A Preliminary Study of the Use of Tablets and Their Applications On Construction Jobsite Operations

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Abstract

Over the past years, tablets have changed the way we think about technology. A person can download an application, and in a matter of minutes, completely alter the interface and function of the machine. Researchers have conducted a study to investigate tablets and their applications and how they are impacting construction jobsite operations. The basis and scope of this study includes review existing research and publications, and conducting surveys and interviews with employees who have constructed basic building projects with tablets. The result of this study leads to the conclusion that tablets and their applications are helping save time and money and help overall constructability. Data collected also gives insight in to how effectively tablets are being used on jobsites and what the future holds for tablet technology in the construction industry. This paper introduce details of this research study and presents preliminary findings of its literature review.

Keywords

Tablets, iPad, Android, IT, Information Technology, Construction, Apps, Applications

1. Introduction

Over the past 10-15 years, new IT developments have changed the landscape of our entire world. They have changed the way we communicate, navigate, schedule, document, transfer money, etc. This new technology has also affected construction jobsite operations. Whether it is computer programs, email, GPS, applications, or digital drawings, new IT developments are reshaping construction jobsites across the world. We have come from hard copy blueprints introduced in the late 1800's, to Mylar drawings in the 1950's, to computer based drawing techniques in the 1980's. We have come from word of mouth, to written word, to instantaneous email, to smartphones. Since the 1980's we have improved our computer technology in all realms especially in respect to digital drawing systems, engineering programs, communication, etc. One of the most recent IT developments that has shaped the way we think about technology is the tablet.

The concept of a tablet that most resembles the modern day tablet was arguably first seen in the science fiction novel turned film 2001: A Space Odyssey. The first commercially available portable tablet computer was the GRiDPad which was released in 1989 using an MS-DOS operating system. Many other tablets were introduced throughout the 1980's and 1990's but the first suitable internet tablet wasn't released until 2005 with the Nokia 770. From there Android-based tablets were released in 2009, the LTE Android Ultra and Vega which had 7-inch and 15-inch displays, respectively. The next dominating tablet to hit the market was the iPad which was released in April 2010. Although they were a year late and borrowed their design from previous designs, Apple is credited for defining a new class of consumer device. (Gruman, 2011) From there, Apple dominated the tablet market for roughly 2 years. (Evans, 2012) The market has since become flooded with tablets of all types of operating systems and Apple's dominance is dwindling. By 2015 is it estimated that 320 Million units will be sold and 62% of large contracting firms will be using iPads on jobs. (Evans, 2012)(Joyce, 2012a)

Tablets are the future. They are handheld, portable, and lightweight and can do almost anything a desktop or laptop computer can do and more. "Consumers are buying tablets because of what they can do with them, and so applications, content and services, intuitive user interfaces and a good design are the vital attributes that have an impact on user experience and ultimately drive sales, not hardware features." (Milanesi, 2011) They allow the transformation of a computer screen into an interface that can process almost any type of information and in any location. The last few decades have seen that "the advent of BIM and 3D modeling programs (can) greatly increased building efficiencies and reduce project timelines by pushing plans into the digital realm – but an insurmountable disconnect still stands between the office and the field…the introduction of powerful tablet computers, however, may help bridge the divide. Big, beautiful screens and powerful processors are opening up unprecedented possibilities for crews on the field to view, manipulate and manage plans in the field, take precise measurements, keep track of job hours, and much more." (Walton, 2012)

This research study investigates tablets and their applications and how they are impacting construction jobsite operations. The intention of this research is to 1) identify what tablets currently exist and what applications are most used on construction jobsites, also identify which tablet hardware/applications need to be embraced/implemented more; 2) identify the purpose of the tablet hardware/applications and define why these are being used over conventional methods; and 3) identify how this tablet hardware/applications are being used and how receptive the construction community, as a whole, is to them. Due to the limit of the conference proceeding, this paper only includes the findings of the literature of this this research study. The researchers plan to publish the entire study through a journal paper.

2. Tablets in Construction

2.1. The Market

Research for tablets in the current market was accomplished using search engines, online shopping websites and product websites. Because the market is currently flooded with tablets, it is difficult to predict what tablets will actually survive an extended period of time. The scope of this research was limited to six tablets produced by major manufacturers. Research was also directed to include tablets that have been manufactured solely for the construction industry. These tablets inhibit certain specifications that allow them to be more suitable (hardware and interface-wise) for jobsite applications. Table 1 was constructed to compare the major tablets in the current market. Figure 1 shows these five major tablets in the current market

Tablet sales have been increasing every year since they came readily available in 2009. With the increase in sales comes new manufacturers, new operating systems and new applications. As the industry grows,

its impact and influence on the construction industry also grow. ENR publishes an article almost every volume with some excerpt on a new application or new way tablets are impacting jobsite operations. That being said, the literature currently although high in quantity is ultimately low in depth or quality. Most literature currently available is either outdated or very brief. Most articles discuss one particular application and how it is being used on a jobsite. No articles or journals could be located that really dig deep into how tablets as a whole are impacting construction contractors across the board. The data collection in this project intends to close some of these gaps.

Table 1: Major tablet manufacturers/models currently in the market (as of 4th Quarter of 2012). (* - Indicates the number of years the manufacturer has been producing tablets) (Jones, 2013; (VentureBeat, 2013)

Manufacturer / Model	OS	Storage	Display	Price	Battery Life	Market Shares	Years in Market *
Apple iPad "4"	Apple iOS 6	16-128 GB	9.7"	$500-$750	10 hrs	44%	3
Samsung Galaxy 2 Tab 10.1	Android	16-64 GB	10.1"	$300-$600	10 hrs	15%	1.5
Amazon Kindle Fire 8.9 HD	Android	8 GB – 64GB	8.9"	$300-$500	8-11hrs	11.5%	1.5
Asus Google Nexus 7	Android	16GB -32GB	7"	$230-$300	8 hrs	5.8%	<1
Panasonic Toughpad FZ-A1	Android	16 GB	10.1"	$1,500-$2,000	10 hrs	unknown	7

iPad 4
Retrieved from http://iosnova.com/ipad-mini-specs-and-information

Samsung Galaxy 2 Tab 10.1
Retrieved from http://bgr.com/tag/galaxy-tab-10-1/

Asus Google Nexus 7
Retrieved from http://www.theinquirer.net/inquirer/news/2188489/googles-nexus-tablet-infringes-nokia-patents

Panasonic Toughpad FZ-A1
Retrieved from http://gadgetsreviewspecs.blogspot.com/2013/01/panasonic-toughpad-fz-a1-fully-rugged.html

Amazon Kindle Fire 8.9 HD
Retrieved from http://blog.laptopmag.com/one-day-only-amazon-kindle-fire-hd-8-9-drops-50

Figure 1: The Five Major Tablets in the Current Market

2.2. Tablet Advantages and Disadvantages for Building Construction

Research shows that most of the tablets listed in Table 1 utilize many of the same features and could accomplish many of the same functions. Almost all tablets have protection cases available and, depending on the operating system, have access to the same basic construction applications. There were however a few nuances to some of these tablets that would make them specifically important in the construction

jobsite operations. The aforementioned tablets presented advantages and disadvantages that could prove to have an impact on operation as it relates to construction jobsite operations, see Table 2.

Table 2: Summary Table of Pros and Cons of Highlighted Tablets.

Tablet	Pros	Cons
Apple iPad "4"	-Familiarity in the Market -Supports most applications	-Inability to multitask -Required syncing iPad with a computer -No removable SD card
Samsung Galaxy 2 Tab 10.1	-Wide ranges in storage capacity -SD card slot -Large screen size -Relatively low cost	-Slow outdated dual-core processor
Amazon Kindle Fire 8.9 HD	-Relatively low cost -Anti-glare screen -Wide variety of storage sizes.	-No removable SD Card slot -Screen size is limited
Asus Google Nexus 7	-Relatively low cost -Quad-core processor	-No removable SD Card slot
Panasonic Toughpad FZ-A1	-Weather/dust resistant -Durable	-High cost -General unfamiliarity in market

3. Tablets Applications ("Apps") for Construction

Along with the influx of tablets, came the production and perfection of applications. Applications are downloadable programs that are loaded directly on the mobile device (phone or tablet). "Economists are beginning to notice "the app economy," saying that it is now responsible for 466,000 jobs in the U.S., up from zero in 2007." (Sawyer, 2012)

Research was conducted in the ENR to determine what apps were considered to be the best in the construction industry. A very recent ENR article dated March 25, 2013 by Erin Joyce, showcases results of a survey that received 726 responses. This survey asked for the top three construction applications to a select group of readers. The most recommended apps as a result of this survey are listed in Table 3.

Table 3: Summary Table of Tablet Applications.

Application	Manufacturer	Platform	Functionalities for Construction
Autodesk BIM 360	Vela Systems, Inc.	iPad (iOS)	-Viewing and marking up of 3D construction drawings -Punchlist Generation
Bluebeam Revu	Bluebeam	iPad (iOS)	-Viewing and marking up construction drawings -Punchlist Generation
Decibel Ultra Pro	Patrick Schaefer	iPad (iOS) and Android	-Allows user to measure noise levels to maintain jobsite safety
Dropbox	Dropbox	iPad (iOS) and Android	-Storage of large construction files online to be accessed anywhere
Evernote	Evernote	iPad (iOS) and Android	-Note taking for daily reports -Voice recording that syncs to devices
eWeather HD, Alerts, Hi-Def Radar	Elecont LLC	iPad (iOS) and Android	-Weather data that helps in planning of construction activities
Good Reader	Good.iWare Ltd	iPad (iOS)	-PDF reader to view drawings and make notes - Navigable file structure
OSHA Heat Index	US Department of Labor	iPad (iOS) and Android	-Check heat index in order to maintain jobsite safety

PlanGrid	Loupe, Inc.	iPad (iOS)	-Viewing and marking up construction drawings -Handles drawings for many projects
Tracing Paper Lite	Hesham Wahba	iPad (iOS)	-Takes pictures and documents existing conditions of buildings

Following is the explanation of interface and functionality of some of the major tablet "Apps" used in construction.

- Autodesk BIM 360 Field by Vela Systems, Inc.: "Enables BIM 360 Field users to create and update issues, reference project documents, and run QA/QC, Safety and Commissioning checklists throughout all project phases - anywhere on the job site - with or without an Internet connection. Drop pushpins onto your project drawings or photos to create issues that are easy to find and fix. Mark up drawings and photos to indicate progress. Email marked up documents to team members to get questions answered. View and access your BIM model on your iPad in 3D - making it easy to access key design information and track progress on your project. Whenever you connect to the Internet, upload your data to the BIM 360 Field web site and immediately share and it across your project…BIM 360 Field lets you track issues and questions until they're fixed or answered, email reports to update other team members and maintain an audit trail of what you've done." (itunes, 2013) Figure 2 shows a screenshot of Autodesk BIM 360 Field.
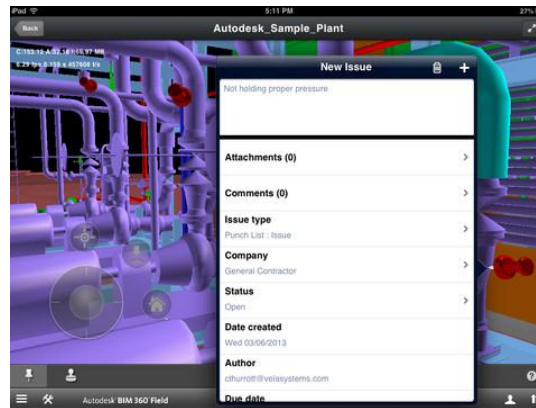

Figure 2: AutoDesk BIM 360 Screenshot
Retrieved from https://itunes.apple.com/za/app/bim-360-field/id372800500?mt=8

- Bluebeam Revu for iPad by Bluebeam: "Access and navigate your PDF files on the go from anywhere, and view your PDFs how they are meant to be viewed – comments and annotations display clearly and accurately so nothing is missed." – (itunes, 2013) "Most vote for its collaboration features and ability to mark up and measure PDFs" – (Joyce, 2012b). Figure 3 shows the interface of Bluebeam Revu for iPad.

- OSHA Heat Index by US Department of Labor: "Allows workers and supervisors to calculate the heat index for their worksite, and, based on the heat index, displays a risk level to outdoor workers. Then, with a simple tap, you can get reminders about the protective measures that should be taken at that risk level to protect workers from heat-related illness—reminders about drinking enough fluids, scheduling rest breaks, planning for and knowing what to do in an emergency, adjusting work operations, gradually building up the workload for new workers, training on heat illness signs and symptoms, and monitoring each other for signs and symptoms of heat-related illness." (itunes, 2013)
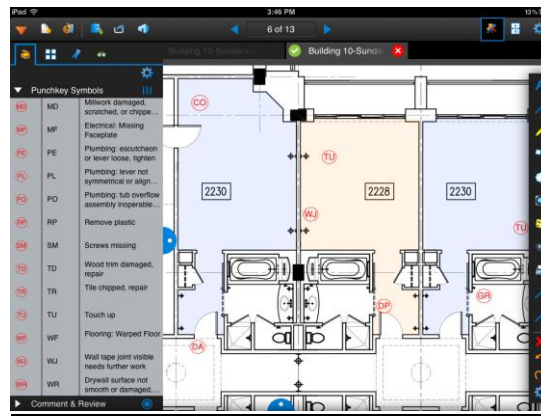
Figure 3: BlueBeam Revu Screenshot
Retrieved from https://itunes.apple.com/us/app/bluebeam-revu/id528122602?mt=8

- <u>PlanGrid by Loupe, Inc.:</u> "Lets you bring all your project plans, specs and photos to your iPad. Sign up for a free account on plangrid.com and drawings you upload will automatically sync to iPads in the field." (itunes, 2013) "Stands out in the crowded market for markup tools; handles many drawings" (Joyce, 2012b) "Ralph Gootee, PlanGrid's cofounder, says, "Most stages of handling blueprints (design, scheduling, bidding) have long been digital – except in the field. The only catalyst missing was the tablet device. For the first time blueprints could be brought in the field via lightweight devices that have a battery that lasts all day and have wireless Internet connectivity." (Walton, 2012) Figure 4 shows a screenshot of PlanGrid.

Figure 4: PlanGrid Screenshot
Retrieved from https://itunes.apple.com/ke/app/plangrid-construction-plans/id498795789?mt=8

4. Supplemental Tablet Hardware for Constrcution

Currently one of the main tablet accessories suitable for construction jobsites are protective The market has many protective cases to prevent tablets from getting damaged. Depending on the tablet manufacturer and model, tablets' screens, backs, and sides can be protected. From analysis on the different products available the main drawback to good protection is added bulkiness and weight. One of the best reviewed (amazon.com), most durable cases is the LifeProof Case (Figure 5) which protects the back, sides and screen. "LifeProof claims that you can fully submerge your iPad to 6.6 feet, drop it from 4 feet, and expose it to dust, ice, and snow. The one drawback is that it weighs 0.7 lbs and makes the iPad almost 1" thick. (Friedman, 2012) The prices for tablet cases range from $20-$70

Figure 5: LifeProof Case

Retrieved from http://www.macworld.com/article/2011627/review-lifeproof-nuud-case-protects-your-ipad-from-almost-everything.html

5. Construction Industry Trends / Receptiveness

By 2015 it is estimated that 320 Million tablets will be sold and 62% of large contracting firms will be using iPads on jobs. (Evans, 2012)(Joyce, 2012a) By 2014, it is estimated that 70 Billion Apps will have been downloaded and by 2015 is it estimated that 320 Million units will be sold and 91% of Subcontractors will be using mobile devices that inhibit applications (Joyce, 2012b). "It's the dawn of a new era" in construction technology, says Jason Burns, vice president of technology with New York City-based construction manager Hunter-Roberts Construction. He "reckons" that 80% of the firm's projects now are using Apple iPads on jobs (Joyce, 2012b). This indicates that tablets aren't just a phase and that they will become more commonplace in the near future.

Research has shown that many construction companies have embraced tablets. From sheetrock subcontractors: "When you put in new drywall, it lets you choose the gypsum board size and calculates the total number of sheets for the room area," he says. "It's not always exact, since you sometimes have oddball cuts and pieces, but it gets you in the ballpark so you can start rolling without exact drawings." (Knapschaefer, 2012) to Project Managers: "I needed a solution so that they could look at documents and approve things on the road," Paul Auer of Miron Construction says. "The benefit was that it basically took a one-week process and moved it to one day." (Van Hampton, 2011).   In another interview a PCL employee stated, "[Tablets] have changed employee productivity for sure…we just did a mega-project at an Edmonton clinic. We had about 20 people working on the job carrying case-hardened tablets doing whatever they do efficiency checks or safety inspections. They were doing their reports live." (Lang, 2013)

As far as the learning curve is concerned, in order to train the work force on these tablets and applications: "We've done a lot of "lunch and learns," where we bring workers in, have lunch and familiarize them with the basics of using the iPad," says Suffolk's Collura. Research showed that in fact the biggest problem managers are having is telling personnel to wait to use the technology until they have the support. (Abaffy, 2011)

In an ENR study in 2011, a study was sent out and received 304 responses. "Asked if tablets and iPads are toys or tools, 59% said tools, 35% said it is too soon to tell, and 6% declared them toys. The highest "toy" count was in the 31- to 40-year-old age group, at 15%. The youngest and oldest came in at 4% and 6%, respectively." (Sawyer, 2011). This shows that although the younger workers are more likely to consider them tools, a majority still say they are tools while many aren't sure yet. In that same study it was stated, "While many named specific tools as their first and second picks, several noted that their firm benefits most from systems that integrate many technological aids." (Sawyer, 2011). Tablets excel at integrating many different technological aids from project management to safety to technical calculations.

6. References

Abaffy, L. (2011). iPads and Tablets: Time Saved Vs. Time Spent. *ENR: Engineering News-Record*, *267*(9), 20–20.

Amazon.com. (2013). Retrieved March, 2013.

Evans, B. (2012, October 2). How Many Tablets Are In The USA? And Does It Matter? – Forbes. *Forbes*. Retrieved March 30, 2013, from http://www.forbes.com/sites/benedictevans/2012/10/02/how-many-tablets-are-in-the-usa-and-does-it-matter/

Friedman, L. (2012, November 29). Review: LifeProof Nuud case protects your iPad from almost everything | Macworld. *Macworld*. Retrieved March 30, 2013, from http://www.macworld.com/article/2011627/review-lifeproof-nuud-case-protects-your-ipad-from-almost-everything.html

Gruman, G. (2011, July 5). The iPad's victory in defining the tablet: What it means. *InfoWorld*. Retrieved March 30, 2013, from http://www.infoworld.com/d/mobile-technology/the-ipads-victory-in-defining-the-tablet-what-it-means-431

Itunes. Various Application Descriptions. (2011-2013). *Itunes*. Retrieved March 30, 2013, from https://itunes.apple.com/us/app...

Jones, C. (2013, February 2). Apple's iPad Market Share Slips Farther Below 50% - Forbes. *Forbes*. Retrieved March 30, 2013, from http://www.forbes.com/sites/chuckjones/2013/02/02/apples-ipad-market-share-slips-farther-below-50/

Joyce, E. (2012a). Aconex Touts Integration With Field App. *ENR: Engineering News-Record*, *269*(10), 20–20.

Joyce, E. (2012b, December 5). Make Way for App Builders in Construction. *ENR*. Retrieved April 4, 2013 from http://enr.construction.com/technology/construction_technology/2011/1205-make-way-for-app-builders.asp

Knapschaefer, J. (2012). A Construction App With Trimmings a la Carte. *ENR: Engineering News-Record*, *268*(17), 22–22.

Lang, Steven. (2013). International construction firm PCL is building a tablet strategy around Windows 8. (n.d.). *TabTimes*. Retrieved January 21, 2013, from http://tabtimes.com/tablet-leaders/deployment-strategy/2012/11/19/international-construction-firm-pcl-building-tablet

Milanesi, C. (2011, September 2). iPad and Beyond: The Future of the Tablet Market Retrieved March 30, 2013, from http://www.gartner.com/DisplayDocument?doc_cd=217137

Sawyer, T. (2011). Embrace of Technology in Construction Swings With Ages and Attitudes, Survey Finds. *ENR: Engineering News-Record*, *267*(16), 41–41.

Sawyer, T (2012). Apps Surge as Developers Create New Ones, Re-engineer Favorites for Mobile Devices. . *ENR: Engineering News-Record*, *268*(5), 24–24.

Van Hampton, T. (2011). Tablets Take Off. *ENR: Engineering News-Record*, *267*(7), 20–23.

VentureBeat. (2013). Top Tablets - Compare Tablet Reviews | VentureBeat. (n.d.). *www.venturebeat.com*. Retrieved March 30, 2013, from http://tablets.venturebeat.com/

Walton, Jon. (2012). The Rise of Construction Tablet Apps. (n.d.). *Construction Digital Retrieved.* January 21, 2013, from http://www.constructiondigital.com/innovations/the-rise-of-construction-tablet-apps.