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Classification of tourism business certification institution auditors based on the decision tree algorithm C4.5: case study of LSUP XYZ

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ABSTRACT

Auditors who have appropriate competence are needed to carry out certification. The amount of experience a person has before becoming an Auditor determines the competence possessed by an Auditor. To be assigned to carry out certification, an auditor needs special competencies such as areas of expertise, work experience, and the Schemes and Standards that become the reference for certification. Auditors owned by LSUP need to be classified so that they can be assigned according to their competence. The C4.5 Decision tree algorithm is one of the methods that can be used to create a model used to classify and predict auditor competence. 65 data from 221 data are used as training data to form a model in the form of a tree structure. This model consists of 3 attributes that form a Node in a tree structure, namely the Workplace, Skill and Standard attributes. Each attribute has a value that forms a branch. The model was evaluated using the Confusion Matrix with a matrix size of 7x7 which resulted in a TP value of 99, FP value of 121, FN value of 121, and TN value of 1199. The accuracy level of this model is quite good, namely 84%. But the Precise and Recall values are not very good, only 45%.

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1. INTRODUCTION

The tourism business in Indonesia is growing very fast Along with the increase in tourist arrivals to Indonesia, various accommodation facilities have been developed, including hotels, restaurants, bars and coffee shops. In addition, tourism businesses engaged in providing interesting activities for guests are also being developed. In 2012 there were 13 tourism business sectors in Indonesia (No, 52 C.E.). This refers to the Explanatory Document on Government Regulation No. 52 of 2012 concerning Competency Certification and Business Certification in the Tourism Sector, including the business sector of tourist attraction, the food and beverage service business sector, the accommodation service business sector, the entertainment and recreation activity organizing business sector. , spa business, and others.

To ensure the quality of this tourism business sector, the Ministry of Tourism and Creative Economy carries out competency certification and business certification in the tourism sector. To carry out competency certification and business certification in the tourism sector, the Ministry of Tourism and the creative economy appoints a Professional Certification Agency (LSP) and a Tourism Business Certification Agency (LSUP) (No, 52 C.E.).

The Tourism Business Certification Agency (LSUP) in Indonesia is an institution appointed by the Ministry of Tourism and Creative Economy to carry out business certification in the tourism sector. Before carrying out its duties, LSUP must first be accredited by the National Accreditation Committee (KAN) (Badan et al., 2021). To be accredited by KAN, LSUP management must refer to the conformity assessment document SNI ISO/IEC 17065:2012.

The management of LSUP in Indonesia, which refers to the SNI ISO/IEC 17065:2008 document, regulates the basic requirements needed in the management of LSUP. In Article 6 one of the requirements that must be met by the LSUP is to have Certification Body Personnel. Article 6.1.1.1 states that the LSUP must employ or have adequate personnel to support the operation of the applicable certification scheme and standards. These personnel are referred to as Auditors.

An Auditor must have certain competencies that are relevant to the scheme owned by the LSUP. One of the competencies that must be possessed is having knowledge of the tourism business business which is audited according to the tourism business sector (Badan et al., 2021). Evidence of fulfilling this competency is the auditor's previous work experience. If an auditor has worked in a number of tourism business sectors such as the accommodation sector, food and beverage services, tourist attraction business and tourism area business, this auditor may be assigned to carry out audits in several tourism business sectors.

In order to be able to select and assign the right auditors and have the appropriate competencies, LSUP must be able to classify its auditors into groups of auditors who will be assigned to hotels, villas, hotel apartments, restaurants and other catering services. If the LSUP has many auditors with various experiences in the tourism business, providing accommodation services and food and beverage services, then the LSUP's task of classifying these auditors becomes quite difficult.

This will become more difficult if the LSUP has several schemes with different references, such as a scheme for certification of standards for cleanliness, health, safety and environmental sustainability where tourism activities are organized and supported, known as Standard SNI 9042:2021 . This standard was published after the Covid 19 pandemic occurred in 2020. This standard was implemented with reference to the scheme issued by the Indonesian National Standardization Agency (BSN), namely BSN Regulation No. 24 of 2021 concerning the second amendment to BSN regulation No. 4 of 2020 regarding the conformity assessment scheme for Standards Indonesian national service sector. This scheme has the scope of SNI 9042:2021 related to restaurants/restaurants, hotels, tourist lodges, tourism information centers, tourist attractions, tourism areas and so on. This shows that this scheme also provides an oppor (Amelia & Prasetyo, 2022) tunity for auditors who have experience in the field of accommodation services to be classified into this scheme.

In 2018, BSN through the technical committee 03-09 tourism management formulated the draft Indonesian National Standard (SNI) for the hotel business (Https://bsn.go.id/main/berita/detail/9497/workshop-pengembangan-sni-usaha-hotel-di-yogyakarta, 2018). But until now it has not been published. If this standard is issued later, there will be a new certification scheme that requires auditors who have experience in the accommodation services business.

To assist LSUP in classifying its auditors, it is necessary to develop a model that can be used to classify auditors appropriately. This model can also be used when new

schemes are published, so that the classification of auditors can be done quickly and accurately.

2. RESEARCH METHOD

2.1 Auditor Classification

Auditors are certification personnel whose job is to carry out audits. To be able to carry out audit tasks, an auditor must have adequate competence relevant to the schemes and standards used to carry out audits on clients.

Scheme is a certification system related to a particular product which contains the requirements, rules and procedures applied. Standards or product requirements are requirements that are directly related to the product contained in the form of normative documents .

LSUP is required to have schemes and standards in carrying out business certification in the tourism sector. One of the things explained in the certification scheme is the competence of the auditor. LSUP is required to determine competency criteria for auditors. Currently there are 2 certification schemes that are generally owned by LSUP, namely the tourism business certification scheme for low-medium risk, medium-high risk and high risk and the SNI certification scheme for cleanliness, health, safety and environmental sustainability where tourism activities are organized and supported.

The tourism business certification scheme for medium-low risk, medium-high risk and high-risk must have auditors who have competence, including understanding Law No. 10 of 2009 concerning Tourism, Law No. 11 of 2020 concerning Job Creation, Regulations of the Minister of Tourism and Creative Economy No. 4 of 2020 concerning business activity standards in the implementation of risk-based business licensing in the tourism sector, and Regulation of the Minister of Tourism and Creative Economy No. 18 of 2021.

In addition, an auditor must understand several ISO documents, including understanding ISO 9001 on Quality Management Systems, ISO/IEC 17065:2012 on conformity assessment requirements for product, process and service certification bodies, and SNI ISO/IEC 19011 on Management system audit guidelines. To support performance when carrying out an Audit, the Auditor must also have specific knowledge related to knowledge requirements regarding HACCP, GMP, SMK3 and/or other systems in accordance with the scope of certification, and have knowledge of the tourism business being audited according to the tourism business sector.

Table 1. Auditor competency comparison

Auditor Competency	PBSN 24 of 2021	Permenparekraf No 18 of 2021
Product, Process or Service Standards/Requirements	knowledge of the requirements of SNI 9042:2021 concerning cleanliness, health, safety and environmental sustainability, understanding of relevant management systems, understanding and/or experience of the service business sector or venues for organizing and supporting tourism activities in accordance with the scope of the certificate	understanding of law No. 10 of 2009 concerning Tourism, law No. 11 of 2020 concerning work copyright, knowledge requirements regarding HACCP, GMP, SMK3 and/or other systems in accordance with the scope of certification, and having knowledge of the audited tourism business according to the tourism business sector. regulation of the Minister of tourism and creative economy no 4 of 2020 concerning business activity standards in the implementation of risk-based business licensing in the tourism sector,

Auditor Competency	PBSN 24 of 2021	Permenparekraf No 18 of 2021
Certification Scheme	understanding of the certification processes and procedures set by LSUP (Referring to PBSN No 24 of 2021)	and Regulation of the Minister of Tourism and Creative Economy No 18 of 2021
Understanding of Management Systems and tourism business products	understanding and/or experience of the service business sector or the venue for organizing and supporting tourism activities in accordance with the scope of the certificate[6].	have knowledge of the tourism business that is audited according to the tourism business sector.
		knowledge requirements regarding HACCP, GMP, SMK3 and/or other systems in accordance with the scope of certification,
LSUP Management System	understanding of relevant management systems,	ISO includes the understanding of ISO 9001 on Quality Management Systems
	understanding of SNI ISO/IEC 17065	ISO/IEC 17065:2012 concerning conformity assessment requirements for product, process and service certification bodies,
Audit understanding and skills	SNI ISO/IEC 19011 concerning Guidelines for management system audits.	SNI ISO/IEC 19011 concerning Guidelines for management system audits.

The SNI certification scheme for cleanliness, health, safety and environmental sustainability in places where tourism activities are held and supporting activities requires that LSUP have auditors with competence in understanding SNI ISO/IEC 17065, understanding of the process and certification procedures set by LSUP, understanding and experience of principles, practices and Audit techniques in accordance with SNI ISO 19011, knowledge of the requirements of SNI 9042:2021 regarding cleanliness, health, safety and environmental sustainability, understanding of relevant management systems, understanding and/or experience of the service business sector or venues for organizing and supporting tourism activities in accordance with the scope of certified.

If the auditor competencies for these schemes are compared, it can be concluded that an auditor must have an understanding of the requirements for product, process or service certification bodies, have an understanding of the certification schemes and standards to be used, have understanding and ability to carry out audits, and understand management systems. and understand the tourism business to be certified. The results of this comparison can be seen in table 1.

Table 1 above shows that auditor competence is categorized into 2, namely general competence and special competence. General competencies are competencies that must be owned by the auditor regardless of the certification scheme and standards used in carrying out the certification. Specific Competences are competencies that are relevant to the management system and products of the tourism business to be certified. This shows that the classification of Auditors can be done by looking at the special competencies possessed by Auditors.

An auditor who has a lot of experience in the field of tourism business such as the field of business providing accommodation will have the opportunity to audit several tourism businesses such as hotel businesses, villas, hotel apartments (Kemenparekraf,

2021). Likewise an auditor who has a lot of experience in the food and beverage service business. They have the opportunity to audit restaurants, catering services, hotels and villas. This is because hotel and villa services also have restaurants or catering services to support hotel and villa operations (Kemenparekraf, 2021). Therefore LSUP requires an auditor who has experience in the food and beverage service business to audit the hotel and villa business. The more experience in the field of tourism business, the auditor can be classified into many groups.

2.2 DecisionTree

Decision tree became known in 1960, is one of the best classification methods for classifying data (Jijo & Abdulazeez, 2021) and also a very effective method in data mining (Song & Ying, 2015). The decision tree method is widely used in classifying data in the medical field (Yang et al., 2018)(Haik et al., 2020), Health (Chern et al., 2019)(Duan et al., 2021), agriculture (Nurkholis et al., 2021) (Munandar, 2018), Education (Jia & Pang, 2018)(Križanić, 2020), as well as the economic sector (Lee et al., 2022).

The Decision tree method is generally used to classify a number of data consisting of many records. Data consisting of many records is analyzed in such a way as to produce a tree structure consisting of nodes and branches (Irena & Setiawan, 2020). The node shows the selected attribute while each branch shows the value of that attribute.

The nodes in the decision tree structure consist of root nodes or decision nodes that describe attribute choices that divide data records into several different groups. In addition to the root node, the decision tree has internal nodes and leaf nodes. Internal nodes are the selected attributes or categories and leaf nodes are the output of the tree structure (Song & Ying, 2015). The nodes in the decision tree are determined by calculating entropy and information gain.

$$Entropy\ (X) = \sum_{j=1}^{k} p_j * \log_2 \frac{1}{p_j} = -\sum_{j=1}^{k} p_j * \log_2 p_j \quad (1)$$

Where :
X : attribute or category to be calculated
K : the number of members of X
Pj : Xj's portion of X

Entropy is a parameter to measure the irregularity of the sample data. The entropy value will be greater if the sample data is more diverse (Hasanah et al., 2020). The entropy value is calculated using a mathematical equation as shown in Equation 1. Apart from entropy, information gain is another important factor in determining nodes. Information gain is a measure for information segmentation (Jijo & Abdulazeez, 2021). Information gain can be calculated with a mathematical equation as shown in equation.

$$Gain\ (X, A) = Entropy(X) - \sum_{j=1}^{k} \frac{|X_i|}{X} * Entropy\ (X_i) \quad (2)$$

Where
X : is the target attribute
A : predictor attribute
K : the number of members of X

There are various types of decision tree algorithms for building tree structures, including the Iterative Dichotomizer 3 (ID3) algorithm (Yang et al., 2018), algorithm C4.5 (Sadiq & Ahmed, 2019), Classification and Regression tree (CART) algorithm (F. Zhu et al., 2018), algorithm (CHAID) (Saeed et al., 2020). One of the commonly used decision tree algorithms is the ID3 algorithm. This algorithm is used for general classification. This algorithm has been developed into other algorithms such as the C4.5 algorithm

which is a refinement of the ID3 algorithm. ID3 uses information gain to determine which attributes are selected as (L. Zhu & Yang, 2017), but C4.5 uses the Gain Ratio to determine which attribute to choose as a node.

$$Gain\ ratio\ (X, A) = \frac{Gain\ (X,A)}{SplitInfo\ (X,A)} \quad (3)$$

Equation 3 shows the mathematical equation used to calculate the Gain Ratio. The gain ratio is a modification of the information gain to reduce unnecessary branches from the tree structure (Irena & Setiawan, 2020). The Gain ratio calculation uses the information gain value divided by the split information value. The split information value shows the entropy by class. Split information shows irregularities between one class and another class (Hasanah et al., 2020). Equation 4 shows the mathematical equation for calculating split information.

$$SplitInfo(X, A) = -\sum_{j=1}^{k} \frac{|X_i|}{X} * \log_2 \left(\frac{|X_i|}{|X|}\right) \quad (4)$$

From the explanation above, it can be concluded that C4.5 uses 4 mathematical equations to determine which attributes are selected as nodes. The value used to determine the value is the value of the gain ratio which is calculated using equation 3. To calculate the Gain Ratio, the Gain value and the value of Split Information are needed. The Gain value is calculated by equation 2 and the split information value is calculated from equation 4.

2.3 Research Method

This study develops a tree structure to classify auditors. Auditors to be classified are auditors who have experience in the business of providing accommodation services and food and beverage services. This is because Auditors who have experience in the business sector of providing accommodation and food and beverage services can carry out certification for various types of Accreditation Schemes with reference to more than 5 tourism business standards.

The stages in this study began with data collection, followed by data pre-processing, setting training data, analyzing data with the C4.5 algorithm, building tree structures, evaluating models with data. Figure 1 shows the stages in this study.

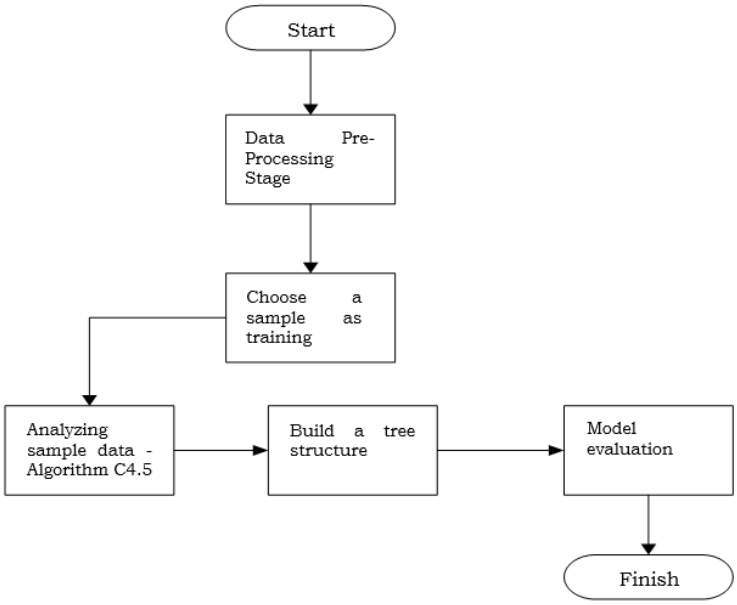

Figure 1. Research stages

Data was obtained from several auditors who carried out their duties at LSUP XYZ through the Auditor's personal data stored by LSUP. Data is processed with the C4.5 algorithm to form a tree structure. To create a tree structure, nodes and branches are needed. The node will be formed from the attribute while the branch will be formed from the possible values of the attribute. The attributes to be used are taken from the special competencies that must be possessed by the auditor, including Schemes and standards (Standards), work experience related to the tourism business sector (Workplace), and technical competence possessed by the auditor (Skills) related to the business sector. Table 2 shows the attributes of the data and the possible values.

Table 2. Attributes and attribute values

Attributes	Mark
Standard (SCST)	CHSE, PP04
Workplace (WP)	Hotel(HTL), Restaurant(RST), Villa(VLA)
skills	Housekeeping(HK), Front Office(FO), Management System(MNJ), Food Beverage Service(FBS), Food Beverage Product(FBP)
output	CHSE_RST, CHSE_HTL, CHSE_PW, RSK_HTL, RSK_VLA, RSK_RST, RSK_BAR

The standard attribute has 2 possible values, the workplace attribute has 3 possible values and the Skill attribute has 5 possible values. In addition to attributes and attribute values, a decision tree also requires output to be used as a leaf node. The output value is taken from the type of certification that can be carried out by an auditor.

Based on the scheme and standards used by LSUP, namely the certification scheme based on PBSN No. 24 of 2021 which is equivalent to the SNI Standard 9024: 2021 concerning CHSE and the certification scheme based on Permenparekraf No. 18 of 2021 which is equivalent to the Permenparekraf Standard No. 4 of 2021 concerning standards for business activities in implementation of risk-based business licensing in the tourism sector. The CHSE standard allows auditors to carry out CHSE standard certification for Hotels (CHSE_HTL) and CHSE for Pondok Wisata (CHSE_PW) and CHSE for Restaurants or restaurants (CHSE_RST). The risk-based business activity standard

enables the auditor to carry out risk-based business standard certification for Hotel(RSK_HTL), Villa(RSK_VLA), Bar(RSK_BAR), and Restaurant(RSK_RST).

The tree structure generated by Algorithm C4.5 needs to be evaluated to ensure the model in the form of a tree structure is an accurate method for classifying auditors. One of the methods used to evaluate the model is the Confusion matrix (Irena & Setiawan, 2020)(Tangirala, 2020).

*Confusion matrix*is the method used to calculate the accuracy of the model that has been made in the process of building a decision tree. This method provides a detailed description of the results of the evaluation by stating correct predictions or incorrect predictions for each group made. The right or wrong prediction is measured by comparing the predicted results with the actual value. There are 4 possible values from the confusion matrix, including True Positive, True Negative, False Positive and False Negative. Table 3 shows the table of the Confusion matrix

.

Table 3. Confusion matrix actual values

		Positives (1)	Negatives (0)
Predicted Values	Positive(1)	TP	FP
	Negatives(0)	FN	TN

A true positive value will be generated if the predicted value is correct according to the actual true value. A False Positive value will be generated if the predicted value is correct while the actual value is wrong. False negative values will be generated if the predicted value is wrong while the actual value is correct. A True Negative value will be generated if the predicted value is wrong according to the actual value is wrong.

After evaluation, the confusion matrix will show certain values that refer to the amount of data that is categorized as TP, FP, FN, or TN. This value will be used to determine accuracy (Accuracy), precision (Precision), sensitivity (recall or Sensitivity) (Tangirala, 2020). Accuracy is calculated by dividing the TP value which is added up to the TN value by the sum of all the TP, TN, FP, FN values. The mathematical equation is as in equation 5. The accuracy value indicates how accurate the model is in the form of a tree structure for classifying LSUP auditors.

$$Accuracy = \frac{TP + TN}{TP + FP + TN + FN} \quad (5)$$

The Precision value is used to describe the level of accuracy of the actual data with the predicted results. Precision is calculated by dividing the TP value by the sum of the TP and FP values. The mathematical equation used to calculate Precision is shown in equation 6.

$$Precision = \frac{TP}{TP + FP} \quad (6)$$

Apart from calculating accuracy and precision, the values in the confusion matrix are also used to calculate the sensitivity of the model in the form of a tree structure. This value describes the success of the model to recover the information that has been used to build the model. Equation 7 shows the mathematical equation used to calculate sensitivity.

$$Recall = \frac{TP}{TP + FN} \quad (7)$$

3. RESULTS AND DISCUSSIONS

Based on Auditor data owned by LSUP XYZ, there are 221 data that can be collected. These 221 pieces of data will be used to create a model in the form of a tree structure to classify LSUP Auditors. 30% of them are used as training data. 65 pieces of data are used as training. Selection of the root for the decision tree is done by calculating the Gain Ratio for each attribute. Calculation of entropy, information gain, split info and gain ratio for each attribute is shown in table 4. The attribute with the highest gain ratio value is the Standard attribute (ST), namely Gain(ST) = 1. This means that the root of the decision tree is standard attribute.

Table 4. Entropy value, information gain and gain ratio

Attributes	Entropy	Gain Information	Split Info	Gain Ratio
Iteration 1				
Workplace(WP)	2.35227	0.235621	1.45133	0.16234
Skills	2.20569	0.3822	1.782856	0.21437
Standard(ST)	1.59627	0.991618	0.991518	1
Iteration 2				
CHSE-WP	1.318224	0.121645	1.35843	0.08954
CHSE-Skills	0.75660	0.693265	0.96525	0.71821
PP04-WP	1.52378	0.198484	1.5	0.13232
PP04-Skills	0.57944	1.142827	1.240341	0.921381

In the second iteration, the CHSE-SKILL gain ratio is greater than the CHSE-WP gain ratio. Likewise, the gain ratio for PP04-SKILL is greater than the gain ratio for PP04-WP, so that the resulting tree structure image is as shown in Figure 2.

*Root*sof the tree structure is the ST attribute. The CHSE branch has an internal SKILL node because the GainRatio (CHSE,SKILL) value is greater than the GainRatio(CHSE,WP) which is 0.71821 compared to 0.08954. On the PP04 branch, the internal nodes that follow this branch are the SKILL attribute, where the GainRatio (PP04,SKILL) is greater than the GainRatio (PP04,WP) which is 0.921381 compared to 0.13232. Automatically, the WP Attribute will be the last internal node before the leaf node.

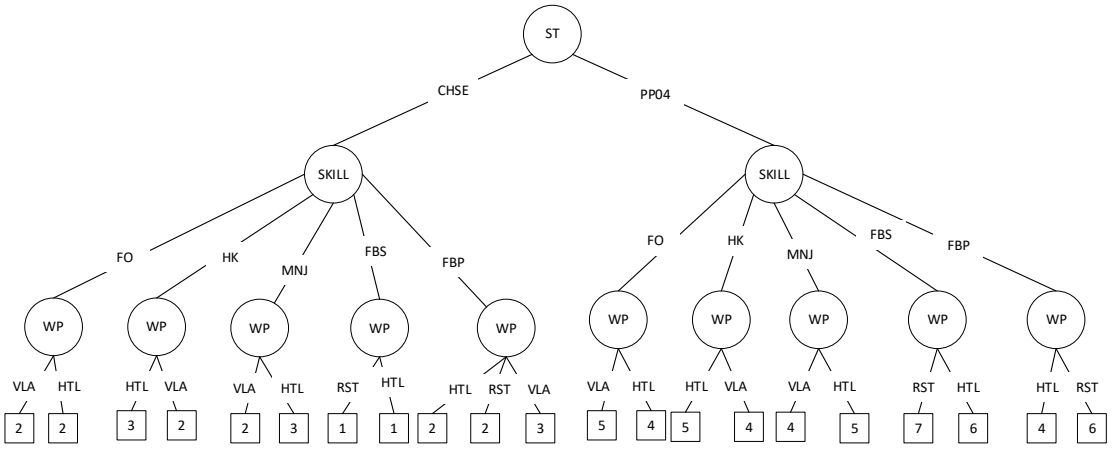

Figure 2. Tree structure

This structure is then evaluated using all existing data using a 7X7 matrix. The results of the evaluation are entered into the Confusion matrix as shown in the table 5. The confusion matrix in this table shows that the TP value is 99, the FP value is 121, the FN value is 121 and the TN value is 1199.

Table 5. Evaluation Results in the Confusion Matrix Actual values

Predicted Values	Positives (1)	Negatives(0)
Positive(1)	99	121
Negatives(0)	121	1199

To evaluate the tree structure, there are 3 equations used, namely accuracy, precision, and recall. The following is the equation for calculating accuracy, precision and recall. Accuracy value is 84.29%. This value means that if this model is used on 100 new data, then there will be 84 data that will be correctly predicted by this model. This shows that the model that has been made is accurate enough to classify LSUP Auditors in LSUP XYZ.

But when viewed from the Precision value, the value does not reach 50%. The Precision value obtained is 45%. This value indicates that 45% of the Auditors are indeed assigned to carry out the certification as the results predicted by the model.

$$Accuracy = \frac{99 + 1199}{99 + 121 + 1199 + 121} = 84.29\% \quad (8)$$

Likewise with the Recall value. The recall value is quite low, namely 0.45 or 45%. This value indicates the success of the model in retrieving information in the data is only 45%. The small Precision and Recall values can be caused by the selection of data for training data that is not good, so that the formed model cannot optimally produce accurate predictions.

$$Precision = \frac{99}{99 + 121} = 0.45 \quad (9)$$

$$Recall = \frac{99}{99+121} = 0.45 \quad (10)$$

One of the weaknesses of the decision tree is the dependence of the model on training data. If the training data undergoes a slight change, the tree structure may change. The small values of Precision and Recall are also due to the insufficient data analyzed to form a tree structure model. In addition, you can consider using other algorithms besides the C4.5 algorithm, such as CART or CHAID to produce a more reliable model.

4. CONCLUSION

Based on the description above, it can be concluded that the resulting model is accurate enough to predict the next Auditor data. This can be seen from the Accuracy value of this model, which is 84%. However, with a small Precision and Recall value of only 45%, this model still needs to be improved to produce better and more accurate predictions. To produce a better model, for further research it is necessary to add data so that the amount of training data is greater, and can produce a better model. Not only that, because research only predicts using the C4.5 algorithm approach, it is hoped that

future research can compare two or more prediction methods to find out which approach is the most appropriate for the related research topic.

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