[1.] Olugboyega OLUSEYE, [1.] Oseghale Godwin EHIS, [2.] Clinton AIGBAVBOA

RELATIONSHIP BETWEEN USER DEMO-PSYCHOGRAPHIC TRAITS AND THE USE OF CONSTRUCTION APPS

[1.]Faculty of Environmental Design and Management, Department of Building, Obafemi Awolowo University, Ile-Ife, NIGERIA
[2.]CIDB Centre of Excellence, University of Johannesburg, SOUTH AFRICA

Abstract: A more significant barrier to the successful deployment and development of construction apps is the lack of reliable data on demo-psychographic factors related to app usage. In order to ascertain whether there is a significant correlation between the demo-psychographic elements and the usage of construction apps, this study evaluated the extent of use of construction apps as well as the demo-psychographics of construction app users. The study suggests that demo-psychographic elements are essential for successfully reaching the target construction workers by comprehending who they are, why they use apps, what influences their decision to use apps, and what applications they enjoy and value. Multiple Zero-Order Correlation (MZOC) is used to analyse data from a sample of construction industry workers who reported having a smartphone or other app-enabled device and having at least one construction-related app installed on it. The results showed that the construction apps are being used fairly frequently. MZOC revealed that the use of construction apps is not wholly and unequivocally linked to demographic characteristics. Psychographic elements are seen as clearly and essentially connected to the use of construction apps, with the exception of expectations, interest, belief, aims, and tendency.
Keywords: construction apps, mobile apps, construction-related apps, psychographic factors, demographic factors

1. INTRODUCTION

Software programmes or applications (apps) are programmes introduced on or available through smartphones and tablets (Owoseni and Twinomurinzi, 2018; Liu et al., 2017). Apps confer on smartphones the capability to communicate from a distance with computers from essentially any place on the planet. During the final quarter of 2010, 100.9 million cell phones were delivered around the world. In 2011, smartphone and tablet shipments surpassed the shipments of desktop and notebook computers combined. This reality has made mobile technology companies shift their considerations regarding the production of smartphones. Similarly, software developers are increasingly creating apps because they recognise that smartphones, through apps, will eventually replace many core components of personal computers, for example, messaging, texting, web browsing, and even gaming (Amro, 2017).The multiplication of apps being developed can only be expected to continue as smartphone usage develops around the world.

Apps have changed various enterprises, such as businesses (Zolkepli et al., 2021; Bui et al., 2021), education (Wöbbekind et al., 2021), and healthcare (Wei et al., 2020). For instance, Wei et al. (2020) detailed that eating routine and wellness applications are helping medical services specialists and app developers to track down better ways of empowering individuals to embrace wellness applications for different reasons. As of late, apps have been viewed as ingenious in the construction industry. This has incited researchers to examine app usage motivations and app awareness. Utilizing the technology readiness (TR) concept, Wu (2013) ordered mobile app usage motivations into extrinsic, intrinsic, and social motives. The study proposes innovativeness as the moderating factor between extrinsic motives and mobile app usage intentions. Intending to boost app utilization, Ekow and Kofi (2016) and Yankah et al., (2022) examined the awareness and utilisation of construction apps in the Ghanaian construction industry and proffered measures to boost their utilization.

The study detailed that a larger proportion of respondents didn't know about the presence or accessibility of the construction apps. In Nigeria, Ojelabi et al. (2018) examined the degree of familiarity with the utilisation of social media apps for client relationship management. This study's findings propose that Nigerian construction organisations are not aware that apps have turned into an irreplaceable device for communication and are still hesitant to implement social media apps in a business climate. The study by Liang et al. (2015) uncovered that there are numerous apps available on the market that can be utilised in construction for activities like quality control, safety, marking up plans in the field, simple calculations, and detailed architectural renderings.

ISSN 1584 – 2665 (printed version); ISSN 2601 – 2332 (online); ISSN-L 1584 – 2665

Liu et al. (2019) maintained that there are almost 13,000 construction apps at present available in the market. As indicated by Liu et al. (2019), the app market will proceed to develop and grow. The significant test, be that as it may, is the reaction of construction professionals to the apps. This exploration contends that the demo-psychographic attributes of construction professionals would emphatically impact their reactions to construction apps and their inevitable utilisation of the apps. Aside from the restricted research with respect to the utilisation of construction apps by construction professionals, the scarcity of legitimate data on their demo-psychographic attributes corresponding to construction app utilisation is a more genuine impediment in the fruitful deployment and development of construction apps. Seeing what demo-psychographic attributes of construction professionals mean for their acknowledgment and dismissal of construction apps is essential to deciding the worth of the apps, advancing their utilization, and illuminating future advancement regarding apps. This paper will describe construction apps as versatile software applications that can be utilised in construction activities. The study's objectives are to assess the degree of use of construction apps; examine the demo-psychographic factors affecting the utilisation of construction apps; and decide if there is a measurably significant linear connection between the demo-psychographic factors and the utilisation of construction apps.

2. LITERATURE REVIEW

The advent of smartphones, coupled with mobile computing technology, gives researchers the challenge to explore mobile computing in the construction sector. These examinations take care of angles like the adoption of mobile computing in the construction industry, mobile computing frameworks and advantages, and hindrances to mobile computing. In an examination of variables that could affect stakeholders' adoption of mICT in the Libyan construction industry, Sheglabo et al. (2017) observed that apparent handiness and usability are significant in deciding to adopt mICT and that they are impacted by self-adequacy and facilitating conditions. The cost of technology was not found to be a barrier to adoption. Studies on mobile computing systems in the construction sector have developed innovative systems such as Context-Aware Cloud Computing Information Systems (Fathi et al., 2012), WiFi-based indoor positioning systems for construction sites for tracking the approximate locations of labour at construction sites (Woo et al., 2011), a framework for mapping digital technologies with the ISO 10845 (Ibem and Laryea, 2014), mobile computing systems with personal digital assistants (PDA) for construction managers on construction sites (Kimoto et al., 2005), and mobile IT systems for site layout (Bowden et al., 2006).

Other proposed mobile computing systems in the construction sector include Wireless Local Area Network (WLAN) for indoor tracking and Global Positioning System (GPS) for outdoor spatial context tracking (Behzadan et al., 2008), a framework for the implementation of mobile computing on construction sites (Chen and Kamara, 2011), mobile computing technology embodied in smartphones for streamlining on-site construction management (Kim et al., 2013), wireless network technology embodied in smartphones for streamlining on-site construction management

With the end goal of examining barriers to mobile computing adoption, Usman and Said (2012) evaluated the impact of technological devices on ICT acceptance for construction site management in Nigeria. The investigation discovered that the attributes of each technological device are obstructing their adoption for construction site management. Utilizing the technology acceptance model, Son et al. (2012) researched the variables that impact the effective implementation of mobile computing devices in the construction industry. The study's results exhibited that user satisfaction was a significant mark of the adoption of the intent to adopt mobile computing devices in the construction industry. It was additionally observed that the satisfaction of construction professionals with mobile computing devices is bound to be impacted by their convictions about the helpfulness of these tools, as opposed to their convictions about the fact that they are so natural to utilize. These previous examinations have contributed to the development and adoption of digital technologies in the construction industry. The suggestions conveyed by the studies have given a new vision to augment usefulness and improve effectiveness in the construction industry.

Because of the discoveries and suggestions of the prior examinations, late investigations have zeroed in on surveys for app development (Wöbbekind et al., 2021; Wang et al., 2017; Zolkepli et al., 2021; Li et al., 2020; Tu et al., 2018; Marquez et al., 2017; Carter and Yeo, 2016), app development (Wei et al., 2020; Peltonen et al., 2020), and testing of apps (Vasilevski and Birt al., 2020; Milner et al., 2018; Tang et al., 2017; Tongaonkar et al., 2017). For instance, Wöbbekind et al. (2021) led a survey for a particular learning app. The study concluded that users of apps can add to their design. In an online survey, Zolkepli et al. (2020) explored the apparent utilisation values of mobile apps and investigated the role of the rating of the apps

ISSN 1584 – 2665 (printed version); ISSN 2601 – 2332 (online); ISSN-L 1584 – 2665

and cost in influencing the behaviour. Using an app usage collection platform, Li et al. (2020) accumulated app usage records of 1,465 users from 2012 to 2017 to concentrate on how mobile app utilisation develops over a drawn-out period. The investigation discovered that in app classification and individual apps, there is a development stage empowered by the presentation of new advancements, and there is a level stage brought about by high connections between app classes and a Pareto impact in individual app utilization.
Tu et al. (2018) systematically quantified the uniqueness of app usage by means of large-scale empirical measurements to understand how likely app users can be remarkably re-recognized in the crowd by their apps. The investigation discovered that the set of apps that a user has installed is now exceptionally interesting. For users with more than 10 apps, the investigation discovered that 88% of them can be extraordinarily re-recognized by 4 irregular apps. The development of apps has been embraced by Wei et al., (2020) (diet and fitness mobile apps) and Bui et al., (2021) (PurPliance Android app).
Vasilevski and Birt (2020) enlisted seventy postgraduate construction management students to evaluate the performance of mobile mixed-reality-BIM apps (MMR-BIM). The aftereffects of the study recommended that utilising MMR-BIM can bring about an upgraded learning climate that works with interesting growth opportunities, commitment, and inspiration. Milner et al. (2018) directed a two-arm randomised controlled preliminary to assess the presentation of a mental health management app in the construction industry. The app was found to have no critical impact on self-disgrace. In light of the supposition that a larger part of the construction workers are users of Twitter, Tang et al. (2017) investigated whether data and information that would be significant in the construction domain could be generated by analysing social media data. The outcomes demonstrated that construction workers will generally have a higher extent of pessimistic messages compared with different groups, which might provoke more consideration regarding enthusiastic direction and understanding by construction companies and the public.
More explicit investigations into construction apps have been directed by Ekow and Kofi (2016); Liu et al., (2017); Liu et al., (2018); Liu et al., (2019); Barbarosoglu and Arditi (2017); Chun (2018); Malik et al., (2017); and Sattineni and Schmidt (2015). In a progression of studies spread over three years (2017–2019), Liu et al. (2017) distinguished hindrances to more prominent take-up of mobile app technology; inspected the apparent advantages in regards to take-up apps (Liu et al., 2017); and fostered a thorough understanding of the advantages and obstructions in the take-up of mobile apps in the New Zealand construction industry (Liu et al., 2019). The 2017 study tracked down the expense of software and licencing as the most powerful limitation to mobile app adoption. In 2018, the study revealed better client relationship management and satisfaction, and productivity improvement. The 2019 study validated that construction apps can be utilised by construction experts at strategic, functional, and vital levels to further develop labour force efficiency. The study by Ekow and Kofi (2016) and Yankah et al., (2022) announced that the best ten apps typically used by construction management team members in Ghana were site photographs, Microsoft, spirit level, material estimator calculator, AutoCAD WS, Construction Master Pro, Universal Estimator, AndCAD, Carpenter's Calculator, and paint estimator. In Malaysia, Chun (2018) determined the current degree of utilisation as well as the elements influencing the use of construction apps among the main contractors. The discoveries demonstrated an elevated degree of app utilisation and medium recurrence. The variables influencing the use of construction apps were identified as convenience, web availability, application rating, and survey.
These examinations have talked about the present status of smartphone applications accessible to the construction industry and analysed the apps' capacities and reception. The examinations have distinguished fulfilment and propensity as the variables affecting the reception of construction apps. Though fulfilment and propensity are derived from personal characteristics. Consequently, the nonstop use of construction apps relies upon the understanding of the segment and the psychographic qualities of the app users. This agreement, aside from assisting with understanding the reception pattern, will provide ways by which construction app developers and marketers can interact with the users. New apps are opening up consistently for use in the construction industry. These apps focus on the business needs and assumptions of the potential users. A significant area that has not been designated is the demo-psychographic attributes of the users. The demo-psychographic characteristics of users are significant in determining how and why they select and deploy construction apps.

ISSN 1584 – 2665 (printed version); ISSN 2601 – 2332 (online); ISSN-L 1584 – 2665

3. METHODS

This study presumes that understanding construction app users' demo-psychographic attributes can significantly improve the market and design of construction apps. The supposition depended on the way that construction app users, similar to consumers, settle on choices in view of demo-psychographic aspects. Along these lines, the study proposes that demo-psychographic factors are vital for arriving at target construction professionals successfully by understanding what their identity is, the reason they use apps, what illuminates the choice to utilise apps, and what apps they like, value, and see as significant. The proposed demo-psychographic factors that are impacting the utilisation of construction and their association with the type of construction apps are distinguished and outlined in figure 1. In light of the propositions in Figure 1, the study hypothesised that:

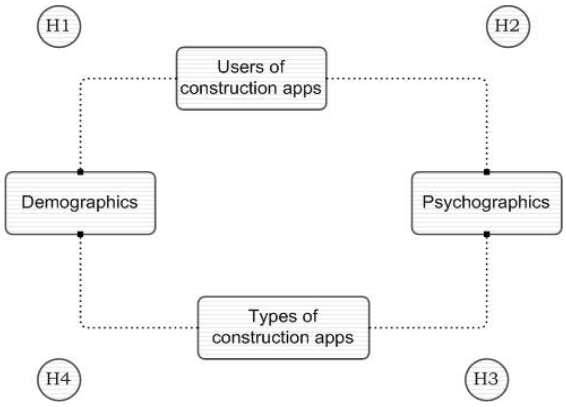

Figure 1. Proposed demo-psychographic factors

- Hypothesis 1 (H1): There is an emphatically critical relationship between demographic factors (designation – H1a; academic qualification – H1b; profession – H1c; professional qualification – H1d; length of experience – H1e; and the number of projects executed – H1f) of construction professionals and the utilisation of construction apps.
- Hypothesis 2 (H2): There is an emphatically critical relationship between psychographic factors (Expectations-H2a, Personality characteristics-H2b, Interest-H2c, Belief-H2d, Goal-H2e, Habit-H2f, Value-H2g, Cognitive competence-H2h, Self-efficacy-H2i, Opinion-H2j, Behavior-H2k, Lifestyle-H2l, Attitude-H2m, Reward-H2n, Preference-H2p) of construction professionals and the utilisation of construction apps.

A total of 4,093 construction professionals enlisted with their various professional bodies in Lagos State were considered for the study. Among this populace, this study only considered those who indicated that they own a technological device powering apps and have introduced somewhere around one construction-related app on the device. This methodology gives 298 willing participants, while only 94 completely took part in the survey. Every one of the participants was a construction professional. 33.8% were assigned as project managers, 32.5% as construction managers, the director (17.5%), and the owner (16.3%). The majority had completed a BSc (67.5%), while others had OND (11.3%), HND (17.5%), MSc (1.3%), and PhD (2.5%). 7.5 % of the participants identified as architects, 50% as builders, 7.5% as facility managers, 1.3% as mechanical engineers, 10% as quantity surveyors, 5% as town planners, and 11.3% as civil/structural engineers.

The distribution of the participants' professional capabilities is MNIA (6.3%), MNIOB (57.1%), MNIEEE (14.3%), MIFMA (8%), and MNIQS (12.7%). Every one of the participants is well-experienced in the business of construction (52.25%-less than 5 years, 25%-somewhere in the range of 5 and 10 years, 11.3%-somewhere in the range of 11 and 15 years, 1.3%-somewhere in the range of 16 and 20 years, and 10%-21 years and above). The participants have field experience (45% took part in under 5 projects, 30% took part in 5 to 10 projects, 10% took part in 11 to 15 projects, 1.3% took an interest in 16 to 20 projects, and 13.8% had partaken in excess of 21 projects).

The questionnaire designed for the study contained three items (degree of use of construction apps, demographic factors, and psychographic factors). The items were assessed by utilising a 5-point Likert scale ranging from Not Used to Very Highly Used (for the degree of use of construction apps) and Highly Disagree to Highly Agree (for demographic and psychographic factors). The use of construction apps was measured with 41 identified construction-related apps. These apps were searched for on Google Play and the IOS Store. The demographic and psychographic factors were measured with the variables that were proposed in the research framework. The items' scores on the Likert scale were deciphered as follows: 1.0-1.49 Mean score = Never Used/Strongly Disagree 1.50-2.49 Mean score = Fairly used/Disagree, 2.50-3.49 Mean score = Moderately used/Neutral, 3.50-4.49 Mean score = Highly used/Agreed, and 4.50-5.00 Mean score = Very highly used/Highly Agreed. The connections between the degree of use of construction apps and the demo-psychographic factors were analysed utilising Multiple Zero-Order Correlations (MZOC). MZOC looks at a basic relationship between two variables where no factor is controlled or held constant.

ISSN 1584 – 2665 (printed version); ISSN 2601 – 2332 (online); ISSN-L 1584 – 2665

The collected data were subjected to reliability (Cronbach Alpha test), linearity (test for a linear relationship using Scatter plot), and normality tests (Shapiro-Wilk and Kolmogorov-Smirnov tests) prior to the MZOC. A straight line was found between the measured variables, which indicates that the data is linear. The Shapiro-Wilk and Kolmogorov-Smirnov tests demonstrated that the data follows a normal distribution (see Tables 1 and 2). The Cronbach Alpha's coefficient of 0.79 – degree of use of construction apps; 0.92 – demographic factors; and 0.84 – psychographic factors demonstrated adequate data reliability.

4. RESULTS

Degree of use of construction apps

Table 2 uncovered the following construction apps as having moderate usage: *BIM Catalogs.net* (mean score=3.05), *Dalux BIM viewer* (mean score=3.16), *CAD Pocket* (mean score=2.78), *AUTO-CAD DNG* (mean score=2.63), and *Viridi Construction* (mean score=2.50). The remaining construction apps are fairly utilized. Prominent ones among them are: *construction site truck driver* (Mean score=2.46), *construction works calculator* (Mean score=2.40), *Builder's Bundle* (Mean score=2.48), *tape measure camera ruler* (Mean score=2.47), *construction +* (Mean score=2.31), *Keylan 3D Lite* (Mean score=2.13), *Planner 5D* (Mean score=2.31), *plumbing and HVAC calculator* (Mean score=2.24), *CAD HD* (Mean score=2.26). These outcomes suggest that the construction apps are reasonable and respectably utilized. A few have a moderate degree of utilisation, but the vast majority of them are genuinely utilized. This implies that all the construction apps are being used, just that their level of utilisation is low.

Demo-psychographic factors impacting the use of construction apps

The demographic profile of the users of construction apps demonstrated that the larger part are *project managers* (33.8%) and *construction managers* (32.5%). Most of them are *BSc holders* (67.5%) and *HND holders* (17.5%). As far as a profession, *builders* represent 50%, while *architects, electrical engineers*, and *facility managers* represent 7.5% each in the proportion. The construction app users have acquired at least *5 years of experience* (52.5%) and *up to 10 years of experience* (25%). With respect to the psychographic profile of the construction app users, Table 1 uncovered that the profoundly occurring profiles are *expectations* (Mean score = 3.55), *attitude* (Mean score = 3.54), *reward* (Mean score = 3.63), *preference* (Mean score = 3.70), and *social class* (Mean score = 3.81). As a result, *personality characteristics* (Mean score=3.36), *interests* (Mean score=3.39), *belief* (Mean score=3.31), *goal* (Mean score=3.09), *habits* (Mean score=3.26), *value* (Mean score=3.15), *cognitive competence* (Mean score=3.33), *self-efficacy* (Mean score=3.29), *opinion* (Mean score=3.29), *behaviour* (Mean score=3.38), and *lifestyle* (Mean score=3.32) have moderate occurrence among the construction apps users. All the demographic factors appear to be significant in the utilisation of construction apps. Given their importance, it is reasonable to conclude that expectations, attitude, reward, preference, and social class are profoundly important demo-psychographic factors among construction app users.

Table 1: Mean score, Kolmogorov-Smirnov, and Shapiro-Wilk analysis of the psychographic factors impacting the use of construction apps

Psychographic factors	Mean score	Kolmogorov-Smirnov	Shapiro-Wilk
Expectations - I use construction apps because it helps me to accomplish task more quickly (expectations)	3.55	.218	.893
Personality characteristics - I use construction apps because it improves my ability to accomplish tasks	3.36	.263	.866
Interest - I use construction apps because I'm interested in increasing productivity	3.39	.232	.895
Belief – I use construction apps because I believe it will enhance my effectiveness in task accomplishment	3.31	.269	.882
Goal – I use construction apps because I seek easier way to do a task	3.09	.221	.908
Habit – I use construction apps because it is my nature to seek useful tool for task completion	3.26	.231	.895
Value – I use construction apps because I love to use digital technology	3.15	.185	.886
Cognitive competence – I use construction apps because I find it easy to use	3.33	.202	.898
Self-efficacy – I use construction apps because I was confident it will be clear and understandable	3.29	.201	.907
Opinion – I use construction apps because it is my opinion that they are flexible to interact with	3.29	.198	.901
Behavior – I use construction apps because it is my behavior to be skillful at using digital technologies	3.38	.240	.890
Lifestyle – I use construction apps because they are new technologies	3.32	.223	.888
Attitude – I use construction apps because I'm enthusiastic about them	3.54	.251	.869
Reward – I use construction apps because it shows that I'm effective	3.63	.253	.861
Preference – I use construction apps because I prefer to work efficiently	3.70	.316	.841
Social class – I use construction apps because it shows that I'm smart	3.81	.298	.841

ISSN 1584 – 2665 (printed version); ISSN 2601 – 2332 (online); ISSN-L 1584 – 2665

Relationship between demographic factors and construction apps

Table 2 shows the results of the Multiple Zero-Order Correlation Analysis of the nature and strength of the relationships between the demographic factors of the users of construction apps and the construction apps in use. The outcomes uncovered that 52 relationships have positively insignificant correlations. The connections are not generally considered critical. A basic glance at the outcomes uncovered that academic qualification (*Vindi construction* (r=0.211, p=0.030), *Estimate ONSITE* (r=0.100, p=0.194), and *Dalux BIM viewer* (r=0.121, p=0.151)), profession (*Crane driving 3D simulator* (r=0.122, p=0.151), *Buildertrend* (r=0.114, p=0.166)), professional qualification (*Dalux BIM viewer* (r=0.177, p=0.066)), length of experience (*Dalux Field* (r=0.195, p=0.048)), and number of projects executed (*Dalux Field* (r=0.102, p=0.194), *BIM Catalogs.net* (r=0.178, p=0.065), *Dalux BIM viewer* (r=0.104, p=0.189)) have an unequivocally positive and insignificant correlation with some of the construction apps. Designation (*Construction works calculator* (r=-0.384, p=0.000), *Viridi construction* (r=-0.360, p=0.001), *Construction +* (r=-0.319, p=0.003), *Planner 5D* (r=-0.306, p=0.004), *AUTOCAD DNG* (r=-0.335, p=0.002)) and number of projects executed (*Excavator Simulator* (r=-0.388, p=0.000), *Construction works calculator* (r=-0.394, p=0.000), *Viridi Construction* (r=-0.398, p=0.000), *Construction +* (r=-0.321, p=0.003)) were found to be emphatically negatively and significantly correlated with.

These outcomes propose that the designation of construction professionals would adversely influence their decision to use planning apps. Job positions that are not related to project planning and concept development would deter construction professionals from utilising project planning apps. The outcomes additionally uncovered that as the number of projects executed by construction professionals expands, their expertise in planning and estimation increases. This demonstrates that exceptionally experienced construction professionals might observe project planning and estimation apps as dreary and insignificant. In light of these outcomes, the proposition in hypothesis 1 (H1a–H1f) was not upheld. This means that there is no certain and critical relationship between demographic factors of construction professionals and the utilization of construction apps.

Table 2: Multiple Zero-Order Correlation analysis of the demographic factors impacting the use of construction apps

Construction apps	Mean score	Kolmogorov-Smirnov	Shapiro-Wilk	Designation	Academic qualification	Profession	Professional qualification	Length of experience	Number of projects executed
Construction site truck driver	2.46	.208	.855	-.230 .024	-.038 .374	.072 .271	-.036 .382	-.130 .135	-.222 .029
City construction simulator(construction machine)	2.01	.248	.805	-.305 .004	-.010 .467	.060 .306	-.007 .476	-.161 .086	-.258 .013
Crane driving simulator 3D Simulator	1.96	.258	.824	-.224 .028	.050 .337	.122 .151	-.045 .353	-.127 .140	-.273 .009
Excavator Simulator	2.28	.237	.832	-.292 .006	-.008 .472	.039 .371	.098 .203	-.287 .007	-.388 .000
Construction simulation 3 life)	2.06	.245	.830	-.182 .060	-.033 .390	.009 .468	-.064 .293	-.204 .040	-.293 .006
Construction works calculator	2.40	.218	.852	-.384 .000	.053 .326	-.098 .203	-.064 .293	-.257 .014	-.394 .000
Construction calculator	2.16	.205	.861	-.176 .066	-.012 .461	-.141 .116	-.059 .308	-.140 .116	-.252 .015
Viridi Construction	2.50	.199	.869	-.360 .001	.211 .036	-.255 .014	-.030 .400	-.213 .034	-.398 .000
Estimate ONSITE for contractors	2.30	.213	.869	-.193 .049	.102 .194	-.154 .095	-.025 .417	-.087 .231	-.240 .020
Builder's Bundle	2.48	.262	.863	-.274 .009	.082 .244	.001 .495	-.026 .415	-.022 .427	-.212 .035
Tape measure camera ruler	2.47	.211	.864	-.136 .124	-.043 .358	-.085 .236	-.151 .100	-.023 .422	-.234 .023
Construction +	2.31	.201	.856	-.319 .003	-.002 .493	-.062 .300	-.214 .034	-.214 .033	-.321 .003
Construction Estimator App	2.05	.236	.809	-.217 .031	-.054 .325	.075 .262	-.105 .186	-.061 .302	-.141 .116
Keylan 3D Lite	2.13	.227	.840	-.211 .036	-.049 .339	.051 .332	-.001 .498	.003 .488	-.083 .240
Designer City	1.87	.270	.807	-.235 .022	-.018 .440	.113 .170	.020 .433	.089 .225	-.021 .429
Planner 5D	2.31	.206	.857	-.306 .004	.038 .374	.009 .471	-.096 .208	-.153 .096	-.180 .063

ISSN 1584 – 2665 (printed version); ISSN 2601 – 2332 (online); ISSN-L 1584 – 2665

Plumbing and HVAC Calculator	2.24	.242	.831	-.202 .042	-.200 .044	-.012 .459	-.248 .017	.066 .288	.078 .254
CAD HD	2.26	.208	.862	-.181 .061	-.040 .369	-.106 .184	-.217 .032	.062 .298	-.168 .076
CAD Pocket	2.78	.193	.881	-.210 .036	.091 .221	-.016 .446	.037 .378	-.047 .344	-.155 .093
AUTO CAD DNG	2.63	.163	.892	-.335 .002	-.082 .244	-.048 .341	-.073 .269	.032 .395	-.068 .282
BIMx (BIM Explorer)	2.14	.257	.828	-.210 .036	.094 .212	-.002 .493	-.078 .254	-.159 .087	-.242 .019
Idle Construction 3D	2.15	.284	.806	-.109 .178	-.028 .407	.062 .301	-.043 .358	-.090 .222	-.197 .046
Bridge Constructor	2.19	.258	.805	-.176 .067	-.061 .302	-.083 .242	-.022 .427	-.012 .460	-.163 .082
Build Roads	2.09	.240	.840	-.261 .012	-.132 .131	.067 .286	-.131 .132	-.001 .498	-.153 .096
Buildertrend	2.06	.237	.844	-.187 .056	-.154 .095	.114 .166	-.093 .216	-.080 .250	-.195 .048
Procore	2.05	.221	.853	-.149 .102	-.151 .100	-.094 .214	.026 .414	-.135 .125	-.230 .024
Dalux Field	2.25	.219	.861	-.115 .166	-.079 .253	.065 .290	.117 .160	.195 .048	.102 .194
Visual Live	2.29	.206	.865	-.163 .083	.011 .462	.005 .483	.076 .260	-.030 .400	-.155 .093
Drone Deploy	1.94	.278	.803	-.094 .213	-.098 .204	-.094 .213	-.069 .280	-.107 .183	-.164 .081
Construction Manager App	1.98	.233	.821	-.092 .217	-.115 .165	-.009 .469	-.114 .167	-.047 .346	-.164 .081
Resync	1.96	.250	.819	-.005 .483	-.079 .252	-.086 .234	-.050 .336	-.046 .350	-.141 .116
HBSA Tool	1.99	.245	.829	.018 .438	-.109 .178	-.074 .265	.057 .316	-.136 .123	-.280 .008
Lifecycle cost	2.20	.217	.857	-.050 .336	.077 .256	.006 .480	.054 .323	-.077 .257	-.009 .469
EMC 20/20	2.04	.270	.811	-.250 .016	.031 .396	.019 .435	.061 .302	-.242 .019	-.285 .007
Structural Engineering Lite	2.16	.256	.818	-.238 .021	.017 .444	-.069 .278	-.063 .298	-.171 .072	-.218 .031
BIM 360 Team (for team management)	2.23	.246	.843	-.160 .087	.027 .409	.005 .484	-.068 .282	-.161 .086	-.228 .025
BIM 360 Field(for site management)	2.16	.232	.846	-.087 .231	-.074 .264	.006 .479	.000 .499	-.183 .059	-.252 .015
BIM 360 Ops(for asset and maintenance management)	2.01	.237	.832	-.067 .285	-.062 .301	-.002 .493	-.019 .435	-.166 .078	-.288 .006
Stream BIM	1.99	.242	.836	-.033 .389	-.017 .441	-.048 .342	.007 .477	-.112 .171	-.232 .023
BIM Catalogs.net	3.05	.196	.899	-.141 .116	.175 .068	.045 .353	.053 .328	.071 .274	.178 .065
Dalux BIM viewer	3.16	.209	.892	-.195 .048	.121 .151	.048 .343	.177 .066	.064 .295	.104 .189
Number of positive and significant correlation				0	0	0	0	0	0
Support for hypotheses				Did not provide support for H1a	Did not provide support for H1b	Did not provide support for H1c	Did not provide support for H1d	Did not provide support for H1e	Did not provide support for H1f

Relationship between psychographic factors and construction apps

The results of the Multiple Zero-Order Correlation examination of the nature and strength of the connections between the psychographic factors of the users of construction apps and the construction apps being used are displayed in Table 3. As displayed in the table, all the psychographic factors have an emphatically positive yet insignificant correlation with some of the construction apps. Only eleven of the factors exhibited a firmly positive and significant correlation with some construction apps. Personal characteristics, beliefs, habits, cognitive capacity, attitudes, and preferences were found to be insignificantly, strongly, and positively correlated with at least six construction apps. Factors having emphatically positive and insignificant correlation with below six construction apps include expectations ((*Construction site truck driver* (r=0.104, p=0.379), *Dalux BIM viewer* (r=0.325, p=0.005)), interest (*Designer city* (r=0.113, p=0.340), *Buildertrend* (r=0.108, p=0.350), *Dalux BIM viewer* (r=0.175, p=0.135)), goal (*City construction* (r=0.118, p=0.315), *Visual live* (r=0.135, p=0.251), *Drone deploy* (r=0.184, p=0.117), *BIM 360 Team*

ISSN 1584 – 2665 (printed version); ISSN 2601 – 2332 (online); ISSN-L 1584 – 2665

(r=0.120, p=0.307), *BIM 360 Ops* (r=0.167, p=0.154)), value ((*Viridi construction* (r=0.158, p=0.79), *CAD HD* (r=0.156, p=0.184), *Idle construction 3D* (r=0.277, p=0.017), *Bridge constructor* (r=0.206, p=0.079), *Dalux BIM viewer* (r=0.108, p=0.360)), self-efficacy ((*Planner 5D* (r=0.307, p=0.008), *Plumbing and HVAC* (r=0.243, p=0.037), *CAD HD* (r=0.170, p=0.148), *Dalux BIM viewer* (r=0.178, p=0.130)), opinion ((*Designer city* (r=0.230, p=0.049), *Pumbing and HVAC calculator* (r=0.229, p=0.050), *Keylan 3D Lite* (r=0.257, p=0.027)), lifestyle ((*Designer city* (r=0.321, p=0.005), *Dalux field* (r=0.114, p=0.333)), reward ((*Keylan 3D Lite* (r=0.264, p=0.023), *Designer City* (r=0.185, p=0.114), *Plumbing and HVAC calculator* (r=0.154, p=0.229), *BIM catalogs.net* (r=0.116, p=0.323)), and social class ((*Designer city* (r=0.230, p=0.049), *Planner 5D* (r=0.303, p=0.009), *plumbing and HVAC calculator* (r=0.257, p=0.027), *CAD HD* (r=0.170, p=0.148), *BIM Catalogs.net* (r=0.118, p=0.317)).

The psychographic factors that exhibited a strongly positive and significant correlation with the utilisation of construction apps are personal characteristics, value, cognitive capacity, self-efficacy, opinion, behavior, lifestyle, attitude, reward, preferences, and social class. A more profound investigation of the results uncovered that self-efficacy, opinion, behavior, lifestyle, attitude, reward, preferences, and social class are strongly positively and significantly correlated with the use of the same set of construction apps (that is, *construction calculator, Viridi construction, Estimate ONSITE, Builder's Bundle, Tape measure camera ruler, Construction +, construction estimator app, designer city,* and *Keylan 3D lite*).

The use of the accompanying construction apps was strongly, positively, and significantly correlated with personal characteristics ((*Dalux BIM viewer* (r=0.407, p=0.000)), value (*Construction calculator* (r=0.392, p=0.001), *Estimate ONSITE* (r=0.354, p=0.002), *Tape measure camera rule* (r=0.346, p=0.003), *Construction +* (r=0.342, p=0.003), *Construction estimator app* (r=0.508, p=0.000), *Keylan 3D lite* (r=.352, p=0.002), *Designer city* (r=0.413, p=0.000), *planner 5D* (r=0.352, p=0.002), *plumbing and HVAC calculator* (r=0.353, p=0.002)), and cognitive capacity (*construction calculator* (r=0.486, p=0.000), *Viridi construction* (r=0.343, p=0.003), *Estimate ONSITE* (r=0.422, p=0.000), *Builder's bundle* (r=0.377, p=0.001), *Tape measure camera rule* (r=0.404, p=0.000), *Construction +* (r=0.498, p=0.000), *Construction estimator app* (r=0.464, p=0.000), *Designer city* (r=0.390, p=0.001)).

An emphatically negative and critical correlation was found between value and *construction site truck driver* (r=-0.333, p=0.004), expectations and *Viridi construction* (r=-0.360, p=0.002), habit and *Viridi construction* (r=-0.398, p=0.000) and *CAD pocket* (r=-0.331, p=0.004), opinion and *CAD pocket* (r=-0.342, p=0.003), behavior and *CAD pocket* (r=-0.399, p=0.000), and social class and *CAD pocket* (r=-0.359, p=0.002).

These results only provide support for H2b and H2g–H2p. This proposes that construction app users are driven by their craving for development and viability; love for digital technologies; mental capability; self-adequacy; adaptability of the apps; longing for computerised abilities; love and energy for new innovation; an inclination for effectiveness; and a mission for brilliance.

Table 3: Multiple Zero-Order Correlation analysis of the psychographic factors impacting the use of construction apps

Construction apps	expectations	Personal character.	Interest	Belief	Goal	Habit	Value	Cognitive capacity	Self-efficacy	Opinion	Behavior	Lifestyle	Attitude	Reward	Preferences	Social class
Construction site truck driver	.104 .379	.122 .300	.020 .866	.047 .690	.010 .935	-.231 .048	-.333 .004	-.305 .008	-.297 .010	-.159 .176	-.163 .166	-.065 .580	-.128 .275	-.091 .440	-.104 .379	-.100 .398
City construction simulator(construction machine)	.096 .415	.169 .151	-.042 .722	.049 .681	.118 .315	-.079 .506	-.088 .454	-.149 .207	-.123 .297	-.068 .566	-.052 .658	-.032 .789	.060 .614	-.165 .160	-.051 .667	-.010 .934
Crane driving simulator 3D Simulator	.010 .933	.017 .883	-.026 .829	-.074 .531	-.023 .845	-.168 .153	-.077 .515	-.160 .173	-.238 .041	-.156 .186	-.024 .836	-.015 .897	.024 .840	-.096 .417	.048 .683	-.046 .698
Excavator Simulator	.064 .588	.091 .441	-.189 .107	-.106 .367	-.037 .753	-.122 .299	-.092 .434	-.193 .100	-.254 .029	-.216 .065	-.236 .043	-.019 .872	-.015 .901	-.191 .103	-.033 .780	-.077 .516
Construction simulation 3 life)	.066 .575	.046 .699	-.085 .471	.059 .616	.078 .509	-.128 .275	-.057 .632	-.090 .444	-.195 .096	-.058 .625	-.046 .697	-.022 .853	-.102 .388	-.241 .039	-.050 .672	-.154 .190
Construction works calculator	.030 .797	.052 .661	-.186 .112	-.076 .517	.014 .907	-.183 .119	-.194 .098	-.199 .089	-.193 .100	-.137 .245	-.179 .128	.018 .878	-.069 .557	-.175 .137	-.020 .865	-.239 .041
Construction calculator	-.176 .133	-.012 .921	-.141 .231	-.059 .617	-.140 .233	-.252 .030	.392 .001	.486 .000	.469 .000	.459 .000	.575 .000	.600 .000	1.000 .000	.431 .000	.588 .000	.519 .000
Viridi Construction	-.360 .002	.211 .071	-.255 .029	-.030 .799	-.213 .068	-.398 .000	.158 .179	.343 .003	.378 .001	.473 .000	.375 .001	.636 .000	.431 .000	1.000 .000	.591 .000	.576 .000
Estimate ONSITE for contractors	-.193 .099	.102 .388	-.154 .189	-.025 .835	-.087 .461	-.240 .040	.354 .002	.422 .000	.547 .000	.496 .000	.591 .000	.524 .000	.588 .000	.591 .000	1.000 .000	.593 .000

ISSN 1584 – 2665 (printed version); ISSN 2601 – 2332 (online); ISSN-L 1584 – 2665

Builder's Bundle	-.274 .018	.082 .488	.001 .991	-.026 .829	-.022 .855	-.212 .070	.298 .010	.377 .001	.560 .000	.565 .000	.488 .000	.562 .000	.519 .000	.576 .000	.593 .000	1.000 .000
Tape measure camera ruler	-.136 .248	-.043 .715	-.085 .473	-.151 .200	-.023 .843	-.234 .045	.346 .003	.404 .000	.465 .000	.369 .001	.498 .000	.384 .001	.639 .000	.351 .002	.455 .000	.588 .000
Construction +	-.319 .006	-.002 .985	-.062 .600	-.214 .067	-.214 .067	-.321 .005	.342 .003	.498 .000	.460 .000	.386 .001	.490 .000	.642 .000	.550 .000	.516 .000	.375 .001	.420 .000
Construction Estimator App	-.217 .063	-.054 .649	.075 .523	-.105 .372	-.061 .605	-.141 .232	.508 .000	.464 .000	.574 .000	.403 .000	.526 .000	.441 .000	.486 .000	.221 .058	.528 .000	.472 .000
Keylan 3D Lite	-.211 .071	-.049 .678	.051 .664	-.001 .996	.003 .977	-.083 .480	.352 .002	.260 .026	.303 .009	.257 .027	.366 .001	.351 .002	.619 .000	.264 .023	.412 .000	.439 .000
Designer City	-.235 .044	-.018 .879	.113 .340	.020 .867	.089 .449	-.021 .857	.413 .000	.456 .000	.390 .001	.230 .049	.362 .002	.321 .005	.234 .045	.185 .114	.225 .054	.230 .049
Planner 5D	-.306 .008	.038 .747	.009 .941	-.096 .417	-.153 .192	-.180 .126	.352 .002	.315 .006	.307 .008	.335 .003	.310 .007	.558 .000	.281 .015	.376 .001	.268 .021	.303 .009
Plumbing and HVAC Calculator	-.202 .084	-.200 .088	-.012 .919	-.248 .033	.066 .576	.078 .508	.353 .002	.184 .117	.243 .037	.229 .050	.300 .010	.405 .000	.371 .001	.154 .189	.227 .052	.257 .027
CAD HD	-.181 .123	-.040 .738	-.106 .369	-.217 .063	.062 .597	-.168 .152	.156 .184	.071 .546	.170 .148	.098 .406	.217 .063	.380 .001	.387 .001	.323 .005	.241 .039	.170 .148
CAD Pocket	-.038 .747	-.038 .745	-.142 .226	-.152 .196	-.155 .188	-.331 .004	-.246 .034	-.206 .079	-.273 .019	-.342 .003	-.399 .000	-.196 .093	-.206 .079	-.114 .332	-.269 .020	-.359 .002
AUTO CAD DNG	.101 .391	.019 .871	.032 .790	-.077 .514	-.009 .936	-.123 .298	-.164 .162	-.193 .100	-.163 .166	-.170 .147	-.172 .142	-.067 .568	-.071 .549	-.125 .290	-.154 .191	-.186 .114
BIMx (BIM Explorer)	-.086 .465	-.113 .340	-.133 .259	-.068 .565	-.176 .134	-.099 .402	-.013 .914	.002 .985	-.131 .267	-.117 .320	-.116 .323	-.126 .284	.002 .989	-.101 .392	.004 .973	-.104 .376
Idle Construction 3D	-.088 .457	-.077 .514	.000 .998	-.061 .608	.054 .645	.167 .154	.277 .017	-.061 .608	.017 .883	.006 .960	.096 .414	-.032 .789	.116 .325	-.089 .451	.111 .348	.058 .626
Bridge Constructor	.020 .866	-.079 .502	-.117 .319	.153	.011 .928	.149 .206	.206 .079	.264 .023	-.055 .640	-.037 .754	.160 .173	.075 .527	.165 .161	-.069 .561	.056 .635	-.042 .723
Build Roads	.013 .910	-.023 .848	-.008 .945	.157 .180	.041 .728	.026 .823	.027 .821	.046 .695	-.121 .305	.011 .929	.196 .094	.024 .842	.016 .890	-.033 .777	.038 .747	-.080 .496
Buildertrend	.058 .624	.018 .877	.108 .358	-.006 .960	.046 .697	-.018 .878	.045 .702	-.059 .618	-.032 .787	-.076 .519	.181 .123	.064 .589	.062 .602	-.002 .989	.033 .778	.037 .757
Procore	-.091 .442	-.067 .573	-.045 .706	.019 .875	-.033 .783	.005 .965	-.037 .754	.081 .492	-.023 .844	-.068 .564	.036 .763	.031 .796	.084 .476	-.011 .924	-.022 .854	-.103 .382
Dalux Field	-.145 .218	-.140 .235	-.137 .243	.122 .300	.054 .649	.054 .646	.004 .971	.131 .266	.006 .960	-.025 .832	.060 .614	.114 .333	.059 .620	-.041 .731	.024 .839	.087 .462
Visual Live	-.053 .651	.053 .652	-.085 .472	.059 .615	.135 .251	.086 .464	.091 .441	.072 .543	-.059 .619	-.119 .313	-.081 .490	.035 .766	-.019 .869	.068 .565	.123 .296	.025 .835
Drone Deploy	-.056 .634	-.072 .542	.027 .820	.064 .587	.184 .117	-.040 .733	-.021 .862	-.013 .912	.023 .847	.012 .919	.098 .405	.027 .819	-.140 .234	.142 .229	.044 .707	-.054 .646
Construction Manager App	-.040 .735	-.036 .764	.024 .842	.036 .760	-.088 .456	-.060 .610	.017 .888	.177 .131	.033 .778	.064 .590	.126 .286	.068 .564	.030 .800	.019 .872	-.022 .851	-.145 .218
Resync	-.148 .208	-.157 .182	-.331 .004	-.116 .325	-.186 .112	-.151 .199	-.167 .156	.071 .546	-.106 .371	-.113 .339	-.104 .380	-.105 .373	-.013 .913	-.026 .824	-.108 .362	-.303 .009
HBSA Tool	-.197 .092	-.081 .491	-.187 .110	.119 .312	.074 .532	-.017 .888	-.015 .902	.148 .210	.009 .941	.009 .938	-.017 .884	-.005 .969	-.035 .764	-.039 .742	-.110 .350	-.246 .035
Lifecycle cost	-.127 .282	-.082 .486	-.158 .179	.082 .488	-.189 .107	.033 .783	-.035 .764	.282 .015	.072 .540	-.049 .676	.081 .495	.090 .446	.082 .486	.070 .555	.067 .568	-.060 .613
EMC 20/20	-.013 .913	.087 .464	-.186 .113	.052 .660	.059 .615	-.125 .290	-.086 .464	.000 1.000	-.166 .157	-.191 .104	-.261 .025	-.054 .647	.013 .911	-.085 .473	-.041 .731	-.341 .003
Structural Engineering Lite	.021 .860	.106 .370	-.172 .142	.166 .158	.099 .400	.000 .998	-.026 .823	.128 .278	-.156 .185	-.052 .662	-.067 .569	-.007 .952	.025 .832	-.089 .453	.097 .410	-.195 .095
BIM 360 Team (for team management)	.047 .692	.117 .321	-.045 .701	.236 .043	.120 .307	.133 .257	.057 .629	.212 .069	-.073 .539	.017 .884	.036 .758	.054 .647	.157 .183	.052 .662	.164 .162	-.021 .860
BIM 360 Field(for site management)	-.054 .650	-.085 .470	-.148 .208	.254 .029	.071 .546	.098 .405	.008 .946	.196 .095	-.108 .359	-.018 .881	.010 .934	.006 .961	.014 .907	.044 .711	.104 .378	-.059 .620
BIM 360 Ops(for asset and maintenance management)	.024 .842	.057 .632	-.096 .417	.201 .085	.167 .154	.120 .308	.074 .532	.158 .177	-.079 .503	-.040 .736	.005 .965	-.011 .928	.055 .642	.010 .931	.170 .148	-.002 .984
Stream BIM	-.172 .143	-.176 .133	-.262 .024	.173 .140	.026 .823	.014 .907	-.110 .352	.160 .173	-.132 .262	-.014 .905	-.013 .911	-.060 .611	.059 .617	-.016 .894	-.030 .799	-.157 .181
BIM Catalogs.net	.272 .019	.222 .057	.203 .083	.214 .067	-.071 .547	.107 .364	-.050 .672	.079 .503	.113 .336	.059 .619	.007 .951	-.058 .626	.137 .246	.116 .323	.137 .246	.118 .317
Dalux BIM viewer	.325 .005	.407 .000	.175 .135	.157 .180	.085 .471	.190 .105	.108 .360	.130 .269	.178 .130	-.014 .906	.050 .673	.024 .841	.167 .156	.081 .491	.035 .770	-.003 .981
Number of positive and significant correlation	0	1	0	0	0	0	10	9	9	9	9	11	10	9	8	8
Support for hypotheses	Did not provide support for H2a	Support H2b	Did not provide support for H2c	Did not provide support for H2d	Did not provide support for H2e	Did not provide support for H2f	Support H2g	Support H2h	Support H2i	Support H2j	Support H2k	Support H2l	Support H2m	Support H2n	Support H2o	Support H2p

ISSN 1584 – 2665 (printed version); ISSN 2601 – 2332 (online); ISSN-L 1584 – 2665

5. DISCUSSION

This study discovered that different sorts of construction apps are being used by the surveyed construction professionals. The construction apps being used cover regions like CAD, project management, estimation, construction calculation, construction and site management, BIM, and simulation of construction plants. These discoveries supplemented the discoveries by Liu et al., (2017), Liu et al., (2019), and Ekow and Kofi (2016). Liu et al. (2018) announced the utilisation of construction apps such as PlanGrid, JobFlex, Procore, and SmartBidNet in the New Zealand construction industry. The 10 applications typically used by construction management team members in Ghana, as indicated by Ekow and Kofi (2016), are site photos, Microsoft, spirit level, material estimator calculator, AutoCAD WS, Construction Master Pro, Universal Estimator, AndCAD, Carpenter's Calculator, and paint estimator. The discoveries of this current study have added BIM apps and construction simulation apps to the rundown of construction apps generally utilised in the construction industry.

It was postulated in this study that the utilisation of construction apps by construction professionals relies upon demo-psychographic aspects. This postulation was tested utilising two theories. The first theory postulates that there is an emphatically huge relationship between demographic variables of construction professionals and the utilisation of construction apps. The demographic factors (academic qualification, profession, professional qualification, length of experience, and the number of projects executed) were found to be emphatically, but not essentially, connected with the utilisation of construction apps. As far as the nature and strength of the correlation, the findings demonstrated that the choice to utilise construction apps may be exceptionally impacted by demographic factors. Notwithstanding, because of the inconsequentiality of the affiliation, the discoveries infer that these elements are inconsistent. This implies that the first hypothesis was not approved and the piece of the postulation in regards to the connection among demographics and the utilisation of construction apps was not maintained. In any case, it shows from the findings that construction managers and site engineers may probably utilise construction apps since the vast majority of the apps that correspond with the profession of the app users are site management-related.

The subsequent hypothesis posits that there is a decidedly significant association between psychographic factors of construction professionals and the utilisation of construction apps. Psychographic factors used to operationalize this hypothesis include expectations (H2a), personality characteristics (H2b), interest (H2c), belief (H2d), goal (H2e), habit (H2f), value (H2g), cognitive competence (H2h), self-efficacy (H2i), opinion (H2j), behaviour (H2k), lifestyle (H2l), attitude (H2m), reward (H2n), preference (H2o), and social class (H2p). All the psychographic factors were found to have an emphatically certain relationship with the utilisation of construction apps. This suggests that all the psychographic variables could decidely influence the choice to utilise construction apps. It shows from the discoveries that the respondents are adept at utilising planner 5D, plumbing and HVAC, CAD HD, bridge constructor, BuildRoad, Buildertrend, and Construction Manager Apps. The respondents, as indicated by the discoveries, find Designer City, plumbing and HVAC, and Keylan 3D lite adaptable to interact with. Construction apps like Planner 5D, plumbing and HVAC, CAD HD, BIM Catalogs.net, and Dalux BIM viewer appear to be clear and justifiable to the respondents. It very well may be made sense of from the discovery that the adoration for savvy and economical urban areas and rich ways of life inspired construction professionals to utilise apps, for example, Designer City and Dalux Field.

The discoveries made clear that construction professionals are energetic about the utilisation of apps like Designer City, Planner 5D, Idle Construction 3D, Bridge Constructor, BIM 360 Team, BIM catalogs.net, and Dalux BIM viewer. These apps likewise give the sensation of working shrewdly. The findings additionally uncovered that self-efficacy, opinion, behavior, lifestyle, attitude, reward, preferences, and social class are essentially, extraordinarily, and decidedly connected with the utilisation of construction calculator, Viridi construction, Estimate ONSITE, Builder's Bundle, Tape Measure camera ruler, construction +, construction estimator app, and Keylan 3D lite. This proposes that these applications are new, successful, effective, and support savvy work. It additionally proposes that construction professionals consider the helpfulness of the apps in achieving tasks, think of them as valuable apparatus, and have an uplifting outlook on construction apps. The discoveries of this current study extend the conclusions of Xu et al. (2016) and Peltonen and Ferreira (2020) that have connected personality traits to app adoption. As uncovered by the discoveries of this study, there is a proportion of fervor, excitement, and energy about the utilisation of construction apps. For construction professionals, there is a proportion of fervor, excitement, and energy

ISSN 1584 – 2665 (printed version); ISSN 2601 – 2332 (online); ISSN-L 1584 – 2665

about the utilisation of construction apps out of the longing to be working shrewd. This could be on the grounds that functioning shrewdly rations energy, gives better judgment, and saves time. Most construction activities demand a specific measure of actual sturdiness and monotony. It may be the case that the utilisation of construction apps permits construction professionals to accomplish physically and mentally challenging undertakings with a few stabs. Working shrewd is additionally a method for expanding confidence by situating oneself as a more certain and useful individual and as somebody that is associated with the need to be around more. Working smart makes one more observant, imaginative, more roused, and certain. It makes errands more charming. This could be a significant justification for the reception of construction apps by construction professionals.

The psychographics likewise uncovered that construction professionals are keen on construction apps, see construction apps as a device to be dominated rather than to be stayed away from, and find apps simpler and more amicable than software. The psychographics demonstrated that construction professionals are very much arranged to deal with the digital insurgency in the construction industry. It is just that they favour a digital technology that will work on their abilities and not challenge their positions, as well as assist them with delivering quality performance. Construction apps, very much like any cutting-edge innovation, have had an impact on the manner in which individuals approach their work. From the psychographics, it appears that app users would rather not be forgotten about or abandoned in the 'technology lifestyle'. Additionally, the kinds of apps that the psychographic factors are associated with are generally connected with BIM and site management. This means that construction professionals with productivity expectations might utilise BIM and site management-related apps.

Likewise, apparently, the quest for a more straightforward way and device to do an undertaking, the affection for new innovation, mental capacity, and self-viability are decidedly associated with the utilisation of BIM-related apps, planning apps, drone apps, construction management apps, design apps, and building services apps. Psychographics like value, expectations, habits, opinions, behavior, and social class were found to have an adversely huge impact on the utilisation of CAD apps. The explanation for this could be that CAD innovation has been eclipsed by BIM innovation. As a result, CAD and CAD apps are currently not fashionable because they have met the expectations of app users, are no longer considered new digital technology, and are not generally associated with savvy working.

IMPLICATIONS

The results of this study infer that construction management should stretch into the utilisation of construction apps at offices, on projects, and construction sites. This will advance the utilisation of digital technology and improve production efficiency. Likewise, construction engineering and management programmes would need to consider the utilisation of construction apps and their advantages as a significant point in order to guarantee that construction professionals get training that makes them abreast with construction apps and the advantages of the use of these apps to improve proficiency in their activities. The findings could help app developers get the particular needs of construction professionals and achieve the commercial success of construction apps. The needs of the app users should be incorporated into the development of the apps (Wöbbekind et al., 2021). Future apps should be created not just on the basis of the specialised needs of the users but with respect to their demo-psychographics. Thusly, construction professionals would have the option to take on apps for various reasons. By appending more significance to users' demo-psychographics, app developers would have the option to diminish users' risk perception, create sensible performance expectancy of the app, and plan compelling and effective apps for construction professionals. The psychographic factors that were distinguished in this study would be valuable for fragmenting the app users, focusing on the app users, situating apps for widespread adoption, persuading users based on their necessities, and exploiting their needs and interests. Theoretically, this study has made known that demographics may influence construction app users' behavior, but without considering their psychographics, the conclusions might be misleading and inadequate to understand them, reach out to them, and create a compelling app.

LIMITATIONS AND FUTURE STUDIES

The sample of this study is restricted to construction app users in Nigeria. The utilisation of construction apps was self-revealed and the claims couldn't be confirmed. Likewise, simply laying out the connection between the demo-psychographics of app users and the use of apps isn't far-reaching enough. The association that was noticed could be the consequence of the controlling factors like task difficulty, app users' self-efficacy, job relevance, gender, culture, income, and size of firms. Future investigations should

ISSN 1584 – 2665 (printed version); ISSN 2601 – 2332 (online); ISSN-L 1584 – 2665

account for the role of these variables. Future examinations are urged to utilise contextual analysis strategies to explore the utilisation of construction apps. The examinations should recognise the business and cycle changes related to the utilisation of construction apps, the utilisation of construction apps as indicated by trades, and construction app-related digital behaviour and gender differences. We suspect that social media apps might influence the space and consideration for construction apps. Consequently, the effect of social media apps on the utilisation of construction apps among construction professionals should be examined.

6. CONCLUSION

This study has shown that there is a moderate degree of use of construction apps in Nigeria and that the users are exceptionally educated, productivity-oriented, intelligent, intuitive learners, and like to work sagaciously and effectively. They additionally have digital skills, experience, and an appreciation for new technologies and innovations. The demo-psychographic characteristics of construction app users, as found in this study, depict people with a craving for usefulness, savvy working, self-viability, adequacy and effectiveness, and advanced abilities. Construction app developers should focus on these qualities to energise the utilisation of their products. It is fundamental that construction apps be designed to supplement the users' capacity, be simple to utilize, clear and justifiable, to complement digital skills, be intriguing, support viability and productivity, and encourage smart working.

Construction app users select the apps that coordinate with their personality, values, way of life, social class, and cognitive competence. This study contributes to knowledge by laying out that there is no critical connection between the demographics of construction app users and the utilisation of construction apps. The study has made sense of how the utilisation of construction apps is associated with the users' psychographics. The study has likewise recognised the psychographic aspects related to the utilisation of construction apps and the potential for correspondence advertising in the space of construction app marketing. This is a huge contribution to the construction app literature.

References

[1] Amro, B. (2017). Malware detection techniques for mobile devices. International Journal of Mobile Network Communications & Telematics (IJMNCT) Vol, 7.
[2] Bae, H., Golparvar-Fard, M., & White, J. (2013). High-precision vision-based mobile augmented reality system for context-aware architectural, engineering, construction, and facility management (AEC/FM) applications. Visualization in Engineering, 1(1), 1-13.
[3] Barbarosoglu, B. V., & Arditi, D. (2016). Mobile applications for the construction industry interaction between theory and practice in civil engineering and construction. In R. Komurlu, A. P. Gurgun, A. Singh, & S. Yazdani (Eds.), ISEC Press
[4] Behzadan, A. H., Aziz, Z., Anumba, C. J., & Kamat, V. R. (2008). Ubiquitous location tracking for context-specific information delivery on construction sites. Automation in construction, 17(6), 737-748.
[5] Bowden, S., Dorr, A., Thorpe, T., & Anumba, C. (2006). Mobile ICT support for construction process improvement. Automation in construction, 15(5), 664-676.
[6] Bui, D., Yao, Y., Shin, K. G., Choi, J. M., & Shin, J. (2021, November). Consistency Analysis of Data-Usage Purposes in Mobile Apps. In Proceedings of the 2021 ACM SIGSAC Conference on Computer and Communications Security (pp. 2824-2843).
[7] Carter, S., & Yeo, A. C. M. (2016). Mobile apps usage by Malaysian business undergraduates and postgraduates: Implications for consumer behaviour theory and marketing practice. Internet Research.
[8] Chen, Y., & Kamara, J. M. (2011). A framework for using mobile computing for information management on construction sites. Automation in construction, 20(7), 776-788.
[9] Chi, S., & Caldas, C. H. (2012). Image-based safety assessment: automated spatial safety risk identification of earthmoving and surface mining activities. Journal of Construction Engineering and Management, 138(3), 341-351.
[10] Chun, I. (2018). Utilisation of construction-related mobile apps in construction industry.
[11] Ekow, Y. J., & Kofi, O. G. (2016). Awareness and utilization of construction related smart mobile device applications in the construction industry. Science and Technology, 6(1), 1-7.
[12] Fathi, M. S., Abedi, M., Rambat, S., Rawai, S., & Zakiyudin, M. Z. (2012). Context-aware cloud computing for construction collaboration. Journal of Cloud Computing, 2012, 1.
[13] Ibem, E. O., & Laryea, S. (2014). Survey of digital technologies in procurement of construction projects. Automation in Construction, 46, 11-21.
[14] Kim, C., Park, T., Lim, H., & Kim, H. (2013). On-site construction management using mobile computing technology. Automation in construction, 35, 415-423.
[15] Kimoto, K., Endo, K., Iwashita, S. and Fujiwara, M. (2005), "The application of PDA as mobile computing system on construction management", Automation in Construction, Vol. 2005, pp. 500-11
[16] Li, F., Wang, D., Wang, Y., Yu, X., Wu, N., Yu, J., & Zhou, H. (2020). Wireless communications and mobile computing blockchain-based trust management in distributed internet of things. Wireless Communications and Mobile Computing, 2020.
[17] Liang, T. P., Li, X., Yang, C. T., & Wang, M. (2015). What in consumer reviews affects the sales of mobile apps: A multifacet sentiment analysis approach. International Journal of Electronic Commerce, 20(2), 236-260.
[18] Liu, T., Mathrani, A., & Mbachu, J. (2019). Benefits and barriers in uptake of mobile apps in New Zealand construction industry: What top and middle management perceive. Facilities.

ISSN 1584 – 2665 (printed version); ISSN 2601 – 2332 (online); ISSN-L 1584 – 2665

[19] Liu, T., Mbachu, J., Mathrani, A., Jones, B., & McDonald, B. (2017). The perceived benefits of apps by construction professionals in New Zealand. Buildings, 7(4), 111.
[20] Malik, A., Suresh, S., & Sharma, S. (2017). Factors influencing consumers' attitude towards adoption and continuous use of mobile applications: a conceptual model. Procedia computer science, 122, 106-113.
[21] Marquez, C., Gramaglia, M., Fiore, M., Banchs, A., Ziemlicki, C., & Smoreda, Z. (2017, November). Not all apps are created equal: Analysis of spatiotemporal heterogeneity in nationwide mobile service usage. In Proceedings of the 13th International Conference on emerging Networking EXperiments and Technologies (pp. 180-186).
[22] Milner, A., Law, P. C. F., Mann, C., Cooper, T., Witt, K., & LaMontagne, A. D. (2018). A smart-phone intervention to address mental health stigma in the construction industry: A two-arm randomised controlled trial. SSM-Population Health, 4, 164-168.
[23] Ojelabi, R., Oyeyipo, O., Afolabi, A., & Amusan, L. (2018). Presence of social client relationship management within the Nigerian Construction Industry. Buildings, 8(4), 60.
[24] Owoseni, A., & Twinomurinzi, H. (2018). Mobile apps usage and dynamic capabilities: A structural equation model of SMEs in Lagos, Nigeria. Telematics and Informatics, 35(7), 2067-2081.
[25] Peltonen, E., Sharmila, P., Asare, K. O., Visuri, A., Lagerspetz, E., & Ferreira, D. (2020). When phones get personal: Predicting Big Five personality traits from application usage. Pervasive and Mobile Computing, 69, 101269.
[26] Sattineni, A., & Schmidt, T. (2015). Implementation of mobile devices on jobsites in the construction industry. Procedia Engineering, 123, 488-495.
[27] Sheglabo, J., McGill, T., & Dixon, M. (2017). An investigation of the factors that impact the intention to adopt and use mICT in the Libyan construction industry. Journal of Construction in Developing Countries, 22(1), 55-74.
[28] Shen, X., Cheng, W., & Lu, M. (2008). Wireless sensor networks for resources tracking at building construction sites. Tsinghua Science and Technology, 13(S1), 78-83.
[29] Son, H., Park, Y., Kim, C., & Chou, J. S. (2012). Toward an understanding of construction professionals' acceptance of mobile computing devices in South Korea: An extension of the technology acceptance model. Automation in construction, 28, 82-90.
[30] Tang, W., & Kreindler, D. (2017). Supporting homework compliance in cognitive behavioural therapy: essential features of mobile apps. JMIR mental health, 4(2), e5283.
[31] Tongaonkar, A., Dai, S., Nucci, A., & Song, D. (2013, March). Understanding mobile app usage patterns using in-app advertisements. In International Conference on Passive and Active Network Measurement (pp. 63-72). Springer, Berlin, Heidelberg.
[32] Tu, Z., Li, R., Li, Y., Wang, G., Wu, D., Hui, P., ... & Jin, D. (2018). Your apps give you away: distinguishing mobile users by their app usage fingerprints. Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies, 2(3), 1-23.
[33] Usman, N., Said, I., & Yahaya, A. Z. (2012). Indolent Disposition towards ICT acceptance among practising Quantity Surveyors in Nigeria. Acta Technica Corviniensis-Bulletin of Engineering, 5(2), 75.
[34] Vasilevski, N., & Birt, J. (2020). Analysing construction student experiences of mobile mixed reality enhanced learning in virtual and augmented reality environments. Research in Learning Technology, 28.
[35] Wang, W., & Reani, M. (2017). The rise of mobile computing for Group Decision Support Systems: A comparative evaluation of mobile and desktop. International Journal of Human-Computer Studies, 104, 16-35.
[36] Wei, Y., Zheng, P., Deng, H., Wang, X., Li, X., & Fu, H. (2020). Design features for improving mobile health intervention user engagement: systematic review and thematic analysis. Journal of medical Internet research, 22(12), e21687.
[37] Wöbbekind, L., Mandl, T., & Womser-Hacker, C. (2021). Construction and First Testing of the UX Kids Questionnaire (UXKQ) A Tool for Measuring Pupil's User Experience in Interactive Learning Apps using Semantic Differentials. In Mensch und Computer 2021 (pp. 444-455).
[38] Woo, S., Jeong, S., Mok, E., Xia, L., Choi, C., Pyeon, M., & Heo, J. (2011). Application of WiFi-based indoor positioning system for labor tracking at construction sites: A case study in Guangzhou MTR. Automation in Construction, 20(1), 3-13.
[39] Wu, H. L. (2013). An integrated framework of mobile apps usage intention. Pacific Asia Conference on Information Systems.
[40] Xu, R., Frey, R. M., Fleisch, E., & Ilic, A. (2016). Understanding the impact of personality traits on mobile app adoption–Insights from a large-scale field study. Computers in Human Behavior, 62, 244-256.
[41] Yankah, J. E., Novieto, D. T., Davies, E., & Adjei, K. O. (2022). Panorama of mobile device applications (Apps) for the construction industry. Frontiers in Engineering and Built Environment, (ahead-of-print).
[42] Zolkepli, I. A., Mukhiar, S. N. S., & Tan, C. (2021). Mobile consumer behaviour on apps usage: The effects of perceived values, rating, and cost. Journal of marketing communications, 27(6), 571-593.

ISSN 1584 – 2665 (printed version); ISSN 2601 – 2332 (online); ISSN–L 1584 – 2665