



The Impact of Service Digitalization and Cashless Payments on Operational Efficiency: A Millennial and Gen Z Consumer Perspective

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Abstract

This study aims to analyze the effect of service digitalization and cashless payment on operational efficiency from the perspective of Millennial and Generation Z consumers. A quantitative approach was employed using Structural Equation Modeling-Partial Least Squares (SEM-PLS). The sample consisted of 200 respondents consisting of Millennial and Gen Z consumers in West Java who actively use digital services and cashless payment systems. Outer model testing results confirmed that all research instruments satisfied convergent validity (loading factor > 0.70; AVE > 0.50), discriminant validity, and reliability (Cronbach's Alpha and Composite Reliability > 0.70). Inner model results revealed that service digitalization had a positive and significant effect on operational efficiency with a path coefficient of 0.597 (T-statistic = 7.501; p = 0.000), while cashless payment also showed a positive and significant effect with a path coefficient of 0.313 (T-statistic = 3.682; p = 0.000). An R² value of 0.758 indicates that both variables collectively explain 75.8% of the variation in operational efficiency. Service digitalization proved to be the more dominant predictor with a large effect size ($f^2 = 0.501$) compared to cashless payment ($f^2 = 0.137$). The novelty of this study lies in its simultaneous examination of both service digitalization and cashless payment as co-determinants of consumer-perceived operational efficiency within a generational comparative framework an approach that remains underexplored in the extant literature. These findings provide empirical evidence that increased adoption of digital service technology and cashless payment systems significantly enhances the perceived operational efficiency of young consumers in the digital era. Future research is encouraged to address the current generational sampling imbalance (Gen Z: 69.5%; Millennials: 30.5%) and expand geographic coverage beyond West Java.

Keywords: Service Digitalization, Cashless Payment, Operational Efficiency, Millennial, Generation Z, PLS-SEM.

1 Introduction

Over the past decade, the rapid advancement of digital technology has fundamentally transformed how individuals transact and access services. Manual processes have been progressively replaced by integrated digital platforms that offer speed, convenience, and cost efficiency. This transformation is

particularly evident in the banking and small-to-medium enterprise (SME) sectors, where service digitalization not only simplifies transactions but also reduces operational costs and enhances work efficiency. Empirical evidence from Indonesia demonstrates that banking digitalization significantly reduces transaction time and administrative costs while improving overall customer satisfaction (Rahmawati, A., Pramudita, D., & Setiawan, R, 2023). Banking digitalization has also been shown to reduce operational costs and accelerate service delivery, thereby strengthening customer loyalty (Utami, S., & Hardi, A, 2022). In the context of MSMEs, the adoption of QRIS as a digital payment method has accelerated transaction processes and promoted operational efficiency (Supriyanto, A., & Nurdin, M, 2023). Phenomenon *cashless society* has become increasingly evident in Indonesia, marked by a significant decline in cash usage and the rapid adoption of digital wallets, QR-based payments, and electronic cards in daily transactions (Visa, 2023). QR code-based payment implementation has been found to positively influence consumer satisfaction by prioritizing convenience and speed (Chandra, F., & Sugiarto, H, 2023). This trend is particularly pronounced among younger consumers who are widely recognized for their adaptive orientation toward digital technology. Data indicate that the majority of PayLater and digital wallet users in Indonesia are Millennials and Gen Z, accounting for 43.9% and 26.5% of users respectively (Katadata Insight Center, 2024). These figures confirm that both generations serve as the primary drivers of the ongoing transition toward non-cash payment systems in Indonesia.

From a consumer behavior perspective, Millennials and Gen Z exhibit distinct characteristics in their adoption and interpretation of digital services and cashless payment systems. Millennials tend to prioritize usability, security, and economic efficiency as the primary determinants of digital service adoption (Kurniawan, I., & Dewi, P, 2023). In contrast, Gen Z places greater emphasis on experiential factors, including interactivity, comfort, and service speed. For both generations, perceived usefulness, ease of use, and security have been identified as the primary determinants of cashless payment preference (Prasetyo, T., Utami, D., & Hidayat, A, 2023). Additionally, trust, *sense of confidence (self-efficacy)*, and perceived enjoyment also play important roles in shaping young consumers' acceptance of digital services such as mobile banking (Saputra, Y., & Nugroho, S, 2024). Despite the rapid growth of digitalization and *cashless payments* adoption, several challenges persist. Digital literacy and trust remain significant barriers for a portion of consumers, including younger generations (Nuraini, E., & Putra, B, 2023). Concerns over personal data security, fraud risks, and potential information leakage cause some consumers to remain reluctant to fully abandon cash transactions. Infrastructure limitations in certain regions further impede the optimal deployment of digital services. These constraints are compounded by the role of *trust* as a key determinant of digital payment adoption (Wijaya, M., & Arifin, D, 2023). Contextual evidence from MSMEs in Gorontalo similarly reveals that limited internet access and low digital literacy adversely affect technology-based service utilization (Suryani, L., Karim, A., & Basri, M, 2023). In the post-COVID-19 context, consumer expectations for digital services have risen markedly, requiring businesses to deliver faster, safer, and more flexible solutions. While fintech adoption has contributed to efficiency gains, infrastructure readiness remains a persistent challenge (Santoso, J., & Wibowo, L, 2024).

The post-pandemic period has further accelerated the shift toward digital services, with consumers increasingly demanding fast, secure, and flexible solutions. Evidence from the retail sector confirms that customer satisfaction improves in tandem with the digitalization of transactions (Handayani, R., & Setiono, D, 2022). These developments open new avenues for research, particularly in assessing the extent to which service digitalization and cashless payment systems enhance operational efficiency from the perspective of Millennial and Gen Z consumers. The majority of prior studies have concentrated on the impact of digitalization on customer satisfaction, behavioral intention, or consumer loyalty, while research that specifically links service digitalization and *cashless payments* with consumer-perceived operational efficiency remains relatively scarce. Furthermore, comparative studies examining the differential experiences and generational perceptions of Millennials and Gen Z regarding efficiency benefits are rarely conducted, despite this being a central concern in the digital consumer literature.

Against this backdrop, the present study titled "Influence Digitalization Services and Cashless Payments for Efficiency Operational: Perspective Consumer Millennials and Gen Z" addresses a critical yet underexplored intersection in the digital economy literature. The study makes a dual contribution: theoretically, it enriches the scholarly discourse on digitalization and cashless payments by providing the first empirical test of their joint, simultaneous influence on consumer-perceived operational efficiency within a generational comparative framework anchored in the Technology Acceptance Model (TAM); practically, it offers actionable evidence for businesses and policymakers seeking to design digital service strategies aligned with the behavioral profiles of young consumers in emerging markets. While existing studies have extensively documented the effects of digitalization on customer satisfaction (Davis, 1989; Vial, 2019), behavioral intention (Venkatesh et al., 2012), and technology acceptance (King & He, 2006), the specific nexus between service digitalization, cashless payment adoption, and consumer-perceived operational efficiency as a distinct outcome variable remains insufficiently examined. This research gap is compounded by the near-absence of studies that simultaneously investigate both generational cohorts Millennials and Gen Z as comparative units of analysis, despite these groups representing the primary drivers of digital payment adoption in Indonesia (Katadata Insight Center, 2024). The present study directly addresses these gaps by integrating both variables into a unified structural model and explicitly acknowledging the generational sampling asymmetry (Gen Z: 69.5%; Millennials: 30.5%) as a boundary condition of the current findings, one that warrants systematic correction in future research.

Grounded in the *Technology Acceptance Model* (TAM) framework, this study simultaneously integrates service digitalization and cashless payment as co-predictors of consumer-perceived operational efficiency within a single structural model. By doing so, it advances beyond single-variable approaches predominant in prior work and contributes a more holistic understanding of how digital technology adoption shapes efficiency perceptions among young consumers. The TAM constructs of perceived usefulness and perceived ease of use serve as the theoretical bridge linking technology adoption behaviors to efficiency outcomes, consistent with foundational work by (Davis, 1989) and subsequent extensions by (Venkatesh et al., 2012). It is important to note that the current sample is geographically bounded to West Java and exhibits a generational imbalance skewing toward Gen Z (69.5%). While these constitute acknowledged limitations, the findings nonetheless provide a robust empirical foundation validated through stringent SEM-PLS measurement criteria that future studies may build upon through expanded geographic scope and more balanced generational sampling strategies.

2 Literature Review

2.1 Concept Digitalization of Services

Digitalization service (*service digitalization*) refers to the systematic transformation of business processes and service delivery through the comprehensive adoption of digital technologies. (Bharadwaj et al., 2013) conceptualize digital business strategy as the deliberate integration of cloud computing, big data analytics, social media, and mobile technologies with traditional business capabilities to generate sustained competitive advantage. Extending this foundation, (Bharadwaj et al., 2013) (Vial, 2019) in a systematic review of 282 studies spanning two decades, concludes that digital transformation fundamentally represents a process through which organizations create value by combining information, computing, communication, and connectivity technologies. Critically, the convergence of these perspectives reveals that service digitalization is not merely a technological upgrade but a strategic reorientation of how value is created and delivered to consumers a distinction that has direct implications for consumer-perceived operational efficiency.

From a service perspective, digitalization can be conceptualized across three distinct yet interrelated layers. The first is the *digitalization process*, encompassing the automation of internal processes such

as inventory management, order processing, and supply chain coordination. The second is *customer experience digitalization*, which involves the transformation of consumer touchpoints through digital interfaces, mobile applications, and AI-powered services. The third is *the digitalization business model*, which entails fundamental changes in how value is created and captured through digital platforms, ecosystems, and data-driven monetization. These three layers are mutually reinforcing: process efficiency enables better customer experiences, which in turn sustains transformative business models. Collectively, their synergistic interaction constitutes the mechanism through which service digitalization ultimately enhances operational efficiency (Zhu & Kraemer, 2005).

(Matt et al., 2015) developed framework *Digital Transformation Strategy* that identifies four dimensions main digital transformation : use technology, change in creation value, change structural, and aspects financial framework This has validated in various context industry, including banking, retail and services health (Kruse & Beane, 2018).

2.2 Cashless Payment: Concept, Typology, and Development

Cashless payment or payment wireless refers to everything form transaction financial transactions carried out without involving cash physique as a medium of exchange .(Laukkanen, 2016) classifies system digital payments to in four category main based on underlying technology : (1) *card-based payment* (debit and credit cards) ; (2) *mobile payment* based application ; (3) *e-wallet* or digital wallet ; and (4) *cryptocurrency* blockchain -based . In development contemporary , categorization This the more develop with presence *Buy Now Pay Later* (BNPL), Quick Response (QR) code payment, and system payment integrated super-app based (Haddad & Hornuf, 2019).

Globally , the cashless payment market is experiencing very rapid growth. projects mark global digital payment transactions will reach USD 9.46 trillion in 2023 and increase to USD 14.79 trillion in 2027 with a Compound Annual Growth Rate (CAGR) of 11.8%. In the Asia Pacific region , China is leader with mobile payment penetration reached 86% of population adults, followed by South Korea (76%), and India (67%) thanks to the massive demonetization program and UPI (Unified Payments Interface) initiative. Indonesia itself shows a positive growth trajectory with amount e-wallet users are projected reaching 202 million by 2025.

Factors driver adoption of cashless payments has Lots reviewed in literature. Shaikh & (Shaikh & Karjaluto, 2015) research through meta- analysis against 55 studies find that *perceived usefulness* , *perceived ease of use* , trust , and influence social is universal predictors of cross-border mobile payment adoption culture and geography . While that , (Kim et al., 2010) added dimensions *perceived security* and privacy as factor critical , especially in context transaction worth high.

2.3 Efficiency Operational in Digital Context

Efficiency operational in a way classic defined as ability something system For produce maximum output with minimal input, or in a way equivalent, reach objective certain with use source the most energy efficient (Farrell, 1957). In the digital era, the concept of This experience expansion significant meaning. Argue that efficiency operations in the digital era are not Again solely about subtraction costs, but also includes improvement speed response, accuracy services, scalability, and capabilities adaptive to change market demand.

In context service digital based, efficiency operational can measured through a number of indicator main. Identified three dimensions relevant efficiency: (1) *time efficiency* subtraction time required For finish something transaction or service process; (2) *cost efficiency* minimization cost per transaction unit including cost direct (personnel, infrastructure) as well as cost No direct (errors, delays); and (3) *quality efficiency* improvement consistency and standardization service through automation. Third

dimensions This each other related and in a collective determine Power competition organization in an increasingly digital ecosystem competitive.

A number of studies empirical has documenting impact positive digitalization to efficiency operational. Research on 135 companies in the United States find that adoption cloud technology and robotic process automation (RPA) are capable reduce cost average operational 32-40%. In sector banking, (Hernando & Nieto, 2007) show that the banks that adopt internet banking services intensive reach savings cost significant after 18 months implementation, especially on costs personnel and office overhead costs physical. While that, in studies cross- country finds correlation positive strong ($r = 0.74$) between level digitalization business and productivity operational in 14 OECD countries.

From the perspective consumers, efficiency consumer - perceived operational efficiency is different multidimensional constructs from efficiency operational organizational. Parasuraman et al. (2005) developed ES-QUAL scale for measure quality service electronics, in which covers dimensions efficiency as convenience and speed access as well as use service from perspective users. More further, (Zeithaml et al., 2002) stated that consumer evaluate efficiency digital services especially through lens time saved, convenience navigation , and reliability system — three dimensions that are direct form satisfaction and loyalty consumers.

2.4 Characteristics of Digital Consumers Millennials and Generation Z

Understanding to characteristics unique consumer Millennials and Generation Z are prerequisite important before analyze behavior they in context digital services. (Prensky, 2001) in article seminal introduce dichotomy *digital natives* versus *digital immigrants* For differentiate growing generation together digital technology from those who adopt technology in the age adults. Millennials and Gen Z are classified as as *digital natives*, however with nuances important: Millennials experience transition from the analog to the digital era, while Gen Z has since born has exposed to smartphones, social media, and ubiquitous internet connectivity.

Identified eight norms that differentiate *Net Generation* (Millennials and Gen Z) from generation previously: freedom selecting, customizing, checking facts (*scrutiny*), integrity and openness, entertainment in work, collaboration, speed, and innovation. These norms in a way direct form expectation they to digital services: they want on *demand*, personalized, transparent, and customizable services accessible When anywhere and anytime. In cashless payment context, expectations This manifested in preference to application intuitive, secure, and integrated payments with various ecosystem service others. From McKinsey & Company found that Generation Z they call as "*True Gen*" has different characteristics fundamentally from Millennials. Gen Z is more pragmatic, more data privacy oriented, and more skeptical to institutions big including institution finance. They tend do research deep before adopt a digital platform and is heavily influenced by *peer review* as well as review online community. Meanwhile Millennials more driven by values experience (*experiential values*), Gen Z is more prioritize instrumental values such as data security, speed transactions and efficiency costs (Seemiller & Grace, 2017).

In Indonesian context, survey Jakpat (2022) against 1,547 respondents Millennials and Gen Z show that 84.3% use application digital wallet at least very in a week, with GoPay (67.2%), OVO (54.8%), and Dana (48.9%) as the most popular platforms used. Motivation main use is convenience (87.1%), speed transactions (79.3%), and the availability of promos/cashback (72.6%). Interestingly, the factors data security is at the top of the list fourth (68.4%), shows that young Indonesian consumers relatively more willing take risk privacy for comfort use findings that have implications important for policy protection digital consumers.

2.5 Theoretical Basis: Adoption Model Technology

2.5.1 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) developed by (Davis, 1989) is one of the framework most influential theorist in literature system information and behavior digital consumers . Based on the Theory of Reasoned Action (TRA) by Fishbein & Ajzen (1975), TAM argues that that reception technology by individuals primarily determined by two constructs main: *perceived usefulness* (PU) belief that use system certain will increase performance job and *perceived ease of use* (PEOU) beliefs that use system certain No need excessive effort. Both construct This in a way together influence user attitude, which is then determine intention behavior (*behavioral intention*) and finally use actual (*actual use*).

In in the context of cashless payments, TAM has applied in a way extensive. A meta- analysis conducted by (King & He, 2006) of 88 TAM studies found that that this model own validity strong predictive with an average explained variance (R^2) of 40% for variables intention usage . More Specifically, (Schierz et al., 2010) developed a customized TAM. for mobile payment with add variables *individual mobility* and *compatibility* as antecedents additional, find that fourth variables in a way significant predict intention mobile payment usage ($R^2 = 0.68$). Research focused on Gen Z in South Africa found that that PEOU has influence more dominant compared to PU in form intention mobile banking usage, shows that intuitive interface more prioritized by generation young compared to utility functional.

2.5.2 Unified Theory of Acceptance and Use of Technology (UTAUT)

As development from TAM and several adoption models technology In addition, (Venkatesh et al., 2012) introduced the Unified Theory of Acceptance and Use of Technology (UTAUT) which integrates eight adoption models technology previous. UTAUT identifies four core construct as determinant direct intention usage: (1) *Performance Expectancy* the extent to which an individual believe that technology will help achievement performance; (2) *Effort Expectancy* level associated convenience with use technology; (3) *Social Influence* to what extent individuals perceive that important people for him believe they should use technology; and (4) *Facilitating Conditions* to what extent the individual believe that infrastructure organizational and technical available For support use technology.

UTAUT2 developed by (Venkatesh et al., 2012) extends the original model by add three more constructs relevant For context Consumers : *Hedonic Motivation* (motivation) hedonistic from use technology), *Price Value* (cognitive trade-off between benefits and costs), and *Habit* (tendency use automatic based on experience previously). The UTAUT2 model is substantial increase the explained variance to 74% for intention usage and 52% for actual usage far surpassing the original TAM. In context study this, UTAUT2 becomes more framework comprehensive Because in a way explicit take into account relevant variables for behavior consumer Millennials and Gen Z in adoption of cashless payments.

2.5.3 Theory of Planned Behavior (TPB) and Dimensions Trust

TPB believes that behavior man determined by intention, which in turn influenced by three factors: *attitude toward behavior*, *subjective norms*, and *perceived behavioral control*. In cashless payment context, *perceived behavioral control* reflects belief individual to ability they For use technology with very safe and effective close relation with construct digital trust.

(Gefen et al., 2003) respectively consistent show that trust is predictor critical in context transaction electronics. Trust in digital ecosystem involves three dimension: confidence in competence provider service , trust in the integrity of the platform, and trust in the system regulations that protect consumers . (Zhou, 2011) in general specific to mobile banking find that trust initial *trust* is built through reputation

brand, perception safety and quality information on the interface application factors that become consideration main consumer Millennials and Gen Z in choose a digital payment platform.

2.6 Relationship Service Digitalization, Cashless Payment, and Efficiency Operational

Nexus between digitalization services, cashless payments, and efficiency operational has become attention of a growing body of research in One decade lastly. In theoretical, relationship This can explained through framework *Resource-Based View* (RBV) from (Barney, 1991) who argues that digital capabilities are source Power difficult strategy imitated and can create efficiency superior in a way sustainable. More specifically, In longitudinal study of 400 companies find that investment in infrastructure technology information correlated positive significant with growth profitability through track efficiency operational, with increasing effects strong along improvement adoption on the side consumers.

In cashless payment context specifically, In a study that includes panel data from 27 European countries find that improvement use instrument payment non-cash correlated positive with growth economy, productivity, and decline cost transaction in a way aggregate. At the level micro-organization, shows that adoption system digital payments by businesses retail capable reduce cost cash handling costs average 1.5-2.0% of total revenue, in addition reduce risk loss and theft. Efficiency This become the more significant when supported by the system data analytics that enables personalization services and optimization management supply in real-time (Brynjolfsson & McAfee, 2014).

From the perspective consumer Millennials and Gen Z, the relationship between cashless payments and efficiency perceived operational nature bidirectional. In one consumer side young in a way active look for platforms that offer efficiency time and convenience usage (Ozili, 2018). On the other hand, adoption mass by group This encourage merchants and providers service For Keep going innovate in increase efficiency operational them so they can fulfil continued expectations increasing. Cycle bait come back positive This create *virtuous cycle* between innovation technology, adoption consumers, and increase efficiency that is collective push more digital transformation fast and comprehensive (Acemoglu & Restrepo, 2019).

Moderating and Mediating Factors: Trust, Security, and Digital Literacy

Connection between digitalization services, cashless payments, and efficiency operational No is simple linear, but rather moderated by a number of variables important contextual factors. Digital trust is one of the most important *moderators* in literature. (Sirdeshmukh et al., 2002) shows that trust consumer functioning as a critical mediator between quality service and loyalty behavior, while in digital context, trust also moderates effect adoption technology to intensity usage. Consumers who have level trust tall towards digital platforms tends to use it more intensive, exploitative more Lots features, and ultimately feel benefit greater efficiency large.

Security cyber (*cybersecurity*) and protection data privacy is factor moderation second crucial. (Anderson & Moore, 2006) estimated that global losses due to crime cyber reach hundreds billion dollar every year, and the threat This in a way direct influence perception risk consumer to digital services. Featherman & Pavlou's (2003) research developed the *Perceived Risk* model in e-services context that identifies seven dimensions risks performance, financial, time, psychological, social, privacy, and overall where risk privacy and finance proven to be the most dominant influence intention adoption service digital payments. For highly conscious Gen Z consumers will data privacy, dimensions This become considerations that even more significant compared to with generation previously (Gerber et al., 2018).

literacy and literacy financial *literacy* is factor moderation the third one who got attention the more big in literature. (Lusardi & Mitchell, 2014) in study comprehensive they emphasize that literacy adequate finances is prerequisite for taking decision optimal finances, including in context adoption instrument

digital payments. Found that digital literacy correlates positive significant with intensity use service digital finance and trends For recommend service the to others. In Indonesia, OJK research (2022) shows that index literacy Indonesian people's digital finance reached 49.68%, with disparity significant between urban-educated segment (which is dominated by Millennials and Gen Z) with rural-elderly segment.

3 Research Methods

Research Design

This study adopts a quantitative research design to examine the effects of service digitalization and cashless payment on operational efficiency from the perspective of Millennial and Gen Z consumers. A quantitative approach was selected because the study seeks to measure inter-variable relationships numerically and to test hypotheses derived from established theoretical frameworks.

The analytical method employed is Structural Equation Modeling-Partial Least Squares (SEM-PLS) version 4. This approach was selected given the latent and multidimensional nature of the research variables, which necessitate a method capable of simultaneously estimating measurement relationships between indicators and their latent constructs, as well as structural relationships between constructs. SEM-PLS is particularly appropriate here because it allows researchers to assess complex causal networks involving multiple latent variables within a single integrated model.

Furthermore, SEM-PLS is well-suited to studies with moderate sample sizes and a predictive modeling orientation. Unlike covariance-based SEM (CB-SEM), which requires large samples and multivariate normality assumptions, SEM-PLS is more flexible and robust across diverse data conditions, including non-normal distributions (Hair et al., 2019). Based on these considerations, two formal research hypotheses are proposed:

H1: Service digitalization has a positive and significant effect on operational efficiency.

H2: Cashless payment has a positive and significant effect on operational efficiency.

Population and Sample

The target population of this study consists of Millennial and Generation Z consumers who reside or conduct regular activities in West Java. These two generational cohorts were selected because they represent the most active consumer segments in the adoption of digital services and cashless payment systems, making them the most pertinent population for addressing the research objectives. A purposive sampling technique was employed, with respondents required to meet two eligibility criteria: (1) age classification within the Millennial (born 1981–1996) or Generation Z (born 1997–2012) cohort, and (2) active usage of digital services and cashless payment systems in daily transactions. To control for sampling quality, questionnaires were distributed via Google Form and supplemented with offline distribution across urban areas in West Java. An initial screening mechanism was embedded at the start of the questionnaire instrument, ensuring that only respondents meeting both eligibility criteria proceeded to the main survey items. Response quality was further monitored through attention-check items and consistency screening prior to data analysis.

The minimum target sample size for this study was set at 200 respondents. This determination follows the general guideline in SEM-PLS analysis requiring a minimum of 5 to 10 respondents per indicator included in the measurement model (Hair et al., 2019). With 19 indicators across three latent constructs, a sample of 200 respondents is statistically adequate to yield stable and reliable parameter estimates. It is acknowledged that the achieved sample exhibits a generational imbalance Generation Z accounts for 69.5% of respondents ($n = 139$) compared to 30.5% Millennials ($n = 61$). This asymmetry is attributable to the predominant distribution channel through social media platforms frequented by Gen Z, and

constitutes a boundary condition of the current study that is explicitly addressed in the limitations discussion.

Data Collection Method

Data were collected through a structured survey administered via both online and offline channels to maximize respondent reach and ensure adequate representation from both target generational cohorts. The online questionnaire was distributed through Google Form, shared across social media platforms including Instagram and WhatsApp, which are widely utilized by Millennial and Gen Z consumers. Offline distribution was conducted at selected locations in West Java urban areas. The survey instrument employed a five-point Likert scale (1 = strongly disagree to 5 = strongly agree), which is appropriate for capturing respondents' perceptual, attitudinal, and evaluative assessments of the study constructs.

Data Analysis Technique

Data analysis was conducted in three sequential stages: descriptive analysis, measurement model (outer model) evaluation, and structural model (inner model) hypothesis testing using SEM-PLS. The first stage, descriptive analysis, characterizes respondent profiles including generational distribution, transaction types, and cashless payment usage frequency, with results presented in frequency and percentage tables. The second stage evaluates the outer model through outer loading values (> 0.70), Average Variance Extracted (AVE > 0.50), and discriminant validity. Reliability was assessed via Cronbach's Alpha and Composite Reliability, both required to exceed 0.70; Composite Reliability (pc) is prioritized as the more appropriate indicator in PLS-SEM contexts (Hair et al., 2019).

The third stage tests the research hypotheses using the SEM-PLS inner model, evaluating path coefficients (β), T-statistics, and p-values derived through bootstrapping with 5,000 subsamples. Hypothesis acceptance follows the conventional criteria of T-statistic > 1.96 and p-value < 0.05 at the 5% significance level. Additionally, effect sizes (f^2) and predictive relevance (Q^2) are reported to assess the practical significance and out-of-sample predictive accuracy of the model, in accordance with established PLS-SEM reporting standards (Hair et al., 2019).

4 Results and Discussion

Descriptive Analysis

A total of 200 respondents participate in survey this, the picture general about profile respondents, including distribution based on group generation, type digital services used, as well as frequency use system payment non-cash. Analysis results descriptive served in form table frequency and percentage. For make it easier interpretation.

Table 1: Respondent Demographic Profile

Characteristics	Category	Frequency	Percentage (%)
Gender	Male	86	43
	Female	114	57
Generation	Millennials (1981-1996)	61	30.5
	Z (1997-2012)	139	69.5
Transaction Type	Online Shopping	107	53.5
	Offline Shopping	37	18.5
	Service Order	4	2
	Payment other	52	26
Payment Methods	Cash	56	28

Cashless	128	64
Bank Transfer	14	7
Debit/ credit card	2	1

A total of 200 respondents participated in this survey, yielding a demographically diverse sample characterized by gender, generational cohort, transaction type, and preferred payment method. The full demographic profile is presented in Table 1.

In terms of gender, female respondents constitute the majority at 57% (n = 114), compared to 43% male (n = 86). While this gender distribution is not perfectly balanced, it broadly reflects the demographic profile of active digital service users in Indonesia, where female consumers have been shown to exhibit relatively high digital payment engagement (Katadata Insight Center, 2024).

With respect to generational composition, Generation Z (born 1997–2012) constitutes the majority at 69.5% (n = 139), while Millennials (born 1981–1996) represent 30.5% (n = 61). This distributional asymmetry is an important methodological boundary condition: it is primarily attributable to the predominant use of online distribution channels (Google Form via social media) that are disproportionately frequented by Gen Z. As a consequence, the aggregate findings of this study more accurately reflect Gen Z perceptions than a balanced cross-generational comparison. Researchers seeking to conduct comparative generational analysis are advised to adopt stratified sampling in future studies to ensure equitable representation of both cohorts.

Regarding transaction types, online shopping is the most common activity among respondents (53.5%; n = 107), followed by other payment activities (26%; n = 52), offline shopping (18.5%; n = 37), and service bookings (2%; n = 4). This distribution confirms a strong digital transaction orientation within the sample, consistent with the study's focus on digital service users. In terms of payment method, cashless payments are the dominant mode, used by 64% of respondents (n = 128), followed by cash (28%; n = 56), bank transfer (7%; n = 14), and debit/credit card (1%; n = 2). The high prevalence of cashless payment adoption is consistent with national trends and aligns with the generational composition of the sample, given that Gen Z consumers are widely documented as early and intensive adopters of non-cash payment systems (Katadata Insight Center, 2024; Visa, 2023).

Outer Model and Inner Model Test Results (PLS-SEM)

Validity Test

Validity test aim For ensure that every indicators (statement items) are true measure the variable in question. In PLS-SEM, there are two types the validity tested, namely validity convergent and validity discriminant.

Validity Convergent

Validity convergent assessed first time through loading factor value, namely size correlation between indicator with variables latent. The required loading factor value is > 0.70, which means indicator the contribute strong in explain variables its latent.

Table 2: Convergent Validity Results – Loading Factor

	Cashless Payment	Digitalization of Services	Operational Efficiency
CP1	0.866		
CP2	0.853		
CP3	0.783		
CP4	0.697		
CP5	0.739		

CP6	0.839	
DL1		0.818
DL2		0.853
DL3		0.713
DL4		0.884
DL5	0.672	
DL6		0.819
DL7		0.823
OP1		0.830
OP2		0.827
OP3		0.837
OP4		0.856
OP5		0.764
OP6		0.876

For Cashless Payment (CP), all indicators CP1 through CP6 yield loading factor values ranging from 0.697 to 0.866. Although CP4 (0.697) falls marginally below the ideal threshold of 0.70, it remains acceptable given its proximity to the criterion and the overall robustness of the construct (Hair et al., 2019). All CP indicators are therefore retained and declared valid. For Digitalization of Services (DL), indicators DL1 through DL7 range from 0.672 to 0.884. DL5 (0.672) is similarly accepted on the same grounds. All DL indicators are declared valid. For Operational Efficiency (OP), indicators OP1 through OP6 all substantially exceed the 0.70 threshold, ranging from 0.764 to 0.876, confirming strong indicator validity for this construct.

Convergent validity is further assessed through the Average Variance Extracted (AVE), which quantifies the proportion of variance in a latent construct explained by its indicators. The required threshold is $AVE > 0.50$, indicating that the construct explains more than half of its indicators' variance (Fornell & Larcker, 1981).

Table 3: Validity Results Convergent — Average Variance Extracted (AVE)

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Cashless Payment	0.885	0.894	0.913	0.638
Digitalization of Services	0.905	0.916	0.925	0.641
Operational Efficiency	0.911	0.914	0.931	0.693

All three constructs exceed the minimum AVE threshold, with values ranging from 0.638 (Cashless Payment) to 0.693 (Operational Efficiency). This indicates that each latent variable explains between 63.8% and 69.3% of the variance in its respective indicators. Operational Efficiency demonstrates the highest AVE (0.693), reflecting the greatest degree of indicator homogeneity and internal consistency. Convergent validity is thus fully established for all constructs.

Discriminant validity confirms that each indicator loads more strongly on its intended construct than on any other construct in the model, demonstrating that the indicators are unique and non-overlapping measures of their respective constructs. Assessment was conducted using the cross-loading criterion, and discriminant validity is confirmed for all constructs.

Reliability Test

Reliability assessment evaluates the internal consistency and stability of the measurement instrument. An instrument is considered reliable when it produces stable and consistent measurements upon repeated application. In PLS-SEM, reliability is evaluated using two primary indicators.

Cronbach's Alpha measures internal consistency between indicator in One construct. Required values is > 0.70 . The more approach the number 1.00, the more tall level reliability instrument. Composite Reliability (CR) is size greater reliability recommended in PLS-SEM because No fully depending on the amount indicator such as Cronbach's Alpha. The required CR value is > 0.70 .

Table 4: Reliability Test Results

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Cashless Payment	0.885	0.894	0.913	0.638
Digitalization of Services	0.905	0.916	0.925	0.641
Operational Efficiency	0.911	0.914	0.931	0.693

All three constructs demonstrate Cronbach's Alpha values well above the 0.70 threshold, with all values exceeding 0.88. Following conventional benchmarks, values above 0.80 indicate high reliability, and values above 0.90 indicate very high reliability. Both Operational Efficiency ($\alpha = 0.911$) and Digitalization of Services ($\alpha = 0.905$) are classified as very high reliability. reliability high and above 0.90 is classified as very high reliability. Operational Efficiency (0.911) and Digitalization of Services (0.905) are included in very high category. Composite Reliability (ρ_c) values across all constructs exceed 0.91, further confirming very high reliability. Collectively, both Cronbach's Alpha and Composite Reliability results confirm that all measurement instruments demonstrate strong internal consistency and are suitable for hypothesis testing.

Inner Model Test

Inner model testing connection structural between latent variables, including strength model prediction, magnitude influence, as well as significance hypothesis study.

R-Square (Coefficient Determination)

R^2 (coefficient of determination) indicates the proportion of variance in the endogenous (dependent) variable explained collectively by the exogenous (independent) variables.

Table 5: R-Square Test Results

	R-square	R-square adjusted
Operational Efficiency	0.758	0.755

value = 0.758 indicates that 75.8% variation in Operational Efficiency is collectively explained by Cashless Payment and Digitalization of Services. The remaining 24.2% of variance is attributable to factors external to the model. Following Cohen's (1988) classification criteria, this R^2 value falls in the substantial (strong) category, substantially exceeding the 0.26 threshold. The Adjusted R^2 value of 0.755

confirms that the inclusion of both predictor variables contributes genuine explanatory power rather than artifactual inflation of the R^2 statistic.

Effect Size (f^2)

Effect size measures size contribution relative to each variable exogenous to endogenous variables in the model. The effect size category refers to Cohen's guidelines: small (0.02), medium (0.15), large (0.35).

Table 6: Effect Size Test Results (f^2)

	Cashless Payment	Digitalization of Services	Operational Efficiency
Cashless Payment			0.137
Digitalization of Services			0.501
Operational Efficiency			

Service Digitalization demonstrates a large effect size ($f^2 = 0.501$), substantially exceeding the large-effect threshold of 0.35 (Cohen, 2013). This confirms that service digitalization contributes a dominant and substantive share of the explained variance in operational efficiency. Cashless Payment yields a moderate effect size ($f^2 = 0.137$), indicating a meaningful but comparatively smaller independent contribution to the outcome variable.

Significance and Hypothesis Testing

Testing hypothesis done use method bootstrapping in PLS-SEM. Hypothesis accepted if mark T-statistic > 1.96 and P-value < 0.05 (at the level significance 5%).

Table 7: Results of Significance and Hypothesis Tests

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (O/STDEV)	P values
Cashless Payment -> Operational Efficiency	0.313	0.317	0.085	3,682	0.000
Digitalization of Services -> Operational Efficiency	0.597	0.594	0.080	7,501	0.000

The bootstrapping results presented in Table 7 provide support for both hypotheses. With respect to Hypothesis 1, cashless payment demonstrates a statistically significant positive effect on operational efficiency ($\beta = 0.313$; T-statistic = 3.682; $p = 0.000$), confirming that greater adoption of non-cash payment systems is associated with enhanced perceived operational efficiency among Millennial and Gen Z consumers. With respect to Hypothesis 2, service digitalization exerts a stronger and highly significant positive effect ($\beta = 0.597$; T-statistic = 7.501; $p = 0.000$), establishing it as the dominant predictor in the model. Both effects substantially exceed the critical threshold of $T > 1.96$ at the 5% significance level, providing robust statistical support for the proposed structural relationships.

The Q^2 value of 0.746 substantially exceeds the zero threshold, confirming high predictive relevance. This indicates that the model not only fits the observed data effectively but also retains strong predictive accuracy for out-of-sample observations. The SRMR value of 0.065, falling below the recommended cut-off of 0.08, indicates that the discrepancy between the observed and model-implied correlation matrices is minimal, confirming good model fit. The NFI value of 0.822, exceeding the 0.80 criterion, further corroborates overall model fit acceptability. Collectively, these fit indices confirm that the

research model achieves good model fit and meets established PLS-SEM reporting standards (Hair et al., 2019).

5 Conclusion

This study examined the effects of service digitalization and cashless payment on consumer perceived operational efficiency among Millennial and Generation Z consumers in the West Java region. Employing a quantitative approach via SEM-PLS with 200 respondents, the analysis proceeded through rigorous outer model validation to inner model hypothesis testing. All research instruments demonstrated strong validity and reliability, providing a sound basis for the statistical conclusions drawn.

First, cashless payment exerts a positive and statistically significant effect on perceived operational efficiency ($\beta = 0.313$; T-statistic = 3.682; $p = 0.000$). This finding indicates that higher levels of non-cash payment adoption among Millennial and Gen Z consumers are associated with meaningfully greater perceptions of transactional efficiency in daily activities. The medium effect size ($f^2 = 0.137$) confirms a substantive, though not dominant, contribution. Theoretically, this result is consistent with the perceived usefulness construct in TAM (Davis, 1989), wherein the time-saving and convenience dimensions of cashless systems translate directly into efficiency perceptions. It further corroborates cross-national evidence by Ozili (2018) and Shaikh and Karjaluoto (2015), who demonstrate that non-cash payment adoption reduces transaction costs and enhances user experience at both micro and macro levels. Notably, the moderate effect size also signals that cashless payment alone is insufficient to fully explain efficiency perceptions, and that its impact is likely contingent on the broader digital service ecosystem within which it operates a finding that warrants further exploration through moderation analyses in future studies.

Second, service digitalization is the stronger and more dominant predictor of operational efficiency ($\beta = 0.597$; T-statistic = 7.501; $p = 0.000$; $f^2 = 0.501$), demonstrating a large effect size that substantially exceeds conventional thresholds (Cohen, 2013). This indicates that comprehensive digital transformation spanning process automation, application-based services, and integrated digital platform ecosystems produces significant and substantive improvements in consumer-perceived operational efficiency among Millennials and Gen Z. Theoretically, this finding aligns with TAM's central proposition that perceived usefulness is the primary determinant of technology adoption behavior leading to efficiency gains (Davis, 1989), and extends it by demonstrating that usefulness perceptions operate at the level of the overall service digitalization environment, not merely individual features. The result is further corroborated by (Vial, 2019) synthesis of digital transformation literature and by (Bharadwaj et al., 2013) digital business strategy framework, both of which position service digitalization as a multi-layered value-creation mechanism. Importantly, the dominance of service digitalization over cashless payment in this model suggests that firms should prioritize holistic digital service redesign rather than payment instrument substitution alone as their primary strategy for improving the efficiency experiences of young consumers.

Third, taken together, service digitalization and cashless payment jointly account for 75.8% of the variance in consumer-perceived operational efficiency ($R^2 = 0.758$; R^2 adjusted = 0.755). This constitutes a substantial level of explanatory power by Cohen's (1988) benchmarks and is further validated by a Q^2 value of 0.746, indicating strong predictive relevance. Model fit is further confirmed by SRMR = 0.065 (< 0.08) and NFI = 0.822 (> 0.80), collectively indicating good fit between the theoretical model and the empirical data.

The findings carry several important theoretical and practical implications. Theoretically, this study enriches the scholarly literature on digital consumer behavior by providing empirical evidence that both service digitalization and cashless payment independently and jointly contribute to consumer-perceived operational efficiency — a relationship that was insufficiently examined in prior research, particularly

within generational consumer frameworks. The dominance of service digitalization ($f^2 = 0.501$) over cashless payment ($f^2 = 0.137$) further advances understanding of the relative weight of these constructs, suggesting that holistic digital service transformation generates more robust efficiency perceptions than payment instrument adoption alone. Practically, these findings offer actionable guidance for business practitioners, digital service providers, and policymakers: strategic investment in comprehensive service digitalization infrastructure should be prioritized as the primary lever for improving operational efficiency perceptions among young consumers. Simultaneously, the development of cashless payment ecosystems that are inclusive, secure, and user-friendly must be sustained to meet the evolving expectations of the Millennial and Gen Z consumer base.

This study is subject to several limitations that must be transparently acknowledged. First, the geographic scope of the research is confined to West Java, which may limit the transferability of findings to other regions of Indonesia that exhibit distinct digital infrastructure conditions, cultural contexts, and technology adoption patterns. National-level replication is recommended to enhance external validity. Second, and critically, the sample exhibits a pronounced generational imbalance: Generation Z comprises 69.5% of respondents compared to 30.5% Millennials. This distributional asymmetry constrains the comparative generational analyses that were originally positioned as a key contribution of the study; the reported results more accurately reflect Gen Z perceptions than cross-generational efficiency comparisons. Future studies should employ stratified sampling strategies to achieve balanced generational representation. Third, the research model does not incorporate moderating variables such as digital literacy, consumer trust, or cybersecurity perception that prior literature (Featherman & Pavlou, 2003; Lusardi & Mitchell, 2014) has identified as critical boundary conditions of technology adoption-to-efficiency relationships. Fourth, the reliance on self-reported perceptual data introduces common method bias risks that should be mitigated through procedural remedies in future research. Future scholars are encouraged to address these limitations through nationally representative samples, balanced generational designs, moderation-mediation frameworks incorporating trust and digital literacy variables, and longitudinal approaches that can capture the dynamic evolution of efficiency perceptions as the digital ecosystem continues to mature.

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