Passenger Mobility Impact on Customer Satisfaction and Environmental Degradation Through Air Transportation Crowdshipping

MODEN PURBA[1*], HASDI AIMON[2], ALPON SATRIANTO[3]

[1*, 2, 3] Environmental & Development Studies Doctoral Programme, Faculty Economy and Business, Universitas Negeri Padang, Padang, INDONESIA

Abstract: This study investigates the impact and implications of passenger mobility through crowdshipping on customer satisfaction and environmental degradation. A questionnaire was used to collect data from customers who have been aeroplane passengers at Hang Nadim Airport in Batam, Indonesia. SmartPLS software was used to evaluate the quality of the questionnaire data and test the research hypotheses. The SmartPLS path model analysis results show that passenger mobility affects Crowdshipping, customer satisfaction, and environmental degradation; Crowdshipping affects passenger mobility and environmental degradation, and customer satisfaction affects environmental degradation. The findings of this study help understand and quantify potential strategies for logistics delivery by utilizing aeroplane passenger crowd shipping. Consequently, it can help policymakers and air transport companies develop air transport-based crowd shipping models to estimate the possible impacts from an economic and environmental point of view as well as environmental utilization.

Key-Words: Passenger Mobility, Crowdshipping, Customer Satisfaction, Environmental Degradation.

Received: March 15, 2024. Revised: August 12, 2024. Accepted: September 15, 2024. Published: October 14, 2024.

1. Introduction

The quick advancement in making use of Crowdshipping systems has actually started a paradigmatic modification in today's traveling characteristics [16]. which enables people to make use of the vacant capability in the travel luggage area for the transport of items using air transport [22]. This produces brand-new opportunities for making use of area formerly not used efficiently in air traveling as well as has substantial ramifications for traditional traveling patterns of actions plus behaviors [46]; [52].

This expanding fad elevates considerable issues concerning its ramifications for customer contentment plus Environmental Degradation [26] despite the financial and easy advantages of executing this company version [3]. In customer complete satisfaction, focusing on elements such as promptness of distribution, the security of items, and top quality of solution is crucial to consider in reviewing the performance of Crowdshipping systems [26].

At the same time from an environmental sustainability point of view a thorough evaluation of the influence of carbon exhausts source usage [30] as well as possible payment to environment modification is required to determine proper reductions steps [53]. Consequently a holistic understanding of this fad's unfavorable and also favorable ramifications is a crucial requirement for creating plans that can fit customer demands while focusing on ecological sustainability [30].

The Crowdshipping sensation, which requires the engagement of people in the distribution of products making use of easily accessible travel luggage centres in air transport [16]; [22]; [52], has been the topic of substantial interest in human flexibility researches. Comprehending how guest flexibility patterns communicate with Crowdshipping methods is vital [16]. This permits scientists to determine behaviour patterns that highlight choices for group delivery solutions and variables affecting choices to take on or desert the method [37]; [38].

Along with the financial advantages and comfort frequently connected with Crowdshipping, there are claims regarding its influence on customer satisfaction and environmental sustainability. Comprehending these elements is vital in creating an alternative plus lasting method. A comprehensive empirical study can assist in repainting a much more full image of the impacts of Crowdshipping methods on customer experiences and their effect on the environment.

It is crucial to examine how crowdshipping influences carbon discharges, power intake, and source use from an ecological viewpoint [39].

Studies on the environmental influence of these methods can determine locations for enhancements to minimize the downsides [4]. Recognizing customer choices based on environmental factors can assist in the creation of sustainable initiatives [43].

Independent research has analyzed subjects associated with passenger mobility, client contentment, and environmental deterioration [33]. Studies on passenger mobility have mainly analyzed travelling patterns, setting selection actions together with the variables influencing travelling choices. [3].

Similarly, complete satisfaction has concentrator-tailored experiences and solutions of high quality [18]. Literary works on environmental degradation have examined how different forms of mobility affect the environment and how this affects air quality and climate change [14].

Passenger mobility is related to the movement of goods and logistics during departure and arrival. [54]. These fads are integrating to develop brand-new opportunities for logistics [12]; [41]; [54]. The integration between passengers and logistics opens up possibilities in transport to minimize complete journeys by enhancing load factor as well as product performance [40]. The level of passenger crowd thickness limits the separation room consisting of guest arrivals [25].

One of the critical challenges identified here is aligning the supply and demand of these services, given that supply first emerges from the passenger transportation sector. In contrast, the freight transportation sector generates demand [57]. If guests have a ticket, they can immediately get a travel solution consisting of free travel luggage that can be used separately [19]. Transportation logistics affects the logistics costs and prices of products consumed in a particular area, so logistics is concerned with efficiency and effectiveness [25].

Passengers departing and arriving on flights have accessible baggage facilities to carry personal or logistical items [12]. Airlines limit accessible baggage facilities, and excess baggage will be shared with passengers with the same flight number [46], which is the basic concept of crowd shipping that can generally be seen and booked through Internet services [22].

Crowdshipping is a method that utilizes crowds of departure people to deliver packages to customers [11]. This method is considered a sustainable business that corresponds to supply and demand for any logistics transportation, [52] with a market concept that allows information connectivity to occur [15]. The primary process of crowdshipping is that the logistics are transported by passenger aircraft that are traveling according to the passenger destination [20].

The type of crowdshipping examined is based on crowd shippers utilizing mass transit, explicitly leveraging travel, and planning urban transportation activities in flight paths for sustainable logistics [22]; [42]. If accessible baggage facilities are still available, cargo/logistics distributors who sign up can utilize the centre, coupled with passengers having the opportunity to become freelance couriers [57]. Through internet solutions, freelancer couriers can view the crowdlogistics schedule to be provided, the logistics delivery location based on the agreement from the operator, the settlement made as a settlement as the operator's settlement approach, as well as various other parcel distribution solutions needed [15]; [22].

Along with the passion for delivery, web solutions are also developing areas in the online world of these freelancers, making web applications particularly important [55]. The increasing variety of freelance service providers will undoubtedly form a group in the social environment of the courier crowd [46].

Nonetheless, the impact of passenger departures and arrivals may be disruptive for crowdshipping air transportation [13]. The unfavourable impact of passenger movement on crowdshipping solutions can be credited to elements such as distribution delays due to travel delays, solution efficiency, passenger overflow, supply factors, and compatibility between passengers and goods [57]. These factors must be carefully considered when developing and implementing crowdshipping solutions to ensure their success and sustainability [46]. In addition, crowdshipping systems are anticipated to be continuously improved to match passengers' flexibility characteristics and how well regulations and policies are implemented to overcome these barriers [34]; [52].

The novelty of this research lies in exploring the complex interactions between customer satisfaction and environmental degradation in the context of crowdshipping activities to support passenger mobility in air transportation. This may include data analysis on passenger behaviour, environmental impact analysis, and policy proposals to mitigate negative impacts while maximizing benefits.

2. Conceptual Framework and Hypothesis Development

2.1. Passenger mobility

Passenger mobility represents the capacity of people to move between places using different transportation arrangements and plays a vital role in facilitating smooth and effective travel to various destinations [47]. More than just convenience, this mobility is a critical facilitator for accessing essential aspects of life, such as employment, education and learning, and healthcare, as highlighted by [36]. The effects go beyond individual benefits, leveraging significant impacts on the economic climate and the environment, specifically the alarming power intake and release of greenhouse gases [16]. Therefore, it is essential to explore and implement advancements in passenger movement, with a more detailed concentration on improving environmentally friendly mass transportation systems. These efforts not only aim to improve people's quality of life but also to ensure environmental sustainability.

A large number of scientific investigations investigate various aspects of passenger mobility, including the profiling of public transport passenger mobility using counterintuitive learning to decipher the complex patterns controlling passenger choices [36], then data-driven models that seek to understand the decision-making processes underlying passenger route choices in urban metro networks [47], furthermore data-driven models that seek to understand the decision-making processes underlying passenger route choices in urban metro networks, explaining the intricacies of passenger behaviour [35]. As the studies above show, innovative research, as demonstrated by the studies above, contributes to the ongoing discourse explaining the various factors that influence passenger mobility.

2.2. Crowdshipping

Crowdshipping, also called team logistics, offers a new perspective for long-distance circulation by utilizing crowdsourcing to improve transportation capabilities and enhance the efficiency of providing goods [21]. It objectifies a cumulative and sustainable method for long-distance delivery that utilizes the travel of travellers and visitors combined with nearby citizens to provide a flawless strategy between areas [51]. By utilizing internet systems that attach service providers, providers, and recipients, crowdsourcing is emerging as an economical and environmentally friendly option to standard circulation techniques [2].

The main principle of crowd delivery involves appointing distribution work to on-demand representatives, such as travellers, tourists, and additional locals who volunteer to augment the transport of goods [5]. By using crowdsourcing for the customized distribution of goods, crowd delivery helps with a collective and holistic approach to overcoming the difficulties inherent in long-distance logistics [21].

2.3. Consumer satisfaction

Improving client satisfaction is a vital component of any service, directly influencing the general success and development of the firm [51]. This procedure includes how consumers review a product's and services' general top quality and their assumptions [56]. It also works as a vital efficiency sign assessing the degree of complete satisfaction clients acquire from a firm's offerings. Pleased consumers are most likely to commit to advising the business to others and add favourable testimonials, which inevitably reinforce sales and earnings [51].

Different aspects significantly affect client satisfaction, such [51]: (1) Product Quality: The top quality of a service or product plays a vital role in shaping complete consumer satisfaction, with high-quality offerings likely to match client assumptions; (2) Customer Service: Top quality of customer support is essential which includes quick reaction to queries, efficient problem resolution, along with interest tailored to the consumer's needs; (3) Convenience: The ease with which a client can access as well as use the service or product considering variables such as delivery time, return plans, and also user-friendly user interface, adds to satisfaction; (4) Price: Price is important: The rate of the service or product emerges as an essential component with clients anticipating a reasonable price according to the perceived value.

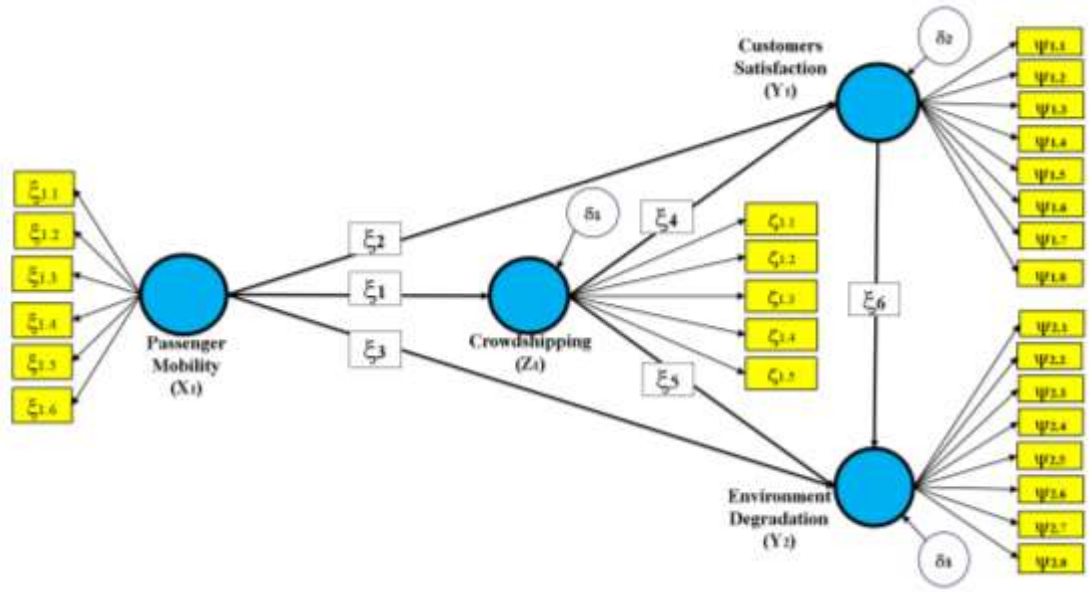
2.4. Environment Degradation

Environmental degradation is emerging as an essential international issue with considerable consequences for human health and the environment [56]. This phenomenon is environmental degradation due to the depletion of essential resources such as air, water, and soil, coupled with the destruction of ecological communities, extermination of wildlife environments, and air pollution [58]. This forms a turbulent procedure that conflicts with the native environment, reduces biodiversity, and jeopardizes the overall health and well-being of the environment [57]. Although

environmental degradation usually occurs, human tasks can help or initiate these procedures [37], turning them into multidimensional obstacles that affect sustainable progress, economic climate, and poverty [4]. Deforestation, overgrazing, pollution, and climate change [9] lead to biodiversity loss, health concerns, and economic impacts.

Then the reasons for environmental degradation [49] consist of (1) Deforestation leading to environmental loss, reduced water and nutrient uptake by plants combined with payments for environmental modification; (2) Overgrazing leading to soil degradation, reduced water and nutrient retention, and loss of biodiversity; (3) Pollution, including the release of harmful compounds into the air, water, and soil, leading to health problems and societal deterioration; (4) Climate adjustment caused by increased greenhouse gases that add to the spike in ocean temperatures worldwide, among other ecological impacts.

Based upon the research as well as examination of various research searchings for, the literary works testimonial, as well as the connections in between the variables as pointed out previously the complying with Figure 1. provides the research study structure:



Picture 1 Conceptual Framework

Environmental degradation is influenced directly by passenger mobility and through the moderating variables of crowdshipping and customer satisfaction. Customer satisfaction is influenced directly by passenger mobility and through the moderating variables of crowdshipping. Crowdshipping is influenced directly by passenger mobility.

The influence of variables can be formulated as the formulas below:

$\mathbf{Z_1} = \xi_1 + \delta_1$ ……..……...…...formula 1

$\mathbf{Y_1} = \xi_2 + \xi_4 + \delta_2$ ……..……. formula 2

$\mathbf{Y_2} = \xi_3 + \xi_5 + \xi_6 + \delta_3$ …… formula 3

Z_1: Determinants of Air Transportation Crowdshipping

Y_1 : Determinants of Customer Satisfaction

Y_2 : Determinants of Environmental Degradation

ξ_1 : Path Coefficient from Passenger Mobility to Crowdshipping

ξ_2 : Path Coefficient from Passenger Mobility to Customer Satisfaction

ξ_3 : Path Coefficient from Passenger Mobility to Environmental Degradation

ξ_4 : Path Coefficient from Crowdshipping to Customer Satisfaction

ξ_5 : Path Coefficient from Crowdshipping to Environmental Degradation

ξ_6 : Path Coefficient from Customer Satisfaction to Environmental Degradation

δ_1 : Crowdshipping Residual

δ_2 : Customer Satisfaction Residual

δ_3 : Environmental Degradation Residual

3. Methodology

This study used primary data. Data was collected from prospective passengers, passengers, and former passengers at Hang Nadim Airport Batam. The data collection technique in this study used a questionnaire method, which was made in Google

Form format and distributed online. The sample in this study, namely 100 respondents, returned valid questionnaires for analysis. Data analysis in this study used a Structural Equation Model with a Partial Least Square approach using SmartPLS 3.2.8 software.

The questionnaire consisted of 27 indicator questions used to measure the constructs of the Passenger Mobility aspect (6 indicator statements), the Crowdshipping aspect (5 indicator statements), the Customer Satisfaction aspect (8 indicator statements), and the Environmental Degradation aspect (8 indicator statements). The variables used in this study were adopted from previous studies:

1. Passenger mobility X_1 is the number of people who travel by air transport from one city to another city, the indicator of which is passengers number $X_{1.1}$, logistics number $X_{1.2}$, vehicles number $X_{1.3}$, destinations number $X_{1.4}$, baggage additions number $X_{1.5}$, logistics regulation $X_{1.6}$, [8]; [12]; [54].
2. Crowdshipping Z_1 sends mass goods using passenger departures crowd as delivery people, known as freelance couriers, [52]. The measurement indicator for this process is the availability of free charge baggage 15-20 kg as a form of service from airlines in the form of logistics ready to be sent via passengers (crowdlogistics $Z_{1.1}$), companies or people sending logistics (crowdshipper $Z_{1.2}$), passengers who are willing to carry logistics on behalf of the ticket (crowdcourier $Z_{1.3}$), means of delivery (crowdplatform $Z_{1.4}$), shipping costs (crowdshare economic $Z_{1.5}$), [29]; [52]; [57].
3. Customer satisfaction Y_1 is the perception of airport service users about the availability of support for passenger mobility, and crowdshipping activities at airport. Measuring indicators can be seen through clarity of service needs such as, simplicity of service procedures (procedures simplicity) $Y_{1.1}$, fast or slow service (duration of services) $Y_{1.2}$, costs required for services (cost of services) $Y_{1.3}$, suitability and compliance with applicable rules (compliance), security and comfort (security), safety of people and goods (safety) $Y_{1.4}$, availability of complaint suggestions and responses to complaints (complaint media) $Y_{1.5}$, [17]; [26].
4. Environment Degradation at Hang Nadim Airport Batam: the degradation of environmental quality due to the impact of air transport operations around the airport, including the airport operations themselves in serving customers in the form of aircraft, passengers, and logistics. The process of changes and degradation of environmental quality, which has a negative impact on Hang Nadim Airport Batam, can certainly be seen from the measurement of indicators such as air pollution, water pollution, rubbish, noises, green open space, sanitation (sanitazion), drainages, and environmental hygiene of the airport in general, [30]; [39]; [56].

4. Results and Discussion

4.1. Demographic Results

This research categorised participants into two groups: males and females. Out of the data collected from 100 respondents, it was found that 62 individuals, or 62%, were male, and the remaining 38 individuals, or 38%, were female. Moreover, in terms of their professions, 76 participants, or 76%, represented the general public, 21 participants, or 21%, were bureaucrats, and 2 participants, or 2%, identified as entrepreneurs.

4.2. Validity and Reliability Test

Table 1 is the outer model table, which is this study's reliability and validity assessment. This research. A reflective measure is considered high if it correlates more than 0.50 with the construct to be measured.

Table 1. Outer Loading

Number	Indicators	Kode	Variabel			
			Passanger Mobility (X1)	Crowdshipping (Z1)	Customers Satisfaction (Y1)	Environment Degradation (Y2)
1	*Passangers Number*	$X_{1.1}$	0.714			
2	*Baggage Number*	$X_{1.2}$	0.782			

3	*Transportation Vehicles*	$X_{1.3}$	0.891			
4	*Destinations Number*	$X_{1.4}$	0.774			
5	*Baggage Additions Number*	$X_{1.5}$	0.883			
6	*Mobility Regulation*	$X_{1.6}$	0.876			
7	*Crowdcourier*	$Z_{1.1}$		0.611		
8	*Crowdlogistic*	$Z_{1.2}$		0.869		
9	*Crowddelivery*	$Z_{1.3}$		0.893		
10	*Crowdshare-economi*	$Z_{1.4}$		0.874		
11	*Crowdair-transportation*	$Z_{1.5}$		0.898		
12	*Requirements Clearly*	$Y_{1.1}$			0.723	
13	*Procedures Simplicity*	$Y_{1.2}$			0.854	
14	*Duration of Services*	$Y_{1.3}$			0.900	
15	*Cost of Services*	$Y_{1.4}$			0.829	
16	*Compliances*	$Y_{1.5}$			0.912	
17	*Security and Comfortable*	$Y_{1.6}$			0.842	
18	*Safety*	$Y_{1.7}$			0.837	
19	*Complaint Media Availables*	$Y_{1.8}$			0.707	
20	*Air Pollution*	$Y_{2.1}$				0.780
21	*Water Pollution*	$Y_{2.2}$				0.801
22	*Rubbish*	$Y_{2.3}$				0.896
23	*Noise*	$Y_{2.4}$				0.604
24	*Sanitation*	$Y_{2.5}$				0.864
25	*Green Open Space*	$Y_{2.6}$				0.891
26	*Drainages*	$Y_{2.7}$				0.758
27	*Environment Hygiene*	$Y_{2.8}$				0.881

Derived from the findings presented in the outer loading results within Table 1, it is evident that all the questionnaire items in all indicators exhibit correlation values surpassing 0.50. Consequently, all items meet the validity criteria, illustrating their capacity to represent the variables effectively.

Table 2. Cronbach's Alpha

Variables	Cronbach's Alpha
Passanger Mobility (X_1)	0.903
Crowdshipping (Z_1)	0.887
Customer Satisfaction (Y_2)	0.933
Environment Degradation (Y_3)	0.925

Of the 4 variables above, X1 Passenger Mobility, Z1 Crowdshipping, Y1 Customer Satisfaction and Y2 Environmental Degradation, all have a Cronbach's Alpha value greater than 0.7 and an Average Variance Extracted (AVE) value greater than 0.5, so it can be stated that all variables are reliable or fulfill the requirements.

4.3. Hypothesis Testing

Table 3 presents the results of direct structural model testing. Hypothesis testing is done by looking at the R square value. The results of direct model testing are as follows:

Table 3. R Square

Variables	R Square	R Square Ajusted
Crowdshipping (Y_1)	0.883	0.882
Customer Satisfaction (Y_2)	0.970	0.969
Environment Degradation (Y_3)	0.950	0.948

Based on the R^2 value in Table 3 above, it is found that the Passenger Mobility able to interpret 88.3% of the variability in Crowdshipping, and the remaining 0.7% is explained by other constructs outside those examined in this research. Then the variables Passenger Mobility and Crowdshipping, are simultaneously able to interpret the variability of the Customer Satisfaction construct by 97.0%, and the remaining 3.0% is explained by other constructs outside those examined in this research. Then the variables Passenger Mobility, Crowdshipping, and Customer Satisfaction are simultaneously able to interpret the variability of the Environmental Degradation construct by 95.0%, and the remaining 5.0% is explained by other constructs outside those examined in this research.

Table 4. Path Coefficient

Variables	Original Sampel (O)	Sampel Mean (M)	Standard Deviation (STDEV)	T Statistics (O/lSTDEVl)	p Value
Passanger Mobility (X_1) vs Crowdshipping (Z_1)	0.940	0.940	0.015	62.483	0.000
Passanger Mobility (X_1) vs Customer Satisfaction (Y_2)	0.494	0.509	0.068	7.22	0.000
Passanger Mobiliy (X_1) vs Environment Degradation (Y_3)	0.740	0.731	0.145	5.101	0.000
Crowdshipping (Y_1) vs Customer Satisfaction (Z_2)	0.506	0.490	0.071	7.125	0.000
Crowdshipping (Z_2) vs Environment Degradation (Y_3)	-0.530	-0.515	0.177	2.986	0.003
Customer Satisfaction (Y_2) vs Environment Degradation (Y_3)	0.745	0.739	0.261	2.849	0.005

As per the data presented in Table 4 it's evident that the collective impact of the independent variable on the dependent variable is statistically significant. This inference is drawn from the observation that the p-values are less than 0.05, indicating that the Passenger Mobility variable significantly influences Crowdshipping, Customer Satisfaction, and Environmental Degradation variables. Moreover, Crowdshipping's impact on Customer Satisfaction and Environmental Degradation is also statistically significant, as is the influence of Customer Satisfaction on Environmental Degradation.

5. Discussion

5.1. Passenger Mobility

The Passenger Mobility variable seen from the external loading results offered in Table 1 can be effectively clarified with suitable indicators consisting of the Number of Passengers (0.714), number of Baggage (0.782), Transport Vehicle (0.891), number of destinations (0.774), number of Baggage Additions (0.883), coupled with Movement Regulations (0.876). This detailed set of indicators precisely represents the Passenger Mobility variable.

As illustrated in Table 4, Passenger Mobility has a significant impact on a number of important measures. Passenger Mobility positively influences Crowdshipping by 0.940, which represents a 94% increase in Crowdshipping procedures. In addition, Passenger Mobility positively contributes to Customer Satisfaction by 0.494, which results in a 49.4% increase in customer satisfaction. In addition, it also affects Environmental Degradation by 0.740,

which brings a 74% increase in environmental degradation. Utilizing passenger mobility in the context of crowdshipping provides an efficient method of overcoming logistical development difficulties, meeting customer needs, and possibly reducing air pollution [16]. This principle emphasizes exactly how the application of Passenger Mobility for logistics transportation can reduce the number of logistics carriers [37].

The movement of individuals, as well as the growing need for effective and cost-effective transportation of goods, are the present and future patterns in the logistics sector. Meeting the need for the transportation of lightweight goods as well as parcels presents both difficulties and opportunities in the logistics chain. Sustainable intercity freight transportation makes every effort to strike a balance between promoting favourable influences on availability as well as financial progress while reducing unfavourable externalities such as environmental pollution. The crowdshipping principle is one possible option to achieve this balance [36].

5.2. Crowdshipping

Using the Crowdshipping variable clarified by the external loading results offered in Table 1, its characterization can be explained through its component indicators, which consist of Crowdcourier (0.61), Crowdlogistics (0.869), Crowddelivery (0.893), Crowdshare-Economic (0.874), and also Crowdair-Transportation (0.898). Collectively, these indicators provide an overall picture of the Crowdshipping variable.

After assessing Table 4, it can be seen that the Crowdshipping variable exerts a remarkable impact on several measurements: it affects Customer Satisfaction by 0.506, which leads to a significant 50.6% increase in the overall customer satisfaction process. On the other hand, it produces an unfavourable effect on environmental degradation, including a directional coefficient of -0.530, which symbolizes a 53% decrease in environmental degradation and efficiently reduces high environmental degradation.

Crowdshipping is defined as a version of crowdsourced delivery, logistics, and freight forwarding that leverages the power of crowdsourcing to provide customized distribution solutions by leveraging transportation guests. This design allows many people to jointly participate in distribution tasks along with their desired journey, promoting shared habits along with shared solutions within the environment [2]. This highlights how individuals utilize the capacity of social media networks to adhere to and also share solutions along with possessions both for the benefit of the area and their benefit [5]. The application of crowdshipping stands as a dependable solution for a variety of jobs, particularly those carried out quickly by intermediaries, which enables a large number of people to take part in the procedure [51].

5.3. Customer Satisfaction

The Customer Satisfaction variable, as shown by the outer loading in Table 1, can be well represented by its constituent indicators. These comprise Clarity of Requirements (0.723), Simplicity of Procedures (0.854), Duration of Service (0.9), Cost of Service (0.829), Compliance (0.912), Security coupled with Convenience (0.842), Safety (0.837) and also Availability of Complaint Media (0.707). Together, this comprehensive set of indicators provides a good representation of the Customer Satisfaction variable.

As seen in Table 4, the variable Customer Satisfaction strongly influences the formation of Environmental Degradation, with a path coefficient of 0.745. This indicates that customer satisfaction plays an important role in strengthening the environmental degradation procedure by 74.5%.

In enterprises, customer satisfaction is an important statistic that affects various elements of business efficiency [39]; [33]. In the context of environmental degradation, overall customer satisfaction can dramatically affect k patterns as well as the need for services and products [3]; [26]. Consumer choice, coupled with the choice to obtain it, contributes to shaping the ecological effects of a company [39]. Research has actually revealed that greater levels of consumer satisfaction are related to increased intake along with the need for products, as well as solutions that lead to more resource disposal, power intake, and waste generation [45]. This increased usage can indirectly add to ecological damage by accelerating procedures such as environmental damage, air pollution, contamination, and also environmental modification [11].

In the era of industrialisation, the logistics sector is demanding improvements, especially in terms of increased emphasis on customer satisfaction. Various logistics solutions have proliferated around the world, providing opportunities to improve the fulfilment of end-to-end customer satisfaction [2]; [7]. Efforts to improve customer satisfaction can also be observed with partnerships associated with factors such as reduced circulation costs, minimized transportation times, reliable payment techniques, and information technology. These aspects indicate a favourable partnership with logistics customer satisfaction, including in the case of crowdshipping

[35]; [28]. Various other emerging principles reveal that the perceived high quality of logistics solutions through crowdshipping is dramatically associated with future acquisition intentions, further intensifying customer satisfaction in the world of logistics coupled with supply chain monitoring.

5.4. Environmental Degradation

The Environmental Degradation variable, as described in the pouter loading results of Table 1, is precisely mentioned by its constituent indicators consisting of Air Pollution (0.780), Water Pollution (0.801), Garbage (0.896), Noise (0.604), Sanitation (0.864), Green Open Space (0.891), Drainage (0.758), plus Environmental Hygiene (0.881). This broad set of indicators provides a broad picture of the Environmental Degradation variable that shows a positive relationship.

Based on Table 4, Passenger Mobility has a considerable impact on environmental degradation, with a coefficient value of 0.740. Meanwhile, Customer Satisfaction also has a considerable impact on environmental degradation, with a coefficient value of 0.745. However, it should be noted that this impact is inversely proportional to crowdshipping, which has an influence on environmental degradation and has a coefficient value of -0.530. This implies that Crowdshipping can mitigate the increase in environmental degradation by reducing it with a coefficient value of 53%.

The unfavourable coefficient suggests an opposite relationship, recommending that crowdshipping can help reduce environmental degradation by facilitating the movement of goods through collaborative transportation and delivery approaches. This remains in line with previous research, which states that crowdshipping can provide advantages in reducing the level of environmental damage by efficient use of vehicles along with passengers and logistics [21]; [47].

Specific indicators related to environmental degradation are defined as follows:

Air Pollution: This refers to a problem where high air quality ends up being endangered and polluted by compounds that can have both safe and harmful outcomes for human health [48]; [4]. Water Pollution: This includes changes in water issues such as lakes, rivers, seas, and groundwater due to human actions [30]; [44]; [49]. Garbage: Refers to recurring waste from daily human activities or natural procedures, usually in a strong form, which is excess, discarded, or disliked, originating from human activities Wongkitrungrueng [9]; [56]. Noise: Defined as unwanted sound that may cause pain to the audience. Sounds can come from natural resources such as speech or created tasks such as the use of devices [24]; [23]; [6]. Eco-Open Space: This term refers to a much more open, extended or landscaped location where plants grow, consisting of normally growing plants and also deliberately planted plants [9]; [56]. Sanitation: Basically, health describes the deliberate method of maintaining sanitation to stop direct contact with dust and various other harmful waste products with the aim of protecting and improving human health [24]; [58]; [50]. Sewerage/drainage: This is a framework created to help drain excess water from one area to another consisting of natural and synthetic water containers that ultimately channel excess water to the ocean, rivers, lakes, wells, and also various other infiltration centres [30]; [1]; [27]. General Environmental Conditions: In a more comprehensive context, the environment encompasses the territorial unit and its stresses and microorganisms, which consist of humans and their actions that affect the survival and well-being of humans and other living things [4]; [39].

6. Conclusions

This study highlights the significant impact of passenger mobility on customer satisfaction and environmental degradation through crowdshipping activities. This study facilitates a more in-depth understanding and measurement of potential strategies for logistics delivery, especially through the utilization of air passengers. In addition, the findings offer valuable knowledge to policy makers and transportation companies, guiding the development of future crowd-based air transportation models. This perspective makes it possible to estimate the possible impacts from an economic, environmental, and utilization point of view.

Acknowledgment:
This research was purely funded by the author's funds to support the final assignment of the Environmental and Development Studies Doctoral Program at Universitas Negeri Padang, Indonesia

References:

[1] Al-Kodmany, K. (2018). The vertical farm: A review of developments and implications for the vertical city. *Buildings*, *8*(2), 24.

[2] Allahviranloo, M., & Baghestani, A. (2019). A dynamic crowdshipping model and daily travel behavior. *Transportation Research Part E: Logistics …*. https://www.sciencedirect.com/science/article/pii/S1366554518310603

[3] Allen, J., Piecyk, M., Piotrowska, M., McLeod, F., Cherrett, T., Ghali, K., Nguyen, T., Bektas, T., Bates, O., Friday, A., & others. (2018). Understanding the impact of e-commerce on last-mile light goods vehicle activity in urban areas: The case of London. *Transportation Research Part D: Transport and Environment*, *61*, 325–338.

[4] Barrett, B. F. D., & Therivel, R. (2019). *Environmental policy and impact assessment in Japan*. Routledge.

[5] Behrend, M., & Meisel, F. (2018). The integration of item-sharing and crowdshipping: Can collaborative consumption be pushed by delivering through the crowd? *Transportation Research Part B: Methodological*. https://www.sciencedirect.com/science/article/pii/S0191261517308810

[6] Bies, D. A., Hansen, C. H., & Howard, C. Q. (2017). *Engineering noise control*. CRC press.

[7] Boysen, N., Emde, S., & Schwerdfeger, S. (2022). Crowdshipping by employees of distribution centers: Optimization approaches for matching supply and demand. *European Journal of Operational …*. https://www.sciencedirect.com/science/article/pii/S0377221721003143

[8] Camps-Aragó, P., Temmerman, L., Vanobberghen, W., & Delaere, S. (2022). Encouraging the Sustainable Adoption of Autonomous Vehicles for Public Transport in Belgium: Citizen Acceptance, Business Models, and Policy Aspects. *Sustainability (Switzerland)*, *14*(2). https://doi.org/10.3390/su14020921

[9] Canton, H. (2021). International Civil Aviation Organization—ICAO. In *The Europa Directory of International Organizations 2021* (pp. 326–330). Routledge.

[10] Chen, C., Zhang, D., Wang, Y., & Huang, H. (2021). Enabling Smart Urban Services with GPS Trajectory Data. *Enabling Smart Urban Services with GPS Trajectory Data*, 1–347. https://doi.org/10.1007/978-981-16-0178-1

[11] Chen, J. K. C., Batchuluun, A., & Batnasan, J. (2015). Services innovation impact to customer satisfaction and customer value enhancement in airport. *Technology in Society*, *43*, 219–230.

[12] Cohen, A. P., Shaheen, S. A., & Farrar, E. M. (2021). Urban Air Mobility: History, Ecosystem, Market Potential, and Challenges. *IEEE Transactions on Intelligent Transportation Systems*, *22*(9), 6074–6087. https://doi.org/10.1109/TITS.2021.3082767

[13] Craps, A. (2021). What are the changes in LCA passengers' mobility practices? Insights from a European survey. *Transportation Research Interdisciplinary Perspectives*, *12*(April), 100477. https://doi.org/10.1016/j.trip.2021.100477

[14] D'Alfonso, T., Jiang, C., & Bracaglia, V. (2016). Air transport and high-speed rail competition: Environmental implications and mitigation strategies. *Transportation Research Part A: Policy and Practice*, *92*, 261–276.

[15] Dai, Q., Jia, H., & Liu, Y. (2020). Private vehicle-based crowdshipping for intercity express transportation: Feasibility assessment. *International Journal of Distributed …*. https://journals.sagepub.com/doi/abs/10.1177/1550147720908203

[16] Dayarian, I., & Savelsbergh, M. (2020). Crowdshipping and same-day delivery: Employing in-store customers to deliver online orders. *Production and Operations …*. https://onlinelibrary.wiley.com/doi/abs/10.1111/poms.13219

[17] Dole, C. E., Lewis, J. E., Badick, J. R., & Johnson, B. A. (2016). *Flight theory and aerodynamics: a practical guide for operational safety*. John Wiley & Sons.

[18] Einwiller, S. A., & Steilen, S. (2015). Handling complaints on social network sites--An analysis of complaints and complaint responses on Facebook and Twitter pages of large US companies. *Public Relations Review*, *41*(2), 195–204.

[19] Fadeev, A. I., & Alhusseini, S. (2023). Determination of Urban Public Transport Demand by Processing Electronic Travel Ticket Data. *Periodica Polytechnica Transportation Engineering*, *51*(4), 394–408. https://doi.org/10.3311/PPtr.21447

[20] Fessler, A., Thorhauge, M., Mabit, S., & Haustein, S. (2022). A public transport-based crowdshipping concept as a sustainable last-mile solution: Assessing user preferences with a stated choice experiment. *Transportation*

Research Part A: Policy and Practice, *158*(January 2021), 210–223. https://doi.org/10.1016/j.tra.2022.02.005

[21] Gatta, V, Marcucci, E., Nigro, M., & Serafini, S. (2019). Sustainable urban freight transport adopting public transport-based crowdshipping for B2C deliveries. In *European Transport Research …*. Springer. https://link.springer.com/article/10.1186/s12544-019-0352-x

[22] Gatta, Valerio, Marcucci, E., Nigro, M., Patella, S. M., & Serafini, S. (2019). Public transport-based crowdshipping for sustainable city logistics: Assessing economic and environmental impacts. *Sustainability (Switzerland)*, *11*(1), 1–14. https://doi.org/10.3390/su11010145

[23] Gdowska, K., Viana, A., & Pedroso, J. P. (2018). Stochastic last-mile delivery with crowdshipping. *Transportation Research Procedia*, *30*, 90–100. https://doi.org/10.1016/j.trpro.2018.09.011

[24] Gray, R. S. (2020). Agriculture, transportation, and the COVID-19 crisis. *Canadian Journal of Agricultural Economics/Revue Canadienne d'agroeconomie*, *68*(2), 239–243.

[25] Hadas, Y., Tillman, A., Tsadikovich, D., & Ozalvo, A. (2023). Assessing public transport passenger attitudes towards a dynamic fare model based on in-vehicle crowdedness levels and additional waiting time. *International Journal of Transportation Science and Technology*, *12*(3), 836–847. https://doi.org/10.1016/j.ijtst.2022.08.003

[26] Hameed, W.-U., Nadeem, S., Azeem, M., Aljumah, A. I., & Adeyemi, R. A. (2018). Determinants of e-logistic customer satisfaction: A mediating role of information and communication technology (ICT). *International Journal of Supply Chain Management (IJSCM)*, *7*(1), 105–111.

[27] Heath, A. G. (2018). *Water pollution and fish physiology*. CRC press.

[28] Hollnagel, E. (2016). *Barriers and accident prevention*. Routledge.

[29] Johnson, B., Sun, T., Stjepanović, D., Vu, G., & Chan, G. C. K. (2023). "Buy High, Sell Low": A Qualitative Study of Cryptocurrency Traders Who Experience Harm. *International Journal of Environmental Research and Public Health*, *20*(10). https://doi.org/10.3390/ijerph20105833

[30] Karakikes, I., & Nathanail, E. (2022). Assessing the Impacts of Crowdshipping Using Public Transport: A Case Study in a Middle-Sized Greek City. *Future Transportation*, *2*(1), 55–81. https://doi.org/10.3390/futuretransp2010004

[31] Khatri, N., & Tyagi, S. (2015). Influences of natural and anthropogenic factors on surface and groundwater quality in rural and urban areas. *Frontiers in Life Science*, *8*(1), 23–39.

[32] Kwasiborska, A., & Stelmach, A. (2014). Analysis of airport traffic in the context of environmental throughput. *Transport Problems*, *9*(1), 129–140.

[33] Lange, A. (2019). Does cargo matter? The impact of air cargo operations on departure on-time performance for combination carriers. *Transportation Research Part A: Policy and Practice*, *119*, 214–223.

[34] Lauenstein, S., & Schank, C. (2022). Design of a Sustainable Last Mile in Urban Logistics—A Systematic Literature Review. *Sustainability (Switzerland)*, *14*(9), 1–14. https://doi.org/10.3390/su14095501

[35] Le, T. V, Stathopoulos, A., Woensel, T. Van, & ... (2019). Supply, demand, operations, and management of crowd-shipping services: A review and empirical evidence. *... Research Part C …*. https://www.sciencedirect.com/science/article/pii/S0968090X18314700

[36] Le, T. V, & Ukkusuri, S. V. (2019). Crowd-shipping services for last mile delivery: Analysis from American survey data. In *Transportation Research Interdisciplinary …*. Elsevier. https://www.sciencedirect.com/science/article/pii/S2590198219300089

[37] Macrina, G, Pugliese, L. D. P., & Guerriero, F. (2020). Crowd-shipping: a new efficient and eco-friendly delivery strategy. *Procedia Manufacturing*. https://www.sciencedirect.com/science/article/pii/S2351978920306077

[38] Macrina, Giusy, Di Puglia Pugliese, L., Guerriero, F., & Laporte, G. (2020). Crowd-shipping with time windows and transshipment nodes. *Computers and Operations Research*, *113*, 104806. https://doi.org/10.1016/j.cor.2019.104806

[39] Mao, Y., Li, G., Ma, W., Mu, Y., Wang, F., Miao, J., & Wu, D. (2019). Field observation of permafrost degradation under Mo'he airport, Northeastern China from 2007 to 2016. *Cold Regions Science and Technology*, *161*, 43–50. https://doi.org/10.1016/j.coldregions.2019.03.004

[40] Marcucci, E, Pira, M. Le, Carrocci, C. S., & ... (2017). Connected shared mobility for passengers and freight: Investigating the potential of crowdshipping in urban areas. *2017 5th IEEE ...*. https://ieeexplore.ieee.org/abstract/document/8005629/

[41] Marcucci, Edoardo, Le Pira, M., Carrocci, C. S., Gatta, V., & Pieralice, E. (2017). Connected shared mobility for passengers and freight: Investigating the potential of crowdshipping in urban areas. *5th IEEE International Conference on Models and Technologies for Intelligent Transportation Systems, MT-ITS 2017 - Proceedings*, 839–843. https://doi.org/10.1109/MTITS.2017.8005629

[42] Mittal, A., Gibson, N. O., & Krejci, C. C. (2020). Assessing the potential of crowd-shipping for food rescue logistics using agent-based modeling. *Conference of the Computational ...*. https://link.springer.com/chapter/10.1007/978-3-030-77517-9_4

[43] Münzel, T., Schmidt, F. P., Steven, S., Herzog, J., Daiber, A., & Sørensen, M. (2018). Environmental noise and the cardiovascular system. *Journal of the American College of Cardiology*, *71*(6), 688–697.

[44] Ostrom, V., & Ostrom, E. (2019). Public goods and public choices. In *Alternatives for delivering public services* (pp. 7–49). Routledge.

[45] Pizam, A., Shapoval, V., & Ellis, T. (2016). Customer satisfaction and its measurement in hospitality enterprises: a revisit and update. *International Journal of Contemporary Hospitality Management*.

[46] Pourrahmani, E., & Jaller, M. (2021). Crowdshipping in last mile deliveries: Operational challenges and research opportunities. *Socio-Economic Planning Sciences*, *78*(March), 101063. https://doi.org/10.1016/j.seps.2021.101063

[47] Punel, A., Ermagun, A., & Stathopoulos, A. (2018). Studying determinants of crowd-shipping use. *Travel Behaviour and Society*, *12*(March), 30–40. https://doi.org/10.1016/j.tbs.2018.03.005

[48] Purba, M., Aimon, H., & Satrianto, A. (2023). The Crowdshipping Business Opportunity in Air Transportation through the Mobility of Inter-Urban Passengers and the Utilization of Internet in Hang Nadim Airport, Batam. *Journal of Hunan University Natural Sciences*, *50*(1), 20–25. https://doi.org/10.55463/issn.1674-2974.50.1.3

[49] Sampaio, A., Savelsbergh, M., Veelenturf, L., & Van Woensel, T. (2019). Crowd-based city logistics. In *Sustainable transportation and smart logistics* (pp. 381–400). Elsevier.

[50] Schäfer, A. W., & Waitz, I. A. (2014). Air transportation and the environment. *Transport Policy*, *34*, 1–4.

[51] Shen, H., & Lin, J. (2020). Investigation of crowdshipping delivery trip production with real-world data. *Transportation Research Part E: Logistics and ...*. https://www.sciencedirect.com/science/article/pii/S1366554520307547

[52] Sina Mohri, S., Ghaderi, H., Nassir, N., & Thompson, R. G. (2023). Crowdshipping for sustainable urban logistics: A systematic review of the literature. *Transportation Research Part E: Logistics and Transportation Review*, *178*(September), 103289. https://doi.org/10.1016/j.tre.2023.103289

[53] Stefanakis, A. I. (2019). The role of constructed wetlands as green infrastructure for sustainable urban water management. *Sustainability*, *11*(24), 6981.

[54] Štefancová, V., Harantová, V., Mazanec, J., Mašek, J., & Foltýnová, H. B. (2023). Analysis of Passenger Behaviour During the Covid-19 Pandemic Situation. *LOGI - Scientific Journal on Transport and Logistics*, *14*(1), 203–214. https://doi.org/10.2478/logi-2023-0019

[55] Sułkowski, Ł., Kolasińska-Morawska, K., Brzozowska, M., Morawski, P., & Schroeder, T. (2022). Last Mile Logistics Innovations in the Courier-Express-Parcel Sector Due to the COVID-19 Pandemic. *Sustainability (Switzerland)*, *14*(13). https://doi.org/10.3390/su14138207

[56] Sun, P., Young, B., Elgowainy, A., Lu, Z., Wang, M., Morelli, B., & Hawkins, T. (2019). Criteria air pollutants and greenhouse gas emissions from hydrogen production in US steam methane reforming facilities. *Environmental Science & Technology*, *53*(12), 7103–7113.

[57] Tapia, R. J., Kourounioti, I., Thoen, S., de Bok, M., & Tavasszy, L. (2023). A disaggregate model of passenger-freight matching in crowdshipping services. *Transportation Research Part A: Policy and Practice*, *169*(January), 103587. https://doi.org/10.1016/j.tra.2023.103587

[58] Touri, L., Marchetti, H. H., Sari-Minodier, I. I., Molinari, N., & Chanez, P. (2013). The airport atmospheric environment: respiratory health at work. *European Respiratory Review*, *22*(128), 124–130. https://doi.org/10.1183/09059180.00005712

Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

The authors equally contributed in the present research, at all stages from the formulation of the problem to the final findings and solution.

Sources of Funding for Research Presented in a Scientific Article or Scientific Article Itself

No funding was received for conducting this study.

Conflict of Interest

The authors have no conflicts of interest to declare that are relevant to the content of this article.