

An Exploratory Study of Smartphone and Smartphone Application Use in the U.S. Forest Products Industry

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This work conducted market research on the use of smartphones and smartphone applications (apps) in the forest products industry and academia. Scholarly literature was reviewed, and related apps were considered. An online survey was conducted to collect data adopting a convenience sampling method. Participants were individuals who work with wood or wood-based products. The sample was compiled from publicly available online and offline sources. A questionnaire was specifically developed for this study. Out of 1,221 email invitations, 311 responses were returned at the response rate of 27.2%. Descriptive statistics and analysis of variance were used for analysis. Nearly all of the respondents (95.7%) had smartphones, and over half of them were iOS users (52.3%). A higher personal use, as compared to work use, of smartphone apps was observed. Respondents of Millennials and Generation X indicated higher personal app use than Baby Boomers. Academia and research users showed higher app uses. More respondents had purchased paid apps (45.2%) than in-app services on free apps (28.5%). This finding indicates that paid apps may be of more interest to respondents than in-app purchases.

Keywords: Smartphone application; Smartphone app; Smartphone use; Forest products; Forest resources; Online survey

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INTRODUCTION

Smartphones are heavily used among the general population in the United States. As the perception toward smartphones becomes more acceptable, the smartphone usage diversifies, and the popularity continues to grow. The number of smartphone users has dramatically increased over the last several years from 62.6 million in 2010 to 207 million in 2016 in the U.S. (Statista 2017). The significance of the smartphone can be observed from the fact that over 60% of the U.S. population owned smartphones in 2016, and the ownership was estimated to grow up to 75% by 2019 (Table 1). The user ratio, according to the different age groups, shows that Millennials (1978-1994) were the heaviest smartphone user group in the second quarter of 2014 (Nielsen 2014). Baby Boomers (1946-1964) and Generation X (1965-1977) represent the two largest workforce groups in the U.S. These groups have started to retire and will continue to exit the workforce for the next several years (Beutell and Wittig-Berman 2008; Ponder 2013). The heaviest smartphone user group, Millennials, is predicted to become the largest workforce in the U.S. Accordingly, forest products job sites may be influenced by such changes. A survey conducted by *Engineered Wood Journal* is also an indication of the generational changes in the forest products industry work force; nearly 60% of the survey respondents responded that 6 to 20% of positions will be replaced, due to retirements, by 2021 (Caim 2017).

However, no obvious presence of smartphone use was observed in the forest products industry. Therefore, this work proposes to conduct market research for current smartphone and smartphone application (app) use in the forest products industry.

Table 1. Smartphone Users in the U.S.

Year	Number of Users (millions)	Yearly Increase	U.S. Population (millions)	Smartphone Ownership Rate
2010	62.6	N/A	309	20%
2011	92.8	48%	312*	30%
2012	122	31%	314*	39%
2013	144.5	18%	316*	46%
2014	171	18%	319*	54%
2015	190.5	11%	321*	59%
2016	207.1	10%	323*	64%
2017*	222.9	8%	325*	68%
2018*	236.3	6%	328*	72%
2019*	247.5	5%	330*	75%

* Estimates (Bureau 2016; Statista 2017)

There are a few studies examining the use of smartphones in the forest products industry. Geographic Information System (GIS) technology embedded in the smartphone is used to collect data for forest management (Kennedy 2012); it substitutes tools that are traditionally used for the data collection, such as Global Positioning System (GPS) device, map, paper forms, and cameras. Of smartphone apps, several uses are found to measure and manage resources. For example, “Smart Measure” and “Measure Height” are used to measure tree height to make field determination easy, fast, and accurate (Bijak and Sarzyński 2015). Itoh *et al.* (2010) developed an iPhone app to measure tree height using an accelerometer function. A number of studies examined the accuracy of other built-in smartphone functions used in apps of GeoTrees, Smart tools, and Trestima. These apps collect information only using smartphones; “GeoTrees” is a tool for inventory management that collects attributes including tree location, species, height, and diameters (Fauzi *et al.* 2016). “Smart Tools” in height and slope modes use the image on the camera screen and lines on the phone case to measure tree height (Villasante and Fernandez 2014). “Trestima” is an app that measures and reports tree positions, species, and width and length of each sample using a smartphone camera (FordaqSA 2017). Land holders use a smartphone app, “iBitterlich”, to aid in managing plantations in Chile (Harris-Pascal 2015). This app can measure the basal area of a stand using the camera on a smartphone (Taakkumn 2012). The same developer that created “iBitterlich”, also developed “iHypsometer”, which measures tree height, stand basal area, and stand volume (Taakkumn 2012).

Overall, these apps are concentrated on measuring dimensions, identifying species or trees, forest inventory, and resource management areas. Among these uses, measuring tree height and tree positions with smartphone apps appears to be the most commonly accepted because their usages are observed throughout publications. However, other examples for apps were not found, such as usages in the lumber or flooring industry. The lack of antecedent studies on smartphones or smartphone apps in the forest products sector limited the scope of the literature review. Therefore, the presence of smartphone apps in the App Store was examined to discover current trends. Thus, a survey was developed to learn how people in the forest products industry use smartphones and smartphone apps.

EXPERIMENTAL

Materials

Participants

Participants were individuals who work with wood or wood-based products in an organization or individually. Because of the specifics and limitations of identifying the whole population of interest, the research used a convenience sample. The sample frame was specified combining the number of forest products researchers including faculty, staff, and students in universities, researchers at laboratories, and employees in the forest products industry. The sample, then, was categorized into two different groups that are academia and industry. The academia group encompasses researchers including faculty, staff, and students at universities or colleges, and those who work at research centers. The industry group is made up of lumber mills and wholesalers in the southern region which includes Alabama, Arkansas, Florida, Georgia, Louisiana, Maryland, North Carolina, South Carolina, Tennessee, Texas, and Virginia. The southern region was defined by Random Lengths (Random Lengths Publications 2017). Import and export companies throughout the U.S. were also included in the industry group. The researchers compiled the sample from publicly available online sources, online directories, print of the Big Book by Random Lengths, and additional contacts that became available.

Survey development

Previous forest products studies primarily used mail and phone surveys for data collection. The context of an online survey is different from that of mail or phone surveys. Thus, a questionnaire was developed specifically for this study to uncover the status of smartphones and use of smartphone apps in the forest products industry. The survey was developed using the Tailored Design Method (Dillman *et al.* 2011). The questionnaire consisted of two parts. Part 1 collected demographic information, while part 2 gathered information about smartphone ownership and the use of smartphones and smartphone apps. The survey implemented several methods to increase participation benefits in an effort to motivate participants to respond to the survey. Those benefits included providing information about the survey, asking for help, appreciating, and showing support for shared values (Dillman *et al.* 2011). Mississippi State University's logo was attached at the top of the questionnaire to increase credibility of the survey. The first question "Do you work with any kind of wood or wood-based products?" was intended to assure the qualification of the respondents. If the response was "No" to the first question, the survey was closed and submitted. The survey was also designed to be mobile phone friendly, so that potential respondents who might take the survey on their mobile phones would find it easy to complete. The questionnaire was reviewed and pretested prior to the execution of the survey. The survey included a pretest to minimize measurement error that might occur with questions.

Methods

Procedure

Email invitations were sent to 1,221 participants through an online survey service, SurveyMonkey. The data collection took place beginning on May 5, 2017 and was open for 10 days. Two reminder e-mails were sent to encourage participation to yield a higher response rate.

Statistical analysis

Data were analyzed using SPSS Statistics version 24 (IBM, Armonk, New York). Age groups (8 different groups) and levels of agreement (5 levels from “strongly disagree” to “strongly agree”) were consolidated into a lesser number of categories. For example, age groups were simplified into three generations, while the levels of agreement were also reduced to three levels (“disagree,” “neutral,” and “agree”). For analysis purposes, the occupational classification was consolidated into two groups: academia (academia and government) and industry (industry and the rest). The level of significance used in the difference comparison was 0.05.

RESULTS AND DISCUSSION

Smartphone Apps in the App Store

The App Store (Apple) was examined using keywords that were related to forest products. The search was conducted only up to 100 because apps that are not ranked on the top chart are considered less successful. Apps on the top chart encourage further downloads from users, as the number of downloads can be as high as 2.3 times or more than apps that do not appear on the top chart (Ansar 2009). Thus, app developers strive to get on the 100 ranking list to promote further downloads, which generates income in the case of paid apps. However, it is notable that the top ranked paid apps are not necessarily receiving high customer ratings (Lee and Raghu 2014), which can also affect the number of future downloads.

On the first stage, three keywords, “forest products,” “wood,” and “lumber” were used to learn about the current market situation. The list of the apps examined in this study may not be exhaustive of all the apps relevant to the forest products industry due to variety of search terms. With the first keyword “forest products,” there were only five apps available in the App Store that were business or reference apps, such as “Horizon Forest Products Web Track” that enables users to access to a corporate system, or “Forest Products Expo” that provides a program guide for attendees and exhibitors of the exposition.

The next keyword “wood” generated more varieties than “forest products.” However, among the top 100 apps with the keyword, only a few apps provided functional apps (productivity) rather than for entertainment purposes (games). The categories to the keyword included Games, Productivity, Reference, Lifestyle, Education, and Catalog. Apps within the productivity category contained information about wood working skills that were “Wood Turning Skills”, “Wood Carving”, and “Carpentry Basics” that are shown as Fig. 1. Those three apps were all available at a price of \$2.99 each.

The keyword “lumber” demonstrated more relevant apps that included wood beam calculators, do-it-yourself (DIY) wood working ideas, and furniture building guides. However, games and business apps again dominated the list. The utility app “Home Builder Pro Cals”, available for purchase for \$4.99, provided over 200 calculators including 20 for wood and other materials. “Home Improvement Cals”, available for purchase for \$1.99, and “Lumber Calculator Pro”, for free with advertisements, were available offering information for lumber and materials. Those apps provided lumber dimensions and board feet information. “Moisture Calculator Lite”, used to predict moisture contents using green and dry sample weights, was listed to promote a paid version that contains the save function. “Woodcraft” was the most expensive, available for purchase for \$19.99, and appeared to be the most sophisticated app that was designed for professionals mainly

working on dimensional lumber projects. This app was one of a few apps that displayed quotes from previous users as a form of review to increase the credibility. Further, its continuing updates from the date of publication (August 2012) to the recent time (May 2017) may make the app appear to be more reliable. One can conclude that the app name and app keywords are critical to improve visibility of apps. Therefore, the app can be listed out when a potential user searches the exact or similar terms on the app market.



Fig. 1. Productivity apps identified with the keyword “wood”: Wood Turning Skills (Apps 2015), Wood Carving (Applications 2015), and Carpentry Basics (Walsh 2015)

Some other apps that can measure characteristics of wood products were also found. These apps included “Timber Engineering Calculator,” “all beam designer,” “TraviGo”, and “A-beam (lite and full versions)” on the App Store.

Other uses of smartphone apps by firms were also found. Several industrial firms had developed apps to provide general company profiles containing contact and location information and product information, such as pricing, new and top products, and stock. Those apps were also used for promotion, event updates, and reward programs. While conducting the research of currently available apps on the market, some keywords such as timber, span, board, engineering, design, and beam were found to be frequently used terms in the forest products industry. Learning from the app market, there were more various options that had been applied to the industry than introduced in the literature. Some companies developed apps to manage their internal resources with customers or employees. A number of apps were also available to provide informative ideas to DIYs as well as professional users. Further, there were apps that calculated and measured certain attributes of forest products, such as wood boards.

Response

Out of 1,221 invitations, the total number of valid surveys after considering those who opted-out and those that were addressed to unreachable accounts (faulty e-mail addresses or other unidentifiable reasons) were 1,144 surveys. Of the valid survey invitations, 311 responses were returned at the response rate of 27.2%. In the forest products industry from 2000 to 2015, the median response rate for published works was 26%, and the number of responses received was 131.5 (Bumgardner *et al.* 2017). The response rate in this survey was slightly higher. The number of responses received was noticeably higher than the industry average by nearly 1.4 times. Of the valid 311 responses, 290 responses were qualified for analyses with a screening question, and 21 responses were disqualified and omitted from the study.

Respondent Demographic Characteristics

Table 2 demonstrates demographic characteristics of the survey respondents. The age group including 55 to 62 years old comprised the biggest portion (23.0%) of the total survey respondents (Table 2). The age groups were, then, re-categorized into three different generations (Millennials, Generation X, and Baby Boomers) for analyses (Table 3). Baby Boomers comprised nearly 45% of the respondents, but when respondents over 71 years old were excluded, Baby Boomers actually accounted for 38.3% of respondents. Thus, one third of respondents fell into Generation X, and less than one fourth of the respondents were Millennials. More Generation X and Baby Boomers were surveyed in the forest products industry than Millennials.

Table 2. Demographics of Survey Respondents

Item	Frequency	%age	True %age*
Age**			n=274
18-22	2	0.6%	0.7%
23-30	27	8.7%	9.9%
31-38	35	11.3%	12.8%
39-46	40	12.9%	14.6%
47-54	49	15.8%	17.9%
55-62	63	20.3%	23.0%
63-70	42	13.5%	15.3%
Over 71	16	5.1%	5.8%
Choose not to respond or skipped including not qualified	37	11.9%	-
Total	311	100%	100%
Occupational field			n=283
Academia	112	36.0%	39.6%
Industry	113	36.3%	39.9%
Engineering	21	6.8%	7.4%
Government	11	3.5%	3.9%
Consult	7	2.3%	2.5%
Other	19	6.1%	6.7%
Skipped including not qualified	28	9.0%	-
Total	311	100%	100%
Business Category			n=282
Education & Research	138	44.4%	48.9%
Lumber	59	19.0%	20.9%
Engineered wood	15	3.2%	3.5%
Chemical	10	4.8%	5.3%
Other	60	19.3%	21.3%
Skipped including not qualified	29	9.3%	-
Total	311	100%	100%
*True %age omitted “not to respond” or “skipped” responses that may include disqualified respondents for this survey. The sample sizes differ for true %ages.			
**Represents age at the time when the survey data were collected.			

After posing the question “Which category best represents your organization or you?” to the 282 respondents, 48.9% indicated that they worked in education or for a research business. One fifth of respondents (20.9%) were engaged in lumber business, one-twentieth dealt with chemicals (5.3%), and the remaining respondents were involved with engineered wood (3.5%) businesses.

Table 3. Generation Categorization of the Survey Respondents

Age	Frequency	Ratio
18-22	2	0.7%
23-30	27	9.9%
31-38	35	12.8%
39-46	40	14.6%
47-54	49	17.9%
55-62	63	23.0%
63-70	42	15.3%
Over 71	16	5.8%
n=274, the years for generations differ by studies, thus, redefined for this study.		

Of the 269 responses to the question of organization location or state, 51 respondents were from non-U.S. locations, which constituted the highest proportion (19%) of the total responses. This could be due to Forest Products Society's international members. Figure 2 displays the distribution of the respondents' locations excluding non-U.S. locations.

With 12.8% of 218 respondents, excluding internationals, Mississippi had the largest proportion of respondents in the U.S., followed by Georgia (8.7%), Oregon (7.8%), Washington (7.3%), and Alabama (6.0%). The variety of states was limited to 35 states as the study focused on the southern regions of the U.S. for lumber manufacturing, wholesale, and retail listed in the Big Book by Random Lengths.

Use of Smartphone and Smartphone Apps

Respondents were asked whether they had a smartphone, and 95.7% of respondents responded positively to this question ($n = 282$) (Fig. 3). This result indicated that a majority of respondents had access to the internet as well as app markets, such as the App Store for Apple apps and the Google Play for Android apps. After being asked "What platform does your phone use?", 52.3% (139 responses) of respondents answered that they used iOS, while 39.5% used Android as their smartphone platforms ($n = 266$). There were also some respondents that indicated they used Windows Mobile and Blackberry OS as their smartphone operating systems, however, the share (3%) was unremarkable (Fig. 3).

Figure 3 demonstrates that Apple was the most popular smartphone brand, being utilized by 54.7% of respondents, followed by Samsung (29.4%) ($n = 265$), LG (3.4%), Microsoft (0.8%), BlackBerry (2.6%), Motorola (3.0%), and other brands constitute the rest of the share.

To learn how respondents used smartphone apps personally as well as for work, two questions asked respondents to indicate the frequency of their app uses (1=never; 3=sometimes; 5=always). Of the 265 respondents, 43.8% responded that they often used apps personally, which was indicated with the mean score (3.84) close to 4 (4=often). Using two-tail t-tests, the frequency of apps use (3.84) from never (1) was statistically different ($p = 0.000$). The use of apps for work was less frequently observed (mean = 3.17) from responses (Table 4). Overall, respondents were found to be using apps for personal means more often than for working purposes.

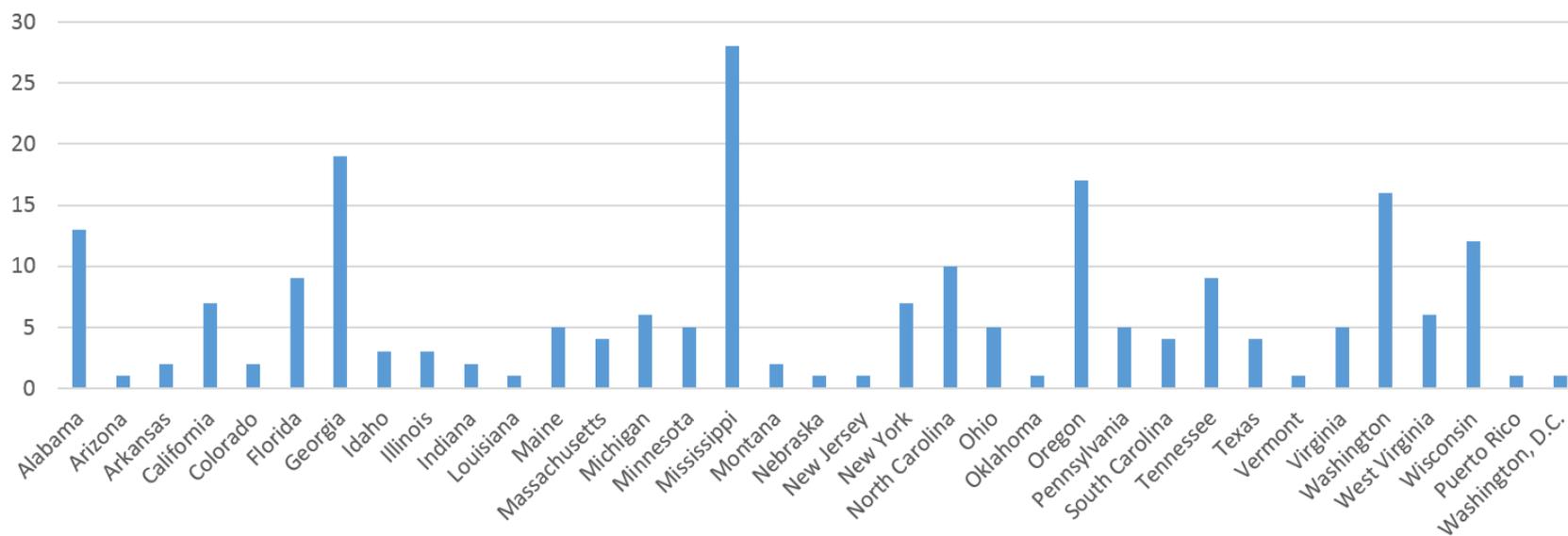


Fig. 2. Frequency of respondents in various states throughout the U.S. Respondents located outside of the U.S. were excluded.

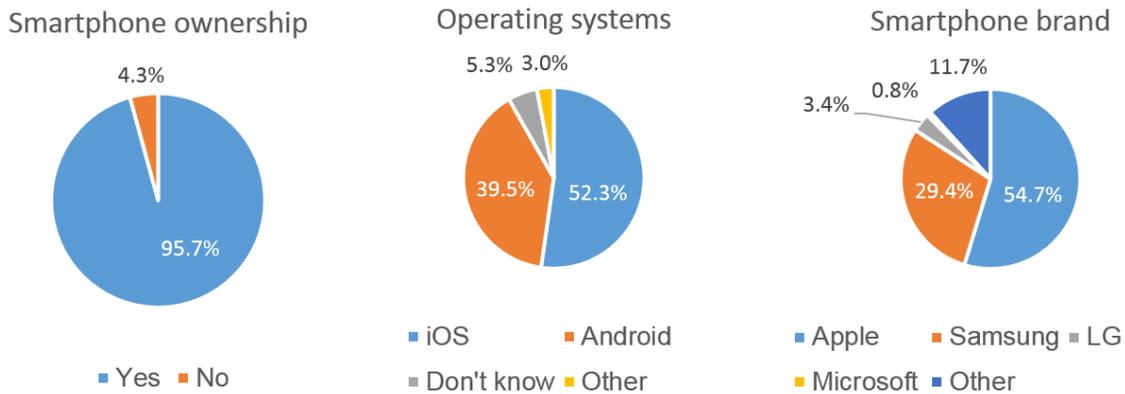


Fig. 3. Responses regarding smartphone ownership (n = 282), mobile phone operating platforms (n = 266), and smartphone brands (n = 265)

Table 4. Ratings of Respondents' Mobile Phone Apps Uses

Questions	Observations	Mean (Std. dev.)
Do you use mobile phone apps for personal use?	n=265	3.84 (0.92)
Do you use mobile phone apps for work?	n=266	3.17 (1.12)

(1=never, 3=sometimes, 5=always)

The differences between Millennials and Baby Boomers and also Generation X and Baby Boomers toward the personal use of apps were statistically significant ($p = 0.000$). Millennials and Generation X respondents indicated higher personal use of apps than Baby Boomers. While there was no significant difference between Millennials and Generation X ($p = 0.847$), there was a difference between academia and industry groups in the personal app use ($p = 0.012$) at the alpha level of 0.05. Respondents who work in academia indicated more personal use of apps than industry. Regarding app use for work, the differences in generations and business types were insignificant.

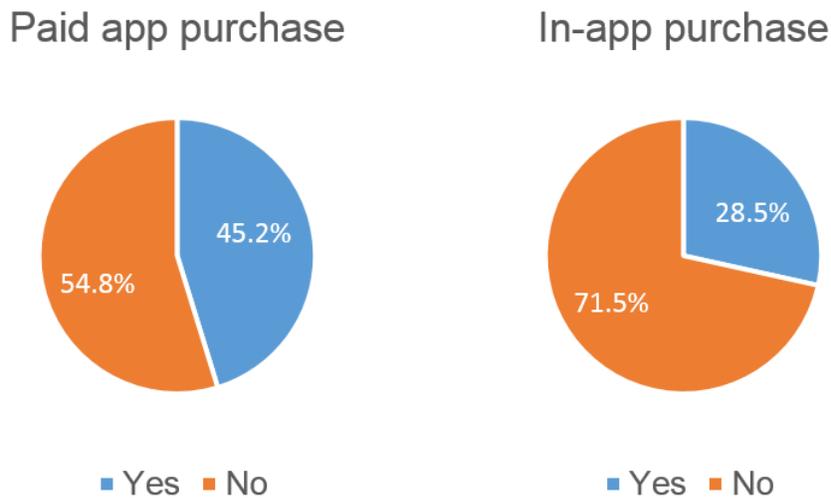


Fig. 4. Paid app (n = 263) and In-app purchase (n = 266) experience

Respondents were then asked whether they had purchased a paid app or service while using a free app. As shown in Fig. 4, slightly over half of the respondents indicated that they had never purchased paid apps (54.8%). However, nearly half of respondents (45.2%) had paid-app experience. Apps that respondents paid for included entertainment (music and games), business (scanner and Microsoft office), and utility (unit converter, engineering, and calculator) apps. Of the 47 respondents who specified the apps they bought, 16 respondents purchased multiple apps for personal as well as business uses. Compared to the paid-app experience, only 28.5% of respondents reported that they had purchased service on free apps. The in-app purchases of respondents may be divided into two categories: goods and data. Goods include tangible and intangible (*e.g.*, music and e-books) items that can be purchased via online stores. Online stores, such as Amazon and eBay, provide tangible goods. Whereas, data was referred to storage services, for instance iCloud. Across three generations and two business categories (academia and industry), significant differences were not observed at the alpha level of 0.05.

Limitation and Future Study

The study adopted the convenience sampling method, as opposed to simple random sampling, to conduct the survey. This sampling method could possibly cause sampling error that the findings from this survey may be different from the true values for the population of interest. The survey drew the sample from certain associations (or institutes), such as FPS, and regions (southern U.S.) that were available to the researcher. Furthermore, the survey mode (online survey via e-mail invitation) may not provide adequate coverage of the population that this study aimed to reach. As cited in existing literature, the forest products sector is less advanced in the use of the internet and new technologies. However, email surveys require internet connection in order for participants to have access to the survey. Thus, this study did not attempt to generalize the observations to represent the entire population of interest who work with wood or wood-based materials on their job sites. In order to validate the summary derived from this study, replication of it with either random sampling or convenience sampling may be necessary. Due to the lack of antecedent research in the forest products industry about smartphones or smartphone apps, the study should be considered exploratory.

CONCLUSIONS

1. Some smartphone apps relevant to the forest products industry are available. In the literature, there are a few studies on reliability and accuracy of apps that provide measurements of tree and wood board attributes including tree species, height, diameter, and basal area.
2. On the app market, more smartphone apps regarding forest products were observed. Those apps help users to manage inventory and corporate resources, provide wood working information, and aid in measuring characteristics of forest products.
3. Nearly all of the respondents in the forest products industry who work with wood or wood-based materials have smartphones. Of these phones, iOS is the single most used platform. This indicates that smartphone and smartphone apps can be used as a tool on their job sites.

4. Respondents used their smartphone apps more personally than for work-related tasks, and those who work in academia and research area showed higher smartphone app use than those who were in the industry group. Further, Millennials and Generation X showed the higher personal use of apps than Baby Boomers. Regarding app use for work purposes, less interest among respondents was observed.
5. Paid apps were more popular than in-app purchase among the respondents. This indicates that paid apps are more likely of interest to respondents than in-app purchase.

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