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Development and Validation of an Instrument to Measure Competency Gaps of Hospital Pharmacists in Facing Telemedicine Integration in Urban Areas of Indonesia

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ABSTRACT

The rapid adoption of telemedicine has expanded hospital pharmacists' roles, particularly in urban areas of developing countries such as Indonesia. However, evidence on pharmacists' telemedicine-related competency gaps remains limited. This study aimed to develop and validate a hospital-specific instrument to assess such gaps. A methodological design was employed, including instrument development, expert content validation, pilot testing, and psychometric evaluation. The instrument covers six domains: digital health literacy, clinical pharmacy competence in telemedicine, communication skills, legal and ethical awareness, interprofessional collaboration, and telepharmacy service management. Validation involved 210 hospital pharmacists from urban Indonesian hospitals. Exploratory factor analysis confirmed a six-factor structure explaining 72.4% of the variance, with strong internal consistency (Cronbach's alpha = 0.89). Unlike existing telepharmacy readiness tools, this instrument specifically captures multidimensional competency gaps relevant to hospital-based telemedicine practice. The largest gaps were observed in legal–ethical competencies and digital health literacy. This instrument can support workforce assessment and targeted competency-based training for hospital pharmacists in Indonesia.

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INTRODUCTION

The rapid expansion of telemedicine has transformed healthcare delivery worldwide, including hospital pharmacy practice. In Indonesia, telemedicine adoption has accelerated since the COVID-19 pandemic and the national digital health transformation agenda, particularly in urban hospitals where service complexity and technological capacity are highest. Hospital pharmacists are increasingly involved in telemedicine-based services such as remote prescription review, telepharmacy counseling, medication therapy management, and virtual interprofessional collaboration. These evolving roles require competencies that extend beyond traditional pharmacy practice.

International evidence suggests that misalignment between professional competencies and digital health demands may compromise service quality, medication safety, and patient outcomes. Consequently, systematic assessment of telemedicine-related competency gaps is essential to inform workforce development, education, and policy interventions. However, such assessment requires validated instruments that capture both digital health competencies and hospital-based pharmaceutical care contexts.

In Indonesia, existing telepharmacy instruments predominantly focus on readiness rather than competency gaps. The most established tool, the Knowledge–Perception–Readiness Telepharmacy (KPR-TP) questionnaire, has demonstrated strong psychometric properties in large national samples and provides valuable insights into telepharmacy readiness determinants and regional disparities (Kusuma et al., 2023; Kusuma et al., 2024). Nevertheless, this instrument was designed for general telepharmacy readiness across practice settings and does not specifically address hospital pharmacists' competency gaps, particularly in clinical, organizational, and regulatory domains.

Other Indonesian studies have adapted readiness-based questionnaires to assess knowledge, perceptions, and willingness related to telepharmacy among pharmacists and students (Wathoni et al., 2023; Ghozali, 2024; Alfian et al., 2023). While these instruments exhibit acceptable validity and reliability, they remain limited to readiness constructs and do not comprehensively measure multidimensional competencies required for hospital telemedicine practice, such as advanced clinical decision-making, legal–ethical accountability, and interprofessional collaboration.

Internationally, several hospital pharmacist competency frameworks have been developed and validated, including comprehensive models from China and the Specialized Competency Framework for Pharmacists in Hospital Settings (SCF–PHS) from Lebanon (Chamoun et al., 2023; Yan et al., 2025; Wang et al., 2025). These frameworks effectively assess clinical and professional competencies in hospital settings, and systematic reviews have shown that competency-based frameworks significantly improve professional performance when linked to targeted training (Udoh et al., 2021). However, these frameworks were not designed to capture the specific challenges of telemedicine integration, particularly within the Indonesian regulatory, cultural, and technological context.

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Thus, a clear research gap exists: no validated instrument currently integrates telepharmacy readiness concepts with hospital pharmacist competency frameworks to specifically measure telemedicine competency gaps in Indonesian hospital settings. Telemedicine practice in Indonesia introduces distinct demands related to digital health literacy, cybersecurity awareness, telecommunication ethics, remote patient engagement, and compliance with evolving national regulations dimensions that are insufficiently addressed by existing tools.

Accordingly, this study aims to develop and validate a context-specific instrument to measure telemedicine competency gaps among hospital pharmacists in urban areas of Indonesia. The novelty of this study lies in the development of a psychometrically validated instrument that moves beyond readiness assessment to explicitly capture multidimensional competency gaps relevant to hospital-based telemedicine practice. The resulting instrument is expected to support workforce assessment, guide targeted professional development, and inform evidence-based policy in Indonesia's ongoing digital health transformation.

METHODS

This study employed a methodological research design to develop and validate an instrument measuring telemedicine competency gaps among hospital pharmacists, conducted between January and June 2025. Instrument development followed established psychometric procedures, beginning with item generation based on a comprehensive literature review on telemedicine, telepharmacy, and pharmacist competency frameworks, as well as Indonesian pharmacist competency standards and national telemedicine regulations. To enhance contextual relevance, semi-structured discussions were conducted with hospital pharmacists and digital health experts to capture real-world telemedicine workflows and competency demands. This process resulted in an initial pool of 45 items, measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), reflecting perceived competency gaps.

Content validity was assessed by a panel of seven experts, including clinical pharmacists, hospital administrators, and digital health academics, using the Content Validity Index (CVI) at both item (I-CVI) and scale (S-CVI) levels. Items with I-CVI values below 0.78 were revised to improve clarity and relevance. The refined instrument was pilot-tested among 30 hospital pharmacists to evaluate readability, clarity, and completion time, resulting in minor linguistic refinements.

For construct validation, data were collected from 210 hospital pharmacists working in urban hospitals in Jakarta, Bandung, Surabaya, and Medan, using purposive sampling. Inclusion criteria included active involvement in hospital pharmacy services and prior exposure to telemedicine practices. The sample size was considered adequate for exploratory factor analysis (EFA), exceeding the commonly recommended ratio of at least five respondents per item and meeting minimum sample size thresholds for stable factor extraction in instrument development studies.

Construct validity was examined using Exploratory Factor Analysis. Principal component analysis was applied at this exploratory stage to identify the underlying factor structure and reduce item dimensionality, followed by varimax rotation to enhance factor interpretability. Sampling

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adequacy was assessed using the Kaiser–Meyer–Olkin (KMO) measure and Bartlett's Test of Sphericity. Internal consistency reliability was evaluated using Cronbach's alpha coefficient. All statistical analyses were performed using SPSS version 26.

Given the methodological focus on initial instrument development, confirmatory factor analysis (CFA), convergent and discriminant validity testing, and test–retest reliability were not conducted in this study. These analyses are planned for future research to further confirm the factor structure and evaluate the stability and predictive validity of the instrument across different hospital settings.

RESULTS

1. Respondent Characteristics

A total of 210 hospital pharmacists from urban hospitals in Indonesia participated in this study. The majority of respondents were female (67.6%) and aged 31–40 years (43.8%). Most participants had more than five years of professional experience and reported prior exposure to telemedicine or telepharmacy services (Table 1).

Table 1. Demographic Characteristics of Respondents (n = 210)

Characteristic	Category	n	%
Gender	Male	68	32.4
	Female	142	67.6
Age (years)	21–30	54	25.7
	31–40	92	43.8
	>40	64	30.5
Work Experience	<5 years	61	29.0
	5–10 years	78	37.1
	>10 years	71	33.9
Telemedicine Exposure	Yes	168	80.0
	No	42	20.0

This respondent profile reflects a relatively experienced hospital pharmacist workforce with substantial exposure to telemedicine, indicating that the sample is appropriate for evaluating telemedicine-related competency gaps in routine hospital practice.

2. Content Validity

Content validity assessment by seven experts demonstrated high relevance of the instrument items. The item-level Content Validity Index (I-CVI) ranged from 0.78 to 1.00, and the scale-level CVI (S-CVI/Ave) was 0.92. Several items were refined for clarity based on expert feedback, with no items eliminated. These results indicate excellent content validity, suggesting that the instrument

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adequately captures key dimensions of telemedicine competency gaps relevant to hospital pharmacy practice.

3. Construct Validity (Exploratory Factor Analysis)

Exploratory Factor Analysis (EFA) supported the underlying factor structure of the instrument. The Kaiser–Meyer–Olkin (KMO) measure was 0.91, and Bartlett's Test of Sphericity was significant ($\chi^2 = 3246.85$, $p < 0.001$), confirming sampling adequacy (Table 2). Six factors with eigenvalues greater than 1 were extracted, explaining 72.4% of the total variance. This finding indicates that telemedicine competency gaps among hospital pharmacists are multidimensional and cannot be captured by a single competency domain.

Table 2. KMO and Bartlett's Test

Statistic	Value
KMO Measure	0.91
Bartlett's Test χ^2	3246.85
df	630
p-value	<0.001

Six factors with eigenvalues greater than 1 were extracted, explaining 72.4% of the total variance. The scree plot also supported a six-factor solution. The high KMO value and significant Bartlett's test confirm sampling adequacy, while the six-factor structure supports the multidimensional nature of telemedicine competency gaps.

4. Factor Loadings

Following EFA, the final instrument consisted of 36 items grouped into six domains, with all factor loadings exceeding the recommended threshold of 0.50 (Table 3).

Table 3. Factor Structure and Loading Ranges

Domain	Items (n)	Loading Range
Digital Health Literacy	8	0.61–0.84
Clinical Pharmacy Competence in Telemedicine	7	0.58–0.81
Communication & Patient Counseling	6	0.60–0.86
Legal & Ethical Awareness	5	0.63–0.88
Interprofessional Collaboration	5	0.57–0.82
Telepharmacy Service Management	5	0.59–0.85

The strong and consistent loading ranges suggest that each domain represents a distinct yet interrelated aspect of telemedicine competency in hospital pharmacy settings.

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5. Reliability Analysis

Internal consistency analysis demonstrated good to excellent reliability across all domains, with Cronbach's alpha values ranging from 0.84 to 0.90, and an overall alpha of 0.89 (Table 4).

Table 4. Reliability Coefficients

Domain	Cronbach's α
Digital Health Literacy	0.88
Clinical Pharmacy Competence	0.86
Communication Skills	0.87
Legal & Ethical Awareness	0.90
Interprofessional Collaboration	0.84
Telepharmacy Service Management	0.85
Overall Instrument	**0.89**

These results indicate that the instrument provides stable and reliable measurement of telemedicine competency gaps, supporting its use for workforce assessment and professional development planning.

6. Telemedicine Competency Gap Levels

Descriptive analysis of mean scores revealed varying levels of perceived competency gaps across domains (Table 5). Using a five-point scale, mean scores above 3.5 were interpreted as indicating *moderate to high perceived competency gaps*, reflecting areas where pharmacists experience substantial challenges in practice.

Table 5. Mean Competency Gap Scores by Domain

Domain	Mean ± SD
Digital Health Literacy	3.82 ± 0.61
Clinical Pharmacy Competence	3.54 ± 0.58
Communication Skills	3.67 ± 0.63
Legal & Ethical Awareness	4.01 ± 0.59
Interprofessional Collaboration	3.46 ± 0.57
Telepharmacy Service Management	3.71 ± 0.60

The highest perceived gaps were observed in legal and ethical awareness (mean = 4.01), suggesting that many hospital pharmacists feel insufficiently prepared to manage regulatory compliance, data privacy, and professional accountability in telemedicine services. Digital health literacy also showed relatively high gap scores (mean = 3.82), indicating challenges in effectively using telemedicine platforms and digital clinical systems. In contrast, interprofessional collaboration demonstrated comparatively lower gap scores (mean = 3.46), suggesting that collaborative digital

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workflows may already be more established in urban hospital settings, although further improvement remains necessary.

DISCUSSION

This study developed and validated an instrument to assess telemedicine competency gaps among hospital pharmacists in urban Indonesia. The findings indicate that the instrument demonstrates strong psychometric properties, including excellent content validity, a stable six-factor structure, and high internal consistency. More importantly, the results provide empirical evidence of specific competency gaps that may hinder effective telemedicine implementation in hospital pharmacy practice.

The six-domain structure reflects the multidimensional nature of telemedicine competency in hospital settings and is broadly consistent with international hospital pharmacist competency frameworks. However, the present instrument extends existing models by explicitly integrating telemedicine-specific demands—such as digital health literacy, legal–ethical accountability, and telepharmacy service management—within a hospital context. This addresses a key limitation of previous Indonesian instruments, which primarily focus on telepharmacy readiness rather than measurable competency gaps.

The most prominent gaps were observed in the legal and ethical domain, suggesting that hospital pharmacists may feel insufficiently prepared to manage regulatory compliance, data privacy, cybersecurity, and professional accountability in telemedicine practice. This finding aligns with evidence from low- and middle-income countries indicating that regulatory uncertainty remains a major barrier to telepharmacy implementation. Given the rapidly evolving telemedicine regulatory landscape in Indonesia, these results underscore the urgent need for structured legal–ethical training integrated into hospital pharmacy education and continuing professional development programs.

Digital health literacy also emerged as a substantial competency gap, despite high levels of telemedicine exposure among respondents. This suggests that experiential exposure alone is insufficient to ensure competency, reinforcing the importance of competency-based training that goes beyond platform familiarity to include digital clinical documentation, virtual communication skills, and safe technology use. In contrast, lower perceived gaps in interprofessional collaboration may reflect the more established multidisciplinary care structures in urban hospitals, although moderate gaps indicate that role clarity and collaborative workflows in virtual environments still require strengthening.

From a policy and educational perspective, this instrument offers a practical tool for workforce assessment, enabling hospital managers and professional organizations to identify priority training areas and evaluate the impact of competency development interventions. At the policy level, the findings support the integration of telemedicine-specific competencies into national hospital pharmacist competency standards and accreditation frameworks, particularly in legal–ethical and digital health domains.

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Several limitations should be considered. First, the use of self-reported data may introduce response bias, as perceived competency gaps may not fully reflect actual performance. Second, the focus on urban hospitals limits generalizability to rural or resource-limited settings, where telemedicine infrastructure and competency demands may differ substantially. Third, construct validation relied on exploratory factor analysis; future studies should employ confirmatory factor analysis, test–retest reliability, and objective performance measures to further strengthen the instrument's validity.

In summary, this study contributes a validated, context-specific instrument that moves beyond readiness assessment to explicitly measure telemedicine competency gaps among hospital pharmacists. By providing actionable insights for education, workforce development, and policy, the instrument supports safer, more effective, and more sustainable integration of telemedicine into hospital pharmacy services in Indonesia.

CONCLUSIONS

This study developed and validated a context-specific instrument to assess telemedicine competency gaps among hospital pharmacists in urban Indonesia. The instrument demonstrated strong psychometric properties, including excellent content validity, a clear six-factor structure, and high internal consistency, indicating that it is both valid and reliable for use in hospital pharmacy settings.

The findings reveal substantial competency gaps, particularly in legal and ethical aspects of telemedicine, digital health literacy, and telepharmacy service management. These results suggest that exposure to telemedicine alone is insufficient to ensure professional readiness and highlight the need for structured, competency-based education and training programs. In contrast, relatively smaller gaps in interprofessional collaboration indicate that urban hospital environments may already support collaborative digital workflows, although further strengthening remains necessary.

Overall, this instrument provides an evidence-based tool to support workforce assessment, targeted capacity building, and policy development related to telemedicine integration in hospital pharmacy practice. Future research should apply confirmatory factor analysis, test the instrument in rural and non-urban settings, and examine its predictive validity in relation to professional performance and patient outcomes.

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