The Negative Effects of Mobile ICT on Productivity in Indian Construction Projects

34

Abid Hasan⬛, Kumar Neeraj Jha⬛, Raufdeen Rameezdeen⬛, SeungJun Ahn⬛, and Bassam Baroudi⬛

Abstract

Due to increased affordability of mobile devices, better network coverage, and availability of a wide range of mobile applications, the use of mobile information and communication technologies (mobile ICT) has increased significantly in construction projects. While considerable research on both positive and negative implications of using mobile ICT has been conducted in different industries and social contexts, relatively few studies have examined the perception of construction management (CM) professionals. A questionnaire survey conducted across the Indian construction industry revealed that the use of mobile ICT could impede construction productivity due to factors such as: (1) pressure to remain accessible outside the work hours, (2) temptation to check it frequently, (3) adverse effects on work-life balance, (4) compulsion to work outside the normal work hours, (5) massive amount of information, (6) distraction, (7) less time to respond to changes, (8) loss of productive time due to personal internet usage, (9) adverse effects on health of the users, and (10) frequent drawing changes. Since potential applications of mobile ICT in construction projects present enormous opportunities for CM professionals, these issues need to be addressed through user awareness, training, and organizational policies.

Keywords

Information and communication technology (ICT) • Mobile ICT • Construction productivity

34.1 Introduction

Unplanned changes to work and design, temporary critical problems, and unanticipated events are inevitable on construction sites [1]. Therefore, the information should be easily available to construction management (CM) professionals to make informed decisions while working on sites. However, due to the outdoor and harsh nature of construction sites, CM professionals often face difficulty in using conventional computers while working in the field [2]. In addition, the temporary nature of project organizations makes communication a very complex process [3]. As a result, poor communication is often identified as one of the major factors that impede productivity in construction projects [4]. Moreover, frequent travels between the site office and work front to gather the information could affect progress, cost, and quality of various construction activities.

The use of mobile devices such as smartphones and tablets by CM professionals could facilitate instant communication and access to information with the help of wireless network and mobile applications [5, 6]. In the last few years, mobile information

A. Hasan (✉) · R. Rameezdeen · S. Ahn
University of South Australia, Adelaide, 5000, Australia
e-mail: abid.hasan@mymail.unisa.edu.au

K. N. Jha
Indian Institute of Technology-Delhi, New Delhi, 110016, India

B. Baroudi
University of Adelaide, Adelaide, 5000, Australia

and communication technologies (mobile ICT) have changed the ways in which communication and information transfer take place across different industries [7]. These technologies provide greater flexibility in communication, collaboration, and information transfer [8]. People carry their mobile devices everywhere and use them for various purposes [9]. These technologies enable their users to easily and quickly connect to other people and information sources from almost anywhere [10]. Therefore, mobile ICT have potential to significantly improve the field work, on-site information management, and productivity in construction projects [11–13]. These technologies can make CM professionals more accessible regardless of their location on site [6, 14]. In addition, the use of mobile ICT can also reduce communication costs in projects [15].

Currently, with the remarkable advancements in both hardware and software, the use of mobile ICT in the construction industry has increased enormously [16]. Although their use usually aims for increased productivity, the impacts may be perceived as both positive and negative depending upon user experience and overall evaluative judgments [17]. Therefore, more studies to inquire into the perception of CM professionals about negative implications of the use of mobile ICT could help the industry to take advantage of their full capabilities by addressing those concerns.

34.2 Literature Review

The information-intensive and knowledge-based nature of the construction industry needs it to embrace ICT to remain competitive. Previous studies have shown that the industry has significantly benefited from successive improvements in ICT and successful adoption over a period [18, 19]. The use of mobile information system to improve work efficiency, reduce costs, and generate both social and economic benefits has remained a significant area of research [20].

Previous studies have found that the users sometimes point out more cons than pros of using mobile ICT at the workplace. These include distraction, safety issues, privacy concerns, software bugs, reluctance of older workers, and issues with data synchronization [16]. Due to proliferation of cloud-based applications and mobile devices, workers now use personal mobile devices for enterprise work [21]. Accidental or purposeful disclosure or dissemination of proprietary, confidential, or material information online by the employees is another major cause of concern for the companies [22, 23]. Moreover, failure to integrate mobile devices into their overall security strategy can put organization's enterprise network and database into risk due to the whole range of devices being used across the organization [24].

While mobile ICT increases the access of workers to one another and to work both within and outside of the workplace [25, 26], it becomes difficult for users to 'escape' work into their non-work lives due to continuous access to information [26]. The greater access to individuals can be problematic due to work–family spillover [27, 28]. Therefore, while implementing modern ICT tools, it is important to remember that the use of any technology does not necessarily ensure better performance [29].

The benefits that mobile ICT have to offer the construction industry are quite evident, however, such benefits cannot be realized until these technologies are adopted and used by CM professionals in productive ways [30]. However, the research investigating the perceptions of CM professionals on the use of mobile ICT has been limited. The present study examines the negative implications of the use of mobile ICT for productivity in construction projects. This knowledge can further enhance understanding of the future deployment of mobile ICT in the construction industry.

34.3 Research Methodology

An initial questionnaire was developed based on literature review. The questions were divided into five parts and covered different areas of mobile ICT usage in construction projects. The first and fourth sections have been reported in the current paper. The link to the relevant sections of the questionnaire is https://www.dropbox.com/s/9f93s7eg1i9nkk3/Questionnaire. pdf?dl=0. The first part of the questionnaire consisted of questions on personal and professional attributes of the respondents. The fourth part had questions on negative implications of the use of mobile ICT use for productivity in construction projects. The initial questionnaire was administered to six CM professionals who had an average eight years of experience of using mobile ICT in construction projects. The feedback received from the participants brought attention to few mistakes committed in the self-administered questionnaire. As a result, some changes in the layout and language were performed to make sure that the members of the population interpret the questions correctly. The questionnaire was tested again after corrections in the initial questionnaire by a different group of four experienced CM professionals [31].

The final questionnaire was administered online. The organizations or respondents accounted for the sample survey comprised of the members of the Construction Industry Development Council (CIDC). The CIDC was set up in 1996 by the Planning Commission, Government of India, jointly with the Indian construction industry to take up activities for the development of the Indian construction industry [32]. It is a consortium of construction companies, construction equipment manufacturers, technology providers, and research institutions. Since most of the key organisations in the Indian construction industry are also the members of CIDC, the authors considered CIDC as a credible source for collecting data. In addition, due to the wider presence of these organisations in construction projects across India, the construction professionals working in these companies were found suitable for examining the use of mobile ICT and its implications for construction productivity. The CIDC had 117 members at the time of data collection. Of these, 62 organisations who directly undertake construction projects of different nature were chosen as the sample for this study. Moreover, nine other construction companies who were not in the CIDC list were also found suitable for collecting data and thereby, included in the sample. The anonymous questionnaire was finally sent to CIDC member organisations and other companies and after a continuous follow-up for 6 months through monthly email reminders, a total of 119 questionnaires were received. However, 14 responses were discarded due to incomplete information provided by the respondents. Finally, 105 completed survey responses received from 54 construction organisations were used for further analysis. Table 34.1 shows the details of participants.

Table 34.1 demonstrates that the respondents came from different educational and professional backgrounds. The average experience of the participants was 7 years. These CM professionals were working at various positions in construction projects. Moreover, the turnover of the organizations show participation of small, medium, and large-sized companies. Therefore, the collected data represented a good mix of respondents and organizations with distinct characteristics.

The responses were obtained in terms of a five-point Likert scale in which 1 represented 'strong disagreement' and 5 represented 'strong agreement'. Each of the factors associated with the use of mobile ICT affecting construction productivity was ranked based on mean values. The highest mean value indicates the most critical factor with rank 1, the next most critical factor with rank 2 and so on. If the mean values are equal, the factor with lower standard deviation received the higher ranking.

Table 34.1 Respondents' profile

Characteristics	Categories	Number of respondents	% of total
Experience (in years)	Less than 5 years	59	56.19
	6–10	26	24.76
	11–15	9	8.57
	Over 15 years	11	10.47
Sector	Residential projects	19	18.10
	Commercial projects	21	20.00
	Industrial projects	26	24.76
	Infrastructure projects	39	37.14
Job title	Site Engineer	29	27.62
	Planner	33	31.43
	Construction Manager	10	9.52
	Project Manager	19	18.10
	Executive	14	13.33
Years of mobile ICT usage in construction projects	Less than 1 year	9	8.57
	Between 1 and 3 years	27	25.71
	Between 3 and 5 years	22	20.95
	Between 5 and 10 years	34	32.38
	More than 10 years	13	12.38
Respondent's company turnover, 2016–17 (in million INR)	Less than 100,000	44	41.90
	100,001–500,000	29	27.62
	Above 500,000	32	30.48

34.4 Results and Discussions

Table 34.2 shows the ranking of different factors based on their mean and standard deviation values. The top ten factors have been discussed briefly in the subsequent sections.

34.4.1 Pressure to Remain Accessible Outside the Work Hours

In developing countries such as India, work on construction sites continues in multiple shifts and even during weekends and holidays due to tight project schedules. Consequently, CM professionals are often contacted by their project team members outside the normal work schedule for various reasons such as seeking clarifications or advice on important issues. This work culture puts pressure on CM professionals to remain in constant touch with their colleagues. This confirms the findings of previous studies that the users of mobile ICT experience huge pressure to be accessible and responsive even during non-work hours [10, 33].

34.4.2 Temptation to Check It Frequently

Since mobile ICT facilitate instant access to information, CM professionals are expected to update themselves on various developments that occur on a construction site. The temptation that they might miss something important forces CM professionals to check their mobile devices on short intervals. This tendency of engaging with mobile devices after every few minutes affects productivity in construction projects. Previous studies have found that the smartphone usage varies from a couple of hours to 14 h per day and the average number of interactions varies from 10 to 200 times per day [34, 35].

34.4.3 Adverse Effects on Work-Life Balance

The construction industry is known for long work hours and harsh working conditions. The increased use of mobile ICT further aggravates these issues. More demands on CM professionals' time and attention could create conflicts in their personal lives. Employees who work outside of the confines of the traditional office space or work time may incur negative impacts on their work–life balance due to excessive burdens of being connected all the time [36]. Due to proliferation of cloud-based applications, workers often use personal devices at home for doing enterprise work [21].

Table 34.2 Ranking of factors

Rank	Factors	Mean	Standard deviation
1	Pressure to remain accessible outside the work hours	4.04	0.865
2	Temptation to check it frequently	4.01	0.882
3	Adverse effects on work-life balance	3.84	0.921
4	Compulsion to work outside the normal work hours	3.82	0.896
5	Massive amount of Information	3.70	0.831
6	Distraction	3.50	0.942
7	Less time to respond to changes	3.44	0.898
8	Loss of productive time due to personal internet usage	3.42	0.959
9	Adverse effects on health of the users	3.30	0.932
10	Frequent drawing changes	3.28	0.995
11	Unsafe acts/behaviour	3.26	0.971
12	Increased workload	3.08	1.026
13	Frustration	2.98	0.961
14	Increase in project cost	2.67	0.816
15	More complex job requirements	2.55	0.796
16	Poor quality of construction work	2.55	0.820

34.4.4 Compulsion to Work Outside the Normal Work Hours

The respondents perceived that the use of mobile ICT results in increased work hours. Although professional use of mobile devices offers flexibility due to ability to work from anywhere, it has reduced personal autonomy of the users and their ability to disconnect from work [37]. Consequently, CM professionals spend considerable amount of time working on queries or emails beyond their normal work hours. The fatigue due to extended work hours could have a negative impact on productivity.

34.4.5 Massive Amount of Information

The large amount of information produced due to continuous use of mobile ICT could be counterproductive. The reduced cost of communications has increased the number of interactions and time required to process the large amount of information exponentially, thus sometimes resulting in unproductive use of time [38].

34.4.6 Distraction

The respondents believed that the use of mobile ICT causes distractions which could be detrimental for both productivity and safety considering the hazardous work environment on construction sites. Often, the users get too immersed into these technologies which leads to the more incidents of slips, trips, collisions on construction sites [39]. Moreover, irrelevant emails and unnecessary information waste the productive time of CM professionals.

34.4.7 Less Time to Respond to Changes

Due to continuous exchange of data and information, CM professionals often have less time to process the information and respond to various changes that are happening continuously on a construction site. This situation may result in overlooking few important details that could lead to construction errors or rework. The continuous flow of information at an incredible pace can be problematic sometimes [39].

34.4.8 Loss of Productive Time due to Personal Internet Usage

The personal use of the internet negatively affects the productivity rates in construction projects. Previous studies have found that the employees spend at least one hour on non-work-related activities using internet [40]. Non-work-related use constitutes approximately 30–50% of internet usage at the workplace [41]. However, many CM professionals use same devices for both personal and professional purposes. Therefore, it could be difficult to eliminate the personal use of internet on construction sites.

34.4.9 Adverse Effects on Health of the Users

The side-effects of mobile ICT usage on CM professionals' health and well-being could lead to more absenteeism and turnover in construction projects and thereby, low productivity. While these technologies provide greater temporal and spatial flexibility, they also constitute adverse consequences on users' health and well-being due to various work-related stressors of ICT use as discussed in previous sections. Moreover, many studies report that the radiations from mobile devices and network can also affect health of the user [42].

34.4.10 Frequent Drawing Changes

Respondents believed that the number of changes in drawings has increased with the uptake of mobile ICT in construction projects. The architects can now change the drawings on the cloud and it is a challenging task for the contractors to communicate those changes across the supply chain. A negative aspect of mobile ICT is the architect's tendency to change drawings at quick intervals [39]. The updates and changes to plans occur more frequently due to the use of mobile ICT [27].

34.5 Conclusion

The full potential of mobile ICT in construction projects can be realised only when various aspects related to the use of these technologies are properly understood. Therefore, research into examining both positive and negative implications of these technologies on productivity is highly warranted. While the previous studies have focused mainly on the extent of usage of different types of mobile ICT and benefits of adoption of these technologies in construction projects, the aim of this research was to examine the negative implications of the use of mobile ICT for construction productivity from users' perspective.

The study uncovered few important issues that require further investigation and thereby, may inform future research in this domain. For instance, CM professionals expressed concerns over their health, safety, work-life balance, and well-being that emerge directly from the use of these technologies for extended periods both within and outside the normal work hours. They also feel pressure to stay connected with work and a regular urge to check their mobile devices for new information. In addition, the personal use of internet, time to process massive information, and distractions due to the use of these technologies negatively affect productivity in construction projects. However, the respondents do not seem to agree that the use of mobile ICT results in frustration, complex job requirements, and increase in project cost. Also, the factor to evaluate adverse effects of mobile ICT usage on the quality of construction work received the lowest ranking. Therefore, it can be concluded that most of the negative aspects of mobile ICT usage are related to the health, safety, and wellbeing of CM professionals rather than construction processes or project outcomes.

It is put forth that construction organizations develop a deeper and wider understanding of the negative implications of the use of mobile ICT to strategize its usage with the help of proper policy framework and training. More research efforts are required to devise innovative measures to address various issues identified in this research. However, the findings of this study must be considered within the context of its limitations. The data for this study was gathered only from CM professionals working in the Indian construction industry and therefore, cannot be necessarily generalized to other contexts due to different work cultures and organizational practices. Nonetheless, the present study highlights some of the major issues associated with the use of mobile ICT in the context of the construction industry. Since most of the research on negative implications of using mobile ICT has been conducted in different contexts, the findings of this research make significant contribution to the construction literature on mobile ICT.

References

1. De la Garza, J.M., Howitt, I.: Wireless communication and computing at the construction jobsite. Autom. Constr. **7**(4), 327–347 (1998)
2. Williams, T.P.: Applying handheld computers in the construction industry. Pract. Periodical Struct. Des. Constr. **8**(4), 226–231 (2003)
3. Kaplan, A.M., Haenlein, M.: Users of the world, unite! The challenges and opportunities of social media. Bus. Horiz. **53**(1), 59–68 (2010)
4. Hasan, A., Baroudi, B., Elmualim, A., Rameezdeen, R.: Factors affecting construction productivity: a 30 year systematic review. Eng. Constr. Architectural Manage. **25**(7), 916–937 (2018)
5. Mathiassen, L., Sørensen, C.: Towards a theory of organizational information services. J. Inf. Technol. **23**(4), 313–329 (2008)
6. Disterer, G., Kleiner, C.: BYOD bring your own device. Procedia Technol. **9**, 43–53 (2013)
7. Bresnahan, T., Yin, P.: Adoption of new information and communications technologies in the workplace today. Innov. Policy Econ. **40**, 95–124 (2017)
8. Nah, F., Siau, K., Sheng, H.: The value of mobile applications: a study on a public utility company. Commun. ACM **48**(2), 85–90 (2005)
9. Finnie, S.: Mobile is immediate. Computerworld, ProQuest Technol. Collect. **46**(2), 32 (2012)

10. Matusik, S.F., Mickel, A.E.: Embracing or embattled by converged mobile devices? Users' experiences with a contemporary connectivity technology. Hum. Relat. **64**(8), 1001–1030 (2011)
11. Anumba, C.J., Aziz, Z., Ruikar, D.: Mobile and semantic web-based delivery of context-aware information and services in construction. In: Anumba, C.J., Wang, X. (eds.) Mobile and pervasive computing in construction, 1st edn. Wiley, UK (2012)
12. Chen, Y., Kamara, J.M.: Using mobile computing for construction site information management. Eng. Constr. Architectural Manage. **15**(1), 7–20 (2008)
13. Son, H., Park, Y., Kim, C., Chou, J.S.: Toward an understanding of construction professionals' acceptance of mobile computing devices in South Korea: an extension of the technology acceptance model. Autom. Constr. **28**, 82–90 (2012)
14. Kim, C., Park, T., Lim, H., Kim, H.: On-site construction management using mobile computing technology. Autom. Constr. **35**, 415–423 (2013)
15. Bertschek, I., Niebel, T.: Mobile and more productive? Firm-level evidence on the productivity effects of mobile internet use. Telecommun. Policy **40**, 888–898 (2016)
16. Sattineni, A., Schmidt, T.: Implementation of mobile devices on jobsites in the construction industry. Procedia Eng. **123**, 488–495 (2015)
17. Väätäjä, H.: Perceived impacts as user experience components in mobile news making with smartphones. In: J Lumsden (ed.) Emerging perspectives on the design, use, and evaluation of mobile and handheld devices. IGI Global, PA, USA, pp. 218–238 (2015)
18. Samuelson, O.: IT-Barometer 2000-the use of IT in the Nordic construction industry. ITcon **7**, 1–26 (2002)
19. Underwood, J., Khosrowshahi, F.: ICT expenditure and trends in the UK construction industry in facing the challenges of the global economic crisis. J. Inf. Technol. Constr. **17**, 26–41 (2012)
20. Chen, X.: Web service based mobile worker supporting system for construction industry applications. Telecommun. Syst. **54**(3), 277–286 (2013)
21. Olalere, M., Abdullah, M.T., Mahmod, R., Abdullah, A.: A review of bring your own device on security issues. SAGE Open **5**(2), 1–11 (2015)
22. Al Harthy, K., Shawkat, W.: Implement network security control solution in BYOD environment. In: IEEE International Conference on Control System, Computing and Engineering, Penang, Malaysia (2013)
23. Jennings, S.E., Blount, J.R., Weatherly, M.G.: Social media—a virtual Pandora's box prevalence, possible legal liabilities, and policies. Bus. Prof. Commun. Quart. **77**(1), 96–113 (2014)
24. Hale, J.: Integrate mobile. SC Mag. **26**(9), 30–33 (2015)
25. DiMaggio, P., Hargittai, E., Neuman, W.R., Robinson, J.P.: Social implications of the Internet. Ann. Rev. Sociol. **27**, 307–336 (2001)
26. Madden, M., Jones, S.: Networked workers', Pew Research Center (2008), http://www.pewinternet.org. Last accessed 21 Mar. 2018
27. Southerton, D.: Time pressure, technology and gender: the conditioning of temporal experiences in the UK. Equal Opportunities Int. **26**(2), 113–128 (2007)
28. Chesley, N.: Blurring boundaries? Linking technology use, spillover, individual distress, and family satisfaction. J. Marriage Fam. **67**, 1237–1248 (2005)
29. Emmitt, S., Gorse, C.: Communication in Construction Teams. Taylor & Francis, Oxon (2007)
30. Basaglia, S., Caporarello, L., Magni, M., Pennarola, F.: Individual adoption of convergent mobile phone in Italy. RMS **3**(1), 1–18 (2009)
31. Saris, W.E., Gallhofer, I.N.: Design, evaluation, and analysis of questionnaires for survey research, 2nd edn. Wiley, NJ (2014)
32. CIDC.: http://www.cidc.in/new/aboutus.html. Last accessed 21 Mar. 2018
33. Orlikowski, W.J.: Sociomaterial practices: exploring technology at work. Organ. Sci. **28**(9), 1435–1448 (2007)
34. Verkasalo, H.: Contextual patterns in mobile service usage. Pers. Ubiquit. Comput. **13**(5), 331–342 (2009)
35. Falaki, H., Mahajan, R., Kandula, S., Lymberopoulos, D., Govindan, R., Estrin, D.: Diversity in smartphone usage. In: Proceedings of the 8th International Conference on Mobile Systems, Applications, and Services, ACM, pp. 179–194 (2010)
36. Diaz, I., Chiaburu, D.S., Zimmerman, R.D., Boswell, W.R.: Communication technology: pros and cons of constant connection to work. J. Vocat. Behav. **80**(2), 500–508 (2012)
37. Mazmanian, M., Orlikowski, W.J., Yates, J.: The autonomy paradox: the implications of mobile email devices for knowledge professionals. Organ. Sci. **24**(5), 1337–1357 (2013)
38. Mankins, M.C.: Is technology really helping us get more done? Harvard Bus. Rev. (2016), https://hbr.org/2016/02/is-technology-really-helping-us-get-more-done?utm_campaign=HBR&utm_source=facebook&utm_medium=social. Last accessed 21 Mar. 2018
39. Hasan, A., Elmualim, A., Rameezdeen, R., Baroudi, B., Marshall, A.: An exploratory study on the impact of mobile ICT on productivity in construction projects. Built Environ. Project Asset Manage. **8**(3), 320–332 (2018)
40. Vitak, J., Crouse, J., LaRose, R.: Personal internet use at work: understanding cyberslacking. Comput. Hum. Behav. **27**(5), 1751–1759 (2011)
41. Restubog, S.L.D., Garcia, P.R.J.M., Toledano, L.S., Amarnani, R.K., Tolentino, L.R., Tang, R.L.: Yielding to (cyber)-temptation: exploring the buffering role of self-control in the relationship between organizational justice and cyberloafing behavior in the workplace. J. Res. Pers. **45**(2), 247–251 (2011)
42. Attalla, S.M.: Health hazards of mobile information communication technologies. In: Abdel-Wahab, A.G., El-Masry, A.A.A. (eds.) Mobile Information Communication Technologies Adoption in Developing Countries: Effects and Implications, pp. 237–251. IGI Global, PA, USA (2011)