ORIGINAL ARTICLE

Indonesian Journal of Blood and Transfusion (*IDJBT*) 2026, Volume 4, Number 1: 6-11
E-ISSN: 3124-8527; P-ISSN: 3032-7520

PUBLISHED BY
THE INDONESIAN SOCIETY BLOOD TRANSFUSION PHYSICIAN

The effect of using the SIDONI application on increasing the number of blood donors at the Blood Transfusion Unit of the Indonesian Red Cross, Tangerang Regency

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Received: 2026-02-04
Accepted: 2026-05-11
Published: 2026-06-09

ABSTRACT

Background: Blood donation depends on voluntary public participation, which is influenced by awareness, access to information, and ease of engagement with blood transfusion services. Digital health applications may reduce barriers to donor participation; however, empirical evidence from Indonesia on the association between donor application use and donation behavior remains limited. This study aims to examine the association between the Sistem Informasi Donor Darah Indonesia (SIDONI) application and blood donor participation at the Blood Transfusion Unit (BTU) of the Indonesian Red Cross Society (IRCS), Tangerang Regency, Indonesia.

Methods: A quantitative cross-sectional design was used. Partial Least Squares Structural Equation Modeling (PLS-SEM) was applied to evaluate the measurement model and structural model properties. One hundred active SIDONI users were recruited through purposive sampling from a total registered user population of 194,274. Inclusion required at least one blood donation in the preceding six months. A self-administered 5-point Likert scale questionnaire was developed based on the Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT). The independent latent construct (X) represented SIDONI application use; the dependent latent construct (Y) represented blood donor participation.

Results: The measurement model demonstrated acceptable reliability (Cronbach's alpha: X = 0.968, Y = 0.933; composite reliability: X = 0.972, Y = 0.943) and convergent validity (AVE: X = 0.716, Y = 0.629). Discriminant validity was supported by HTMT = 0.871, with a 95% bootstrapped confidence interval of 0.781–0.935, which did not include 1.0. Four indicators showed outer loadings below 0.70 (X03 = 0.584, Y01 = 0.610, Y08 = 0.635, Y07 = 0.701). The structural model yielded a path coefficient of β = 0.850 (95% CI: 0.774–0.912), and R^2 = 0.723, indicating a strong positive association between SIDONI use and donor participation within this sample. VIF = 1.0 indicated no multicollinearity concern.

Conclusion: SIDONI application use was strongly and positively associated with blood donor participation among active users in Tangerang Regency.

Keywords: SIDONI, Digital Health Application, Blood Donation, Donor Participation, PLS-SEM, Technology Acceptance, Indonesia.

Cite This Article: Muttaqien, Z., Setiawati, F., Imami, F. 2026. The effect of using the SIDONI application on increasing the number of blood donors at the Blood Transfusion Unit of the Indonesian Red Cross, Tangerang Regency. *Indonesian Journal of Blood and Transfusion.* 4(1): 6-11.

INTRODUCTION

A safe and sustainable blood supply is a fundamental requirement of functional health systems. The World Health Organization (WHO) recommends that at least 2% of a country's population donate blood voluntarily and on a regular basis to meet clinical demand.[1] Indonesia, with a population exceeding 270 million, requires approximately 5.1–5.7 million blood bags per year; however, national collection has not consistently met this target, reflecting a persistent challenge in voluntary blood donor recruitment and retention.[2]

Blood donor participation is shaped by multiple intersecting factors, including knowledge and awareness, perceived safety and comfort of the donation process, access to donation facilities, social and cultural norms, trust in blood transfusion institutions, and organizational capacity for donor outreach and engagement.[3,4] Traditional recruitment strategies, including community campaigns, health education, and institutional mobile collection, have contributed to Indonesia's blood supply, but geographic, logistical, and informational barriers continue to limit participation, particularly in rapidly urbanizing peri-urban areas.

Mobile health (mHealth) and digital health applications have been proposed as scalable tools for improving public health participation, including blood donation.[5,6] By providing real-time information, scheduling support, personalized

reminders, and transparent blood stock data, digital applications may reduce friction in the donor engagement process. Technology acceptance frameworks — principally the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) suggest that perceived ease of use, perceived usefulness, and social influence are key predictors of individual technology adoption and continued use.[7-10] Studies from various settings have demonstrated associations between mobile reminder systems and improved blood donation intentions and behaviors.[5,6]

In Indonesia, the *Sistem Informasi Donor Darah Indonesia* (SIDONI) or Indonesian Blood Donor Information System is a government-supported digital application designed to support blood donor recruitment and engagement through the national PMI network. SIDONI integrates features such as donor information access, donation history tracking, blood stock notifications, scheduling, and location-based services. Despite its national deployment, empirical evidence on the association between SIDONI use and actual donor participation, evaluated using rigorous structural measurement approaches, remains limited.

Based on demographics, Tangerang Regency, located in the metropolitan periphery of Jakarta (Banten Province, Indonesia), presents a dynamic context with high population density, rapid urbanization, and significant variation in digital literacy and mobile application access. BTU IRCS Tangerang Regency serves as a major blood collection point for this region. Examining the association between SIDONI use and donor participation in this context may yield contextually relevant insights applicable to similar urban-peripheral settings in Indonesia.

Based on those mentioned above, this study aims to examine the association between SIDONI application use and blood donor participation among active SIDONI users at BTU IRCS Tangerang Regency, using a PLS-SEM analytical approach. The study hypothesizes that the use of the SIDONI application would be positively and significantly associated with blood donor participation among active users.

METHODS

Study Design

This was a quantitative cross-sectional study. PLS-SEM was employed to evaluate both the measurement model (reliability and validity of latent constructs) and the structural model (the association between SIDONI use and donor participation). Given the cross-sectional design, findings describe statistical associations and should not be interpreted as causal evidence.

Study Setting

The study was conducted at the Blood Transfusion Unit (UTD) of the Indonesian Red Cross Society (PMI), Tangerang Regency, Banten Province, Indonesia. SIDONI is a nationally deployed digital application developed to support voluntary blood donor services across PMI units, integrating features including donor registration, donation history tracking, real-time blood stock information, donation scheduling, event notifications, and location-based services.

Population and Sample

The target population consisted of all registered SIDONI users in Tangerang Regency (N = 194,274 at the time of the study). Purposive (non-probability) sampling was applied. The final sample comprised 100 active SIDONI users who met the following inclusion criteria: 1) Registered and active SIDONI user at the time of data collection; 2) Had donated blood at least once in the preceding six months; 3) Aged ≥17 years (minimum blood donation eligibility age in Indonesia); and 4) Willing to complete the self-administered questionnaire.

The sample size of 100 respondents was determined based on the rule-of-thumb recommendation for PLS-SEM that the minimum sample size should be at least 10 times the largest number of indicators associated with a single latent construct in the model.[10] As construct X contained 14 indicators, this criterion was formally satisfied. However, it is acknowledged that this remains a small sample relative to the total registered SIDONI user population of 194,274, and this limits external validity.

External Validity and Representativeness

Because the sample was purposively selected, limited to active SIDONI users with recent donation experience, external validity is constrained in two important respects. First, the findings should be interpreted as reflecting the behavior and perceptions of active, experienced SIDONI users, not the broader population of registered SIDONI users (many of whom may be inactive or have varying levels of application engagement). Second, the sample cannot be assumed to represent the general donor-eligible population of Tangerang Regency. To assess representativeness, demographic and behavioral comparisons between the study sample and the broader SIDONI user base — including variables such as age, sex, donation frequency, digital literacy, and duration of SIDONI use — should ideally be conducted using available BTU IRCS administrative data.

Instrument and Measurement

Data were collected using a self-administered structured questionnaire. All items were rated on a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The questionnaire comprised two sections corresponding to the two latent constructs. Construct X (SIDONI Application Use) was operationalized through 14 indicators (X01–X15, excluding X02) spanning six dimensions: frequency of application use, perceived ease of use, information quality, application features and functions, user satisfaction, and trust in the application. Construct Y (Blood Donor Participation) was operationalized through 10 indicators (Y01–Y10) spanning five dimensions: donation frequency, motivation to donate, participation in donor events, habit formation, and awareness and attitudes toward donation. The SmartPLS 3 was used in this PLS-SEM analysis.

PLS-SEM Analysis Procedure

PLS-SEM was applied in two stages: measurement model evaluation (outer model) followed by structural model evaluation (inner model), consistent with the guidelines of Hair et al.[10] Measurement Model Evaluation: a) Indicator reliability:

outer loadings ≥0.70 preferred; items between 0.40 and 0.70 may be retained if theoretically justified and if AVE and composite reliability remain above thresholds; b) Internal consistency: Cronbach's alpha and composite reliability ≥0.70 (good), ≥0.90 (excellent). rho_A provides an additional consistency estimate; c) Convergent validity: Average Variance Extracted (AVE) ≥0.50; and d) Discriminant validity: Heterotrait-Monotrait Ratio (HTMT) <0.85 (strict) or <0.90 (lenient). The 95% bootstrapped confidence interval for HTMT should not include the value of 1.0 for discriminant validity to be supported. The Structural Model Evaluation is: 1) Collinearity: Variance Inflation Factor (VIF) <3.3 (strict) or <5.0 (lenient); 2) Path coefficient (β): standardized, with 95% bootstrapped confidence interval. The relationship is considered statistically significant if the CI does not include 0; and 3) Coefficient of determination R^2: proportion of variance in Y explained by X.

RESULTS

Table 1 presents the outer loadings for all indicators. For construct X (SIDONI application use), 13 of 14 indicators demonstrated outer loadings ≥0.70, with several exceeding 0.90, indicating strong indicator reliability. Indicator X03 had a loading of 0.584, below the conventional threshold of 0.70. For construct Y (blood donor participation), six of 10 indicators had loadings ≥0.70. Four indicators — Y01 (0.610), Y07 (0.701), and Y08 (0.635) — fell below 0.70, with Y01 and Y08 notably lower.

Table 2 presents the internal consistency and convergent validity statistics for both constructs. Both constructs demonstrated excellent internal consistency, with Cronbach's alpha of 0.968 (X) and 0.933 (Y), and composite reliability of 0.972 (X) and 0.943 (Y), all substantially exceeding the 0.70 threshold recommended for research purposes.[10] AVE values of 0.716 (X) and 0.629 (Y) both exceeded the 0.50 threshold, confirming convergent validity and indicating that the indicators explained more than 50% of the variance in each latent construct.

Table 3 presents the HTMT ratio for the Y–X construct pair. The HTMT value

Table 1. Outer Loadings for Constructs X and Y

Indicator	X (SIDONI Use)	Y (Donor Participation)
X01	0.815	—
X03	0.584*	—
X04	0.898	—
X05	0.896	—
X06	0.712	—
X07	0.865	—
X08	0.905	—
X09	0.865	—
X10	0.861	—
X11	0.868	—
X12	0.853	—
X13	0.921	—
X14	0.826	—
X15	0.914	—
Y01	—	0.610*
Y02	—	0.772
Y03	—	0.801
Y04	—	0.845
Y05	—	0.863
Y06	—	0.867
Y07	—	0.701†
Y08	—	0.635 *
Y09	—	0.880
Y10	—	0.894

*Outer loading < 0.70 (below conventional threshold; retained on theoretical grounds with acceptable AVE and composite reliability). † Y07 = 0.701, borderline acceptable.

Table 2. Construct Reliability and Convergent Validity

Construct	Cronbach's Alpha	rho_A	Composite Reliability	AVE
X (SIDONI Use)	0.968	0.971	0.972	0.716
Y (Donor Participation)	0.933	0.949	0.943	0.629
Threshold	≥ 0.70	—	≥ 0.70	≥ 0.50

Table 3. Heterotrait-Monotrait Ratio (HTMT) — Discriminant Validity

Construct Pair	HTMT	Bootstrap Mean	CI 2.5%	CI 97.5%
Y → X	0.871	0.869	0.781	0.935

Note: Discriminant validity supported if HTMT < 0.90 and 95% CI does not include 1.0.

Table 4. Structural Model: Path Coefficient (X → Y)

Path	β	Bootstrap Mean	CI 2.5%	CI 97.5%
X (SIDONI Use) → Y (Donor Participation)	0.850	0.853	0.774	0.912

Note: Significant if 95% CI does not include 0. β = standardized path coefficient from PLS-SEM bootstrapping.

Table 5. Structural Model: R^2 for Construct Y

Construct	R^2	Bootstrap Mean	CI 2.5%	CI 97.5%
Y (Donor Participation)	0.723	0.729	0.599	0.832

CI: Confidence Interval

of 0.871 was below the lenient threshold of 0.90, and the 95% bootstrapped confidence interval (0.781–0.935) did not include the value 1.0, supporting discriminant validity between the two constructs. This indicates that the constructs X and Y, while strongly correlated, are empirically distinct.

The Inner VIF for predictor X in the structural model was 1.0, indicating the complete absence of multicollinearity. In a model with a single predictor, VIF = 1.0 is the expected value and confirms that collinearity does not threaten the validity of the structural model estimates. **Table 4** presents the bootstrapped path coefficient for the X → Y structural relationship. The path coefficient of β = 0.850 (bootstrapped 95% CI: 0.774–0.912) was positive and statistically significant, as the confidence interval did not include zero. This indicates a strong positive structural association between SIDONI application use and blood donor participation within the sampled group.

Table 5 presents the R^2 value for the dependent construct Y. The R^2 of 0.723 indicates that SIDONI application explained approximately 72.3% of the variance in blood donor participation within the sample. The 95% bootstrapped CI for R^2 (0.599–0.832) confirmed the stability of this estimate. However, because this is a self-reported, cross-sectional model with purposively sampled active users, the R^2 should be interpreted cautiously. In self-reported survey studies, high R^2 values may partly reflect common method bias, particularly when both predictor and outcome are measured in the same survey at the same time.

Four indicators demonstrated outer loadings below the conventional 0.70 threshold: X03 (0.584), Y01 (0.610), Y08 (0.635), and Y07 (0.701, borderline). These indicators were retained in the final model because: (i) all loadings remained well above the 0.40 minimum threshold below which item retention is generally not justified; (ii) AVE values for both constructs (X = 0.716; Y = 0.629) remained above the 0.50 threshold; and (iii) each item was deemed theoretically meaningful to its construct dimension.[10]

The lower loadings of X03, Y01, Y07, and Y08 may reflect that these items capture aspects of application use or donor participation that are less strongly determined by the aggregate latent constructs as measured. For example, Y01 (donation frequency) and Y08 may be influenced by external non-digital factors such as donor eligibility (medical criteria, blood pressure, hemoglobin), work schedule, fear of the procedure, or peer invitation — all of which operate independently of SIDONI use.

DISCUSSION

This study found a strong positive structural association between SIDONI application use and blood donor participation among active SIDONI users at BTU IRCS Tangerang Regency, with a path coefficient of β = 0.850 (95% CI: 0.774–0.912) and R^2 = 0.723. H_1 was therefore supported: SIDONI application use was positively and significantly associated with blood donor participation in this sample. These findings are consistent with prior literature demonstrating that digital health applications and mobile reminder systems may support health behavior engagement.[5,6]

The finding that SIDONI use was strongly associated with donor participation aligns with core propositions of TAM and UTAUT. The dimensions of construct X — particularly perceived ease of use, information quality, functional features, and user satisfaction — reflect the TAM constructs of ease of use and perceived usefulness, both of which are theoretically linked to continued behavioral engagement.[7-16] User satisfaction and trust, encompassed within the SIDONI use construct, additionally reflect UTAUT's facilitating conditions and performance expectancy dimensions, which predict sustained use behavior.[8-16]

In the Indonesian blood donation context, social and institutional trust in PMI as an organization likely complements application-level trust, creating a reinforcing relationship between institutional credibility and digital engagement. This suggests that application effectiveness cannot be evaluated in isolation from the institutional environment in which it is deployed.

A path coefficient of 0.850 and R^2 of 0.723 indicate a strong statistical relationship within the sampled group. However, several interpretive caveats are essential. First, because the study is cross-sectional, the direction of association cannot be established with certainty from the data alone; it is theoretically plausible, based on prior evidence, that application use precedes and supports donation behavior, but reverse causality (in which more frequent donors are more motivated to use SIDONI) cannot be excluded. Second, both X and Y were measured simultaneously through the same self-administered questionnaire, creating conditions for common method variance (CMV), which may artificially inflate the observed association. The high R^2 should therefore be interpreted cautiously and not taken as evidence that 72.3% of the variance in actual blood donation behavior is attributable to SIDONI use in the broader population.

The sample of 100 active SIDONI users with recent donation experience represents a self-selected, highly engaged subgroup of the broader registered user population. Active, experienced users are likely to perceive greater application utility, report higher satisfaction, and engage more consistently with donation activities than newly registered or inactive users. Therefore, the findings have the strongest relevance for this engaged subgroup and should not be generalized to the full population of 194,274 registered SIDONI users without further evidence.

The lower outer loadings of X03, Y01, Y07, and Y08 suggest that certain facets of donor participation are not fully captured within a single-item, application-use-centric framework. Donation frequency (Y01) and event participation may be substantially determined by donor eligibility (hemoglobin thresholds, health criteria, donation intervals), institutional scheduling, geographic proximity to BTU IRCS, work commitments, and peer social dynamics — factors that exist largely outside the domain of application use. Habit formation and new behavior (Y08) may similarly require longer observation periods than a cross-sectional design can capture.

These patterns suggest that while SIDONI may function as a significant facilitating factor in donor engagement, it operates within a broader socio-

behavioral ecosystem. Application use alone is unlikely to fully determine donation behavior in the absence of aligned institutional services, enabling environmental conditions, and personal motivational factors.

First, this study contributes Indonesian empirical evidence from a blood donation context — a domain that is underrepresented in the digital health adoption literature, most of which focuses on clinical patient management applications, chronic disease self-management, or epidemic response platforms. Blood donation presents a uniquely humanitarian, voluntary, and episodic health behavior, in which participation is not driven by personal health need but by altruistic motivation, social identity, and institutional accessibility.

Second, the SIDONI application operates within the specific institutional ecosystem of PMI — a deeply embedded, trusted national organization in Indonesia. This institutional trust context may amplify the effect of application use on behavior in ways that differ from commercially developed health applications in which institutional trust is less established. The association between SIDONI use and donor participation may thus partly reflect trust in PMI rather than application quality per se.

Third, the study illuminates the limitations of purely digital explanations for donor behavior. The lower-loading behavioral indicators suggest that digital application use, even when perceived as useful and easy to use, does not fully determine donation participation. Community norms, altruistic and religious motivations, physical eligibility, and emotional experiences during donation remain important non-digital determinants of donor engagement in the Indonesian context. This insight — that digital tools facilitate but do not replace relational and institutional factors — is a meaningful contextual contribution to global digital health adoption discourse.

Nevertheless, overclaiming is to be avoided. The single-construct X design aggregates multiple theoretically distinct TAM/UTAUT dimensions into one composite variable, which limits the specificity of insight. Future studies using separate latent constructs for ease of use, perceived usefulness, social influence, and trust would better isolate the mechanisms through which SIDONI influences donor behavior.

For BTU IRCS Tangerang Regency and similar institutions, the findings suggest that investment in SIDONI's ease of use, information completeness, functional features, and reliability may support donor retention among active users. Personalized reminder systems linked to individual donation intervals, real-time blood stock transparency, and event notification functions may further strengthen the application's role in promoting repeat donation.

However, digital tools should be integrated with — not replace — offline donor experience quality, staff communication, donor safety assurance, and community outreach. Data privacy and ethical management of donor contact information and donation history within SIDONI must be formally governed to maintain user trust over time.

Future research should address the limitations of the present study through probability sampling from the full SIDONI user registry, larger, multi-site studies spanning diverse PMI units and regions, comparison between active and inactive SIDONI users, and between SIDONI users and non-users; (iv) use of objective SIDONI app analytics (login frequency, features accessed) linked to actual BTU IRCS donation records rather than self-reported outcomes, longitudinal or quasi-experimental designs to establish temporal relationships, re-specified PLS-SEM models with separate TAM/UTAUT latent constructs, and formal sensitivity analysis for lower-loading indicators.

This study provides one of the few empirical PLS-SEM analyses of a national blood donor digital application in Indonesia, contributing structured measurement evidence to a domain with limited quantitative data. The use of composite reliability, AVE, HTMT, and bootstrapped confidence intervals reflects an attempt to apply current PLS-SEM best practices.

Several limitations must be acknowledged. The cross-sectional design precludes causal inference. Purposive sampling from active SIDONI users limits external validity; findings should not be generalized to the full SIDONI user population or to non-users. The sample of 100 respondents, while meeting the PLS-SEM 10× rule, is small relative to the 194,274 registered users and reduces the precision of estimates. No demographic comparison with the broader SIDONI user base was performed. Self-reported questionnaire data create potential for common method bias, particularly given the same-instrument, same-time measurement of both X and Y. Objective SIDONI app usage data and actual donation records from BTU IRCS were not linked to the survey responses. Lower-loading indicators (X03, Y01, Y08) were retained without formal sensitivity analysis, which should be acknowledged as a methodological limitation. The aggregation of multiple TAM/UTAUT constructs into single composite variables limits theoretical specificity. The single-site design in Tangerang Regency limits transferability to other regions with different SIDONI implementation status, institutional capacity, and user demographics.

CONCLUSION

SIDONI application use was strongly and positively associated with blood donor participation among active users at BTU IRCS Tangerang Regency. These findings are consistent with TAM- and UTAUT-based predictions and with prior evidence on digital health application adoption. They support the potential role of the SIDONI application in facilitating donor engagement among active, experienced users.

However, interpretation must account for the study's limitations, such as purposive sampling of active users, a small sample relative to the total SIDONI user base, a cross-sectional self-reported design susceptible to common method bias, the absence of demographic comparison with the broader SIDONI population, and the lack of objective app usage or donation record linkage. These factors constrain the external validity and causal interpretation of the findings.

CONFLICT OF INTEREST

The authors declare no conflict of interest. The institutional affiliation of all authors with BTU IRCS Tangerang Regency is acknowledged; however, data collection, analysis, and interpretation were conducted with an effort to maintain objectivity and transparency.

ETHICAL CONSIDERATIONS

This study involved voluntary survey participation with no direct health risk. The study was conducted in accordance with the Declaration of Helsinki and applicable national research ethics regulations. All respondents were informed of the study's purpose and voluntarily provided consent before completing the questionnaire.

FUNDING

This study received no external funding

AUTHOR CONTRIBUTIONS

ZM is responsible for conceptualization, methodology, supervision, formal analysis, writing — original draft, and writing — review and editing. FS is responsible for data collection, data curation, project administration, validation, and writing, review, and editing. FI is responsible for data collection, investigation, statistical analysis, visualization, and writing, review, and editing. All authors read and approved the final manuscript.

ACKNOWLEDGMENTS

The authors acknowledge the staff of BTU IRCS Tangerang Regency and all respondents who voluntarily participated in this study.

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