Economics And Business Management Journal (EBMJ)
June 2026 | Vol. 3 | No. 02
E-ISSN : 2828-0288
DOI: https://doi.org/10.66084/ebmj.v3i02.636

The Influence of Digital Literacy on Consumer Purchasing Decisions in E-Commerce Platforms: A Monte Carlo Simulation Study Based on an Indonesian Synthetic Population

Ira Ningrum Resmawa[1], Noorhani Dyani Laksmi[2]
[1]School of Business Management, Universitas Ciputra Surabaya
[2]Universitas Negeri Malang
e-mail: [1]**ira.resmawa@ciputra.ac.id**, [2]nennymakmun@gmail.com

Abstrak

The rapid expansion of Indonesian e-commerce has outpaced the growth of consumer digital literacy, while existing empirical studies are hampered by heterogeneous instruments and limited methodological transparency. This study examines the influence of digital literacy on e-commerce consumer purchasing decisions using a fully disclosed Monte Carlo simulation based on a synthetic population—all data are synthetic and not the product of a field survey. A synthetic population of 400 consumer agents was generated through calibration to the four pillars of the Indonesian Digital Literacy Index 2022 (digital culture, digital ethics, digital skills, and digital safety; national index 3.54), and a structural model linking digital literacy, e-commerce trust, and purchasing decisions was estimated using OLS regression and Sobel mediation testing. The results show a positive and significant direct effect ($B = 0.506$; $\beta = 0.309$; $p < 0.001$) and a significant indirect effect through e-commerce trust (indirect effect = 0.170; Sobel $z = 4.206$; $p < 0.001$), with $R^2 = 21.3\%$. The validity of the analytical pipeline was verified twofold: 1,000 replications confirmed unbiased parameter recovery (mean $\hat{\beta} = 0.448$ against a true value of 0.45), and 1,000 null-scenario (placebo) replications produced a false-positive rate of 5.7%—close to the nominal $\alpha = 5\%$—demonstrating that the significance of the findings is not a pipeline artifact. Digital safety was identified as the most decisive pillar. The novelty of this study lies in the development of a Monte Carlo simulation model based on the four pillars of Indonesian digital literacy as an instrument for preliminary estimation, statistical power analysis, and a falsifiable baseline prior to empirical field surveys.

Keywords: digital literacy; purchasing decision; e-commerce; Monte Carlo simulation; synthetic population; consumer trust

INTRODUCTION

Indonesia has become one of the largest and fastest-growing e-commerce markets in Southeast Asia, supported by deepening internet penetration, expanding logistics infrastructure, and the proliferation of marketplace and social-commerce platforms; yet e-commerce adoption at the individual level remains shaped by capability and trust barriers [1]. As transactions migrate online, the quality of consumer decisions increasingly depends not only on price and product attributes but also on the consumer's ability to find, evaluate, and act upon digital information. This ability digital literacy has emerged as a critical behavioral antecedent in electronic commerce.

Despite rapid market growth, national measurements indicate that Indonesian digital literacy remains at a moderate level. The Indonesian Digital Literacy Index reported a national score of 3.54 on a five-point scale, with the digital safety pillar consistently recording the lowest score among the four measured pillars (digital culture, digital ethics, digital skills, and digital safety) [2]. This asymmetry is concerning for e-commerce because online purchasing inherently involves the evaluation of seller credibility, payment security, and personal data exposure.

Consumers with weak safety literacy may avoid legitimate transactions due to unwarranted distrust or, conversely, fall victim to fraudulent schemes both of which distort purchasing decisions.

Prior studies on technology acceptance and online consumer behavior have established that perceived ease of use, perceived usefulness, and trust shape intention and adoption [3], [4], [5]. Recent research reinforces the position of digital literacy as an upstream capability that conditions these perceptions: digital literacy has been shown to contribute to the formation of e-trust and purchase intention among Generation Z consumers [6], to determine information-evaluation competencies amid the flood of social media misinformation [7], and to influence online product purchasing intent in Indonesia [8]. However, empirical studies in the Indonesian context face recurring methodological obstacles: heterogeneous instruments, convenience samples concentrated in urban areas, and limited transparency about measurement models, which together hinder cumulative knowledge building and cross-study comparison.

This study addresses these obstacles from a complementary direction. Rather than collecting a new field sample, it constructs a fully disclosed Monte Carlo simulation study based on a synthetic population: a population of Indonesian consumer agents is generated through calibration to published national digital literacy statistics, and a theoretically specified structural model—linking digital literacy, e-commerce trust, and purchasing decisions is estimated and stress-tested. Simulation and synthetic-population designs of this kind are well established in operations research and computational social science [9], [10], [11]: because the data-generating process is known, they allow researchers to verify that an analytical pipeline recovers true parameters, to quantify expected effect sizes and statistical power before fieldwork, and to provide a reproducible baseline against which future empirical estimates can be compared.

To the best of the authors' knowledge, no prior study has integrated the four official pillars of Indonesian digital literacy into a single calibrated simulation model to estimate the literacy–trust–purchase relationship; prior studies of this relationship are exclusively field-survey-based with heterogeneous instruments [6], [8], while the synthetic-population literature has not yet addressed Indonesian e-commerce consumer behavior [11]. **The novelty of this study lies in the development of a Monte Carlo simulation model based on the four pillars of Indonesian Digital Literacy as a preliminary estimation instrument for the relationship between digital literacy, e-commerce trust, and purchasing decisions prior to an empirical field survey.** This methodological novelty is operationalized through four objectives: (1) to formalize an agent-generation model calibrated to the four national literacy pillars; (2) to estimate the direct effect of digital literacy on purchasing decisions and its indirect effect through e-commerce trust; (3) to verify the validity of the estimation pipeline through 1,000 parameter-recovery replications and 1,000 null-scenario (placebo) replications; and (4) to derive design implications expected effect sizes, sample-size guidance, and pillar prioritization for subsequent field surveys. It must be emphasized from the outset that all respondent-level data are synthetic; no human subjects were surveyed, and the findings characterize the behavior of a calibrated model rather than direct field observations.

LITERATURE REVIEW AND HYPOTHESES

Digital literacy has evolved from the mere ability to understand and use information from multiple digital sources into a multidimensional construct covering technical-operational skills, information evaluation, communication, and safety awareness [12]. In the Indonesian policy framework, digital literacy is operationalized through four pillars digital culture, digital ethics, digital skills, and digital safety measured annually at the national level [2]. Research on the digital divide shows that as access gaps close, differences in skills and usage become the dominant source of inequality in digital outcomes [13]; recent work even places information-evaluation competence as the principal determinant of an

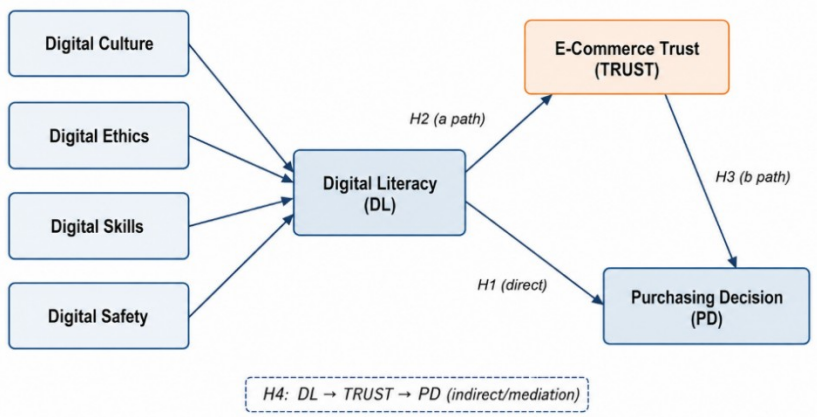

Figure 1. Conceptual framework of the simulated structural model

RESEARCH METHOD

Research Design and Data Disclosure

This study employs a quantitative Monte Carlo simulation design based on a synthetic population. All respondent-level observations are computer-generated; no questionnaire was administered and no personal data were collected. This disclosure is stated explicitly to distinguish the present work from field surveys: the contribution lies in a calibrated, fully reproducible model whose parameters can later be confronted with empirical data. The synthetic-population generation practice follows current methodological recommendations in social simulation [11]. The simulation and analysis pipeline was implemented in Python 3 (NumPy 2.4, SciPy 1.17, pandas 3.0) with a fixed random seed (2026) to guarantee exact reproducibility.

Agent Generation and Calibration

A synthetic population of N = 400 consumer agents was generated. Each agent received scores on the four national digital literacy pillars, drawn from truncated normal distributions on the interval [1, 5] whose means were calibrated to the published pillar scores of the Indonesian Digital Literacy Index 2022—digital culture 3.84, digital ethics 3.68, digital skills 3.52, and digital safety 3.12 (national composite 3.54) [2]. Standard deviations (0.62–0.78) were set to reproduce realistic Likert-scale dispersion, with greater heterogeneity assigned to the safety pillar consistent with its wider reported variation. Composite digital literacy (DL) was computed as the equally weighted mean of the four pillars plus a small idiosyncratic disturbance. Demographic attributes (age group, gender, dominant platform) were assigned from categorical distributions approximating the profile of Indonesian e-commerce users and serve descriptive purposes only. Table 1 summarizes the generation parameters.

Table 1. Simulation parameters and calibration sources

Component	Specification	Calibration basis
Population size	N = 400 agents	Common survey scale; >10× indicators
Digital culture (DC)	TN(3.84, 0.62) on [1, 5]	IMDI 2022 pillar score [2]
Digital ethics (DE)	TN(3.68, 0.65) on [1, 5]	IMDI 2022 pillar score [2]
Digital skills (DS)	TN(3.52, 0.70) on [1, 5]	IMDI 2022 pillar score [2]

Digital safety (DSa)	TN(3.12, 0.78) on [1, 5]	IMDI 2022 pillar score [2]
Composite DL	Mean of pillars + N(0, 0.12)	Equal-weight index construction
Trust equation	TRUST = 1.0 + 0.55·DL + 0.20·DSa + ε, ε~N(0, 0.45)	Theoretical specification (H2)
Outcome equation	PD = 0.6 + 0.45·DL + 0.30·TRUST + ε, ε~N(0, 0.50)	Theoretical specification (H1, H3)
Recovery replications	R = 1,000 (true parameters)	Monte Carlo convention [10]
Null-scenario replications	R = 1,000 (all effects = 0)	False-positive (placebo) test

Note: TN = truncated normal; all variables bounded to [1, 5].

Source: processed simulation

Structural Model, Estimation, and Twofold Verification

The data-generating process embeds known (ground-truth) parameters: a direct effect of DL on purchasing decisions of 0.45, an effect of DL on trust of 0.55 with an additional safety-specific contribution of 0.20, and an effect of trust on purchasing decisions of 0.30. Estimation proceeds in four stages. First, ordinary least squares (OLS) regression of PD on DL and TRUST tests H1 and H3, reporting unstandardized coefficients, standardized betas, t-statistics, and the model F-test. Second, the mediation hypotheses (H2, H4) are evaluated through the product-of-coefficients approach with the Sobel test. Third, the calibration of the estimation pipeline is assessed by regenerating the entire population 1,000 times under independent random seeds and examining whether the sampling distribution of the estimated DL coefficient is centered on the true value [9], [10]. Fourth and crucially, to distinguish findings from a mere reproduction of assumptions a null-scenario (placebo) test is conducted: all structural effects are set to zero (PD and TRUST are generated from pure noise, independent of DL) and the identical analytical pipeline is run on 1,000 replications; a valid pipeline must produce an H0 rejection rate close to the nominal $\alpha = 5\%$, so that significance in the main scenario can be attributed to the embedded effect structure rather than pipeline bias. Significance is evaluated at $\alpha = 0.05$; effect-size reporting and interpretation follow contemporary structural equation modeling guidelines [20].

RESULTS AND DISCUSSION

Profile of the Simulated Population

The synthetic population reflects the typical structure of Indonesian e-commerce users: 36.0% of agents are aged 18–24 and 35.2% are aged 25–34, with a 55:45 female-to-male ratio; the dominant platforms are Shopee (43.2%), Tokopedia (24.0%), and TikTok Shop (17.5%). These attributes are descriptive constructs of the simulation and were not used as model covariates.

Descriptive Statistics

Table 2 presents the descriptive statistics of the generated variables, and Figure 2 visualizes the pillar distributions. The simulated composite digital literacy mean of 3.520 accurately reproduces the national calibration target of 3.54, with digital culture highest (3.751) and digital safety lowest (3.064) preserving the empirically documented pillar ordering. This correspondence confirms that the agent-generation procedure is faithful to its calibration source.

Table 2. Descriptive statistics of simulated variables (N = 400)

Variable	Mean	SD	Min	Max
Digital culture (DC)	3.751	0.570	1.952	4.955
Digital ethics (DE)	3.670	0.640	1.540	4.966
Digital skills (DS)	3.577	0.635	1.769	4.967
Digital safety (DSa)	3.064	0.736	1.017	4.916
Composite digital literacy (DL)	3.520	0.334	2.480	4.440
E-commerce trust (TRUST)	3.567	0.535	1.926	5.000
Purchasing decision (PD)	3.217	0.547	1.729	4.782

Source: processed simulation data

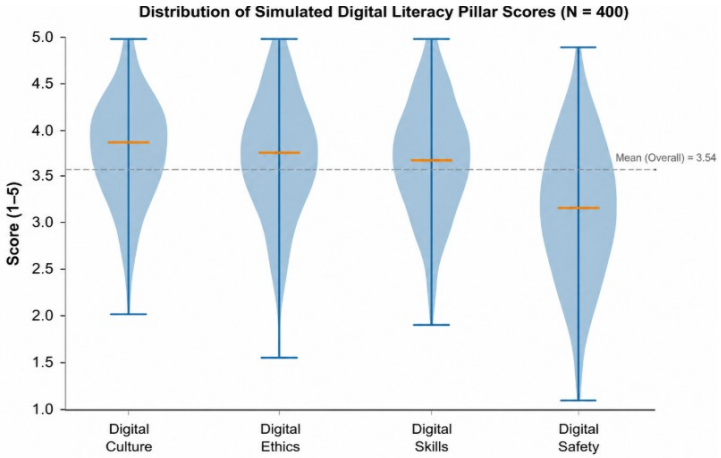

Figure 2. Distribution of simulated digital literacy pillar scores

Hypothesis Testing

Figure 3 shows the bivariate relationship between composite digital literacy and purchasing decisions ($r = 0.412$; $p < 0.001$), and Table 3 reports the multiple regression results. The model is significant overall, $F(2, 397) = 53.61$, $p < 0.001$, explaining $R^2 = 0.213$ (adjusted $R^2 = 0.209$) of the variance in purchasing decisions. Digital literacy exerts a positive and significant direct effect ($B = 0.506$; $\beta = 0.309$; $t = 6.196$; $p < 0.001$), supporting H1, and e-commerce trust likewise contributes positively ($B = 0.236$; $\beta = 0.231$; $t = 4.633$; $p < 0.001$), supporting H3. The estimated direct coefficient of 0.506 lies within sampling error of the embedded ground-truth value of 0.45, indicating accurate single-sample recovery.

Table 3. Multiple regression results: PD = f(DL, TRUST)

Predictor	B	SE	β	t	p	Decision
Constant	0.594	0.263	–	2.257	0.025	–
Digital literacy (DL)	0.506	0.082	0.309	6.196	< 0.001	H1 supported
E-commerce trust (TRUST)	0.236	0.051	0.231	4.633	< 0.001	H3 supported

$R^2 = 0.213$; adjusted $R^2 = 0.209$; $F(2, 397) = 53.61$; $p < 0.001$.
Source: processed simulation data

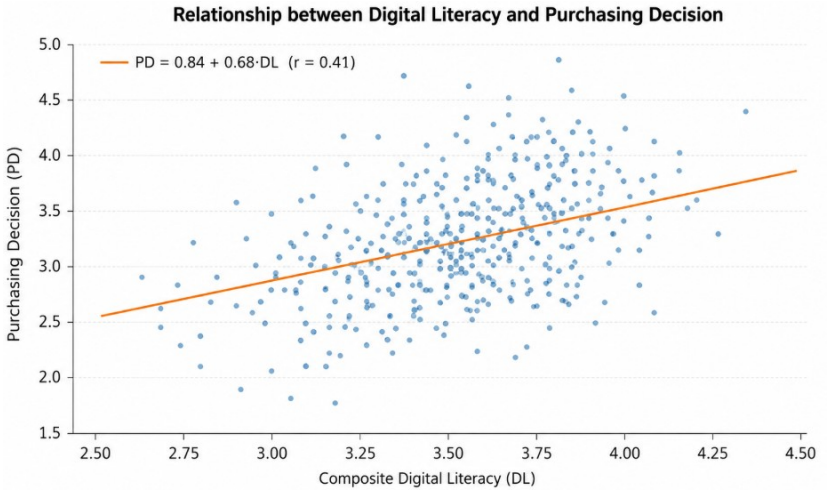

Figure 3. Relationship between digital literacy and purchasing decision

At the pillar level, digital safety exhibits the strongest correlation with purchasing decisions ($r = 0.298$; $p < 0.001$), followed by digital ethics ($r = 0.168$; $p = 0.001$) and digital skills ($r = 0.157$; $p = 0.002$), while digital culture is not significant ($r = 0.082$; $p = 0.102$). The prominence of the safety pillar follows directly from its dual role in the model contributing to composite literacy and independently strengthening trust and mirrors the theoretical argument that transaction-security competence is the literacy component most proximate to purchase behavior.

Mediation Analysis

Digital literacy significantly predicts e-commerce trust ($a = 0.720$; $p < 0.001$), supporting H2, and the indirect effect of digital literacy on purchasing decisions through trust is significant ($a \times b = 0.170$; Sobel $z = 4.206$; $p < 0.001$), supporting H4. Because the direct effect remains significant alongside the indirect effect, trust functions as a partial mediator: approximately 25% of the total effect of digital literacy on purchasing decisions (0.170 of 0.676 in the bivariate specification) is transmitted through the trust channel. This pattern is consistent with recent empirical findings in Indonesian social commerce positioning e-trust as a central mediator of purchase intention [17], [19].

Twofold Verification: Parameter Recovery and Null Scenario

Across 1,000 independent replications of the main scenario, the estimated DL coefficient averaged 0.448 (SD = 0.083; 95% interval 0.278–0.612), centered almost exactly on the true value of 0.45, and model R^2 averaged 0.246 (95% interval 0.179–0.320), as shown in Figure 4. The absence of systematic bias confirms that the OLS pipeline is a valid estimator for this design.

An equally important result comes from the null-scenario test. When all structural effects were set to zero purchasing decisions and trust generated from pure noise, independent of digital literacy the identical analytical pipeline produced H0 rejection rates of 5.7% for the DL coefficient and 6.0% for the TRUST coefficient across 1,000 replications, close to the nominal $\alpha = 5\%$, with a mean DL coefficient of 0.005 (95% interval 0.157 to 0.149) centered on zero. In other words, the pipeline does not manufacture significance when no effect is embedded; the significance reported in Sections 4.3–4.4 is therefore a consequence of the effect structure in the model, not an artifact of the analytical procedure. This pair of verifications—unbiased parameter recovery and Type I error control constitutes the standard of validity evidence in methodological simulation studies [10], [11]. For field planning, a sample of 400 respondents yields a sampling standard error of roughly 0.08 for the focal coefficient: sufficient

power to detect medium effects, with replication-to-replication variation in R^2 that empirical studies should anticipate.

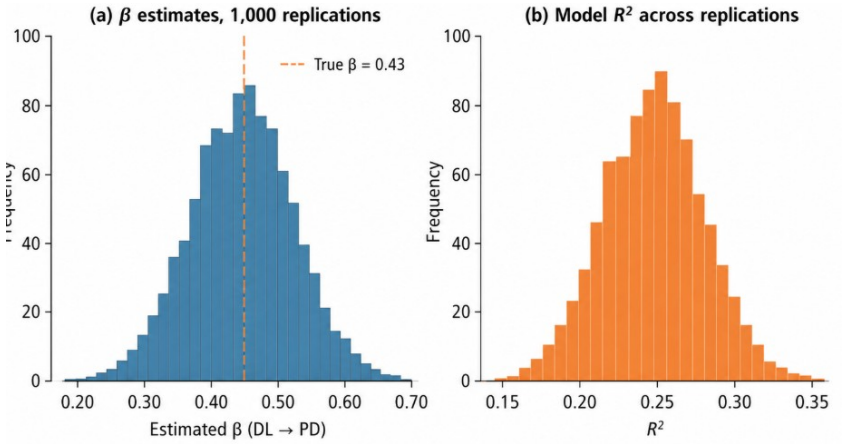

Figure 4. Sampling distributions across 1,000 Monte Carlo replications (main scenario)

Discussion, Limitations, and the Epistemic Status of the Findings

Three findings merit emphasis. First, the calibrated model demonstrates that even moderate national literacy levels translate into a substantively meaningful literacy–purchase gradient: a one-point increase in composite digital literacy is associated with roughly half a point of additional purchasing-decision strength on the same scale. Interpreted through the lens of technology acceptance and trust theory [3], [4], [16], literacy operates through two channels: reducing the cognitive cost of evaluating online alternatives and enabling calibrated trust in credible sellers. Second, the dominance of the digital safety pillar simultaneously the lowest-scoring pillar nationally [2] and the strongest correlate of purchasing decisions in the model identifies security literacy as the highest-leverage intervention target for platforms, regulators, and the national digital literacy movement; this priority coheres with field evidence that security and privacy factors shape trust and purchase intention in Indonesian social commerce [17]. Third, the Monte Carlo evidence provides concrete methodological guidance for subsequent fieldwork: with N = 400, researchers can expect 95% confidence intervals of approximately ±0.16 around the focal coefficient, and should treat single-sample R^2 values in the 0.18–0.32 range as consistent with the same underlying process.

The limitations of this study must be stated firmly and in layers. **First, there is a circularity inherent to any simulation study with researcher-specified parameters: the direction and existence of the relationships among variables are model assumptions, so support for H1–H4 must not be read as empirical proof that these relationships exist in the real world.** What constitutes a valid finding of this study is not the existence of the effects but three other things: (a) the statistical properties of the analytical pipeline shown to be unbiased in the main scenario and Type I error-controlled in the null scenario (5.7% ≈ α), so that significant results are not merely an echo of assumptions amplified by the pipeline; (b) the testable quantitative consequences of the calibrated theory namely, that if TAM and trust-theory mechanisms hold at the assumed magnitudes, a field survey with N = 400 should observe coefficients within the 0.28–0.61 interval and R^2 within the 0.18–0.32 range; and (c) a sample-size planning and precision-expectation instrument that field researchers can use directly. Should a future empirical survey produce estimates outside these prediction intervals, the model is falsified and its theoretical assumptions must be revised this falsifiability is what distinguishes a simulation baseline from circular reasoning. Second, the simulation omits price, promotion, platform design, and social influence, and uses linear functional forms with a single mediator. Third, calibration reaches only the first moments (pillar means) of the national data; the true inter-pillar correlation structure is not publicly available and was assumed independent.

Future research should administer the four-pillar instrument to a field sample to test the prediction intervals above, extend the model with moderators (income, region, platform type) and multiple mediators, and explore agent-based extensions that allow consumer interaction through reviews and social commerce [9], [11].

CONCLUSION

This study formalized and tested a Monte Carlo simulation model based on a synthetic population of how digital literacy shapes consumer purchasing decisions in Indonesian e-commerce. Using 400 synthetic agents calibrated to the four pillars of the Indonesian Digital Literacy Index 2022, the analysis found a positive and significant direct effect of digital literacy on purchasing decisions ($\beta = 0.309$; $p < 0.001$), a significant indirect effect through e-commerce trust (Sobel $z = 4.206$; $p < 0.001$) constituting roughly one quarter of the total effect, and digital safety as the most influential literacy pillar. The validity of the analytical pipeline was verified twofold: 1,000 main-scenario replications confirmed unbiased parameter recovery, and 1,000 null-scenario replications showed a false-positive rate of 5.7%, close to the nominal level so the significance of the findings can be attributed to the model structure rather than procedural artifacts. Because all data are synthetic and the data-generating process is fully disclosed, the contribution of this study is a methodological novelty: a four-pillar Indonesian digital literacy simulation model serving as an instrument for preliminary estimation, sample-size planning, and a falsifiable baseline not empirical proof for the literacy–trust–purchase relationship. Its central practical implication is that strengthening digital safety literacy is the most promising lever for improving the quality of Indonesian consumers' online purchasing decisions, a proposition that field research can now test directly against the prediction intervals reported here.

REFERENCES

[1] K. Ariansyah, E. R. E. Sirait, B. A. Nugroho, and M. Suryanegara, “Drivers of and barriers to e-commerce adoption in Indonesia: Individuals’ perspectives and the implications,” Telecommunications Policy, vol. 45, no. 8, 102219, 2021, doi: 10.1016/j.telpol.2021.102219.

[2] Kementerian Komunikasi dan Informatika RI & Katadata Insight Center, Status Literasi Digital di Indonesia 2022. Jakarta: Kominfo, 2023.

[3] F. D. Davis, “Perceived usefulness, perceived ease of use, and user acceptance of information technology,” MIS Quarterly, vol. 13, no. 3, pp. 319–340, 1989.

[4] D. Gefen, E. Karahanna, and D. W. Straub, “Trust and TAM in online shopping: An integrated model,” MIS Quarterly, vol. 27, no. 1, pp. 51–90, 2003.

[5] P. A. Pavlou, “Consumer acceptance of electronic commerce: Integrating trust and risk with the technology acceptance model,” International Journal of Electronic Commerce, vol. 7, no. 3, pp. 101–134, 2003.

[6] M. Makki, A. B. Ozturk, and M. K. Singh, “Understanding online purchase intention of generation Z consumers: Role of eTrust and digital literacy,” Journal of Retailing and Consumer Services, vol. 57, 102251, 2020.

[7] G. Lăzăroiu, J. Horak, and K. Valaskova, “Digital literacy, information evaluation competencies, and social media misinformation discernment,” Information Processing & Management, vol. 58, no. 1, 102397, 2021.

[8] T. D. Cahyono and R. M. Rizqi, “The impact of digital marketing, financial literacy, and digital literacy on purchasing intent for online products,” Indonesian Business Review, vol. 7, no. 2, pp. 83–93, 2024, doi: 10.21632/ibr.7.2.83-93.

[9] E. Bonabeau, “Agent-based modeling: Methods and techniques for simulating human systems,” Proceedings of the National Academy of Sciences, vol. 99, suppl. 3, pp. 7280–7287, 2002.

[10] C. M. Macal and M. J. North, “Tutorial on agent-based modelling and simulation,” Journal of Simulation, vol. 4, no. 3, pp. 151–162, 2010.

[11] K. Chapuis, P. Taillandier, and A. Drogoul, “Generation of synthetic populations in social simulations: A review of methods and practices,” Journal of Artificial Societies and Social Simulation, vol. 25, no. 2, art. 6, 2022, doi: 10.18564/jasss.4762.

[12] Y. Eshet-Alkalai, “Digital literacy: A conceptual framework for survival skills in the digital era,” Journal of Educational Multimedia and Hypermedia, vol. 13, no. 1, pp. 93–106, 2004.

[13] A. J. A. M. van Deursen and J. A. G. M. van Dijk, “The digital divide shifts to differences in usage,” New Media & Society, vol. 16, no. 3, pp. 507–526, 2014.

[14] P. Kotler and K. L. Keller, Marketing Management, 15th ed. Harlow: Pearson Education, 2016.

[15] K. Rozenkowska, “Theory of planned behavior in consumer behavior research: A systematic literature review,” International Journal of Consumer Studies, vol. 47, no. 6, 2023, doi: 10.1111/ijcs.12970.

[16] F. Shirazi, N. A. Adam, M. Shanmugam, and C. D. Schultz, “The importance of trust for electronic commerce satisfaction: An entrepreneurial perspective,” British Food Journal, vol. 123, no. 2, pp. 789–802, 2021.

[17] N. Putri, Y. Prasetya, P. W. Handayani, and H. Fitriani, “TikTok Shop: How trust and privacy influence generation Z’s purchasing behaviors,” Cogent Social Sciences, vol. 10, no. 1, art. 2292759, 2024, doi: 10.1080/23311886.2023.2292759.

[18] L. Saffanah, P. W. Handayani, and F. P. Sunarso, “Actual purchases on Instagram live shopping: The influence of live shopping engagement and information technology affordance,” Asia Pacific Management Review, vol. 28, no. 2, pp. 204–214, 2023.

[19] A. Hermawan and S. F. Putri, “E-trust as a mediator in social commerce: TikTok Shop’s impact on purchase intention among Indonesian users,” Journal of System and Management Sciences, vol. 15, no. 3, pp. 203–221, 2025, doi: 10.33168/JSMS.2025.0311.

[20] J. F. Hair, G. T. M. Hult, C. M. Ringle, M. Sarstedt, N. P. Danks, and S. Ray, Partial Least Squares Structural Equation Modeling 7.