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Predicting Airline Customer Loyalty by Integrating Structural Equation Modeling and Bayesian Networks

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Abstract: The aviation industry has grown rapidly worldwide and is struggling against intense competition. Especially in Thailand, the compound annual growth rate of passengers traveling by air has increased continuously over the past decade. Unfortunately, during the past two years, the ongoing COVID-19 pandemic has caused severe economic crises for nearly all businesses and industries, including the aviation industry and especially for passenger airlines whose number of customers has decreased astoundingly due to travel restriction. To maintain business stability, therefore, airlines must build customer loyalty to survive in times of crisis. This study thus examines critical factors' impact on airline loyalty by using a Bayesian network (BN) derived from a structural equation modeling (SEM). The study integrates the SEM and BN to refine causal relationships between critical factors, identified as critical pathways. Findings reveal that customer satisfaction and customer trust, followed by perceived value, dramatically influence customer loyalty and so are considered priorities for building airlines' customer loyalty. This study also recommends practical strategies and policies to improve customer loyalty amid the competitive airline business during and after the COVID-19 era.

Keywords: Bayesian network; structural equation modeling; airline; customer loyalty

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1. Introduction

Before the current COVID-19 crisis, some businesses and industries were growing rapidly but also facing intense competition. Especially in the aviation industry, both demand and supply have been increasing continuously. According to the State of Thai Aviation Industry 2019 Report, the compound annual growth rate of Thai air transport over the past decade has been 11.4%, with average annual growth rates of 10.8% for international and 12.1% for domestic passengers [1]. These percentages reflect the Thai aviation industry's rapid growth, thus offering travelers both convenience and comfort [2]. Currently, in Thailand, over 40 airlines operate with full-service and low-cost, so, obviously, the market share is much divided, meaning that passengers can readily choose a service that fulfills their requirements [1,3].

During the ongoing COVID-19 pandemic, however, the global economic crisis [4–6] has significantly impacted air transportation worldwide [7]. Due to this challenging situation, all flights, both domestic and international, were temporarily interrupted, and even when some flights resumed, the number of passengers had tremendously decreased compared to the previous year [1,5]. Indeed, most airlines, including Thailand's, are still striving to maintain financial liquidity [8], so effective policies and strategies are needed

to enhance chances of long-term survival and competitiveness. Especially in a country with 40 airlines, competition is fierce, so building a good reputation for reliability is crucial [9–11]. In fact, several previous studies—Curry and Gao [12], Feng Jr and Zhang Jr [13], Hossain et al. [14]—have mentioned that airlines' long-term success depends mainly on the critical factor of brand or customer loyalty.

Especially during the COVID-19 epidemic, policies and strategies to encourage and build customer loyalty have been highly significant in attracting passengers' repurchase behavior [15,16]. Key determinants of customer loyalty include customer satisfaction, customer trust, perceived value, service quality, customer commitment, and airline image, as reported by Akamavi et al. [17], Al-Refaie et al. [18], Calisir et al. [19], Salah and Abou-Shouk [20], and Vlachos and Lin [21]. These antecedents are essential for building customer loyalty. In fact, many scholars, e.g., Chonsalasin et al. [22], Rahim [23], and Rizan [24], have indicated that customer satisfaction, trust, and service quality had direct effects on building customer loyalty toward airlines. Indirect effects on customer loyalty include airline image and customer commitment. In contrast, a few studies have found these factors that did not enhance customer loyalty [25,26].

In this context, seeking insight into factors affecting customer loyalty toward the airline business is necessary for its survival. Although some studies have previously investigated customer loyalty toward airlines, few have examined determinants' impact by integrating structural equation modeling (SEM) and the Bayesian network (BN). Therefore, the study aims to address this research gap by examining empirical factors' impact on airline loyalty by using the BN derived from SEM. In this study, the BN was developed based on an empirically validated structural model conducted by Chonsalasin et al. [22]. The structural model reveals causal relationships among determinants in enhancing customer loyalty. The BN is used as an exploratory approach to identify critical determinants using sensitivity analysis. After identifying these critical determinants, scenario analysis has been applied to formulate strategies to improve airline customer loyalty. The study thus seeks to contribute empirical insight into the relationship between certain priority factors and long-term customer loyalty to airlines.

2. Literature Review

Passenger behaviors play a crucial role in developing and building customer loyalty to an airline service, but building and enhancing that loyalty is actually an airline's indispensable task [27]. Customer loyalty is such a commitment between customers and brands or service providers which caused the customers to make repeat purchase [28,29]. However, customer loyalty can be achieved by brands developing incentives and programs that attract customers to repurchase. In terms of the airline business, many studies stated that offering a pleasant service to the passenger is one way to build customer loyalty [30–32].

When an airline manages to increase its customer loyalty, it increases sales volume and profit, thus demonstrating stability and financial liquidity [33] and also representing customer behavior in support of its service. This behavior's result can be reflected by several customer activities, for instance, repurchasing intention, reluctance to switch airlines, and recommending the airline to other consumers by word of mouth [34]. Customer loyalty also indicates customers' positive attitude toward the airline's service, leading to long-term success [35,36]. Therefore, in building customer loyalty, understanding influencing factors is necessary, so, in this study, the following eight factors were applied in the causal model.

Customer trust is a reciprocal behavior based on what customers have received. Building customer trust depends on understanding customers' needs, offering service relevant to their needs, and showing them respect [37,38]. Each service provider receives a level of trust based on customers' perception of service quality [37,38]. Thus, including trust as a factor in the model demonstrates the relationship between customers and brands [39]. This is consistent with Song et al. [11], who stated that earning customers' trust can help retain their patronage.

Customer satisfaction is defined as individuals' discontent or pleasure according to their comparison of service quality or products [40,41]. In other words, customer satisfaction is likely to depend on individuals' expectations and perceptions [42]. In the airline business, for instance, customers' perception of flight attendants and staff can enhance and/or retain a customer satisfaction level as evaluated by their repurchase over time [41].

Several previous studies, e.g., [20,22,43], have highlighted customer commitment as a vital factor influencing customer loyalty. Commitment to a product or service reflects a provider's ability to influence customers' feelings about using that service [39]. Bendapudi and Berry [44] have provided examples of aspects between providers and customers related to customer commitment: environmental, relational, and interactive.

Customer expectation includes individuals' anticipated behaviors or actions by provider staff, depending on each customer's experience, social background, and environment [22]. Customer expectation is important for measuring service quality and passenger perspective [45]. In this study, customer expectation correlated with customer satisfaction, as found by many scholars, e.g., [31,38,46–50].

As several previous studies related to the airline context have demonstrated, perceived value positively influences customer satisfaction [47,51–53]. Perceived value can be defined as customers' judgment and evaluation of the service and product, that is, comparison of pros and cons according to awareness of cost and benefit [51].

Perceived service quality means customers' perception and evaluation of overall service quality in comparison to expectations for received service [41,45,54]. Besides that, perceived service quality positively influences customer satisfaction [10,22,36,44,46,55–58].

Airline image refers to perception of a brand as expressed by brand associations in consumer memory, including an attitude that combines consumers' values, experiences, and ideas about goods, services, staff, businesses, or brands [59]. A service provider with a good reputation and image can retain current customers and attract new ones to compete successfully with rivals [11,41,52].

3. Methodology

3.1. Participants and Data Collection

Data were gathered through face-to-face surveys conducted at Thai airports to collect data from passengers. The interview was performed at the arrival terminal building from March 2019 to May 2019. The 15-min interviews were administered with participants who were willing to participate and were qualified as passengers with prior plane travel experience. This study applied stratified sampling to determine the sample size of airports in the four regions of Thailand (i.e., southern, northern, central, and northeastern). As a result, we interviewed 400 participants per region, obtaining a total sample of 1600 participants.

In the sample, 53.8% were female and 46.2% were male. Almost half of the samples were aged between 18 to 29 years, 37.2% were aged 30–39 years, and 153 respondents (9.6%) were older than 40. Most of the sample travel for leisure purposes with 48.2%, followed by business trip purposes with 28.6% and visiting hometown purposes with 9.6%. Regarding travel frequency, 48.7% traveled by air transport every year, and 33.3% traveled every 4–6 months. The distribution of the respondents' demographic profile approximated the distribution of the population from that they were selected.

3.2. Measurement Instruments

The measurement items for all constructs were adapted from the literature review of previous studies relevant to airline context and customer behavior. After slight adjustments to confirm their suitability in an airline context, perceived service quality was evaluated using five items, and three items measured airline image. Customer expectation was measured with five items, while customer commitment was assessed with three items. Four indicators covered customer satisfaction with airline service [17,60]. Three statements represented perceived value, which asked questions related to comparing received service

with the cost [60,61]. For customer trust, five indicators measured the overall feeling of trust adapted from studies by Akamavi et al. [17], Jomnonkwao et al. [62]. To measure customer loyalty, the respondents were asked about the intention to repurchase and travel with the same airline and recommend it to others [62]. These indicators were measured using multiple items and a 7-point Likert scale anchored at 1 = strongly disagree and 7 = strongly agree. The high score represented the high level of agreement in each measurement item. Cronbach's alpha is an indicator used for testing construct reliability. As presented in Appendix A, Cronbach's alpha is greater than 0.7 for all constructs, indicating that the measurement items of all constructs are reliable and represent the uni-dimensionality of their measurement scale [63].

3.3. Analysis

SEM was conducted using Mplus version 7.2. The maximum likelihood method was adopted since it is, in theory, the superior parameter estimation. It also offers the researchers more suitable statistical features, with a weaker assumption that the data are randomly missing [64]. To evaluate model fit, these goodness-of-fit indices were adopted to establish the validity of the structural model: chi-square/degrees of freedom $(\chi^2/df) < 3$, root mean square error of approximation (RMSEA) < 0.06, comparative fit index (CFI) > 0.95, Tucker-Lewis index (TLI) > 0.95, and standardized root mean square residual (SRMR) < 0.08 [65].

To predict airline customer loyalty, this study proposes a hybrid approach integrating the SEM and the BN. The study developed an empirically validated structural model to explore causal relationships of customer loyalty's determinants. Then, based on the structural model, it constructed the BN to predict and diagnose improvement in airline customer loyalty due to various strategies' implementation. Because SEM is a confirmatory approach for proving a causal model's hypothesized relationships [66,67], it can be used as an empirical validation to establish causal relationships between latent constructs [68]. However, SEM does not have causality inference capacity, thus limiting the ability to transfer knowledge from a theoretical model to practical actions [69]. The BN is a graphic model that learns automatically from data based on probability theory and can apply scenario analysis to support prediction and decision-making [68]. The BN's limitation is that the direct acyclic graphs (DAG) is developed based on expert judgment, so the model's accuracy depends on experts' knowledge background [70]. Therefore, this study proposes a hybrid SEM-BN methodological process that can address both methods' limitations.

The BN is a probabilistic model based on the DAG that present causal relationships between factors or variables. Moreover, the BN is a DAG compiled to encode probabilistic relationships between nodes for knowledge reasoning with uncertainty [68]. The DAG, consisting of nodes associated with a probability distribution, represents the BN model. Bayes' theorem of probability is applied in the BN as a mathematical model that can update belief of hypothesis E_i in consideration of event A [71,72]. Therefore, Bayes' theorem can calculate $P(E_i|A)$ in terms of $P(A|E_i)$, as expressed in Equation (1) [73].

$$P(E_i|A) = \frac{P(A/E_i) \cdot P(E_i)}{P(A)} \quad (1)$$

Belief in event E_i can be updated given occurrence of event A. Where $P(E_i|A)$ refers to the posterior probability of E_i, given occurrence of A, $P(A|E_i)$ refers to the conditional probability of A given E_i alone. $P(E_i)$ is called the prior probability of the event E_i and $P(A)$ is the prior probability of event A and is assigned a scaling factor [71]. The BN applies Bayes' theorem to estimate unknown $P(E_i|A)$, where the probability occurrence of event A relies on occurrences of events E_i $(i = 1, 2, \ldots, n)$ for n number of events [74].

4. Results

4.1. Linking SEM to BN

The goodness of fit indices exhibited the validity of the model (χ^2/df = 2.812, RMSEA = 0.034, CFI = 0.982, TLI = 0.979, SRMR = 0.035). These fit indices confirm that

the conceptual model fits the observed data and can be adopted as the final structural model [75]. This study constructed a causal map of customer loyalty based on a structural model developed by Chonsalasin et al. [22]. Figure 1 presents the final structural model, that is, causal relationships among customer loyalty's determinants, including eight significantly associated factors. Customer satisfaction had a significantly moderate impact on customer loyalty (0.407, $p < 0.001$) and a highly positive impact on customer trust (0.989, $p < 0.001$). The path coefficient from customer expectation to perceived service quality had a significantly positive effect (0.585, $p < 0.001$). Perceived service quality showed strong positive influence on perceived value (0.954, $p < 0.001$), which moderately impacted customer loyalty (0.225, $p < 0.001$). Customer commitment and airline image slightly impacted customer loyalty, with standardized coefficients of 0.097 and 0.035, respectively. Readers can find more comprehensive details about the model's development and assessment in the study by Chonsalasin et al. [22]. Questionnaire items' descriptive statistics are presented in Appendix A. Consequently, the BN was performed to refine the causal relationship between the structural model's factors.

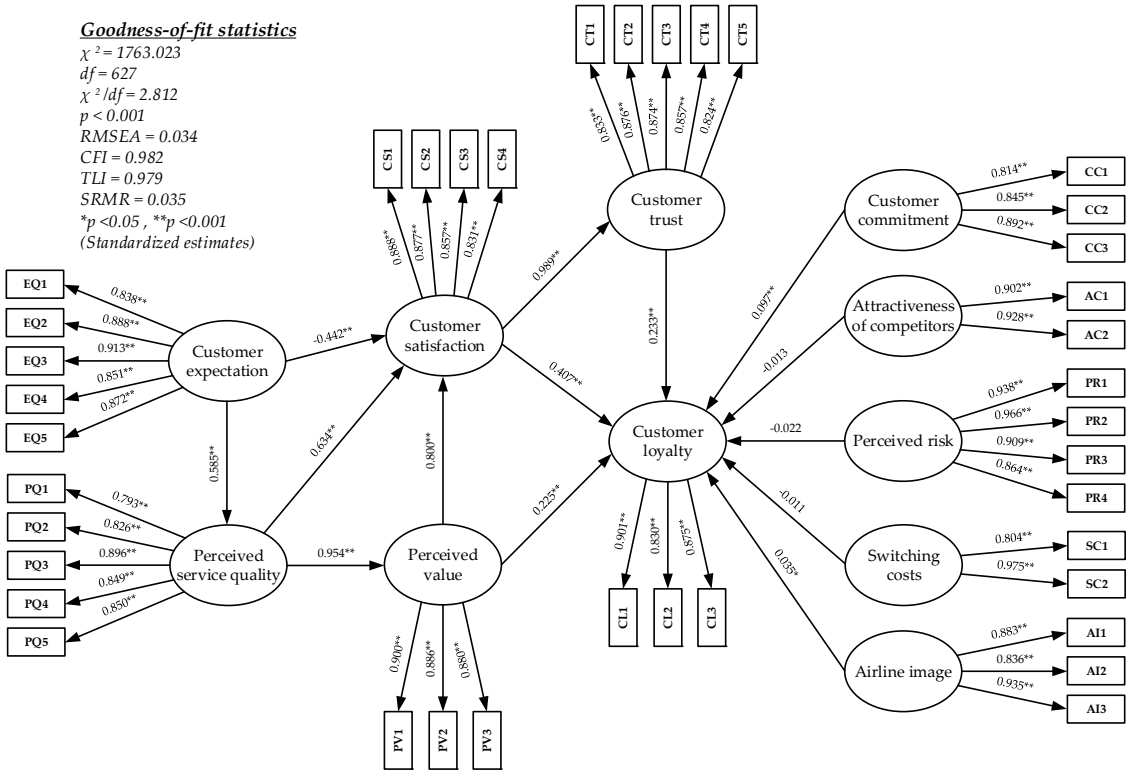

Figure 1. Structural model of airline customer loyalty [22].

The DAG is defined by two sets: random variables and directed edges. The random variable, represented by a node, is drawn as an ellipse designated by the variable name. The edge reflects direct dependency between random variables, represented by arrows connecting nodes. Furthermore, the edge presents probability distribution associated with corresponding nodes [68,71]. As Figure 1 shows, the DAG was developed based on the structural model. Only eight factors with significant relationships were adopted to construct the DAG, following the method of Wipulanusat et al. [68]. Figure 2 illustrates the DAG of customer loyalty toward the airline business, in which customer commitment, airline image, customer satisfaction, and customer trust directly affect customer loyalty. Perceived value, directly and indirectly, impacts customer loyalty through customer satisfaction, while perceived service quality and customer expectation influence customer loyalty only indirectly.

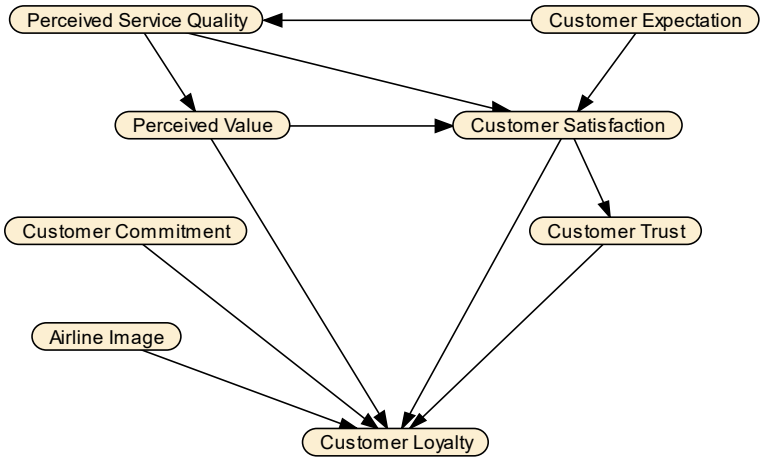

Figure 2. Directed acyclic graph representing dependencies among factors.

The BN comprises two elements, represented as BG, Θ, where G stands for the DAG consisting of nodes and edges [74]. Joint probability distribution is represented by Θ. The conditional probability table presents each node's joint probability distribution [69]. The BN with n nodes represents random variables $(X_1, X_2, X_3, \ldots, X_n)$. Parent nodes of child node X_i are represented by π_i. Conditional probability distribution is denoted by $P(X_i|\pi_i)$, similar to the parameters of $\Theta_{X_i|\pi_i}$. The BN's joint probability can be illustrated as a chain rule in Equation (2) [68,76].

$$P(X_1, X_2, X_3, \ldots, X_n) = \prod_{i=1}^{n} P(X_i \Big| \pi_i) = \prod_{i=1}^{n} \Theta_{X_i|\pi_i} \quad (2)$$

When the DAG has been created, BN states must be specified to construct a model. Variables can be categorized into two. First, a discrete variable is characterized as a finite set of fixed values. Second, a continuous variable comprises any value from a given range [77]. In this study, a 7-point scale was applied to measure all factors' values. To determine BN states, a continuous variable was converted to a discrete variable following Wipulanusat et al. [68]. Because of data's uneven distribution, numerical value was classified into three categories based on each state's opportunity of occurrence: 0–4 = low; 4–5.5 = medium; 5.5–7 = high. BN parameter learning was conducted using the software package Netica [78].

Figure 3 depicts the BN of customer loyalty's determinants. The compiled network revealed eight nodes and ten edges between nodes. Each node has a different probability, shown as a percentage in high, medium, and low states. For the customer loyalty node, 58.3% of respondents considered it to be at a high state, expressed by *P(customer loyalty = high)* = 0.583. In comparison, 35.6% believed in a medium state and 6.01% in a low state. As a result, since the high state has the highest proportion, high consumer loyalty is likely to happen. The mean value and standard deviation are presented at the bottom of the belief bar, which displays the customer loyalty node's mean value as 5.46 and its standard deviation as 1.2.

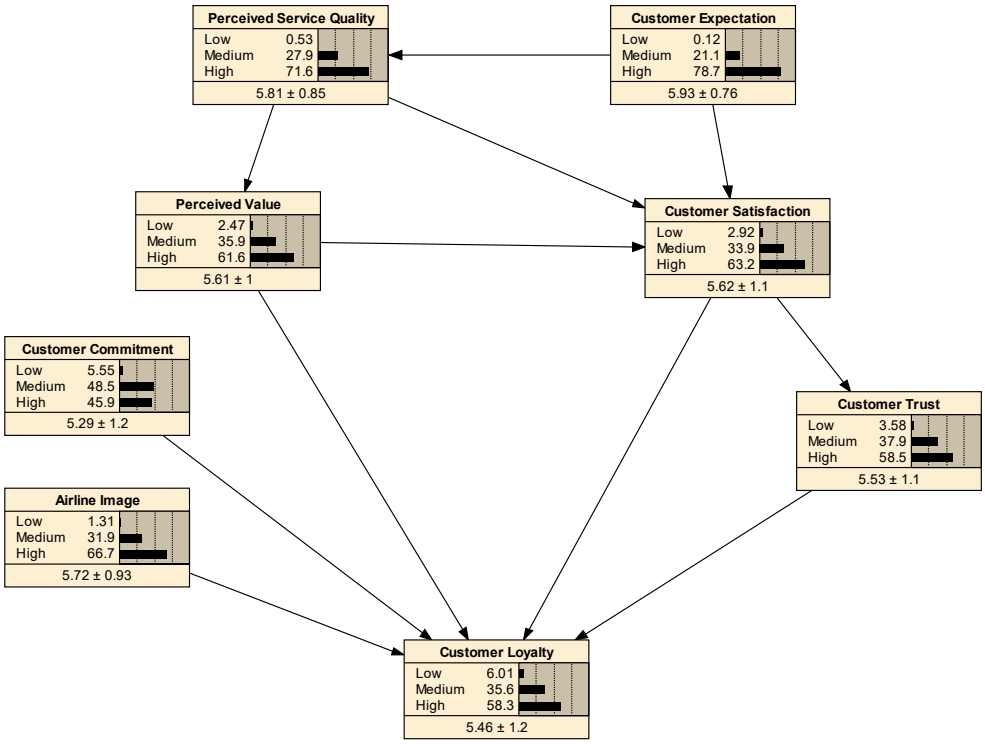

Figure 3. Bayesian network for airline customer loyalty.

4.2. Network Validation and Robustness Test

After building the BN, the following step is to assess the model's accuracy. For this investigation, a confusion matrix was used as a classification test to evaluate the performance of the BN. The confusion matrix was created with columns representing the predicted values from the BN and rows corresponding to the actual values from respondents' answers. The confusion matrix employs a crossing table operation to count the predicted value and actual value used to calculate an error rate. The error rate indicates classification accuracy as an assessment of the predictive abilities of states over a set of nodes [79]. To assess predictive power, a total of 100 cases were chosen at random from the data set. Then, using a 'test with cases' function in the Netica software, the customer loyalty node was selected as an output to develop a confusion matrix. Table 1 shows the findings of the confusion matrix used to test the BN's robustness.

Table 1. Confusion matrix for the robustness test.

Actual from Responses	Predicted from the BN		
	Low	**Medium**	**High**
Low	3	1	0
Medium	0	30	4
High	0	5	57
Total error rate = 10%			

According to the confusion matrix, the total error rate was 10%, implying that the model was 90% correct in its predictions for the customer loyalty node. Therefore, the error rate indicated that the developed BN was accurate. As part of the confusion matrix, scoring rules were also provided to assess the degree of fit over a set of nodes. The scoring rules consist of logarithmic loss, quadratic loss, and spherical payoff, which evaluate how

well the BN corresponded to values in a case file. These scoring rules are expressed by the following equations [80]:

$$\text{Logarithmic loss} = MOAC\ [-\log\ (P_c)] \tag{3}$$

$$\text{Quadratic loss} = MOAC\left[1 - 2P_c + \sum_{j=1}^{n} P_j^2\right] \tag{4}$$

$$\text{Spherical payoff} = MOAC \cdot \left[\frac{P_c}{\sqrt{\sum_{j=1}^{n} P_j^2}}\right] \tag{5}$$

where $MOAC$ is stand for the mean over all cases (i.e., all cases where the case file gives a value of the node in the question). P_c is the predicted probability for the correct state, P_j is the predicted probability for state j, and n is the total number of states.

The logarithmic loss spans from 0 to infinity. The closer to zero represents the model's goodness of fit. The quadratic loss ranges from 0 to 2, with a lower number indicating better BN execution. Finally, the spherical payoff ranges from 0 to 1, with 1 indicating the best model performance. The logarithmic loss and quadratic loss scores were 0.3177 and 0.1641, close to 0, while the spherical payoff was 0.9162, which was close to 1. Thus, these three indicators confirm the predictive performance of the BN.

4.3. Sensitivity Analysis

Sensitivity analysis determines how an output parameter is apportioned to variation of uncertainty in input parameters [81] and offers critical details about effects and their variability according to minor variation of the input parameter under uncertainty [82]. Because the BN model's results depend on prior assigned probabilities, sensitivity analysis can identify critical factors with significant effects on the output variable [63,83]. Castillo et al. [84] have suggested several approaches for performing sensitivity analysis in the BN, and this study adopted the variance reduction method to assess the BN model's output sensitivity due to modifying an input variable. This approach calculates variance reduction of the expected real value of a query node R (i.e., customer loyalty) due to a finding caused by varying an input variable node P, such as customer satisfaction. Thus, variance of the real value of R given evidence P, $V(R|q)$ is calculated using the following equation [74].

$$V(R|q) = \sum_{z} p(r|q)[Y_r - E(R|q)]^2 \tag{6}$$

where r is the state of the query node R, q is the state of the varying variable node P, $p(r|q)$ is the conditional probability of r given q, Y_r is the value corresponding to state r, and $E(R|q)$ is the expected real value of R after the new finding q for node P.

Because this study's ultimate aim is to improve customer loyalty, this node was selected as a query node for sensitivity analysis to determine critical factors' degree of impact on customer loyalty. Table 2 presents sensitivity analysis results, which show variance reduction, percentage of variance reduction, and input parameters' variance of belief. Customer satisfaction contributed the most to customer loyalty, with a variance reduction of 15.2%. To a lesser degree, customer trust and perceived value had variance reductions of 13.4% and 11.6%, respectively. Other nodes' sensitivity was relatively low, indicating that enhancing customer satisfaction, customer trust, and perceived value are necessary to maintain and increase customer loyalty in the airline business [47,48].

Table 2. Sensitivity analysis of the Customer Loyalty node.

Factor	Variance Reduction	Percent	Variance of Beliefs
Customer Satisfaction	0.2306	15.2	0.0530
Customer Trust	0.2034	13.4	0.0485
Perceived Value	0.1758	11.6	0.0396
Perceived Service Quality	0.0538	3.54	0.0111
Airline Image	0.0191	1.25	0.0013
Customer Commitment	0.0156	1.03	0.0028
Customer Expectation	0.0135	0.88	0.0028

5. Scenario Analysis

5.1. Scenario 1: Effect of Customer Satisfaction

Sensitivity analysis revealed that customer satisfaction was the highest explanatory factor for customer loyalty. To evaluate customer satisfaction's significance, this node's high state was set to 100%, as shown in Figure 4. The result indicated that the odds of high customer trust increased remarkably from 58.5% to 84.6%, and the mean value increased by 8.9% (5.53–6.02). Mean values of perceived value, perceived service quality, and customer expectation also increased by 6.8%, 3.8%, and 1.7%, respectively. The chance of high customer loyalty reached 77.3%, with a mean value increase of 6.4% (5.46–5.81).

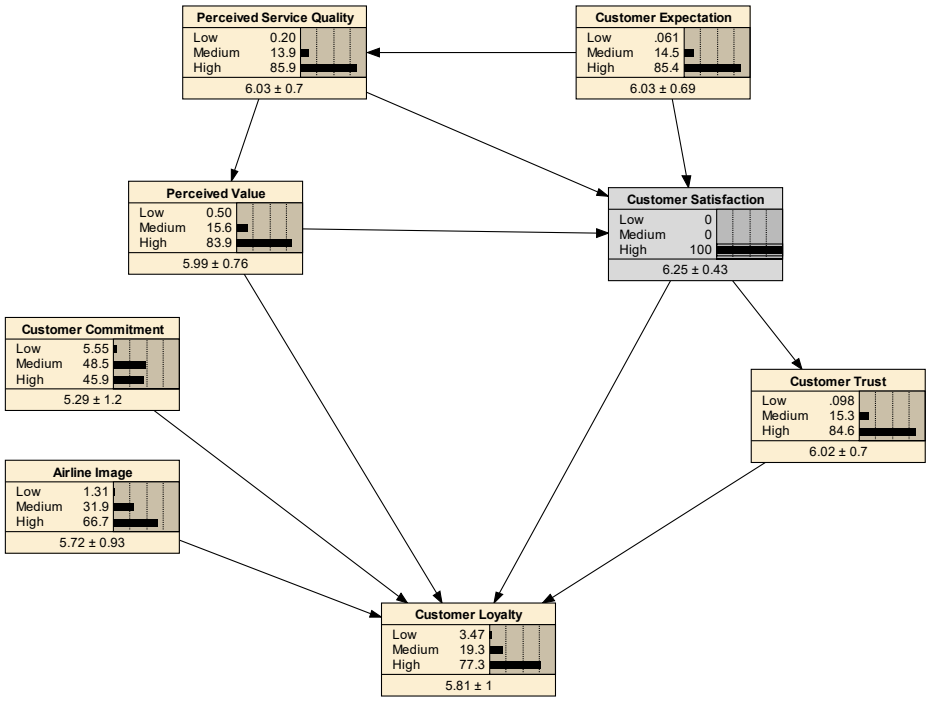

Figure 4. Effect of customer satisfaction.

Customer satisfaction significantly influenced customer loyalty [22]. Since the airline business provides service, its primary mission is to offer the highest service quality to attract demand and meet customer satisfaction [55,85]. Especially, the BN showed that perceived service quality directly impacted (or caused) a high level of customer satisfaction [10,22,31,86], in turn positively affecting customer loyalty. Hence, customer satisfaction, including service quality and facilities (e.g., staff, cleanliness) both on the ground and in the air should be improved to build customer loyalty and sustainable business [87]. This is consistent with studies by Chang and Chang [42], Ganiyu [57], Ahmed et al. [88], Gures et al. [89], who all mentioned that increasing satisfaction, including service and facil-

ities, affects customer loyalty toward airlines. Thus, travelers continue to select the airline as their first choice.

During and after the COVID-19 pandemic, airlines should implement self-check-in kiosks (SCK) as a critical touchless service strategy to enhance customer satisfaction [6]. The SCK should be designed based on kiosk functionality, usability, and relevancy, which is necessary for customers to satisfy with the airlines. In addition, the passengers' flow should be used to locate self-check-in zones to increase the kiosks' accessibility and prevent passengers from wasting time wandering around the airport. Furthermore, to attract customers to use the SCK, new features should be developed, such as directing passengers to a gate, providing amenities near the gate, and depicting larger font sizes on a screen for seniors [90]. The airlines should also arrange demonstration kiosks with training employees to demonstrate these new features to passengers.

5.2. Scenario 2: Effect of Customer Trust

In scenario analysis, customer loyalty was selected as the target node for identifying customer trust's influence, with the result indicating that customer trust is a factor impacting customer loyalty. Thus, trust's impact on other nodes or factors was explicit, as illustrated in Figure 5. When the high stage of 100% was assumed, high customer satisfaction increased to 91.5%, and mean value also increased by 8.9% (5.62–6.12). In this condition, the chance of high perceived value reached 78.7% with a 5.3% change of mean value (5.61–5.91). This result indicated that customer loyalty's mean value increased by reaching 5.82, representing 6.6% (5.46–5.82). Hence, customer trust significantly impacted customer satisfaction, perceived value, and customer loyalty.

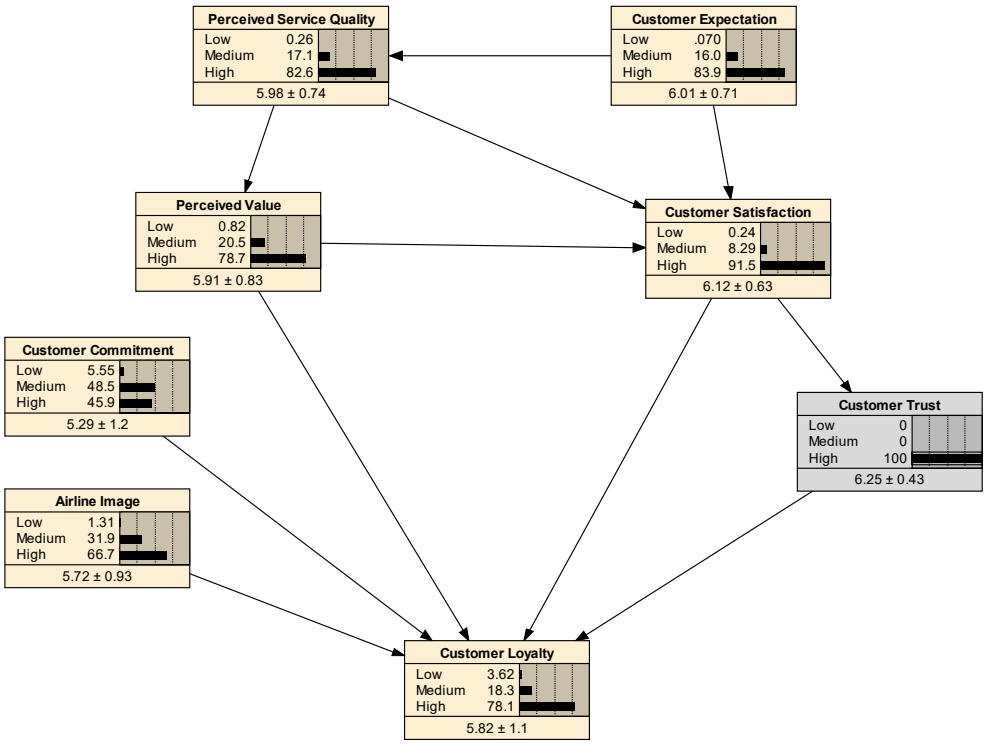

Figure 5. Effect of customer trust.

Reliability and integrity are essential to build and maintain customer loyalty, especially in this decade of intense and plentiful competition [91,92]. Many aspects related to reliability, including punctuality and ticket payment, should be improved to achieve high customer trust [58,93]. Punctuality is crucial for building a reputation for reliability because most customers choose air travel to save time [94]. Providing punctual flights and

avoiding delays help build a good reputation, in turn building a high level of customer trust [95,96]. Furthermore, ticket payment, a changing system, and reservation processes are also crucial for reliability and integrity. These processes should be easy for customers to achieve customer satisfaction and trust, in turn improving customer loyalty [97,98].

Because the aviation business transitions to the new normal in the COVID-19 era, the new value is becoming increasingly significant—the feeling of safety. According to this value, airlines can build customer trust by focusing on making their passengers feel as safe as possible via efforts such as improving sanitizing practices, mandating the use of protective equipment, offering free cleaning products to passengers, and monitoring staff and traveler temperatures [99].

In addition, airlines can enhance trust by communicating safety features required to prioritize their passengers' well-being and safety. For example, airlines have published their standards on cabin sterilization and the usage of advanced HEPA filters, which can eliminate a virus and bacteria by 99.99%. Indeed, these filters have been used before the present crisis. However, this time was an excellent opportunity to provide information for passengers about the sterilization measures that airlines always have in place to help create trust and confidence [90].

5.3. Scenario 3: Effect of Perceived Value

According to sensitivity analysis, perceived value potentially influences customer loyalty. To assess perceived value's significance, this node was set to the high state, and the result illustrated maximizing a high stage of perceived value, as shown in Figure 6. High customer satisfaction reached 86% with a 6.9% increase in mean value (5.62–6.01). In customer trust caused by customer satisfaction, the mean value also increased by 5.4% (5.53–5.83). Besides that, high perceived service quality reached 85.8%, a 3.8% increase (5.81–6.03), and high customer expectation reached 84.7%, a 1.5% increase (5.93–6.02). The mean value of customer loyalty increased by 5.7% (5.46–5.77).

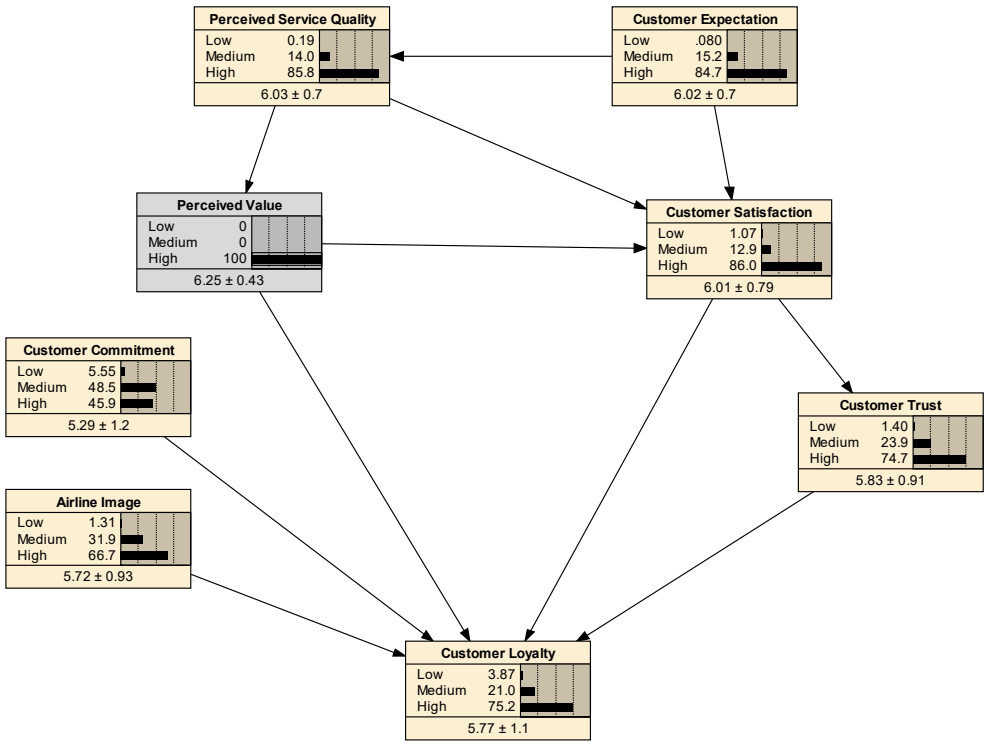

Figure 6. Effect of perceived value.

To build airline customer loyalty, perceived value should consider judgment and evaluation, that is, comparison of pros and cons based on customers' experience and perception

of service and facilities [51]. Providing excellent value represents worth to customers. Several strategies to enhance value include ticket fees and service quality, ranked by customers as significant aspects [100,101]. More specifically, when compared with service quality, including air and ground service, flight attendants, air operation, and information, customers should perceive ticket fees as reasonable and affordable [102–104]. Therefore, enhancing service quality to provide positive perception based on customers' considerations is necessary to obtain the highest level of customer satisfaction, which, according to studies by Ostrowski et al. [50], Shah et al. [53], considerably impacts brand loyalty.

In the post-COVID-19 pandemic, premium economy seating becomes the preferred choice even at a higher price because passengers demand a greater seat pitch, although it means less frequent flying. In addition, passengers require more space due to social distancing norms because they are not psychologically used to being cheek-by-jowl with other passengers anymore. As a result, many airlines are increasing the mix of premium economy seating in their planes [105]. Thus, the airlines should reconsider pricing strategy of the premium economy seating to reflect these customers' considerations.

5.4. Scenario 4: Effect of Customer Satisfaction, Customer Trust, and Perceived Value

Regarding results of sensitivity and previous scenario analyses, the three greatest explanatory factors significantly impacting customer loyalty were customer satisfaction, customer trust, and perceived value. This suggests that enhancing all factors influencing customer loyalty might be unnecessary and waste resources. For this scenario, therefore, integrating factors highlighted by sensitivity analysis should be prioritized. As Figure 7 illustrates, maximizing high states of customer satisfaction, customer trust, and perceived value will likely achieve the greatest effects on customer loyalty. Maximizing these factors indicated variation of customer loyalty's mean value, increasing it by 9.5% (5.46–5.98), the highest change rate compared to other scenarios.

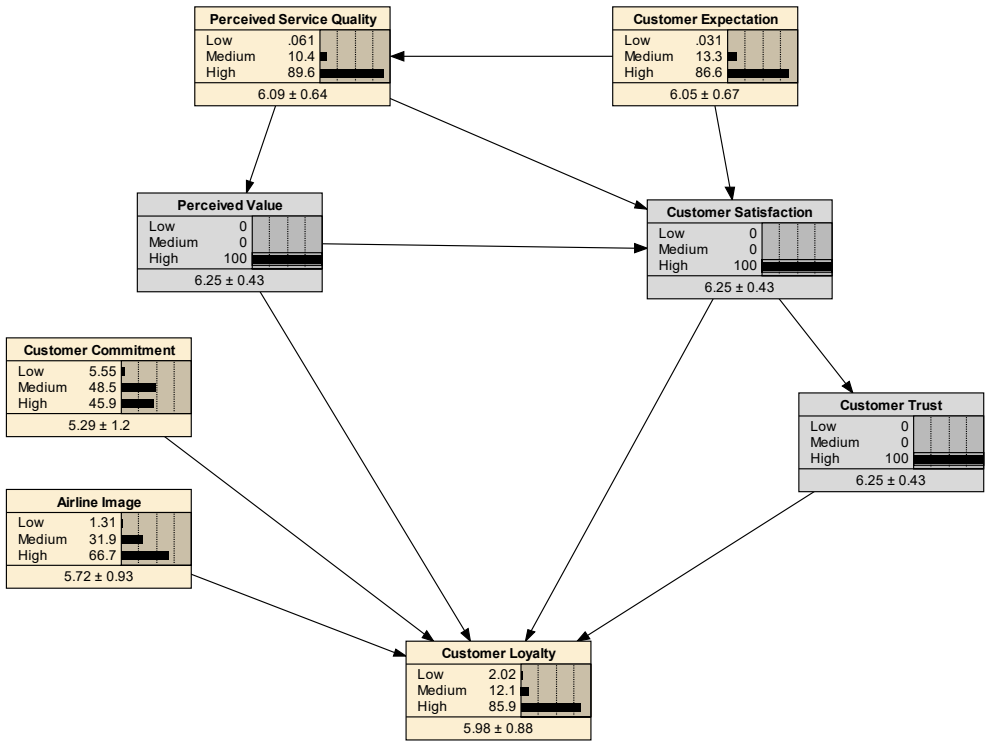

Figure 7. Effect of high customer satisfaction, customer trust, and perceived value.

Furthermore, building and maintaining customer loyalty involves improvement of several factors. Customers' perceived value, satisfaction, and trust are crucial for enhancing repeated use, which represents customer loyalty [46,49,56]. Customers' perception of

worth positively impacts a high level of satisfaction and trust [106,107]. If the three highlighted factors simultaneously reach a high level, customer loyalty dramatically increases, consistent with findings by Akamavi et al. [17].

According to the findings of this scenario, perceived value, customer satisfaction, and customer trust in the airlines all play a crucial role in building customer loyalty. It would be impractical for airlines to invest extensively in all determinants of customer loyalty. We suggest that airline managers concentrate their efforts on these three critical factors to capture as many loyal consumers as possible with our recommended strategies instead of investing unfocused resources [108]. The empirical results and theoretical literature highlighted that airline customer loyalty is developed not just by satisfaction but also by perceived value and customer trust. Consequently, airlines should compete in this COVID-19 crisis by adopting the acronym 'VTS,' which stands for the three significant antecedents contributing to loyalty: value, trust, and satisfaction.

5.5. Scenario 5: Maximize Customer Loyalty

As Figure 8 shows, backward inference was conducted by setting a high state for the customer loyalty node to 100%. As a result, customer satisfaction and trust increased considerably so that those factors' posterior probabilities were 83.7% and 78.3%, respectively. In addition, the posterior probability of perceived value also changed significantly to reach the high level of 79.4%. Consistent with sensitivity analysis, backward inference revealed that customer satisfaction, customer trust, and perceived value are critical factors needing improvement to maximize customer loyalty.

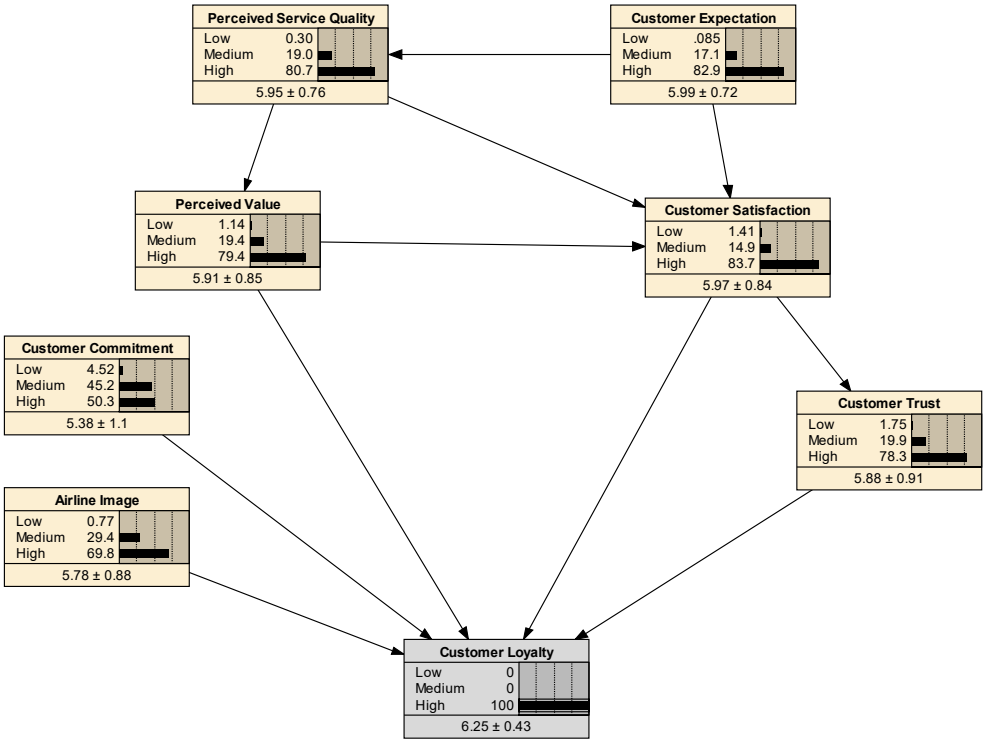

Figure 8. Maximization of customer loyalty.

Table 3 presents each factor's prior and posterior mean value and change rate. Customer trust had the highest change rate at 6.33%, followed by customer satisfaction at 6.23% and perceived value at 5.35%. In contrast, airline image and customer expectation slightly affected customer loyalty with change rates of 1.05% and 1.01%, respectively. According to the BN structure, customer satisfaction and perceived value directly and indirectly impacted the customer loyalty node, whereas customer trust directly affected it. This scenario analysis highlights that paths connecting perceived value, customer satisfaction,

and customer trust critically influence customer loyalty. Thus, maintaining and improving customer loyalty through customer satisfaction, trust, and perceived value should be an airline's first priority. Conversely, airline image and customer expectation should be the least important considerations because these factors rarely influence customer loyalty.

Table 3. Prior and posterior mean values for each factor.

Factor	Mean Value		Change Rate (%)
	Prior	Posterior	
Customer Trust	5.53	5.88	6.33
Customer Satisfaction	5.62	5.97	6.23
Perceived Value	5.61	5.91	5.35
Perceived Service Quality	5.81	5.95	2.41
Customer Commitment	5.29	5.38	1.70
Airline Image	5.72	5.78	1.05
Customer Expectation	5.93	5.99	1.01

Loyalty programs have progressively become vital for airlines as critical strategies employed during the COVID-19 crisis. During the COVID-19 pandemic, airlines should use loyalty programs as a practical approach to engaging with their loyal frequent travelers. Most airlines elected to prolong the expiration date on miles, extend elite status, and award threshold reduction as immediate responses to ease the worry of losing membership status. Several airlines expand or bring individuals up through the tiers to keep customers engaged and surprise them with additional points [99]. Therefore, airlines can attract and retain their loyal customers by making them feel valued, as they have honestly cared for their loyalty.

Furthermore, airlines should offer new point-to-point services between unique city pairs to attract more loyal customers. Point-to-point travel, which avoids major hubs, provides customers with faster and direct nonstop flights between secondary cities, linking highly profitable city pairs with high demand in both directions. By allowing passengers to bypass major congested hubs, point-to-point flying can maintain a critical health benefit to avoiding risky or infected stopover points during the COVID-19 period [109].

6. Discussion

6.1. Theoretical Contributions

With the aim of developing a novel comprehension of airline service attributes, this paper has advanced the literature on determinants of customer loyalty in the airline industry. This study is among the first to investigate the impacts of these determinants using a hybrid SEM–BN approach. We applied the sensitivity analysis to identify critical determinants of airline customer loyalty: customer satisfaction, customer trust, and perceived value. This research also applied confusion matrix and scoring rules to examine the robustness of the BN, and the results confirmed the prediction accuracy of the model. Thus, this paper also provides a methodological contribution in the new context of the airline industry. Furthermore, this study was conducted in Thailand, contributing to the body of knowledge of air transportation in Southeast Asia, where low-cost carriers have dominated airline markets [110]. Therefore, the empirical results can be used as a source of reference for other studies conducted in countries in the Association of Southeast Asian Nations (ASEAN) due to the same pattern of aviation development.

6.2. Practical Implications

Significant critical factors impacting airline customer loyalty are customer satisfaction, trust, and perceived value. These critical factors need special attention as major priorities for long-term airline success, especially during canceling routes or reducing their frequency due to the COVID-19 pandemic. The study recommends practical strategies to guide decision-makers.

Because saving time is a primary purpose of choosing air travel, one of the most crucial issues affecting customers' trust is expectation of punctuality [94,111]. Recently, several flight-delay case studies have reported wide criticism from passengers. Lack of punctuality negatively affects both trust and satisfaction, reducing both brand loyalty and repurchase intention. Therefore, avoiding flight delays should be prioritized. In case of unavoidable technical and weather conditions, providing precise information about delays, especially boarding time for the next flight, is essential for passengers and a necessary strategy for airlines. If a flight must be canceled, an effective contact center providing information that includes claim compensation, refund and return tickets, flexible bookings and re-routing should operate efficiently to represent the airline's integrity. This strategy not only builds trust but also satisfies passengers as to service.

Another vital point is that passengers' received service quality should align with ticket price. Zhang [112] mentioned that passengers are willing to pay higher prices for better service. Moreover, they seek ideal service at an affordable price, and this point was also crucial for greater levels of customer satisfaction. Therefore, to obtain higher levels of satisfaction, training programs for staff should concentrate on encouraging positive attitudes toward providing strategic service and paying particular attention to taking care of passengers' needs. Improving facilities such as online check-in and kiosks at terminals enables the most seamless journeys. Ultimate handling and caring impresses passengers with an airline's service and, finally, builds and retains customer loyalty [11].

Throughout the COVID-19 pandemic, airlines should highlight three dimensions of service quality. First, social distance and hygiene dimensions during flight comprise essential features such as meals, seats, and cleaning [105]. Airlines urge customer trust to return to travel by emphasizing protocols such as cleaning flights, distributing disinfectant kits, reinforcing existing safety standards, and minimizing contact with crews and other passengers [113].

The second dimension is information awareness and concern, which is crucial for passengers and is directly tied to service quality. Flight attendants should present information about COVID-19 mitigation methods to ease passengers' anxieties and increase their awareness. It is critical to instruct staff on how to recognize the awareness and concerns of travelers. Simple yet straightforward information for passengers assists in improving views of the airline's attention and caring and preventing the misleading and inaccurate flow of information [90]. Another effort to increase customer trust has been made directly by airline CEOs who have been more involved in consumer engagement. Delta CEO Ed Bastian, for instance, is emailing customers regularly with information on how the company is acting in response to COVID-19, emphasizing the significance of keeping customers engaged and informed during this health crisis [99].

The third component is the infection notification process, representing the actions taken to prevent passengers' health, increasing customer satisfaction, and attracting new customers to the airlines. Passengers' top priority expectation from airline carriers is security [113]. Airlines that take precautions by informing passengers about their safety can increase customer loyalty.

6.3. Limitation

First, although this study was based at least partially during the COVID-19 pandemic, no factors measured or involved COVID-19 prevention because the data had been collected before the pandemic. However, the pandemic is tending to stretch into the future. Empirical studies should be conducted on factors related to COVID-19 prevention, such as self-service technology, which includes explicitly self-check-in kiosks (SCK) that allow passengers to access services without human interactions. By using the tenets of the attribution theory, Moon et al. [6] revealed that SCK quality significantly induces customer satisfaction, which in turn increases their airline customer loyalty. Therefore, future research should include SCK quality in a causal model to explore the underlying mechanism of improving customer satisfaction and loyalty.

Second, as this study was conducted in Thailand, a developing Southeast Asian country, the findings may not be generalizable to other geographical regions. Future work can solve this constraint by carrying out a cross-country comparison study with a more diversified pool of respondents from different countries, telling us more about the cultural influence on determinants of customer loyalty. Third, this study used the confusion matrix and scoring rules to check the robustness of the BN. In the future, researchers may compare the BN's prediction results with those of back-propagation neural networks (BPN) or classification and regression trees (CART). This comparative analysis could contribute to the development of the network architecture that provides the most predictive results. Fourth, questionnaire analysis does not provide qualitative validation of the hypothesized relationships [114]. As a result, interview-based data from a case study methodology should be collected to confirm discovered correlations, provide a complementary perspective on forming the arguments, and a different perspective to comprehend how airlines survive a pandemic resulting in travel restrictions.

7. Conclusions

Structural equation modeling (SEM) and Bayesian network (BN) have often been generally applied. Although most studies related to airline customer loyalty conduct either the SEM or the BN, few have adopted an integrated SEM–BN approach. Therefore, this study examined empirical factors' impact on airline customer loyalty by integrating SEM and BN, which applied an empirically validated structural model to develop the BN. The study also revealed which critical factors influence customer loyalty, and critical pathways were identified for improving critical factors that lead to enhanced customer loyalty.

The sensitivity analysis that identified critical factors influencing customer loyalty revealed that customer satisfaction impacted loyalty the most. Furthermore, customer trust and perceived value also critically influenced customer loyalty. Through sensitivity analysis, scenario-based simulation revealed causal relationships between critical factors, so that policymakers have a guideline for establishing the most effective policies and strategies for building customer loyalty. The first priority should improve customer satisfaction, which consists of staff service quality and facilities' cleanliness both on the ground and in the air. Customer trust also needs special attention, specifically by enhancing reliability in service and ticket processes (e.g., reservations, cancellations, refunds), which are customers' first concerns. Perceived value represents worth to customers in that they compare ticket price with received service quality. Enhancing customer satisfaction, trust, and perceived value would positively affect repurchasing behavior, increase the airline company's market share and profit, and ultimately lead to the airline's long-term success. Due to the COVID-19 outbreak, we recommend practical strategies to cope with the COVID-19 pandemic and in the post-COVID-19 era for the commercial aviation industry.

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Appendix A

Table A1. Descriptive statistics.

Variable	Measurement Items	$\bar{X}$	SD	SK	KU
	Customer Loyalty (α = 0.910)				
CL1	Word of mouth	5.70	0.88	−0.43	−0.20
CL2	Identification	5.50	1.02	−0.79	1.33
CL3	Repurchase	5.70	0.91	−0.60	0.40
	Customer Satisfaction (α = 0.924)				
CS1	Happy to use this airline's service	5.63	1.00	−0.56	0.33
CS2	Overall satisfaction with airline's service	5.70	0.96	−0.62	0.42
CS3	Received service quality higher than expected	5.63	1.03	−0.62	0.44
CS4	Received service quality was ideal	5.55	1.11	−0.86	1.35
	Customer Trust (α = 0.937)				
CT1	Always trust this airline	5.59	1.07	−0.81	1.24
CT2	The airline's good handling achieved satisfaction	5.62	1.06	−0.73	0.87
CT3	Reliability of the airline	5.64	1.03	−0.70	0.87
CT4	This airline supplied the best service	5.50	1.10	−0.81	1.27
CT5	This airline is stable and reliable	5.62	1.05	−0.75	0.92
	Perceived Value (α = 0.910)				
PV1	The received service was worth its cost	5.64	0.98	−0.60	0.56
PV2	Provided service was reasonable compared to its cost	5.67	0.96	−0.69	0.73
PV3	Traveling with this airline was worth its cost	5.65	0.98	−0.72	0.72
	Perceived Service Quality (α = 0.927)				
PQ1	Airline operation	5.85	0.70	−0.48	0.02
PQ2	Ground services	5.88	0.78	−0.56	0.63
PQ3	Information	5.82	0.78	−0.44	−0.03
PQ4	Flight attendants	5.98	0.67	−0.45	−0.04
PQ5	Airline tangible	5.80	0.73	−0.39	0.23
	Customer Expectation (α = 0.944)				
EQ1	Airline operation	6.07	0.70	−0.50	−0.37
EQ2	Flight attendants	6.15	0.68	−0.59	−0.42
EQ3	Ground services	6.09	0.75	−0.50	−0.55
EQ4	Information	6.03	0.73	−0.43	−0.46
EQ5	Airline tangible	6.08	0.72	−0.60	−0.24
	Customer Commitment (α = 0.908)				
CC1	Better personal image when traveling with this airline	5.32	1.17	−0.52	0.09
CC2	Concern about airline's long-term success	5.29	1.16	−0.43	−0.06
CC3	Proud to use this airline	5.25	1.17	−0.32	−0.21
	Airline Image (α = 0.914)				
AI1	This airline has a good image in passengers' minds	5.78	0.95	−0.69	0.19
AI2	I am always very impressed with this airline	5.75	0.96	−0.56	−0.14
AI3	I trust that this airline has a better image than others	5.63	1.02	−0.84	1.10

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