APPLICATION OF THE UTILITY THEORY IN MANAGERIAL DECISIONS MADE BY METALLURGICAL ENTERPRISES

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Abstract

This article deals with the application of the utility theory as a useful tool for the decision making process analysis under risk. While the theoretical value of the concept is clear, its application in practice is not easy. In addition to frequent skepticism common among managers, certain measurement issues have to be overcome in order to obtain relevant results. This article aims to use the example of a metallurgical enterprise to apply the theory for use in practice.

Keywords: Utility theory, managerial decision making, decision making under risk

1. INTRODUCTION

Managerial decision-making is a basic management function, the quality of which largely depends on the efficient functioning of the business units. Therefore, basic management skills should include knowledge of various procedures and methods to ensure high quality decision-making problem solving. One of these processes is the use of the utility theory in managerial decision making.

2. UTILITY AND ITS RELATION TO MANAGEMENT DECISIONS

When analyzing decision making under risk, the best alternative is usually chosen based on the calculation and comparison of expected return (cash or in-kind). However, there are situations in which the expected cash income is not the correct criterion:

- If the decision maker has problems expressing the value of certain outcomes of his/her decisions as a cash contribution, then the expected monetary value cannot be used.
- If we assume that the decision maker is willing to risk a short-term loss of money, when he/she is better off in the future. Typically, the decision-maker acts to minimize the short-term risk, especially if there is an option of a big initial loss.
- We assume a linear relationship between the amount of money and its value (utility), e.g. CZK 2 mil. is double CZK 1 mil. In fact, with an increasing amount of accumulated wealth, the value of additional money decreases, e.g. the value of CZK 10 added to CZK 100 is higher than CZK 10 added to CZK 10,000.

For all these situations, it is necessary to make a scale that would better describe how the decision-maker assigns value to each possible outcome. [1]

The utility as a measure of the outcome value was suggested by von Neumann and Morgenstern. They assumed that each individual has a measurable extent between various choices in risk situations. This measure is indicated as a utility. It is measured in units that are agreed to by the utility [2]. Appropriate inquiries can determine the utility of the decision maker from various sums of money; it is called the utility function of the decision maker. The graph of this function shows the attitude of the decision maker in the relationship to the risk [3]. We assume that the decision maker, when making a decision that involves risk, chooses the option that maximizes the expected benefit.

This idea is based on the following assumptions:

- The utility can be measured on a cardinal scale, where numbers (1, 2, 3, etc.) describe how many utility units form the yield. E.g. a 5% market share is twice as important as a 6% return on investment.
- The utilities of various objects can be combined. If the value of enterprise A corresponds to 10 units of utility and enterprise B to 5 units of utility, then A and B together are worth 15 units of utility.

3. AN EXAMPLE OF USING UTILITY THEORY IN MAKING A MANAGERIAL DECISION

Suppose that the management of a metallurgical company is about to decide on taking out a business insurance policy against fire for CZK 50 million. The chance that the company will be destroyed by fire during the year is 1:2,000 (i.e. 0.0005). The annual premium is CZK 37,500. Should the company take out the insurance policy or not? The situation is depicted in **Table 1**.

Table 1 Fire Insurance

Conditions / Alternatives	0.0005	0.9995	Expected monetary value
	fire	Without fire	
Insurance	37,500	37,500	37,500
Without insurance	CZK 50 mil.	0	25,000

According to the expected monetary value, the management should not insure the company because the alternative without insurance involves a lower value. Over the long run, the insurance would cost much more than the uninsured condition. Since the problem to be solved is from an area of uncertainty, there is a chance, albeit very small, that a fire may occur in the very first year. The loss of CZK 50 million would bring the company to bankruptcy, i.e. to a point that the enterprise's management could not afford. Therefore, it would be preferable to pay the insurance policy, although it has a higher expected monetary value.

If we analyze the problem in terms of utility, it may look like this:

The paid policy of CZK 37,500 has a value of 1 utility unit for the enterprise. CZK 0 corresponds to 0 units of utility. The loss of CZK 50 million has the value of 10,000 units of utility. This information is incorporated in **Table 2**.

Table 2 Insurance against fire and its expected utility

Conditions / Alternatives	0.0005	.9995	Expected utility
	fire	Without fire	
Insurance	-1	-1	-1
Without Insurance	10,000	0	-5

The results show that the expected utility of insurance is higher than the uninsured condition, so the company chooses to take out the insurance policy.

The previous text indicates that the application of utility is similar to the use of money. The only difference is that the expected value is expressed in terms of expected utility instead of expected monetary value. The biggest problem lies in determining the values of utility as a substitute for expected cash value. The relationship between money and utility can be expressed graphically using a curve called the curve of utility or using the utility function.

If you build a utility curve, you can read individual utility values from it corresponding to cash values. The utility curve itself is constructed based on the decision maker's attitudes towards risk.

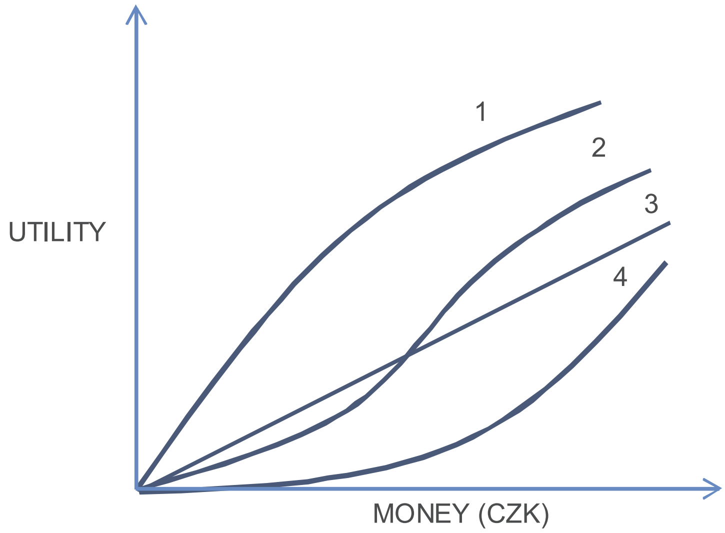

Fig. 1 Various utility curves

The shape of the curve is a function of individual attitudes towards risk (**Fig. 1**):

- Curve 1 shows a decision maker with a typical amount of aversion to risk.
- Curve 2 shows a decision maker who is poor and wants to play the lottery in order to improve his/her standard of living. This decision-maker automatically becomes risk-averse as soon as he/she accumulates wealth.
- Curve 3 shows a decision maker indifferent to the risk.
- Curve 4 shows a decision maker who has a willingness to take a risk and wants to take it.

As soon as the personal benefit curve is known, then it is possible to replace any monetary value with its utility equivalent. [4]

4. DECISION MAKING UNDER RISK

For decision making under risk, we compare the results of each alternative according to their probabilities. This is called the risk profile. [5]

Below are shown risk profiles for investing in two projects. The first project involves an investment in a new saw for cutting pipes. The second one is for the repair to an existing saw in **Table 3**.

Table 3 Investing in the given projects

Project	Possible result	Probability	Expected monetary value
The first	-1,000,000	0.1	100,000
	6,000,000	0.6	3,600,000
	10,000,000	0.2	2,000,000
	15,000,000	0.1	1,500,000
	Total		7,000,000
The second	0	0.1	0
	5,000,000	0.5	2,500,000
	10,000,000	0.4	4,000,000
	Total		6,500,000

Using utility curve number 1, we will find the expected values of the utility. [6]

Table 4 Investing in individual projects, complemented by benefits

Project	Possible result	Utility	Probability	Converted utility (U)
The first	-1,000,000	16	0.1	1.6
	6,000,000	70	0.6	42
	10,000,000	83	0.2	16.6
	15,000,000	100	0.1	10
	Total			70.2
The second	0	30	0.1	3
	5,000,000	65	0.5	32.5
	10,000,000	83	0.4	33.2
	Total			68.7

The first project prevails over the second and its expected monetary value is also higher (CZK 7 million compared to CZK 6.5 million the second project) in **Table 4**.

The utility curve can be expressed as a function, for example:

$$U(M) = 0{,}8.M + \sqrt{9.M} \quad (1)$$

The benefit is algebraically compared to the amount of money using a formula. If *M* = 1,000,000, the utility will be:

$$U\left(1\,000\,000\right) = 0{,}8.1\,000\,000 + \sqrt{9.1\,000\,000} = 803\,000\ Kč \quad (2)$$

5. CONCLUSION

The utility curves show the relationship between the utility and money, or probability. It is a useful tool that is applicable when making managerial decisions under risk. Obtained values are particularly dependent on the relationship between the decision maker and the risk. It is also necessary to address the question whether the utility curves remain constant over time or if they change. We must also take into account group or enterprise-wide preferences.

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