EFFECTS OF ELECTRONIC COMMUNICATION TOOLS AS MODERATING VARIABLES ON TACIT KNOWLEDGE ELICITATION IN INTERVIEW TECHNIQUES FOR SMALL SOFTWARE DEVELOPMENTS

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ABSTRACT

Interviewing is an important technique and initial step, during the process of software development, and due to its simplicity and awareness with the participants, it is largely used to conduct the detailed exploration during the process of requirements elicitation, but it is widely accepted that the experts face problems in collecting the tacit knowledge, which can interrupt the process of interviewing. In this paper, we have tested a proposed framework, to use the electronic communication tools, 'Audio Podcasts', 'E-mails', 'Chatting' (Online Chat Sessions) and 'Hybrid' (Combination of Podcasts + E-mails + Online Chatting), to discuss the detailed interview agenda, between the interviewer and interviewee, before the process of interviewing, for the semi-structured interviews. This study has used mixed methods. Firstly, the research has utilized the collected, quantitative data for testing the hypothesis to compare the difference of effects among all the e-tools, and secondly, after using these e-tools, evaluations have been done to find the difference of outcomes, through the qualitative data, collected via semi-structured interviews. Results suggest that the use of these electronic communication tools as moderating variables have strong impact on effectiveness. The findings are adequate to encourage further research work, and the outcomes have proved to be of great interest for the software specialists. Several recommendations have been given for the future research work.

Keywords: *Electronic Communications, Interviewing, Interview Agenda, Requirements Elicitation, Semi-structured interviews, Tacit Knowledge.*

1.   INTRODUCTION

Computers have moved in almost every area of our society, and all of us are getting the enormous benefits from these machines, as today our banks, security and communication systems, supermarkets, shopping centers, mobiles, shops, airplanes, almost everything is based on these computers, and the key of success to these computers is the proper functioning of their software systems. Lets' think for a moment, if all the software systems around the world stopped working, or all the computers are switched off for a very short period of time, what will happen? Definitely, unmanageable tragedies would arise; because, today, the dealings of routine life are based on the computers, and the computers are based on the software, running these computers. These software systems are developed by the software specialists, and interviewing is one of the primary techniques used by these specialists, to start the process of software development, for the collection of detailed user requirements; and the agenda of interview is an outline that is given to the interviewee for reading, prior to the process of interviewing, to get a general idea about the interview meeting. Software specialists are conducting the online interviews using Podcasts, E-mails, and Online Chat sessions.

Overall, 52.7% of the software projects increase the projects cost to 189% of the original estimates, and before the stage of completion the percentage of cancelled projects is 31.1%, whereas the success rate is only 16.2% [5]. The cost of software failure was $1.1 trillion assets that affected 4.4 billion people [1]. Weak requirements are one of the key factors for the software projects failure [5, 6, 7, 2]. Elicitation is a term that is used to validate the fact that the accurate and detailed requirements can be collected from the user and during this process of

elicitation, tacit is a type of knowledge that is hidden, and needs to be best shared by the interviewees [8, 9], but the fact is that people have their own vocabularies and terminologies, and cannot find proper way or wordings to explain their knowledge [9]. The key of success for a software system is the proper elicitation of tacit knowledge toward the collection of right requirements [5, 10, 11, 12, 13].

Providing the interview agenda to the interviewee, for reading only, is not enough to create a detailed understanding; Podcasts, E-mails and Online Chat sessions are mostly being used as electronic communication tools for the routine communications or to conduct the electronic interviews only. These e-tools can be used to discuss the interview agenda in details, prior to the process of interviewing that could help to increase the tacit knowledge elicitation, is the theory of this research. This research study has used 'Podcast', 'E-mail', 'Online Chatting' and 'Hybrid' (a combination of Podcast + E-mail + Online Chatting) as electronic communication tools between the interviewer and interviewees, for the discussion of detailed interview agenda, before the process of interviewing, and then the process of interviewing towards a software development of creating a website, to analyse the outcomes of these electronic communication tools as moderating variables, on the elicitation of tacit knowledge, during the process of interviewing. Major focus of this research is to test the effects of above mentioned e-tools on the elicitation of tacit knowledge sharing process, and to provide the recommendations on the basis of outcomes.

2. LITERATURE REVIEW

In the current world, computers are most important part of our lives. The key of success for these computers is based on successful running of the software systems. During the stage of software development, interviewing is a key practice used by the software specialists for the elicitation of requirements, and elicitation is a process of collecting the requirements, and is one of the major phases for requirements engineering [11, 13, 14, 3]. Requirements elicitation is a Critical Success Factor (CSF) or critical factor for the software projects [11, 13, 4], and the requirements should be specific and detailed for a successful project [8, 11]. During the elicitation process, the collection of important knowledge could be unclear; therefore the terms of tacit and explicit knowledge have been used to simplify the complex areas [8, 15]. Tacit knowledge can be defined as the perception or

personal belief of a person, whereas, explicit knowledge is easy to define and describe [8, 16, 17, 76]. Machines can be the best source of sharing the explicit knowledge, whereas, people can be the best source of sharing the tacit knowledge [8, 9, 75]. All experts have to deal up with both, tacit and explicit knowledge [8, 13, 17]. It's an ability of an individual to keep more knowledge, as compared to what he or she can share [8]. During the process of knowledge sharing, individuals have their own vocabularies, terminologies and wordings, thus they cannot find a proper way or wordings to explain and share their knowledge [9].

Understanding the user requirements and ideas are the main challenges during the elicitation of requirements [5, 18, 19, 78]. If the elicitation of requirements isn't done in a proper way, and if they are weak, unpredicted future work needs to be done to solve the problems at later stages [19, 20], according to the analysis, weak requirements is one of the major factor, causing the failure of software projects [5, 6, 7], and due to the elicitation of weak requirements, overall, the software projects failure rate is ranging between 60 to 80% [21], while, the rate of success is around 16.2% [5].

'Table 1' lists some of the acknowledged patters in the research areas for Explicit and Tacit Knowledge.

Table 1: Some of the known basis of Explicit and Tacit Knowledge

Tacit Knowledge	Explicit Knowledge
Facial recognition	Written Reports
Rule of thumb	Manuals
Trade tricks	Forms
Workarounds	Standard Operating Procedures (SOPs)
Undocumented processes	Directions – Instructions
"Gut Feel"	Check Lists - Task lists
Know-how	Hierarchal Structure - Workflow diagrams
Expertise	Observational video
Perception - Intuition	Rules – Guide Lines – Policies

This research was inspired by two primary drivers:

a). Tacit knowledge elicitation is always a challenge for the experts [41, 42, 43, 44].

b). Always the researchers have opportunities to propose different elicitation techniques for a known problem [45, 46].

During the process of elicitation, one or more techniques can be used to collect the requirements [13]. Table 2 shows some of these elicitation techniques.

Table 2: Some Methods Used For Requirements Elicitation

Method	Description
Interviewing	Interviewing is a method that gives rich data that is qualitative in nature. Interviewer asks a range questions from interviewee and the responses are collected [22].
Observation	Observation is a method of carefully observing the actions and activities of an individual, in a natural setting, and then documenting these observations [23, 24]
Brainstorming	Brainstorming is a method of getting the ides for the creation of concepts, and revealing the additional knowledge, and then documenting the ideas of individuals. It is a group based practice [25, 26].
Group Support Systems (GSS)	GSS is a method of using the ICT (Information and Communication Technologies) for the creation of innovative ideas, to ease, and streamline the contribution of participants, during the process of knowledge collection [27, 28].

The effects of any electronic communication tool can be evaluated on the basis of factors like; e-tool's Comfortability, its essentiality, friendly usage, the help of e-tool in understanding and learning a particular area or goal [29, 30, 31, 32]. The development of a website, as small software development project requires the collection of following common requirements: 'General', 'Functional', 'Usability', & 'Content' [31, 32]. Collecting the usability, content and functionality requirements are important areas for the software development [77, 80, 81, 82, 83]

Audio Podcasts are used to listen the information saved in audio files, and are valuable tool for the dissemination of information, and work as catalyst, for the creation of knowledge [47, 48, 79]. Audio Podcast has the potential to enhance and enrich the learning experience and is very useful for the participants' engagement [49, 50, 51, 52].

E-mail is an easier way for the dissemination of information, and also makes people reachable with extraordinary skills for a better response rate, response time, data quality, good trust and positive relationship [53, 54, 55, 56]. E-mail is very informal and casual way of communication that enables to write and convey the message, with in less amounts of time, and without worrying about grammatical mistakes [35]. E-mail is as essential as any other medium of communication like phone, fax, paper, or mail [34].

Online Chat rooms/Sessions/Online Chatting encourages thoughtful conversation among the participants, and a useful tool for sharing the knowledge and learning [57, 58, 59, 60, 61, 62, 63]. Participants of online chatting can review the earlier comments and may also take time in replying, or selection of words [64]. Online chat sessions are useful in improving and refining the ideas and outcomes of the participants [65]. Online Chatting creates ideas, and ideas turn in to projects [66]. The virtual ('computer-generated') resources for learning, linked with electronic communications could be more effective and efficient as compared to the traditional methods [36, 37, 67]. Online

asynchronous and synchronous based communication promotes communication and collaboration among the participants [68].

A new method of Global Software Development (GSD) had been proposed for the requirements elicitation that had four stages i). Collection of data, ii). Stake holders' education concerning the GSD issues iii). Post education assessment iv). Elicitations of requirements and analysis [94]; but from this method, the gaps of understanding between the requirement engineers and the participants of requirements gathering were still there, and the time frame for the implementation of this model was lengthy that in turn would increase the overall cost of the project. [95] had proposed an improved version of an existing model (by Nathan W Mogk) for collecting and managing the requirements, and had proposed to involve the user when the conflicts arises; they didn't discuss to minimize the gap of understanding between the interviewer and interviewee, towards a common goal for the better elicitation of requirements. [96] had used cognitive psychology and Felder-Silverman learning style models [LSM] for the elicitation of requirements; and had integrated cognitive psychology with the process of elicitation; had claimed the integration of cognitive psychology with the process of elicitation as an optimistic method for getting improved results, but the gap of initial understanding between the interviewer and interviewee towards the common goal of interview, with known and understandable vocabulary was still in place, that eventually leads to the elicitation of weak requirements.

Researchers have done interviewing through these electronic communications like Podcast, E-mails, and Online Chatting; for purely conducting and asking the interview questions. Audio Podcasts are very effective to conduct interviews [69]. Audio Podcasts are very good electronic tools for sending the interview questions to interviewee, but, as a one way communication tool it may leave understanding ambiguities [47]. E-mail interviewing provides useful understanding and is potentially a very strong tool for the interviewing

[40, 70]. Asynchronous e-mail interviewing has unique benefits in data gathering and may gain a solid position in qualitative interviewing, but there are lots of understanding gaps those cannot be discussed and covered through this mode, therefore this method cannot fully replace the face to face interview technique [71]. Interviewing can be done through online chat sessions (instant messaging service). These interviews give the advantage of adjusting the questioning based on the responses received from the participant [72]. Participants found online interviewing through chat sessions as a convenient way, and maintain that online interviewing is an effective way for interviewing, however needs some other methods to bridge the understanding gaps, between interviewer and interviewee, towards a common goal [73].

During the process of interviewing, providing the agenda of interview to the interviewee, for the purpose of reading, is an important step of every interview, that helps the interviewee to get an understanding about the interview, and is an effort to create a general understanding between the interviewer and interviewee toward a shared goal of interview [38, 39], but still, the understanding and elicitation of user requirements, is a main challenge, during the process of requirements elicitation [5, 18, 19], and these weak requirements are among one of the major key factors, causing the failure of software project failure [5, 6, 7]

Although, these electronic communication tools have huge benefits, as stated above, yet, nearly all the studies on the use of electronic communication tools have been done for conducting the interviews, and the e-tools have been simply used for inquiring the interview questions, and the agenda of the interview have been given to the interviewee, as an outline, for the purpose of reading, only; weak requirements elicitation is until now, one of the major problems, contributing to software projects failure. Keeping in view the research studies, it appears that the use of electronic communication tools as moderating variables, for discussing the detailed interview agenda, prior to the process of interviewing for the elicitation of tacit knowledge, has been overlooked. Therefore, the 'elicitation of tacit knowledge', through detailed discussion of interview agenda, before the process of interviewing, is the major area this research study has addressed.

3. HYPOTHESIS AND RESEARCH QUESTION

3.1. Hypothesis:

According to the literature review, the use of e-communications (like podcast, E-mail, Online Chatting) is merely to conduct the interviews. Therefore, the use of e-communications as moderating variables to discuss the detailed interview agenda is not a known practice in the field, thus this research gap needs to be filled. This research paper is based on both Quantitative and Qualitative data. Firstly, hypothesis has been tested through the Quantitative data (Appendix-A), and then, secondly, for the in depth exploration, an

Table 3: Hypothesis For The Comparison Of Difference Among The Group For Six (6) Key Areas:

Friendly: H_0: All the electronic communication groups have equal effectiveness on the average or $\mu_1 = \mu_2 = \mu_3 = \mu_4$ for the key area 'friendly' H_1: The mean effectiveness of at least one electronic communication group is significantly different for the key area 'friendly'.
Comfortable: H_0: All the electronic communication groups have equal effectiveness on the average or $\mu_1 = \mu_2 = \mu_3 = \mu_4$ for the key area 'comfortable' H_1: The mean effectiveness of at least one electronic communication group is significantly different for the key area 'comfortable'
Essential: H_0: All the electronic communication groups have equal effectiveness on the average or $\mu_1 = \mu_2 = \mu_3 = \mu_4$ for the key area 'essential' H_1: The mean effectiveness of at least one electronic communication group is significantly different for the key area 'essential'
Understanding: H_0: All the electronic communication groups have equal effectiveness on the average or $\mu_1 = \mu_2 = \mu_3 = \mu_4$ for the key area 'understanding the interview requirements' H_1: The mean effectiveness of at least one electronic communication group is significantly different for the key area 'understanding the interview requirements'
Learning: H_0: All the electronic communication groups have equal effectiveness on the average or $\mu_1 = \mu_2 = \mu_3 = \mu_4$ for the key area 'learning the interview requirements' H_1: The mean effectiveness of at least one electronic communication group is significantly different for the key area 'learning the interview requirements'
Elicitation of Tacit Knowledge: H_0: All the electronic communication groups have equal effectiveness on the average or $\mu_1 = \mu_2 = \mu_3 = \mu_4$ for the key area 'elicitation of tacit knowledge sharing process' H_1: The mean effectiveness of at least one electronic communication group is significantly different for the key area 'elicitation of tacit knowledge sharing process'

interview questionnaire has been used for conducting the interviews (Appendix-B).

For finding the comparison of difference in effectiveness, significantly among different groups, following hypothesis in 'Table 3' has been tested, separately for each of six key areas (i). 'Friendly', ii). 'Comfortable', iii). 'Essential', iv). 'Understanding', v). 'Learning', and vi). 'Tacit Knowledge Elicitation', toward the usage of four electronic communication tools (i. 'Audio Podcast', ii) 'E-mail', iii). 'Online Chatting', iv. 'Hybrid

(Combination all three e-tools [Audio Podcast + E-mail + Online Chatting]')

3.2. Research Question:
Is there any difference in the effectiveness of four electronic communication tools "Audio Podcast, E-mail, Online Chatting, and Hybrid" on the elicitation of tacit knowledge during the process of interviewing?
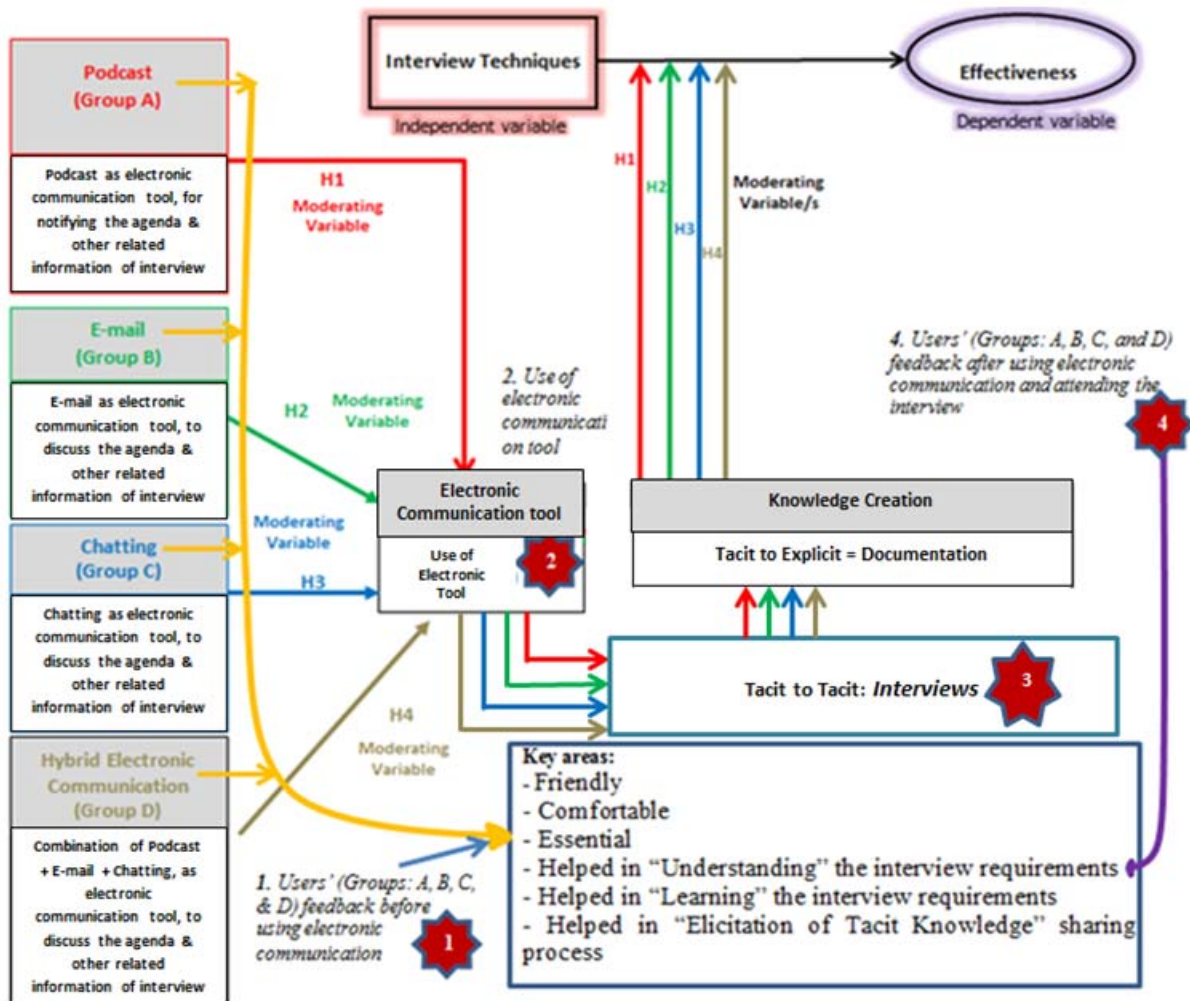
4. RESEARCH DESIGN

Fig. 1 [31, 32]

This Research Design In Fig.1. Has Four Major Steps Including I). Users' Feedback (Appendix - A) Of Each Group, Before Using The Electronic Communication Tools, Ii). Use Of Electronic Communication Tools To Discuss The Detailed Interview Agenda Iii). Attending The Interview (Appendix B) [31, 32], Iv). Furnishing The Feedback After The Use Of E-Communication Usage (Appendix - A) [31,32]

5. METHODOLOGY

This research study has been tested for a small software development project, through the creation of a course website, for the students, studying the course "Computer Skills". These students had similar educational backgrounds, and their age group was same. They had a very good idea and experience of the website usage, and they had previously used computers, Audio Podcasts, E-mails, Online Chat sessions, educational websites for their studies, and were involved in other web based electronic activities. These participants were using the hardcopies of their course material, and were demanding the provision of course material in the electronic form, and electronic based resources through a course website, for getting additional help in their studies. Interviews had been conducted for the need analysis, keeping in view their requirements.

Two interviewers and one hundred twenty (120) interviewees had participated for this study. These 120 interviewees were divided in four groups of thirty (30) interviewees each, as following.

Group 'A': 30 Participants (Audio Podcast)
Group 'B': 30 Participants (E-mail)
Group 'C': 30 Participants (Online Chatting/Chat Sessions)
Group 'D': 30 Participants (Hybrid [Combination of Audio Podcast + E-mail + Online Chatting])

Three opening sessions were organized for the participants of each group, to let them know about the website development process, and their role during the process of this study. During these sittings, participants were generally informed about the purpose of interview, general interview agenda, the use of Podcasts, E-mail, Chat sessions, and Hybrid, as electronic communication tools (according to their group distribution), to discuss the detailed interview agenda, for the duration of one month, non-recording of interview (as most of the participants were reluctant towards the recording of interview), notes-taking during the interviews, presence of two interviewers (including one interviewer and an assistant for taking the notes), and privacy of the collected information for the research purposes, only, Summary of the interview particulars, venue of interview and general idea about the interview timings and duration. Then the participants were informed about the plan of discussion and distribution of interview agenda in four parts, during four weeks, as following: *'Week#1)'.* General requirements, *'Week#2)'.* Functional requirements, *'Week#3)'.*

Usability requirements, *'Week#4)'.* Content requirements.

Audio Podcasts were recorded using Audacity, a free audio recorder and editor, and handed over to the students of Group-'A' for the detailed discussion of interview agenda. This way of communication was one way asynchronous communication, as this group had heard the Audio Podcasts only, and weren't allowed to ask further queries, and were asked to search the related information at their own, through search engines etc., if needed. Participants of Group-'B' were communicated through E-mails, a two way asynchronous communication, and they were allowed to inquire further details through E-mails. Group-'C' was communicated through Online Chat sessions (through LMS 'Moodle' Chat rooms), a two way synchronous mode of communications, and they were allowed to communicate through Online Chat Sessions. Group-'D' was tested through the combination of all three communication modes (Audio Podcasts, E-mails, and Online Chat Sessions).

All the details of detailed interview agenda were shared with these four groups through e-tools, based on weekly division, as mentioned above for Week#1, 2, 3 and 4.

During each week, detailed discussions of agenda through Audio Podcasts were divided in two parts and handed over to the participants of Group 'A' (like for week#1, 'General requirements' were divided into two parts and handed over during two meetings, and similar division of two meetings were followed for weeks# 2, 3, and 4). Likewise, Group 'B' had received two major E-mails for discussion, during each week, Group 'C' had two chat sessions each week, and Group 'D' had discussed the detailed interview agenda, divided in two parts for each week, through the combination of all three e-tools together.

5.1. Quantitative data:

A well-organized questionnaire *(Appendix A)* based on 10 point Likert scale that was previously tested by researchers [31, 32] in terms of performing the electronic activities, had been used to gather the important data. As, the main focus of this paper was on the usage and effects of electronic communication tools for the process of interviewing, therefore, this questionnaire (*Appendix A*) had been used toward following key domains, for the purpose of comparison toward the electronic tools:
Participants' feedback for each group towards each electronic tool, concerning:

i). 'Friendly' [29, 30, 31, 32] **ii). 'Comfortable'**[29, 30, 31, 32] **iii). 'Essential'**[29, 30, 31, 32] **iv).** Help of E-tool in **Understanding** the requirements of interview [29, 30, 31, 32] **v).** Help of E-tool in **Learning** the requirements of interview. [29, 30, 31, 32], **vi).** Help of E-tool in the Process of **Tacit Knowledge elicitation** [31, 32]

There were two stages:

- **Filling questionnaire – Before Interview** (Appendix A) *[and then the usage of e-tool/s, and attending the interview] & then*

- **Filling questionnaire – After Interview** (Appendix A)

5.1.1. Analysis:

The Quantitate analysis has been done through:

i). One Way Anova - Single Factor *(comparison of 'One Way Anova', among the four groups was based on the results of filled questionnaire (Appendix A), 'After' attending the interviews)*

5.2. Qualitative data:

A Semi-structured interview questionnaire (Appendix B), that has four areas (General, Functionality, Usability, & Content requirements), and was previously tested by the researchers [31, 32] had been used for conducing the interviews.

5.2.1.   Analysis:

For the purpose of analysis, each interviewer's knowledge was converted, based on 5 point Likert scale, for each question of each section (Appendix B), and the overall result for the whole group (separately for groups A, B, C, and D, for Audio Podcast, E-mail, Online Chatting, and Hybrid, respectively) towards four separate factors (General, Functionality, Usability and Content) has been presented using:

i). Spider Chart – *(For the comparison among four factors, toward four groups for e-tools 'Audio Podcast', 'E-mail', 'Online Chatting', and 'Hybrid')*

ii). Comparison Chart *(For the comparison of Prompting during interview)*

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6.   RESULTS

6.1. One way Anova - Single Factor (Quantitative data)

Tables 4, 5, 6, 7, 8, and 9 are showing the results of One way Anova: Single Factor, the difference comparison of four groups (Audio Podcast, E-Mail, Online Chatting, and Hybrid) toward the key areas "Friendly, Comfortable, Essential, Understanding, Learning, & Tacit Knowledge Elicitation"-

Table 4: One Way Anova: Single Factor (Key Area: Friendly)

Anova: Single Factor						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Friendly-Podcast	30	187	6.233	0.460		
Friendly-Email	30	211	7.033	0.654		
Friendly-Chatting	30	242	8.066	0.202		
Friendly-Hybrid	30	271	9.033	0.309		
ANOVA						
Source of Variation	*SS*	*Df*	*MS*	*F*	*P-Value:* IE-33 (P<0.05)	*F crit* 2.682
Between Groups	133.825	3	44.608	109.708		
Within Groups	47.166	116	0.406			
Total	180.991	119				

Table 5: One Way Anova: Single Factor (Key Area: Comfortable)

Anova: Single Factor						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Comfortable-Podcast	30	194	6.466	0.671		
Comfortable-Email	30	215	7.166	0.764		
Comfortable-Chatting	30	239	7.966	0.240		

Comfortable-Hybrid	30	272	9.066	0.271		
ANOVA					*P-Value:* 1.934E-27 (P<0.05)	*F crit* 2.682
Source of Variation	*SS*	*Df*	*MS*	*F*		
Between Groups	112.2	3	37.4	76.831		
Within Groups	56.466	116	0.486			
Total	168.666	119				

Table 6: One Way Anova: Single Factor (Key Area: Essential)

Anova: Single Factor						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Essential-Podcast	30	193	6.433	0.667		
Essential-Email	30	218	7.266	0.891		
Essential-Chatting	30	243	8.1	0.231		
Essential-Hybrid	30	274	9.133	0.395		
ANOVA					*P-Value:* 1.207E-26 (P<0.05)	*F crit* 2.682
Source of Variation	*SS*	*Df*	*MS*	*F*		
Between Groups	120.066	3	40.022	73.226		
Within Groups	63.4	116	0.546			
Total	183.466	119				

Table 7: One Way Anova: Single Factor (Key Area: Understanding)

Anova: Single Factor						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Understanding-Podcast	30	195	6.5	0.672		
Understanding-Email	30	213	7.1	0.713		
Understanding-Chatting	30	241	8.033	0.240		
Understanding-Hybrid	30	275	9.166	0.419		
ANOVA					*P-Value:* 5.38E-28 (P<0.05)	*F crit* 2.682
Source of Variation	*SS*	*Df*	*MS*	*F*		
Between Groups	121.866	3	40.622	79.418		
Within Groups	59.333	116	0.511			
Total	181.2	119				

Table 8: One Way Anova: Single Factor (Key Area: Learning)

Anova: Single Factor						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Learning-Podcast	30	185	6.166	0.419		
Learning-Email	30	215	7.166	0.764		
Learning-Chatting	30	237	7.9	0.506		
Learning-Hybrid	30	271	9.033	0.309		
ANOVA					*P-Value:* 1.099E-29 (P<0.05)	*F crit* 2.682
Source of Variation	*SS*	*Df*	*MS*	*F*		
Between Groups	131.466	3	43.822	87.644		
Within Groups	58	116	0.5			
Total	189.466	119				

Table 9: One Way Anova: Single Factor (Key Area: Tacit Knowledge Elicitation)

Anova: Single Factor						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Tacit knowledge elicitation- Podcast	30	186	6.2	0.510		
Tacit knowledge elicitation- Email	30	218	7.266	0.754		
Tacit Knowledge Elicitation-Chatting	30	239	7.966	0.240		
Tacit Knowledge Elicitation-Hybrid	30	278	9.266	0.340		
ANOVA						
Source of Variation	*SS*	*Df*	*MS*	*F*	*P-Value:*2.3E-33 (P<0.05)	*F crit* 2.682
Between Groups	148.825	3	49.608	107.562		
Within Groups	53.5	116	0.461			
Total	202.325	119				

6.1.1. Groups Average for One Way Anova – Single Factor:

Graphical description for the Groups Average of One way Anova – Single Factor can be seen in Fig.2.
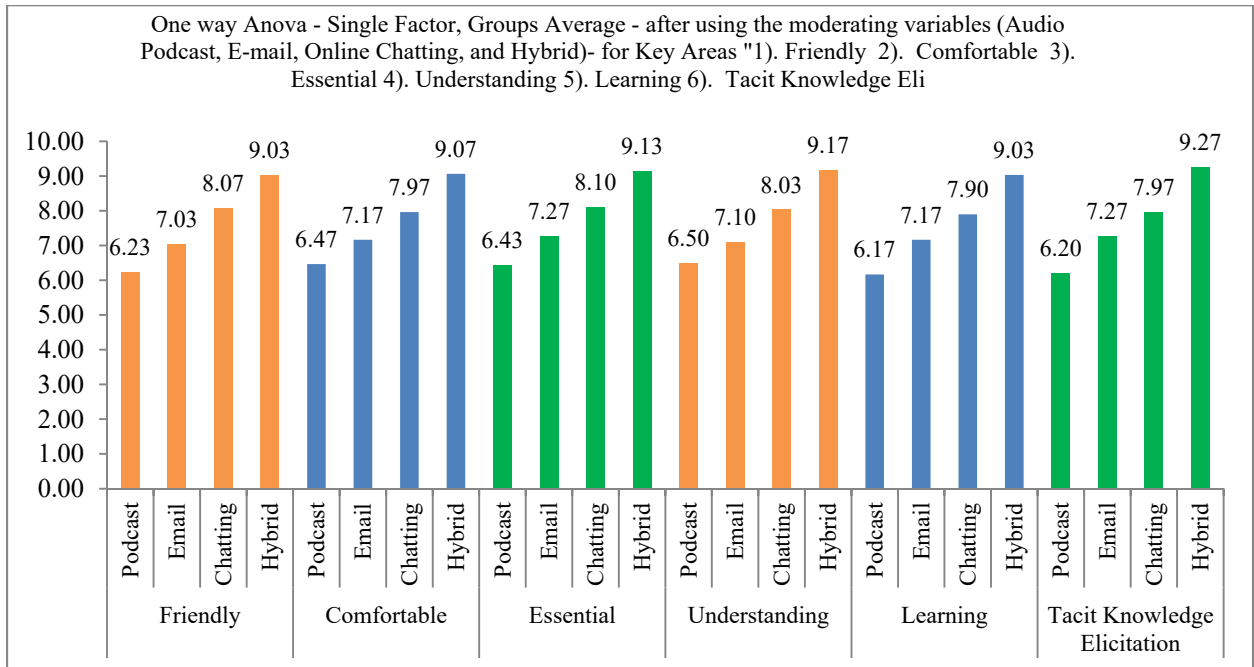
Fig. 2. Groups Average – After Using The Moderating Variables – Key Areas (Friendly, Comfortable, Essential, Understanding, Learning, And Tacit Knowledge Elicitation)

6.1.2. Summary and comparison of overall outcomes (One Way Anova – Single Factor, Groups Average)

Table 10. is presenting the overall summary of the outcomes for six key areas

Table 10 – Summary Of Outcomes For All The Six Key Areas (One Way Anova-Single Factor), Tables (4, 5, 6, 7, 8 And 9):

Key areas toward (Podcast, E-mail, Online Chatting, and Hybrid)	P-Value	Outcome	Comments	
Friendly	1E-33	<0.05 (Significant)	Reject H_0	Difference
Comfortable	1.934E-27	<0.05 (Significant)	Reject H_0	Difference
Essential	1.207E-26	<0.05 (Significant)	Reject H_0	Difference
Helped in Understanding	5.38E-28	<0.05 (Significant)	Reject H_0	Difference
Helped in Learning	1.099E-29	<0.05 (Significant)	Reject H_0	Difference
Helped in Tacit knowledge elicitation	2.3E-33	<0.05 (Significant)	Reject H_0	Difference

6.1.3. Percentage of overall outcomes – Groups' Average (E-tools for interviewing)

Table 11. is presenting the overall outcomes of the e-tools group average for interviewing (ref: Fig.2).

Table 11- Overall Groups Average, After Using Moderating Variables - Summary Of Outcomes For Interviewing (Ref: Fig.2.)

Percentage of outcomes (E-tools for interviewing)	Podcast	E-mail	Online Chatting	Hybrid
Friendly	62.30%	70.30%	80.70%	90.30%
Comfortable	64.70%	71.70%	79.70%	90.70%
Essential	64.30%	72.70%	81%	91.30%
Understanding	65%	71%	80.30%	91.70%
Learning	61.70%	71.70%	79%	90.30%
Tacit Knowledge Elicitation	62%	72.70%	79.70%	92.70%

6.2. Spider Chart – (Qualitative Data)
6.2.1. Output of Semi-Structured interview using 'Audio Podcast':
Following 'Fig. 3' is the graphical illustration of the comparison for qualitative data, collected through semi-structured interview, toward four areas (General, Functionality, Usability and Content), from Group-'A', communicated through electronic tool 'Audio Podcast'.
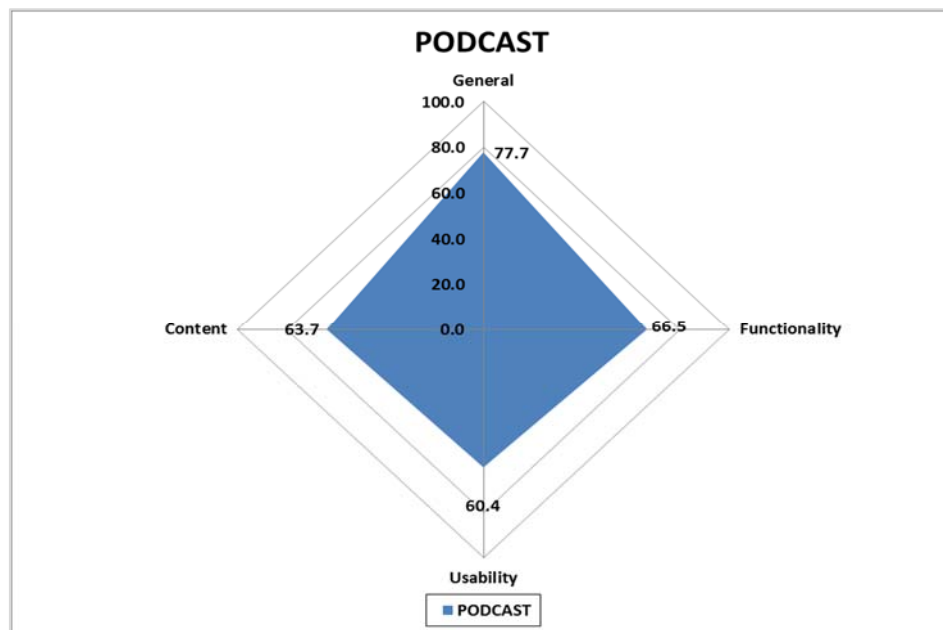
Fig. 3. Spider Chart - Semi-Structured Interview Using Audio Podcast

6.2.2.   Output of Semi-Structured interview using 'E-mail':

The under mentioned representation in 'Fig. 4' shows the comparison of four areas (General, Functionality, Usability and Content), collected through semi-structured interview, from Group-'B' communicated through electronic tool 'E-mail'.
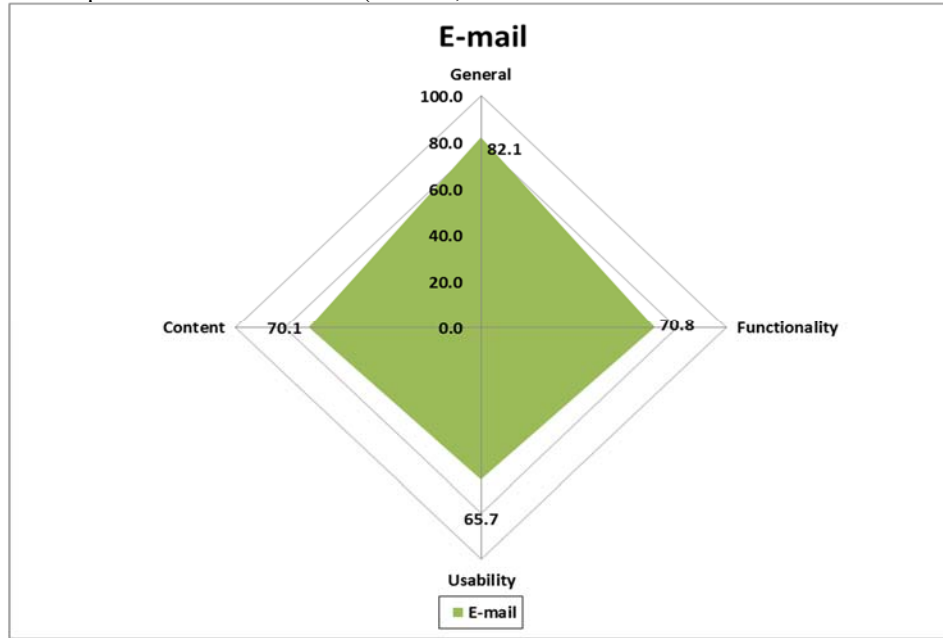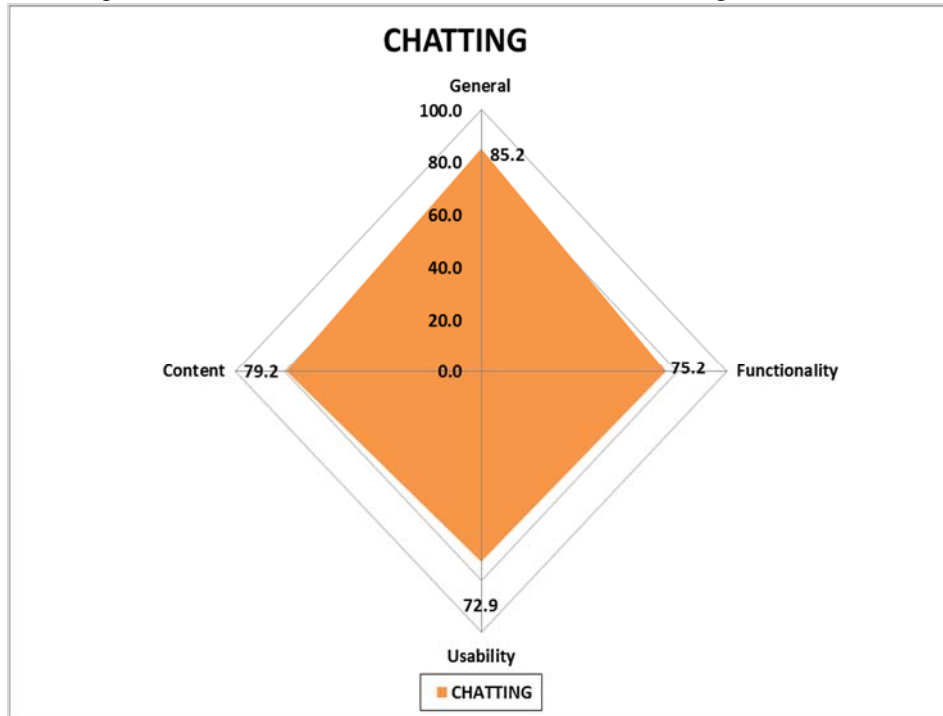

Fig. 4. Spider Chart - Semi-Structured Interview Using E-Mail

6.2.3.   Output of Semi-Structured interview using 'Online Chatting/Sessions':

'Fig. 5' is the graphical illustration of the comparison for qualitative data, collected from Group-'C' though semi-structured interview, toward four areas (General, Functionality, Usability and Content), and communicated through electronic tool 'Online Chatting'.

Fig. 5. Spider Chart - Semi-Structured Interview Using Online Chatting/Chat Sessions

6.2.4. Output of Semi-Structured interview using 'Hybrid':

Following 'Fig. 6' graphically shows the comparison of data collected through semi-structured interview from Group-'D', communicated through electronic tool 'Hybrid (Combination of Audio Podcast + E-mail + Online Chatting), concerning four areas (General, Functionality, Usability and Content).
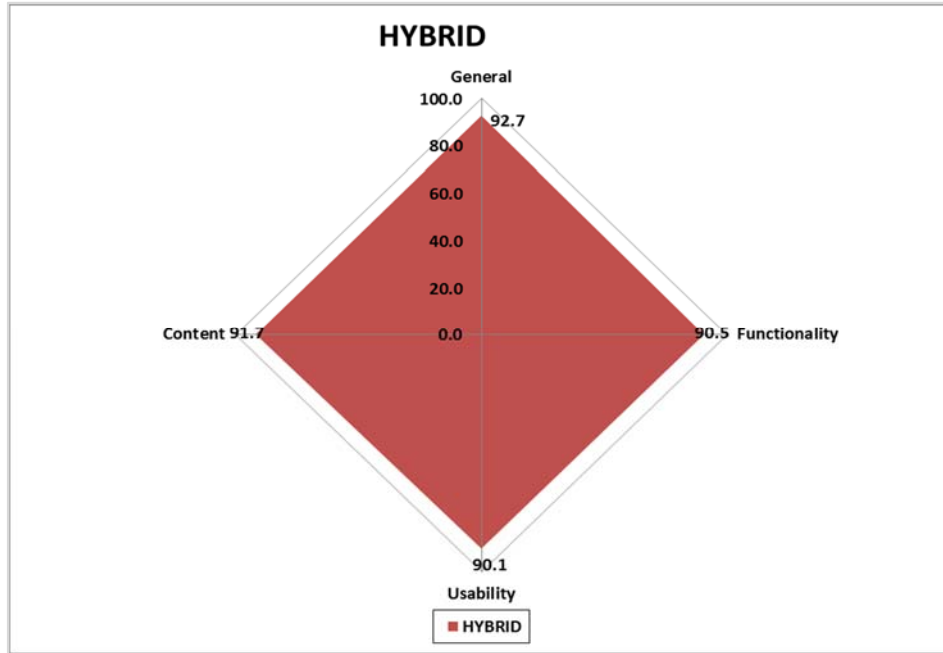
Fig. 6. Spider Chart - Semi-Structured Interview Using Hybrid

6.2.5. Summary and comparison of overall outcomes (Spider Chart)

Following Spider Chart 'Fig. 7' shows the overall comparison of the data, gathered from four groups (A, B, C and D), toward four moderating variables (Podcast, E-mail, Online Chatting and Hybrid), along four areas (General, Functionality, Usability and Content) through the process of Semi-Structured interview. Overall comparison of the arithmetic means, for all the four groups can be found in Table 12.
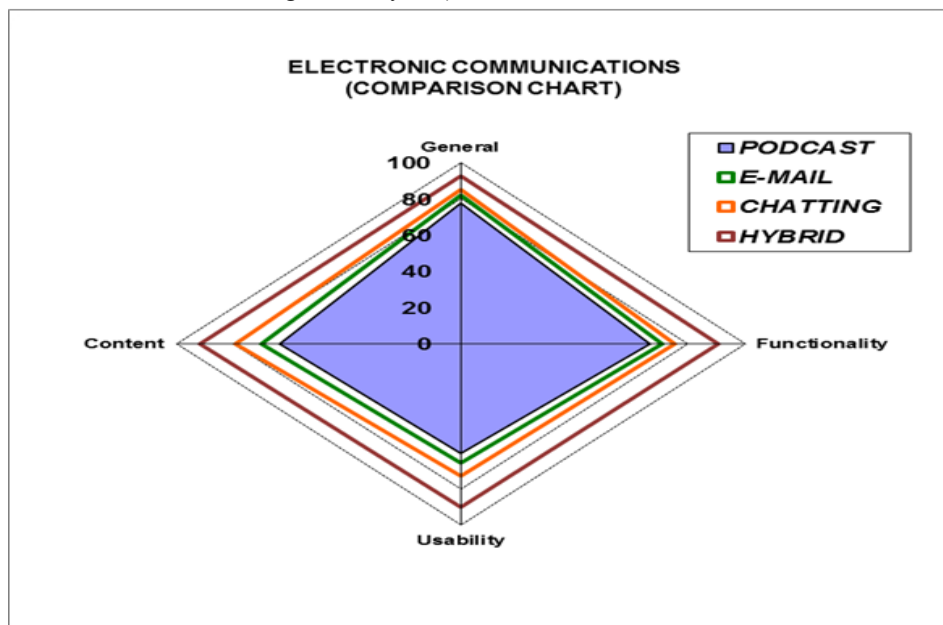
Fig. 7. Spider Chart - Semi-Structured Interview – Overall Comparison

Table 12. Overall Comparisons Of Arithmetic Means For All Groups (Audio Podcast, E-Mail, Chatting & Hybrid) Toward Four Areas

Areas	Group-'A' (Audio Podcast) Arithemetic Mean	Group-'B' (E-mail) Arithemetic Mean	Group-'C' (Online Chatting) Arithemetic Mean	Group-'D' (Hybrid) Arithemetic Mean
General	77.70%	82.10%	85.20%	92.70%
Functionality	66.50%	70.80%	75.20%	90.50%
Usability	60.40%	65.70%	72.90%	90.10%
Content	63.70%	70.10%	79.20%	91.70%

6.3. Key comparison of the points - Qualitative data gathered through Semi-Structured interview

Table 13. shows the overall comparison of the gathered data through Semi-Structured interview.

Table 13. Overall Key Comparison Of The Qualitative Data

Podcast (Group A)	E-mail (Group B)	Online Chatting (Group C)	Hybrid (Group D)
Participants had a general idea about the purpose of interview, things to be discussed, gathering the information about the project. but they had some doubts about some of the information, and many participants had used to say as an answer that they had the idea of the asked question/s, but they couldn't explain the idea of mind, in a proper way, or they didn't have the idea, how to explain their thoughts. Ovearll, interviewer had used prompting with almost 70% of the interviewees (i.e. 21/30 participants), during the interviews.	Participants had a good idea about the purpose of interview, things to be discussed, type of information required to be gathered for the project. they were familiar with a good technical vocabulary, only some of them had doubts, or had asked the questions/queries to clarify their doubts, therefore some of the participants used to say as an answer that they had the idea of the asked question/s for the interview, and they had the ideas about the answers of the asked questions, but they were not able to find proper words or way to explain the idea/s or thoughts in the mind. Overall, interviewer had used prompting with around 40% of the interviewees (i.e. 12/30 participants), during the interviews.	Participants had a better idea about the purpose of interview, things to be discussed, the type of information required to be given for the project. they had a very good technical vocabulary, as all the chat session were led by the interviewer, and all the participants had attended the chat sessions, and were involved in all the discussions, probably because of that mostly participants had no doubts about anything related with the interview. Overall their explanation was better for the asked questions during the interview. They replied well with a good confidence, and understood almost all the asked interview questions. Only, few of them were bit reluctant to answer few questions and had asked queries to clarify the doubts and to speak their mind. Overall, interviewer had used prompting with few interviewees, around 27% of the interviewees (i.e. 8/30 participants) during the interview.	Participants of this group were the best. They were very much confident about the interview process. Very much clear about all the questions related with interview, overall, fully ready for the requirements gathering process, had a very strong vocabulary related with the interview. Their ideas in mind were very clear, and they had mentioned that they had explained their best whatever they knew or the idea/s or thought/s in their minds. They were following the questions very easily, and replying in a very good manner. They replied very well with a great confidence, and understood fully almost all the asked questions. Interviewer had used overall prompting around 7% of the interviewees (i.e. only two participants, 2/30 participants), during the interview.

6.3.1 Comparison Chart – Overall Percentage of Prompting during interview

'Fig 8' shows overall percentage of prompting:
***Prompting:* (**is pushing the participant's attention in the right direction of the interview question).
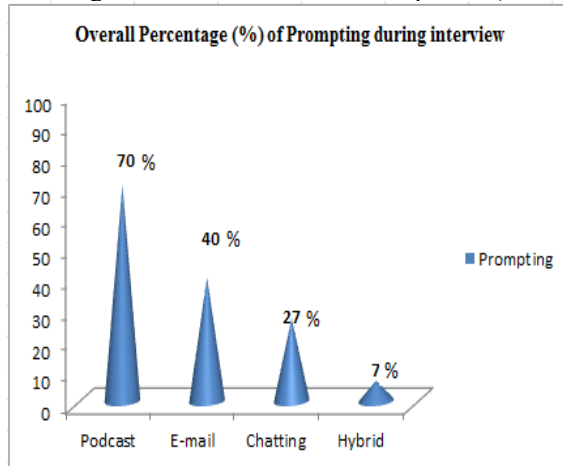

Fig. 8. Overall Percentage (%) Of Prompting During Interview

The results of One way Anova: Single Factor – for finding the difference comparison of effectiveness, among four groups (Audio Podcast, E-Mail, Online Chatting, and Hybrid) towards the six key areas "'Friendly', 'Comfortable', 'Essential', 'Understanding', 'Learning', and 'Tacit Knowledge Elicitation'" in Tables: 4, 5, 6, 7, 8, & 9, the summary of these outcomes in Table 10, the comparison of Groups Average from One Way Anova – Single Factor, in Fig. 2., and the percentage of outcomes in Table 11., verify and evidently prove that each electronic tool is effective, with having a significant difference of effects, among the electronic communication tools 'Audio Podcast', 'E-mail', 'Online Chatting' and 'Hybrid'.

For the qualitative data, Spider Chart (Fig. 7) shows the overall comparison of Spider Chart, and table 12, shows the overall comparison of arithmetic means for all the groups, and verifies the overall positive effects, and difference in effectiveness of four moderating variables (Audio Podcast, E-mail, Online Chatting and Hybrid) with different values of means, towards four areas (General, Functionality, Usability and Content) for the process of Semi-Structured interviews. Hence this difference proves that these electronic communication tools (Audio Podcast, E-mail, Online Chatting and Hybrid) have worked as moderating variables to elicit the tacit knowledge from the interviewees, and have positively affected

the outcomes of the interviews, with different values of effects through arithmetic means.

The overall key comparison of qualitative data gathered through semi-structured interview in table 13., and the comparison chart (Fig. 8) shows a clear difference among the e-tools effectiveness, and difference of percentage in prompting, during interview process towards the usage of four moderating variables, Podcast (70%), E-mail (40%), Online Chatting (27%) and Hybrid (7%), respectively.

7. CONCLUSION AND FUTURE WORK

A novel contribution of this research is the use of electronic communication tools (Audio Podcast, E-mail, Online Chatting, and Hybrid) to discuss the detailed interview agenda between interviewer and interviewee, to define a new way of interview type. What becomes evident in the literature review is that the uses of these electronic communication tools are for the routine communications through audio podcasts, e-mails, online chat sessions, or merely conducting the electronic interviews. In fact, [69] say that audio podcasts are very effective in conducting interviews and [47] discusses the positive use of audio podcasts for sending the interview questions to interviewee, but due to its nature of one way communication, understanding ambiguity remains there. [40, 70] claim that e-mail is a very good medium and strong tool to conduct interviews, and [71] argues that asynchronous e-mail interviewing is good with unique benefits for the collection of information that could be effective in qualitative interviewing, but there are lots of understanding gaps those are impossible to discuss and cover through this method of interviewing, therefore this method cannot replace the traditional face to face interviewing technique. [72] Claims that interviewing can be done through online chat sessions, that is effective because during these interviews questioning can be adjusted based on the interviewee responses, and [73] further explains the benefits of online chat sessions as a convenient and efficient way of conducting the online interviews, but, still, lack of understanding, between the interviewer and interviewee remains there that needs to be bridged through some other methods.

[38, 39] argues that the provision of interview agenda to the interviewee, for purpose or reading and understanding and getting an idea of interview, is a crucial step of every interview, that helps the interviewee to get an idea about the interview, and is a good effort to create an understanding between the interviewer and interviewee towards a common goal of interview, but [5, 18, 19] claims that, still,

the user requirements elicitation and understanding is a major challenge during the process of requirements elicitation, and [5, 6, 7] debate that weak requirements elicitation is among one of the major key factors, that causes the software project failure.

The idea of bridging the understanding gap between the interviewer and interviewee as it relates to this research study has its origin with that of [47, 71, and 73] and [38, 39, 5, 18, 19 and 5, 6 and 7].

This research study has discussed the effects of four electronic communications (Audio Podcast, E-mail, Online Chatting and Hybrid); those have worked as moderating variables for eliciting the tacit knowledge, through detailed discussion of interview agenda, prior to the process of interviewing. Six key areas have been used to test the hypothesis, and four factors toward research question. The results of hypothesis testing have proved that each e-tool is effective, and there are differences of effectiveness among four e-tools towards six key areas, and have verified effective results. The major purpose of this research is to drag the attention of software specialists toward the use of these e-tools from a different approach, for the discussion of detailed interview agenda, prior to the process of interviewing, as per their feasibility, in selecting the e-tool, keeping in view their outcomes; as these moderating variables acted as catalysts for the interviewing, and subsequently caused performance improvement for the key areas "Friendly", "Comfortable", "Essential", "Understanding", "Learning" and "Tacit Knowledge Elicitation", and also the results of the spider chat, that was a thorough assessment for the research question, toward the development of a course website, concerning four areas (General, Functionality, Usability, Content) has verified that these four e-communication tools worked well for the process of interviewing for small software developments and positively affected the process of interviewing process, and produced state-of-the-art results.

These research findings provide the inspiration to further evaluate the effectiveness of interview techniques from different aspects and through different moderating variables. This research study had been piloted purely, to elicit the tacit knowledge from different groups, and comparison of the outcomes in the perspective of small software engineering projects. These kinds of projects, are often overlooked from studies, by most of the organizations, whereas, these organizations are usually focusing on large implementations. Worth considering, further research studies can be

done to discuss the detailed interview agenda prior to the interviewing, for the big, industrial software development projects, or with the participants having different age groups, participants with different backgrounds, or different combinations of e-tools like 'Podcasts + E-mail', or 'Podcasts + Online Chatting' or 'E-mail + Online Chatting', or focusing more on the functional requirements, or content requirements, or thorough different other types of electronic communication tools, like Video Chats, Voice e-mails, Wikis, Blogs and their combinations, can be used for the future research.

This research provides experimental evidence that the use of electronic communication tools (Audio Podcasts, E-mail, Online Chatting and Hybrid) is an effective technique to elicit the tacit knowledge. We envision that this study will support to enrich the tacit knowledge elicitation process for interviewing during the process of software development. It is strongly recommended to use all or any one of the e-communication types, keeping in view the conditions of software development projects, for the process of interviewing, toward a clear understanding between the interviewer and interviewee. 'Hybrid' has been verified as the best combination. Therefore, Hybrid could be the first choice, if the project condition allows for using all e-communication tools, or else, any one of the other types (Audio Podcast or E-mail or Online Chatting) can be utilized, separately. If the interviewee can afford to be online as required, synchronous mode (real time communication) "Online chatting" can be one of the recommended e-communication options. E-mail can be easily used for communications, because this mode is asynchronous (two way communication tool, any time reading or replying mode). Audio Podcast is good for those participants, mostly having the time for listening through their portable devices, as podcast is asynchronous, one way communication for listening only.

Therefore, the analysis and outcomes of these e-communications verify that these e-tools as moderating variables through discussing the detailed interview agenda, can lend a helping hand for the development of better understanding between the interviewer and interviewee towards the questions, topics, and issues going to be discussed during the interview process, and support the software experts in the requirements elicitation phase for conducing the interviews, during the process of software development. These moderating variables can play a vital role to convert the tacit knowledge to explicit, and successively better elicitation can result in successful project. The results of this study are closely related with

most famous model of knowledge creation, the "Nonaka's Model", associated with Tacit and Explicit knowledge elicitation. Explicit knowledge is obvious, accurate and can be described easily, however tacit knowledge relates with the difficulty to describe, and main amount of our understanding is based on tacit knowledge, and if tacit knowledge is elicited properly, it results in successful projects [74], and also in line with the following statement of [10] that the biggest crucial activity in the process of software development is gathering the right requirements that leads to successful projects, and in turn saves the overall time and cost of the projects.

Overall, the review of literature reveals that the evaluation studies related with elicitation techniques are substantially deficient [84, 85, 137, 45]. There is need of comprehensive study for all the leading techniques of elicitation. Having such a comprehensive study will furnish a thorough baseline of technique effectiveness to the professionals, practitioners and academicians, and provide a solution to the crucial need, to have a comprehensive body of knowledge in the field of software engineering.

Interviewing is the most commonly used technique for requirements elicitation [86, 87, 88, 89, 90]. Specifically, interviewing is a particular method of choice in the business domain. The eventual practical application of the findings of this research study is to improve the elicitation technique to create quality software. These results of the study should factor into literature, methods, techniques and tools that argue and manage suitable and applicable elicitation techniques for a particular project. Organizations, those are widely using the interview techniques for the elicitation of requirements should have a great interest in the results of this research study.

This research might produce the foundation for approaches to assess the effectiveness for all the famous elicitation techniques. The deficiency of these assessments is a limitation to the advancement of software engineering as an established discipline [91, 92].

SWEBOK is the abbreviation for Software Engineering Body of Knowledge that is an international standard specifying a guide to commonly accepted knowledge of Software Engineering, or, also called Software Engineering Body of Knowledge [93]. Moreover, the contribution of the research outcomes might enrich the contents of requirements engineering in the Software Engineering Body of Knowledge (SWEBOK).

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Appendix A [31, 32]

QUESTIONNAIRE FORM

Effect of the Electronic Communication on the Elicitation of Tacit Knowledge on Interview Techniques for Small Software Developments

Please Tick
O Male
O Female

Electronic Communication tool: Audio Podcast/E-mail/Online Chatting/Hybrid

Dear Student:
The function and intention of this form is to obtain your opinion regarding the Electronic Communication tool used for interviewing (Audio Podcast/E-mail/Online Chatting/Hybrid). Your input will help out in understanding the effects of electronic communication on the elicitation of tacit knowledge in interview techniques for small software development process and will not at all affect the evaluation of your work. Assess the following statements by selecting:

1	2	3	4	5	6	7	8	9	10

1=Strongly Disagree   10=Strongly Agree

Please encircle your answer;
Thanks for your help.   **Before / After Interview**

01.	I think Electronic Communication tool is friendly.	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5 6 7 8 9 10
02.	I think Electronic Communication tool is comfortable,	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5 6 7 8 9 10
03.	I feel that Electronic Communication tool is an essential	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5 6 7 8 9 10
04.	On the whole, Electronic Communication tool helps in understanding the interview requirements.	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5 6 7 8 9 10
05.	On the whole, Electronic Communication tool helps in learning about the interview requirements.	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5 6 7 8 9 10
06.	On the whole, Electronic Communication tool helps in the elicitation of tacit knowledge sharing process.	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5 6 7 8 9 10
07.	I wish this interview to be conducted by the interviewer	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5 6 7 8 9 10
08.	I wish this interview to be conducted by Interviewer and supported through Electronic Communication tool.	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5 6 7 8 9 10
09.	I will recommend my friends, to the use of Electronic Communication tool for interviews	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5 6 7 8 9 10
10.	I think the Electronic Communication tool is helpful in the collection of ideas in mind.	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5 6 7 8 9 10
11.	I think the Electronic Communication tool is helpful in the organization of ideas in mind.	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5 6 7 8 9 10
12.	I think the Electronic Communication tool is helpful in the presentation of ideas in mind.	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5 6 7 8 9 10

Appendix B [31, 32]:

Requirements and Tacit Knowledge Elicitation:
One-on-One Semi-Structured Interview
Warm up questions:
Welcome to the interview, how are you.....etc.
Feel free to ask any question during interview……etc.
Note: Further follow-up questions (Probing) will be asked, as appropriate, with each interviewee/participant to gain further response, and (Prompting) the pushing of participant in the right direction, as appropriate.
You may be asked to review your answer, if required, to add more clarity.
Questions about General, Functionality, Usability, and Content requirements and Tacit Knowledge Elicitation

Interview Questions	This column is for interviewer's use only *Rate the knowledge level of the interviewee from 1 to 5, after asking the relevant question*				
General Requirements:					
1. Define the term WWW?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
2. Please explain what your problem statement is?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
3. a). Can you explain the role of interviewee (i.e. your role) for this interview? b). Can you explain the role of interviewer (i.e. my role) for this interview?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
4. a). List the name of Modules (or Components) you want to add to your educational website: b). Explain the existing Grading System, and your website requirements for the grading system:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
5. What are your expectations from an educational web site?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Functional Requirements:					
6. Explain the difference between "Static Website" and "Dynamic Website"	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
7. a). Which one of the following site fulfills your requirements? o Static site o File based dynamic site o Database driven dynamic site b). Explain the detailed reason, why have you selected the above mentioned site format?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
8. Do you have any experience in using the about the above mentioned site format? Describe your overall experience, briefly.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
9. Do you need to add User Interaction Feature to your educational website? o Yes O No If Yes, explain the benefits of and impacts of this feature to your website:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
10. Do you have any other final thoughts or suggestions in terms of functional requirements of the website?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Usability Requirements:					
11. a). What is your requirement about font size and font spacing for your website?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
b). would you like to share your experience about the impacts of font size and its spacing on a website?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
12. a). What kind of overall format, you want to have for your website? O Consistent O Inconsistent	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

	1	2	3	4	5
b). How do you explain the role of your choice (Consistent or Inconsistent) in the performance of a website?					
13. What is your requirement about the load time of the home page of your website? ○ Long time ○ Short time Explain why?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
14. What do you think about the impact of the text-to-background contrast?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
15. What are the other special features in terms of usability, would you like to add to your course website?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Content Requirements:					
16. Explain, the term 'FAQ':	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
17. How do you explain the importance of 'FAQ' for your website?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
18. State the requirements of important contents you want to have in your website?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
19. State the format of the documents (files) along with their extensions you want to see in your website:	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
20. Anything else would you like to say, to be added as content requirements to your course website?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Many thanks for your contribution in this interview.
Overall interviewer's observations and opinions about the interview:

_____

Overall prompting was done for this participant, during the interview: ○ Yes   ○ No