Short Message Service Technology: A Comprehensive Literature Review

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Abstract— Out of the information communication technologies (ICTs) available today, the most popular is short message service (SMS) text-messaging, especially among teens and young adults who comprise a sizable percentage of the college population worldwide. However, very little research appears in the scholarly literature on text-messaging due to the fact it is still a relatively new technology and therefore, the quantity of research on it is notably limited. Because of its immense popularity, text-messaging is the subject of this extensive review of literature. Numerous research topics pertaining to text-messaging spanning across several disciplines will be addressed.

Keywords- text-messaging; information communication technologies (ICTs); short message service (SMS); information systems (IS); information technology (IT)

I. INTRODUCTION

Information Systems (IS) is a very broad field of study [1]. IS, in our context, also includes education, psychology, and allied health. The literature that was reviewed for this research is indicative of all these fields. Although this study is primarily multidisciplinary in scope, it uniquely aims to add to the scientific body of knowledge (BoK) within IS.

This review of literature will discuss SMS (short message service) text-messaging technology and will address how it has been used and the types of problems previous SMS research has explored, along with results and conclusions derived from various studies and experiments. This review of literature will also explore unanswered questions regarding SMS text-messaging to include suggested implications and future work that the scholarly community could consider with regard to continuing research.

II. SMS TEXT-MESSAGING TECHNOLOGY

A. SEMINAL RESEARCH

"SMS is a text-messaging cell phone technology" [2], which within some definitions would also classify it as an information communication technology (ICT). Prior studies relating to text-messaging do not reflect a sufficient breadth of knowledge with the majority of this research focusing on adoption, design, and social factors. Communication choice, as well as user behavior, has been addressed in the pre-existing body of IS literature [3]. It was offered that prior research has also explored mobility dealing with issues concerning various channel coding, portability, location discovery, limited battery life, risk of data loss, unreliable network connections and volatile access points [4].

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Collaborative mobility has become an upcoming field of study in IS research [4]. Collaborative mobility involves how mobile applications, or technology on-the-go, supports humans in school, the workplace, and in the performance of daily tasks. With mobility, there are no physical demands of an office, residence, or classroom. Findings from collaborative studies can help in our understanding about anywhere, anytime access that will also permit researchers to continue to contribute to the scholarly BoK on text-messaging technology. Students, from a mobility standpoint, will be more likely to send a text-message or use a cell phone, and not be as likely to use email for interpersonal communication [3].

As a majority of the earlier research on SMS text-messaging technology originated in Europe and Asia, it has only in the past few years appeared as a relatively new research area in America [5]. Preliminary research relating to SMS usage can be traced back to Scandinavia [6]. Prior Scandinavian research mostly examined usage and adoption among young girls and boys. In one such study, text-messages sent and received by 10 participants comprised of five boys

and five girls between the ages of 15 and 16 were examined to report on their texting patterns.

More precisely, the language used within the conversations of the young participants was of major concern. The results of this study, derived from examining the conversations of the text participants, demonstrated that teenage text users did not participate in an abundance of simultaneous or multiple conversations and they frequently alternated between other communication mediums such as chat to conclude their discussions upon terminating their texting sessions. Another finding was that boys and girls were likely to send and receive text messages with the same frequency. The conclusion drawn from these results suggested that the participants tend to engage in asynchronous conversations while also planning and coordinating their activities.

Recurring qualitative studies have examined the unique behaviors of text-messaging such as why and how text messages are exchanged and with whom. A comprehensive and lengthy review of the literature on SMS text-messaging uncovers a seemingly abrupt gap in the literature prior to the year 2001 with perhaps only a few sporadic articles appearing before that year. This is most likely due to the fact that SMS was officially introduced to the mainstream public in 1992 [7]. One of the earlier SMS studies conducted was on Point-to-Point Gateway Short Message (GSM) service, a wireless network architecture providing a connectionless transfer of messages with low-time performance and low-capacity.

A method was developed on point-to-point SMS which offered the ability to send short text messages to specific users by way of an enhanced two-way paging service [8]. This study conceded that text-messaging, as it is known today, was still in its very early stages of development during this period. It was also revealed that even though SMS text-messaging was implemented with the first GSM networks, it was the introduction of "pay-as-you-go" mobile plans that fueled text-messaging usage in Scandinavia [6]. Reiterating that literature on text-messaging was practically absent prior to 2001, after the year 2001 however, the scholarly body of research on SMS text-messaging began to increase, in small scope, but in greater quantity.

B. ADOPTION AND DESIGN FACTORS

Adolescent use of socially interactive technologies (SITs) and their relationship to offline social networks was under scrutiny in an earlier adoption study [9]. This study reported that previous research on youth and SITs primarily focused on who uses this technology and why, with the results derived from small ethnographic samples. SITs were defined as technology-mediated communications tools, i.e. instant messaging and text messaging that is redefining the social networks of today's youth [9]. The study participants were seventh graders from a Midwestern US middle school. The results revealed that the participants were not exclusively text-messaging their friends as they sometimes listed someone as a close friend, yet they only contacted them occasionally through a SIT. Moreover, the results revealed the possibility of the participants using different or specific SITs to contact specific or different people. Another finding revealed that instant messaging rated better than text-messaging as an SIT among the participants. The results prompted the conclusion that SITs were not necessarily creating strong ties among the participants in online (instant messaging, text messaging) networks, nor were they creating weak ties in offline (person-to-person) networks.

Age adoption is another topic of interest when it comes to text-messaging research. An increasing number of middle-aged people are beginning to adopt non-verbal methods of communication such as text-messaging [5]. The use of text-messaging services by middle-aged users was the focus of a study concerned with ease of use (EU) and other difficulties experienced by older users, 35-60 years old, who engaged in text-messaging. Twenty participants engaged in text-messaging activities using two different mobile handsets. Usability goals of memorability, efficiency, learnability, errors, and user satisfaction were evaluated [5]. An analysis of the findings first revealed that the keyboard layout of the handsets was a concern among the older participants. The size and spacing between the keys became an issue with the male participants.

As a result, the males were forced to use the tips of their index fingers and thumbs to input data in an attempt not to inadvertently press more than one key at a time. The middle-aged participants also expressed a legitimate concern about the lack of ease at which they could send text-messages [5]. As such, the substandard usability, which affected their efficiency, prompted the middle-aged participants to believe that the actual level of utility employed by text-messaging was quite low. Middle-aged participants experienced difficulties utilizing text-messaging due to the low-level usability of the handsets that were utilized in their study. Keypad design played a crucial role in the poor usability factor.

In conjunction with adoption factors of technology, investigations into design factors of mobile phones with text-messaging capability for older adults (seniors) was also a topic of scholarly focus [10]. The authors asserted that although mobile phones can be a useful tool for seniors, they are typically designed for younger people. Creating a "senior-friendly" phone first relies on decreased sensor-motor skills and a reduction in complexity by infusing minimal functionality in its design. A prototype of a redesigned mobile phone was created and numerous participatory activities were conducted that permitted the senior participants to evaluate the mobile phone, including its vital applications.

A very small sample of only five participants was recruited for this study ranging in ages from 55-86 [10]. Upon evaluating the prototype handset, the seniors desired multiple application domains; however, usability problems were encountered due to hardware and operating system designs that affected the prototype's functionality. A lack of technical support or fears of radiation exposure, and critical-mass adoption were discovered to be potential contributing factors among the senior participants with regard to EU and perceived functionality.

A recent study was conducted that focused on text-messaging use on a large scale [11]. This study was comprised of 70,000 students in the United States with approximately 60,000 text-messages aligned into 8,500 distinct conversations that were collected throughout a four-month data collection period. The texting habits of the participants and the content of their messages were examined to observe how this highly popular method of communication among college students had changed over the past decade. The findings revealed that students communicate with a large number of contacts for extended periods while at the same time, engaging in simultaneous conversations with what was discovered to be as many as nine contacts. It was also found that text-messaging was beneficial for switching the mode of communication among the student participants in line with Stephen's ICT succession Theory. The findings further revealed that text-messaging had evolved dramatically over the years leading to the proposal of some future design implications [11]. The first design implication was the support of simultaneous communications. The second design implication was that of interoperability between other communications mediums such as social networking Websites, chat, and email. While change with regard to text-messaging was studied [11], its more useful and innovative aspects were examined from a reflective point of view [12]. This was accomplished by surveying the literature and reporting on the results of a pilot university study centered on a SMS system.

A quasi-intuitive theoretical framework was proposed that became a catalyst for a generation of ideas in the business development process [12]. A project-based methodology was incorporated to support a mobile SMS text-messaging prototype that was launched in a higher education setting. Students and faculty utilized the text-messaging system to offer opinions regarding its usefulness and effectiveness. Qualitative data were collected from focus groups by academic course coordinators who were also a part of the pilot study. Conclusions drawn surmised that the impact of mobile text-messaging was considered an emergent technology that had inadvertently become vital in the design and development of new social networks on a global scale. In higher educational settings, text-messaging has received attention in the literature primarily as either an instructional aid or learning tool [13] [14].

C. APPLICABILITY OF SMS FOR FORMAL TASK COMPLETION

Emergency response workers dealing with natural disasters and other related incidents could benefit from text-messaging [15]. The concept of a Database Management System (DBMS) was applied in a theoretical framework to implement a quick and easy-to-use SMS text-messaging system to send important messages, warnings, and to summon rapid response teams during an earthquake [15]. Although databases, such as the one they deployed for the earthquake response, are largely used as an IS, the capability to interconnect them with messaging systems is still minimally executed. The Earthquake Response SMS system using a DBMS that was applied in this study could greatly lower the time that rescuers use to enter and station at their disaster relief post. An empirical study of user perceptions of text-messaging was another study of interest [16].

It was suggested that applying text-messaging as a means to improve compliance is a new application of ecommerce that promotes numerous unknown consequences [16]. A qualitative experiment was conducted to assess user perceptions upon their receipt of encouraging text-messages that related to their personal health that specifically encouraged the participants to follow a healthy regimen. Fifty-one participants took part in the one-month study and all participants had access to cell phones. The results disclosed that user perceptions are the primary factor in determining the use of mobile technology for compliance. Of the perceptions that were revealed, usefulness was found to be the most important. This finding was supported by other technology adoption studies found in the literature, further suggesting that opportunities for utilizing text-messaging to improve adherence lies within its perceived usefulness along with the advantages of mobile technology.

In 2009, a study was conducted investigating the attitudes and credibility of text-messaging as a tool to serve the political agenda in Kuwait [17]. The main point of interest was to determine how persuasive political text-messages were in comparison to traditional media. A questionnaire was distributed to 210 subjects of which only 98 responded. Additionally, the questionnaire was uploaded to a Web site where 140 participants completed it out of 186 who responded to it. The data analysis revealed that the respondents fervently disapproved of SMS text-messaging for promoting public opinion on voting in Kuwait. The results suggested that respondents generally had a negative attitude toward political text-messages with less than one third considering the text-messages to be credible, and even a smaller percentage actually considering them persuasive. Additionally, text-messaging itself was a medium that the Kuwaiti participants generally found to be non-credible. However, during actual political campaigns, political text-messages were found to be beneficial, especially during an election period. It was

affirmed that text-messaging, as a medium to promote advertising with consumers, has now sparked the interest of research scholars, as in a 2010 investigation of the effectiveness of text-messaging and its usefulness to encourage consumer advertising in Bangladesh [18].

A mixed methods approach was used that included field interviews with prospective customers of different businesses, in addition to 160 stakeholders who completed a survey. Findings provided evidence that text-messaging was found to be an effective method for consumers to receive advertisements for products in Bangladesh by way of their cell phones. However, conclusions from this study promoted that thinking patterns and perceptions of people have recently changed with individuals now demonstrating receptiveness toward new mediums for advertising, such as SMS text-messaging, including an emerging and larger percentage of the Bangladesh population.

A SMS based wireless home appliance control system (HACS) was evaluated for automating appliances and security [19]. HACS is based on global system communications for mobile (GSM) network technology. GSM permits the transmission of text-messages between a sender and a receiver while allowing for discretionary access of appliances and detectable control at home. Two subsystems composed of securities and appliances were targeted for evaluating the HACS. During testing the HACS allowed for the provision of security and delivered a breach alert when a simulated intrusion was detected. The remote control component allowed the user to turn a simulated appliance on and off through an incoming text-message, and the system automatically performed diagnostics and tests for continued SMS receiving and sending capability and made any necessary configuration adjustments. It was determined that the design approach was novel and it was further determined that the required goals and objectives of the HACS had been met [19].

Text-messaging has been used in medical facilities to manage pre and post-operative patient care [2]. Not surprisingly, the medical sector seems to be embracing text-messaging at an increasing rate. Text-messaging was said to be preferable by surgeons who cite many advantages of using it [20]. The surgeons reporting in [20] informed that text-messaging is instantaneous that permits reaching the recipient within seconds and consequently, allows for a speedy reply. Its cost benefit was also a positive factor and it is highly accessible because 80% of the surgeons surveyed reportedly carried a cellular phone.

The anywhere, anytime accessibility of text-messaging was also positively received as it negated the need for online access or a pc. Text-messaging is considered non-intrusive and surgeons could utilize it inside the operating room by placing their cell phone inside a sterile object or container such as a bag [20]. A final consideration in favor of text-messaging is the conciseness of its messaging, which surgeons prefer and need to help them make rapid decisions.

Text-messaging was again investigated in a health-care setting to determine its effectiveness on diabetic patients in a six-month experimental study [21]. Fifty-one patients participated in an experiment to assist in evaluating a telemedicine management system to aid type-2 diabetes patients in maintaining healthy, normal blood glucose levels. The researchers were registered nurses who divided the participants into a control group and an intervention group.
The intervention group used cellular phones to send daily text-messages to the researchers to report their blood glucose levels and their diet and exercise routines. The researchers would send text replies back to the intervention group with feedback or recommendations to help them manage their glucose levels. The results yielded decreases in patient blood glucose levels after three months continuing through the end of the study. From the results, it was concluded that the SMS text-messaging intervention improved the levels of the diabetic patients who participated in the study [21].

A 2008 study examined how text-messaging affected the anxiety levels of pregnant women who were awaiting the reports of their prenatal biochemical screening for Down syndrome [22]. The aim of the study was to improve health informative services as well as to shorten the waiting time of prenatal reports. Two reporting groups were utilized in this study, one where each of the participants utilized cellular phones to receive fast reports, and a second group who received reports without text-messaging. A total of 2,782 pregnant women were targeted to participate in the study who were screened for potential Down syndrome. Some of the participants received negative results in their prenatal screening, while others received positive results in their prenatal screening.

Significantly increased anxiety levels were associated with women who received positive results on their Down syndrome screening, compared to those with negative results [22]. The researchers questioned whether faster reporting by a text-message could reduce the anxiety levels in women who were waiting for a prenatal biochemical screening report for Down syndrome and received a negative result. The findings informed that screen-negative women showed no significant change in anxiety level before prenatal screening up to three days after the clinical appointment. Conversely, state-anxiety scores declined significantly with the fast reporting group utilizing text-messaging on the second occasion of measurement. It was summarized that the addition of text-messaging, as a routine reporting system, offered increased benefits with regard to reducing anxiety among women with a negative screening result. Research on text-messaging seems to lean more in favor of socio-cultural adoption among teenagers. However, some higher-level research issues have

recently been addressed in the scholarly literature concerning SMS text-messaging.

D. HARD PROBLEMS IN SMS RESEARCH

People appear to prefer text-messaging for messaging and the exchange of information [23]. A model was presented for a basic, extendable application that could be used to administer several services with the inclusion of text-messaging. A proposed model was theorized as an inexpensive way of providing useful information to users in areas without Internet service. They also concluded that this system should be scalable to allow for the exchange of information and SMS transactions. Another prototype design was developed for a text-message performance management system and it was critiqued with the use of case studies based on various scenarios and simulations [7]. This design was deemed effective in meeting the performance objectives set by an administrator at an efficient computational cost. Conclusions derived as a result of the critique process suggested that the design adapted to changes in networking conditions while continuously meeting performance expectations and objectives, consequently affirming the effectiveness and efficiency of their design.

A SMS architecture was proposed that allowed Web providers to market their services through text-messaging by reaching low-end mobile phone users [24]. The architecture that was referred to as SMBots, allowed for the management of dynamic services centered on text-messaging, thus making them available to mobile phone users on the go. Although the architecture looked promising, security concerns were presented such as protection from malicious routines that could make critical files vulnerable. In addition to malicious worms and viruses, future considerations were to understand the number of SMS requests that could be computed without affecting service quality and the maximum load of submitted services that could be supported. In support of IS security concerns addressed by [24], authentication was the most important line of defense directing the proposal of yet another novel mobile authentication scheme using SMS text-messaging [15]. In this new model, public key encryption provided two-way authentication and non-repudiation that allowed for a high level of security.

While the implications of text-messaging in advertising was explored [18], a similar contribution was made with the proposition of mobile commerce by combining text-messaging with an enterprise commerce application [25]. It was suggested that effective mobile business applications must meet the conditions of being flexible, reliable, efficient, and accurate. Thus, text-messaging was promoted to be fast, cheap, and reliable leading to the conclusion that SMS text-messaging has definitive advantages for the achievement of mobile applications [25].

Positive results was reported with regard to consumer feedback from text-messaging [26]. During this experiment, three experimental groups and two control groups were utilized from among 1,452 households to examine the effect that feedback text-messages had on household electric energy consumption. Findings revealed that email messages and text-messages warning consumer participants of high-energy consumption periods resulted in a reduction of the use of electricity, which resulted in a conservation of energy. It was noted that the implementation of text-messaging feedback for their proposed notification system was minimal, especially from a cost perspective [26].

In a more technical study, the pattern of eye movements of skilled texters was examined while they read sentences within text-messages in relation to sentences that were written normally [27]. This experiment involved 26 student participants and 72 sentences that were read across four experimental conditions. The findings informed that although SMS sentences with abbreviations and jargon are much shorter than normal sentences, reading times were notably longer for SMS sentences than for normal written sentences. SMS words were also found to be more difficult to read but skipped less often than normal written words. Due to a significant effect in time and gaze duration in the eyes while reading SMS sentences, there is a phonological reading cost at both global and local levels for individuals, even those classified as experts in SMS communication [27].

There is an increasing problem of interruption in communication with text-messaging; however, current text-messaging systems are incapable of allowing users to manage these interruptions [28]. An intelligent text-messaging platform was devised that gave the user a notification at a suitable time if someone had attempted to contact them, which awarded the user unwanted interruptions during the completion of tasks. The system worked on a decision-making module, also referred to as a decision tree. A total of 382 messages were self-contained within the text-messaging platform. Five student participants evaluated the notification system over a two to four-week period. Noted findings were the participants were more concerned with accuracy in the notifications during busy activities because incorrect notifications affected their productivity and performance. However, during non-active times, a greater tolerance was accepted with regard to inaccurate notifications. The results of this developmental study [28] supported the primary goal of reducing unwanted interruptions for mobile users during the completion of tasks.

E. Unanswered Questions And Future Research

With text-messaging being such a relatively new research area, especially in the United States, there are issues

that have been acknowledged by researchers that warrant future study. Critical factors were cited that seemed to influence use of technology, such as general comfort level (self-efficacy) with technology, culture, demographics, and experience with technology [29]. Adoption factors seemed to still be a continuing area of consideration as it was stipulated that there is a crucial need to understand how and why individuals adopt mobile devices. A previous argument was made in support proposing that continuing research is important toward our understanding of a new technology's usage [9]. A couple of interesting research questions were suggested that deserve further examination as well. First, what group dynamics influence youth to adopt particular technologies or to use them in a particular manner? How does using these technologies actually affect how children and adolescents communicate with one another? [9]. Another area of virtually unexplored research deals with the effects of SITs on teenagers.

There are obviously more unanswered questions relating to text-messaging. Text-messaging is a freely open, typically private method of communication among close-knit groups that is rarely, if ever, formally governed by a single entity. Hence, it is noted that limited research exists on text-messaging regarding its impact on interpersonal communications [2], particularly when dealing with college students and teenagers. Barely any research exists on gratifications of text-messaging as a lot of what is known regarding the use of text-messaging and the motives behind its use has been drawn from the experience of teenagers. The general theoretical conclusion of current and past use and gratifications studies alludes that gratifications sought act as a motivator toward the use of a technology [2]. One weakness of SMS text-messaging is its limitation of only 160 characters per message [5] [2]. While SMS text-messaging has its definite advantages, coincidentally, the 160-character limitation has in large part contributed to its huge popularity with the global generation of youth [2].

With all the technological modes of communication available at the present time, the question was posed ascertaining what is the best communication tool to get the message out today and consequently in the future with the utilization of cell phones and other ICTs? [30]. Usage and age adoption of communications technology was investigated among four different age groups. First, the most receptive age group of 18-23 year olds reporting high use of cell phones and text-messaging was observed. Next, 30-40 year olds who used text-messaging heavily was observed. Upon observing this group, it was revealed that email was their preferred communication method.

There were also 40-50 year olds who used email and cell phones primarily, but did not engage in text-messaging and who also reported minimal use of instant messaging. The last age group consisting of 50-60 year olds demonstrated the greatest variance. Some within this age group used email extensively while others used it only minimally. This group used the World Wide Web, but they mostly utilized older, more traditional communication methods such as US Postal mail and landline telephones. The members of this age group did not appear to engage in text-messaging, at least at notable rates of usage.

Another promising direction for text-messaging research concerns the concept of context [3]. To pose a relevant question, in what novel ways could text-messaging and cell phones be applied? Along with the suggestion of examining context, further scrutiny was offered on the concept of standardization [2]. It was proclaimed that hand-held communications devices would require additional technical support, which in turn will create an increased and new focus on standards. Researchers will ultimately have to be concerned with the ramifications involved for supporting hand-held devices within their miniaturized environments [2].

III. Conclusion

This discussion offered a comprehensive, multidisciplinary review of SMS text-messaging including its roots in the scholarly literature, its applicability for conducting important tasks, and unanswered questions, including hard problems that dictate further study, hence promoting future research. In light of this lengthy review, the current BoK sways researchers toward the notion that SMS text-messaging is still a largely uncharted research area among IT/IS scholars, and is still a relatively new research area at that.

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