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Digitalization On Operational Efficiency At Soekarno Hatta International Airport

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Abstract: This study aims to find out whether digitalization can affect the operational efficiency of Soekarno Hatta International Airport by analyzing various conditions if digitalization is applied at the airport. This study uses quantitative methods and SEM-PLS to analyze the data. Data collection was carried out by accidentally distributing questionnaires through Google Forms to passengers or visitors at Soekarno-Hatta International Airport. The population taken is passengers or visitors at Soekarno Hatta International Airport in January 2024. The sample was taken by an accidental sampling technique and obtained 100 respondents who were calculated using the Slovin formula. The results of the study show that digitalization aspects such as the internet of things, artificial intelligence, and big data analytics have a significant impact on improving operational efficiency at Soekarno Hatta International Airport.
Keywords: *Airports, Digitalization, Operational Efficiency*

1. Introduction

Globally, digitalization has been growing rapidly and affecting many industries, including the aviation sector. This shift is crucial as it can greatly improve operational efficiency. Airports, which serve as the main gateway of a country, must embrace technological digitalization in the face of increasing competition. Indonesia's airport, as the main airport in Indonesia, has started implementing various digital initiatives in order to improve its operational efficiency (Yuliana et al., 2020).

On 23 October 2018, Awaluddin, President Director of PT Angkasa Pura II, stated that Soekarno Hatta International Airport is now utilising beacon technology on buggy cars in Terminal 3 to demonstrate the use of digital technology with internet of things capabilities. In addition, Awaluddin (9/9/2023) stated that Project Sky Horizon 2023 has encouraged close collaboration with communities, practitioners, corporations, and startups in applying artificial intelligence in service, operational, and commercial aspects of the airport. In addition, on 29 December 2019, Awaluddin revealed the intention to use big data analytics in Soekarno Hatta International Airport, which is expected to help airlines maximise revenue management, improve safety procedures, personalise customer service, and optimise flight schedules (Hanisah et al., 2023). Digitalization can also reduce passenger waiting time, improve flight punctuality, and lower operational costs (Wu & Caves, 2000). In addition, digitisation can also

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help with more efficient data management, product and service innovation, better customer relationship development, which ultimately supports better decision-making (Lesnussa et al., 2023).

However, the implementation of digitalization is not without challenges. Key obstacles include the need for training and upskilling of human resources, inefficiencies in operational management, decreased competitiveness in the aviation market, and performance issues that affect customer service (Intan Pratiwi, 2023). Moreover, with the belief that Indonesian civil aviation can successfully undergo digital transformation, the dynamics of building a digital and sustainable transformation in the country's air transport sector, as well as the challenges posed by global strategic priorities and objectives, can be managed with an appropriate and deliberate approach to improving its operational efficiency (Sena & Prayitno, 2024).

Conversely, a number of international airports have demonstrated that the advantages of digitalization far outweigh the disadvantages. Airports that have effectively integrated digital technologies claim significant improvements in customer service and operational efficien (Situmorang et al., 2023). Therefore, it is imperative for Soekarno Hatta International Airport to continue to make the most of digital technology and continue to emphasise it in all aspects of operations. This research aims to determine whether digitalization can affect the operational efficiency of Soekarno Hatta International Airport by analyzing various conditions if digitalization is applied at Soekarno Hatta International Airport.

2. Literature Review

Digitalization

Digitalization is the process of using data and digital technologies to transform business models, increase revenue, and put companies in an environment focused on digital information (Schallmo & Williams, 2018). Further explanation of digitalization was provided by Soemantri (2012) in (Rahayua et al., 2021), Defining digitalization as a transfer medium Digitalization is the process of converting textual records into new media records that can be read by computers, which are used to improve operational efficiency. The use of digitisation aspects such as the internet of things, artificial intelligence, and big data analytics is intended to help airports improve operational efficiency, cut costs, improve safety, and provide a better passenger experience (Hanantyo & Susanto, 2022).

Internet of Things

Internet of things (IOT) is a set of technologies that allow physical items to connect to the Internet and interact with each other. It can be used to expand and develop sustainable internet connectivity to improve operational efficiency at Soekarno-Hatta International Airport and optimise real-time operations (Baláž et al., 2023). The concept of internet of things technology (anytime, anywhere, any device, any network) its formation depends on several

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factors related to operational efficiency, these factors are collection, convergence, connectivity and computing. (Yaqoobi, 2019)

Artificial Intelligence

Artificial intelligence (AI) is a significant algorithm used to mimic human intelligence to some extent in solving problems, analysing, and suggesting actions to facilitate human activities at Soekarno Hatta International Airport in order to facilitate work at the airport like humans, as well as to improve efficiency, security, and competitiveness (Kabashkin et al., 2023). In helping to facilitate passenger processing, there are four types that can be created using artificial intelligence, namely natural language processing, problem solving and planning, machine learning (Sadou & Njoya, 2023).

Big Data Analitycs

Big data analytics (BDA) is the science and technology of organising, integrating and analysing big data, and discovering knowledge, insights, patterns and intelligence from big data, filtering, correlating, visualising and reporting the discovered knowledge and insights such as hidden patterns or unknown correlations, the application of big data analytics can also enable high-speed retrieval, discovery, and/or analysis that makes it possible to stay ahead in dynamic and highly competitive industries to help high-speed decision making at Soekarno Hatta International Airport (Sun, Sun, & Strang, 2018). However, it should be noted that there are limitations in the big data analytics review process, there are several factors that can be used to improve operational efficiency at Soekarno-Hatta International Airport, namely by paying attention to variety, volume, and speed (Ju, 2022).

Operational Efficiency

Operational efficiency is the airport's capacity to effectively utilise resources, such as facilities, staff, and technology, to meet the needs of air traffic and passengers. It is concerned with the ability to provide efficient processes, from check-in facilities to security and baggage handling, streamlining operations, lowering costs, and improving safety, which can be achieved if it is able to control all costs incurred to generate revenue in running the business. As operational efficiency increases, so does the output-to-input ratio (Belfiore et al., 2024). Operational efficiency supports the company's most fundamental strategic goal, which is to increase customer service and improve the achievement of operational efficiency within the airport, to measure operational efficiency, measurements are required of inputs such as, aircraft numbers, gate numbers, terminal area size. And output measurements such as total number of flights and total number of passengers (Asker & battal, 2017).

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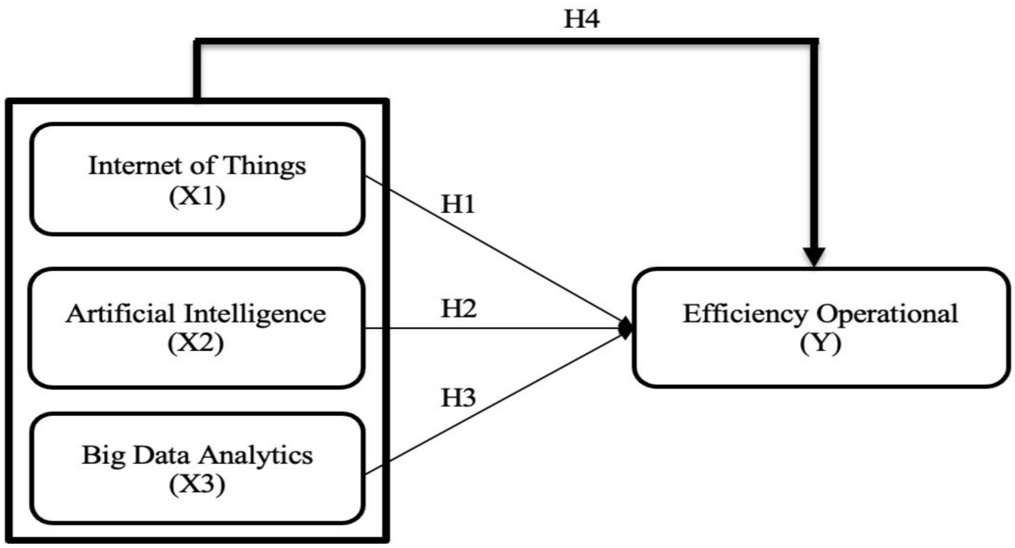

Figure.1. Research Paradigm

Hypothesis

H1 : Internet of Things affects Operational Efficiency
H2 : Artificial Intelligence affects Operational Efficiency
H3 : Big Data Analytics affects Operational Efficiency
H4 : Internet of Things, Artificial Intelligence and Big Data Analytics affects Operational Efficiency

3. Methodology

Population and sample

According to (Sugiyono 2014), Population is a generalization of an area consisting of objects or subjects that have certain qualities and characteristics that are determined by the researcher to be studied and then draw conclusions. The population in this study is passengers or visitors to Soekarno Hatta International Airport in January 2024, with a total population of 1,377,314.

According to (Sugiyono, 2014), sample is part of the number and characteristics that a population has. The accuracy precision in this study was set at 10%, as the tolerable sampling error rate was 10% for a large population. The sampling technique used is accidental sampling, which is a sampling technique based on chance. The number of samples was calculated using the Slovin formula. Based on the Slovin formula, the required sample size can be calculated by the following formula, the sample size is:

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$$n = \frac{\mathrm{N}}{1 + \mathrm{N}\,(\mathrm{e})^2}$$

$$n = \frac{1.377.314}{1 + 1.377.314(10\%)^2}$$

n = 99,99 (rounded to 100)

Data Source

a. Primary Data

According to Umar (2007) in (Hidayat, 2018) Primary data is data obtained from first sources, both individuals and individuals such as the results of filling out questionnaires conducted by researchers.

b. Secondary Data

According to Indriantoro & Supomo (2009) in (Hidayat, 2018) Secondary data is a source of research data received by researchers indirectly through intermediary media (obtained and recorded by other parties). Secondary data is generally in the form of evidence, records, or historical reports arranged in published and unpublished archives (documentary data). In this study, secondary data was obtained from documents or records owned by the company and can also be obtained from previously published literature.

Data Analysis Technique

In statistical analysis of data using the PLS SEM method. The following is the PLS method analysis technique:

Outer Model Analysis

According to (J. Noor 2014), Outer model analysis is carried out to ensure that the measurements to be used are accurate (valid and reliable). This analysis includes several calculations, which are described below:

1. Convergent Validity: Factor loadings are latent variables with expected values more than 0.70.
2. Discriminant Validity: is the value of the cross loading factor which is useful for establishing whether the construct has sufficient discriminant. The value of the construct of interest, which should be higher than the value of the other constructs, is compared to achieve this.
3. Composite Reliability: is a measurement made if the reliability value is > 0.70, then the construct value has a high reliability value.
4. Average Variance Extracted (AVE): AVE shows the average variance results, this finding will be accepted, if the expected value of AVE is more than 0.5.
5. Cronbach's Alpha: This calculation verifies the composite reliability results, the findings will be accepted if the value is higher than 0.70.

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Inner Outer Analysis

According to (Hair et al., 2014), the squared R value can be classified into three categories: Strong (0.75), medium (0.50), and weak (0.25).

Hypothesis Test

According to (J. Noor, 2014), hypotheses can be found using t-statistics and probability. To test the hypothesis using statistics, the 5% alpha t-statistic used is 1.98. Consequently, the hypothesis testing criteria is whether Ha is accepted or Ho is rejected based on the t-statistic > 1.98. If the P-value is less than 0.05, then the hypothesis (Ha) can be accepted.

4. Result & discussion

4.1 Model Evaluation

a. Outer Model Testing

In this study, hypotheses will be developed to better understand the findings of the outer and inner construction models, as well as the results of the PLS algorithm used in SmartPLS 4 software.

b. Construct Validity Test

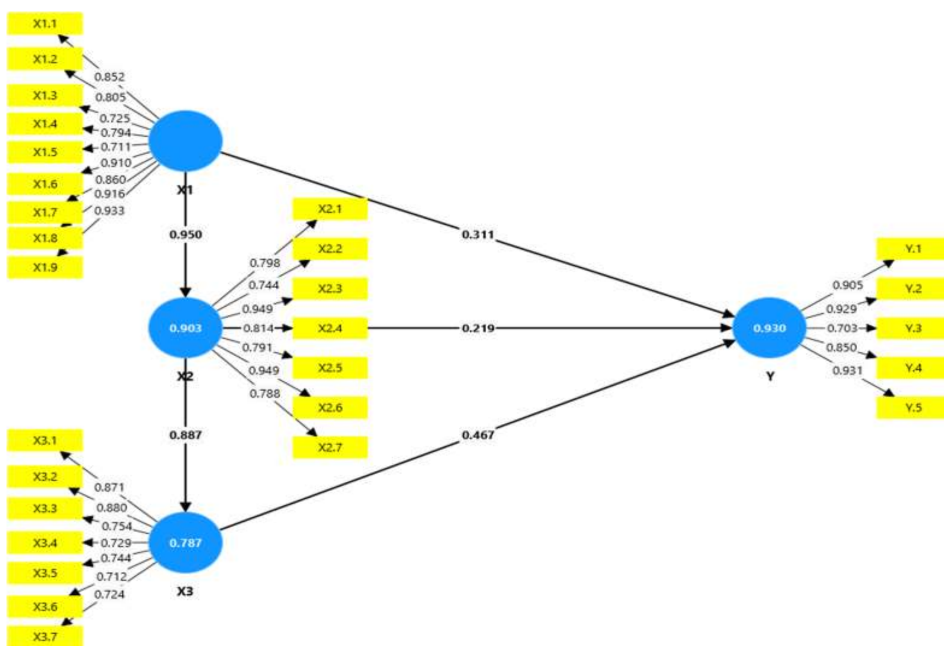

Figure.2. PLS Algoritm

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(Source: processed by researchers using smartPLS 4)

This model design shows how the theoretical research, problem description, and hypotheses all refer to latent variable connections. The study variables are represented by blue circles in Fig.2, which shows the model architecture in SmartPLS software processing. internet of things is represented by X1, which has four indicators and nine statements ; artificial intelligence is represented by X2, which has three indicators and seven statements ; Big Data Analytics is represented by X3, which has three indicators and seven statements ; and operational efficiency is represented by Y, which has two indicators and five statements.

Table 4.1

Construct Validity Test Table

VARIABLE	INTERNET OF THINGS (X1)	ARTIFICIAL INTELLIGENCE (X2)	BIG DATA ANALYTICS (X3)	OPERATIONAL EFFICIENCY (Y)
X1. 1	0.852			
X1.2	0.805			
X1.3	0.725			
X1.4	0.794			
X1.5	0.711			
X1.6	0.910			
X1.7	0.860			
X1.8	0.916			
X1.9	0.933			
X2.1		0.798		
X2.2		0.744		
X2.3		0.949		
X2.4		0.814		
X2.5		0.791		
X2.6		0.949		
X2.7		0.788		
X3.1			0.871	
X3.2			0.880	
X3.3			0.754	
X3.4			0.729	
X3.5			0.744	

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X3.6	**0.712**	
X3.7	**0.724**	
Y.1		**0.905**
Y.2		**0.929**
Y.3		**0.703**
Y.4		**0.850**
Y.5		**0.931**

(Source: processed by researchers using smartPLS 4)

In this study, there are several stages of testing the measurement model which aims to prove the requirements to meet the validity of the research, namely, having a loading factor limit > 0.70 (more than zero point seven). An indicator can be said to be valid can be stated by fulfilling the convergent validity test with an external loading value > 0.70 (more than zero point seven).

4.2 Discriminant Validity Test

Reflective indicators must be checked for discriminant validity by comparing their values in the cross-loading table. An indicator is considered valid if it has the largest factor loading value for the intended construct when compared to other constructs.

Table 4.2

(Source: processed by researchers using smartPLS 4)

	X1	X2	X3	Y
X1.1	0.852	0.837	0.767	0.831
X1.2	0.805	0.694	0.664	0.635
X1.3	0.725	0.607	0.553	0.554
X1.4	0.794	0.714	0.627	0.633
X1.5	0.711	0.676	0.641	0.686
X1.6	0.910	0.897	0.844	0.895
X1.7	0.860	0.834	0.758	0.805
X1.8	0.916	0.887	0.814	0.909
X1.9	0.933	0.929	0.876	0.939

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X2.1	0.717	0.798	0.598	0.633
X2.2	0.694	0.744	0.661	0.658
X2.3	0.939	0.949	0.885	0.934
X2.4	0.744	0.814	0.759	0.848
X2.5	0.748	0.791	0.592	0.614
X2.6	0.939	0.949	0.885	0.934
X2.7	0.738	0.788	0.744	0.738
X3.1	0.915	0.915	0.871	0.929
X3.2	0.865	0.881	0.880	0.915
X3.3	0.534	0.512	0754	0.636
X3.4	0.481	0.490	0.729	0.552
X3.5	0.738	0.788	0.744	0.738
X3.6	0.506	0.504	0.712	0.576
X3.7	0.519	0.492	0.724	0.552
Y.1	0.867	0.874	0.824	0.905
Y.2	0.874	0.892	0.855	0.929
Y.3	0.558	0.536	0.774	0.703
Y.4	0.818	0.787	0.720	0.850
Y.5	0.879	0.895	0.883	0.931

4.3 Construct Reliability Test

Table 4.3
Construct Reliability Test Table

Variable	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	AVE	Result
X1	0.946	0.956	0.954	0.701	Reliable

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X2	0.927	0.941	0.942	0.700	Reliable
X3	0.892	0.919	0.913	0.603	Reliable
Y	0.915	0.927	0.938	0.753	Reliable

(Source: processed by researchers using smartPLS 4)

The table above shows that each latent variable measured has a Cronbach alpha value of more than 0.70, indicating acceptable or high reliability. The reliability test results show that the Internet of Things (X1) variable has a Cronbach alpha value of 0.946 > 0.70; Artificial Intelligence (X2) has a Cronbach alpha value of 0.927 > 0.70; Big Data Analytics (X3) has a Cronbach alpha value of 0.892 > 0.70; and Operational Efficiency (Y) has a value of 0.915 > 0.70.

The square root of the average variance extracted (AVE) for each variable is more than the coefficient for the other variables. This measure is suitable for any variable with a significant value determinant. The discriminant validity test shows that all variables in Internet of Things, Artificial Intelligence, Big Data Analytics, and Operational Efficiency, have AVE values more than 0.5.

4.4 Model Fit Test

Table 4.4
R-square Table

	R-square	R-square adjusted	Result
Operational Efficiency (Y)	0.930	0.928	Strong

(Source: processed by researchers using smartPLS 4)

The R-squared values are: 0.75 strong, 0.50 medium, and 0.25 weak. Based on the R2 value, the table above reveals that Operational Efficiency has a value of 0.928, or 92.8%, indicating a strong level of value, as it is above 0.75.

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4.5 Goodness of Fit Test

Table 4.5
Path coefficients and T-values

Path	Original sample (O)	T statistics (|O/STDEV|)	P values	Result
Internet Of Things -> Operational Efficiency	0.311	3.197	0.001	Accepted
Artificial Intelligence -> Operational Efficiency	0.219	3.110	0.001	Accepted
Big Data Analytics -> Operational Efficiency	0.467	7.787	0.000	Accepted
Internet Of Things, Artificial Intelligence And Big Data Analytics -> Operational Efficiency	0.393	7.429	0.000	Accepted

(Source: processed by researchers using smartPLS 4)

1. **H1 Hypothesis Test**
   The first hypothesis test was conducted to see if the internet of things has a positive impact on operational efficiency. Table 4.5 displays the test findings; Internet of Things obtained an original sample estimate value of 0.311 with a T statistic value of 3.197 > 1.98, indicating that Internet of Things has a positive impact on operational efficiency at a significance level of less than 5% (significant). Based on the test results, we can conclude that the first hypothesis (H1) is accepted.

2. **H2 Hypothesis Test**
   The second hypothesis test will investigate how artificial intelligence affects operational efficiency. According to the test findings, the original sample estimate value is 0.219 with a t-statistic value of 3.110 > 1.98 t-table, indicating that the artificial intelligence variable has a 31.10% positive effect on operational efficiency at a significance level of less than 5% (significant). The findings of the regression hypothesis indicate that the second hypothesis (H2) is accepted.

3. **H3 Hypothesis Test**

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The third hypothesis test examines the effect of big data analytics on operational efficiency. According to the test findings, the original sample estimate value is 0.467, with a t-statistic value of 7.787 > 1.98 t-table, indicating that the big data analytics variable has a 77.87% positive effect on operational efficiency, with a significance level of less than 5% (significant). The regression hypothesis results show that the third hypothesis (H3) is accepted.

4. H4 Hypothesis Test

The fourth hypothesis test assesses the impact of the Internet of Things, artificial intelligence, and big data analytics on operational efficiency. According to the results of the internet of things, artificial intelligence, and big data analytics, the original sample estimate value is 0.393 with a t-statistic value of 7.429 > 1.98 t-table, indicating that the internet of things, artificial intelligence, and big data analytics variables have a positive impact of 74.29% on operational efficiency with a significance value of less than 5%. The regression hypothesis findings show that the fourth hypothesis (H4) is accepted.

Discussion

The results of testing the hypotheses of this study revealed some significant findings. The first hypothesis (H1) suggests that the Internet of Things (IOT) positively affects operational efficiency, with a significance level of less than 5%, thus supporting the next hypothesis. The second hypothesis (H2) argues that artificial intelligence (AI) contributes to the improvement of operational efficiency, with confidence at a level below 5%. The third hypothesis (H3) suggests that big data analytics (BDA) positively affects operational efficiency at Soekarno Hatta International Airport. The fourth hypothesis (H4) shows that the integration between the Internet of Things, artificial intelligence, and big data analytics positively affects operational efficiency. Therefore, the results of this study emphasise the importance of utilising the Internet of Things, artificial intelligence, and big data analytics to optimise operational efficiency at Soekarno Hatta International Airport.

5. Conclusion

Based on the results of data analysis and discussion in the previous section regarding the digitization of operational efficiency at Soekarno Hatta International Airport, many important findings can be drawn. First, the internet of things has a positive influence on operational efficiency. According to statistical studies, there is a considerable correlation between the improvement of operational efficiency and the ability of the internet of things to integrate different devices into the airport system. Second, artificial intelligence has a positive influence on operational efficiency, which improves passenger satisfaction from check-in to boarding and has the ability to automate a number of operational procedures. Third, it has been proven that big data analytics have a positive influence on operational

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efficiency, which helps in personalizing customer service, optimizing flight schedules, and improving safety protocols. These findings show the need not only to provide fast services through various digital technologies, but also to be able to minimize market competitiveness to improve operational efficiency at Soekarno Hatta International Airport.

According to the findings, the Internet of Things (X1), Artificial Intelligence (X2), and Big Data Analytics (X3) have a significant impact on operational efficiency (Y).

6. Implication

Based on these results, it can be concluded that the implications obtained are :

1. Improving Passenger Experience : The results show that Soekarno Hatta International Airport must prioritise improving the experience felt by passengers or visitors. To improve the experience felt by passengers or visitors, Soekarno Hatta International Airport may need to upgrade various facilities so that they are all technology-based and invest in technology-based systems, so that Soekarno Hatta International Airport can provide even better services to passengers or visitors. By addressing these aspects, Soekarno Hatta International Airport can improve Operational Efficiency.
2. Invest in Infrastructure and Labour Development : To achieve the recommended improvements, Soekarno Hatta International Airport should consider investing in technology-related infrastructure upgrades and workforce development. This may involve upgrading and modernising the Airport's facilities, as well as implementing advanced management systems. In addition, the company should invest in training and development programmes to empower their workforce with the skills needed for digital-based operations and customer service to run efficiently. By investing in infrastructure and human resources, Soekarno Hatta International Airport can move towards a more competitive and customer-centric business model.

7. Research limitations

The main constraint of this research comes from the shortened time frame. The short duration of the research study limited our capacity to collect more extensive and in-depth data, as well as to conduct a thorough analysis covering all relevant aspects of the subject. As a result, certain aspects of deeper or long-term development may not have been thoroughly explored within the confines of this investigation. Nonetheless, we have made every effort to build a comprehensive understanding of this topic, utilising the resources available and operating within the time constraints set.

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