
Optimizing Hospitality Choices: A Forward Chaining and Certainty Factor-Based Expert System for Recommending 4-Star Hotels in Batam City**Deosa Putra Caniago¹, Devid Trinaldo Simatupang², Okki Kurnia³, Reski Septiana⁴, M. Y. Meinadia Sekar⁵**deozaofficial@gmail.com, devid.simatupang@gmail.com, okki.kurnia@yahoo.com¹Institut Teknologi Batam^{2,3}Politeknik Pariwisata Batam

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Abstract

Tourism and travel is the largest industry in the world with hotels as a key factor in enjoying a holiday. As the cornerstone of tourism, the hotel industry continues to develop to meet increasingly high customer expectations. The application of high technology is the key to competition between hotels, with several hotels moving towards an innovative and efficient "smart hotel" concept. This research explores the hotel industry in Batam as a unique tourism destination and industrial center. The main focus includes analyzing the level of technology adoption in Batam hotels, identifying trends and factors driving the "smart hotel" concept, and developing expert system models to improve the tourist experience. By combining the two methods of Forward Chaining and Certainty Factors in an Expert System, it is hoped that the results of this research can provide important insights regarding the development of the hotel industry in Batam and the positive impact of technology in improving the quality of service to travelers.

A. Introduction

Tourism and travel is one of the largest industries in the world [1]. Every tourist who travels will need accommodation. Most tourists currently choose to use hotel services to stay overnight during their trip [2]. Hotels are a key factor in enjoying one's holiday and sometimes holidays are only taken in hotels when inclusive holiday packages are available [3]. The hotel industry is the cornerstone of tourism. The increasing expectations of contemporary tourists may prove too much for conventional hotel management systems to handle [4]. Hotels provide food and beverage services for their guests as well as various recreation, relaxation, and other leisure programs [5]. Nowadays, more and more people are traveling outside the city to travel the world and experience new things. Customers want more connectivity with their hotels and want to know everything before arriving and during their stay at the hotel. Likewise, regulations and guidelines must be adhered to to safeguard personal and visitor information [6]. Customers are increasingly technology-driven and want more automated space than ever before. Hotels actually can start adapting smart hotels to improve the guest experience [7]. Hotels that use innovative technology and rely less on human employees are believed to be able to provide exceptional guest experiences[8].

Today, hotels rely more on technology than ever before. The dramatic development of the hotel industry to raise customer expectations to the next level has triggered intense competition between hotels [9]. To build the core competitiveness of hotels, the application of high technology is repeatedly considered the most valid way [10]. The level of technology adoption varies by hotel. However, some hotels visualize themselves as smart hotels by utilizing various technologies for customer experience. Smart hotel is a practical term that describes hotels that use innovative technology and rely less on human employees to provide exceptional customer experiences [11]. The hospitality industry aims to provide the best experience, and personalized service to their customers with efficiency. To increase guests' intentions to stay at their hotel, it is anticipated that all hotels will need to implement technological amenities and services in the future [12]. Travelers have two main reasons for wanting to stay at hotels: business travelers are more influenced by technology's privacy and dependability, while vacationers are more influenced by the "fun" aspects of cutting-edge mobile technology [13].

Batam, with its unique appeal as a combination of a developed industrial center and an attractive tourist destination, is a favorite among travelers. Its strategic location, close to overseas, makes Batam the main destination for those who want to enjoy the beauty of tourism while carrying out business activities. With a variety of star-rated accommodation options, Batam creates an environment that is not only comfortable but also safe for travelers, making this city an inviting place to always return to [14]. The successful adoption of smart hotel technology will not only enhance the hospitality sector but also contribute to the overall growth and reputation of the region as a modern and innovative tourist destination [15]. With a vision to improve guest experience and operational efficiency, there are many important factors that can determine the successful implementation of smart technology in a hotel [16].

There is a great diversity and complexity of obstacles that hotels may face when implementing smart technologies such as connectivity and network security [17]. The rapid development of computer technology has also had a positive impact in various fields, including the tourism sector. In the context of an expert system, this technology can be used to provide solutions and recommendations related to various aspects of tourism, such as destination selection, travel plans, and management of tourist experiences. In addition, the willingness of hotel management to invest in smart devices and systems, as well as the expertise to utilize these technologies effectively, is critical for successful implementation [18]. With the existence of expert systems, users can get more personalized and effective guidance, making this technology a valuable aspect in improving the tourist experience [19]. Implementing energy-saving solutions and smart resource management not only contributes to cost savings for hotels but also demonstrates their commitment to sustainable practices [20].

Expert Systems is a field of computer science that utilizes computer devices to imitate human intelligence. In the processing process, there are two main components: the development environment and the consultation environment, as depicted in Figure 1 [21].

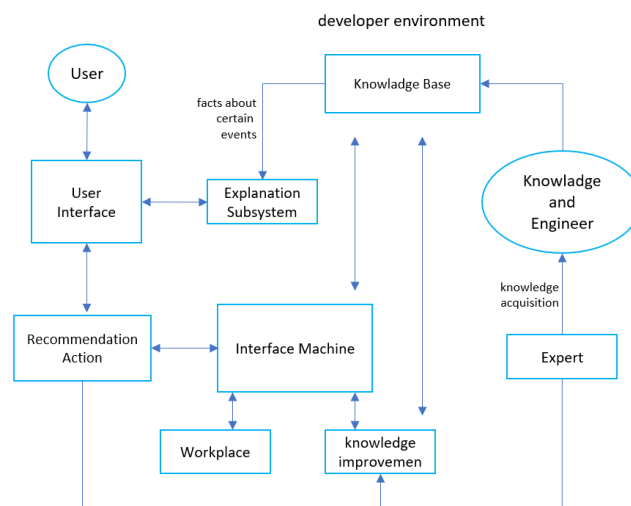


Figure 1. Expert System Architecture

B. Research Method

The research method is a conceptual basis that provides an overview of the work steps that are expected to be achieved. In this research, the research methods used include two main approaches:

- Field Research :**
Data collection from various tourism and lodging reference sources in Batam. As well as through joint interviews (travel/tourism consultants).
- Library Research :**
Literature reviews are carried out to read, review, and find conclusions related to research. Literature sources involve books, journals, and internet media related to Tourism, Forward Chaining Methods, and Certainty Factors.

The research framework used can be seen in the following figure;

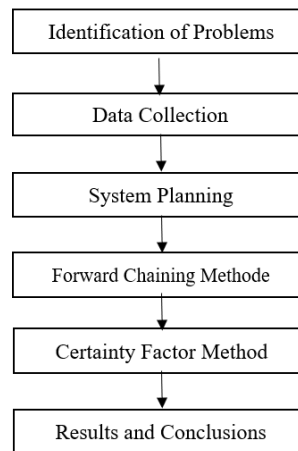


Figure 2. Research Framework

Identification of Problems

The first stage carried out in this research was problem identification. This research is important because the tourism and hotel industry is a large sector that is experiencing significant changes in customer preferences and intense competition. With Batam as a growing business and tourism destination, the adoption of technology, including smart hotel concepts and expert systems, is key to improving efficiency, competitiveness, and guest experience. This research is expected to provide insight into the implementation of this technology, support sector growth in Batam, and contribute to innovation in the hotel industry.

Data Collection

Studying Literature and Data Collection. Literature becomes a reference source in research activities, from reading sources related to research, after that research-related data is collected in the form of tourism-related information and direct interviews with tourism consultants.

Table 1. Data for 4 Star Hotels in Batam City

No	Code	Destination
1	P1	ASTON Batam Hotel dan Residence
2	P2	Beverly Hotel Batam
3	P3	Da Vienna Boutique Hotel Batam
4	P4	Swiss-Belhotel Batam
5	P5	BWP Panbil (Best Western premier)

In the Expert System to determine the best 4-star hotel destination in Batam City, we compiled criteria based on various factors with coding P1 to P5. The system considers amenities, location, guest reviews, and service quality to recommend optimal hotel choices. Using this method, users can easily find hotels that suit their preferences and needs. Of the 5 best hotel destinations, there are 25 questions which can be seen in Table 2 below

Table 2. A list of questions

No	Code	Questions
1	T1	Do you prefer hotels that offer holiday promo packages?
2	T2	How important is it for you to choose a hotel with easy meeting access such as a WiFi connection or photocopy machine?
3	T3	Are you looking for a hotel room with a beautiful view of the city from the room?
4	T4	How important is it to you to have access to a restaurant or cafe that serves traditional seafood dishes?
5	T5	Do you prefer a hotel that has a strategic location?
6	T6	Do you prefer to stay at a hotel that is close to the Mall or that has easy transportation accessibility to get there?
7	T7	How important is it for you to choose a hotel that has unique food & drinks that are only available at that hotel?
8	T8	Are you looking for a hotel that provides tour packages or local guides to visit tourist attractions in the area?
9	T9	How important are relaxation facilities in a hotel, such as a swimming pool or spa?
10	T10	Are you more interested in staying in a hotel with a unique interior design?
11	T11	Do you prefer to stay in a hotel that has a calm and peaceful atmosphere?
12	T12	Do you choose a hotel that offers unique room designs?
13	T13	Do you want to stay at a hotel in the city center?
14	T14	How important is it for you to have access to souvenir centers in Batam?
15	T15	How important is it for you to have accommodation with the world's top hotel brands?
16	T16	Do you consider the room price in determining the hotel where you stay?
17	T17	How important is it for you to choose a hotel with ease in booking room reservations?
18	T18	Do you prefer to stay at a hotel that has swimming pool facilities?
19	T19	Would you return to a hotel with such friendly staff?
20	T20	Will you choose a hotel that serves local food that is known to be delicious?
21	T21	How important is it for you to choose a hotel that has very complete bar facilities?
22	T22	How important is it for you to choose a hotel with an easy check-in and check-out process?
23	T23	Are you more interested in staying at a hotel that has laundry service?
24	T24	Are you more interested in staying at a hotel that is not far from the airport or port?
25	T25	Would you prefer to stay at a hotel that has access to golf?

Table 2 above explains a list of questions that can be used to determine the best 4-star hotel destination in Batam City, which has been coded with T1 to T25.

System Planning

Analysis and planning activities are carried out to analyze the needs of the system to be built, in the form of display design to file design of the system. So users can easily carry out consultations using the designed system.

Forward Chaining Methode

Formation of rules using the Forward Chaining method. Data collected from experts or consultants will be processed into a series of rules using the Forward Chaining method. In this process, the point is to move the thinking patterns of experts into a system.

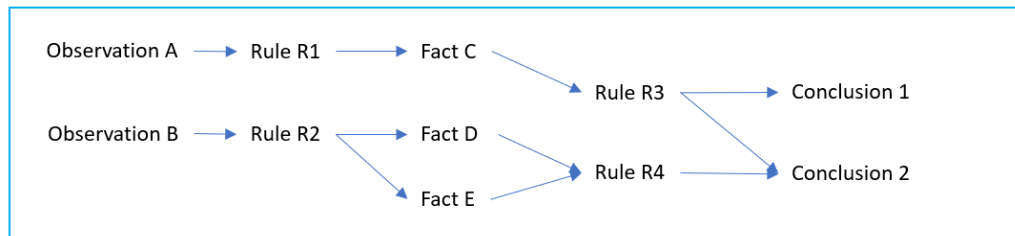


Figure 3. Process Flow of the Forward Chaining Method

The expert system flow that occurs in the system is that there is a search based on observations of the questions given so that it leads to conclusions that have been determined from the data collection.

Table 3. Formation of Rules

No	Rule	Formation
1	Rule1	IF T1 is true AND T2 is true AND T3 is true AND T4 is true AND T5 is true AND THEN P1
2	Rule2	IF T6 is true AND T7 is true AND T8 is true AND T9 is true AND T10 is true AND THEN P2
3	Rule3	IF T11 is true AND T12 is true AND T13 is true AND T14 is true AND T15 is true AND THEN P3
4	Rule4	IF T16 is true AND T17 is true AND T18 is true AND T19 is true AND T20 is true AND THEN P4
5	Rule5	IF T21 is true AND T22 is true AND T23 is true AND T24 is true AND T25 is true AND THEN P5

Table 3 is the result of establishing rules that have been determined based on data collection. It can be seen that the relationship between T6, T7, T8, T9 and T10 is the tourism destination in P2.

Certainty Factor Method

After the previous rules have been formed, the next step is to carry out calculations using the Certainty Factor method to assess the certainty related to selecting the best 4-star hotel in Batam City. By using this approach, we can determine the extent to which the sustainability of these regulations can be relied upon in achieving the goal of selecting the desired hotel in Batam City.

$$CF(\text{Rule}) = MB(H, E) - MD(H, E)$$

$$MB(H, E) = \left\{ \frac{\max[p(H|E), p(h) - p(h)]}{\max[1, 0] - p(h)} \right\}$$

$$MD(H, E) = \left\{ \frac{\max[p(H|E), p(h) - p(h)]}{\max[1, 0] - p(h)} \right\}$$

Explanation :

CF(rule) : Certainty factor.

MB(H, E) : Measure of confidence in the hypothesis H in the presence of evidence E (in the range 0 up to 1).

MD(H, E) : Measure of lack of confidence in hypothesis H in the presence of evidence E (in range 0 to 1).

P(H) : Probability of truth of hypothesis H.

P(H|E) : Probability that H is true given the existence of E.

Table 4. Certainty Value Weight

No	Interpretation	Score
1	Certainly not	-1.0
2	Almost certainly not	-0.8
3	Most likely not	-0.6
4	Probably not	-0.4
5	Don't know	-0.2-0.2
6	Possible	0.4
7	Most likely	0.6
8	Almost certainly	0.8
9	Certain	1.0

In this stage, a Certainty Factor algorithm will be used to find the confidence value from the rule search results obtained from Forward Chaining. The MB and MD values obtained from experts in rule 1 are as follows; IF T6 is true AND T7 is true AND T8 is true AND T9 is true AND T10 is true AND THEN P2.

MB Value	MD Value
CFMbcomb1 (CFMBT06, CFMBT07) = CFMBG06 + CFMBG07 x (1 - CFMBG06) = 1.0 + 0.8 * (1 - 0.8) = 1.0 + 0.8 * 0.2 = 1.0 + 0.016 = 1	CFMdcomb1 (CFMDT06, CFMDT07) = CFMDG06 + CFMDG07 x (1 - CFMDG06) = 0.2 + (-0.2 * (1-0.2)) = 0.2 + (-0.2 * 0.8) = 0.2 - 0.16 = 0.04
CFMbcomb2 (CF Mbcomb1, CFMBT08) = 1.0 + 0.6 * (1 - 1.0) = 1.0 + 0.6 * 0 = 1.0 + 0 = 1	CFMdcomb2 (CF Mbcomb1, CFMDT08) = 0.04+ 0.2*(1 - 0.04) = 0.04 + 0.2 * 0.96 = 0.04 + 0.192 = 0.232
CFMbcomb3 (CF Mbcomb2, CFMBT09) = 1.0 + 1.0 *(1 - 1.0) = 1.0 + 1.0 * 0 = 1.0 + 0 = 1	CFMdcomb3 (CF Mbcomb2, CFMDT09) = 0.232 + (-0.2 * 0.768) = 0.232 - 0.1536 = 0.0784
CFMbcomb4 (CF Mbcomb3, CFMBT10) = 1.0 + 0.8 * (1 - 1.0) = 1.0 + 0.8 * 0 = 1.0 + 0	CFMdcomb4 (CF Mbcomb3, CFMDT10) = 0.0784 + 0.1 * (1 - 0.0784) = 0.0784 + 0.09216 = 0.17056

= 1

$$\begin{aligned}
 CF(Rule2) &= MB(H, E) - MD(H, E) \quad (1) \\
 &= CFMBbcomb4 - CFMDcomb4 \\
 &= 1 - 0.17056 \\
 &= 0.82944
 \end{aligned}$$

The CF value that has been found for the Beverly Hotel Batam is 0.82944 or the equivalent of 82.944%.

C. Result and Discussion

The similarity of the certainty value of each 4 star hotel destination in Batam City can be found through manual and system calculations, which are documented in Table 5 as follows:

Table 5. Batam City 4 Star Hotel Data

No	Code	Hotel Destination
1	P1	ASTON Batam Hotel dan Residence
2	P2	Beverly Hotel Batam
3	P3	Da Vienna Boutique Hotel Batam
4	P4	Swiss-Belhotel Batam
5	P5	BWP Panbil (Best Western premier)

Form of Application

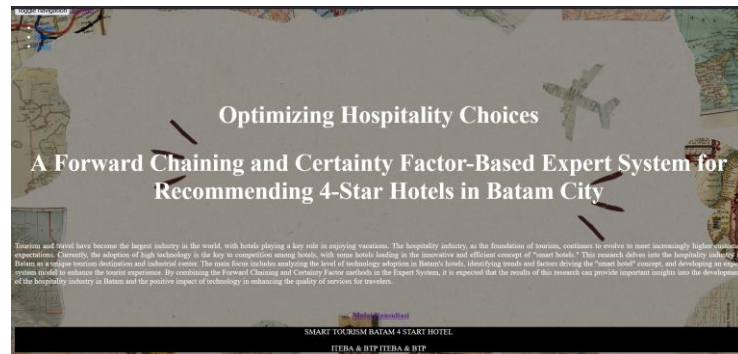


Figure 4. Home display



Figure 5. Registration display

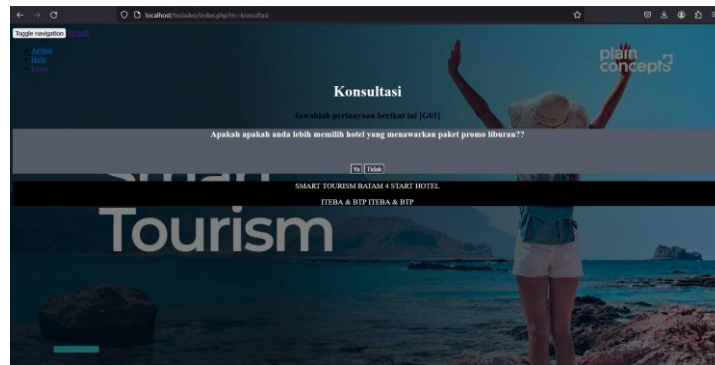


Figure 6. Consultation

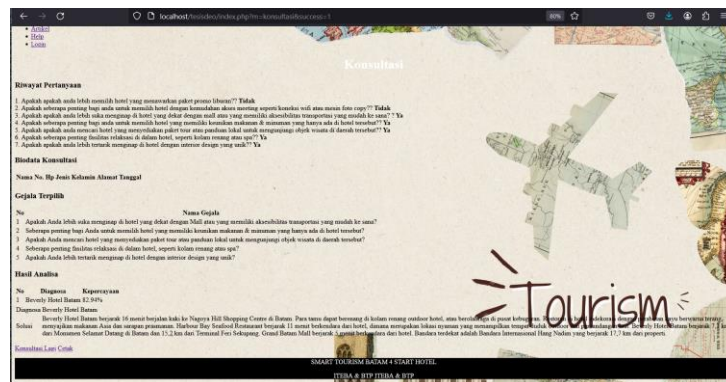


Figure 7. Display of Consultation Results

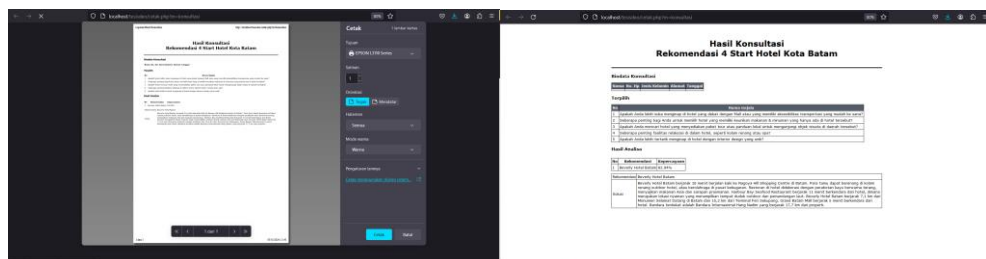


Figure 8. Consultation Report Display

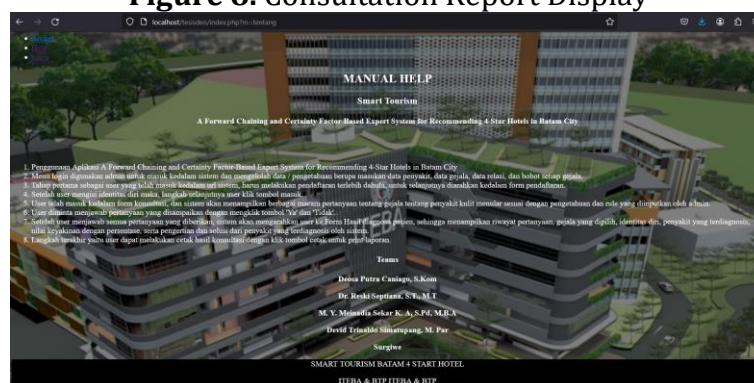


Figure 9. Manual Display

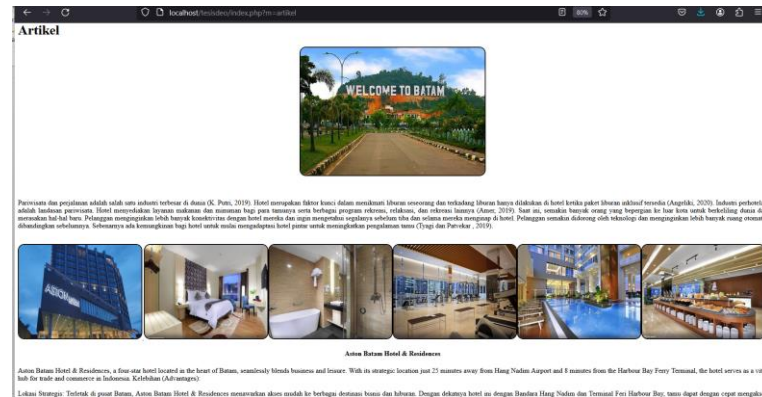


Figure 10. Article display

Results and Discussion Explanation of the accuracy of the designed application, so that it provides appropriate results in direct consultation with a Tourism consultant.

D. Conclusion

This research highlights the importance of applying technology, especially expert systems and smart hotel concepts, in choosing a 4-star hotel that suits your needs in Batam. With a match percentage of 82.94%, this technology provides the best hotel recommendations according to customers' wishes, increasing their satisfaction, and efficiently optimizing time during their visit in Batam. Technology integration not only provides a better stay experience but also provides effective personalized solutions. It is hoped that this step will not only meet customer expectations but also support time efficiency for travelers, making their visit to Batam more satisfying and memorable.

E. Acknowledgment

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