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DECISION THEORY AS A TOOL FOR IMPROVING OPERATIONAL ACTIVITIES IN BUSINESS CORPORATE ORGANIZATIONS

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This paper reveals the relationship between decision theory and operational activities in business administration. It clearly emphasized that decision theory is imperative for rational decision making in business administration. 71w paper also states that decision theory is not an end in itself but a means for improving the operational activities of any system.

INTRODUCTION

In business Administration, the essence of management is good decision making necessary to improve the operational activities of every organization. This good decision-making can be achieved by the use of decision theory. Moreso, the increasing difficulty of rational decision - making has been following by numerous efforts to put this process on a more quantitative objective and routine basis.

Decision is the art of choosing the best out of *a* number of options to achieve a predetermined/desired objective. Here, art means style while option means strategy or alternative course of action. Decision-making is the process involved in taking a decision. In other words, decision-making is the process of analyzing decision situations to arrive *at* the best choice of action or strategy that will achieve the desired objective most effectively. Here, process means ways and means that produce gradual change.

The decision-maker must follow the logical process as stipulated hereunder:

- Clear identification and definition of the desired objective.
- Generation of options, for the pursuit of the identified objective:
- Identification and definition of the screening criteria for the generated options.
- Evaluating the options generated in the light of the defined objective. (Ogbechi, 1999)
- Selecting the best option, i.e. the proper decision. Decision comprises three basic phases, which include:

Intelligence activity phase, Research / Design activity phase and choice activity

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phase by intelligent activity phase (IAS) we mean: the conceptual stage where the decision-maker becomes aware of the need to make a decision. *Research/ Design Activity Phase (RAS) we mean* this is the analysis stage where data are collected, organized, presented and interpreted for decisions. By Choice Activity Stage Phase. this is the judgmental stage where the decision-maker decides and selects the best option.

DECISION ANALYSIS AND IT'S INTERACTING ENTITIES

Decision analysis is the articulation of the interacting entities/elements in a decision situation showing how they relate with each other. The interacting entities are conceptualized as:

- The decision maker and his value system,
- Decision options, strategies or alternative courses of actions,
- Decision environment,
- Decision space or state,
- Decision sample or event,
- Decision screening criteria (Akingbade 1998)

The decision-maker is the one who takes the decision. It is expected that the decision-maker should be rational in his decisions, i.e. he should be wise. Rationality has to do with choosing a worthwhile objective in the light of benefit-cost analysis. He is required to possess a genuine/acceptable value system. The two basis concepts of decision theory are bounded rationality and rationality paradox.

Bounded rationality is considered bounded when the decision-maker takes decision within the limit of information available for him at a given time and place. Rationality in decision-making is considered by inadequacy of information available.

Rationality paradox occurs when the decision-maker takes decision based on the present information available to him at a given time, and then revises decision in future as a result of his change in ability of acquiring more information.

The Strategies are decision options/alternative courses of action open *to* decision *-makers* choice. If there were only one way in which to accomplish a task, no problem would exist.

In the usual way the decision-maker has to make a choice from among several strategies. The decision-maker must determine which of these alternatives will be most effective.

The environmental states are those factors/events, which affect the outcome/

result of a particular strategy and one over which the decision-maker has little or no control. Examples of the common environmental factors include the life of a project, competitor strategy, market share and economic conditions. Frequently, some knowledge exists about the likelihood of each environmental state. One might, for example, subjectively feel that the likelihood of a 10-year project life is 10%, of an 8-year, 80% and of a 6-year life. 10%. This knowledge may be based on either a subjective evaluation or historical observation.

Decision Screening Criteria are the basis for comparing outcome. The strategy, which is finally selected, is the one associated with the most attractive outcome. The degree of attractiveness, of course, depends upon the criterion by which the decision-maker is comparing outcomes. It is much easier if the comparison is based on a single dimension as cost project or sales. Whenever there are multiple objectives and the weighing of each one is unclear, it becomes quite difficult to draw comparisons.

In the management of an operational system, the criterion chosen is usually the revenue which is usually out of the control of operational decision-makers. Therefore, the focus of operations management is the only variable over which control can be exercised.

One way of categorizing decision problem is by state of knowledge about the environment. One of three situations can prevail: decision-making under certainty, under risk, and under uncertainty.

In decision-making under certainty, it is assumed that only one environmental state will exist and the probability distribution i.e likelihood of the events occurring is known without doubt. That is, the state of environment is known with certainty.

The good examples of decision problem that fall under this category are the process scheduling problem and the inventory problem which employs the solution techniques of sequence and inventory technique respectively.

A decision matrix illustrating this situation is shown in the Table below

Table 1.1 A decision-making problem under certainty

Strategy (option)	***State of environment (event)***
S_1	$Q_1 = 14,000$
S_2	$Q_2 = 12,000$
S_3	$Q_3 = 11,500$
S_4	$Q_4 = 12,300$

Here the decision-maker must choose from among four alternatives. The outcomes represent the total cost for each strategy. If the objective is to minimize total cost, strategy 3 is chosen. In this example, only four strategies had to be searched to find the optimal one.

In another case, if you some how 'got the word' and know that it was going to rain today, our problem .would be considered a decision problem under certainty. As you will shortly see, decision-making under certainty is not always a trivial exercise.

In decision-making under risk, it is assumed that more than one environmental state exists and the probability distribution (i.e. likelihood of occurrence) of the possible environmental states is known with doubt. For example, a decision-maker might have the subjective feeling that there is a 10% chance that the life of a project will be 5 years, an 80% chance that it will be 6 years, and a 10% chance that it will be 7 years.

Consider an inventory problem where four ordering strategies are under review. One of three environmental states is likely to occur: demand for the product can be low, medium or high. The likelihood that any of these states will exist has been estimated by management to be 0.1, 0.6, 0.3. The outcome represents the consequence of a particular strategy occurring together with an environmental state. They were measured by the naira cost of operating the inventory system under those conditions as shown in Table

1.2. Since it is possible for stock-outs to occur, the proper adjustments have been made to the costs associated with each outcome.

Table 1.2 A Decision-Making under Risk

	Environmental State (E)		
Strategy *(S)*	E_1 *(Low)*	E_2 *(Medium)*	E_3 *(High)*
S_1	/0	15	12
S_2	7	19	11
S_3	8	12	16
S_4	12	7	[illegible]

It is probably reasonable to expect that this kind of decision will be made one and one again, and that none of these strategies involves substantia' portion of the firm's available resources. As a consequence, whichever strategy minimizes expected costs will be selected as the best.

The expected cost of strategy is simply the average cost that would be incurred if the process were repeated one and one again and if the likelihood of environmental outcome are accurate. Following this rule, the expected costs (Ec) for each of these strategies can be computed in the following way:

$EC_1 = 0.1\ (10) \times 0.6\ (15) \times 0.3\ (12) = 13.6$

$EC_2 = 0.1\ (7) \times 0.6\ (19) \times 0.3\ (11) = 15.4$

$EC_3 = 0.1(3) \times 0.6\ (12) \times 0.3\ (16) = 12.8$

$EC_4 = 0.1\ (12), \times 0.6\ (7) \times 0.3\ (20) = 11.4$

The selected strategy is therefore number 4, which has an expected cost of 11.4. Finally, in decision-making under uncertainty, it is assumed that nothing is known about possible states of the environment. Here, more than one environmental state exists but the probability distribution of these states is not known.

There are three major ranges of decision analysis namely: short-range decision analysis, medium-range decision analysis and long-range decision analysis.

- A decision analysis is short-ranged when the decision-making spans a period of not more than 2 years.
- A decision analysis is medium-ranged when the decision-making spans between 3 and 5 years.
- A decision analysis is long-ranged when the decision-making spans a period of more than 5 years.

DECISION TECHNIQUES AND TYPES

The two main decision analysis techniques include the qualitative decision technique and the quantitative decision techniques. Qualitative decision analysis is an aspect of decision analysis, which is not subjected to any known mathematical model. This is so because there is no available previous data to articulate the interacting and interdependent entities quantitatively in a decision situation. It is subjective in nature as it involves the use of human judgement as experts. It employs the sales' force opinion, rule of the thumb and intuitive reasoning as the basis of decision-making. In decision analysis, qualitative method can be subdivided into Delphi method, Market Research method and Historical Analogy method.

Delphi method of qualitative decision analysis is long range forecasting technique designed to obtain expert consensus opinion for particular future events. These. experts based their opinion on their past experiences and knowledge. It is not subjected to any known data based model.

The market research method is a short range forecasting technique which designs questionnaires to obtain the market response for a particular product design and price. It involves opinion surveys, analysis of market data and often very accurate for the relatively short range forecasts.

Historical Analogy method of qualitative decision analysis is the short and long range forecasting technique designed to establish the life cycle and the expected sales of the new products that have no past data. To establish the forecasting trend of the new product, data on similar product are analyzed and applied for it.

Quantitative decision technique is an aspect of decision analysis which is subject to some known mathematical models. It is very objective because it does not involve the use of human judgement as experts. Usually, previous data is always available to establish the trend of such events for forecasting purposes. The basic tools of Quantitative Decision Analysis include the statistical tools and the mathematical tools or Operations Research tools.

DECISION SITUATIONS AND MODELS

According to Fabrycky (1987:125), decision situations are categorized into four: The first postulates the state of certainty in which it is assumed that a single known future (or state of nature) will occur. The second is the state of risk in which the several factors that exists can be assigned probabilities of occurrence. The third is the state of uncertainty in which it is inappropriate or impossible to assign probabilities to the future. The fourth category states that the decision-maker is in competition with a goal-seeking opponent, instead of a passive opponent often called nature.

Akingbade (1995:50) identified five decision situations and the appropriate criteria for analyzing them.

In decisions involving certainty: there is complete information about the state of nature e.g. interest rate may be known for certain as against when it is unstable. Prices of a commodity may be known for certain in different markets. What we do is to go to where the price is least.

In Decision involving uncertainty: the decision-maker knows the events that may occur but does not know which will occur or the probabilities of their occurring. The analysis of this situation depends on the attitude towards risk of the decision-maker as to whether he is optimistic (i.e Hurwicz maximums criteria) indifferent (i.e. average outcome), pessimistic (i.e. Wald maximum criterion or best of the worst), Variable attitude (i.e. coefficient of optimism).

in decisions involving risk: the decision-maker may be able to assign to or compute probabilities of the event occurring, e.g. 0.4 probability that price rises, 0.3 that it is stable and 0.3 that it falls. The expected monetary value is employed to compute for each option and is the sum of the product of the probability and the corresponding outcome.

The matrix formulation of decision model deals with the tabular representation of outcomes of possible actions in the face of events that may occur. This paper presents the three basic classifications of decision models and the four categories of decision situations are developed and presented.

Once the objective, alternative strategies and the decision-making environments are known, the next step which a decision-maker faces is to select the decision model which can fit into his problem. There are various models used in decision-making, Some of the models are as deterministic.

DECISION MODEL

Deterministic model is related to certainly situation, probabilistic. The objectives and strategies in this model have to be listed and the pay-off for each strategy towards each objective is determined. For instance, if there are two objectives O~ and 02, the strategies to be selected are S_1 and S_2 and then pay-oil's are shown in the following matrix table

Table 2.1

Objective/Strategies	O_1	O_2	Total Payoff
S_1	a_{11}	a_{12}	A_{ij}
S_2	a_{21}	a_{22}	a_{2J}

Here, a_{ij} (I=1,2; j=1,2) refers to payoffs of ith strategy towards jth objective. Total payoff for strategy 1 is a_{ij} (i.e., a_{11} payoff towards objective 11 and a_{12} payoff towards objective 12) and for strategy 2 is a_{2j}. The optimum strategy would be the one having the largest total payoff (i.e. Maximum of a_{ij} and a_{2j}). In general, with m objective and n strategies, the decision payoff is as follows:

Table 2.2

Objectives/Strategies	O_1	O_2	O_m	Total Playoff
S_1	a_{11}	a_{12}	aim	Σa_{ij}
S_2	a_{21}	a_{22}	aim	Σa_{2j}
.	.	...	...	...
.	.	...	...	...
S_n	a_{nj}	A_{n2}	a_{nm}	Σa_{nj}

Here again 'a' refers to payoff of ith strategy toward jth objective. The optimum strategy in this case would be the one having the largest payoff (i.e. maximum of a~, a~... a~. Some of the deterministic decision problems can be solved by 'Mathematical and statistical model'.

Probabilistic/stochastic decision model relates to risk situation.
Decision payoffs are not fixed but generally happen to be a random variable.

Payoffs are determined partly by chance and partly by the strategies adopted. Hence, in a probabilistic decision model, a decision is made in favor of that strategy which has the maximum expected payoff.

Let us consider a simple matrix formulation decision and sample space example in which we have three sample spaces with three decision spaces. Sample spaces/objective are denoted by Q_1, Q_2 and Q_3 and decision spaces/options/strategies by

S_1, S_2 and S_3. The payoff matrix can be stated as under:

Table 2.7

Objectives/Strategies	O_1	O_2	O_3
S_1	a_{11}	a_{12}	a_{13}
S_2	a_{21}	a_{22}	a_{23}
S_3	a_{31}	a_{32}	a_{33}

The matrix of risk function can similarly be denoted as under. Table 2.8: **Table 2.8**

Risk Payoff Matrix

Objectives/Strategies	O_1	O_2	O_3
S_1	11	12	13
S_2	21	22	23
S_3	31	32	33

Where ij refers to the probability of selecting ith strategy toward the achievement of jth objective. Also p_{ij} for all i,j or p_{ij} = I

After knowing the above stated two matrices, the next step is to calculate the expected payoffs ε_{ij}, which can also be termed as Expected Monetary Value (or EMV). ε_{ij} is equal to the multiplication of decision payoff elements to the corresponding probabilities. The expected, payoff matrix would be as follows:

Table 2.9: Expected Payoff Matrix

Objectives/ Strategies	0_1	0_2	0_3	Total Expected Payoff (EMV)
S_1	E_{11}	E_{12}	E_{13}	E_{ij}
S_2	E_{21}	E_{22}	E_{23}	E_{2j}
S	E_{31}	E_{32}	E_{33}	E_{3j}

The best strategy in this case would be the one having the largest expected payoff or the EMV (i.e. maximum of E_{ij}, ΣE_{2j} and ΣE_{3j}). The similar treatment can be extended for n strategies with m objectives.

Competitive model is one related to the situation of uncertainty. In a situation of uncertainty, the decision-maker does not know the probabilities of occurrence of the different events (or the states of nature) and therefore act with imperfect information in such a situation, thus making it impossible for him to compute the expected payoff for his strategies. Consequently, there are no single best criteria for selecting a strategy to do within such a situation but there are many different criteria available for selecting a strategy. The different criteria available for selecting a strategy include: maximin rule, minimin rule, maximum rule, and minimum rule.

A maximum rule is the criterion of pessimism where the decision-maker is completely pessimistic and assumes that the situation will always be disadvantageous. As such, he selects the strategy, which gives largest of the minimum payoffs, i.e. the maximum of the minimum profit. This uses of profit or gain matrix. A minimum rule uses i in which the loss/cost matrix, we select the minimum of the maximum loss/cost.

MAXIMAX RULE

A maximax is a criterion of optimism where the rule of the decision-maker is quite optimistic assuming that the situation will always be to his advantage. He therefore selects the strategy, which yields him the best possible payoffs or the best of bests. It was a profit matrix, where the decision-maker selects the strategy which yields him the highest of the maximum payoffs, i.e. maximum of the maximum. The minimum uses the cost matrix, he selects a strategy which yields him the lowest of the minimum payoffs, i.e. minimum of the minimum.

A savage decision is a criterion of general insurance against risk where the decision-maker ensures against the maximum possible risk. Under it, the decision-maker adopts the strategy, which causes minimum of the maximum possible losses. Because of such an attitude, this rule sometimes also known as 'regret rule', for one looks at cost opportunities (losses) as regrets. Under it the payoff matrix is converted into regret matrix. In each cell, we enter the difference between what the decision-maker would have done if he had known which outcome would occur, and the choice represented by cell. Once the regret matrix is formed, the minimize criterion can be applied to it to select the best course of action.

A Hurwicz Decision Rule is a criterion of maximum and maximize rules with an index

of optimism (a) and an index of pessimism (1 - *a*). Developed by Hurwicz, the value of a always Lies between C) and I. The decision-maker should assign a value to a somewhere between 0 and 1. The value of a nearer to I means that the decision-maker is optimistic, and nearer to 0 reflects a pessimistic decision-maker and a = I ½ reflects a neutralist.

Largest and smallest values say V. U, respectively, be determined for each and every strategy by applying the maximum and maximize rules and then the expected value be determined as under:

Expected value X.V (I - a). u

The strategy having the highest expected value as per the above formula given by Hurwicz is selected.

The major difficulty in applying this rule is the measurement of the value of a., although more information than in minimize is being used while applying Hurwicz rule. Yet only the two extreme payoffs (viz: V and U) are considered and the remaining information is ignored.

A Laplace Decision Rule: Is a criterion of insufficient reason where the decision-maker assumes that the probabilities of different t states of nature for a given strategy are all equal. Considering these equal probabilities the expected payoffs will be calculated as per the method already stated in the maximize rule (i.e. the strategy with the highest expected payoff is selected).

Note that there is no single best rule for decision-making under the situation of uncertainty. There are several models for the purpose. The choice for the selection of a model should be left on the decision-maker who should ultimately decide as per his own skill and experience considering the environment, firm's policy and other relevant factors.

DECISION THEORY AND VALUE OF PERFECT INFORMATION:

Situations involving uncertainty is one in which there is imperfect information, One may want to obtain lull information in the manner of situation involving certainty. There is a level of expenses above which it is not economical to pay.

Example 1

Consider the following payoff table

	State of nature		
Probabilities	0.4	0.5	0.1
Alternatives	S_1	S_2	S_3
A_a	100	-500	250
A_2	-1000	750	-200
A_3	250	-300	-200
A_4	150	-100	300

Computation of value of perfect information: Value of perfect information can be computed as follows:

For each column, select the best outcome known as columns maximize. In the above they are 250, 750, 300 for the respective columns. The expected value for this scenario is:

$0.4(250) + 0.5(750) + 0.1(300) = 100 + 375 + 30 = 505$

This is the expected value of paying for information as against the expected value of not paying for the information

$A_1 = 0.4(100) + 0.5(-500) + 0.1(250) = 40 - 250 + 25 = -185$

$A_2 = 0.4(-100) + 0.5(-750) + 0.1(-200) = -400 + 357 - 20 = -45$

$A_3 = 0.4(250) + 0.5(-300) + 0.1(100) = 10 - 150 + 10 = -130$

$A_4 = 0.4(150) + 0.5(-100) + 0.1(300) = 60 - 50 + 30 =$

Thus the highest that could be paid to break-even is *505* – 40 = N465

This is the value of information in the situation.

2. **Maximize criteria**

	Min	Max.
A_1	-500	
A_2	-1000	
A_3	-300	
A_4	-100	100 Accept
		A_4 option.

3. **Maximize criteria**

Options	Max.	Max.
A_1	250	
A_2	750	750 A2 option is
A_3	200	chosen
A_4	300	

4. **Laplace (Average)**

A_1 $\frac{100-500+250}{3} = \frac{-150}{3} = -50$

A_2 $\frac{-450}{3} = -150$

A_3 $\frac{50}{3} = 16.67$

A_4 $\frac{350}{3} = 116.67$ A4 is chosen

5. **Hurwicz criteria with 0.3**

$A_1 = 0.3(250) + 0.7(500) = 75 - 350 = -275$

$A_2 = 0.3(750) + 0.7(-1000) = 225 - 700 = -475$

$A_1 = 0.3(250) + 0.7(-300) = 75 - 250 = -135$

$A_1 = 0.3(300) + 0.7(-100) = 90 - 70 = 20$ A4 is chosen

6. **Minimize Regret.**

Column Max:	*250*	750	300	Max Mm	
A_1	-150	-125	-50	-50	is chosen A_1
	750	0	-500	750	
	0	-10	50	-200	0
	100	-850	0		
	0.4	0.5	0.1		

7. **Expected monetary value = -20 option A4 is chosen**

8. **Expected opportunity loss**

A_1: 0.4(-150) + 0.5(-125) + 0.1(-50) = -60-625 - 5 = 690

A_2: 0.4(750) + 0.5(0) + 0.1(-500) = 300 + 0-50 = 250

A_3: 0.4(0) + 0.5(-1050) + 0.1(-200) = 0-525 -20 = 545

A_4: 0,4(-100) + 0.5(-850) + 0.1(0) = -40 -425- 0 = -465

CONCLUSION:

Only very few decision makers will simply adopt the results of decision analysis without questions. There may be other quantifiable factors to be considered.

According to Akingbade (1995) the six interacting entities of decision analysis are the decision-maker, the decision environment, the decision objective, the alternative courses of action, the pay-off and the decision criteria. The decision maker is the manager. The decision environment is the decision situations of certainty, uncertainty or risk. The decision objective is the goal or objective the manager is trying to achieve as maximizing profit, sales, market share, or minimizing cost, loss etc. The alternative course of action is the range of possible options the manager should systematically search for. The pay-off is the value of the possible outcome associated with each strategy in terms of decision -maker's objectives, and the decision-making criteria are the techniques of selecting the best out of a number of options. It is possible that some conflicts may arise between different objectives (e.g. between maximize profit and market share) it is important that all reasonable courses of action are identified as it is possible that an unlikely strategy may best achieve an objective, The discipline of attempt to apply decision analysis should help to ensure that such conflicts are resolved and such options are not over looked. The decision structure is usually presented in the pay-off matrix (i rectangular format) that portrays the relationships between the pay-oils and the associated outcomes.

The experience, skill and flair of the management is extremely important for good decision-making but decision — making can be helped by the use of decision analysis (Bunu. D., Hampton H., Moore, P. and Thomas H. 976). Decision analysis can help to identify the relationship between a sequence of decisions and their outcomes. It can also help the manager take uncertainty into account in a more formal way. Subjective judgment is highly important but decision analysis introduces a technique for revising it in the light of subsequent evidence.

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