Chapter 9

Decision Making and Information Systems

Decision making is one of essential management tasks. Effective decision making is *informed* decision making. Managers get informed via information systems, oral communication, and possibly in other ways. This chapter explores decision making from the perspective of a standard rational model and two alternatives that exist in reality. The chapter also discusses information systems for making decisions at different levels of management – Decisions Support Systems (DSS), and TPS and MIS, which were already described in great detail.

Decision Making and Management

A big part of management is decision making. It is involved in almost anything managers do. A classical list of managerial tasks includes planning, organizing, staffing, delegating or directing, coordinating or controlling, reporting, and budgeting (note the acronym POSDCORB). Some of these tasks are a direct application of decision making, such as planning and delegating or directing. Other tasks usually result in decisions. So for example, organizing work in organizational departments and offices requires analyzing a current work situation and the next step may be deciding on changes. Similarly, hiring new employees and assigning employees to jobs (staffing tasks) also end up with a management decision.

A decision is about choice making. A decision maker needs to have two or more choices (options) available and then choose (select) one of those that makes the decision. Recall that in process diagrams a decision is represented with a question inserted in a diamond shape, followed by optional output steps resulting from possible answers (choices). In more detailed diagrams, the decision diamond can be broken down to an entire process.

The choices can be carefully evaluated to arrive at the best one. This is the case of ideal, rational decision making. However, when decision makers work under some pressure they may need to settle for a choice that is good enough rather than perfect. Even more of deviation from rational decision making happens when decision making is performed over prolonged periods without delivering a clear decision.

Any decision is made for a purpose. When a manager faces some problem, she/he concentrates on it in order to find a solution. As there is a start point (a problem) and the end point (a decision), there must be some activities in between these. Altogether, they make a process. Here are some examples of the problem that can initiate a decision process: supplies are being expended more quickly than planned, a job position gets vacant and has to be filled, a budget must be allocated between purchase requests, annual bonuses are to be awarded, strategic goals need to be defined, and so on. Decisions can apparently apply to everyday operations (e.g., delegating tasks to subordinates), a close future (e.g., monthly purchases for replenishing the inventory), and a more distant future (strategic goals setting).

Once a decision is made, a decision maker needs to ensure that it will really solve the problem it was made for. This includes additional steps of monitoring decision effects and of adjusting the decision if the effects are not as expected. Only when a decision really solves the problem, the problem solving process is over.

Decision making processes are data-intensive. A manager may need various reports, business documents, analyses, and direct communication in order to get prepared for making effective decisions. The scope of data coverage depends on the level of management and the problem dealt with. In addition, decision making requires knowledge. In particular, knowledge of business is a part of management competence. This knowledge is practical experience rather than theoretical knowledge, and it facilitates effective informing of the manager. All IS types supporting management, which were mentioned before, assist in decision making.

Process of Rational Decision Making and Problem Solving

Herbert Simon developed a rational model of decision making and problem solving, which intended to raise this management task to the level of science. Figure 1 depicts this model as a circular process. The process starts with the problem identification. Competent managers are familiar with the workings of their organization and have a sense of potentially problematic areas. Still, they need to do their homework and learn about a problematic situation as soon as the first signals occur. At this point, TPS and MIS play an important role. Managers use reports and queries from these systems in order to recognize potential problems requiring management attention.

MIS exception reports are particularly helpful at the problem identification step because these are automatically created when a significant deviation from a planned organizational performance occurs. For example, a processed food producer may have a sudden drop in sales in the past quarter. This drop would trigger a purchasing MIS to create an exception report. This report could be sufficient for a sales manager to identify the drop in sales as a problem. The MIS exception report also helps in identifying the products with the declined demand and their buyer (let us assume it is one single distributor company).

Once a sales drop is detected as a problem, the manager-decision maker has to dig deeper and narrow down the problem definition. The manager gets into a role of investigator who makes hypotheses about the source of troubling sales, examines them, and filters them out until reaching the most valid definition of problem. But before going any further, the manager wants to check historical figures in order to see whether a drop in sales of the problem products has ever occurred in the past. The exception report may or may not show such historical figures. If not, the MIS usually has such querying capability. It usually provides the answer in graphical format for quick informing. Finding out that the current drop in sales is cyclical may actually be the end of the decision making process, as there is really nothing that can be solved in that case. The sales will rebound anyway, once the period of the cyclical drop is over.

But if the sales drop is not a cyclical event, the manager turns to the leads from the MIS exception report – the underselling products and their distributor. He may want to explore if there is anything in the characteristics of these products that can define the problem in more specific terms. For example, what are the ingredients of those food items? An ad-hoc query in a product database (which is a part of a production TPS) would answer the manager's question. He finds that the products contain higher concentrations of fats and sugars. Does that fact turns the consumers away? It might, but the manager does not really know for certain and needs help of market research.

Let assume that this company does not have the capability of researching consumer markets, so help must be sought outside. At this point, the decision process is escalated to higher management levels, as the environment scanning enters in the decision process. Vice presidents for marketing and operations joins the decision making team. A corporate business analyst also gets involved. Luckily, the business analyst quickly locates a market research firm that had published reports on trends in the processed food demand within the geographical markets of interest. With this help, the managerial team gets to learn that the products comparable to their company's underselling products have not really experienced a significant drop in sales. Therefore, they conclude that the market does not reject the sort of food products that the company sells.

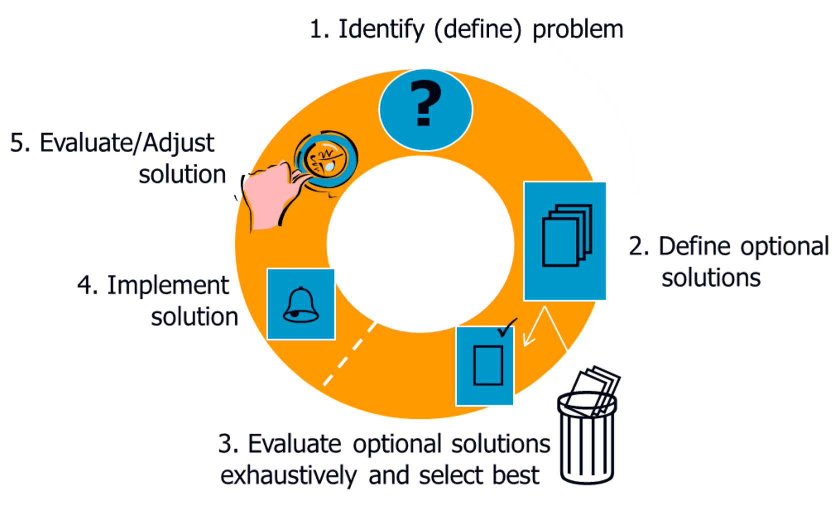

Figure 1. Rational decision making

Rational decision making implies that all possible angles are examined at the problem identification step until the problem gets defined perfectly. To do so, the decision making team needs to expand investigation inside the company to potentially relevant issues, such as production quality. The investigation outside the company would also need to expand by focusing on substitute products. To keep it simple, let us assume that this investigation ends by returning to the initial lead. The management team defines the problem as “distributor-related sales drop.” They are reassured of this when they discover through their sales MIS that the sales of other products to the same distributor have also fluctuated significantly in the past. With this conclusion reached, the first step of rational decision making is completed.

The *second step* in rational decision making is about defining optional solutions. In our example, one solution may be to inquire with the distributor about reasons for the sales drop and to renegotiate terms of trade, so that the distributor accepts purchasing quotas. The next option may use the similar idea but defined in a more formal way – changing the contract with the distributor with the formally defined liability for the distributor’s underperformance, and perhaps with rewards for an outstanding performance. Yet another solution may be to switch to a new distributor. This option would include searching for a comprehensible list of distributors operating in different geographical markets. Still another option is to bypass the distributor and to sell directly to retailers. Furthermore, some of these options may be combined (e.g., renegotiating the terms of trade with the distributor and exploring the retail option at the same time). Still, this is not an exhaustive option list. The rational decision making assumes that all valid solutions are to be defined because only in that way the final solution is really the best option.

The *third ste*p in rational decision making is the evaluation of optional solutions. The management team evaluates pros and cons, or benefits and costs of the options. Most of the analysis is financial. For example, the first option in our example (“inquire and renegotiate terms of trade”) may be cheap, but its benefits in terms of increased sales are questionable. Changing the contract with the distributor may cost more in time and money (tangible costs) and it could be hard for the distributor to accept (which is an intangible cost). However, this option could give the company more control over sales, that is, larger benefits. The distributor switching option could be even costlier but more capable of resolving the problem. And so on. Larger benefits cost more.

In weighing costs and benefits, our decision making team puts at work the company’s financial DSS. Their system has a data modeling module that consists of formulas for processing numerical data. For a moment, think of spreadsheet software like Excel (see more below). A financial analyst has entered all the solutions in the DSS. Upon a discussion, the decision makers determine benefits and costs to each of the solutions and make quantitative assessments of these. The benefits are assessed in terms of the sales increase in certain periods of time.

The DSS is further instructed to weigh costs and benefits for each solution, so that it creates several scenarios. Assuming that costs are constant, one scenario increases benefits while another decreases benefits for the same percentage. Another set of scenarios keeps benefits constant, while varying costs up and down. The DSS is instructed to evaluate the optional solutions and to rank order them according to the benefit/cost ratio. The system delivers the requested scenarios within seconds. Now it is up to the decision makers to examine each scenario and to select the winner. Optionally, they may need to adjust some numbers and to run the DSS again before arriving at the commonly agreed outcome.

Figure 2 depicts the rational decision making process with accompanying support of MIS, TPS, and DSS.

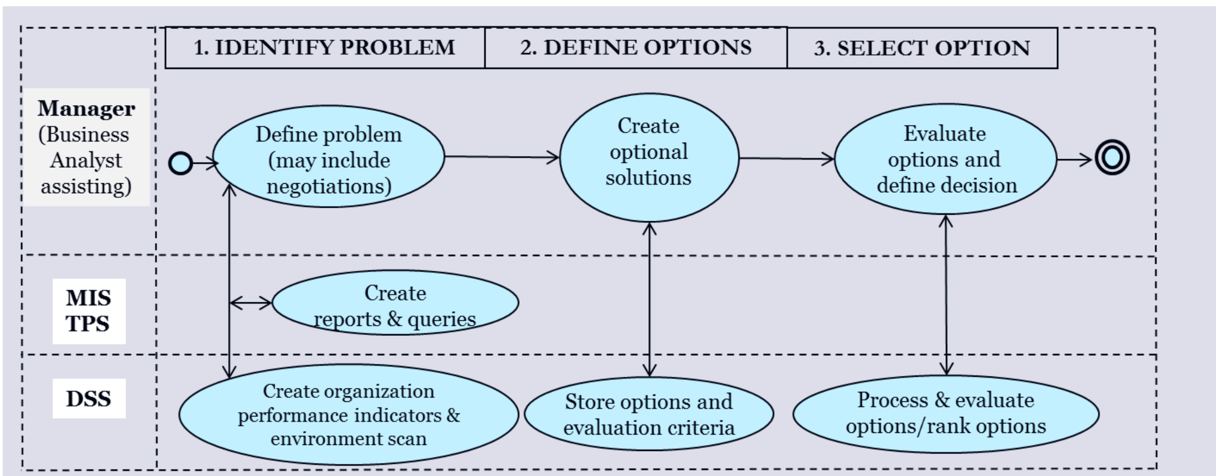

Figure 2. Rational decision making with support of IS

Completing Problem Solving

Although a decision is made, the larger problem solving is not over yet. A decision is officially put in force so that it becomes a guide for conduct. The manager-decision maker then needs to monitor effects of the decision. He expects that the decision will resolve the problem for which it was made. This may happen so, or not quite as expected. This monitoring makes the fourth step in the entire problem solving process. If the decision effects are as expected, the decision maker does not need to intervene. However, if the decision has not produced expected effects, the decision maker has to take another step toward adjusting the decision. In the given example, if the sales do not recover within an expected period, the decision makers need to adjust the decision (the solution). For example, if option one was the winner ("inquire with the distributor and renegotiate terms of trade"), the decision makers need to get back to the negotiation table with the distributor. After adjusting the solution, monitoring of real effects resumes.

The rational model of decision making and problem solving is based on several assumptions. First, a decision maker is perfectly informed when defining a problem, creating optimal solutions, and when evaluating them (steps 1-3 in Figure 1). Second, the model does not account for constraints, such as time and resources (human, material). While you should deploy the rational model whenever possible, you should know that its assumptions are rarely matched in reality. This fact limits the model's applicability. For example, it is used in situations that are more familiar, such as in IT purchases. When a particular piece of software or hardware is to be purchased, you can identify comparable products and then rate them on capabilities and cost items. The result is a long scoring table that will clearly identify the winning product. Therefore, the rational model will certainly be valuable. Still, keep in mind that its full implementation requires that the list of competing products is exhaustive, the list of features and cost items is complete, and that a scoring table should be created for each piece of IT while planning an IS. Such a tall order is apparently hard to meet, and some compromising is necessary. Therefore, even with this simple problem, the rational model may not apply in full. In real-world organizations there are even more extreme deviations from the rational model, as the further discussion will show.

Decision Support System

DSS is deployed when important decision about an organization's future have to be made. If the food producer in the discussed example does not put a halt to the dropping sales of certain products, the company's revenues may suffer on the long run. DSS serves higher management levels. In the food producer case, the problem was initially addressed by a mid-level manager, but then it was escalated up the hierarchy. The team of decision makers then used a financial DSS in evaluating optional solutions to the problem of underselling products.

Another DSS that was implied in the case is a marketing DSS that the company did not own and therefore had to rely on services of a marketing research firm. Producers that are directly involved with consumer markets may own such a DSS. As the larger segment of data in this system comes from the organizational environment, it brings the challenge of feeding it with current, complete and accurate market data. Not every company can afford responding to this challenge.

Problems to solve with a DSS are less structured, that is, less possible to understand and analyze than those pushed down to MIS and TPS. This lack of structure is due to viewing a larger picture of an enterprise. In addition, a whole new segment of the organizational environment is added. Therefore, sources of DSS data are both within a company and outside of it. As for the organizational sources, a DSS delivers *key performance indicators*. Examples are the state of cash flow in the whole enterprise, year-to-date summaries, year-to-date breakdowns of earnings, expenditures, business hours, purchases and sales, and similar aggregated figures.

The key performance indicators are usually represented visually in easy to understand and attractive formats. One such format is the dashboard represented in Figure 3. It resembles the dashboard in cars, with gauges indicating safety (the green zone of the round gauge), danger (the red zone), and neutrality (the yellow zone).

Figure 3. A DSS dashboard

Any DSS also has a *drill-down capability* that allows for investigating what is behind the aggregate figures. The user just needs to click on a particular number or button on the screen to get more specific data.

The content of environmental data varies with the DSS domain. Examples are competition figures, government regulations, product development trends, technology trends, and market analyses. Environmental data can also be displayed via dashboards.

A model of DSS is depicted in Figure 4. It shows that DSS performs modeling and mining of data. These capabilities are supported by a core module of a DSS. As any other information system, the DSS also has the user interface (as a dashboard cited above), and some databases (e.g., for environmental data). The figure also indicates a link between the DSS and MIS. Drawing on TPS databases, a MIS outputs feed into a DSS. (Recall the concept of hierarchy of information systems supporting different levels of management.)

Figure 4. Basic design of DSS

Model-Driven DSS

There are two main types of DSS: the *model-driven DSS* and the *data-driven DSS*. The DSS discussed in this chapter's case is model–driven. A model-driven DSS is a system that has a special module for analyzing quantitative data in order to get answers to particular questions. This module can perform what-if analysis, statistical tests, process simulation, and some other kinds of analysis.

A model-driven DSS for what-if analysis can modify or create input data in order to arrive at a desired result of calculations that the user programs into the system. For example, a user wishes to optimize returns from an investment given the certain input parameters (cost, interest rate, return period). The system can calculate one of the input parameters (as in Excel's Gaol-Seek) or several (as with the Solver that runs multiple structural equations). The analysis can also move in the opposite direction, where the target result keeps changing with changes in input parameters (in Excel, this is called scenario analysis).

Another kind of the modeling core of DSS performs statistical testing. Usually, a hypothesis about a causal relationship is tested for its acceptance or rejection. An executive may want to see if the productivity increase is due to job satisfaction or investments in new IS, or perhaps both of these factors combined. A DSS supporting statistical regression analysis may suggest an answer.

In contrast to the above DSS modules that work with static data, a special kind of DSS modeling core can run simulations. An example is simulating complex manufacturing operations in the global space, where supplies come from distant places, and there could be unforeseen events, such as the equipment downtime, disruptions in operations and fluctuations in orders. Another example is simulating business processes to test their different designs and effects on process performance. Figure 5 is a screen shot from one such business process simulator, which can be used in a DSS. Simulations are used when decisions are made about dynamic reality, where changes of different aspects coincide and some values cannot be predicted with certainty.

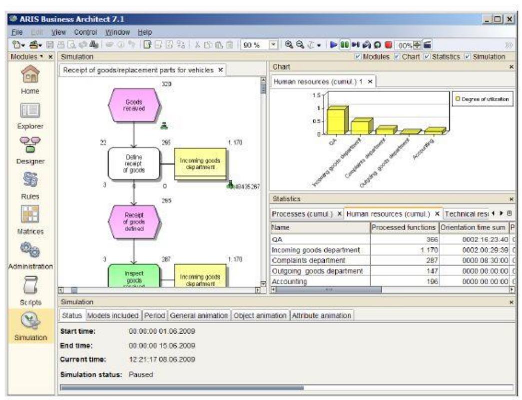

Figure 5. Business process simulator as part of DSS

Data-Driven DSS

Data-driven DSS deploy large repositories of organizational and environmental data in order to find out new relationships and patterns. One widely used data repository is called *data warehouse*. Think of a warehouse of material products, which may store various kinds of things in large quantities. The same idea applies to a data warehouse. Its data come from various sources, including relational databases used in TPS and MIS. However, the table structure usually must be abandoned in order to integrate the data from relational databases with other data.

Once a data warehouse is created, software for *data mining* is applied on it (see Figure 4). As if the soil is mined for precious metals, different data mining software may detect different things. Put in the perspective of decision making, data mining defines the problem of decision making in the form of three questions:

(a) Which events do flow in sequence?
(b) Which events coincide?
(c) Which entities go together?

As an example of question A, the specific problem to solve is: Do customers buy a new TV and a DVD player sequentially within a predictable period of time? A "yes" answer may shorten the decision making process immensely. It leads directly to management action of promoting the products whose purchases are related in time.

An example of question B is the following problem: What do customers buy together? For example, it was found through mining sales data of an American grocery chain that beer and baby diapers were purchased together by a particular profile of customer (a male of the usual parenting age) always at a particular day and time. This sort of finding can again lead to immediate management action. In this case, the identified products can be displayed together in order to increase sales.

An example of question C refers to identifying customer groups based on income level, age, home location, purchase period, etc. In other words, the data-driven DSS is used for market segmentation, as mentioned above.

Note that the data-driven DSS modifies the classical rational model of decision making: if the above questions could be taken as the problem definition, the subsequent steps in the model are performed by the system in a straightforward manner without options characterizing the rational model. Current efforts in the data-driven DSS are focused on using Big Data in addition to the traditional sources. Big Data come in forms that are more varied than the alpha-numeric data fitting relational databases.

Figure 6. Sometimes data mining delivers surprises

Satisficing Decision Making

Trying to make decisions in the rational manner discussed at the start of the chapter, decision makers carefully investigate problems to arrive at the best definition, work hard on creating optional solutions, and weigh these carefully. However, there are various kinds of limitations in organizations that can derail this process. Managers often lack time and resources to get to the best possible decision. Other limitations involve opposed views and unsupportive reaction of the people involved. Perhaps even more upsetting for a rational decision maker is the fact that not everything is always clear in organizational life. Even the first process step of problem identification may present a stumbling block that is hard to get around. Decision makers usually need some time to "digest" and investigate an initial recognition of a problem, as discussed above.

The author of the rational decision making model realized these constraints, and developed an alternative model. So, Simon came up with a model of "satisficing" decision making. He invented this word to convey the idea of decisions that are good enough, given the constraints under which they are made. A satisficing decision is less than satisfying, but it may be made quickly and can serve the purpose.

To understand this model, imagine that you want to buy a mouse for your PC. You have only five minutes to complete the purchase in an unfamiliar electronics store. The store is large, and there is no sales assistant in sight. You run around as the clock is ticking. Finally, you find a shelf with computer mice and browse through it. But you cannot see your favorite product. You change your mind: instead of looking for that perfect mouse you will go for one that will do the job for the moment. At the least, the mouse should sit well in your hand and be on the cheaper end. You spot one cheaper mouse, and you try it. It feels OK in your hand. Here is another. A bit less comfortable but the price is right. There is no time for more searches. You decide to go for the lower price since you will not use that mouse forever, anyway.

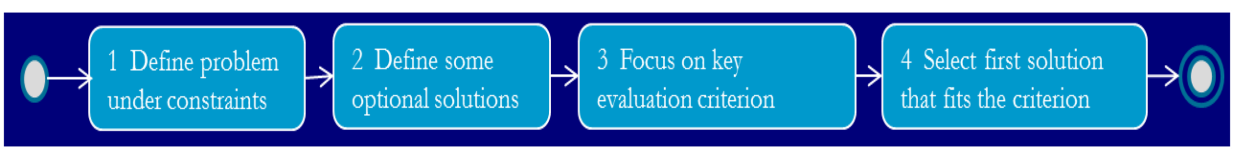

Figure 7. Decision Making

What you have done in this example complies with satisficing decision making (see Figure 7). You purchased a mouse under a severe time pressure, in an unfamiliar environment, and with no help. Realizing the constraints, you simplified the problem definition ("buy an affordable mouse that fits your hand"). Then you found two candidates and ended the search. Assuming that you are buying a throwaway thing, you stacked your final decision on the price, and picked the fitting product.

More often than not, organizations have to make decisions under similar and even worse constraints. There are limitations in time, organizational resources, conflicts between factions with different interests, as well as in cognitive capabilities of decision makers. Therefore, quick and imperfect solutions are a real rescue in these circumstances. They can do an important part a job in an acceptable manner. For example, instead of running an elaborate rational decision process when buying a PC, the problem can be defined so that a "good enough PC" is sought. It should have a large RAM and a mid-range speed of CPU, and be in a mid-range price category. An online search of PC products can deliver screens of corresponding products. In quick decision making, you may look at the first screen or two and pick out the first PC that matches your criteria. The trouble with "good enough" decisions is when the temporary solutions they deliver become permanent, and when decision makers get used to make most of decisions that way.

MIS and TPS may help in satisficing decision making by shortening the time for steps 2 and 3 in the model shown in Figure 7. Assume that the electronics store had an online catalog on its Website. You could browse it in the store or on your smart phone while making stops during the drive to the shop. You could set search conditions for the size and price and get the picks instantaneously and neatly sorted. Informed so well, you would enter the store with the clear idea of what you wanted to buy.

Evolutionary Decision Making and Problem Solving

As the service sector is capturing an increasing part of economy, it is important to know something about the way decisions are made in it. In particular, American public hospitals as the place for decision making were on the research agenda of Charles Lindblom. He found that decision making and problem solving unfolded through a more flexible process than those discussed so far. However, this process was usually complex, involving too many players. An administrator could not make a decision without other stakeholders (internal and external). The exact number of stakeholders was not always possible to plan in advance. Struggles over budgets and assets were a norm rather than an exception, making the process very political. Nobody was able "to cut the knot" and move the process decisively forward. The uncontrollable process complexity led to problems in process coordination.

The sub-optimal process design resulted in suboptimal performance of the decision process in the hospitals Lindblom investigated. Most apparently, the start-to-end time was out of control as decision making in some cases dragged in nearly infinite loops. Some processes could not even get past the first step of defining the problem. Decision makers would engage in prolonged negotiations and maneuvering in order to protect their interests. Worse yet, decision makers would reopen the solution repository after one solution was already put in effect. The consequence was a prolonged decision process time. All in all, decisions evolved via slow, complex processes, rather than being made in a rational fashion. To characterize this, Lindblom used metaphors of muddling through and zig-zig movement.

Figure 8 represents some of the characteristics of evolutionary decision making. Solution options are defined tentatively because decision makers cannot agree on clear-cut definitions. An optional solution is implemented just partly. If there is a strong push back, the administrator switches to an alternative. This may happen as many times as the blockages occur, resulting in a zig-zag path. And it may so happen that after trying many optional solutions, decision makers even get back to the first option that was discarded a long time ago.

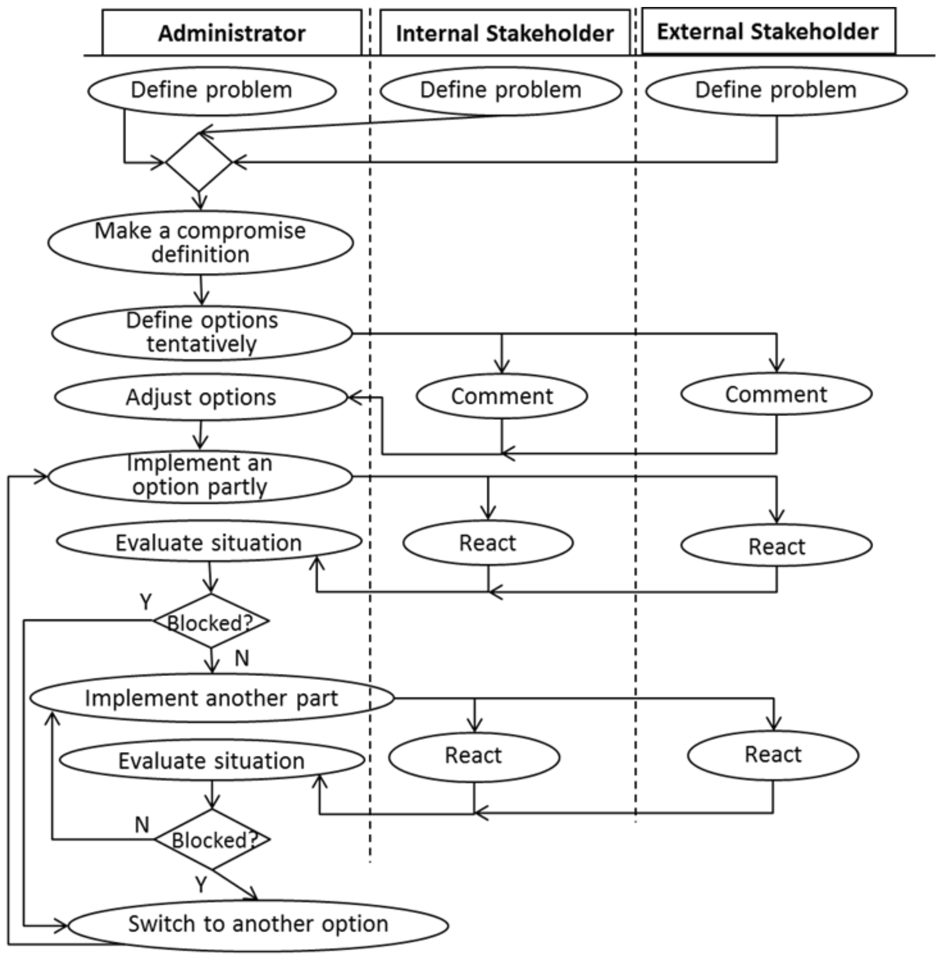

Figure 8. Evolutionary decision making process

Evolutionary decision making may deploy TPS, MIS and even DSS. However, given the maneuvering and struggling aspects of this process, it is difficult to predict if the systems will really be used and what impacts they can make. Nevertheless, enforcing the use of IS in public organizations may contribute to more effective channeling of their decision processes.

Questions for Review and Study

1. Define steps in the rational decision making. (Simon's model)

2. What is the relationship between rational decision making and problem solving? (Simon's model)

3. How do information systems support rational decision making?

4. What is the core part of a DSS? Give an example.

5. List three examples of DSS use.

6. Define data-driven DSS, and provide an example of its capabilities.

7. Define model-driven DSS, and provide an example of its capabilities.

8. Why the rational model of decision making may not work in reality?

9. Define an alternative to rational decision making and explain two differences between it and the rational model.

10. Specify two similarities and two differences between satisficing and evolutionary decision making.