INDONESIAN TREASURY REVIEW
JURNAL PERBENDAHARAAN, KEUANGAN NEGARA DAN KEBIJAKAN PUBLIK

AN ANALYSIS OF THE IMPACT OF DIGIPAY UTILIZATION ON THE EXPENDITURE EFFICIENCY OF CENTRAL GOVERNMENT WORK UNITS

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ABSTRACT

Research Originality — Existing empirical research shows that digital marketplace platforms can improve expenditure efficiency, yet evidence in the public sector, especially in developing countries, remains scarce. This study provides novel empirical evidence by examining the implementation of Digipay in central government work units to assess its impact on expenditure efficiency.

Research Objectives — Digipay was designed as a digital payment platform to address several challenges in the government procurement process. This study therefore examined the impact of its adoption on procurement efficiency at the central government work unit level.

Research Methods — This study used the 2022 fiscal year data primarily drawn from the Online Monitoring Sistem Perbendaharaan dan Anggaran Negara (OMSPAN) database and the Ministry of Finance's Digipay database. The analysis applied the Mahalanobis Distance Matching (MDM) method with the Kernel Matching algorithm, supplemented by regression adjustment, to estimate the effect of Digipay.

Empirical Results — The findings indicated that Digipay adoption has enhanced procurement efficiency among central government work units nationwide. Empirical estimates suggested that its use increased efficiency by 2.59%.

Implications — Based on these results, the Ministry of Finance is encouraged to further optimize Digipay utilization to strengthen procurement efficiency across central government work units, which serve as the primary implementing unit of government expenditure.

Keywords: Digipay, efficiency, work unit
JEL Classifications: D41, O33, O38
How to Cite: Muqimuddin, S. A. & Mahi, B. R. (2025). An analysis of the impact of digipay utilization on the expenditure efficiency of central government work units. *Indonesian Treasury Review: Jurnal Perbendaharaan, Keuangan Negara dan Kebijakan Publik, 10*(3), 206-217. https://doi.org/10.33105/itrev.v10i3.1235

INTRODUCTION

Background

Budget disbursement sourced from the State Budget (*Anggaran Pendapatan dan Belanja Negara*, APBN) is regulated under Regulation of Minister of Finance No. 210/PMK.05/2022 on Payment Procedures for the Implementation of the State Budget. Despite these regulations and the administrative framework of the APBN—from the central level down to implementing work units—issues of spending efficiency remain. Allas et al. (2018) found that public sector organizations, such as governments, generally possess greater potential for expenditure efficiency than other sectors. This is because private organizations primarily aim to maximize profits, whereas public organizations aim to deliver services to society (Bastian, 2010). Likewise, the European Public Administration Network (EPAN, 2004) emphasized that government expenditure efficiency is closely related to cost savings (input) while simultaneously improving service quality (output).

According to Ministry of Finance data, in the 2020 fiscal year, 4,577 central government work units— or about 32% of the total—recorded efficiency levels below 100%, as shown in Figure 1. As the State Treasury Office, the Ministry of Finance continues to introduce measures to reduce inefficiencies in APBN spending. One approach is to encourage competition among goods and service providers (Allas et al., 2018).

To this end, the Directorate General of Treasury at the Ministry of Finance, in collaboration with the State-Owned Banks Association (*Himpunan Bank Negara*, Himbara), adapted e-commerce practices from the private sector and launched a digital marketplace called Digipay, which was rolled out nationally in the second quarter of 2021.

The objectives of Digipay align with the principles outlined in Law No. 1 of 2004 on State Treasury, particularly the promotion of sound financial management within government institutions. Hutabarat (2021) noted that one of Digipay's primary goals is to support expenditure efficiency at the work unit level, which is responsible for executing APBN expenditures. Expenditure efficiency of central government work units has been quantitatively measurable since 2020, when each unit was required to set output targets and report on their achievements. The trend in average efficiency between 2020 and 2022 is presented in Figure 2.

Alongside improvements in average efficiency, the number of inefficient work units (those with efficiency below 100%) also declined significantly. As shown in Figure 3, the number decreased from 4,577 work units in 2020 to 2,002 in 2021, and further down to 266 in 2022. This represents a 94% reduction in inefficient work units by 2022 compared to the baseline year 2020. Further, this study compared the expenditure efficiency of work units that only began using Digipay in 2022. A total of 561 work units that had not used Digipay in 2021 adopted the platform in 2022. Their average expenditure efficiency, as shown in Figure 4, rose from 105.8% in 2021 to 124.8% in 2022. This improvement indicates that Digipay utilization contributed to enhanced expenditure efficiency among these units.

Despite its potential benefits, only 1,031 out of 14,606 work units used Digipay during the 2022 fiscal year. Previous studies have identified several factors influencing purchasing decisions in digital marketplaces. Sapitri and Suprapti (2014) highlighted that credit card ownership facilitates transactions through digital channels. From the organizational perspective, the more complex the institution, the greater the need to adopt applications as a means of standardizing business processes (Schaefermeyer et al., 2012). In the case of Digipay, the availability of *Uang Persediaan* (UP, or petty cash) also influences a work unit's decision to conduct transactions through the platform.

In light of these considerations, an evaluation of Digipay implementation is necessary as it represents one form of government adoption of e-commerce, which has become increasingly prevalent in Indonesian society. This study therefore conducted a quantitative analysis of Digipay utilization and its impact on the expenditure efficiency of government work units. Digipay adoption may be regarded as a random treatment, given that its use is optional. The central research question addressed in this study is: "Does the use of Digipay affect the expenditure efficiency of central government work units?"

This study had two main objectives. First, to analyze the factors that drive work units to adopt Digipay as a government procurement platform. Second, to examine the impact of Digipay utilization on the expenditure efficiency of central government work units. By undertaking this analysis, the study sought to provide insights that can support the Ministry of Finance in formulating policies to optimize Digipay adoption across all central government work units. In addition, the findings expectedly contribute to policy making oriented toward improving central government expenditure efficiency, as well as to enrich both academic and practical discussions on evaluating the impact of Digipay utilization.

The research sample consisted of data on output achievements, budget realization, and other relevant information from the central government work units during the 2022 fiscal year. However, the work units

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APPLICATIONS FOR PRACTICE

- The findings confirm that Digipay adoption has a causal effect on improving the expenditure efficiency of government work units. Given these benefits, the Ministry of Finance, as the steward of state budget implementation, may formulate policies that encourage a greater use of Digipay across work units.
- Optimization can be pursued through several policy measures, including maximizing the allocation of *Uang Persediaan* (UP, or petty cash) and promoting the adoption and use of Government Credit Cards (KKP) by all work units.
- Maximizing UP allocation and KKP utilization would provide work units with greater flexibility in conducting procurement transactions through Digipay.

Figure 1 Expenditure Performance of Government Work Units, Fiscal Year 2020
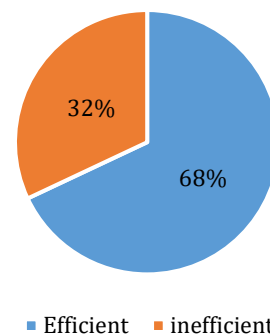
Source: OMSPAN Database, processed (2020)

located in Aceh Province were excluded from the analysis because, during the study period, Digipay was only connected to the Himpunan Bank Negara (Himbara), while all the central government work units in Aceh were mandated to use Islamic banks. The data used in this study were drawn from the Online Monitoring Sistem Perbendaharaan dan Anggaran Negara (OMSPAN) database and the Digipay database managed by the Directorate General of Treasury (DJPb), Ministry of Finance. Additional data included the availability of Base Transceiver Stations (BTS), obtained from the Ministry of Communication and Information Technology, as well as population data at the regency and municipal levels from the 2020 Population Census conducted by Statistics Indonesia (BPS). With this dataset, the study aimed to provide an evidence-based analysis to assist the government in optimizing expenditure efficiency through Digipay utilization.

**Digipay Utilization in Petty Cash (*Uang Persediaan*, UP) Expenditure**

Digipay is a platform that integrates the government marketplace with a digital payment system. The marketplace serves as a digital medium connecting sellers (goods and service providers) with buyers (work units), while the payment system facilitates non-cash transactions. Within the Digipay framework, payments are made using the work unit's UP balance and can be executed through virtual accounts (VA), cash management systems (CMS), or government credit cards (KKP) managed by the work unit.

A work unit refers to an organizational entity within a ministry, agency, or local government unit that executes ministry or agency activities and holds both authority and responsibility for budget utilization. Since all government spending is executed exclusively through work units, this study appropriately adopted them as the unit of observation to analyze spending behavior.

Digipay shares several similarities with e-commerce, as its concept is essentially an adaptation of e-commerce for government procurement. Hutabarat (2021) notes that both Digipay and e-commerce simplify and digitize business processes in procurement, integrating transactions with payment and reporting systems. Both platforms also ensure data security and provide user-friendly features. Hutabarat (2021) further elaborates on the rationale behind the establishment of Digipay, namely to:
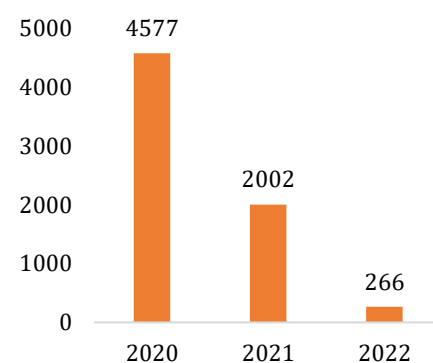
a. provide an effective and efficient government payment system;
b. support efficiency in state financial management; and
c. improve the quality of state cash management.

Figure 2 Average Efficiency of Central Government Spending from 2020 to 2022
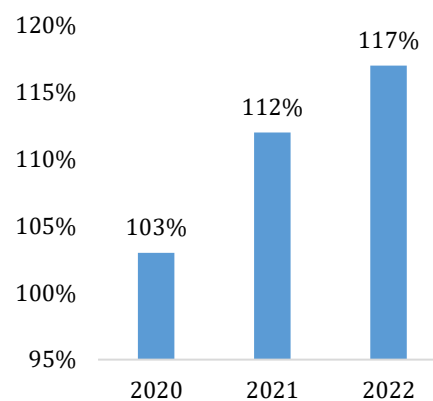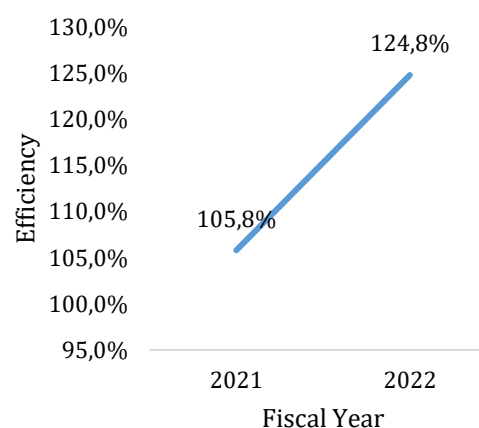

Source: OMSPAN Database, processed (2020)

Figure 3 Trend in the Number of Inefficient Work Units in 2020-2022

Source: OMSPAN Database, processed (2020)

Figure 4 Work Unit Spending Efficiency Before and After Using Digipay

Source: OMSPAN Database, processed (2020)

Despite these similarities, Digipay has distinct features. Unlike open e-commerce platforms, Digipay is a semi-closed marketplace, restricted to central government work units as buyers (Hutabarat, 2021). Furthermore, Digipay incorporates modules for automatic tax calculation, collection, withholding, and documentation for both buyers and sellers, ensuring that all transactions comply with prevailing tax regulations.

The business process of Digipay, illustrated in Figure 5, involves three main actors: work units as buyers, MSME vendors as sellers, and banks as financial service authorities. The transaction process can be described as follows:

1. The work unit places an order with an MSME vendor.
2. The MSME vendor delivers the goods and issues an invoice to the work unit.
3. The work unit instructs the bank to process the payment to the MSME vendor via CMS or KKP.
4. The bank executes the payment in accordance with the work unit's instructions.
5. The bank provides the work unit with a payment report for the MSME vendor.
6. The MSME vendor may apply for a loan from the bank, which can use Digipay's transaction database to conduct financial assessments before disbursing financing.

Figure 5 Digipay Business Process
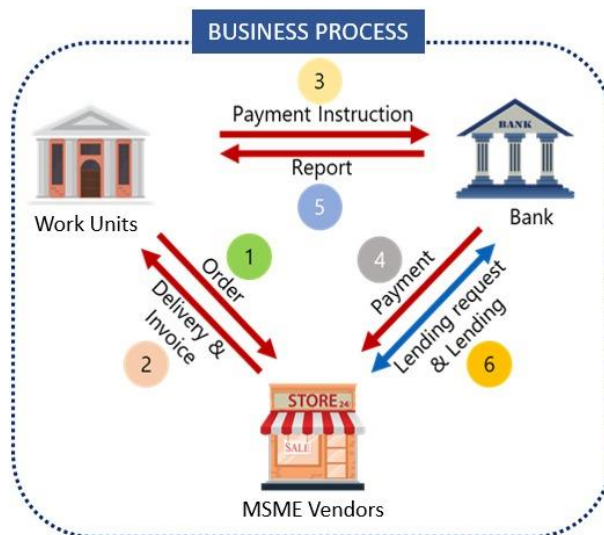
Source: Ministry of Finance (2018)

This process illustrates several potential benefits for all the stakeholders involved. Work units, as buyers, can conveniently procure routine needs online. MSMEs, as sellers, gain greater opportunities to market their products within the government procurement system. Banks, in turn, can leverage Digipay's database to enrich creditworthiness assessments when MSME vendors apply for financing.

As of 2022, more than 10,000 work units and over 4,000 MSME vendors had registered on the Digipay system. However, because Digipay use for UP expenditure is optional, not all work units adopt the platform. Only 1,035 work units were recorded to have conducted transactions through Digipay. There are no formal regulations mandating Digipay transactions, nor are there incentives or rewards for work units that adopt it. These conditions suggest that the decision to use Digipay can be regarded as free from potential selection bias.

LITERATURE REVIEW

The use of digital transactions through e-commerce platforms and non-cash payment methods has become increasingly common among consumers. In particular, millennial consumers have shifted their purchasing behavior from offline to online shopping (Hutabarat, 2021). Furthermore, non-cash payment methods such as digital banking make shopping transactions more accessible and efficient for buyers who prefer faster transactions (Ojijo & Ombok, 2023).

Digital marketplaces create competitive environments for market participants by reducing barriers to entry and issues of asymmetric information. With only a device and internet connection, buyers and sellers can easily enter or exit the digital market. In addition, digital marketplaces provide transparency regarding prices, product specifications, and availability (Jiang & Balasubramanian, 2013). Such transparency ensures that information is freely available to all market participants, which can intensify price competition among sellers (Bakos, 1997). Consequently, competition increases market efficiency, leading to lower equilibrium prices.

Efficiency is generally classified into three types: technical efficiency, allocative efficiency, and economic efficiency (Coelli et al., 1998). Technical efficiency refers to the relationship between inputs and outputs in a production process (Berger & Mester, 1997). For this study, technical efficiency was the most relevant given the availability of data on output achievements and budget realization at the work-unit level. In the context of government, efficient public services can either reduce service delivery costs or improve service quality at the same cost level (Davies, 2015). Therefore, organizational efficiency in the public sector must be measured. Common approaches include Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). However, both methods are typically applied only to relatively homogeneous groups of organizations (Coelli et al., 2005).

According to data from OMSPAN, more than 15,000 central government work units actively executed APBN functions in the 2022 fiscal year. These work units are highly diverse in terms of tasks and functions. Given this heterogeneity, DEA and SFA methods were not suitable. Instead, efficiency in this study was measured by calculating the ratio between the percentage of output target achievement and the percentage of expenditure realization for each work unit.

This measurement approach follows the methodology prescribed in Regulation of the Minister of Finance No. 22/PMK.02/2021 concerning the Measurement and Evaluation of Budget Performance in the Implementation of Ministry/Agency Work Plans and Budgets. A limitation of this method is the potential for measurement bias arising from differences in the operational fields of work units. Organizational characteristics and operational risks affect planning strategies and goal-setting (Kenton, 2024). To mitigate such bias, this study incorporated control variables, specifically dummy variables for the functions of the parent ministries/agencies.

Beyond digital marketplace usage, other factors may also influence expenditure efficiency. Employees with higher educational attainment provide greater value added per hour compared to less-educated employees (Kampelmann et al., 2018). Moreover, organizational location also matters: institutions in major cities tend to operate more efficiently due to stronger infrastructure readiness in adapting to economic shocks (Glaeser & Saiz, 2003). Based on these considerations, this study included the education level of financial management staff and organizational location as variables that may influence the expenditure efficiency of government work units (Glaeser & Saiz, 2003).

This study therefore sought to examine the impact of Digipay adoption on the expenditure efficiency of government work units. In addition, it also accounted for organizational characteristics affecting decisions to adopt Digipay, alongside other factors potentially influencing efficiency. By incorporating these variables, the study aimed to contribute novel insights to both academic and practical relevance.

METHODS

Data

The primary dataset used in this study comprised APBN implementation data at the work-unit level, sourced from the OMSPAN database. In addition, Digipay transaction data were obtained from the Digipay database. After validation and verification, a total of 14,604 central government work units were identified as the units of observation. The dataset included information on output achievements, budget realization, UP expenditure realization, Digipay transactions, KKP ownership, type of authority, and the number of certified staff in APBN financial management. To capture geographical context, the study also incorporated data on the number of 4G Base Transceiver Stations (BTS), sourced from the Ministry of Communication and Information Technology. Due to time and data constraints, the study focused on the 2022 fiscal year, when Digipay had been fully implemented for one complete year.

Analysis of Digipay Utilization Factors

The determinants of Digipay adoption were analyzed using a Probit regression model. The dependent variable was binary: work units that did not use Digipay were assigned a value of 0, while users were assigned a value of 1. The independent variables included the proportion of UP realization relative to total expenditure, KKP ownership status, and type of authority code. The authority code served as a proxy for organizational complexity. Probit regression was appropriate for this analysis given the cumulative normal distribution of the data (Gujarati, 2004). The Probit regression model is specified as follows:

$$grupdigi_i = f\ (porsirealup_i, grupkkp_i, kodekewenangan_i) \tag{1}$$

Or expressed mathematically as:

$$grupdigi_i = \beta_0 + \beta_1 porsirealup_i + \beta_2 grupkkp_i + \beta_3 kdkewenangan_i + \varepsilon_i \tag{2}$$

In this model, the dependent variable $grupdigi_i$ takes the value of 1 if a work unit adopts Digipay and 0 if it does not. The probability of Digipay adoption is therefore expressed as a function of three independent variables: the proportion of UP expenditure relative to total spending, KKP ownership, and the type of authority of the work unit. The first independent variable, $porsirealup_i$, represents the share of UP expenditure in relation to overall work-unit expenditure, with β_1 as its coefficient. The second variable, $grupkkp_i$, captures whether the work unit possesses a Government Credit Card (KKP), coded as 1 if the unit owns a KKP and 0 if it does not, with $\beta_2\backslash beta\_2\beta_2$ as its coefficient. The third variable, $kdkewenangan_i$, reflects the type of organizational authority, taking the value of 2 for central office units, 1 for regional office units, and 0 for units managing deconcentration funds (DK) or co-administration tasks (TP), with β_2 as its coefficient.

Main Regression Analysis Model

The main analysis in this study estimated the impact of Digipay adoption by government work units on expenditure efficiency using a matching approach. Matching methods generate counterfactual conditions that allow for the estimation of treatment effects by comparing outcomes between the treatment and control groups, which are statistically balanced based on predetermined criteria (Jann, 2017). Since Digipay adoption is optional and provides no rewards to its users, this setting minimized potential selection bias in the study.

The primary matching method employed was Mahalanobis Distance Matching (MDM). This model was selected because, under the same algorithm, MDM is considered more efficient than Propensity Score Matching (PSM). Unlike PSM, which functions as a completely random experiment, MDM operates as a fully blocked experiment. As a result, PSM may lead to imbalance, inefficiency, and bias, particularly with large sample sizes, because it does not eliminate unnecessary observations in the matching process (King & Nielsen, 2019). The main matching algorithm used was Kernel Matching. Jann (2017) found that Kernel Matching yields lower variance, reduced bias, and more reliable bootstrap standard errors and confidence intervals compared to nearest-neighbor or pair matching algorithms. The MDM regression equation applied in this study is expressed as follows:

$$d(i,j) = (u - v)^T C^{-1}(u - v) \qquad (3)$$

where i is the treated unit and j is the control unit, while u and v represent the values of the matching variables for i and j, respectively. The superscript TTT denotes transposition, and CCC is the covariance matrix of the matching variables across the entire control group. The matching variables in this model include the proportion of UP expenditure relative to the total budget, KKP ownership, and the type of authority of the work unit.

Following the matching process, regression adjustment was performed as recommended by Jann (2017) to further reduce bias and improve variance estimates. The regression-adjustment equation is specified as:

$$Y_i = \beta_0 + \beta_1 X_i + \gamma Z_i + \varepsilon_i \qquad (4)$$

where Y_i is the dependent variable, representing work-unit expenditure efficiency; X_i is the independent variable, equal to 1 if the work unit uses Digipay and 0 otherwise; and Z_i represents the control variables, which include the number of certified APBN financial management staff, the number of Base Transceiver Stations (BTS) in the regency/city where the work unit is located, and the function of the parent ministry/agency. Coefficient β_1 captures the estimated program effect between the treatment and control groups, while Y represents the vector of control variables. Standard errors were computed using bootstrapping with 100 repetitions.

RESULTS AND DISCUSSION
Descriptive Analysis

As shown in Table 1, there were 1,031 work units adopting Digipay, representing approximately 7% of the total observed sample. Adoption remained relatively low, as Digipay was only recently introduced and no regulation obliges work units to conduct UP transactions through the platform. Across all variables, the average values for Digipay users were higher than those for non-users.

Table 1 Probit Regression Results for Matching Variables and Digipay Adoption

Variables	Digipay Users (grupdigipay = 1)					Non-Users (grupdigipay = 0)				
	N	mean	std.dev.	min.	max.	N	mean	std.dev.	min.	max.
Efficiency	1031	1.13	0.20	0.79	2.56	13573	1.07	0.19	0.01	5.44
Matching Variables										
Share of UP (porsiup)	1031	0.18	0.15	0.001	0.97	13573	0.17	0.20	0.00	1
KKP Group (grupkkp)	1031	0.92	0.27	0	1	13573	0.63	0.48	0	1
Authority Code (kdkewenangan)	1031	1.13	0.35	0	2	13573	0.98	0.38	0	2
Control Variables										
Budget Ceiling (bts)	1031	1667.62	1796.72	47	8984	13573	1496.35	1671.41	1	8984
Employee Certification (sertpeg)	1031	4.96	7.97	0	196	13573	2.82	3.47	0	102
Function (fungsi)	1031	4.76	2.76	1	11	13573	5.72	3.34	1	11

Source: Processed from OMSPAN and Ministry of Communication and Information Technology (Kemenkominfo) databases, 2022.

Probit Analysis of Digipay Adoption Factors

Before conducting regression with the matching method, the matching variables were first determined. Matching variables are derived from factors influencing whether an individual receives treatment. In this study, they represented factors that influenced a work unit's decision to adopt Digipay. The results of the probit regression analysis of Digipay adoption factors are presented in Table 2.

Table 2 shows that all the three matching variables significantly increased the probability that a work unit would use Digipay. A higher proportion of UP expenditure relative to the total expenditure increased the likelihood of adoption, since Digipay transactions are funded from UP allocations. Work units with KKP ownership were also more likely to use Digipay compared to those without such ownership, likely because credit cards facilitate digital marketplace payments. In addition, more complex work units have a greater tendency to conduct procurement digitally rather than through conventional means.

Table 2 Probit Regression Results of Matching Variables on Digipay Adoption

Variables	(1) Digipay Group
Share of UP (porsiup)	0.692***
	(0.0924)
KKP Group (grupkkp)	0.758***
	(0.0494)
Authority Code = 1 (1.kdkewenangan)	0.812***
	(0.152)
Authority Code = 2 (2.kdkewenangan)	1.111***
	(0.162)
Constant	-2.994***
	(0.154)
Observations	14,604

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Processed by the author

To facilitate the interpretation of the influence of the independent variables on the dependent variable, Table 3 presents the estimation results in the form of marginal effects of the factors that encourage government work units (*satuan kerja*) to adopt Digipay. An increase of 1% in the share of expenditure realized through the UP mechanism, relative to the total expenditure of a work unit, increased the probability of Digipay adoption by 8.7%. Furthermore, work units that possessed a KKP had a 9.6% higher probability of using Digipay compared to those without a KKP. In addition, work units with KD authority (1) had a 5.7% higher probability of adopting Digipay compared to work units with DK/TP authority (0). Similarly, work units with KP authority (2) exhibited a 10.4% higher probability of Digipay adoption compared to those with DK/TP authority (0).

Table 3 Marginal Effects of Factors Influencing Digipay Adoption

Variables		dy/dx	Delta Method Std. Err.	z	P>|z|	[95% *Conf. Interval*]	
Share of UP (porsiup)		0.877505	0.0117718	7.45	0.000	0.0646782	0.1108228
KKP Group (grupkkp)		0.961161	0.0064566	14.89	0.000	0.0834614	0.1087708
Authority Code (kdkewenangan)							
	1	0.053695	0.0050745	11.31	0.000	0.4742370	0.0673154
	2	0.1040769	0.0107151	9.71	0.000	0.0830756	0.1250781

Source: Processed by the author

OLS Regression

As an initial step in assessing the relationship between Digipay adoption and the expenditure efficiency of government work units, the author conducted an Ordinary Least Squares (OLS) regression. The results are presented in Table 4. Column (1) of Table 4 displays the OLS regression results for the variable of interest in work unit expenditure efficiency. Column (2) reports the OLS regression results after incorporating the control variable of the number of employees within the work unit holding APBN financial management certification. Meanwhile, Column (3) presents the OLS regression results after including both the number of certified employees and the location of the work unit as the control variables.

Based on the regression results in Table 4, Column (1) indicates that Digipay adoption was associated with a 6.42% increase in expenditure efficiency, statistically significant at the 1% level. The results in Column (2) show that Digipay adoption was correlated with a 6.04% improvement in work unit expenditure efficiency, while additional employees holding APBN financial management certification were associated with a 0.18% increase in efficiency. Furthermore, Column (3) estimates that Digipay adoption was associated with a 6.02% improvement in expenditure efficiency; additional certified APBN financial management employees were correlated with a 0.15% increase; and an additional BTS unit in the regency/municipality where the work unit was located was correlated with a 0.000004% increase in efficiency.

To strengthen the OLS estimation results, an additional regression was conducted involving an interaction variable between Digipay adoption and the number of BTS units in the regency/municipality

Table 4 Ordinary Least Squares (OLS) Regression Results

	(1) Efficiency	(2) Efficiency	(3) Efficiency	(4) Efficiency	(5) Efficiency
Digipay Adoption (1 = Yes; 0 = No)	0.0642***	0.0604***	0.0602***	0.0499***	0.0358***
	(0.00616)	(0.00622)	(0.00621)	(0.00840)	(0.00835)
Observation	14604	14604	14604	14604	14604
Control Variables:					
Certified Employees	No	Yes	Yes	Yes	Yes
Number of BTS Units	No	No	Yes	Yes	Yes
Interaction: Digipay Adoption × BTS Units	No	No	No	Yes	Yes
Function of Parent Ministry/Agency	No	No	No	No	Yes

Source: Processed by the author

where the work unit operated. The regression results, presented in Column (4), show that the interaction variable carried a positive coefficient. This finding suggested that BTS availability in a given regency/municipality supported Digipay adoption as a digital procurement platform and was correlated with a 0.000006% increase in work unit efficiency. Meanwhile, the coefficient of interest was adjusted to 4.99%.

To address potential measurement bias in efficiency, the regression incorporated a control dummy variable for the functional classification of the parent Ministry/Agency of each work unit. The results of this regression, presented in Column (5), use Function 1 (General Services) as the base category. The estimations indicated that the majority of the observed functions had a significant effect on efficiency. In addition, the coefficient of interest was further adjusted to 3.58%.

The OLS estimation results, incorporating all covariates, suggested that Digipay adoption was correlated with a 3.58% increase in work unit expenditure efficiency. However, this estimation could not establish a causal relationship between Digipay adoption and efficiency. This limitation arose due to heterogeneity across work units, making it uncertain whether the control and treatment groups met the counterfactual condition. Therefore, further estimation using alternative models is required.

Mahalanobis Distance Matching (MDM) Regression

To anticipate potential bias in the OLS model, this study employed a matching method using the Mahalanobis Distance Matching (MDM) model with a kernel algorithm. The matching results demonstrated that most observations across both groups were successfully paired, providing a reliable basis for estimation. The detailed results of matching between the two groups are presented in Table 5.

Table 5 Results of Mahalanobis Distance Matching

	Matched			Controls			Bandwidth
	Yes	No	Total	Used	Unused	Total	
Treated	969	62	1031	7541	6032	13573	0.0024102

Source: Processed by the author

Table 5 shows that most treated group observations (Digipay users) were successfully matched with the counterfactual units from the control group. Specifically, 969 Digipay-using work units were matched with 7,541 non-using work units, forming the analytical basis for estimating the Average Treatment Effect on the Treated (ATT). Under these conditions, the matching results are expected to produce unbiased estimates.

To assess the balance of data after matching, a post-estimation balance diagnostic was conducted, the results of which are presented in Table 6. The results showed that the standardized mean differences between the treatment and control groups approached zero, while the variance ratios between the two groups approached one. A standardized mean

Table 6 Balance Diagnostic Results

Source: Processed by the author

difference close to zero and a variance ratio close to one indicate strong data balance (Ye, 2021).
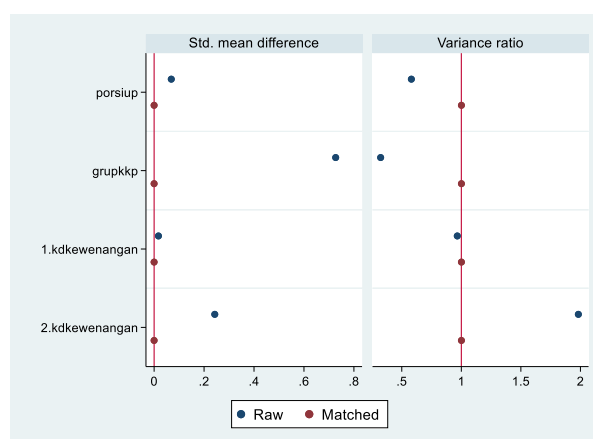
The main estimation results using the MDM-Kernel model with regression adjustment, based on the matching variables, are presented in Table 7. Column (1) reports the effect of Digipay adoption on work unit expenditure efficiency without including the control variables. Column (2) shows the effect after incorporating the control variable for the number of employees holding APBN financial management certification. Column (3) further includes the location of the work unit as the control variable.

Table 7 Estimation Results of the Main Model

Variables	(1) Efficiency	(2) Efficiency	(3) Efficiency	(4) Efficiency
	0.0504***	0.0476***	0.0476***	0.0259***
Digipay Adoption – ATT	(0.00776)	(0.00890)	(0.00766)	(0.00925)
Observations	14,604	14,604	14,604	14,604
Control Variables:				
Certified Employees	No	Yes	Yes	Yes
Interaction: Digipay Adoption × Number of BTS Units	No	No	Yes	Yes
Function of Parent Ministry/Agency	No	No	No	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Processed by the author

The effect of Digipay adoption by work units, as the variable of interest, on expenditure efficiency is represented by the Average Treatment Effect on the Treated (ATT) derived from the matching regression in Table 7. The regression results without any control variables, shown in Column (1), yield an ATT value of 0.0504, statistically significant at the 1% level. This finding indicated that, on average, Digipay adoption increased work unit expenditure efficiency by 5.04%.

Columns (2), (3), and (4) present the results of matching regressions that incorporated control variables, namely the number of employees within the work unit holding APBN financial management certification, the interaction between Digipay adoption and the number of BTS units, and dummy variables for the functional classification of the parent Ministry/Agency. The final ATT estimation, incorporating all the control variables, yielded a value of 0.0259, implying that, on average, Digipay adoption increased expenditure efficiency by 2.59%. This result is consistent with the findings of Florian Bauer and Martin Göbl (2019), who reported that the digitalization of procurement processes improved efficiency by 3.12%. The consistency in direction and similarity in ATT values is expected to increase the robustness of the estimation results in this study.

Table 8 Comparison of Estimation Results: OLS, PSM, and MDM Models

	(1) OLS	(2) PSM Kernel	(3) MDM Kernel
Digipay Adoption – ATT	0.0358***	0.0197***	0.0259***
(1 = Yes; 0 = No)	(0.00835)	(0.00866)	(0.00925)
Observations	14,604	14,604	14,604
Control Variables:			
Certified Employees	Yes	Yes	Yes
Interaction: Digipay Adoption × BTS Units	Yes	Yes	Yes
Function of Parent Ministry/Agency	Yes	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Processed by the author

Robustness Test

To strengthen confidence in the estimation of the main regression model, robustness testing was conducted. This stage of testing involved comparing the estimation results of the main model with those of alternative models. Furthermore, to obtain more stable standard errors, the author applied bootstrapping with 100 replications for each estimation model. In this study, the robustness test was performed by comparing the estimation results of the MDM model with those of Propensity Score Matching (PSM) and OLS regressions, thereby assessing the extent to which the main model mitigated potential bias. The comparison of the estimation results across the models is presented in Table 8.

The results in Column (1) of Table 8 show that Digipay adoption by work units was correlated with a 4.54% increase in expenditure efficiency. However, the OLS estimation produced an overestimated coefficient. This is evident from the reduction in ATT values when the alternative models were employed, with estimates ranging between 2.07% and 2.56%. The consistent direction and relatively stable magnitude of coefficients confirmed the robustness of the main model (MDM-Kernel), which estimated that Digipay

adoption increased efficiency by 2.56%. The correction of ATT values relative to the OLS regression results demonstrated that the use of matching models is effective in addressing potential bias inherent in OLS estimations.

CONCLUSION

Research on the impact of digitalization and e-commerce utilization on budget efficiency has been widely conducted, both in the public and private sectors. The majority of studies argue that the use of information technology in creating digital marketplaces can enhance efficiency in terms of both time and cost. Motivated by these benefits, the Ministry of Finance adopted e-commerce practices from the private sector by developing a government marketplace integrated with a digital payment module known as Digipay. Against this backdrop, the present study aimed to estimate the impact of Digipay implementation on central government expenditure efficiency. In addition, the study analyzed the factors influencing the decisions of work units, as budget implementing agencies, to adopt Digipay as a platform for procurement transactions.

Using Ministry of Finance data for the 2022 fiscal year and Probit regression analysis, the study found that Digipay adoption by work units was influenced by three key factors: the proportion of UP-managed expenditure relative to the total budget, the possession of a government credit card (KKP), and the complexity of the work unit's business processes. These factors were subsequently employed as the matching variables in regressions using the Mahalanobis Distance Matching (MDM) model.

The MDM regression model, combined with regression adjustment, yielded a positive and significant impact of Digipay adoption on expenditure efficiency, with an estimated increase by 2.56%. This regression also included three control variables: the number of certified APBN financial management staff, the number of BTS units in the regency/municipality where the work unit was located, and the functional classification of the parent Ministry/Agency. The estimated effect was slightly lower than the findings of Bauer and Göbl (2019), who reported that procurement digitalization in private companies increased efficiency by 3.12%.

In addition to the impact of Digipay adoption, this study also showed that other control variables significantly influenced expenditure efficiency. Estimations using the OLS model, Propensity Score Matching (PSM), and the main model consistently demonstrated that both the variable of interest and the control variables significantly affected work unit efficiency, while also correcting the ATT coefficients. This correction indicates that the MDM model employed in this study is effective in mitigating potential bias that may arise from OLS regression.

Recommendations

The study provides evidence that Digipay adoption has a causal effect on improving work unit expenditure efficiency. Based on these findings, the Ministry of Finance, as the authority overseeing APBN implementation, should design policies that encourage the optimization of Digipay utilization across work units. Policy strategies could include: (1) optimizing the proportion of UP-managed expenditure to provide work units with greater flexibility in conducting procurement transactions through Digipay, and (2) promoting the application and use of government credit cards (KKP) across all work units to facilitate greater transactional flexibility on the Digipay platform.

A more assertive approach to Digipay optimization could involve phasing out cash-based UP expenditure mechanisms, thereby making Digipay a mandatory platform for all UP-related transactions. Such policy is expected to improve efficiency across all work units. However, implementing mandatory Digipay utilization would require addressing several key challenges, including: (1) integrating Digipay's marketplace system with Islamic banking systems, particularly to accommodate the work units in Aceh Province where Sharia-compliant banking is mandatory; (2) Conducting socialization and training programs through the Ministry of Finance's regional offices, involving all work units, local MSMEs, and banks within the region; and (3) expanding supporting infrastructure, such as providing BTS units in underserved areas, to ensure reliable internet access nationwide.

In addition to optimizing Digipay, the Ministry of Finance could also introduce complementary policies to improve expenditure efficiency, such as: (1) monitoring the availability of certified APBN financial managers within work units. For those without any certified staff, the Ministry should provide training and certification programs, and (2) conducting regional evaluations of work unit spending performance as a basis for formulating policies to enhance efficiency in regions where efficiency levels are still low.

Furthermore, technical ministries/agencies should carry out thorough assessments of budget planning and target-setting processes within their respective work units to ensure more accurate measurement of efficiency outcomes.

Limitations

Despite the contributions of this study, several limitations should be acknowledged. First, the measurement of the impact of procurement digitalization on efficiency focused solely on Digipay utilization, without considering other forms of digital technology adoption. Second, the study utilized only the 2022 data, the first year when Digipay was implemented fully. This limits the ability to capture behavioral changes in work units across multiple years. Future studies should therefore incorporate longitudinal data (2022 onwards) to examine temporal shifts in Digipay utilization and expenditure efficiency.

Third, work units in Aceh Province were excluded from the sample because, in 2022, Digipay was only connected to Himbara banks, while Aceh requires all government financial management to be conducted through Islamic banks. Fourth, Digipay adoption as the variable of interest did not account for transaction volume or frequency of use. Future research should refine the measurement of Digipay utilization by incorporating these dimensions to generate more accurate estimates and more comprehensive policy recommendations.

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Appendix Results of Ordinary Least Squares (OLS) Regression

Variables	(1) Efficiency	(2) Efficiency	(3) Efficiency	(4) Efficiency	(5) Efficiency
Digipay Adoption (grupdigipay)	0.0642***	0.0604***	0.0602***	0.0499***	0.0358***
	(0.00616)	(0.00622)	(0.00621)	(0.00840)	(0.00835)
Certified Employees (sertpeg)		0.00178***	0.00152***	0.00148***	0.00124***
		(0.000398)	(0.000402)	(0.000403)	(0.000404)
Number of BTS Units (bts)			4.33e-06***	3.84e-06***	1.51e-06
			(9.47e-07)	(9.85e-07)	(9.98e-07)
Interaction: Digipay × BTS				6.27e-06*	5.65e-06*
(grupdigipay × bts)				(3.45e-06)	(3.40e-06)
Defense (2)					-0.0347***
					(0.0131)
Law and Order/Security (3)					0.0170***
					(0.00591)
Economy (4)					0.0882***
					(0.00628)
Environment (5)					0.0194**
					(0.00777)
Housing and Public Facilities (6)					0.00582
					(0.00930)
Health (7)					0.118***
					(0.0106)
Tourism and Culture (8)					0.0496 (0.0488)
Education (10)					0.0200***
					(0.00570)
Social Protection (11)					0.0161 (0.0231)
Constant	1.068***	1.063***	1.057***	1.058***	1.034***
	(0.00164)	(0.00198)	(0.00235)	(0.00240)	(0.00538)
Observations	14,604	14,604	14,604	14,604	14,604
R-squared	0.007	0.009	0.010	0.010	0.014

Source: Processed by the author