Optimization of Candidate Selection Using Naive Bayes: Case Study in Company X

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Optimization of Candidate Selection Using Naive Bayes: Case Study in Company X

JA Kadar*, **D Agustono**, **D Napitupulu**
Research Center for Quality System & Testing Technology, Indonesian Institute of Sciences, Tangerang Selatan, Banten, Indonesia

*jimmy.abdel.kadar@lipi.go.id

Abstract. This research was conducted as a decision-making system, and an alternative solution to complete the candidate assessment for a particular position. The human resources (HR) section on company X is responsible and initiative in selecting candidates in accordance with the assessment of their superiors. Selection by using the method of filling out the manager's assessment questionnaire on the candidate's subordinate. Three (3) managers have been determined to assess the 11 candidates for subordinates. By using questionnaire of quality classification of human resources and formula naive bayes it will get result which finally grouped using criteria scale as final grouping. The HR department has also determined that what is received is that which meets criteria 5. The result is three (3) candidates who can be proposed as candidates for certain positions in company X, and have met all required calculations. Furthermore the candidate will be given to management as an alternative input data in the selection of candidates.

1. Introduction

The role of decision-making by management to select division heads within an organization is common, either tightly sealed, direct appointments or using a method of calculation. The development of a company forced management to organize and prepare competent personnel in their field to take part and work further. The human resources department (BSDM) of a company is the part that regulates and distributes the capabilities of the workforce in accordance with the field and its competence. The HR department is also responsible for selecting candidates from internal companies in ensuring the careers of their employees [4].

According to Argue [1] the problematic functions in employee planning are recruitment and selection. This is the most complex function in the BSDM section of an organization, and it is important to concentrate on this function, as this is time-consuming, not least costly and most often a complicated process [1] [19]. BSDM in selecting the personal required to hold a certain position can use a scientific approach by examining the needs of what is needed and the solution can be done to meet the answer to the problems in selecting employees to be placed in certain positions with specifications that have been determined.

Assigning and searching for candidates required for a particular position can be made with decision-making methods (PK) or more commonly known as decision support (DS), but at this point the PK to be used is not as complicated as imagined. Step PK use in the selection of candidates is based on the selection of candidates with scientific methods, transparent and can be more effective and efficient with adjusted at certain times, this provision is contained in the company's management policy X. Simple steps can be done is by selecting candidates from the manager that one slice with the

position to be occupied. Implementation can be through several stages and / or ways, in this paper using questionnaire method by assessing candidates by superiors, the data have been collected and processed and classified according to rating scale rules. The rating scale classification is formed by using the classification defined by the HR department. Next use the calculation of naive bayes to classify candidates positioned according to their calculations. Use of naive bayes as part of statistics to calculate candidate chances for a particular position in a hypothesis. Thus understanding Bayes Optimal Classifier refers to the probability of a classification of the attribute criteria available and determines which classification is optimal [25].

The process of selecting and selecting candidates helps the organization in several ways. The whole purpose of the selection process and selection so that the organization can find a suitable person with a job with personal competence, thus the organization will be managed with the right people with the right skills [24]. Therefore, the aim of this study is to help management in providing alternative solutions or one reference information that can be a reference management in deciding the choice of candidates for certain positions especially in company X.

2. Literature Review

2.1   Decision Making System (DSS)
Decision-making system (SPK) is part of computer science, now SPK is one part of science that can be a solution for management. Decision-making system as a support for the solving of structured and unstructured problem analysis [12] [21]. According to Hasan [10] basically the SPK is used in support of all stages of decision making; can start from the identification of problems, data and information formed in several relevant classifications, determine the process approach, to the SPK evaluation. Syamsi [17] argues that decision-making should take into account the elements: (1) the purpose of decision-making, (2) identification of alternative decision-making solutions, (3) taking into account external factors, (4) the means used in evaluating or measuring decision-making.

Based on the above knowledge then the decision can be based on the measurement or assessment of management of its employees. The organizational structure, culture, and personal inclinations of managers influence the decision-making process [23]. This assessment is an alternative to the many measurement methods for employees in a company. This alternative solution reaches all the information to be assessed. Information based from the human resources section will get detailed information and still raw. This information needs to be processed and developed in accordance with the needs to be used in producing the desired output in accordance with the overall plan.

2.2   Naive Bayes
The naive bayes classification is one of the simplest opportunity classifications of the bayes theorem, which predicts future probabilities with previous experiences. In a simple sense, it can be assumed that a classification of naive bayes is assumed that the presence (or absence) of a particular feature of a room is unrelated to the presence (or absence) of other features. In Bayes terms, X is considered a "proof." As always, it is explained by the measurements performed on a set of attributes n. Let C be some hypothesis, such as X tuple data included in class F. For classification problems, the goal is to determine P (C | X), the probability that hypothesis C is applicable, given the "proof" or observed tuple data X. P (C | X) is the posterior probability of C conditioned on X. Posterior probability is estimated as follows [15]:

$$P (C \mid X) = P (X \mid C) \cdot P (C) / P (X) \qquad (1)$$

Where:
P (X) is constant for all classes
P (C) is a frequency. relative sample of class C
Searchable P (C | X) is maximum, as well as P (X | C) • P (C) is also a maximum value

The common flexibility of the probability model, the naive bayes classifier can be efficiently directed, for example a supervised learning. As another example of a simple application, the estimation parameter for the naive bayes model uses the maximum likelihood method, in other words, one can work with the naive bayes model without believing in bayesian probability or using bayesian methods. In the naive bayes classifier, another advantage feature is in the classification stage only requiring a small amount of training data to estimate the parameters (means and variances of the variables) required for classification. Since the independent variable is assumed, only the variance of the variables for each class needs to be determined and not the entire covariance of the matrix.

2.3   State of the art
Organizational dynamics in line with employee career dynamics, the selection of candidates to be placed in a certain position requires careful planning. Company X, represented by the HR department, has determined in the selection of candidates using a decision-making system as input for management. Based on candidate behaviour data and interviews as one of the basic assessments [7], a questionnaire was distributed to managers.

Questionnaire design to measure employee behaviour / competence and manage it as accumulated data to predict related achievement [14]. Several factors influence decision making. These factors, including the past experience of the candidate [11], cognitive differences [18], age and individual differences [5], believe in personal relevance [2], and the escalation of commitment, influence the choice of others. Understanding the factors that affect the decision-making process is important to understand what decisions are made. That is, the factors that influence the process can affect the outcome [6]. The HR section has a basis for determining the criteria in selecting candidates according to the needs of the position. The criteria can be seen in Table 4. The determination of the criteria has been done with the previous review, this study is internal and has been recognized by management. Based on these criteria, candidate assessment and placement can be done according to plan.

3. Research Methodology
Methodology used in this study is quantitative method [16] while the instrument used was a questionnaire compiled based on the needs of the firm as the concept measurement framework in this study. Quantitative research begins with a problem statement and involves the formation of hypotheses, literature review, and quantitative data analysis [22]. Primary data collection is done to managers who will assess candidates for specific positions. The number of respondents obtained from data collection is 3 managers to assess 11 candidates. The rating scale in the questionnaire was based on Muchinsky's theory [13] by assessing the candidate's perceptions of 5 choices of answers: "1" Unsatisfactory Performance, "2" Improvement Desired, "3" Meets Expectation, "4" Exceeds Expectation, "5" Outstanding Performance. Based on Muchinsky's theory [13], it is translated for the kusioner making as in Table 1.

Table 1. Questionnaire of Human Resource Quality Classification

a.	Quality of Work		
5	The quality of work always exceeds the standard that has been set.	3	Have enough passion to learn for self-improvement and improvement of work ability, but need to request support from superiors to apply it in their duties.
4	The quality of work sometimes exceeds the established standard.		
3	The quality of the work always meet the standards that have been set.	2	Less enthusiasm for learning for self-improvement and improvement in work ability, and or need to be controlled / reminded always to really apply it in its duties.
2	The quality of the work sometimes does not meet the established standards.		
1	The quality of the work is always less than the standard set.	1	Less have the spirit to learn for self-development and improvement of work

b.	**Quantity of Work**
5	The quality of the work in the form of quantities, or the volume or frequency or speed of completion of work always exceeds the standard set.
4	The quality of work in the form of quantities, or the volume or frequency or speed of completion of work sometimes exceeds the established standard.
3	Quality of work in the form of quantities, or volume or frequency or speed of completion of work always meet the standards that have been set.
2	The quality of the work in the form of quantities, or the volume or frequency or speed of completion of work is sometimes insufficient to meet established standards.
1	The quality of work in the form of quantities, or the volume or frequency or speed of completion of work is always less than the standard set.
c.	**Knowledge and Skills on Work**
5	Very good in mastering and understanding the knowledge and skills of the field of duties and responsibilities.
4	Mastering and understanding the knowledge and skills of the field of responsibilities.
3	Simply master and understand the knowledge and skills of the field of responsibilities.
2	Lack of mastering and understanding the knowledge and skills of the areas of his duties.
1	Very lacking in mastering and understanding the knowledge and skills of his field of duties.
d.	**Initiative**
5	Has the ability to be very fast, precise, correct in acting to carry out and complete his duties without waiting for orders and instructions.
4	Has the ability to be very fast, precise, correct in acting to carry out and complete the tasks, and sometimes still waiting for instructions with a relatively global instruction.
3	Has the ability to be very fast, precise, correct in acting to carry out and complete the tasks, and sometimes wait for a relatively detailed command.
2	Slow and always wait-for-command capability and with detailed instructions.
1	Slow and always wait-for-command capabilities and with very detailed instructions.
e.	**Cooperation**
5	Be active in helping and supporting each

	ability, although already reminded.
h.	**Attendance Level**
5	During the performance appraisal period is never too late, leave early, work lost, leave the work permit.
4	During the 1-2 late performance appraisal period, leave early and or 1 day lost to work.
3	During the period of achievement assessment 3-5 late, home early and or 2-3 days lost to work.
2	During the period of the 6th to 10th weekly achievement, leave early and or 4-5 days lost to work.
1	During the performance appraisal period more than 10 times late, leave early and or more than 5 days lost to work.
i.	**Planning & Organizing**
5	Excellent in setting task priorities and placing and managing existing resources, so that the realization of their work is very effective and efficient.
4	Have a good ability in setting task priorities and placing and managing existing resources, so that the realization of work is always effective and efficient.
3	Have a pretty good ability in setting task priorities and placing and managing existing resources, so the realization of the work is good enough.
2	Less able to set priorities and less effective in managing existing resources, so that the planned work is rarely realized properly
1	Not able to assign task priorities and manage existing resources, so that the planned work is not realized.
j.	**Control**
5	It is good to monitor and control all resources under their responsibility in the rules / regulations / procedures in carrying out their duties so that the resources are very optimal in doing actuality.
4	Can do well in monitoring and controlling all the resources under his responsibility remain in the rules / regulations / procedures in carrying out its duties so that the resources are optimal enough.
3	It is good enough to monitor and control all the resources under its responsibility in the rules / regulations / procedures in performing its duties, but sometimes it needs guidance so that sometimes it is less than optimal.
2	It is good enough to monitor and control all resources under its responsibility in the rules / regulations / procedures in performing its duties, but must always be

	co-worker and / or giving very seriously towards the achievement of company goals.			reminded for completion so that it is less than optimal in performing its activities.
4	Active in helping and supporting co-workers only in the section / section / group only and or give serious attention to the achievement of the goal group / section / section only.		1	Simply monitoring and controlling all resources under his / her responsibility remain in the rules / conditions / procedures in performing his duties, but must always be reminded to make the settlement so that less than optimal.
3	Need to be reminded / reprimanded, to assist and support co-workers and or need to pay serious attention to the achievement of group / company goals.		**k.**	**Decision-Making**
			5	In making a decision on a problem very quickly and precisely as well as the results can be justified.
2	Less enthusiastic to help and support colleagues despite being reminded / reprimanded and or less attention to the achievement of group goals / company.		4	In making decisions on a problem is always fast and accurate as well as the results can be justified.
1	No matter to colleagues and / or always become obstacles in achieving the goal group / company.		3	Quite capable in making decisions quickly, precisely although several times need support and direction and the results can be justified.
f.	**Reliability**		2	Sometimes it takes great support and direction to dare to make decisions quickly, appropriately and / or decisions are sometimes less accountable.
5	Always willing without reasons if given the tasks and responsibilities outside of the main duties and responsibilities and can solve it as expected.			
4	Always willing without reasons if given the task and responsibility outside of the main duties and responsibilities, but in completing the results are relatively in accordance with what is expected.		1	Always slow in making decisions, even if they have been given their dukurang and their directives or decisions are not accountable.
			l.	**Development of Staff**
3	Always willing for certain reasons if given the task and responsibility outside of the main duties and responsibilities, and in resolving the results are less in line with what is expected.		5	Be very attentive in the improvement and development of subordinates and or have a planned program for staff.
			4	Attentive in the improvement and development of subordinates, but lacks a planned program for staff.
2	Always willing but for some reason given assignments and responsibilities outside of the main duties and responsibilities, and or when executing the results rarely as expected.		3	Just enough attention in the improvement and development of subordinates, but does not have a planned program for his staff.
1	Always unwilling to be assigned duties and responsibilities outside of the main tasks and responsibilities, and or carrying out the tasks in resolving them rarely in accordance with what is expected.		2	Lack of attention in the improvement and development of subordinates, and does not have a planned program for his staff.
			1	No attention in the improvement and development of subordinates, and does not have a planned program for his staff.
g.	**Have Learning Ability and Willingness**			
5	Have a great passion for learning for self-improvement in order to improve work ability and earnestly apply what has been learned in his duties.			
4	Have a good spirit to learn for self-development and improvement of work ability and seriously want to apply it in its duties.			

In Table 1, it can be seen that the indicators of Work Quality, Quantity, Knowledge and Work Skills, Initiative, Cooperation, Reliability, Ability and Learning Will, Attendance, Planning and Organizing, Controlling, Decision Making, and Development of Subordinates, each have variables which can directly measure the intended employee. This measurement is intended for the selection of candidates for certain positions, becoming one of the inputs for the leadership in determining the personal to be selected.

The HR department has an important and responsible role in this assessment activity. The need for a lightweight interview with candidates with the basics: values, beliefs, feelings, and motives [20]. Next Steps distributed the research questionnaire. Managers are asked to rate their subordinates as well as subordinates from other sections, the results of the manager's appraisal are returned to BSDM. The next step is to make the category of choice from the classification of the quality of human resources into the criteria scale. Scale criteria can be seen in Table 2. The HR section has determined that for each position requires certain criteria, and in the position to be occupied by the candidate has been established yag incorporated in the criterion scale 5, in other words calculations in this study determine the candidate that matches criterion 5. The other side also sees opportunities by prioritizing the personality approach of the candidate [8]. This determination on the scale of this kirteria (table 2) has become a reference in the selection of candidates and established by company X. The next step is to calculate the naive bayes formula (1) and the calculation will be shown in Table 3.

Table 2. The Division of Criteria Based on the Assessment Aspect

Criteria of Scale	Description
Criteria 1	Have good learning ability, high morale and quality of work satisfactory
Criteria 2	The results obtained are very effective with near perfect level of accuracy
Criteria 3	Self-organization and subordinates are optimal and responsible for all the work done
Criteria 4	Having a high level of creativity and initiative in working with the task of applying the knowledge mastered
Criteria 5	Have the courage to take decisions and dare to account for all the risks that occur

4. Result and Discussion

The questionnaire that has been given to the managers and has been filled in compliance with the terms of compliance, that this assessment is confidential during the assessment process for the assessed employees. Calculations using the naive bayes formula based on the assessment criteria can be seen in Table 3 as follows:

Table 3. Naive Bayes of Human Resource Quality Classification

Criteria		Human Resource Quality Classification											
		a	b	c	d	e	f	g	h	i	j	k	l
1	1/5	9/58	8/58	7/58	1/58	1/58	1/58	10/58	11/58	7/58	1/58	1/58	1/58
2	1/5	11/59	10/59	4/59	1/59	1/59	9/59	1/59	9/59	4/59	1/59	7/59	1/59
3	1/5	7/75	1/75	4/75	8/75	11/75	1/75	1/75	10/75	11/75	1/75	9/75	11/75
4	1/5	8/69	1/69	11/69	11/69	4/69	1/69	9/69	11/69	1/69	4/69	4/69	4/69
5	1/5	7/48	1/48	1/48	10/48	4/48	4/48	7/48	9/48	1/48	4/48	11/48	1/48

Description: a = Quality of Work; b = Quantity of Work; c = Knowledge and Skills on Work; d = Initiative; e = Cooperation; f = Reliability; g = Have Learning Ability and Willingness; h = Attendance Level; i = Planning and Organizing; j = Control; k = Decision-Making; l = Development of Staff

Table 3 is a series of calculation processes with naive bayes formulas, by combining the classification of human resource quality and criteria scales. The results of calculations and comparisons with Table 1 can be seen in Table 4. In table 4, the criteria column is the result of calculation with naive bayes, whereas in the candidate column is the personnel judged by the managers. This assessment is subjective from managers, assuming it has worked enough time to allow it to be assessed. In addition, the assessment is based on good performance, skills and attitudes, as the initial basis for personnel selection.

Table 4. Classification of Human Resources Quality Based on Assessment Aspect
with Naive Bayes Calculation

Candidate	Criteria	Classification of Human Resource Quality
K-1	Criteria 1	Quality (4), quantity (3), knowledge and skills (3), ability and willingness of learning (5), attendance (5), planning and organizing (3)
K-2	Criteria 4	Quality (4), knowledge and skills (5), initiative (5), ability and willingness of learning (3), attendance (5), decision making (3), development of subordinates (3)
K-3	Criteria 2	Quality (5), quantity (5), reliability (4), attendance (4), planning and organizing (3), decision making (3)
K-4	Criteria 3	Quality (3), initiative (3), cooperation (5), attendance (5), planning and organizing (5), decision making (4), development of staff (5)
K-5	Criteria 5	Quantity (3), initiative (5), cooperation (3), ability and willingness to learn (3), attendance (4), control (3), decision making (5)
K-6	Criteria 4	Quality (3), knowledge and skills (5), initiative (5), cooperation (3), ability and willingness of learning (5), attendance (5), controlling (3)
K-7	Criteria 1	Quality (4), quantity (4), knowledge and skills (3), ability and willingness of learning (4), attendance (5), planning and organizing (3)
K-8	Criteria 3	Quality (3), knowledge and skills (3), initiative (4), cooperation (5), attendance (4), planning and organizing (5), decision making (4), development of staff (5)
K-9	Criteria 5	Quantity (3), initiative (4), reliability (3), ability and willingness of learning (3), attendance (4), decision making (5)
K-10	Criteria 2	Quality (5), quantity (4), knowledge and skill (3), reliability (4), attendance (4), decision making (3)
K-11	Criteria 5	Quantity (3), initiative (3), cooperation (3), ability and willingness to learn (5), attendance (4), decision making (5)

In table 4 can be seen in the candidate column is the person who is assessed and will be screened. Column Criteria is the result of calculation with naive bayes so that the results obtained with certain criteria. The classification column of the HR criteria is the result of the manager's assessment of each individual by the manager. In the classification of the quality of human resources, the results of the assessment of the managers in the form of questionnaires. Questionnaires actually contained 12 indicators, but managers did not entirely select and fill out the questionnaire, and it was still considered valid as it had represented more than 6 indicators. In this study, from 12 indicators used as measurement materials, specific decision-making indicators become important and occupy the top priority because related positions that will be held. Other indicators become supportive and remain important to note.

At this stage it has been found that there are 3 candidates who can be used as reference material for placement in the position to be occupied (figure 1). Candidate 5, candidate 9 and candidate 11. The three candidates have fulfilled the calculation after the assessment by the relevant managers, and all three are eligible to be further promoted to the management as a step to select this activity. Among all candidates in criterion 5, only Candidate 5 (K-5) has more indicators than the other candidates, and becomes an added value for the next calculation. Thus candidate 5 (K-5) can be recommended in management to be established as an alternative decision-making materials for management. Thus the

task of the HR department in selecting candidates for a particular position has been enforced. Alternatively, candidates with criteria 5 (K-9, K-11) may be good assistants to new officials or replace other parts of the Assistant with their expertise and competencies.

Persons who have followed this stage of measurement as in Figure 1, who occupy criteria 4 will then be placed on the division that has been prepared as an alternative to other solutions. At this stage criterion 4 will be placed as assistant to the division chairman. This task becomes important because as a counterweight of the elected head of office. Personnel with criterion 3 scale will be placed in the area around the factory machine. Handles and is responsible for the machines and schedules of his subordinates. Likewise with personnel mapped on criteria 2 and 1 that assist personnel with criteria scale 3.
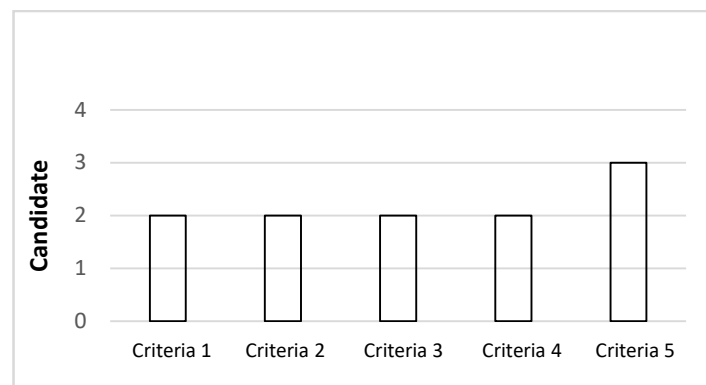

Figure 1. Classification of Human Resource Quality

5. Conclusion

The selection of candidates in company X for certain positions is done by assessing candidates to be submitted and judged eligible by the HR Section after going through several stages that have been determined. The initial stage is to look at the length of time working, performance, skills and good attitude, as the initial basis of selection. The next stage of assessment of managers through questionnaires distributed by the HR Section. With the distribution of questionnaires will be obtained assessment results for all candidates. Recapitulation of the assessment results are processed by naïve bayes formula and placed in accordance with the criteria set by the HR Section.

The provisions of the HR Section are only candidates who occupy criteria 5 that will be promoted to certain positions to be determined by management. Three candidates have been selected from criterion 5, and one candidate (K-5) has been selected as the result of calculation with this method, will be submitted to management to be selected and determined, or otherwise established by management. The selection of candidates as an alternative solution for management in determining the right candidates placed according to the field and competence and is part of decision making (PK). This research is quantitative with the assessments made by managers. In this research method candidates who belong to criterion 4 will be the assistant of the elected head of office. While candidates with criteria 3, 2, and 1 will be placed around the factory with the responsibility of holding machines and scheduling required.

There are 12 indicators to be assessed by the candidates, such as Work Quality, Quantity, Knowledge and Work Skills, Initiative, Cooperation, Reliability, Ability and Learning Will, Attendance, Planning and Organizing, Controlling, Decision Making and Development of Subordinates, -an indicator has a certain variable. After the following classification is obtained by calculation using the naive bayes formula, then the criteria for the candidate are assessed.

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