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Perceptions on Regional Benefit of Airport Development and Operation

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Abstract: Airport development and operation has a significant impact on local economy. However, the impact is assessed differently from different perspectives. In this paper, the authors investigated how the public think on the benefit of airport development and operation from a regional perspective. More specifically, the paper focuses on what the main factors are in public perceptions on the regional benefit of airport development and operation. The authors analyzed a survey collected in South Korea using structural equation models. The authors assigned five categories of perception factors and examined these factor relationships regarding the ripple effects caused by airport development and operation on each region. The five factors were "increased use in air transportation", "increased exchange with other regions", "regional economic benefit", "regional development", and "dis-benefit to the region". The model was verified with structural equations and path analysis results for each factor. It was revealed that people perceive the increased use in air transportation and the increased exchange with other regions as bringing about the most significant ripple effects, followed by regional development and regional economic benefit in this order, according to the order of path groups. The results of this paper are expected to provide stakeholders' perspectives and insights when planning airport development and operation.

Keywords: airport development and operation; regional benefit of airport; perception on regional benefit of airport; airport development strategy; structural equation analysis

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1. Introduction

Air transportation is growing rapidly, and airports are making significant impacts on every aspect of areas surrounding airports. While the impact can be recognized by all the stakeholders in the surrounding areas, the impact is perceived differently by different stakeholders; for example, developers, local governments, and the general public. The authors in this paper focus on the perception of the general public on the benefit of airport development and operation from a regional perspective. The authors investigate what the major contributing factors are in public perceptions on the regional benefit of airport development and operation. Public perceptions regarding how airports affect regional benefit were analyzed in order to propose strategies for building social consensus on developing and operating an airport. Social consensus on airport development and operation has been a key issue, because airports are a fundamental social overhead capital that have a huge influence on regional social and economic development. The authors believe that this study would enhance the rationale to construct and operate airports more and further.

The development and operation of airports is driven by the argument of suppliers that the economic benefits outweigh the negative effects, but opposition is raised when the argument that the negative effects inflicted on residents and the environment in the surrounding areas outweigh the benefits. Several strategies [1–3] may be applied to airport

development and operation to resolve such conflicts. However, in the absence of studies on general public perception regarding regional benefit accompanying airport operation and development, arguments must be formed that rely solely on biased analytical effects and this may lead to a sharp division of opinion.

Studies on the ripple effects of airport development and operations have dealt with empirical cases [4–6], causality [7–9], mutual effect [10,11], related theory [12–14], and so on. However, the authors could not find research that has looked into the values people expect to gain from the airports and their current perceptions of the functions of an airport. In fact, the perception shared amongst various stakeholders towards the ripple effects resulting from airport development and operation has a value-oriented tendency of relying on anecdotal experience and the like, rather than analytical perspectives that are based on previous findings in the related literature. Strategies intended to remedy conflict surrounding the issue of airport development and operation that are based solely on analytical information face limitations.

The value of an airport, as a piece of transportation infrastructure, should be determined based on the socio-economic purpose for which the infrastructure is used. To this end, it is necessary to identify general perceptions regarding the ripple effects caused by airport development and operation in order to determine the objectives that should be pursued by airports through back-casting. For example, decision makers will be able to review future airport development and operation plans along with the level of perceptions regarding the economic effects of airport development and the importance of the effect of demand created through airport operations.

The authors found wide spectrum research on areas concerning the development and operation of airports related with their regional benefit; especially various studies that continue to be carried out on the ripple effects felt throughout regions related to airport development and operation with regards to their economic and non-economic aspects. Among them, the authors reviewed previous studies on the relationship between them and related factors.

Researchers have generally believed that airport development and operation have positive effects on regional economic growth. In terms of urban employment growth, Marquise J. McGraw (2020) [15] stated that airports increased the employment rate and population in each region by 3.9% and 3.4%, respectively, every decade after the Second World War, between 1950 and 2010, and contributed to regional economic development by up to 1.2%. In addition, studies claiming that the operation of an airport directly leads to positive effects in the regional economy have been continuously carried out, as seen in Blonigen and Cristea (2012) [16], Florida et al., (2012) [17], and Zak and Getzner (2014) [18].

Salewski et al. (2018) [19] presented the ripple effect of an airport on a region through five factors, and Hartwig (2000) [20] provided the effect with regards to the improved quality of life and job creation through the revitalization of the regional economy through the airport. There have been studies that have suggested several positive effects originating with airport development, with Dunning and Norman (1983) arguing that there is an effect with regards to multinational enterprises, due to the proximity to the airport. On the contrary, Knippenberger (2012) [21] presented a study on the environmental damage caused by airports, and Kasarda (2010) [22] brought up conflicts resulting from airport development as a negative effect of airport development and operation.

Recently, Ulf Liebe et al. (2020) [23] conducted an empirical study on various economic and non-economic factors, and analyzed the social acceptance of each impact attribute based on the assumption that airports play a relatively minor role in the regional economy compared to their importance, seen through the cases of Mainz in Germany and Zurich in Switzerland. Direct or indirect, and positive or negative effects on the area around an airport have been continuously analyzed through numerous studies, but no literature is found to have conducted surveys on general public perception regarding the ripple effects on the region brought about by airports.

Schubert (2011) [24] raised the need to consider comprehensive variables on account of the ripple effects on the regional economy caused by airports and presented five different types of airport development. Furthermore, there are urban development models that actively incorporate airports such as the "airport city" [25] and "aerotropolis" [26] models. Dan Wang et al. (2020) [27] presented a method of rational selection of industrial land use and of increasing economic benefit through an empirical study on the economic zone of Zhengzhou Airport.

Jin Murakami·Hironori Kato (2020) [28] assessed that the accessibility of an airport in the city affects its strategic location, and especially labor productivity was found to be related to having a strategic location that provides a high degree of accessibility to the airport. There have been studies to suggest ways to actively utilize the ripple effects of airports, but studies on the perception of the general public, with regards to the ripple effects caused by airports in order to develop a consensus on the ripple effects of airport development and operation, could not be found at the time this study was prepared.

Therefore, in this study, perceptions regarding the ripple effects that have not been dealt with in previous studies of airport development and operation within its region will be surveyed. In this study a hypothetical model for the ripple effects of airport development and operation has been established, based on previous study findings about the attributes and severity of the ripple effects and about the maximization of such ripple effects in consideration of spatial structure. To verify this model, sociological and psychological structural equation analysis has been applied [29–31].

In this paper, the ripple effects of airports based on the perceptions of airport development and operation were examined using cases from Korea. Section 2 establishes a methodology for analyzing the perceptions of the ripple effects of airport development and operation. The authors assigned the influenced factors on public perceptions to five categories and examined these factor relationships regarding the ripple effects caused by airport development and operation on each region. In Section 3, the authors verified the model hypothesis through structural equations and the path analysis results for each factor, while its discussion, conclusions, and recommendations are presented in Section 4.

2. Methodology

The authors conducted an online survey of 510 people to investigate the effects of airport development and operations. A professional survey company was hired, and the survey data were taken from people aged 18 or older in South Korea during the period of 13–16 August 2019 through an in-house developed platform. The subjects were taken from an active panel with approximately 200,000 people. The active panel was managed by a professional survey company and place of living, job, sex, age, economic status, and education level of the active panel were considered in the panel management process, and the proportion was maintained to represent the general public of South Korea. For example, 18–29 age group, 30–39 age group, 40–49 age group, 50–59 age group, and 60 or older age group for male and female were sampled for each region in South Korea and then a weight factor was applied for each group based on the population of each group. As a sampling method, the professional allocation method was applied for each age group, and measurement variables were asked according to a 5-point Likert scale (Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree).

Actual samples were taken to reach 110% of the targeted sample size, and then normality of the sample was verified. If any anomalies were found, they were replaced by another sample from the same group. Skewness and kurtosis were verified and it was found that no questions did not satisfy normality. Additional survey was conducted on which, if any, sub-factors of the 5 factors are affected the most by the airport development and operation in order to investigate the items that are most affected as well as the contributions of airport development and operations in individual surveys.

The questionnaire consisted of a total of 31 latent variables and measurement variable with a 5-point Likert scale for the effects of airports on the region. Initially, more than

10 questions were devised for each factor, and a total of 31 questions were created after gathering opinions on the questions themselves from thirty persons, including five researchers, five aviation workers, five related field university professors, five airport operators, and ten non-experts. (See Table 1 for survey questions.)

The study questions are intended to identify public perceptions regarding the impact of an airport on regional development, and the hypothesis to be verified is that the public perceives regional development through five different factors. The authors assumed that the perception of the general public towards the ripple effects of airports on regional benefit arises through five different factors. The hypothesis of a five-factor model (Figure 1) was verified through structural equation modeling. The five factors were reconstructed from territorial effects, aviation effects, flow effects, allocation effects, and urbanization effects, which were presented in Salewski et al. (2018) [19] as ripple effects of airports in their region, which mean direct and indirect effects induced from airport construction and operation.

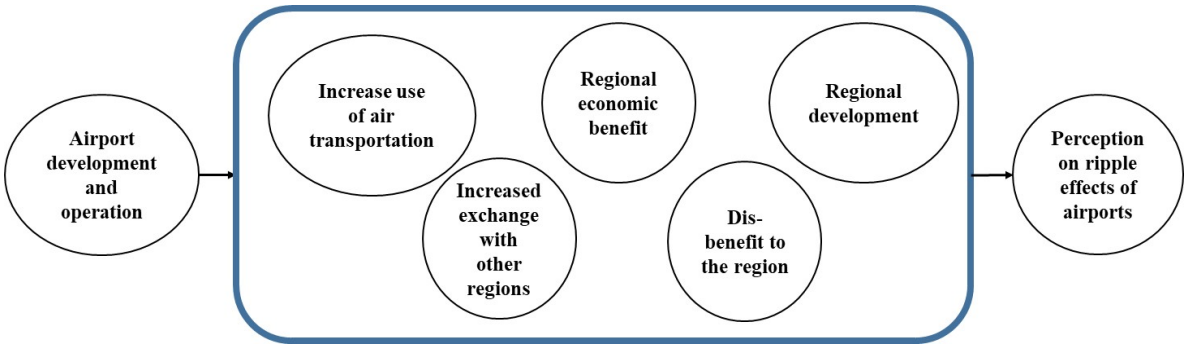

Figure 1. The concept model for the perception on the ripple effects of airports on the region.

- Flow effects refer to "regional economic benefit" (hereafter referred to as "R").
- Territorial effects and urbanization effects refer to "regional development" (hereafter referred to as "D").
- Aviation effects refer to "regional development" (D) and "dis-benefit to the region" (hereafter referred to as "B").
- Allocation effects refer to "increased use in air transportation" (hereafter referred to as "A") and "increased exchange with other regions" (hereafter referred to as "M").
- Detailed ripple effects presented by Salewski et al. (2018) [19] were included in the survey.

An initial structural equation that included all survey questions was constructed. Structural equation modeling is a powerful, multivariate technique and it is increasingly being used in scientific investigations to test and evaluate multivariate causal relationships. This method differs from other modeling approaches as it tests the direct and indirect effects on pre-assumed causal relationships. To verify the model fit, a confirmatory factor analysis was carried out. Confirmatory factor analysis is a statistical technique used to verify the factor structure of a set of observed variables. Using this analysis method, the hypothesis can be tested that a relationship between observed variables and their underlying latent constructs exists. The relationship between the variables is identified and then the hypothesis is tested statistically. Structural equation model evaluation is based on the fit indices for the test of a single path coefficient (i.e., p value and standard error) and the overall model fit. Generally, the more fit indices applied to the model, the more likely that a miss-specified model will be rejected—suggesting an increase in the probability of good models being rejected. It is recommended to use a combination of at least two fit indices.

Structural equation is also known as covariance structural modeling. It consists of a confirmatory factor analysis that explores the relationships among factors with measurement variables, as in the following Equation (1) and multiple regression/path analysis [29–31]. If the initial model does not meet the goodness-of-fit standard, survey questions are deleted to

improve the goodness-of-fit of the model in an iterative manner. Example of the structural equation in this paper is shown in Figure 2.

Table 1. Survey Questions.

Factor	Question	Code
Regional economic benefit (R)	It contributes to an increased activity in airport construction/operation-related industries/service industries.	R-1
	It contributes to the revitalization of related industries (travel/accommodation business, the tourism industry, etc.).	R-2
	It contributes to creating new jobs.	R-3
	It contributes to increasing the incomes of local residents.	R-4
	It contributes to overall revitalization (such as increases to resident income or increases in tax revenue).	R-5
	It positively affects regional economic development (misc.).	R-6
Effects related to increased use in air transportation (A)	More people will travel to other regions (or abroad).	A-1
	It will be more convenient to travel into and out of the area.	A-2
	It will be more convenient for logistics/shipping/labor, etc., to arrive to or depart from the area.	A-3
	Access from outside to inside the airport and from inside the airport to the city center will be easier than before.	A-4
	It will have positive effects on the use of air transportation by local residents (others).	A-5
Effects related to increased exchange with other regions (M)	It helps attract foreign tourists.	M-1
	It makes it easier to export or import goods.	M-2
	It seems that there are more exchanges occurring (such as human resources and knowledge exchanges) with foreign countries compared to areas without an airport.	M-3
	It seems that international content (cultural and industrial) are consumed/distributed more around the airport compared to areas without airports.	M-4
	It has a positive effect by promoting more active exchange with foreign countries (misc).	M-5
Effects related to regional development (D)	It helps develop areas around the airport.	D-1
	It helps expand the local transportation network (roads, bridges, KTX/High-speed rail, etc.).	D-2
	It helps increase the number of tourists in the area.	D-3
	It helps industrial development in the area.	D-4
	It is effective for attracting or establishing factories belonging to overseas or foreign companies to the region, when compared to areas without an airport.	D-5
	Activities related to airport development/operation have a positive impact on the construction of relevant infrastructure in the region.	D-6
	Developing or operating an airport has a positive impact on regional development (misc.).	D-7
Dis-benefit to the region (B)	Environmental destruction in the region caused by airport construction/expansion is severe.	B-1
	Noise from airport construction/expansion is severe.	B-2
	Carbon dioxide (greenhouse gas) emissions caused by airport construction/expansion are severe.	B-3
	Airport construction/expansion causes conflict in the region.	B-4
	Noise caused by the increase in the number of flights due to airport construction/expansion is severe.	B-5
	Carbon dioxide (greenhouse gas) emissions caused by the increase in the number of flights due to airport construction/expansion is severe.	B-6
	Traffic congestion around the airport due to airport construction/expansion is severe.	B-7
	Airport construction/expansion causes a large degree of inconvenience in the area (misc.).	B-8

Equation (1) means that each correlation between measurement variables is expressed through parameters and covariance between latent variables related with corresponding measurement variables. Latent variables are flow effects (regional economic benefit), territorial effects and urbanization effects (regional development), aviation effects (regional development and dis-benefit to the region), and allocation effects (increased use in air transportation and increased exchange with other regions).

$$\begin{gathered} X_{R1} = P_{R1}L_R + e_{R1} \\ X_{R2} = P_{R2}L_R + e_{R2} \\ \\ X_{Rq_r} = P_{Rq_R}L_R + e_{Rq_R} \\ \\ X_{D1} = P_{D1}L_D + e_{D1} \\ X_{D2} = P_{D2}L_D + e_{D2} \\ \\ X_{Dq_D} = P_{Rq_D}L_D + e_{Rq_D} \\ \\ X_{B1} = P_{B1}L_B + e_{B1} \\ X_{B2} = P_{B2}L_B + e_{B2} \\ \\ X_{Bq_B} = P_{Bq_B}L_B + e_{Bq_B} \\ \\ X_{A1} = P_{A1}L_A + e_{A1} \\ X_{A2} = P_{A2}L_A + e_{A2} \\ \\ X_{Aq_A} = P_{Aq_A}L_A + e_{Aq_A} \\ \\ X_{M1} = P_{M1}L_M + e_{M1} \\ X_{M2} = P_{M2}L_M + e_{M2} \\ \\ X_{Mq_M} = P_{Mq_M}L_M + e_{Mq_M} \end{gathered} \tag{1}$$

where

L_y: latent variable (y: R, D, B, A, M),
X_{yn}: quantitative or qualitative variable related with y latent variable
p_{yn}: parameter of L_y that explains X_{yn}
e_{yn}: error of X_{yn} that cannot be explained by L_y
q_y: number of X_{yn}.

Parameters are estimated to minimize the difference between the observed and estimated population covariance matrices, which minimizes G in Equation (2) [30].

$$G = (D - w(\eta))'S(D - w(\eta)) \tag{2}$$

where

D: the vector of data
w: the vector of the estimated population covariance matrix
η: the parameters of the model
S: the squared differences between the sample and estimated covariance.

In order for to overcome the sensitivity of Chi Statistics to the sample size [32], the authors applied TLI (Tucker–Lewis index) over 0.90 [33–35], CFI (Comparative fit index) over 0.9 [33], and RMSEA (Root Mean Square of Error Approximation) between 0.05 and 0.08 [36] as the goodness-of-fit standard for the model. If the initial model did not satisfy the goodness-of-fit standard for the model, the authors removed variables with p values of regression weights that were not significant, or which had standardized regression weights that were less than 0.5 or with squared multiple correlations (SMC) that were less than 0.4. The authors also deleted those that had variance for which the Heywood case was a negative number [37] to build a final model that satisfied the goodness-of-fit standard.

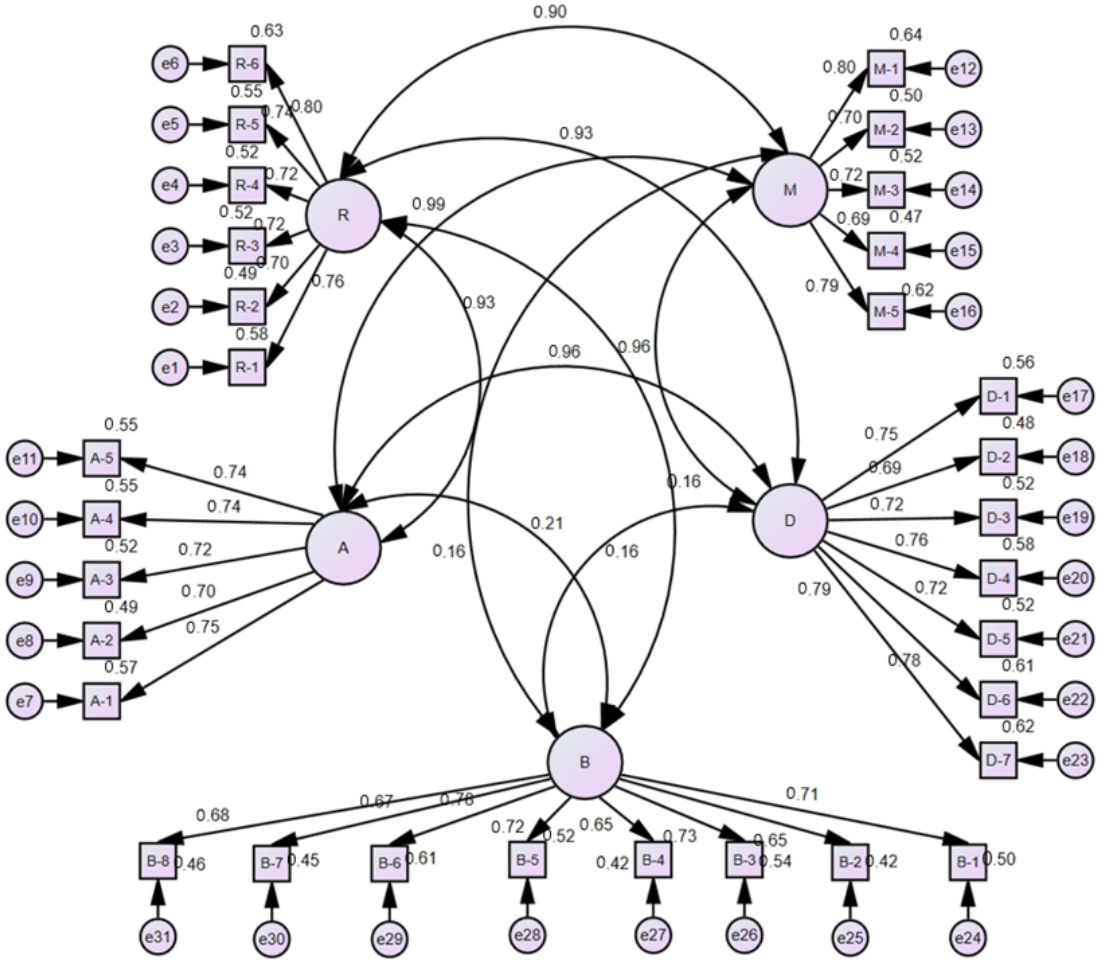

Figure 2. Structural equation model. Note: R = Regional economic benefit; A = Effects related to increased use in air transportation; M = Effects related to increased exchange with other regions; D = Effects related to regional development, B = Dis-benefit to the region.

3. Results

The average results of the measurement variables by question for the regional economic development (R) showed that R-3, R-2, and R-1 were 3.87, 3.79, and 3.72, respectively, being assessed as the most important factors of the airport in terms of how it affected regional development. As for the proportion answered as factors with large effects, R-2, R-1, and R-3 were 31.6%, 27.3%, and 24.2%, respectively, indicating that the effects contributing to regional development and factors largely affected by the airport development and operation were similarly perceived. However, the effects on airport-related industries/service industries, or R-1, was perceived to be the most positive, while the ratio of respondents who answered that they are indeed affected by the airport development and operation was the lowest among the three items. (See Table A1 in Appendix A).

Regarding the effect on the increased use in air transportation (A), the average of the measurement variables corresponding to A-2 and A-3 were rated the highest at 3.82 and 3.77 points, but the ratio of answers for the most affected factors was 29.5%, with A-1 being the highest. It was found that people perceived that the convenience in movement to and from the airport due to airport operation and development and the convenience in logistics/shipping/personnel movement internationally were more affected than increases in more simple movement. Regarding the increased exchange with other regions (M), the average measurement variables of M-1 and M-2 were the highest at 3.76 and 3.75 points, respectively, and 41.4% answered that M-1 was the most affecting. This implies that their

perception that airports have the most positive impact towards attracting tourists in terms of increased exchange. (See Table A1 in Appendix A)

Regarding the factors about how positively the airport development and operation affect transportation infrastructure and industrial development in the region, the average measurement variables of D-3, D-1, and D-2 for airport development and operation were derived to be the highest at 3.79, 3.78, 3.78, respectively. According to the ratio of those who answered to be most affecting, the ratios of D-2 and D-3 were the highest at 28.5% and 22.2%, indicating that people considered airports as having contributed greatly to the expansion of transportation infrastructure and regional development through the attraction of tourists. As for the effects regarding dis-benefit to the region (B), the average measurement variables of B-2 and B-5 related to noise were 3.84 and 3.79, respectively, with 35.7% and 18.3% answering that they were most affected by airport development and operation for the same items. This means that people perceive noise as the damage of their greatest concern regarding the airport development and operation. (See Table A1 in Appendix A).

The initial model applied with all the survey questions satisfied all of the model goodness-of-fit standards the authors set (Table 2). The confirmatory factor analysis showed that the path reaching from latent variables for the regional economic development, the increased use in air transportation, the increased exchange with other regions, the regional development, and the dis-benefit to the region to measurement variables were all significant at 0.001.

Table 2. Model's Goodness of Fit Index.

x^2 (CMIN)	RMSEA	TLI	CFI	CMIN/DF
1068.494	0.055	0.925	0.932	2.520

Nevertheless, in order to verify whether the goodness-of-fit could be improved, the standards for removing questions were reviewed. The *p*-values of the regression weights, which represent the relationship between the latent variables and the measurement variables, were all less than 0.05, and the standardized regression weights, which show the degree of consistency of the measurement variables that make up the latent variables, were all 0.5 or higher. The variance in measurement errors were all positive, and it turned out to be unnecessary to remove questions to improve the goodness-of-fit, as the squared multiple correlations (SMC) were derived to be at 0.4 or higher for all of the questions. The convergent validity was also surveyed to determine whether respondents showed a similar tendency for questions composed to measure latent variables. It was surveyed that most of the β values of the estimates were 0.7 or higher, the average variance extracted (AVE) values, excluding the factor of advantages/disadvantages to the region, were 0.5 or higher, while the AVE for the advantages/disadvantages to the region was 0.495 and the concept reliability of each latent variable was 0.8 or higher. Thus, the final model had convergent validity.

All possible combinations of structural model paths were found to be significant at 1%. The derived standardized coefficients show either the combination of positive effects or the combination of negative effects. The combination of paths with technically positive effects indicates that associations with the increased use in air transportation (A) and the effects related to increased exchange (M) were the greatest, and it is divided into a path associated with the regional development (D) and a path associated with the regional economic benefit. However, the differences among the combinations of positively perceived paths were not great compared to the perception paths for negative effects (Table 3).

The paths that showed the most significant standardized coefficients (β) in the structural model paths were derived to be the effects related to the increased use in air transportation (A) and the effects related to increased exchange with other regions (M). This means that people perceive that the increased use in air transportation and the increased exchanges are the most relevant effects with regards to airport development and operation. The authors found that the relationships between regional development (D) and the increased use in air transportation (A), and the effects related to increased exchange (M)

and the effects of regional economic benefit (R) were perceived to have the next highest relevance. On the other hand, it was found that people perceived that the relationship between the effects of dis-benefit to the region (B) and other effects had a lower correlation than that between other factors (Figure 2 and Table 4).

Table 3. Results of Confirmatory Factor Analysis.

Latent Variables (L.V)	Measurement Variables (M.V)	Estimate		S.E. (Standardized Estimates)	C.R. (Critical Ratio)
		B	β		
Regional economic benefit (R)	R1	1	0.76		
	R2	0.964	0.697	0.06	16.084 *
	R3	1.041	0.722	0.062	16.722 *
	R4	1.106	0.721	0.066	16.711 *
	R5	1.095	0.741	0.063	17.248 *
	R6	1.153	0.795	0.062	18.696 *
Effects related to increased use in air transportation (A)	A1	1	0.754		
	A2	0.888	0.701	0.054	16.374 *
	A3	0.957	0.718	0.057	16.832 *
	A4	1.009	0.741	0.058	17.439 *
	A5	1.005	0.743	0.057	17.485 *
Effects related to increased exchange with other regions (M)	M1	1	0.8		
	M2	0.876	0.704	0.051	17.335 *
	M3	0.907	0.722	0.051	17.897 *
	M4	0.904	0.687	0.054	16.806 *
	M5	0.985	0.786	0.049	19.99 *
Effects related to regional development (R)	R1	1	0.745		
	R2	1.037	0.694	0.065	15.938 *
	R3	1.031	0.719	0.062	16.591 *
	R4	1.097	0.761	0.062	17.662 *
	R5	1.063	0.718	0.064	16.551 *
	R6	1.087	0.781	0.06	18.179 *
	R7	1.156	0.789	0.063	18.393 *
Dis-benefit to the region (B)	B1	1	0.707		
	B2	0.985	0.647	0.073	13.567 *
	B3	1.035	0.734	0.068	15.303 *
	B4	1.008	0.648	0.074	13.584 *
	B5	1.085	0.721	0.072	15.038 *
	B6	1.174	0.781	0.072	16.203 *
	B7	0.964	0.67	0.069	14.02 *
	B8	1.04	0.678	0.073	14.175 *

* $p < 0.001$ (two-tailed).

Table 4. Analysis of Structural Model path per Factor.

Factor			Estimate		S.E.	C.R.
			B	β		
Regional economic benefit (R)	↔	Effects related to increased use in air transportation (A)	0.339	0.929	0.029	11.539 **
Regional economic benefit (R)	↔	Effects related to increased exchange (M)	0.354	0.899	0.03	11.697 **
Regional economic benefit (R)	↔	Effects related to regional development (D)	0.317	0.932	0.028	11.498 **
Regional economic benefit (R)	↔	Dis-benefit to the region (B)	0.054	0.16	0.017	3.112 *
Effects related to increased use in air transportation (A)	↔	Effects related to increased exchange (M)	0.412	0.989	0.034	12.158 **
Effects related to increased use in air transportation (A)	↔	Effects related to regional development (D)	0.347	0.961	0.03	11.624 **
Effects related to increased use in air transportation (A)	↔	Dis-benefit to the region (B)	0.074	0.207	0.019	3.903 **
Dis-benefit to the region (B)	↔	Effects related to increased exchange (M)	0.062	0.159	0.02	3.077 *
Dis-benefit to the region (B)	↔	Effects related to regional development (D)	0.053	0.159	0.017	3.12 *
Effects related to increased exchange (M)	↔	Effects related to regional development (D)	0.373	0.96	0.031	11.942 **

* $p < 0.05$; ** $p < 0.001$ (two-tailed).

4. Conclusions and Recommendations

In this paper, the authors investigated how the public think on the benefit of airport development and operation from a regional perspective. More specifically, the paper focused on what the main factors are in public perceptions on the regional benefit of airport development and operation. The authors identified factors to influence public perception on the benefit of airport development and operation and categorized them into five groups. The structural equation model that is composed of a confirmatory factor analysis and multiple path analysis was applied and the hypothesis was verified. We confirmed that the five factors are related with each other and affect public perceptions on the regional benefit of airports significantly.

Transportation facilities have close relationships with other factors [38]. The authors confirmed, with the samples surveyed for this study, that the five-factor model for the ripple effects of airport development and operation on the region was significant. To be specific, it was found that people perceived the ripple effects of airport development and operation presented in the previous studies such as Salewski et al. (2018) [19] as significant. Among the path combinations composed of five factors, the survey found that people most clearly perceived the relationship between the effects of an increased use in air transportation and the effects of increased exchange with other regions, demonstrating a directional relationship with airport functions, thereby producing results consistent with general expectations.

The authors found that people perceive the combination of positive effects as being clearly different than negative effects. These results are interpreted as indicating that the perception of positive effects is more evident than the perceptions of negative effects regarding airport development and operation. However, the application of these results is limited with regards to the justifications or decision-making in regards to pursing airport development and operation. This is because this study, which validates the general ripple effect model for regions with an airport, does not reflect the concentration of damage inflicted around an airport, such as noise. This study should be interpreted as describing a phenomenon by which, despite the concentrated damage around airports, the paths of currently positive factors are more significantly perceived than negative factors. Subsequent studies will need to reflect the negative effects concentrated around airports with regards to the feasibility of airport development and operation.

As expected, people perceive that the functions of an airport, the increased use in air transportation (A), and the effects of increased exchange with other regions (M) are the most significant effects (β = 0.989). Subsequently, it was found that people perceive the effects of regional development (D) and regional economic benefit (R) as significant regional ripple effects caused by airport development and operation (β = 0.961), and they perceive that all positive effects are highly interrelated. Among these effects, this study found that people perceive the effects of regional development (D) (maximum β = 0.961) as having a greater benefit than the effects of regional economic benefit (R) (maximum β = 0.929) in terms of regional ripple effects. Based on these comprehensive results, this study confirms that regional development around airports, such as the case with airport cities, is a strategic field that is advantageous to pursue when trying to develop a consensus for the promotion of airport development and operation, rather than promoting the individual benefits.

On the other hand, it has been analyzed that people perceive that dis-benefits to the region (B) are most closely related to the effects of the increased use in air transportation (A) whereas the other factors are perceived as having similar relationships. It can be interpreted that the dis-benefits to the region (B) are perceived as being most directly caused by the increased use in air transportation. In particular, noise was found to be the most contentious issue among individual factors. These findings indicate that there is a limit to the ability of positive effects to convince people to accept negative effects. Therefore, using a strategy that emphasizes the positive effects of airport development and operation in order to offset negative effects is expected to have limited results.

The findings from the analysis in this paper demonstrate that the perceptions on the regional benefit of airport development and operation have a close agreement with the empirical evidence in the previous studies [15–18]. The outcome confirms the effect of airport operation and development on both regional development and economic progress, and the general perception about the positive correlation with airport development and regional economic benefit.

In this paper, a similar approach has taken the following suggestions of Ulf Liebe et al. (2020) [23]. Various economic and non-economic factors were analyzed to study the social acceptance of each impact attribute regarding airport development on regional economy. However, this study conducted surveys on general public perceptions regarding the ripple effects on the region by airport development. Similar to studies by Salewski et al., (2018) [19], Hartwig (2000) [20], Knippenberger (2012) [21], and Kasarda (2010) [22], the findings in this paper shows several positive and negative effects of airport operation and development. The findings in this paper confirm the effect of airport operation and development and are expected to provide insights on people's positive and negative perceptions on airport development. It is expected that the outcome has a contribution for future airport development processes in terms of fostering public confidence on airport development.

It is recommended that the negative effects on airport development should be discussed between all corresponding stakeholders. Usually, airport projects are welcomed with strong supports during the feasibility study and planning periods. However, they face more frequent and fierce opposition once the project or initial construction starts. The findings in this paper can provide insights to foster public confidence on airport development.

In this study, findings and strategies have been proposed to promote airport development and operation through the development of a social consensus. Five factors that make up the individual ripple effects caused by airport development and operation were hypothesized and verified in this study, uncovering a hidden relationship among individual factors, and forming a foundation for strategy. In the future, a follow-up study should be carried out to reflect the spatial distribution of the ripple effects caused by airports and the differences in perception towards each type of airport, as they are factors that this study did not examine. The further study on this public perception structure change following each stage of airport lifecycle would be needed, and recommended strategies would be tested based on empirical studies. The authors look forward to seeing how the results of

this study will be used to develop and implement strategies for building social consensus on airport development and operation.

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Appendix A

Table A1. Survey Result Summary. (Unit: %, Point/5 Likert-Scale).

Question		Mean	Answer Ratio for Most Important Item
R	1	3.72	27.3
	2	3.79	31.6
	3	3.87	24.2
	4	3.46	6.3
	5	3.57	10.3
	6	3.58	0.3
A	1	3.68	17.3
	2	3.82	29.5
	3	3.77	27.1
	4	3.68	25.8
	5	3.70	0.3
M	1	3.76	41.4
	2	3.75	25.8
	3	3.66	25.2
	4	3.54	7.3
	5	3.67	0.3
D	1	3.78	18.8
	2	3.78	28.5
	3	3.79	22.2
	4	3.66	16.1
	5	3.61	3.2
	6	3.70	11.2
	7	3.63	-
B	1	3.52	19.2
	2	3.84	35.7
	3	3.69	7.2
	4	3.49	13.0
	5	3.79	18.3

Table A1. *Cont.*

Question		Mean	Answer Ratio for Most Important Item
B	6	3.67	2.7
	7	3.43	3.9
	8	3.18	-

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