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OPTIMIZATION OF LOGISTICS ARRANGEMENT OF AVIATION INFRASTRUCTURE IN PAPUA

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Abstract
The Air Bridge cargo air transport subsidy program in Papua aims to reduce price disparities and ensure logistics availability in the 3TP (Underdeveloped, Remote, Outermost, Border) regions that are highly dependent on air transportation. This study analyzes logistics movements and examines their implications for the capacity of airport cargo terminal infrastructure. The method used is descriptive with quantitative and qualitative approaches. This study integrates *Least Square forecasting* , *Systematic Layout Planning* (SLP) through *Activity Relationship Chart* (ARC), and safety and operational standards analysis. The analysis results project Sentani Airport's cargo load to reach 120,167 tons in 2026, which could trigger *overcapacity conditions* . Existing findings indicate weaknesses in warehouse layout and stockpiling that obstruct circulation routes. Optimization is focused on rearranging the layout through the ARC approach and separating specific goods placement using *Systematic Layout Planning* (SLP), as well as implementing strict Standard Operating Procedures (SOPs) for special cargo and *perishable goods* . This development, combined with the *Business Model Canvas* (BMC) strategy and optimal distribution routes, is essential to support an effective aviation logistics ecosystem in Papua.

Keywords: *Activity Relationship Chart*, *Business Model Canvas*, Airport Infrastructure, Air Logistics, *Systematic Layout Planning*, Papua, Air Bridge Program.

INTRODUCTION

Papua Province has extreme geographical characteristics with mountainous and forested topography that causes a high dependence on air transportation for food logistics distribution. These limited infrastructure and geographical location create structural barriers that lead to high logistics costs (*high-cost economy*). In response, the government initiated the Air Bridge program through subsidies for pioneering air cargo transportation to reduce price disparities in the 3T region as a form of *Public Service Obligation* . (Ana Devi Simatupang, 2018; Nopiah et al., 2024; RI, 2021). As the Air Bridge program progresses, the volume of air cargo movements continues to experience a significant increase every year, which is also supported by the trend of increasing loading and unloading activities nationally. This increase in cargo flow requires comprehensive optimization of aviation infrastructure, particularly in the capacity and layout *of* airport cargo terminals. Well-organized warehousing facilities have been proven to have a positive and significant impact on the effectiveness of logistics management in the Papua region.(Riadi et al., 2021; Wahyu Poncotoyo et al., 2024)

Currently, cargo warehousing management, such as that at the Sentani International Airport Cargo Terminal, faces challenges related to its disorganized layout. The accumulation of goods—whether general cargo, special cargo (*perishable goods*), or quarantine goods *during* the *receiving inspection stage* —often blocks operational circulation and evacuation routes. Warehouse optimization requires a structured approach such as *Systematic Layout Planning* (SLP) using *Activity Relationship Charts* (ARC) to analyze and reorganize the proximity between workstations. Furthermore, the physical arrangement of goods within the warehouse needs to be refined using the *Grouping Method* to separate goods based on their characteristics, so that the loading and unloading process (*inbound* and *outbound*) becomes more effective and efficient. This layout arrangement must also be supported by the implementation of standard operating procedures (SOPs), optimization of transportation distribution routes, and business model innovation so that the implementation of this pioneering subsidy can be sustainable and truly impact the development of the Papua region.(BPS Provinsi papua, 2024; PT.Angkasa Pura Indonesia, 2024; Wahyu Poncotoyo et al., 2024)

LITERATURE REVIEW

Air cargo movement in Papua relies on major hub airports such as Sentani, Timika, and Wamena to distribute logistics to remote areas (*spokes*). To facilitate this smooth logistics flow, airport warehouse facilities play a crucial role. The efficiency of material handling within the warehouse is highly dependent on its layout. A good workstation arrangement is evaluated using the SLP method, which analyzes the proximity of facilities through *an Activity Relationship Chart* (ARC).(Fithri Azizah et al., 2023; Gunawan Mohammad, 2023)

In addition to the proximity of work stations, the placement of the goods themselves is key. The use of the *Grouping Method* has proven very effective in grouping and separating the placement of goods specifically—for example, the separation between general cargo *and* special cargo *,* as well as raw cargo and finished goods—to prevent overlapping stacking. Handling special cargo such as *perishable* goods and dangerous goods *requires* strict SOPs from the *receiving inspection stage* by *the Regulated Agent* until they are loaded onto the aircraft, to minimize damage claims and delays.(Dr. Ir. Agus Purnomo, 2022; L Kartika, 2014; Putu Talia Jayanti, 2021; Sianipar et al., 2024)

Strategically, to ensure the sustainability of this program, optimal distribution modeling is required. Distribution problem solving can be simulated using *the Capacitated Vehicle Routing Problem with Time Windows* (CVRPTW) approach to minimize distribution operational costs. Furthermore, collaboration between stakeholders and service providers needs to be mapped using the *Business Model Canvas* (BMC) framework to create a responsive and sustainable service ecosystem.(Hidayat dan Diah Imawati, 2011; Muhammad et al., n.d.; Syafaruddin Mahaputra, 2017)

METHOD

mixed-method approach that combines qualitative and quantitative analysis. Secondary data, in the form of a summary of cargo volumes from 2021 to 2025, was collected to forecast *future* cargo loads using the *Least Squares calculation* .(Frenton Togatorop, 2021; Ricardianto et al., 2014; Supriyono et al., 2017)

The evaluation of the work station facility layout was analyzed using the *Activity Relationship Chart* (ARC) method, which classifies the degree of absolute importance of bringing work points closer or further apart (*receiving, screening, build-up, delivery*). (Fithri Azizah et al., 2023; Gunawan Mohammad, 2023)Furthermore, the cargo placement system in the warehouse was improved using the *Grouping Method approach* to unravel the accumulation of goods (*bottlenecks*) and ensure compliance with cargo inspection SOPs.(Ana Devi Simatupang, 2018; Dr. Ir. Agus Purnomo, 2022; Nuning Muhayyaroh, 2022)

Quantitative analysis for cargo volume projection in 2026 is calculated using the *Least Square Trend Forecasting method* . The linear trend line equation is formulated as:

$$Y = a + bX$$

Where the constant value a and trend coefficient b are found using the equation:

$$a = \frac{\sum Y}{n}$$

$$b = \frac{\sum XY}{\sum X^2}$$

RESULTS AND DISCUSSION

Subsection 1 Business Strategy and Network Distribution Optimization

Based on historical data on cargo volume (Tons) at Sentani Airport from 2021 to 2025, the cargo load projection for 2026 is calculated using *the Least Square method* by setting 2023 as the midpoint (X = 0).

Table 1. Calculation of *Least Square Trends* for Sentani Cargo Volume

Year	Actual Cargo Volume (Ton) (Y)	Year Code (X)	X^2	XY
2021	112,175	-2	4	-224,350
2022	125,533	-1	1	-125,533
2023	132,402	0	0	0
2024	137,115	1	1	137,115
2025	103,191	2	4	206,382
Total	**∑ Y = 610.416**	**∑ X = 0**	**∑ X^2 = 10**	**∑ XY = -6.386**

From this table, the equation is obtained:

- a = 610,416 / 5 = 122,083.2

- b = -6.386 / 10 = -638.6
- Equation: Y = 122,083.2 - 638.6X

2026 Projection (X = 3):
Y = 122,083.2 - 638.6(3) = 120,167.4 Tons

Based on the calculation above, the linear equation of the demand trend is Y = 122,083.2 - 638.6X. For the 2026 projection (X = 3), the estimated Sentani cargo load in 2026 which reached **120,167 tons** triggered an *overcapacity condition* of **52.4%** exceeding the existing maximum design capacity.

Subsection 2 Facility Layout Analysis (Activity Relationship Chart)

This surge in cargo volume exacerbated weaknesses in the existing warehouse layout . Observations revealed irregular stockpiling, blocking staff circulation and evacuation routes. To optimize the flow of goods, an analysis of workstation proximity was formulated using *an Activity Relationship Chart* (ARC) as the basis for terminal *relayout* , as shown in Table 2.

Table 2. Activity Relationship Matrix (ARC) of Sentani Cargo Terminal

Facilities / Work Stations	Weighing	X-Ray	Warehouse Racking	Build-up	Delivery Apron
Weighing (Receiving)	-	A	U	X	X
X-Ray (Screening)	A	-	E*	I*	U
Racking (Stacking)	U	E*	-	A	O
Build-up (Assembly)	X	I*	A	-	A
Delivery (To Apron)	X	U	O	A	-

(Note: A = Absolutely Adjacent, E = Very Important, I = Important, O = Ordinary, U = Not Important, X = Prohibited Adjacent).

The ARC matrix above emphasizes the physical layout regulations: Weighing (*Receiving*) stations must be absolutely adjacent (A) to X-Ray (*Screening*) for smooth inspection, while Weighing is strictly prohibited from being adjacent (X) to *Delivery Apron* and assembly. This is vital to prevent mixing between *inbound cargo* that has not been security checked with *outbound cargo* that is ready to be loaded onto the aircraft.

Subsection 3 Implementation of Grouping Methods and Operational Standards

To address *overcapacity* and the problem of mixed storage, improvements in cargo placement within the warehouse were addressed using the Grouping Method. This method strictly separates goods based on their type, shelf life, and handling requirements.

Table 3. Segregation of Goods Placement Using the Grouping Method

Item Category	Warehouse Location / Placement	Purpose of Operational Separation
Cargo Type 1 (Equivalent to Heavy Cargo/Raw Material)	Warehouse Block 1 / Lower Level Shelves	Requires lifting equipment (Forklift). Store below to prevent risk of falling and damage.
Type 2 Cargo (Equivalent to General Cargo/Finished Goods)	Warehouse Block 2 / Mid-Level Vertical Rack	Quick accessibility for *fast-moving cargo* . Facilitates *picking staff* .
Special Cargo (Perishable Goods & Quarantine)	Dedicated Block Warehouse / Cold Storage Area & Segregated	Prevent food commodity spoilage. Separate *quarantine goods* from *clearance goods according to Regulated Agent* SOPs .

This grouping method, combined with strict adherence to *Standard Operating Procedures* (SOPs), ensures that *perishable goods* or priority food subsidies are not held for long periods in storage areas, potentially damaging their quality. *Receiving inspections* by *regulated agents* are also streamlined and controlled.

Subsection 4 Business Strategy and Network Distribution Optimization

To address the long-term challenges of high logistics costs, airport infrastructure governance must be supported by a robust distribution network and business strategy. *The Capacitated Vehicle Routing Problem with Time Windows* (CVRPTW) algorithm can be adapted to determine the most efficient pioneer distribution routes and schedules, ensuring fleets do not return empty and minimizing *lead times* for essential goods deliveries. Furthermore, from an operational perspective, logistics service providers can implement *the Business Model Canvas* (BMC) management approach to enhance strategic partnerships, integrate digital administration services, and improve service delivery for communities in remote areas of Papua.

CONCLUSION

The public service obligation program through the Air Bridge in Papua faces critical challenges in infrastructure capacity. Logistics forecasting calculations show that the Sentani Cargo Terminal is projected to handle loads of up to 120,167 tons in 2026, triggering *overcapacity conditions* . To resolve the problem of logistics queues and inefficiencies, space optimization is mandatory by implementing *an Activity Relationship Chart* (ARC) that establishes absolute proximity between the *Receiving* and *X-Ray areas* . Furthermore, the accumulation of goods is overcome using the *Grouping Method* that separates *general cargo areas* , heavy cargo, *perishable goods , and quarantine* goods into segregated rack blocks. This improvement in warehousing infrastructure, supported by distribution route optimization (CVRPTW) and an adaptive business model (BMC), is essential to ensure the smoothness, security, and success of the air transportation logistics subsidy program in Papua Province.

REFERENCES

Ana Devi Simatupang. (2018). *Analysis of Standard Operating Procedure (SOP) Design in the Export Cargo Delivery Process of Perishable Goods (Special Cargo) at PT. Angkasa Pura Kargo, Kualanamu International Airport Branch, Deli Serdang* .

BPS Papua Province. (2024). *Papua Statistics Document* .

Dr. Ir. Agus Purnomo, MT (2022). Warehouse Relayout Analysis for Dangerous Goods Arrangement at PT Linfox Logistics Indonesia Cikarang. *Journal of Business Logistics* , *12* .

Fithri Azizah, N., Agil Apriani, R., Mahardika, FP, Zikra Zizo, MA, Aji Pradana, F., & Azzam, A. (2023). Analysis of Layout Design Using Activity Relationship Chart (ARC) and Computerized Relationship Layout Planning (Corelap) Methods at CV. Tunas Karya. In *Jurnal Teknik Industri* (Vol. 9, Number 1).

Frenton Togatorop, RG (2021). Application of Transportation Methods for Freight Analysis at PT Cargo Indonesia Medan. In *Journal of Computing and Informatics Research* (Vol. 1, Number 1).

Gunawan Mohammad. (2023). Proposal for Improving the Layout of Production Area Facilities Using the Activity Relationship Chart Method. *Scientific Journal of Research and Development Student* , *1* (1), 22–29. https://Doi.Org/10.59024/Jis.V1i1.255

Hidayat and Diah Imawati, YA (2011). *Simulated Annealing for Solving Vehicle Route and Schedule Problems with Multiple Trips and Time Windows* .

L Kartika. (2014). *Designing Layout and Warehouse Organization Using the Grouping Method and Implementing 5S at the Petruk Jepara Shop* .

Muhammad, A., Achmad, F., Sutina Azis, I., Elisa, C., Katili, M., Teknik, J., Agro, I., Manufaktur, JT, & Ati Makassar, P. (ND). Determination of Vehicle Routes with Time Windows for Product Distribution by Pt. X. *Journal of Agro-Industry Engineering Research (Jaier)* , *2* (1), 2023.

Nopiah, R., Azansyah, Ekaputri, RA, Sunaryo, & Prasetya, BA (2024). Connectivity Infrastructure Spending And Its Indicator Achievement: Case Study Of Southern Sumatra Region. *Journal Of Sustainable Economics* , *2* (2), 94–103. https://Doi.Org/10.32734/Jse.V2i2.18708

Nuning Muhayyaroh. (2022). *Improvement of Goods Placement Layout at PT. Angkasa Pura Logistik Pasuruan (Warehouse & Distribution Center) Using the Grouping Method* .

Pt.Angkasa Pura Indonesia. (2024). *Business Transformation to Improve Connectivity Pt Angkasa Pura Indonesia Transform To Improve Connectivity* .

Putu Talia Jayanti. (2021). *Differences in the Degree of Agglutination in Blood Type Examination Using the Cell Grouping Method Based on the Concentration Levels of Cell Suspensions of 5%, 10%, and 40%* .

Ri. (2021). Law Number 2 of 2021 concerning Special Autonomy for Papua Province. *Law (Uu) Number 2 of 2021* , (1), 1–40. https://Peraturan.Bpk.Go.Id/Details/172403/Uu-No-2-Tahun-2021

Riadi, S., Bestario Harlan, F., Zelmiyanti, R., Wahyu Hati, S., Wirawan, A., Managerial - Batam State Polytechnic, A., & International Trade - Batam State Polytechnic, L. (2021). Inventory Management and Warehouse Layout in Aircraft Maintenance Engineering, Batam State Polytechnic in Project-Based Learning Review . Indonesian *Scientific Journal of Accounting and Finance* , *5* (1).

Ricardianto, RP, Kuntohadi, H., Rifni, M., & Trisakti, S. (2014). Air Cargo Capacity on Cargo Terminal Development Plan at Soekarno-Hatta International Airport. *Journal of Transportation & Logistics Management (Jmtranslog)* , *01* (02).

Sianipar, RJ, Januar, RR, & Silalahi, SDC (2024). Analysis of Potential Mapping and Realization of New and Renewable Energy (EBT) Using Consumption Determinant Modeling and EBT Grouping Analysis Method in Indonesia. *Journal of New and Renewable Energy* , *5* (2), 30–49. https://Doi.Org/10.14710/Jebt.2024.22970

Supriyono, Widodo S Pranowo, Sofyan Rawi, & Bambang Herunadi. (2017). *Analysis and Calculation of Tidal Prediction Using the Admiralty Method and the Least Square Method (Case Study of Tarakan and Balikpapan Waters)* .

Syafaruddin Mahaputra, M. (2017). Solving Vehicle Routing Problems with Multiple Trips, Time Windows, and Simultaneous Pickup and Dropoff Using Genetic Algorithms. In *Jurnal Teknik Industri* (Vol. 12, Number 2).

Wahyu Poncotoyo, Dinar Kania, Sarinah Sihombing, Sesaria Mardhiani Rachma Puspitsa, Sita Aniisah Sholihah, & Luluk Fauziah. (2024). Analysis of Distribution Warehouse Layout in an Aerospace Company Using System Layout Planning and Class-Based Storage Methods. *Journal of Transportation & Logistics Systems* , *4* , 1. https://Journal.Itltrisakti.Ac.Id/Index.Php/Jstl