Research and Applications

Psychometric evaluation of the *Smartphone for Clinical Work Scale* to measure nurses' use of smartphones for work purposes

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ABSTRACT

Objective: This study reports the development and psychometric evaluation of the *Smartphone for Clinical Work Scale* (SCWS) to measure nurses' use of smartphones for work purposes.

Methods: Items were developed based on literature review and a preliminary study. After expert consultations and pilot testing, a 20-item scale was administered in January-June 2017 to 517 staff nurses from 19 tertiary-level general hospitals in Metro Manila, Philippines. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were used to evaluate construct validity. Structural equation modeling (SEM) was used to test the predictive validity of SCWS on perceived work productivity.

Results: EFA results show that 15 out of 20 items loaded on five factors: communication with clinicians via call and text, communication with doctors via instant messaging, information seeking, communication with nurses via instant messaging, and communication with patients via call and text. CFA results suggest that the five factors that form SCWS have adequate fit to the data, thus supporting construct validity. SEM results suggest predictive validity since SCWS was positively associated with perceived work productivity.

Conclusions: The 15-item SCWS showed satisfactory psychometric properties for use in future studies. These studies can focus on identifying factors associated with nurses' use of smartphones for work purposes.

Key words: nurses, smartphone, Philippines, IT consumerization, mHealth

INTRODUCTION

In the 21st Century, nurses use various forms of health information technologies (HITs) as part of their clinical routines.[1] These HITs may range from essential electronic health records to advanced clinical decision support systems.[2] Using these technologies is mandated by hospital administrators, and training sessions orient nurses on how to properly use them.[3] While various forms of HITs exist, some hospitals cannot provide even the most basic implementation.[4] This situation is prevalent in most hospitals from developing countries where HITs are either limited or absent.[5]

Recent studies suggest that HITs used by nurses at work are not limited to those instituted by hospitals.[6,7] Instead, these studies show that nurses use their smartphones when communicating with healthcare colleagues through voice calls and text messaging; searching for clinical information through the Internet or mobile apps; or documenting various aspects of patient care.[6–12] Studies suggest that nurses use them to efficiently accomplish tasks and become more productive at work.[7,13] This situation is unsurprising since smartphones are easy to use, widely adopted, and have sufficient computing power to handle clinical tasks.[14] Unfortunately, personal

smartphones are not hospital-provided technologies and its use may present concerns for hospitals (e.g., privacy and confidentiality concerns, infection control problems, and issues of professionalism).[13,15] Consequently, most hospitals ban or discourage their nurses from using smartphones, even for work purposes.[13,15] Nonetheless, it is important to note that this phenomenon occurs in both developed countries[6,7,10–12] and developing countries.[8,9,11]

A key concern about this research topic is how to measure nurses' use of smartphones for work purposes. Although previous studies have used surveys to determine the extent of nurses' use of smartphones for work purposes,[6,7,12] their measurement gave limited details on important psychometric properties. Evaluating the psychometric properties of a scale is important to determine which set of items are valid and reliable to operationalize a construct. Consequently, the absence of a validated scale that measures nurses' use of smartphones for work purposes makes it difficult to advance research on this topic.[16] For instance, statistically testing propositions from previous studies (e.g., nurses' use of smartphones for work purposes enhances work productivity)[6–8,12,13,17] is problematic without a psychometrically validated scale.

One way to advance research on this topic is to develop a psychometrically valid and reliable scale. In this study, the psychometric properties of the *Smartphone for Clinical Work Scale* (SCWS) are evaluated using measures of validity (i.e., content, construct, and predictive validity) and reliability (i.e., internal consistency) based on survey data from 517 staff nurses in the Philippines. While previous studies evaluate the construct validity of nurse-related scales with exploratory factor analysis (EFA) only,[18,19] this study utilizes confirmatory factor analysis (CFA) to provide a robust evaluation of SCWS's construct validity. Developing the SCWS is vital so that future studies may employ similar measurement and statistically identify factors associated with nurses' use of smartphones for work purposes. Moreover, the scale can be used as a basis to guide policies on nurses' use of smartphones in clinical settings. While it is designed to measure nurses' use of smartphones for work purposes, the scale can be modified to measure the use of smartphones by other healthcare professionals as well as non-healthcare workers.

METHODS

This study is divided into two phases. Phase 1 involves the development of the scale and its evaluation by experts and staff nurses. Preliminary validation includes a pilot testing among staff nurses. Phase 2 involves a cross-sectional survey among staff nurses to evaluate the scale's construct validity through exploratory and confirmatory factor analyses. It is followed by an evaluation of its predictive validity by testing the association of nurses' use of smartphones for work purposes with perceived work productivity. Ethical clearance from the Institutional Review Board of Nanyang Technological University was obtained for this study (IRB-2016-09-003).

Phase 1
Item development
An initial version of SCWS was created by reviewing results of a preliminary study[8] and relevant literature.[6,7,10–13] Through in-depth interviews with 30 nurses in the Philippines, the preliminary study showed that nurses use their smartphones for communication, information seeking, and documentation purposes.[8] Overall, the review produced a 22-item scale that includes 14 items on communication, 5 items on information seeking, and 3 items on documentation.

Items for communication measure nurses' use of smartphones to communicate with other healthcare providers (doctors and nurses) using voice calls, text messaging, and instant messing apps. These items also measure communication with patients via voice calls and text messaging. Items for information seeking measure information seeking through mobile apps, websites, and e-books. Additional items measured the sharing of clinical or nursing-related information with nurses and doctors. Finally, items for documentation measured the use of smartphones to take pictures relevant to patient care (e.g., wounds, patient chart) as well as its use to create notes, reminders, and checklist regarding patient care.

These items appeared in English in a pen-and-paper questionnaire. An English questionnaire is appropriate because it is the primary language of nursing education in the Philippines.[20] In the survey, respondents were instructed to indicate on a 5-point Likert-type scale their frequency of using their smartphone for each activity for the past month. Response options ranged from 1 (*never*) to 5 (*all of the time*).

Phase 2
Sampling procedure
Staff nurses working for at least a year in tertiary-level general hospitals in Metro Manila, Philippines were the target respondents of this study. Metro Manila served as the research locale, since it is the capital region of the Philippines and most of the hospitals in the country are located there.[21] Moreover, staff nurses were selected because they are mostly young adults who are familiar with digital technologies,[8,9] and they spend more time on direct patient care than other healthcare professionals.[22]

This study employed multi-stage sampling, which enhances respondent heterogeneity.[23] Multi-stage sampling was possible since a list of hospitals containing relevant characteristics (i.e., level, ownership, bed capacity, and location) was publicly available from the Philippine Health Insurance Corporation's website.[21] Initially, tertiary-level general hospitals were identified from the list and consecutively stratified based on ownership (i.e., government and private), bed capacity (i.e., <300 beds and ≥ 300 beds) and location (i.e., North, Central, and South). The resulting stratification produced a sampling frame of 32 private and 13 government hospitals across 12 clusters. These clusters had a minimum of 2 and a maximum of 10 hospitals. Within clusters, half of the hospitals were randomly selected. For clusters containing an odd number of hospitals, hospitals were oversampled to obtain a whole number of hospitals sampled from those clusters. At the hospital level, respondents were selected based on purposive sampling of those at least 21 years of age who held a staff nurse position and had worked for at least a year.

Data collection procedure
Data collection was conducted from January to June 2017. A letter requesting permission to collect survey data was submitted to all hospitals that were randomly selected for this study. In instances that a hospital declined to participate in the study, another hospital was randomly selected among the previously unselected hospitals within a cluster. Among the hospitals that declined to participate in the study, most did not specify any reason for declining. However, some explained that they did not allow research by unaffiliated or external researchers. Overall, 19 hospitals agreed to participate. These hospitals included 14 private and 5 government hospitals. The distribution of the hospitals for this study is close to our sampling frame where private hospitals are at least 2.5 times more present than government hospitals. After securing permission to

conduct the research, the first author coordinated with each hospital's nursing department to identify potential respondents.

Staff nurses were invited to take the survey after working hours in a place designated by the nursing department (e.g., after nurses' shift in a lounge adjacent to employees' exit or canteen outside hospital premises). Verbal and written consent was obtained before starting the anonymous survey. Aside from SCWS items, demographic (i.e., age, gender, and education) and work-related (i.e., hospital category, nursing unit, monthly income, years of clinical experience) information were collected. For the purposes of evaluating predictive validity, three items on perceived work productivity were also included. Completion time was generally under 15 minutes. An incentive of 100 Philippine Pesos (Approximately USD 2) was given after each respondent completed the survey. The incentive is reasonable since it is approximately worth one to two hours of their daily income. There were 28 respondents for all hospitals except for one which had 30 respondents, yielding a total of 534 respondents. However, we retained data from 517 respondents after removing 17 non-smartphone users. Pett, Lackey, and Sullivan recommend a minimum of 10 respondents per item in factor analysis.[24] Following this recommendation, the 20 items of the SCWS require at least 200 respondents, for which the current sample is more than adequate.

Data preparation and analysis

Data were prepared and analyzed using various statistical methods. First, descriptive statistics were used to obtain an overview of the survey data and identify missing values. Next, respondents were randomly allocated into two groups, with the data from one half used for exploratory factor analysis ($N = 258$) and data from the other half used for confirmatory factor analysis ($N = 259$). Using the split-half validation technique helps establish robust construct validity.[25,26]

Missing values should be addressed before conducting EFA in *SPSS Statistics 23*.[27] Missing values analysis showed that missingness on items did not exceed 0.8%. Little's missing completely at random (MCAR) test was non-significant ($p = 0.40$) suggesting that the missingness was completely at random.[28] Given this result, listwise deletion of missing values would be acceptable; however, it would result in a smaller sample size.[29] To maintain the sample size, results were imputed using expectation maximization, which produces unbiased estimates of missing values.[29]

EFA was used to determine the factor structure of the scale. Factors were extracted using maximum likelihood estimation and items were rotated using promax rotation. Factors were selected if they had eigenvalues greater than 1. Items were retained if they had factor loadings on a single factor greater than 0.40. After determining the factor structure, reliability estimates were obtained for each factor to evaluate their internal consistency.

CFA was used to validate the factor structure based on EFA and determine if the factors have adequate model fit. *Mplus 7* was used to perform CFA. There was no missing value analysis or imputation for this data set because the full information maximum likelihood algorithm in *Mplus 7* can compute model estimates based on all observed data.[30] Recommendations from previous studies indicate that a CFA model has acceptable fit if relative chi-square (X^2/df) is less than 3, the comparative fit index (CFI) and Tucker-Lewis index (TLI) are greater than 0.95, the root mean square error of approximation (RMSEA) is less than 0.06, and the standardized root mean square residual (SRMR) of is less than 0.08.[31,32]

Finally, to test predictive validity, SCWS was used to predict perceived work productivity using structural equation modeling (SEM) in *Mplus7*. According to IT consumerization theory,[33] nurses' use of smartphones for work purposes should positively correlate with perceived work productivity. The test of this hypothesis was performed using the full sample of the study ($N = 517$) with 5000 bootstrap sampling procedures.[34] Three items from Torkzadeh and Doll[35] measured perceived work productivity. An example of these items is '*Using my own mobile phone at work for work purposes increases my productivity*'. All items were measured using a five-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). These items had excellent internal consistency (Cronbach's alpha = 0.90). Aside from the relationship of SCWS to perceived work productivity, the relationship of the respondents' profile to SCWS was also examined to provide more insights to the scale.

RESULTS

Phase 1

Content validity

Content validity is the degree to which items or measures adequately represent a given construct. A panel of 5 experts with doctoral degrees was invited to evaluate the content validity of SCWS. Three of the experts are faculty members in Singapore who have doctoral degrees in communication and information, while the other two experts are faculty members in the Philippines who have doctoral degrees in nursing and several years of clinical experience. A few changes to the scale were made based on the suggestion of the experts. First, two items from the communication sub-scale were removed since staff nurses in the Philippines rarely used email to communicate with nurses and doctors. This revision resulted to a revised 20-item SCWS. Second, the wording of each item was checked and, if necessary, revised to improve its clarity and reduce repetitiveness.

In addition to obtaining input from experts, 31 staff nurses in the Philippines were consulted in September 2016 to provide feedback on the clarity of the scale. Based on consultation with staff nurses, items asking about their communication with patients (i.e., COM11 and COM12) should also reflect communication with their guardians since they serve as their representative during hospitalization. The scale was revised after discussing this feedback with the experts. Figure 1 shows the revised 20-item SCWS.

Pilot testing

In December 2016, 30 staff nurses in the Philippines answered the pilot version of the SCWS. These nurses work in either government or private hospitals, and are assigned to different nursing areas (e.g., wards, emergency room, operating room, intensive care, ancillary). Aside from evaluating its clarity and completion time, the pilot testing was conducted to determine the preliminary internal consistency of the scale and its sub-scales. Verbal and written consent was acquired before starting the anonymous survey. Respondents were able to complete the survey within 15 minutes. Post-survey interviews with the respondents indicated that the items were easy to understand, and they had no difficulty estimating their smartphone usage at work for the past month. There was good internal consistency for the 20-item scale (Cronbach's alpha = 0.92), and adequate internal consistency for the communication (Cronbach's alpha = 0.89), information seeking (Cronbach's alpha = 0.80), and documentation (Cronbach's alpha = 0.76) subscales. Overall, the 20-item scale is fit for full data collection for phase 2.

The following questions ask about your use of your own mobile phone at work during the past month.
Selection: 1 = Never, 2 = Almost never, 3 = Sometimes, 4 = Most of the time, 5 = All of the time

How often did you use your own mobile phone at work to engage with <u>nurses</u> for the following communication activities?
[COM1] 1. Making work-related calls
[COM2] 2. Exchanging work-related text messages via SMS (*Short Message Service, the usual way of sending text messages.*)
[COM3] 3. Exchanging work-related text messages via instant messaging apps (*Viber, Facebook Messenger, Line, WeChat, etc.*)
[COM4] 4. Exchanging work-related images via instant messaging apps
[COM5] 5. Exchanging work-related videos via instant messaging apps
[INFO1] 6. Asking for clinical information (DROPPED)

How often did you use your own mobile phone at work to engage with <u>medical doctors</u> for the following communication activities?
[COM6] 7. Making work-related calls
[COM7] 8. Exchanging work-related text messages via SMS
[COM8] 9. Exchanging work-related text messages via instant messaging apps
[COM9] 10. Exchanging work-related images via instant messaging apps
[COM10] 11. Exchanging work-related videos via instant messaging apps
[INFO2] 12. Asking for clinical information (DROPPED)

How often did you use your own mobile phone at work to engage with <u>patients or patients' guardian(s)</u> for the following communication activities?
[COM11] 13. Making work-related calls
[COM12] 14. Exchanging work-related text messages via SMS

How often did you use your own mobile phone at work to search for clinical information from the following sources?
[INFO3] 15. Clinical reference apps (*Some clinical reference apps include WebMD, Epocrates, Medscape, etc.*)
[INFO4] 16. Websites (*Some websites include Google, WebMD, Medscape, etc.*)
[INFO5] 17. E-books saved on your own mobile phone

How often did you use your own mobile phone at work for the following clinical documentation activities?
[DOC1] 18. Using mobile apps to document patient care such as creating notes, reminders or checklists. (DROPPED)*
[DOC2] 19. Taking a picture of patient outcomes like wounds, ECG tracing, X-ray films, skin rashes, etc. (DROPPED)*
[DOC3] 20. Taking a picture of the patient's chart. (DROPPED)*

Figure 1. SCWS items. Notes for Figure 1: COM = Communication purposes, INFO = information seeking purposes, DOC = documentation purposes. Key for retained items (15 items) - Communication with clinicians via call and text: COM1, COM2, COM6, COM7; Communication with doctors via instant messaging: COM8, COM9, COM10; Information seeking: INFO3, INFO4, INFO5; Communication with nurses via instant messaging: COM3, COM4, COM5; Communication with patients via call and text: COM11, COM12. *Dropped items can be included for exploratory purposes.

Phase 2

Respondents' profile

The 517 survey respondents ranged in age from 21 to 49 years old ($M = 28.93$, $Mdn = 27$, $SD = 5.90$) and most of them belong to the 21 to 29 age group (66.9%). Most were female (69.8%) and held a Bachelor of Science in Nursing degree (90.9%). A majority were employed in private hospitals (73.3%) and had a clinical experience from 1 to 27 years ($M = 4.61$, $Mdn = 3$, $SD = 4.28$). About 53.8% were assigned in general areas (e.g., wards, ancillary, and outpatient) and 46.2% were in specialty areas (e.., intensive care, emergency department, operating room). Most (43.3%) of the respondents earned PHP 10 000—14 999 (approximately USD 200—299) per month.

Exploratory factor analysis

Preliminary results suggested an adequate sample and appropriate data structure for conducting EFA. First, Bartlett's test of sphericity was significant ($X^2 = 3636.66$, $df = 190$, $p < 0.001$) and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.85. In general, the former should have a p-value of less than 0.05 and the latter should exceed 0.50.[36] Finally, Harman's single factor test showed that no single factor accounted for more than 50% of the total item variance.[37] The reason to conduct this test is to check whether survey items with a common method of measurement tend to correlate as a function of their measurement.[38] Such common method bias obscures conceptual differences among items. Current results suggest common method bias is not a concern.

The EFA resulted in five factors ($X^2 = 439.43$, $df = 100$, $p < 0.001$) with eigenvalues larger than 1, which explained 73% of the variance in 15 out of 20 items. Four factors were related to the use of smartphones for communication with healthcare practitioners and patients, and one factor related the use of smartphones for information seeking. Interestingly, items on the use of smartphones for documentation did not load on any factor. Similarly, INFO 1 and INFO2 did not load on any factor. Table 1 shows the results of the EFA analysis.

Confirmatory factor analysis

The CFA supported the proposed 15-item five-factor model, and included a second-order factor indicating all five factors (Figure 2). The factor model had good fit with the observed data, $X^2/df = 1.65$, RMSEA = 0.050 (90% CI = 0.034 – 0.065), CFI = 0.98, TLI = 0.97, SRMR = 0.047. Standardized factor loadings were all significant ($p < .001$) and ranged from 0.60 to 0.95. Factor loadings of 0.60 and above are acceptable.[39]

Predictive validity

The SEM fit was adequate, $X^2/df = 2.06$, RMSEA = 0.046 (90% CI = 0.040 – 0.052), CFI = 0.96, TLI = 0.95, and SRMR = 0.056. Results showed a significant positive relationship between nurses' use of smartphones for work purposes and perceived work productivity ($\beta = 0.28$, $p < .001$). This result is consistent with IT consumerization theory and suggests that the SCWS has predictive validity.

Table 1. Exploratory Factor Analysis Results (*n* = 258)

Item	*M*	*SD*	*CITC*	Factors and factor loadings				
				1	2	3	4	5
Factor 1: Communication with clinicians via call and text								
[COM7] Exchanging work-related text messages via SMS with doctors	3.31	1.20	0.83	0.90				
[COM6] Making work-related calls with doctors	3.10	1.18	0.83	0.89				
[COM1] Making work-related calls with nurses	3.27	1.01	0.78	0.81				
[COM2] Exchanging work-related text messages via SMS with nurses	3.40	1.04	0.77	0.80				
Factor 2: Communication with doctors via instant messaging								
[COM9] Exchanging work-related images via instant messaging apps with doctors	1.88	1.02	0.83		0.91			
[COM10] Exchanging work-related videos via instant messaging apps with doctors	1.63	0.91	0.81		0.89			
[COM8] Exchanging work-related text messages via instant messaging apps with doctors	2.07	1.14	0.75		0.78			
Factor 3: Information seeking								
[INFO4] Websites	2.94	1.09	0.78			0.90		
[INFO3] Clinical reference apps	2.84	1.07	0.78			0.86		
[INFO5] E-books saved on your own mobile phone	2.34	1.15	0.66			0.71		
Factor 4: Communication with nurses via instant messaging								
[COM4] Exchanging work-related images via instant messaging apps with nurses	2.35	1.10	0.64				0.90	
[COM3] Exchanging work-related text messages via instant messaging apps with nurses	2.84	1.21	0.82				0.79	
[COM5] Exchanging work-related videos via instant messaging apps with nurses	1.92	1.01	0.70				0.75	
Factor 5: Communication with patients via call and text								
[COM12] Exchanging work-related text messages via SMS with patients or patients' guardian(s)	2.01	1.12	0.83					0.99
[COM11] Making work-related calls with patients or patients' guardian(s)	2.01	1.10	0.83					0.84
Dropped items								
[INFO1] Asking for clinical information with nurses	2.97	1.11						
[INFO2] Asking for clinical information with doctors	2.66	1.23						
[DOC1] Using mobile apps to document patient care such as creating notes, reminders or checklists	2.02	1.02						
[DOC2] Taking a picture of patient outcomes like wounds, ECG tracing, X-ray films, skin rashes, etc.	2.17	1.09						
[DOC3] Taking a picture of the patient's chart	1.70	1.03						
Reliability				0.91	0.89	0.86	0.85	0.91
Eigenvalue				8.14	2.23	1.61	1.45	1.17
Percentage of variance explained				40.70	11.13	8.06	7.27	5.85

Notes: *M* = mean; *SD* = standard deviation; *CITC* = corrected item-total correlation.

Interestingly, none of the variables in the respondent's profile were related to SCWS.

DISCUSSION

Prior studies have examined nurses' use of smartphones for work purposes.[6–13,17] However, none has yet utilized a psychometrically validated scale to measure this phenomenon. Developing a psychometrically validated scale is needed to help researchers clarify the predictors and outcomes of nurses' use of smartphones for work purposes. Thus, this study aimed to develop and validate the 15-item SCWS.

This study found that nurses' use of smartphones for work purposes divides into five factors, four of which are related to communication with healthcare providers and patients, and one that is related to information seeking. This finding diverges from prior research where nurses also use smartphones for documentation purposes.[7,8,12] Yet, the variety of communication uses is consistent with prior findings that nurses use smartphones primarily for communication purposes.[7,8] The current study extends previous works by conceptually and statistically differentiating communication uses.

The dominant communication factor (Factor 1) is the use of smartphones for voice calls and text messaging with fellow nurses and doctors. This result is somewhat intuitive, as voice calls and text messaging are the most basic functions of mobile phones.[14] Another important function of smartphones is to communicate using instant messaging, which nurses do with doctors (Factor 2) and with fellow nurses (Factor 4). These factors make sense, as access to instant messaging apps is available for smartphones.[40] With instant messaging apps, nurses can send and receive text, image, and video messages.[9,10] Previous studies highlight that accessing instant messaging apps for work purposes enhances communication and information sharing among the healthcare team.[9,10] It is also important to note that communication for work purposes in the clinical setting is not limited to communication among clinicians: nurses may also use smartphones for voice calls and text messaging with patients or their guardians (Factor 5). Prior research shows that such use of smartphones is an important aspect of communication in Philippine hospitals since it expedites the sharing of information with patients or their guardians.[8]

In addition to communication, information seeking (Factor 3) is an essential way nurses used smartphones for work purposes. Smartphones enable the use of a range of information utilities, such as
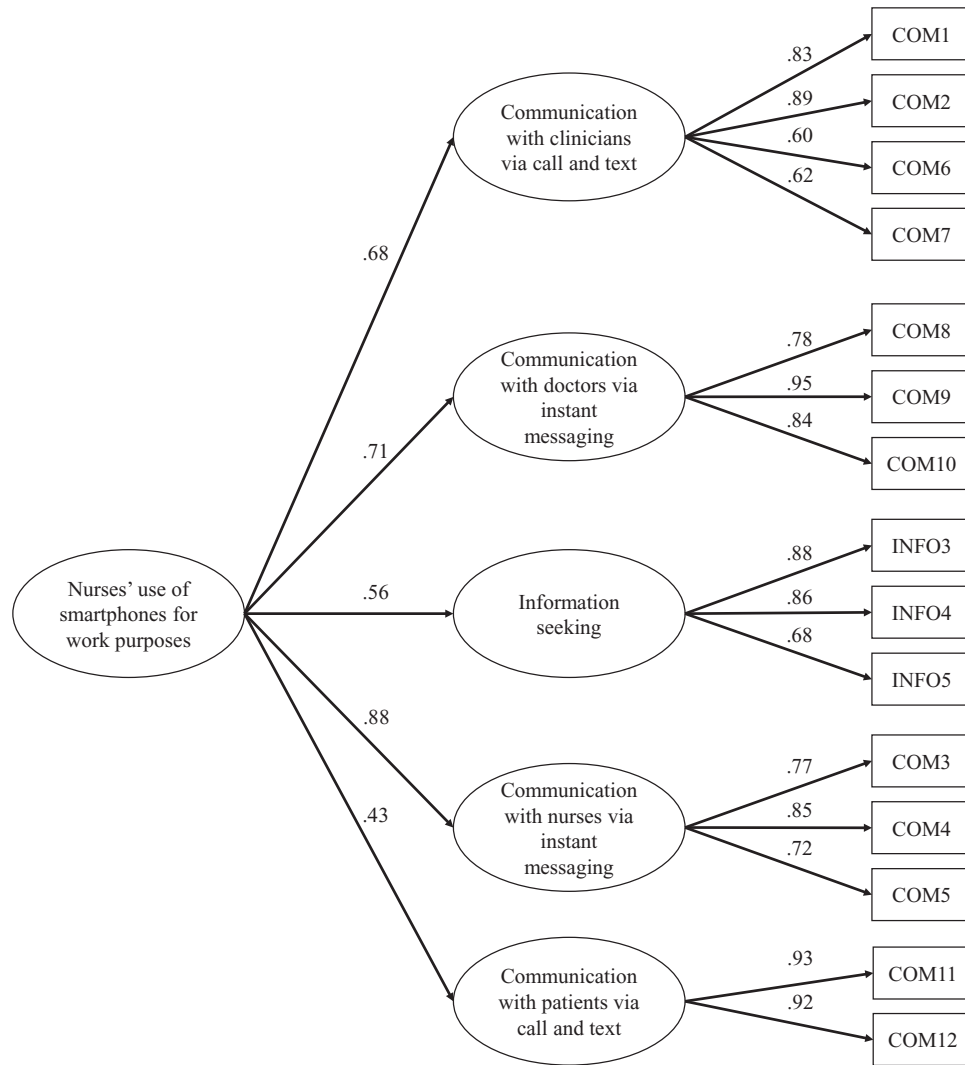
Figure 2. CFA results (n = 259). Notes for Figure 2: The model fits the data: X^2/df = 1.65, RMSEA = 0.050 (90% CI = 0.034 – 0.065), CFI = 0.98, TLI = 0.97, SRMR = 0.047.

clinical mobile apps, websites, and eBooks. These applications facilitate faster and easier acquisition of useful information, which can help nurses efficiently perform their task at the point of care.[7,17] Out of the five items developed for information seeking, items on information seeking with nurses (INFO1) and doctors (INFO2) using smartphones did not load as part of factor 3. A potential reason is that respondents might have preferred to search for information on their own rather than asking a colleague. This finding supports one of the results of the preliminary study where nurses noted that instead of consulting a colleague, they would search for information on their own using their smartphones.[8]

Whereas the current analysis identified communication and information seeking as factors in the scale, items for documentation did not load on any of the factors nor constitute a separate factor. This outcome is interesting and accords with prevailing hospital policies on the use smartphones for work purposes,[13] particularly in the Philippines.[8] Typically, permitted uses of smartphones in a hospital setting are limited to communication and information seeking purposes, while documentation purposes such as taking pictures are prohibited.[13] This restriction is reasonable because taking pictures in a hospital setting may risk patient privacy and confidentiality.[13,15] Although

nurses can use their smartphones for other documentation purposes, such as creating notes, reminders, or checklists, it is possible that they prefer to use pen and paper for those purposes. In the future, this may change, since other uses of smartphones for documentation may arise as the HIT community develops new smartphone applications for documentation purposes.[41] Therefore, future research should continue to examine the use of smartphones for documentation and possibly revisit SCWS development.

In addition to establishing the construct validity of the SCWS, this study also established its predictive validity based on a hypothesis from IT consumerization theory. According to that theory, the use of personal devices, such as smartphones, for work purposes can lead to greater work performance or productivity.[33] SEM results support this hypothesis and corroborate findings from previous studies.[7,8,13,17] Those prior studies asserted that nurses' use of smartphones for work purposes enhanced their productivity. Current findings are preliminary since only perceived work productivity was measured. This suggests that more work is needed to evaluate if nurses' use of smartphones for work purposes improves actual work productivity. Nonetheless, this finding can be used as a basis to develop appropriate guidelines on the use of smartphones in clinical settings.

Although the SCWS was developed to measure nurses' use of smartphones for work purposes, this scale is also directly applicable when measuring other healthcare professionals' use of smartphones for work purposes. Interestingly, the entire scale or its subscales can also be administered to non-healthcare workers since it provides a generic list of items on how smartphones were used for work purposes. For instance, items under factors like *communication with clinicians via call and text* and *communication with patients via call and text* can be modified to denote *communication with 'coworkers' via call and text* and *communication with 'customers' via call and text*, respectively. To date, relevant studies on the use of smartphones for work purposes among non-healthcare workers only measured general mobile phone use without identifying the specific functions used for work purposes.[42,43] Overall, this scale can help researchers validly operationalize the use of smartphones for work purposes and statistically determine several factors associated with it.

Limitations and Future Research

This study presents a novel characterization of nurses' use of smartphones for work purposes, but there are several limitations. First, since the study was conducted in the Philippines, the results may not be fully generalizable to other countries. For instance, the patterns of smartphone usage may vary by the degree of HIT advancement within a healthcare system. To address this limitation, future studies should conduct cross-national validations of SCWS. Second, although this study used probability-based sampling techniques for top-level sampling strata, respondent selection at the hospital level involved purposive sampling. It is possible that selection bias affected the results. Finally, this study did not conduct test-retest reliability to assess its temporal stability. Although there is no evident reason to expect responses to change over time, conducting test-retest reliability analysis would further support the scale's research utility.

CONCLUSION

This study reports the development and psychometric evaluation of the SCWS. Exploratory and confirmatory factor analyses supported a five-factor model containing 15 items (out of 20 items). Not only are the 5 factors distinct from each other, but they collectively reflect nurses' use of smartphones for communication and information seeking purposes. Consistent with a hypothesis from IT consumerization theory, the 15-item SCWS was positively related to perceived work productivity, and this suggests the scale's predictive validity. Future studies can use the SCWS to measure nurses' (or other healthcare professionals') use of smartphones for work purposes and correlate it with predictors and outcomes that address theoretical and practical needs. e.g.,[44] Considering that smartphones are just one of the technologies that can be used in clinical settings,[1] future works should consider how existing hospital resources (e.g., pagers, ward phones, electronic health records, and WiFi connectivity) can influence the extent that healthcare professionals use of their smartphones for work purposes. Finally, studies can also explore the use of the scale to examine the use of smartphones for work purposes among those working in non-healthcare occupations.

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