inability to create new tweet messages for responding to the questions might be an influential factor that has demotivated the participants. Therefore, careful consideration should be taken to know the capability of the participants for using such type of social media. Moreover, the participants should be provided with the real case scenario during the practice session. Regarding this design issues, one of the participants in the post-survey also mentioned that participants might be more enthusiast if the questions were not related to the courses.

Another issue from the observation point of view is the inability to get the opinions of the participants for changing their opinions in between two consecutive rounds. In this experiment, the participants were asked to provide their point of view for changing their opinions only in the comment round. In this respect, we were not able to collect the opinions of the participants as per the experiment theme in the comment round. At this stage, the comment round did not support well enough to gather the opinions of participants for changing their opinions. It is unclear about the best possible solution for this issue but, it might be good to asked immediately after the completion of two consecutive rounds.

Although there were some design issues, the experiment acted as a proof of concept and which is able to provide the answer to the research questions.

9. Conclusion

In this research, for studying the possibility of incorporating the Delphi technique with social media the multimethodological research process proposed by Nunamaker et al. (1991) was selected and then the literature review related to the Delphi technique and social media was conducted. The literature review provided the design guidelines to implement the prototype system to conduct the field experiment. In order to conduct the field experiment, the university course feedback was selected as the context area. After the experiment, the results were collected and analyzed which have helped to provide the answer to the following research questions.

Research question: What are the design requirements and challenges for integrating social media with the Delphi technique?

This is the main research question in this research. The main purpose of the research work is to demonstrate the feasibility to use social media in the Delphi technique in order to make the consensus among experts.

In order to demonstrate the feasibility, Design science research process is adapted and the literature review related to Delphi technique is studied and it was found that there are only a few numbers of studies related to the process of integrating Delphi technique with social media because of which the process of implementing the Delphi technique using social media is difficult. However, Lyons and Lessard (2012) social feature integration technique was taken into consideration to incorporate social media with the Delphi technique. After the literature review, the design guidelines were identified to build the new conceptual framework. Then after high level system architecture is designed and possible solutions for the system module were analyzed. Furthermore, an appropriate solution is selected to design the system. In the end, the prototype system is developed to carry out the Delphi techniques with an automated process for synthesizing the opinions of experts and to provide the feedback to the experts through graphs.

The results of the experiment show that the experiment was successful and the experts were able to make the consensus on their opinions. However, there were some design issues which limit the study and those design issues should be taken into account while performing this type of experiment. The concept of integrating social media with Delphi technique is not mature yet and more studies are required.

Research question: How does the Delphi technique integrated with social media affect the motivation of experts for expressing their opinions?

The main motive of the second research question is to know how the developed prototype system influences the participant's opinion. To provide the answer to this research question, the results from the experiment and the survey are analyzed. In this experiment, Twitter was selected as social media application.

The technological background information survey results reveal that 55 percent (37 participants out of 67) of the participants are willing to use social media to provide the course feedback which is indeed a good number of participants who are motivated towards using social media to provide the course feedback.

The survey result discloses that 97 percent of the participants use the twitter to tweet messages either 0 times or couple of times in a week. Similarly, 75 percent of participants use the twitter to view other's tweet message either zero times or couple of times in a week.15 percent of the participants view the tweet messages 1-3 times daily and 4 percent of the participants view 4-6 times and 10 times or more times each. This statistical result clearly shows that a larger number of people view other's tweet messages instead of tweeting their own new tweet messages. However, it can be concluded that the frequency of use of twitter in the participants is low.

A reminder of the deadline for the answer's submission played an important role to increase the number of participants in this experiment. During the experiment, approximately 39 percent of the participants (9 participants out of 23) provided their answers in round 1 after sending the reminder. Similarly, about 58 percent of the participants (7 participants out of 12) and 33.33 percent of the participants (3 participants out of 9) provided their answers for round 2 and round 3 respectively only after the reminder.

From the above analysis, it can be concluded that despite the large number of participants who are willing to use social media to provide course feedback, the low frequency of the use of twitter might have affected the motivation of the experts for expressing their opinions. Moreover, an increase in the number of the participants after the frequent reminders reflect that the use of twitter among the participants is not regular since the time to complete each round would take just around 10 minutes. However, if the participants were the regular users and had used their own Twitter account in the experiment, then the participants might have higher interest in the experiment and also could be more familiar with social media platform for expressing their answers. Furthermore, the post-survey results also show that the motivation of the participants was mixed for using the Twitter as a social media platform.

In addition, the lack of technical competence of using the Twitter account might have demotivated the participants to express their answers. For example, in the experiment, different hash tags were used to provide the answer for questions in each round. In such case, a novice twitter user might easily get confused and find difficulty in expressing their answers.

Despite the success of the experiment, it can be concluded that the Twitter may not be the ideal social media for such experiment due to the low participation and poor knowledge of participants on the use of twitter. In support, the post-survey results also show that participants will prefer to use Facebook as a social media for such experiment. Incase if the twitter is used as a social media platform in such type of experiment, the selected expert should be an active Twitter user with sufficient technical competency in twitter or the general people selected for the experiment should be trained on the use of the twitter.

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Appendix A. Experiment questions

1) Please rank the factors in order of importance from high to low that helped to learn and understand the research method's lectures.
    a. Adequate lectures' contents
    b. Lecturer's presentation
    c. Class interaction
    d. Lecture's videos
    e. Writing of learning diary
2) Please rank the factors in order of impact from high to low that hindered to learn and understand the research method's lectures.
    a. Inadequate lectures' contents
    b. Less class interaction
    c. Poor lecture notes
    d. Lectures timing
    e. Lecturers insufficient expertise
3) Please rank the factors in order of importance from high to low that helped to learn and understand the research method's exercises.
    a. Appropriate exercise task
    b. Group work
    c. Teacher's feedback
    d. Clear learning objectives
    e. Enough time for exercise tasks
4) Please rank the factors in order of impact from high to low that hindered to learn and understand the research method's exercises.
    a. Irrelevant exercise task
    b. Large exercise group
    c. Inadequate lecturer feedback
    d. Tough exercise task
    e. Lack of joint discussion

Appendix B. Training example question

#Q2_code Please rank the factors in order of importance from high to low that motivate you to study research method's lectures.

a. Irrelevant exercise task
b. Large exercise group
c. Inadequate lecturer feedback
d. Tough exercise task
e. Lack of joint discussion

How would you write the answer in twitter if the above question number is 2 (#Q2_code) for round 2?

Answer: _____

For e.g. Example answer format should be #Q1_code #R1_answer DAECB

Appendix C. Questionnaire of technological background survey

Page one

The question marked with asterix (*) is mandatory to provide the answer.

This survey gathers background information of technological knowledge of Research Methods course's students. The information is used in anonymous statistical form as a part of Master's thesis research on new course feedback system field experiment, where the students of Research Methods course will be participating.

Thank you for your participation.

Demographic background

1) What is your age (in years)? *

   _____

2) What is your current degree? *
   a. Below bachelor degree
   b. Bachelor degree
   c. Master degree
   d. Above master degree

Page two
Technological background

3) How many years on average do you use social media daily? *
   a. 1 hour or less (approx.)
   b. 2 hours (approx.)
   c. 3 hours (approx.)
   d. 4 hours (approx.)
   e. More than 4 hours

4) Which social media mentioned below are you using? (choose all that apply) *
   a. Facebook
   b. Twitter
   c. Google+
   d. YouTube
   e. Other _____
5) Which social media do you use the most? *
   a. Facebook
   b. Twitter
   c. Google+
   d. YouTube
   e. Other _____

6) Which social media you usually recommend for other people to use? (choose all that apply) *

a. Facebook
b. Twitter
c. Google+
d. YouTube
e. Other _____

7) Do you have a twitter account? *
   a. Yes
   b. No

8) Do you use the twitter account actively? *
   a. Yes
   b. No

9) How would you rate your level of knowledge on using twitter? *
   a. Not at all
   b. Basic
   c. Intermediate
   d. Expert

10) Are you familiar with the use of hash tag (#) in the twitter? *
   a. Yes
   b. No

11) On average, how frequently do you use twitter to view other's tweet messages daily? *
   a. Not at all (0 times) or couple of times in a week
   b. 1 – 3 times
   c. 4 – 6 times
   d. 7 – 9 times
   e. 10 or more times

12) On average, how frequently do you use twitter to tweet the messages daily? *
   a. Not at all (0 times) or couple of times in a week
   b. 1 – 3 times
   c. 4 – 6 times
   d. 7 – 9 times
   e. 10 or more times

Page three
Course feedback system usage

13) Please select what kind of course feedback system you have been using in University of Oulu. (choose all that apply) *
   a. Paper based feedback forms
   b. University of WebOodi feedback system
   c. Other _____

14) How often have you provided course feedback in the University of Oulu? *
   a. Never or Almost never
   b. Occasionally
   c. About half of the time
   d. Mostly
   e. Always or almost always

15) In general, are you willing (or motivated) to provide feedback on courses? *
    a. Yes
    b. No

16) How well the current systems motivate you to give feedback? *
    a. Very low
    b. Low
    c. Medium
    d. High
    e. Very high

17) Would you be interested (or willing to) use social media for providing course feedback? *
    a. Yes
    b. No

18) Do you have any other comments or ideas about course feedback system?

_____

Appendix D. Hash tags used in Twitter

Twitter hash tags to respond to each question in each round

Delphi round	Questions	Questions code	Answer code
Round one (R1)	1 (Q1)	#Q1_code	#R1_answer
	2 (Q2)	#Q2_code	#R1_answer
	3 (Q3)	#Q3_code	#R1_answer
	4 (Q4)	#Q4_code	#R1_answer
Round one (R2)	1 (Q1)	#Q1_code	#R2_answer
	2 (Q2)	#Q2_code	#R2_answer
	3 (Q3)	#Q3_code	#R2_answer
	4 (Q4)	#Q4_code	#R2_answer
Round one (R3)	1 (Q1)	#Q1_code	#R3_answer
	2 (Q2)	#Q2_code	#R3_answer
	3 (Q3)	#Q3_code	#R3_answer
	4 (Q4)	#Q4_code	#R3_answer

Twitter hash tags to provide the comments after round three

Delphi round	Questions	Questions code	Comments code
Round three (R3)	1 (Q1)	#Q1_code	#R3_comment
Round three (R3)	2 (Q2)	#Q2_code	#R3_comment
Round three (R3)	3 (Q3)	#Q3_code	#R3_comment
Round three (R3)	4 (Q4)	#Q4_code	#R3_comment

Appendix E. Symbolic representation of the statistical name

Mean value in round one	M_1
Mean value in round two	M_2
Mean value in round three	M_3
Coefficient of variation in round one	CV_1
Coefficient of variation in round two	CV_2
Coefficient of variation in round three	CV_3
Absolute difference between CV2 and CV1	$CV_{R1\&R2}$
Absolute difference between CV3 and CV2	$CV_{R2\&R3}$

Appendix F. Post survey questionnaires of the field experiment

Page one

The question marked with asterix (*) is mandatory to provide the answer.

This survey gathers information about the experience of Research Method course experiment participants. The information is used in anonymous statistical form as a part of Master's thesis research.

There are only 6 questions.

Thank you for your participation.

System use

1) In the experiment, the questions in the Twitter were understandable?*

    a. Strongly agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly disagree

2) In the experiment, the feedback provided to each question after the completion of each round was understandable.*

    a. Strongly agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly disagree

3) In the experiment, the mechanism to provide the answer to the questions in the Twitter was easy.*

    a. Strongly agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly disagree

4) In the experiment, the use of social media (Twitter) motivated you to participate to provide the answer to the questions.*

    a. Strongly agree
    b. Agree
    c. Neutral
    d. Disagree

e. Strongly disagree

5) In such experiment, what other social media use (except twitter) will have highly motivated you to participate to provide the answer to the questions? (choose all that apply)*

a. Facebook
b. Google+
c. YouTube
d. Other, _____

6) Do you have any other ideas/comments about the experiment?

_____