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Integration of Logistics Mobility and Passengers through Crowdshipping to Reduce Environment Degradation

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Abstract

This study intends to examine the chances of combining logistic mobility and aviation passengers using crowdshipping to prevent environmental degradation and analyze four variables: logistic mobility, passengers mobility, and crowdshipping, on environment degradation from 200 aircraft passengers data surveyed and processed using SEM PLS. The results indicate that logistic mobility can significantly increase crowdshipping by 0.381 and environment degradation by 0.998. Passengers mobility can increase Crowshipping by 0.597 and increase Environmental Degradation by 0.338. Crowdshipping can reduce the influence of Environmental Degradation by -0.376. This study successfully highlights the impact and implications of logistics mobility and passenger mobility integration in crowdshipping on environment degradation while opening up new commercial options, through logistics and passenger integration in the cargo transportation business.

Keywords: *Logistics Mobility, Passengers Mobility, Crowdshipping, and Environment Degradation.*

Introduction

Air transportation provides an essential part in supporting global passengers mobility, and logistics delivery, (E Marcucci et al., 2017), (Fessler et al., 2022), (Hadas et al., 2023). However, airport activities are also a significant contributor to carbon emissions, especially through flight operations, logistics delivery, and ground vehicle movements, (Štefancová et al., 2023). Hang Nadim Airport Batam, as one of the main transportation hubs in the Riau Islands, experiences an increase in passenger and logistics traffic every year, (Cohen et al., 2021), (Edoardo Marcucci et al., 2017), (Štefancová et al., 2023). This raises challenges related to congestion, high fossil fuel use, and an increasing carbon footprint that has hurt the natural world, (Tapia et al., 2023).

On the other hand, the swift rise of online purchasing has increased the amount of package deliveries through airports, which often go out by vehicles separate from passenger mobility, (Fadeev & Alhusseini, 2023), (Hadas et al., 2023). By utilizing the unused space in these vehicles, crowdshipping contributes significantly to reducing congestion in high-traffic areas, such as around airports, (Valerio Gatta et al., 2019). In addition, the initiative can reduce carbon emissions because it eliminates the need to use additional delivery vehicles that usually contribute to air pollution, (E Marcucci et al., 2017), (Fessler et al., 2022). In the identical times, this method improves the efficiency of logistics operations at airports by utilizing existing trips, reducing shipping costs, and speeding up the distribution process of goods, (E Marcucci et al., 2017), (Sina Mohri et al., 2023). As an outcome, crowdshipping not only provides a more environmentally friendly solution but also offers a more economical alternative in the logistics supply chain, (E Marcucci et al., 2017), (Valerio Gatta et al., 2019). Crowdshipping is a freight forwarding model that utilizes passengers who are traveling to deliver packages to their final destinations, thus optimizing the use of existing vehicles and reducing the need for additional trips, (Valerio Gatta et al., 2019; Mittal et al., 2020), (Dai et al., 2020), (Siregar et al., 2024).

Adopting crowdshipping at airports like Hang Nadim Batam can be an effective option for integrating logistics mobility, and passengers mobility. By utilizing the empty capacities of private vehicles and public transportation services used by passengers, crowdshipping can help reduce congestion, reduce carbon

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emissions, and improve the operational efficiency of logistics at the airport, (E Marcucci et al., 2017), (Sina Mohri et al., 2023).

Integration is joining or combining disparate elements to form a harmonic whole. In a social setting, integration refers to efforts to reconcile cultural, value, or community differences to achieve harmony. Integration is a calculus procedure that calculates a function's area, volume, or accumulated change, (Jianguo Liu et al., 2015), (Saleem et al., 2021)

Integration of logistics mobility and passengers mobility is an effort to align the transportation system of logistics and passengers to create efficiency, comfort, and sustainability, (Carbone et al., 2017), (Punel & Stathopoulos, 2017). This allows for optimal use of transportation infrastructure, such as transporting light goods with passengers in one mode or utilizing digital systems to align routes and logistics and passenger needs, (Jianmiao Liu et al., 2023), (Sina Mohri et al., 2023). With this integration, operational costs can be reduced, carbon emissions reduced, and connectivity between regions increased, thus supporting sustainable economic growth and more managed urbanization, (Macrina et al., 2020), (Boysen et al., 2022)

Novelty

The research conducted at Hang Nadim International Airport in Batam seeks to provide empirical insight into crowdshipping potential as a recurring logistical solution for airports. Similarly, the results of this study could serve as suggestions for airport managers, logistics groups, and legislators on using the crowdshipping concept to optimize operations and reduce negative environment impact. The novelty of this research is that it applies the crowdshipping concept to the airport environment, especially Hang Nadim Airport Batam, with a focus on merging passengers transportation and logistics to prevent environment degradation. Unlike prior research on crowdshipping in urban settings, this study investigates its potential in airport operations to increase shipping efficiency and minimize carbon emissions.

Basic Theory

This analysis tries to investigate the relationship between four variables, research components, which are: logistics mobility X_1 together with passengers mobility X_2, integrated with Crowdshipping Z_1 to reduce Environment Degradation Y_1

Logistics Mobility

Logistics mobility is the departure and arrival of logistical travels via airplanes from Batam to other cities, whereby criteria include the movement of cargo is logistics mobility X_1 The arrival and departure of logistics trips via air transport from Batam to other places whose indications include the movement of cargo where the indicators are logistics enumerated $X_{1.1}$, vehicles enumerated $X_{1.2}$, destination enumerated $X_{1.3}$, baggages enumerated $X_{1.4}$, mobility regulation $X_{1.5}$, (Camps-Aragó et al., 2022; Cohen et al., 2021; Štefancová et al., 2023)

Passengers Mobility

Passenger mobility X_2 is the departure and arrival of passenger travels by air transportation to Batam and numerous other cities, which indicators are passengers enumerated $X_{2.1}$, vehicles enumerated $X_{2.2}$, destination enumerated $X_{2.3}$, baggage enumerated $X_{2.4}$, mobility regulations $X_{2.5}$, (Camps-Aragó et al., 2022; Cohen et al., 2021; Štefancová et al., 2023).

Crowdshipping

Crowdshipping Z_1 transfers mass objects utilizing passenger departures flow as delivery persons, additionally recognized as freelance couriers, (Valerio Gatta et al., 2019; Pourrahmani & Jaller, 2021; Sina Mohri et al., 2023). The measurement a measure for this is approach involves an abundance of for free baggage weighing 15-20 kilograms as a style of treatment provided by airlines in the form of cargo able to

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be delivered via passengers, (crowdlogistics) $Z_{1.1}$, firms or individuals sending cargo (crowdshipper) $Z_{1.2}$, passengers have agreed to transport logistics as part of the ticket (crowdcourier) $Z_{1.3}$, means a website that allows interaction between passengers and shippers (crowdplatform) $Z_{1.4}$, shipping costs (crowdshare economic) $Z_{1.5}$, (Johnson et al., 2023; Sina Mohri et al., 2023; Tapia et al., 2023).

Environtment Degradation

Environment degradation Y_1: Deterioration of environmental quality due to air transportation activities around the airport, including the airport's operations in serving customers in aircraft. The process of changes and degradation of environmental quality, which hurts airports, can certainly be seen from the measurement of indicators such as: air pollution Y_{11}, water pollution $Y_{1.2}$, rubbish $Y_{1.3}$, noises $Y_{1.4}$, green open space $Y_{1.5}$, sanitation $Y_{1.6}$, drainages $Y_{1.7}$, and the environment hygiene $Y_{1.8}$, (Sun et al., 2019), (Mao et al., 2019), (Karakikes & Nathanail, 2022).

Research Hypothesis

The research hypothesis could be expressed as follows:

Logistics mobility and passengers mobility have a significant impact on crowdshipping, as well as environment degradation. Crowdshipping has a substantial impact on environment degradation, as does the passengers mobility.

Research Method

To analyze the factors influencing the adoption of crowdshipping, and provide new insights into the key determinants that can support the implementation of sustainable logistics strategies in air transportation, this study uses the SEM-PLS method.

A conceptual framework was established by considering the research variables listed in Table 1 Operational definitions description, and Figure 1 Framework of thinking. Before the analysis, 200 customer samples were surveyed, which included potential passengers, current passengers, and former passengers. The survey responses have been evaluated using SEM PLS 4.0.1.

Table-1. Operational Definitions Description

No	Variables	Deventions	Indicators	Literatures
1	Logistics mobility X_1	The departure and arrival of logistics flights by plane from one airport to another.	logistics enumerated $X_{1.1}$, vehicles enumerated $X_{1.2}$, destination enumerated $X_{1.3}$, baggages enumerated $X_{1.4}$, mobility regulation $X_{1.5}$,	(Camps-Aragó et al., 2022; Cohen et al., 2021; Štefancová et al., 2023)
2	Passengers mobility X_2	The departure and arrival of passengers via air transport from one airport to another, with indicators such as the movement of travelers	passengers enumerated $X_{2.1}$, vehicle enumerated r $X_{2.2}$, destination enumerated $X_{2.3}$, baggage enumerated $X_{2.4}$, mobility regulatio $X_{2.5}$,	(Camps-Aragó et al., 2022; Cohen et al., 2021; Štefancová et al., 2023).
3	Crowdshipping Z_1	Transfers mass logistics using passenger departures flow as distribution individuals	passengers enumerated $Z_{1.1}$, crowdshipper Z_{12}, crowdcourier Z_{13}, crowdplatform Z_{14}, crowdshare economic Z_{15}	(Johnson et al., 2023; Sina Mohri et al., 2023; Tapia et al., 2023).

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4	Environment Degradation Y_1	Deterioration of the environment caused by air transportation activities within the airport, including the airport's operations in supporting clients in planes.	air pollution Y_{11}, water pollution Y_{12}, rubbish Y_{13}, noises Y_{14}, green open space Y_{15}, sanitization $Y_{1.6}$, drainages $Y_{1.7}$, environmental hygiene $Y_{1.8}$	(Sun et al., 2019), (Mao et al., 2019), (Karakikes & Nathanail, 2022)

Source. Processed author data, 2024

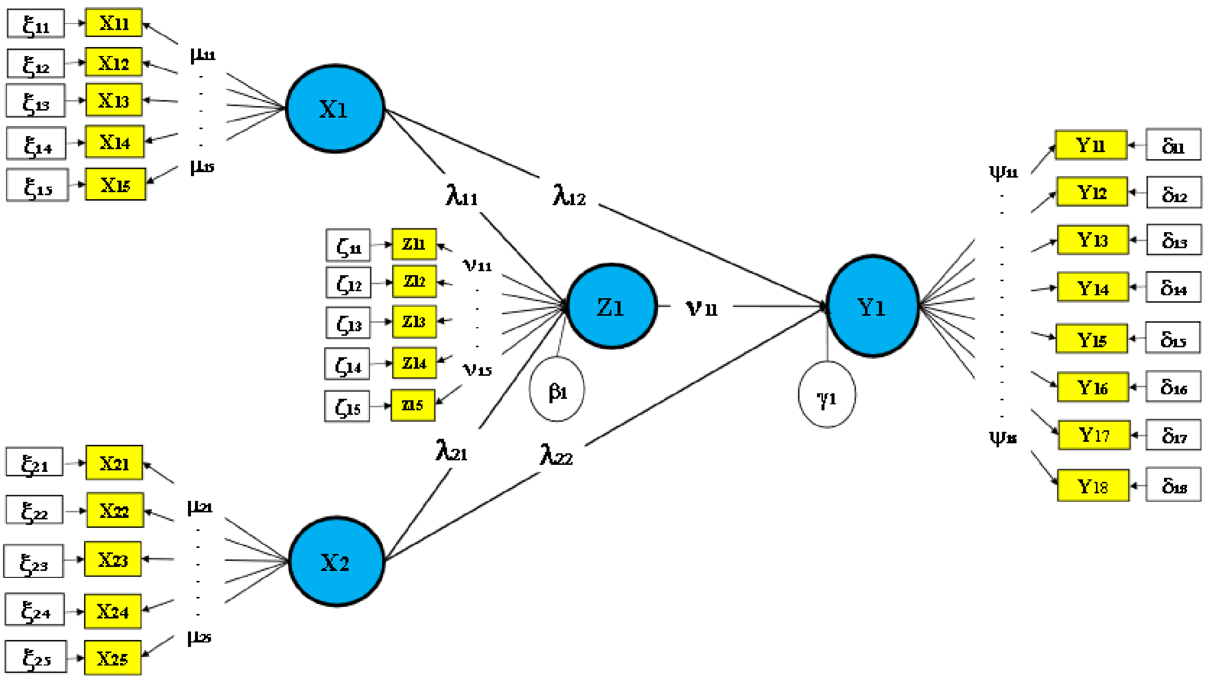

Figure-1. Framework of Thinking

Source: Processed Author Data, 2024

Results and Discussion

The Results section can be broken into numerous segments. This part presents a fast and accurate description of the results, interprets them, and concludes.

Characteristics of Respondents

Figure-2 Gender Respondent shows that the respondents are separated into two categories: males and females. According to the data acquired from 200 respondents, the gender makeup of respondents is 124 males, or 62%, and 66 females, or 38%, as shown in Figure 2. The figure shows that the amount of male participants is the largest. So, based on the author's data, it can be assumed that males often travel by plane.

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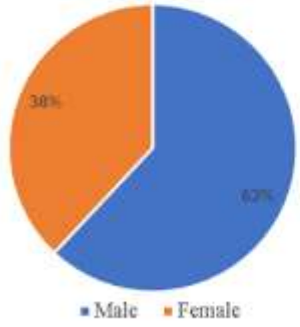

Figure-2 Gender Respondent

Source: Processed author data, 2024

Figure-3 shows that respondents are separated into four age groups: 18 to 30 years, 31 to 40 years, 41 to 50 years, and 51 years and older. According to the data collected from 200 participants, the age allocation is as follows: 18 individuals, or approximately 9% aged 18 to 30 years, 34 people, or approximately 17% aged 31 to 40 years, 134 people or approximately 67% aged 41 to 50 years, and 14 people or approximately 7% aged 51 and up. According to the findings in Figure 3, almost 67% of respondents are between the ages of 31 to 40, which is considered a productive age.

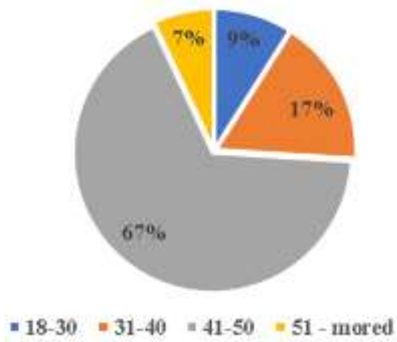

Figure-3. Age Respondent

Source: Processed author data, 2024.

Figure-4 shows that respondents are grouped into three occupation categories: privates, bureaucracy, and students. According to data gathered by 200 respondents, occupation breakdown is 152 respondents (76% Private), 42 respondents (21% Bureaucracy), and 6 respondents (3% Students). According to Table 3, the private sector had the most responders (152, or 76%) who travel by plane

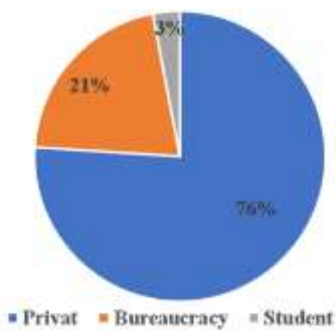

Figure-4. Occupation Respondent

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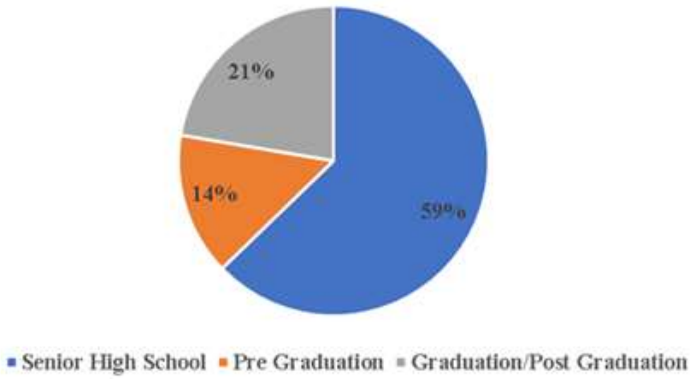
Source: Processed author data, 2024

According to Figure-5 Education Respondents, they are classified into three education categories: High School, Pre-Graduate, and Graduate/Postgraduate. From the data of 200 respondents collected, the composition of respondents based on education, High School 118 or 59%, Pre-Graduate 24 or 14%, and Graduate/Postgraduate 42 or 21%. Based on the statistics in Figure-5, high school students totaling 118 respondents (59%) are the largest participants traveling by plane.



Fugure-5. Education Respondent

Source: Processed author data, 2024

Validity and Reliability Test

Table-2 until Table-5 are the outer model value tables, and they assess the validity and reliability of the research. The reflection measure is considered capable of describing the construct variable if it has a correlation of more than 0.70 with the construct variable being measured. From the outer loading results in the tables below, it can be seen that the correlation value of all question items in the questionnaire for all indicators and items is above 0.70, which can be concluded that all items have met the validity requirements so that the indicators can describe the construct variables accurately.

Variable X_1

According to Table-2 below, the exogenous latent variable X_1 logistics mobility has 5 (five) manifest variables or indicators, which include: $X_{1.1}$ logistic enumerated with a loadt factor of 0.795; based on the load factor value, it can be concluded that the logistic enumerated is confirmed to be able to describe the logistics mobility variable. $X_{1.2}$ vehicles enumerated with a load factor of 0.789, indicating that vehicles enumerated is confirmed to be able to describe the logistics mobility variable. $X_{1.3}$ destinations enumerated with a load factor of 0.893; based on this result, it can be stated that destinations enumerated is confirmed to be able to describe the logistics mobility variable. $X_{1.4}$ pieces of baggage enumerated, with a load factor of 0.814. Based on the load factor value, it can be determined that the baggage enumerated is confirmed to be able to describe the logistics mobility variable. $X_{1.5}$ logistics mobility regulation has a load factor of 0.875. Based on the load factor value, it can be stated that mobility regulation is confirmed to be able to describe the logistics mobility variable.

Tabel-2. Logistics Outer Loading

Variable	Manifest	Outer Loading
X_1	$X_{1.1}$	**0.795**
	$X_{1.2}$	**0.798**

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	$X_{1.3}$	**0.893**
	$X_{1.4}$	**0.814**
	$X_{1.5}$	**0.875**

Source: Processed author data, 2024

Variable X_2

According to Table-3 below, the exogenous latent variable X_2 passengers mobility has 5 (five) manifest variables or indicators consisting of: $X_{2.1}$ passengers enumerated with a load factor of 0.842. Based on the load factor value, it can be concluded that passengers enumerated confirmed to be able to describe the passengers mobility variable. Based on the load factor value of 0.931, $X_{2.2}$ vehicles enumerated are validated to be able to describe the passengers mobility variable. $X_{2.3}$ destination enumerated have a load factor of 0.945, indicating that destination enumerated to be able to describe the passengers mobility variable. $X_{2.4}$ Baggage enumerated with a load factor of 0.829; based on the load factor value, it can be stated that baggage enumerated to be able to describe the passengers mobility variable. $X_{2.5}$ mobility regulation has a load factor of 0.872, indicating that mobility regulation to be able to describe the passengers mobility variable.

Tabel-3. Passengers Outer Loading

Variable	Manifest	Outer Loading
X_2	$X_{2.1}$	**0.842**
	$X_{2.2}$	**0.931**
	$X_{2.3}$	**0.945**
	$X_{2.4}$	**0.829**
	$X_{2.5}$	**0.872**

Source: Processed author data, 2024

Variable Z_1

Variable crowdshipping Z_1 as an intermediate variable, as indicated in Table 4 Crowshipping Outer Loading, contains five manifest variables or indicators, including Crowdlogistic $Z_{1.1}$, with a load factor value of 0.706. Based on the load factor value, it is possible to conclude that Crowdlogistic can accurately characterize the crowdshipping variable. Based on the load factor value of 0.872, crowdcourier $Z_{1.2}$ is certified to describe the Crowshipping variable. Crowdshipper $Z_{1.3}$'s load factor of 0.892 confirms its ability to characterize the Crowdshipping variable. Crowdshare-economic $Z_{1.4}$ has a load factor of 0.876, implying that it accurately describes the Crowshipping variable. Based on a load factor of 0.897. Crowd-air-transport $Z_{1.5}$ has been shown to accurately characterize the Crowshipping variable.

Tabel-4. Crowdshipping Outer Loading

Variable	Manifest	Outer Loading
Z_1	$Z_{1.1}$	**0.706**
	$Z_{1.2}$	**0.872**
	$Z_{1.3}$	**0.892**
	$Z_{1.4}$	**0.876**
	$Z_{1.5}$	**0.897**

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Source: Processed author data, 2024

Variable Y_1

Environment Degradation Y_1 has eight variables or indicators according to Table-5 Environment Degradation Outer Loading below, namely: The load factor value for air pollution $Y_{1.1}$ is 0.776, and it has been demonstrated that this value can characterize the Environment Degradation variable. Water pollution $Y_{1.2}$ have a load factor of 0.804, implying that it can describe the Environment Degradation variable. Rubbish $Y_{1.3}$ has a load factor of 0.895, which indicates that it may describe the Environment Degradation variable. Noises $Y_{1.4}$ have a load factor of 0.709, implying that they can explain the Environment Degradation parameter. Green open space $Y_{1.5}$ have a load factor of 0.862, which suggests that it can explain the Environment Degradation variable. Sanitization $Y_{1.6}$ has a load factor of 0.888, which indicates that it can explain the Environment Degradation variable. Drainages $Y_{1.7}$ have a load factor of 0.764, implying that they could describe the Environment Degradation variable. Environment hygiene $Y_{1.8}$ of the airport in general, with a load factor of 0.879, we may conclude that environmental hygiene is demonstrated to be able to reflect the environment degradation variable.

Tabel-5. Environment Degradation Outer Loading

Variable	Manifest	Outer Loading
Y_1	$Y_{1.1}$	**0.776**
	$Y_{1.2}$	**0.804**
	$Y_{1.3}$	**0.895**
	$Y_{1.4}$	**0.709**
	$Y_{1.5}$	**0.862**
	$Y_{1.6}$	**0.888**
	$Y_{1.7}$	**0.764**
	$Y_{1.8}$	**0.879**

Source: Processed author data, 2024

Reliability Test

The reliability of the indicators is tested using Cronbach's Alpha and AVE Test.

Table-6. Cronbach's Alpha and AVE Test

No	Variables	Cronbach's Alpha	Average Variance Extracted (AVE)
1	Logistic Mobility X_1	**0.851**	0.631
2	Passengers Mobility X_2	**0.841**	0.617
3	Crowdshipping Z_1	**0.855**	0.639
4	Environment Degradation Y_1	**0.856**	0.638

Source: Processed author data, 2024

Based on Table-6 Cronbach's Alpha and AVE Test, it was clear that the four variables above, Logistics Mobility X_1, Passengers Mobility X_2, Crowdshipping Z_1, and Environment Degradation Y_1, all have the

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Cronbach's Alpha value greater than 0.7 and the Average Variance Extracted (AVE) value greater than 0.5, indicating that all variables are reliable or meet the criteria.

Table-7. Determinants Test

No	Varables	R^2	Adjusted R^2
1	Crowdshipping Z_1	**0.930**	**0.929**
2	Environment Degradation Y_1	**0.937**	**0.935**

Source: Processed author data, 2024

The degree of capability to influence variables is reflected in Table-7 Determinants Test above. Based on the R^2 value, the Logistics Mobility and Passengers Mobility variables could be accountable for 93.0% of the variability in integration in Crowdshipping, with the remaining 7% explained by constructs other than those investigated in this study. The variables logistics mobility, passengers mobility, and crowdshipping can simultaneously interpret the variability of the Environment Degradation construct by 93.7%, while the remaining 6.3% is explained by other constructs outside of those studied in this study.

Based on Table-8 Path Coefficient Significan, logistics mobility has a significant impact on crowdshipping 0.381 and environment degradation 0.998. Passenger mobility has a significant impact on crowdshipping 0.597 and environment degradation 0.338. Crowdshipping has a significant -0.376 impact on environment degradation.

Table-8. Path Coefficient Significan

No	Paths	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (IO/STDEVI)	P Value
1	Logistics Mobility X_1 -> Environment Degradation Y_1	0.998	0. 990	0.114	8.731	**0.000**
2	Logistics Mobility X_1 -> Crowdshipping Z_1	0.381	0.383	0.137	2.769	**0.006**
3	Passengers Mobility X_2 -> Environment Degradation Y_1	0.338	0.355	0. 161	4.398	**0.000**
4	Passengers Mobility X_2 -> Crowdshipping Z_1	0.597	0.595	0.136	2.096	**0.037**
5	Z_1Crowdshipping -> Environment Degradation Y_1	-0.376	-0.386	0.136	2.761	**0.006**

Source: Processed author data, 2024

Discussion

Logistics mobility has a substantial impact on crowdshipping by 0.381, meaning that growing logistics mobility by one will affect the rise in crowdshipping by 0.381, while 0.619 has an effect outside of this study.

Logistics mobility has had an enormous influence on innovation in the aviation industry, particularly through the concept of crowdshipping. Crowdshipping is contingent on the presence of passengers and the availability of logistics to be sent.

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This is consistent with previous opinions, which stated that Crowdshipping is a concept for delivering logistics via aviation passenger excursions from one site to another. These passengers leverage the available space in free baggage areas or the capacity of their carriers to send logistics to the same destination as their trip, (Manstead, 2018), (Dayarian & Savelsbergh, 2020). This occurrence indicates a paradigm shift in harnessing transportation connectivity to increase productivity and versatility in the chain of distribution.

Using spare capacity on airplanes for logistics mobility opens up fresh opportunities for overcoming the density of logistics delivery. According to previous research, people traveling to or around the same region can provide logistics delivery services to those in need, (Francesconi, 2014; Sterchi & Schwaninger, 2015). Employing a specific app or platform, travelers can use the complimentary capacities to carry logistics to destinations that coincide with their flights.

The major effects of logistics mobility at crowdshipping in air transportation involve improved supply chain ecosystem efficiency and lower shipping costs. Passengers participating in integrated logistics mobility transportation in crowdshipping can do so by maximizing the use of the airline's free baggage facility space, (Francesconi, 2014; Sterchi & Schwaninger, 2015), hence lowering transit costs and environmental effects. In addition, the influence of logistics mobility on crowdshipping will also provide an alternative for speedier and more adjustable delivery of goods, especially to areas that may be problematic to acces by regular delivery systems, (Park et al., 2020), (Satrianto & Juniardi, 2023).

Concerning this, logistics mobility, which affects air transportation crowdshipping, will provide new potential for increasing effectiveness as well as versatility in shipping freight, (Edoardo Marcucci et al., 2017; Simoni et al., 2020), by partnering amongst passengers, logistics, and air transport vendors, this model can rethink how items are carried and contribute meaningfully to the flourishing of the logistics and transportation industry.

Nonetheless, various factors should be taken into account ahead of adopting logistics delivery using the model of crowdshipping in aviation, involving security and privacy, and legislation, (Barrett & Therivel, 2019). Government and transportation companies must create a smooth and trustworthy framework to make sure sustain the trust of passengers and cargo recipients, (McKibben, 2017).

Overall, logistics mobility makes it possible to improve air transportation operations, especially due to the increase in logistics number, vehicles number, destinations number, luggage number, and mobility regulations to support the smooth delivery of cargo/logistics directly to leaving for the other airport, (Fadeev & Alhusseini, 2023), (Satrianto & Juniardi, 2023). The existence of logistics baggage space for travelers is utilized by travelers departing by plane with bearing an obligation of accountability for what they carry, both in the form of goods and supplies, as well as in terms of the permitted quantity including weight and size limits, (Torenbeek, 2013). The impact of this influence is the formation of a crowdcourier or mass courier group by utilizing the luggage assistance facilities provided on each flight in the form of a crowdplatform in the form of an internet application to make agreements to search for free luggage, search for crowdcouriers, and other information including payment methods to carry out crowdshipping transaction, (Carbone et al., 2017), crowdshare-economy, in the form of crowdshipping prices gained by crowdcourier for his duties as a logistics courier, (Theodossiou et al., 2020).

Logistics mobility strongly affects environmental degradation by 0.998, which indicates that if logistics mobility grows by one, it is going to impact the rise in environment degradation by 0.998, and by 0.002 it has an effect outside of the scope of the study.

Logistics mobility, as an integral part of the global transportation system, contributes a crucial bit to the dynamics of the modern supply chain. However, this activity also contributes significantly to increasing environmental degradation, (Karakikes & Nathanail, 2022). This degradation is mainly related to greenhouse gas emissions, consumption of natural resources, and pressure on ecosystems, (Barrett & Therivel, 2019), (Mao et al., 2019), (Karakikes & Nathanail, 2022).

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In line with previous findings, the logistics sector produces large amounts of carbon dioxide (CO_2) and other pollutants. Logistics transport particularly those driven by fossil fuels, adding to the effect of greenhouse gas emissions, that contribute to universal warming. Studies show that land, sea, and air transportation are the main contributors to CO_2 emissions in the logistics sector, with trucks and cargo ships being the dominant sources, (Ostrom & Ostrom, 2019), (Manstead, 2018).

More intense logistical transportation degrades the environment by polluting the air and water. The use of fossil fuels produces nitrogen oxides (NOx) and sulfur dioxide (SO_2), which not only affect air quality but also contribute to acid rain. In the maritime sector, wastewater and spilled oil hurt marine ecosystems, (Edoardo Marcucci et al., 2017; Simoni et al., 2020), (Sina Mohri et al., 2023)

As a result, there will be an immediate association between the intensity of logistics mobility and the level of environment degradation, especially through the sector's significant contribution to greenhouse gas emissions, resource consumption, and ecosystem degradation, (Karakikes & Nathanail, 2022). The higher the volume of logistics activities, the greater the pressure on the environment, whether in the form of air pollution, increased carbon footprint, or exploitation of natural resources. Therefore, efforts to overcome this challenge require a holistic and sustainable approach, (Ostrom & Ostrom, 2019), (Van Stekelenburg & Klandermans, 2013).

One of the main steps is adopting environmentally friendly technologies, such as using electric or hydrogen-based vehicles in logistics transportation, as well as implementing an efficient energy management system, (Ryan & Deci, 2020). This technology not only reduces dependence on fossil fuels but also minimizes pollutant emissions that harm the environment. In addition, optimizing logistics routes through the implementation of data-based cargo systems and information technology can increase operational efficiency by reducing the number of flights while reducing fuel consumption. This strategy includes the implementation of the concept of "green logistics," where route planning is carried out to minimize travel distances and maximize load capacity, (Zeigler-Hill et al., 2015).

Furthermore, the implementation of policies that support emission reduction is a crucial aspect of realizing sustainable logistics. Such policies can include incentives for companies that implement environmentally friendly practices, strict regulations on logistics vehicle emissions, and encouragement for the private sector to adopt higher environmental standards, (Carbone et al., 2017), (Ryan & Deci, 2020).

Collaboration between governments, industry players, and research institutions is also important to develop innovative solutions that can reduce the ecological impact of logistics activities. By systematically integrating these approaches, the logistics sector can contribute positively to sustainable development goals, while minimizing negative effects on the global environment, (Huxham & Vangen, 2013), (Waddell, 2017), (Lin et al., 2020)

Passengers mobility strongly affects environment degradation to go past 0.597, and this indicates if case passengers mobility grows from one, it will have an impact on the increase in the environment degradation to 0.597, and salvage value 0.403 it has implications away from this study.

Passengers mobility refers to how people move around during their daily activities, such as routine travel, tourism, or business, (Hadas et al., 2023) This element considers not only the quantity of journeys, but also the pattern and frequency of movement, which is influenced by infrastructure development, urbanization, and digitization trends. In the context of crowdshipping, passenger mobility provides a flexible and dynamic logistics foundation, (Sina Mohri et al., 2023).

Passengers' high mobility allows for the optimization of delivery routes by reusing existing journeys, lowering costs and carbon emissions. According to studies, combining crowdshipping systems with daily mobility can boost logistics efficiency by up to 30%, particularly in metropolitan regions, (V Gatta et al., 2018).

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High passenger mobility, particularly in metropolitan areas, enhances the package delivery network and provides more coverage. With many people traveling, the potential to send packages through the crowdshipping system gets bigger and faster, (Pan & Truong, 2018). While passenger mobility improves system flexibility, timetable changes, and personal preferences might be difficult. According to research, crowdshipping systems must be well integrated with mapping and prediction technology to overcome these uncertainties, (Le et al., 2021).

The high level of passengers mobility promotes active community participation in the crowdshipping concepts. Technology-based tools make it easier to match shippers and couriers in real-time, which supports this model even more, (Allahviranloo et al., 2019).

Thus, passengers mobility has a significant impact on the implementation of crowdshipping effectively and efficiently, by utilizing existing mobility, it can become a sustainable and innovative logistics delivery option, (Huang et al., 2023). However, to attain its full potential, teamwork among technology, policy, and user behavior is required, (De Mooij, 2019).

In general, passengers mobility refers to the movement of people from one area to another using a variety of means of transportation, including private automobiles, public transportation, and air travel, (Pham et al., 2020). Population expansion, urbanization, and globalization all contribute to increased passenger transportation. Although mobility has economic and social benefits, its negative impact on the environment is becoming a growing concern in academic research. Environment degradation, involving air pollution, enhanced greenhouse gases, and pressure on ecosystems, is typically associated with high levels of mobility, (Karakikes & Nathanail, 2022).

One of the most significant effects of passenger transportation is a rise in warming, exhaust emissions, and air pollution, (Fessler et al., 2022). The majority of the release of carbon from the transportation sector comes from vehicles fueled by fossil fuels, such as private cars and flights. According to research, transportation contributes to around 25% of total world emissions, with passenger mobility being the most significant source. Pollutants such as CO, NO_2, and PM2.5 lead to poor air quality, harming human health and ecosystems, (Lan et al., 2022), (Jianmiao Liu et al., 2023).

Height passengers mobility leads to increased energy consumption, particularly from nonrenewable resources, (Mao et al., 2019). The production and distribution of fossil fuels not only emit pollutants but also degrade the ecosystem through resource extraction and the possibility of oil spills, (Sadiq et al., 2018). Furthermore, transportation infrastructure, such as the construction of highways and airports, involves land conversion, which can disrupt natural ecosystems, induce deforestation, and loss of habitat for flora and animals, (Martin & Boland, 2018).

Increased passenger mobility in metropolitan areas frequently results in traffic congestion, which indirectly contributes to environmental deterioration,(Martin & Boland, 2018). Congestion increases travel time and fuel consumption, all of which contribute to higher carbon emissions. Furthermore, unsustainable transportation infrastructure expansion can raise the danger of flooding due to limited water catchment regions and enhance the urban heat island (UHI) impact, (Cohen et al., 2021), (Wang et al., 2021).

Crowdshipping has an important effect on reducing the pace of environment degradation, with a coefficient of variation of -0.376. This demonstrates that a measurement increase in crowdshipping activity is predicted to reduce the rate of environment degradation to 0.376 measurements, providing that other factors continue to equal.

This finding suggests that crowdshipping, as part of a public participation-based logistics system has an opportunity to achieve a beneficial effect on environmental conservation efforts, (E Marcucci et al., 2017), (Waddell, 2017).

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The negative impact indicated by the coefficient can be attributed to the efficiency of flight routes and optimization of resource use, which in turn reduces carbon emissions and excessive energy consumption. Therefore, the wider and more organized implementation of crowdshipping can be one of the sustainable solutions to reduce environmental impacts in the logistics and transportation sector, (Carbone et al., 2017) (Kagermann, 2015),

Flight route efficiency plays a key role in reducing carbon emissions. Through optimal route planning, shipping trips can minimize travel distance and travel time, which directly reduces fuel consumption, (Hadas et al., 2023). Crowdshipping leverages digital technology to coordinate travel and deliveries, ensuring that each trip maximizes cargo capacity, (Fadeev & Alhusseini, 2023). By reducing empty flights or trips, the potential emissions generated from freight transportation can be significantly reduced, helping to support environmental mitigation initiatives, (Carbone et al., 2017), (Sternberg & Norrman, 2017)

Optimizing using of resources in crowdshipping involves utilizing air vehicles that are already in operation for the delivery of cargo. In conventional systems, many logistics trips are made without return loads, which causes fuel and energy inefficiencies, (Hadas et al., 2023), (Carbone et al., 2017). In disparity, crowdshipping utilizes the unused free baggage of private or commercial vehicles that are already running on certain routes. This not only increases logistics efficiency but also reduces the need for additional resources, such as fossil fuels and electricity, thus supporting the principles of a circular and environmentally friendly economy, (Wang et al., 2021)

Carbon emission reduction is one of the main goals of efficient crowdshipping implementation. By integrating existing on-the-go deliveries, crowdshipping helps to reduce the number of air and road vehicle cargo, which means a cumulative reduction in greenhouse gas emissions, (Chao, 2014). Numerous investigations have revealed that the transportation industry is among the most significant drivers of to global carbon emissions, (Sulej et al., 2012). Therefore, the widespread implementation of crowdshipping can significantly contribute to achieving emission reduction targets in global environmental policies, (Mao et al., 2019), (Wang et al., 2021)

Even though crowdshipping has great potential to reduce environmental damage, its implementation certainly faces several challenges. Among them are complex logistics coordination and the need for advanced technology to manage routes efficiently, (Simoni et al., 2020), (Theodossiou et al., 2020). However, advances in digital technology and artificial intelligence are opening up new opportunities to overcome these challenges, (Mittal et al., 2021). With the support of advanced logistics management systems, crowdshipping can be implemented more effectively, providing positive impacts not only environmentally but also economically and socially, (Birolini et al., 2020).

Based on the efficiency of flight routes and optimization of resource use, crowdshipping offers an innovative solution to address environmental challenges in the logistics sector, (Ermagun & Stathopoulos, 2021). The negative coefficients found in the analysis reflect the potential of crowdsourcing for lowering carbon emissions and energy consumption, (Boysen et al., 2022). Therefore, encouraging the adoption of crowdshipping as part of a sustainable logistics strategy is essential in mitigating global climate change, (Schlenker & Walker, 2016). With a holistic approach, crowdshipping is not only a more efficient shipping alternative but also supports long-term sustainable development, (Kieso et al., 2019), (Theodossiou et al., 2020).

The integration of logistics mobility and passengers mobility in crowdshipping refers to the practice of merging the activity of moving products with scheduled individual travels, resulting in synergy between the two types of mobility,(Fessler et al., 2022) (Sina Mohri et al., 2023). This concept takes advantage of passengers mobility—both on daily and long-distance trips—to deliver items or packages as part of their activity

According to the notion, passengers mobility serves not only as a means of transporting people from one site to another but also as an active component in the logistics distribution chain, (Boysen et al., 2022). This connection enables users to act as temporary couriers, transporting products alongside their excursions,

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(Craps, 2021). This concept is supported by an application-based technology platform, which connects shippers with individuals traveling along certain routes and schedules, (Rechavi & Toch, 2022).

From a logistics efficiency standpoint, this integration has considerable benefits, such as lowering operational costs, optimizing available transportation capacity, and helping to reduce carbon emissions by leveraging current journeys, (Fessler et al., 2022). This strategy, in particular, makes shipping more accessible in locations where traditional logistical services may be limited, (Karcz & Slusarczyk, 2016).

Indeed, implementing this integration will present issues such as shipping security, personal data protection, and compliance with transportation and logistics rules, (Park et al., 2020). That is why, the success of crowdshipping execution necessitates the creation of strong verification procedures and operational policies that meet shipping safety and ethics standards.

Finally, the integration of logistics mobility and passenger mobility in crowdshipping is an innovation in a modern transportation system where the movement of cargo and people is seen as an important individual activity, that must be synergized to become an important component of a more efficient and sustainable logistics solution.

Conclussion

This paper clearly explains the impact and repercussions of integrating logistics mobility and passengers mobility within the framework of crowdshipping on environment degradation. The impacts and implications found can be seen from logistics mobility, which can significantly affect crowdshipping and environment degradation, then passengers mobility, which can significantly affect crowdshipping and environmental degradation, then crowdshipping as a medium for integrating logistics mobility and passengers mobility, which can significantly affect environment degradation. Crowdshipping combines logistics delivery with scheduled passenger journeys, resulting in a more effective logistics solution delivered through a technology-based platform that can reduce operational costs and carbon emissions by utilizing existing journeys. Through this concept, the major impact on environmental degradation from mobility can be reduced. The study's findings will open the path for new expansions in the cargo transportation business by integrating logistics and passenger mobility. The novelty of this research lies in applying the crowdshipping concept to the airport environment, with an emphasis on merging passenger transportation and logistics to reduce the environmental effect. The study did not yet include local contextual aspects that can affect the use of crowdshipping, such as cultural, legal, and policy differences between locales, which can lead to significant changes in outcomes.

Recommendation

Following the research results and conclusions, several recommendations are proposed to enhance the logistics delivery business in air transportation, First, due to the significant influence of logistics mobility and passengers mobility on crowdshipping, it is necessary to anticipate that stakeholders will be more able to adapt crowdshipping services into companies that enable the surge of passengers and logistics and form new models. Second, the effect of significant tandem domination of logistics mobility, passenger mobility, and crowdshipping on environment degradation, presents possibilities to encourage proactive engagement from society in general and especially people involved with the delivery sector, where in this case a means must be found to form connections and raise technology commitment. Third, the investigation remains concentrated on the impact of environment degradation, where the variables of logistics mobility, passenger mobility, and crowdshipping can reduce the reduction of environment degradation which has an impact on the opening of profession opportunities for logistics delivery integration platforms in the logistics delivery business. However, many additional elements need to be addressed considering the influence of airline flights on the environment and other revenue streams.

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