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EXPERT SYSTEM DEVELOPMENT TO IDENTIFY EMPLOYEE PERSONALITY TYPES USING DEMPSTER SHAFER THEORY

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Abstrak

Sumber daya manuisa menjadi aset penting bagi perusahaan untuk berkembang dan mewujudkan cita-cita perusahaan. Salah satu usaha untuk mengoptimalkan kapasitas karyawan adalah dengan mengetahui kepribadiannya. Kepribadian merupakan bentuk yang dimiliki seseorang individu dalam bertingkahlaku dan segala watak yang membedakan antara seorang individu yang satu dengan seorang individu lainnya. Mengetahui kepribadian karyawan menjadi suatu hal yang penting bagi perusahaan dan karyawan itu sendiri. Karena dengan mengetahui kepribadian seseorang perusahaan dapat dapat memaksimalkan potensi karyawan dan dapat menepatkan posisi tertentu yang sesuai dengan kepribadian karyawan. Penelitian ini bertujuan untuk mengimplementasikani dempster-shafer theory pada mesin inferensi dalam membangun sistem pakar untuk mengidentifikasi tipe kepribadian karyawan. Dempster-shafer theory dapat melakukan perhitungan probabilitas sehingga dapat dilakukan pembuktian berdasarkan tingkat kepercayaan dan penalaran yang logis. Sistem yang dikembangkan mampu mengidentifikasi tipe kepribadian karyawan melalui sifat atau gejala yang ada pada diri karyawan. Selain itu, sistem dapat menampilkan hasil diagnosis dengan penjelasan tentang tipe kepribadian, sifatnya dalam pekerjaan dan pekerjaan atau posisi yang cocok untuk tipe kepribadian tersebut. Berdasarkan hasil uji akurasi yang diperoleh dari hasil perbandingan diagnosa sistem pakar dengan analisis seorang pakar menunjukkan nilai akurasi mencapai 85%.

Kata kunci: dempster-shafer theory; sistem pakar; mesin inferensi; tipe kepribadian

Abstract

Human resources are an essential asset for the company to develop and realize the company's goals. One of the efforts to optimize the capacity of employees is to know their personality. Personality is the form an individual possesses in behaving and all the characteristics that distinguish one individual from another. Understanding employees' personality is essential for the company and the employees themselves. Because by knowing a person's personality, the company can maximize the potential of employees and place certain positions that suit the employee's personality. This study aims to implement the dempster-Shafer theory on an inference engine in building an expert system to identify employee personality types. Dempster-Shafer's approach can perform probability calculations so that evidence can be carried out based on confidence and logical reasoning. The system developed can identify the employee's personality type through the nature or symptoms that exist in the employee. In addition, the system can display the diagnosis results with an explanation of the personality type, its character in work and occupations or positions suitable for that personality type. Based on the results of the accuracy-test obtained from the comparison of expert system diagnoses with the analysis of an expert, the accuracy value reaches 85%.

Keywords: dempster-Shafer theory; expert system; inference engine; personality type

INTRODUCTION

Human resources are one of the most important elements for a company or organization to run well. Where human resources have a significant influence on the success of achieving goals in order to realize the company's vision and mission. Today, many companies have viewed human resources not only as resources but rather as valuable capital or assets that must be cared for and maintained for development (Zulkarnaen, 2018). One of the developments of human resources is knowing each employee's personality. The reason is that each employee has various

psychological behaviours that must be processed to achieve company goals. Personality is the form an individual possesses in behaving and all the characteristics that distinguish one individual from another (Sya'baniah et al., 2019). Personality is something that someone needs to know so that everyone can develop the potential that exists in each individual (Darmansah et al., 2021). Human personality types have been studied and summarized into 4 (four) types. The four types are included in the proto-psychological theory. This theory was first discovered in the century BC by Hippocrates, then by Galen was developed into a medical approach. According to this theory, human personality is grouped into four categories: choleric, sanguine, phlegmatic, and melancholic. Knowing employees' personalities is essential for the company and the employees themselves. Because by knowing a person's personality, the company can place certain positions that are appropriate and can maximize the potential of employees. To find out a person's personality type, you can use technology such as an expert system.

Expert system is a sub-field of artificial intelligence that can manage and draw conclusions based on specific rules obtained from knowledge (Borman et al., 2020). Expert systems are also called knowledge-based systems, and this is because the expert system provides a collection of knowledge obtained from an expert and the required knowledge sources (Putri, 2018). The purpose of developing an expert system is to build a system that can ease human work, especially those related to the use of the ability and experience of an expert (Sucipto et al., 2019). One of the inference engine methods in expert systems that can overcome uncertainty is the dempster-Shafer theory. The dempster-Shafer idea comes up with an approach to calculating probabilities so that proof can be done based on the level of belief and logical reasoning so that it can be used in combining information (evidence) (Rahmanita et al., 2019).

Several studies have shown that the dempster-Shafer theory can reasonably produce expert systems. Research the expert system used to diagnose gastric disease using the dumpster-Shafer algorithm (Ardiansyah et al., 2019). In this study, the dempster Shafer produced a system based on the confidence function with an accuracy of 95%. Further research, developing a system that can diagnose human skin diseases using the Dempster-Shafer algorithm (MZ et al., 2020). In this study, the expert system developed for each symptom has a confidence value used to calculate the density that results in conclusions. Based on the accuracy test, it produces a discount of 90%.

Meanwhile, the Mean Opinion Score (MOS) test resulted in a MOS size of 4.35, which means the system has a good feasibility level. Furthermore, research on developing an expert system for diagnosing oral cancer shows that the Dempster-Shafer algorithm can overcome the uncertainty in constructing an inference engine. It is indicated by the results of the accuracy test of 86.6% (Napianto et al., 2018).

This study aims to implement the dempster-Shafer theory on the inference engine in building an expert system to identify the employee personality type. An expert system is built based on a website to make it easier for users to use the system. The system can recognize personality types based on symptoms or a person's character. The system also includes an explanation of the personality type, its nature in the job, and the job or position that is suitable for that personality type.

RESEARCH METHODS

Research needs to be arranged in stages so that the research carried out is by the objectives to be achieved. The locations of research carried out in this study are presented in Figure 1.

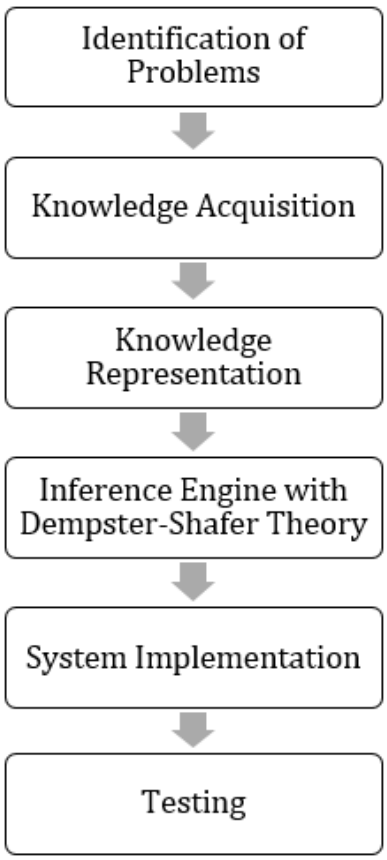

Figure 1. Research Stages

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Identification of problems

The first step is identifying the main problem to get the right solution. The output of this stage is a statement of the problem to be solved. The situation in the world of work that is often experienced is the inaccuracy of a person's position or job with his personality. It results in not working optimally. So we need a system that can identify a person's personality type to suit his career.

Knowledge Acquisition

Expert systems are also known as knowledge-based systems, so they cannot be separated from the collection of knowledge from experts or experts. To get an understanding from an expert, a knowledge acquisition stage is needed. Knowledge acquisition is the process of extracting, structuring, and organizing knowledge from knowledge sources, so that knowledge can become a knowledge base that is the basis for decisions in expert systems (Anita et al., 2019). The output of this stage is knowledge in the form of symptom data, personality type data, and diagnostic rules. This study was obtained through interviews and gathering sources of knowledge through books to get the required data, such as data on symptoms, personality types, and the level of confidence for each sign and personality type. The data was obtained from the results of consultations with experts or experts, namely a psychologist. From the results of interviews with psychologists and collecting data from books, he got 4 (four) personality types with 30 characters or symptoms. The personality type used is based on Hippocratic Theory and developed by Galen. According to this theory, human personality is grouped into four categories: Choleric, Sanguine, Phlegmatic, and Melancholic.

Knowledge Representation

The next stage is knowledge representation, where the results obtained in knowledge acquisition will be organized regularly to encode expert knowledge into appropriate media forms. Knowledge representation is vital in developing expert systems because a good solution will also depend on a good word. If the knowledge representation is not made correctly, the impact will affect the next stage, and the resulting system is not as desired (Nasution & Khairuna, 2017). From the knowledge acquisition process, knowledge is obtained that will be used as a knowledge base, then knowledge representation is carried out using a decision table, and rules are made based on the understanding that has been obtained from experts, which will later be used to build an inference engine.

Inference Engine

The inference engine can be said to be part of an expert system that carries out a reasoning function that utilizes rules with specific patterns (Annisa, 2018). The inference engine will perform a search based on the rules in the knowledge base, which results from the conclusion in the form of a solution that suits your needs. In this study, the inference engine used is the dempster-Shafer theory. Dempster-Shafer's approach performs probability calculations to obtain evidence based on the level of belief and logical reasoning because later, it will be used to combine evidence to get firm conclusions.

Dempster-Shafer's theory generally uses the [Belief, Plausibility] format. Bel (Belief) is a measure of evidence's ability to support a condition (Rahmanita et al., 2019). If belief has a value of 0, then the indication is that there is no evidence. On the contrary, there is a certainty if it has a value of 1. The belief function can be denoted by equation (1).

$$Bel(X) = \sum_{\subset X} m(Y) \quad \text{.....(1)}$$

Where *Bel* (*X*) is a belief of (*X*), while m (*Y*) is a mass function of (*Y*), plausibility (*Pls*) is denoted in equation (2) below.

$$Pls(X) = 1 - Bel(X') = 1 - \sum_{Y \subset X}^{n} m(X') \quad \text{.....(2)}$$

Bel(*X*) is a belief of (*X*), while m is a mass function. Pls(*X*) is the plausibility of (*X*). Plausibility can have a value between 0 to 1, if there is belief in *X*′ then Belief (*X*′) = 1 which results in the result *Pls*(*X*) = 0. Table 1 below is the possibilities that occur between belief and plausibility.

Table 1. Possible Bell and Pls Ranges

Certainty	Description
[1, 1]	All true
[0, 0]	All wrong
[0, 1]	Uncertainty
[Bel, 1] where 0< Bel<1	Tendency of support
[0, Pls] where 0<Pls<1	Tendency to reject
[Bel, Pls] where 0< Bel≤Pls<1	The tendency to support and rejection

In fact, in the expert system, some elements describe the possibility of the user's answers, but adjustments are needed. This possibility in dempster-Shafer theory is called a power set denoted P, so it becomes equation (3) below.

$$m = P(\theta) \quad \text{.....(3)}$$

Based on equation (3), m is the mass function, and $P(\theta)$ is the power set. Mass function (m) in dempster-Shafer theory is the level of confidence in the number of correct answers (evidence) or known as evidence measure with the notation (m) if there is hypothetical information so that m{θ} = 1- (m) and if there is no information, then m{θ} = 1.0.

In an expert system, it is possible to have a large amount of evidence that can be used in the uncertainty factor to make a decision. For this evidence to be resolved, the dempster-Shafer theory uses rules with the term dempster's rule of combination. The combination between m_1 and m_2 can be denoted by equation (4) below.

$$m_1 \oplus m_2(Z) = \sum_{X \cap Y = Z} m_1(X) m_2(Y) \quad \text{.....(4)}$$

Where $m_1 \oplus m_2(Z)$ is the mass function of the evidence, $m_1(X)$ is the mass function of the evidence (X), $m_2(Y)$ is the mass function of the evidence (Y), and $\oplus$ is the direct sum operator. The following equation (5) is to calculate the dempster's rule of combination.

$$m_1 \oplus m_2(Z) = \frac{\sum_{X \cap Y = Z} m_1(X) m_2(Y)}{1 - k} \quad \text{.....(5)}$$

From this equation, k is the number of evidential conflicts, the value of toral k can use equation (6) below.

$$k = \sum_{X \cap Y = \theta} m_1(X) m_2(Y) \quad \text{.....(6)}$$

$m_1 \oplus m_2$ is a combination of m_1 and m_2, so it becomes m_3. So, if the formulation in formula (5) is entered into formulation (6), then for m_3 it can be formulated by equation (7) below.

$$m_3(Z) = \frac{\sum_{X \cap Y = Z} m_1(X) m_2(Y)}{1 - \sum_{X \cap Y = \theta} m_1(X) m_2(Y)} \quad \text{.....(7)}$$

Implementasi Sistem

This stage is the stage of making the system through coding to be realized into an expert system (Monica & Borman, 2017). At this stage the inference engine that has been built using the dempster-shafer algorithm is then implemented into a website-based system using PHP through a text editor, namely Sublime Text 3 and a MySQL database..

Testing

The next stage is the testing stage, where the system will be tested for its performance. At this stage, the accuracy of the dempster-shafer approach will be tested on an expert system for diagnosing mental disorders. At this stage the success rate of the developed method is tested using an accuracy test. The level of accuracy is used in order to know the closeness of the test results or the average test results to the actual value (Herdiansah et al., 2022). So, the output of this stage is in the form of accuracy test results. The calculation of diagnostic accuracy is obtained from comparing the results of the system diagnosis and the diagnosis of an expert with random cases and the number of cases that have been determined. The following equation (8) is the formula used to calculate the accuracy:

$$Accuracy = \frac{\text{Number of Correct Diagnosis}}{\text{Total Test Data}} \times 100\% \quad \text{.....(8)}$$

RESULTS AND DISCUSSION

To build an expert system for identifying employee personality types with the dempster-shafer theory algorithm. Dempster-Shafer theory performs probability calculations to obtain evidence based on the function of belief and reasoning, which then functions to combine information (evidence). The following is a case study of calculations using the Dempster-Shafer theory method of diagnosing mental disorders with symptoms including:

1) Likes work to be done privately or alone.
2) Have an innovative and creative mind.
3) Have a strong will and always succeed in achieving the predetermined target.

Then the solution is as follows:

Symptom 1 (G1): Likes work to be done personally or alone. The density value for G1 which has been determined by the expert is 0.8. G1 is a symptom of Melancholic personality type (P1).

m1 { P1} = 0.8

m1 {θ}= 1-0.8 = 0.2

Symptom 2 (G2): Have an innovative and creative mind. The density value for G2 which has been determined by the expert is 0.4. G2 is a Melancholic and Sanguine personality type (P1, P2).

m2 { P1, P2} = 0.4
m2 { θ }= 1-0,4 = 0.6

From the results of the density values obtained from G1 and G2, it can be calculated the combined density value of the two, through the table of the density combination rules using equation (7) which was previously discussed. The results of the combination are then used as the basis for calculating the value of new symptoms. Table 2 below is a combination of m_1 and m_2 into m_3.

Table 2. Combination Rules For m3

		{P1, P2}	(0.4)	θ	(0.6)
{P1}	(0.8)	{P1}	(0.32)	{P1}	(0.48)
θ	(0.2)	{P1, P2}	(0.08)	θ	(0.12)

Berdasarkan persamaan (7) maka kombinasi dari $m_3$adalah:

m3 {P1,P2} $= \frac{0.08}{1-0} = 0.08$

m3 {P1} $= \frac{0.32+0.48}{1-0} = 0.6$

m3 {θ} $= \frac{0.12}{1-0} = 0.12$

Symptom 3 (G3): Have a strong will and always succeed in achieving the predetermined targets. The density value for G3 which has been determined by the expert is 0.6. G2 is a symptom of Melancholic, Sanguine and Choleric personality types (P1, P2, P3).

m1 { P1, P2, P3} = 0.6
m1 { θ }= 1-0.8 = 0.4

From the results of these combinations, then it becomes the basis for calculating the value of new symptoms. The following table 3 is a combination of m_3 and m_4 into m_5.

Table 3. Combination Rules For m_5

		{P1, P2, P3}	(0.6)	θ	(0.4)
{P1,P2}	(0.08)	{P1, P2}	(0.048)	{P1, P2}	(0.032)
{P1}	(0.6)	{P1}	(0.36)	{P1}	(0.24)
θ	(0.12)	{P1, P2, P3}	(0.072)	θ	(0.048)

Based on equation (7) the combination of m_5 is:

m5 { P1,P2 } $= \frac{0.048+0.032}{1-0} = 0.08$

m5 {P1,P2,P3} $= \frac{0.072}{1-0} = 0,072$

m5 {P1} $= \frac{0.36+0.24}{1-0} = 0,6$

m5 { θ } $= \frac{0,048}{1-0} = 0,048$

Because there are no more new symptoms, it can be concluded that the highest score is the Melancholic personality type (P1) with a value of 0.6 or if it is converted into a percentage, it becomes 60%.

The next step after the inference engine is built, then realized in the form of an expert system. At this stage, the coding will be based on the results of analysis and design using a particular programming language in order to produce a system that can be used by users. The expert system application that is built has functional requirements, including: the system can manage symptom data, personality type data, knowledge representation, diagnose personality types and see results and explanations of personality types. Figure 2 below is the interface of the main menu of the employee personality type identification system.

Figure 2. Main Menu Interface

In this application, the user can choose the symptoms or character of the employee whose personality will be identified. Figure 3 below is an interface for diagnosing employee personality types.

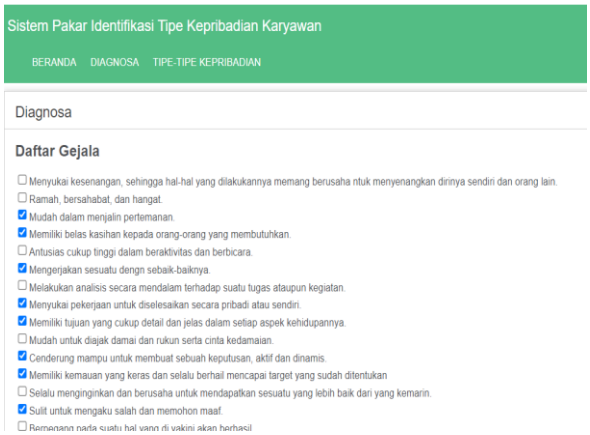

Figure 3. Diagnostic Interface

After selecting the symptom or character of a person whose personality will be identified, the next system will display the results of the diagnosis and the density value generated by the Dempster-Shafer algorithm. After that, the user will be shown an explanation of the personality type of the diagnosis. Figure 4 below is the result of the diagnosis and explanation.

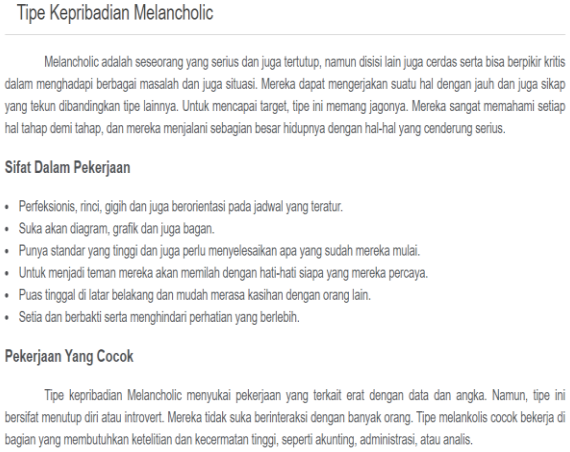

Figure 4. Diagnostic Results Interface Equipped with Explanations

Furthermore, after the application is implemented, testing is carried out on the application. The test uses an accuracy test, through a comparison of the results of an expert system diagnosis with the results of an expert's analysis. The test data used were 20 test cases with random symptoms, then diagnosed by experts and expert systems. Of the 20 test cases, the system was able to correctly diagnose 17 cases. If these results are included in equation (8), then the resulting accuracy rate is 85%. The graph of the accuracy test results can be seen in Figure 5.

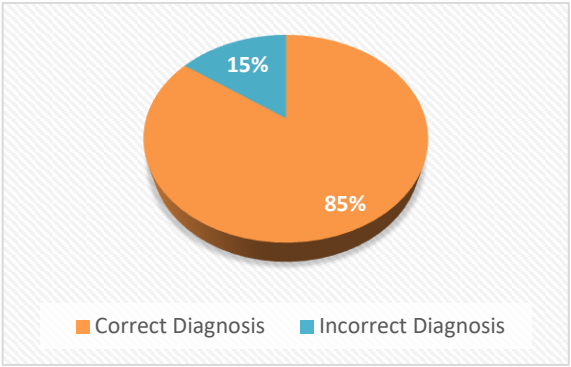

Figure 5. Chart of Accuracy Test Results

Furthermore, the accuracy results are converted using accuracy criteria guided by the following criteria: Good, namely 76% to 100%; Enough, that is 56% to 75%; Less Good, which is 40% to 55%, and Less Good, which is less than 40% (Mayatopani et al., 2021). The accuracy of the dempster-shafer theory algorithm is 85%. So that the accuracy generated in the developed model is in the good category. Based on the test results and analysis of these results, this is due to the workings of the dempster-shafer theory method on the inference engine, namely by calculating probability so that evidence can be carried out based on the level of confidence and logical reasoning. However, based on the results of the accuracy test, the average error value reaches 15%. This is caused by several factors, including several personality types have the same symptoms. In addition, the dempster-shafer works based on the mass function and the combination of variables, this will affect the diagnostic results. Thus, the value of plausability and its combination greatly affects the accuracy results obtained.

CONCLUSIONS AND SUGGESTIONS

Conclusion

This study developed an expert system to identify the personality type of employees using the dhempster shafer method. The dempster-shafer algorithm is used as an inference engine and is able to overcome uncertainty by combining evidence from several sources and providing a level of confidence from the available evidence. The system developed is able to identify the type of employee personality through the nature or symptoms that exist in the employee. In addition, the system can display the results of the diagnosis with an explanation of the personality type, its nature in work and work or positions that are suitable for that personality type. Based on the results of the accuracy test obtained from the results of the comparison of expert system diagnoses with the

analysis of an expert, it shows the accuracy value reaches 85%. The accuracy value is influenced by the plausability value and its combination.

Suggestion

To improve future research, there are several things that can be considered, including making comparisons with other methods, in order to get a method that has the maximum accuracy. In addition, the system can be developed based on Android so that users do not have to open a browser when using the system via a SmartPhone.

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