Implementation of Expectation Value and Variance in Decision-Making with Risk in Economic Learning in High School

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Abstract: Learning outcomes in economics learning at SMA Phase E that are related to material on production activities are that students understand the economic system as a way of organizing various economic activities to meet the various needs of society. Decision-making is commonly found in production activities, and every decision-making process has risks. To overcome this, the concept of probability is needed. Decision-making needs to be taught to students so that they can understand economic activities, which are always dynamic in nature, and the impact of these economic dynamics. Therefore, in learning economics, especially in material on production activities related to decision-making with risk, teachers can start with the theory of expected value and variance so that production activities do not experience losses and can even increase profits. This research aims to explore the relationship between statistical material and economics learning in high school. The research method used is a literature study method and is descriptive-qualitative in nature. The results show that economics teachers in high schools can teach and implement opportunity theory in economics learning in Phase E high schools to equip students to manage various economic activities, especially production activities.

Keywords: Expected value, Variance, Decisions with risk, and Economic learning.

INTRODUCTION

A decision is a choice of action strategy. Decision-making is a management activity in the form of selecting an action from a series of alternatives that have been previously formulated to solve a problem in management. However, the decisions to be taken may still contain risks because the results of these decisions are not yet known with certainty (TriHandoko & Adhi, 2010). If, in a state of uncertainty, the decision-maker can know the magnitude of the probability value regarding the uncertain outcome or event, then the decision is said to be in a state of risk. However, the existence of this risk certainly does not prevent decision-makers from continuing to make decisions. What must be done is to reduce the risks posed by decision-making by looking for the possibility of uncertain events occurring.

Empirical studies have demonstrated the significance of decision-making in daily productive living. It's also possible that managers view creative decision-making as crucial to the success of their organizations. There is disagreement, though, over how much an organization can actually alter daily managerial decision-making to create an organizational advantage in the face of a difficult business environment marked by rapid industrialization, technological advancements, and frequent economic fluctuations (Asikhia et al., 2021).

Organizations in the manufacturing industry have their own criteria for determining the number of orders and production schedules in order planning (Kokuryo et al., 2020). In the production process in the made-to-stock manufacturing industry, production planners must be able to determine the most optimal production quantity. The problem that occurs is that product demand is not the same in each period. The literature has several models that jointly determine the quantity of economic production and the rate of production. Very few models define production levels explicitly (AlDurgam et al. 2019).

Decision-making needs to be considered and considered carefully so as not to suffer losses. Human decision-making is frequently examined as the product of carefully weighing the pros and cons of many possibilities in relation to the likelihood and importance of the potential outcomes. These presumptions form the

foundation of Subjective Expected Utility Theory, which is arguably the most popular normative theory. To better understand the cognitive processes that underlie human judgment and decision-making, a substantial amount of research focuses on systematic violations of these rationality rules (van der Pligt, 2001).

Decision-making is usually found in production activities. Production activities are one of the materials in economic learning at Phase E High School. Learning outcomes in economic learning at Phase E High School that are related to the production activity material are that students understand the economic system as a way of organizing various economic activities to meet various community needs. Decision-making needs to be taught to students so that they can understand economic activities, which are always dynamic in nature, and understand the impact of these economic dynamics (Permendikbudristek, 2022). Therefore, in economics learning, especially in material on production activities related to decision-making with risk, teachers can relate it to the theory of expected value and variance so that production activities do not experience losses and can even increase profits.

In the 17th century, mathematicians like Blaise Pascal and Pierre de Fermat assumed that the allure of gambling offered payoffs $(x_1, \ldots, x_n)$ with probabilities $(p_1, \ldots, p_n)$ indicated by anticipated value $\bar{x} = \sum x_1 p_i$. This led to the creation of contemporary probability theory. Finding alternatives, calculating the outcome value and probability, and selecting the option that maximizes the expected value appear to be the only steps involved in this process, making it appear very straightforward and easy (Li, 2003). Meanwhile, the theory of variance, or deviation from the average, is used as a risk. Thereby, the researcher was interested in conducting research with the title "Implementation of Expectation Values and Variance in Decision Making with Risk in Economics Learning in High School", which aims to explore the relationship between statistical material and economics learning in high school.

METHODS

This research uses a literature study method and is descriptive-qualitative in nature.

This method is used to compile this scientific article by collecting relevant theories. In this research, literature from various literature sources related to this topic is collected and presented systematically. Researchers identified literature sources relevant to the research topic in the journals ScienceDirect, Google Scholar, SINTA, Scopus, and documents related to the kurikulum merdeka regarding the application of opportunity theory in economics learning in high school.

RESULT AND DISCUSSION

The expected value, also known as the mathematical expectation, average, or first moment, of a random variable in probability theory and statistics is the random variable's integral to the probability measure. For discrete random variables, this value is equal to the probability densities of the possible values weighted together. For continuous random variables with a density function, this value is the probability density of the possible values weighted together (Yadav, 2019).

To see existing opportunities, every decision is always taken using the concept of probability. The basic aim of decision-making theory is to provide information for decision-makers to provide concrete results regarding relative probabilities. Every decision must have an alternative; if there is only one alternative, then this is not a decision-making problem. Judgment must be used in limiting alternatives based on predetermined criteria (Orga & Ogbo, 2012). Probability is very useful as a basis for decision-making in situations of risk and uncertainty. The number in the probability distribution must be 1 (=1), which can be written as:

$$\sum_{i=1}^{n} p_i = p_1 + p_2 + \cdots + p_n = 1 \qquad \ldots (1)$$

One important idea in decision-making is expected value, which enables people to base choices on possibilities and probability. By considering all potential values and their probabilities, it is a statistical metric used to determine the average value of a random variable. The expected value can be computed by adding all the products of multiplying each conceivable outcome by its likelihood. The expected value of the random variable is the outcome (Sampe et al., 2023).

Expected value is crucial to decision-making because it enables people to base their decisions on possibilities and possible results. People can analyze potential outcomes and their probability by computing the expected value of each conceivable decision to decide on the optimal course of action. If someone is thinking about buying stocks, for instance, they can figure out the expected value of the stock by looking at both the likelihood that the stock will make a profit and its potential for profit (Adnyana, 2020).

Apart from expected value, variance theory can also be used to support and complement the results of decisions taken using expected value theory. In probability theory and statistics, variance refers to the expected value of a random variable's squared deviation from its mean. As a measure of dispersion, variance expresses the distance between a set of numbers and their average value. Variance is usually designated as $Var\ (X)$, or sometimes as $V\ (X)$, or symbolically as $\sigma_x{}^2$ or simply σ^2. The variance expression can be written as follows (Bain & Engelhardt, 1992):

$$Var\ (X) = E[(X - E[X])^2] \quad …\ (2)$$

Compared to other measures of dispersion, such as the predicted absolute deviation, variance has the advantage of being more easily manipulated algebraically; for instance, the variance of a sum of uncorrelated random variables is equal to the sum of their variances. Standard deviation is more frequently provided as a measure of dispersion after the calculation is finished because variance, unlike standard deviation, has units that are different from those of a random variable, which is disadvantageous for practical applications (Boos & Brownie, 2004).

Decision-making is a very important process in every life. Likewise, in the business world, this also has the same importance. According to the Oxford Advanced Learner's Dictionary, the term decision-making means the process of making decisions about something important, especially within a group of people or within an organization. Decision-making is the process of choosing the best action from many existing alternatives. This is useful for the operational success of organizational activities. All managerial functions, such as planning, organizing, directing, and controlling, are determined by decisions. Decision-making describes the process by which a series of actions are selected to deal with a particular problem (Jadhav, 2019).

The definition of decision-making is the process by which an individual, group, or organization reaches a conclusion about what action should be taken in the future by considering a set of goals and the limitations of available resources. This process is often iterative, involving issue framing, intelligence gathering, drawing conclusions, and learning from experience (Schoemaker & Russo, 2014). People at all levels in an organization are constantly making decisions and solving problems.

In general, decision-making involves first recognizing issues and possibilities, then working to find solutions. Within the field of management, decisions are classified into two groups: pre-programmed decisions and spontaneous decisions. To build rules that can be implemented in the future, such as inventory and operations, managers typically use programmed judgments as a response to recurrent events. Another type of decision-making involves non-programmed actions taken in reaction to singular, unanticipated, and unstructured occurrences that have a big impact on the organization. Because the decision-making process is highly unclear, we see it most often in the strategic planning decisions made by businesses. There is a noticeable distinction between judgments that are programmed and those that are not, usually in terms of the amount of data and knowledge managers require to make decisions on event certainty, uncertainty, risk, and ambiguity. Making decisions is the most difficult and significant task in management (Ahmad et al., 2021).

Decision-making that contains risk is decision-making that is related to dynamics or uncertainty. The results obtained in calculating decision-making with risks must be borne accordingly. The consequences can be in the form of profits obtained or losses because they do not meet the desired expectations. Risk can mean the possibility of loss, uncertainty, deviation from actual results, or differences in results from expectations. The result of risk is the emergence of uncertainty (TriHandoko & Adhi, 2010).

Economic education, in the context of learning at school, needs to be built with the paradigm that the world can change quickly following the times. Economics subjects in high

school aim to ensure that students: 1) are grateful for the grace of God Almighty for the abundance of available resources through an attitude of utilizing resources efficiently and sustainably; 2) able to understand general economic problems and be able to solve economic problems efficiently and responsibly; 3) able to understand economic activities which are always dynamic in nature and understand the impact of these economic dynamics; 4) able to make future plans related to economic activities carried out and make decisions regarding financial issues or problems; 5) able to understand financial service institutions and financial service products including features, benefits and risks, rights and obligations related to financial products and services, and have skills in selecting financial products and services according to their needs; and 6) be critical in responding to economic policies at the local, national and international levels, and be able to map the impact of an economic policy on the stakeholders (Permendikbudristek, 2022).

Economic subjects are subjects that originate from economic behavior in the social life of society and are selected using economic concepts that are used for learning purposes. Economics learning at SMA Phase E is generally for class X SMA, MA, or equivalent. At the end of phase E, students in Class X SMA can reflect on the concept of scarcity in everyday life. Students can clearly differentiate between needs and wants. Students can arrange a priority scale of needs, starting with primary needs, secondary needs, and tertiary needs. Students understand that economic activity is a cycle that occurs in the context of human efforts to meet their needs. Students understand money as a resource that needs to be utilized and managed to meet current needs and plan for future needs through financial planning based on an understanding of the various benefits of banking and non-banking financial products (Permendikbudristek, 2022).

The implementation of the kurikulum merdeka can be done by applying many varied learning models so that the quality of learning can improve. One of the learning methods that can be applied to implementing the kurikulum merdeka is the integrative learning model. The integrative learning model is a combined learning process that uses inter-subject learning methods carried out by uniting subjects by applying learning process priorities and gaining skills, plans, and behaviors related to other subjects (Purhanudin et al., 2023). The integrative learning model is divided into two parts: internal integrative is the linkage formed from the learning material taught, and external integrative is the connection between one subject and another.

The application of integrative learning models in Economics and Mathematics (the statistics field of study) to grade X students is able to improve and develop various basic competencies between subjects; students' understanding is deeper, and students feel the benefits and meaning of learning more (Millah & Syah, 2017).

Based on the teaching module of Phase E High School Economics (generally class X) by the Ministry of Education and Culture of the Directorate of Senior High Schools in 2022 on the subject matter of the concept of production costs, revenue, and maximum profit, it only discusses the total costs incurred for production, producer revenue because of selling all outputs, maximum profit, and minimum loss. If this subject matter is associated with statistics lessons, especially mean, expectation, and variance material, then understanding the concept of production costs can be broader. Some of them are being able to know the amount of production to obtain maximum profit and minimize risk (loss) and being able to know the amount of raw materials used in production to make costs more efficient.

The following is the implementation of mathematics (the statistical field of study) in the economics subject of Phase E high school on production cost material presented in detail (Nurwulandini et al., 2014; Sayuni et al., 2014).

Knowing the production amount with optimum profit and minimal risk

hrough expectation analysis, a company can know the optimum amount that can be produced to maximize the profit that occurs and how much risk is generated on the profit using variance analysis. The calculation of profit expectations is done using the equation:

$$E_\pi(Q) = (s - c)Q - (s - v) \sum_{x=0}^{Q}(Q - x)P(x) \qquad \dots (3)$$

While the calculation of risk expectations is done using the equation:

$$V\pi(Q) = (s - v)^2 \left(2Q \sum_{x=0}^{Q}(Q - x)P(x) - 2\sum_{x=0}^{Q} x(Q - x)P(x) - \left[\sum_{x=0}^{Q}(Q - x)P(x)\right]^2 \right) \quad \dots (4)$$

Based on the results of the calculation, a company, in making decisions on the amount of production, does not only look at the large profits; it would be better if it was also seen from the risks arising from these profits. Then the Newsboy model (equation above) can be used to get the optimum amount of production by knowing the maximum profit expectation and the expected risk or loss caused.

Knowing the control of raw materials for efficient costs

In addition to the amount of production, through expectation and variance analysis, raw material inventory control can be done. A company engaged in production, which in the production process uses certain raw materials, faces a challenge in making decisions on the number of raw materials to be used. Based on several sources, it is known that the level of raw material inventory is always excessive. This is because consumer demand is fluctuating or not fixed. Seeing these conditions, the determination of inventory can be done by implementing the expectation value and variance with the Continuous Review System (CRS) method with the Q model. The equation used in finding the total amount of inventory for a year:

$$O_T = D_p + \frac{AD}{q0} + h\left(\frac{1}{2}q0 + ss\right) + \left(\frac{C_u DN}{q0}\right) \quad \dots (5)$$

Based on this equation, a company's decision-making in determining raw material inventory can be more accurate to determine how much quantity and the right time to order raw materials and calculate the amount of cost that must be incurred to be more efficient.

In improving students' understanding of learning for the development of the kurikulum merdeka, teachers can use an integrative model by linking statistics material to economics lessons, especially production cost material. Through this model, students' understanding, which was initially limited to knowing the amount of production, is now able to understand in depth how to make decisions on the amount of production by considering the various risks that will arise. In the implementation process, teachers are required to have good competencies in terms of pedagogical, professional,

personality, and social aspects so that learning outcomes can be optimally achieved.

CONCLUSION

Every decision has risks. Decision-making is needed to minimize losses and increase profits. This can be seen through the probability of customer demand. Through this probability of customer demand, the theory of expected value and variance can be used so that production activities do not experience losses and can even increase profits. Production activities are related to economic learning in SMA Phase E. In learning practice, teachers can apply expected value and variance material with production activity material in making decisions with risk. In this way, the objectives of economic learning in SMA Phase E can be achieved more optimally by providing a trajectory of learning material in classroom learning.

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