

The Effect of Using CHRONOS (Slot Time Application) on Runway Capacity Management at Adisutjipto Airport, Yogyakarta

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Abstract

This study aims to examine the use of the Slot Time Application (CHRONOS) in runway capacity management, analyze its effect on the effectiveness of runway capacity management, identify obstacles encountered in its implementation, and formulate efforts to improve its effectiveness at Adisutjipto Airport Yogyakarta. The study is motivated by the importance of runway capacity management in maintaining the safety, efficiency, and smooth operation of air transportation. CHRONOS is a slot time management system used to regulate aircraft movements in accordance with the available airport capacity. This research employed a quantitative method with a simple linear regression approach. Data were collected through questionnaires distributed to 60 respondents involved in flight operations at Adisutjipto Airport Yogyakarta. Data analysis was conducted using IBM SPSS, including validity, reliability, and normality tests, as well as simple linear regression, partial t-test, and coefficient of determination (R^2) analysis. The results indicated that all research instruments were valid and reliable, and the data were normally distributed. The findings revealed that the use of the Slot Time Application (CHRONOS) has a positive and significant effect on the effectiveness of runway capacity management. This is evidenced by a regression coefficient of 1.024, a calculated t-value of 25.570 which is greater than the t-table value of 2.001, and a significance value of $0.000 < 0.05$. Furthermore, the coefficient of determination (R^2) of 0.917 indicates that CHRONOS accounts for 91.7% of the variation in runway capacity management effectiveness, while the remaining 8.3% is influenced by other factors. Therefore, optimizing the use of CHRONOS is essential to enhance runway capacity management effectiveness and support efficient flight operations

Keywords: CHRONOS, slot time, runway capacity, effectiveness, Adisutjipto Airport.

INTRODUCTION

Air transportation is widely regarded as a fast and efficient mode of travel, capable of covering long distances within a relatively short time and reaching areas that are difficult to access by other means. In Indonesia, this advantage supports mobility, economic growth, and tourism, particularly in the Special Region of Yogyakarta, a province renowned for its cultural heritage, history, education, and arts that attracts a substantial flow of domestic and international visitors.

Yogyakarta is served by two airports: Adisutjipto Airport and Yogyakarta International Airport (YIA). Although most commercial flights have shifted to YIA, Adisutjipto—operating under enclave civil status—continues to accommodate military operations, selected civil flights, and flight training activities for the Indonesian Air Force (TNI AU), and its proximity to Yogyakarta's city center keeps it relevant for a portion of air travelers despite the shift in commercial traffic. Traffic data compiled by AirNav Indonesia's Yogyakarta branch over the past three years recorded 14,950 civil aircraft movements and 28,911 military aircraft movements at Adisutjipto (LPPNPI Yogyakarta, 2025), reflecting a substantial volume of mixed civil–military operations. Airport capacity, which the International Civil Aviation Organization (ICAO) describes as a function of runway configuration, navigation systems, weather conditions, and coordination among operational units, is declared for Adisutjipto at 17 movements per hour for its runway, alongside terminal and apron capacities of 411 passengers and 11 movements per

hour, respectively, for the Summer 2026 period. Direct observation during operational duty at AirNav Indonesia's Yogyakarta branch, however, indicates that this runway limit is frequently exceeded during military training flight activities, creating the potential for air traffic congestion, increased Air Traffic Controller (ATC) workload, flight delays, and a diminished margin of separation.

To manage this imbalance between flight demand and airport capacity, AirNav Indonesia relies on slot time—defined under Minister of Transportation Regulation No. PM 57 of 2014 as an allocated time period granted to a flight for using airport facilities—administered through the CHRONOS application as part of its Air Traffic Flow Management (ATFM) system. CHRONOS allows ATC, ATFM units, airlines, and airport operators to monitor capacity availability in an integrated, real-time manner so that aircraft movements remain aligned with declared capacity.

Prior studies support the relevance of slot time management to airport traffic effectiveness. Fauziah and Budi (2023) found a measurable relationship between slot time compliance and Target Take-Off Time (TTOT) achievement at Juanda International Airport, while Kusuma (2023) reported that post-pandemic growth in flight demand at Sultan Mahmud Badaruddin II Airport had outpaced existing slot time arrangements, limiting their effectiveness. Specifically regarding CHRONOS, Ramadhan (2022) noted that the system supports the regularity of estimated departure and arrival times but remains constrained by full-booking conditions and coordination gaps between airlines and ATFM units, and Tanjung (2025) similarly found that slot time management affects on-time performance and hourly traffic flow at Radin Inten II Airport. Collectively, these studies confirm that slot time and CHRONOS meaningfully influence airport traffic effectiveness, yet none examine this relationship within an enclave civil airport that simultaneously serves civil and military traffic, a context in which shared runway use by two distinct operational demands is likely to introduce coordination challenges not captured in single-use airport settings (Setiawan, 2019).

This gap underlies the need for empirical investigation into how CHRONOS is used in practice at Adisutjipto Airport, the extent of its influence on runway capacity management effectiveness, the obstacles encountered in its implementation, and the measures that could strengthen its contribution. Accordingly, this study aims to (1) examine the use of the CHRONOS slot time application in runway capacity management at Adisutjipto Airport, Yogyakarta; (2) analyze the effect of CHRONOS usage on the effectiveness of runway capacity management; (3) identify the obstacles encountered in its implementation; and (4) propose recommendations to enhance its effectiveness in supporting runway capacity management at Adisutjipto Airport, Yogyakarta.

RESEARCH METHODS

This study employs a quantitative approach using a survey method to examine the influence of the CHRONOS slot time application (independent variable, X) on the effectiveness of runway capacity management (dependent variable, Y) at Adisutjipto Airport, Yogyakarta. The population consists of all AirNav Indonesia Yogyakarta Branch personnel involved in the use of the CHRONOS application — including Air Traffic Controllers (ATC), Air Traffic Flow Management (ATFM) officers, and related operational officials — totaling 101 people. The sample size was determined using the Slovin formula with a 10% margin of error, yielding a minimum of 50 respondents; this was set at 60 respondents to increase data representativeness. Respondents were selected based on direct involvement in slot time and air traffic management, and a minimum of one year of operational work experience.

Variable X was measured through indicators of ease of application use, accuracy of slot time management, capability for airport capacity monitoring, and ease of coordination among

aviation stakeholders, drawing on the Technology Acceptance Model (Davis, 1989), the Information System Success Model (DeLone & McLean, 2003), and the concept of Collaborative Decision Making within ATFM (ICAO, 2018). Variable Y was measured through indicators of flight operation smoothness, alignment between aircraft movements and runway capacity, reduction of air traffic congestion, and efficiency of navigation services, based on airport capacity management concepts (Horonjeff et al., 2010; ICAO, 2018) (Table 1).

Data were collected through a five-point Likert-scale questionnaire, supplemented by direct observation of slot time management practices and documentation such as SOPs, ATFM data, and flight traffic reports. Data were processed using IBM SPSS through validity testing (Corrected Item-Total Correlation, $\alpha = 0.05$), reliability testing (Cronbach's Alpha > 0.60), and normality testing (One-Sample Kolmogorov-Smirnov). The relationship between variables was analyzed using simple linear regression, followed by a t-test to examine the significance of the effect and a coefficient of determination (R^2) test to determine the magnitude of variable X's contribution to variable Y.

Table 1. Operational Definitions and Variable Indicators

Variable	Operational Definition	Indicators
Use of the CHRONOS Application (X)	Utilization of the CHRONOS application in managing flight slot time to support ATFM	Ease of use; slot time accuracy; capacity monitoring; operational coordination
Effectiveness of Runway Capacity Management (Y)	Level of success in managing runway capacity so that flight operations run safely, orderly, and efficiently	Flight operation smoothness; runway capacity alignment; traffic congestion reduction; navigation service efficiency

RESULTS AND DISCUSSION

Result

Adisutjipto Airport operates a single 2,200-by-45-metre runway as a civil enclave shared with military traffic, a configuration that leaves little room for scheduling error and makes accurate slot time management essential to safe, orderly operations. Before testing the study's hypothesis, the research instrument and the assumptions underlying parametric analysis were verified using data collected from 60 respondents drawn from ATC, ATFM, and related operational personnel at AirNav Indonesia's Yogyakarta branch. Table 2 summarizes the validity, reliability, and normality test results.

Table 2. Instrument and Assumption Test Results

Test	Variable	Result	Criterion	Remark
Validity (r-count range)	CHRONOS Use (X)	0.580–0.790	$> r\text{-table}$ 0.254	All items valid
Validity (r-count range)	Runway Capacity Effectiveness (Y)	0.645–0.808	$> r\text{-table}$ 0.254	All items valid
Reliability (Cronbach's Alpha)	X	0.874	> 0.60	Reliable
Reliability (Cronbach's Alpha)	Y	0.889	> 0.60	Reliable
Normality (K-S Sig.)	X	0.373	> 0.05	Normal
Normality (K-S Sig.)	Y	0.374	> 0.05	Normal

Source: Data processed using SPSS, 2026.

All sixteen questionnaire items exceeded the critical r-table value of 0.254, confirming that each item validly represented its intended indicator. Within the CHRONOS Use variable, the item measuring ease of coordination among operational stakeholders returned the highest correlation, 0.790, while the item concerning the application's role in controlling aircraft movement volume scored lowest, though still valid, at 0.580. A parallel pattern appeared for the Runway Capacity Management Effectiveness variable, where the items on flight operation smoothness and navigation service efficiency tied for the highest correlation at 0.808, and the item on alignment between aircraft movements and runway capacity scored lowest at 0.645. Both variables also showed strong internal consistency, with Cronbach's Alpha values of 0.874 and 0.889, well above the 0.60 threshold, and the Kolmogorov-Smirnov test confirmed both variables were normally distributed, with significance values of 0.373 and 0.374.

Simple linear regression, presented in Table 3, produced the equation $Y = -0.617 + 1.024X$. The coefficient of 1.024 indicates that each one-unit improvement in CHRONOS use corresponds to an increase in runway capacity management effectiveness. The t-test confirmed this relationship was statistically significant, with a t-count of 25.570 against a t-table value of 2.001 and a significance level of 0.000, leading to rejection of the null hypothesis. The coefficient of determination, at 0.917, shows that CHRONOS use explains 91.7 percent of the variance in runway capacity management effectiveness, with the remaining 8.3 percent attributable to factors outside this study.

Table 3. Simple Linear Regression, t-Test, and Coefficient of Determination Results

Variable	B	t-count	Sig.	R	R ²
Constant	-0.617	-0.506	0.615		
CHRONOS Use (X)	1.024	25.570	0.000	0.958	0.917

Source: Data processed using SPSS, 2026.

Discussion

These results support the proposition that a well-functioning slot allocation system materially strengthens runway capacity management at airports with constrained infrastructure. The finding is consistent with the ease-of-use dimension of the Technology Acceptance Model (Davis, 1989) and the system- and information-quality constructs of the Information System Success Model (DeLone & McLean, 2003). Respondents rated coordination among operational units as the strongest indicator of CHRONOS's value, aligning with the application's design purpose as a tool for Airport Collaborative Decision Making and Air Traffic Flow Management under ICAO's (2018) guidance.

The comparatively lower, though still valid, score for the item on directly controlling aircraft movement volume suggests that respondents perceive CHRONOS primarily as a scheduling and allocation instrument rather than a real-time traffic control mechanism. This is consistent with its function as a slot management system operating upstream of, and in support of, the tactical separation duties performed by air traffic controllers: CHRONOS shapes the conditions under which traffic flows, while moment-to-moment aircraft movement remains an air traffic control responsibility.

The coefficient of determination here is notably higher than the 52.6 percent reported by Amany and Kusuma (2025), whose study at the same AirNav Yogyakarta branch linked CHRONOS use to Target Take-Off Time achievement rather than to overall runway capacity effectiveness. This gap may reflect that Target Take-Off Time achievement is affected by additional operational variables, such as taxiway sequencing and aircraft readiness, that fall outside slot allocation itself, as well as Adisutjipto's especially tight runway constraints, which may make accurate slot management contribute proportionally more than it would at airports with greater capacity headroom.

The residual 8.3 percent of unexplained variance is consistent with the broader view that runway capacity outcomes are shaped by more than any single information system. Given the airport's shared civil-military runway and limited land for expansion, factors such as weather conditions, taxiway queuing, and inter-agency coordination continue to influence capacity outcomes independently of slot management, consistent with ICAO's (2018) framework and Horonjeff et al.'s (2010) account of runway capacity determinants. CHRONOS therefore functions best as one component within a broader capacity management system rather than as a stand-alone solution.

Taken together, these findings point to practical priorities for strengthening runway capacity management at Adisutjipto: sustained training to raise user proficiency with CHRONOS, particularly its monitoring and communication features; closer integration of CHRONOS data with other operational systems used by the air navigation service provider; and periodic evaluation of slot realization against actual aircraft movements to identify and correct emerging mismatches. Addressing these complementary factors alongside continued CHRONOS optimization offers the clearest path toward further improving runway capacity effectiveness at similarly constrained airports.

CONCLUSION

This study concludes that the CHRONOS slot time application functions as a structured, technology-based tool that meaningfully supports runway capacity management at Adisutjipto Airport, an airport whose single, shared civil-military runway leaves little tolerance for scheduling inefficiency. By enabling flight slot allocation, airport capacity monitoring, and coordination among aviation stakeholders to be carried out through an integrated, real-time system, CHRONOS strengthens the ability of AirNav Indonesia's Yogyakarta branch to keep flight operations safe, orderly, and efficient.

The application's use is shown to exert a strong, positive influence on runway capacity management effectiveness, confirming that more optimal use of CHRONOS corresponds to better capacity management outcomes, although these outcomes are not determined by the application alone: user competence, sudden schedule changes, weather conditions, traffic density, and inter-agency coordination continue to shape results. Sustaining and extending this influence will depend on regular training to deepen user proficiency with the application's full feature set, stronger coordination among aviation stakeholders, continuous monitoring and evaluation of slot time realization against actual aircraft movements, and closer integration between CHRONOS and other operational systems so that decisions can be made more quickly and accurately. Taken together, these findings indicate that a well-managed slot allocation system, supported by competent personnel and coordinated institutional practice, is central to sustaining safe, orderly, and efficient runway operations at airports facing similarly constrained capacity.

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