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Radical Impact of Change in Actions and Confidence Index on Reverse Decision Making an Application Based Study

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RADICAL IMPACT OF CHANGE IN ACTIONS AND CONFIDENCE INDEX ON REVERSE DECISION MAKING: AN APPLICATION BASED STUDY

by

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ABSTRACT

RADICAL IMPACT OF CHANGE IN ACTIONS AND CONFIDENCE INDEX ON REVERSE DECISION MAKING (RDM): AN APPLICAION BASED STUDY

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While making decisions under uncertainty, people are often unaware of the logical approach to form the decision process. It is assumed that collecting details, analyzing and evaluating data is enough to make 'proper' decisions. However, past research in the decision making arena has significantly validated that there exists a class of decision problems which is complex, ill-structured and not defined to the level where decision makers can draw logical conclusions based on existing traditional decision approaches. RDM (reverse decision making), one of the novel approaches of decision making under conditions of uncertainty, has shown potential towards addressing some of these ill-structured, chaotic problems.

Research group from the Department of Engineering Management and Systems Engineering (Old Dominion University) has validated the RDM approach at the exploratory level where some of the RDM constructs are verified. For instance, these RDM constructs include the following: under dynamic and consistently changing decision environments initial decisions are based on desired outcomes and their perceived feasibility; secondly, the sequence of events happening during the decision process significantly impact or alter the decision makers' confidence level of attaining the outcome at a given point in time. The postulation is that when confidence drops below an acceptable threshold or the desire to attain an outcome dissipates, the decision makers

shift to a new decision alternative. Nevertheless, there is a vital RDM component which is yet to be captured in RDM, and that is the effect of the decision maker's action on the confidence index in the selected decision alternative and the impact of those variations on the confidence index in the RDM process. Our research proposes that under the RDM process the outcome from the actions taken by decision makers to achieve a desired objective leads to change in their confidence index in the selected decision alternative. Further variations in these confidence indices also results in a positive or negative impact to the decision path selection.

The experimental study has been conducted to verify the proposed RDM constructs. The experimental results validated the correlation between the decision makers' action and their confidence index in the chosen decision alternative.

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1. INTRODUCTION

1.1 Problem Statement

Reverse Decision Making involves a process in which decision makers make an initial decision based on their desired goal (value premise) which is very much inspired by their desire (motivation) and confidence to achieve that particular outcome (Sabne 2006). The desired state or decision may be considered as the end point towards which the decision maker directs the decision-making (McFarland 1979) and what they would like to see as a final outcome. The proof of concept for RDM at an exploratory level has made appreciable efforts to post challenges to some of the great work done by decision theorists like Simon (1960), Hammond (1980), Redford (1977), etc. who support various rational procedures for making decisions following rational laws of behavior. Hammond's (1980) judgmental analysis proposes the role and usefulness of judgment while making decisions in situations of stress. Redford's decision model also demonstrates decision approach under complexity. Nutt's (2002) conventional model sees clear sequential decision steps such as identifying the problem, generating alternative solutions, evaluating and choosing, and implementing the solution. However, the problems with these classical and behavioral models are that they assume a stable and consequently linear environment (McKenna and Smith 2005). These methods fail to represent decision approaches under complex, unstable and chaotic environments. RDM presents a framework that facilitates decision making for certain types of complex, chaotic situations. Reverse Decision Making at the exploratory level intends to represent how decisions are effectively made and desirable states are attained in complex situations

that incorporate high levels of aleatory uncertainty and incomplete knowledge is incomplete (Sabne 2006). RDM is intended to provide guidance for the decision making process as it applies to immediate or a long term course of actions (Sabne 2006).

Today, the existing status of RDM clearly demonstrates the following: firstly, the effect of the decision maker's desired goal and perceived feasibility role in selection of decision alternatives under dynamic and consistently changing decision environments, and secondly, the positive or negative impact of a sequence of events on the decision maker's confidence level and decision path in regards to attaining the particular outcome at a given point in time. However, according to Beech and Connolly (1980), typical methods begin with an analysis of the decision problem; then a suitable selection of actions in regards to the desired goal, and finally the implementation of actions selected.

In uncertain situations, the actions may not lead to feasible outcomes as there are anomalous events occurring (Beech & Connolly 1980). This adds a new dimension to the RDM process where, to counter or respond, based on the type of feedback from the decision environment, decision makers consistently take actions to keep up their decision path. Decision makers either take these actions based on their previous experience, or they attempt to fine tune their decisions based on their previous ones they made to achieve the desired goal (Sabne 2006). Beech and Connolly's findings clearly indicate the need for understanding the radical impact of the decision maker's actions in the RDM process. They would provide new RDM construct in terms of action and also new insights to understand how decision makers' action outcome results in variations in the RDM process. The expected outcome of analyzing action construct would be to capture one of the prime factors that cause variations in the RDM decision patterns and also to

improve our understanding of how the decision outcome impacts people's choice while making decisions under chaotic, uncertain environments. Based on these conditions it is not feasible to predict the decision maker's actions during the sequence of events or provide a more "optimal" solution during the goal attainment process. Nevertheless, impact can be observed to the extent that we can predict real approach by decision makers' in the RDM approach.

1.2 Purpose

The purpose of this research project is to empirically demonstrate the impact of vital RDM components, such as action and confidence index on select RDM constructs during the decision process. This is to be measured by using a lab based quasi - experiment and a dynamic model. The objectives are to see the following: 1) how decision makers use actions (or change in actions) to oppose the effect of negative feedback from the environment 2) how variations in confidence result in a positive or negative impact on the decision path selected.

The intended outcome of this research is to obtain categories of generic levels of the action based on RDM patterns by analyzing the impact of the decision maker's action and confidence index on existing RDM patterns. This will also improve our understanding of the decision making process under uncertain and dynamic situations. Ultimately, the goal of this research project is to contribute knowledge to the decision making arena and expand our horizon of our understanding of the Reverse Decision Making process.

1.3 Significance

At present, although there exist numerous studies and validated decision models to explain decision making under complex situations, there are no sound methods or studies that have a holistic and robust view of how people make decisions in those complex situations. Even though the RDM approach has shown considerable progress at rudimentary level to explore real world approaches by decision makers under such situations, research remains to test critical factors. Reverse Decision Making is still considered to be in its infancy, and this research is undertaken as an extended exploratory research to capture select variables in the RDM process. The research would be significant in various ways:

1) Analysis and comparison of existing RDM patterns and newly obtained action based patterns will give useful insights on causes of misperceptions in decision making and how people take different approaches in various chaotic situations.
2) The RDM model has the potential to support decision making in almost all existing fields where decisions are made under chaotic and uncertain situations; such as military decision planning, DRP (disaster recovery planning), organizational decision making, finance sectors, medical and health science, project management, etc.
3) The RDM model is also capable of posing challenges to the established decision approaches and finding out flaws in those processes of our understanding of decision making under uncertain conditions.

1.4 Framework

This thesis will provide an extension to the existing RDM proof of concept at the master level. The research project would specifically focus on studying the radical impact of the decision maker's actions on change in confidence index and decision path during Reverse Decision Making process. The research topic was chosen based on conclusions from the RDM proof of concept that expresses the need for understanding the role of actions as an RDM construct while making decisions under uncertainty and also due to current research undertaken in the Department of Engineering Management and Systems Engineering (Old Dominion University). Additionally, literature collections of Beech and Connolly (1980) support the same need of looking at the decision making processes from an actions perspective.

2. LITERATURE REVIEW

The literature review starts with defining the decision process and a briefing on the existing decision models. Further, it illustrates the uncertainty in the decision making process and how the RDM captures those uncertainties. The later half of the literature focuses on the role of action as a critical component of this research project and how the decision maker's actions have an impact on the decision making process. The literature review concludes with an explanation of variations in confidence index due to decision makers' action outcome in the RDM and validating the importance of identifying the impact of action and confidence index parameters on RDM.

2.1 Decision Making: A Roller Coaster Ride

Everyone makes numerous decisions every day, from where to go, what to eat, and how to spend money and time. Many of these decisions require little effort or thought, but at times, we face circumstances that require a major consideration of the decisions we make. In such cases, it is important to understand what makes a decision a 'good decision.'

Hastie postulated that under idealized conditions, actions must be identified that minimize undesirable and maximize desirable outcomes when it involves making good decisions (Hastie 2001). An individual can solve problems more comprehensively and more realistically when a decision-making process is used. This process, when understood and applied, can assist in making present and future decisions.

Gregory (1988) defines a decision as a selection process leading to a particular action being taken. Decision making is essentially a process of choosing among

alternative courses of actions in order to attain goals and objectives and follows a step by step approach to reach a particular outcome (Forman & Selly 2001). For instance, Herbert Simon (1960) was the first one who introduced the most widely accepted categorization of the decision making process. This categorization consists of three phases

- Intelligence
- Design
- Choice

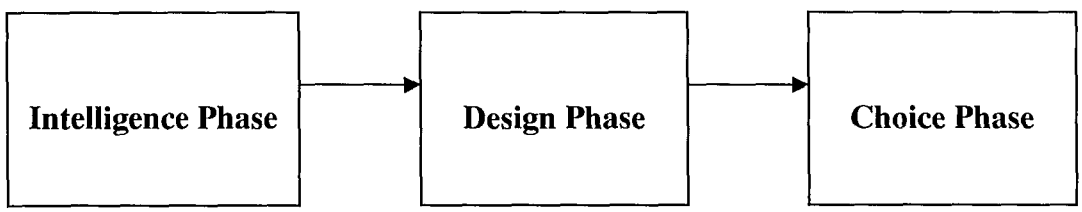


Figure A: - Simons Decision Making Model (1960)

In Simon's model, intelligence involves identifying problems or opportunities and the need for a decision. Once the decision need has been identified, the problem domain and alternatives are formed in the design phase. Simon's final phase is choice, which describes the activity of selecting the most feasible or appropriate course of action from the available alternatives taken into account (Dillon 1998 originally by Simon 1960). Similarly, many authors have proposed the classical decision making process in numerous ways.

According to McGuire (2002) the decision process involves:

1) Defining the issue
2) Gathering information

3) Generating choices
4) Identifying and evaluating alternatives
5) Choosing the best alternative

Geoffrey Gregory's decision model (1988) also consists of the following process:

1) List all the possible alternatives
2) List all the possible outcomes
3) A combination of feasible actions and outcomes
4) An assessment of likelihoods of various outcomes
5) Selection of a decision

Nevertheless, decision making has never been an easy thing to understand and looks extremely mysterious when numbers of alternatives are faded, and the likelihood of achieving the desired outcome is unknown; in other words, decision making is difficult for those decisions that involve uncertainty.

2.2 Study of Existing Models

2.2.1 Decision Making Under Certainty

Decisions can be made with certainty when we have a feeling of complete belief or complete confidence in a single alternative that we have for the situation. Decisions can be considered to fall under certainty when for each decision alternative there is only one event, and therefore, we have only one outcome for each action. For instance, decisions, such as buying clothes and going to a movie can be undertaken with certainty.

If we were to consider it mathematically, there are two predictable actions from one possible event; for example: the two actions are "No move" where you end up losing and "Win" where you end up gaining.

Actions	**State of nature (probability 1.0)**
No move	**Lose $10000**
Win	**Gain $ 10000**

Note that there is only one state of nature in the matrix because there is only one possible outcome for each action (with certainty). The decision is obviously to choose the action that will result in the most desirable outcome (least cost), that is to "win."

2.2.2 Decision Making Under Risk

"Risk is a concept that denotes a potential negative impact to an asset or some characteristic of value that may arise from some present process or future event (http://www.wikipedia.com). In everyday usage, "risk" is often used synonymously with the probability of a known loss. Risk based decision making often relies on the assumption that the decision maker is aware of specific outcomes with certain probability. Here, probability is defined as *the proportion of times that some outcome will occur over the long run if the action is repeated many times under uniform conditions* (Mansfield, 1987). Mansfield designed the process for decision making under risk which is given below:

1) The problem is defined and all feasible alternatives are considered. The possible outcomes for each alternative are evaluated.

2) Outcomes are discussed based on their monetary payoffs or net gain in reference to assets or time.
3) Various uncertainties are quantified in terms of probabilities.
4) The quality of the optimal strategy depends upon the quality of the judgments. The decision-maker should identify and examine the sensitivity of the optimal strategy with respect to the crucial factors.

2.2.3 Decision Making Under Uncertainty

The simplest and complete definition of uncertainty would be that "it is a general concept that reflects our lack of sureness about something or someone, ranging from just short of complete sureness to an almost complete lack of conviction about an outcome" (NRC, 2000). While making decisions under uncertainty, people are sometimes unaware of the logical approach to the decision itself. They believe it is sufficient to collect data, analyze the data and simply "think hard" in order to make 'good decisions' (Forman & Selly 2001). However, there exists a class of decision problems which are complex, ill-structured and not well-defined which are encountered by decision makers in many situations. The decision in these situations cannot be improved by classical approaches and procedures since it is not easy to identify where the cause of the difficulty lies (Redford 1977). According to Redford (1977), "courses of action selected in response to complex decision problems are often tentative and experimental rather than final solutions." However, many statistical approaches have been successfully used to determine decision making under uncertainty. Below are some of the most commonly used techniques for making optimal decisions under uncertainty.

Utility theory

Expected Utility Theory (EUT) states that the decision maker chooses between risky or uncertain prospects by comparing their expected utility values, i.e., the weighted sums obtained by adding the utility values of outcomes, which are multiplied by their respective probabilities (Mongin 1987).

In utility theory, the utility measures of the consequences are assumed to reflect the decision maker's preferences in the following way: (i) the numerical order of utilities for consequences preserves the decision maker's preference order among the consequences; (ii) the numerical order of expected utilities of alternatives (referred to, in utility theory, as gambles or lotteries) preserves the decision maker's preference order among these alternatives (lotteries). For example, if alternative X can have three mutually exclusive consequences a, b and c, then also, the decision maker prefers c to b and a to c; the utilities U_1, U_2, U_3 assigned to a, b, c must be such that $U_3 \subset U_2 \subset U_1$. If the probabilities of the consequences a, b, c, are P_1, P_2,$1-P_1$,$-P_2$, respectively, the expected utility of alternative X is calculated as

$$\mathbf{E(u/P) = P_1U_1 + P_2U_2 + (1-P_1-P_2)U_3}$$

Decision tree

Uncertain decisions can also be resolved by using the decision tree approach where most of the outcomes are known, and some extent of probability can be associated for those outcomes. See the example below.

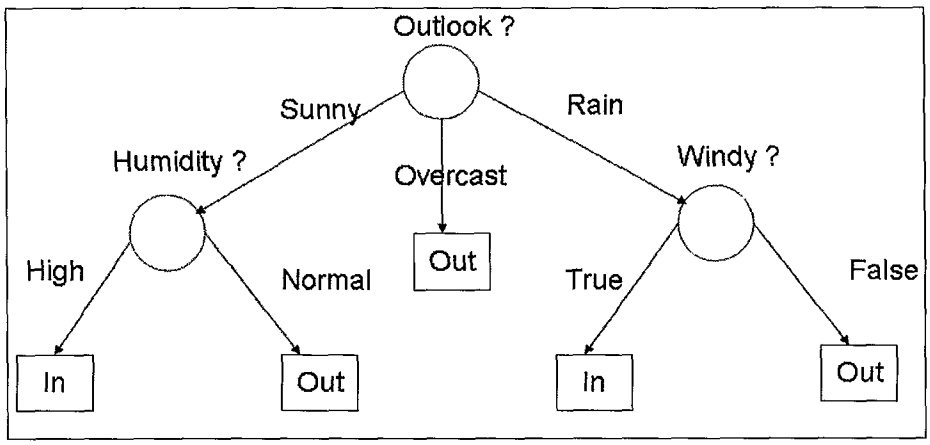


Figure B: Decision Tree example (Delisle 2006)

When there are several actions to choose from, decision trees provide an excellent tool to help choose. Decision makers can lay out options and investigate the possible outcomes of selecting an option which is a structure provided by the decision tree. A balanced picture is formed of the risks and rewards associated with each possible course of action with the help of decision trees.

Simulation approach

Uncertainties are represented by probability distributions when it comes to the simulation approach. These probability distributions are then combined to provide a probability distribution of the response variable, which incorporates the uncertainties.

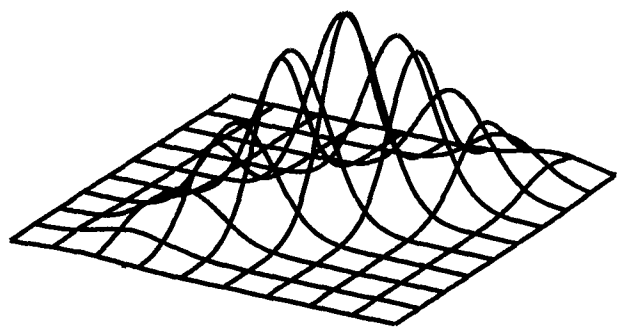


Figure C: Probability Distribution to Measure Uncertainty in Decisions

Sensitivity testing

The robustness of a decision is tested using sensitivity testing. Without attaching probabilities, a number of scenarios can be examined. It enables the preliminary exploration of the potential consequences of uncertainty in future performance.

It can be used to identify how many key variables can change before a different, preferred option is selected. There will then follow some judgment of the likelihood of that change actually taking place. Sensitivity tests should be conducted before embarking on more thorough probabilistic methods.

2.3 Comparison between Chaos, Complexity and Uncertainty

2.3.1 Chaos Theory

According to Vicente Valle (2000), "Chaos theory is the qualitative study of unstable periodic behavior in deterministic nonlinear dynamical systems." Valle drew several conclusions out of this: first, that the system is dynamical, meaning it changes over time; second, the behavior of the system is unstable, which means that it does not repeat itself; third, although chaotic behavior is complex, it can have simple causes; fourth, because the system is nonlinear, it is, as we have already seen, sensitive to initial conditions. (Nonlinearity means that the output of the system is not proportional to the input).

2.3.2 Complexity

Complexity is closely related to chaos theory. However, a complex system is one in which countless independent elements continuously interact and spontaneously organize and reorganize themselves into illustrative structures over time (Williams 1997). Williams characterized complexity by:

1) Independent elements which are greater in numbers;

2) Consistent responses by these elements to other agents;

3) Adaptiveness so that the system adjusts to new situations to ensure survival;

4) Self organizations with chaos, the behavior of self-organizing, complex systems cannot be judged, and they do not observe the principle of additivity, i.e., their components cannot be divided and studied in isolation (Williams 1997). Complex systems can naturally evolve to a state of self-organized criticality in which behavior lies

at the border between order and disorder. Again, the same system can display order, chaos, and self-organizing complexity, depending on the control parameters.

2.3.3 Uncertainty

Under uncertain situations, infinite alternatives exist, and the likelihood of each alternative may be considered equally likely. This means that complex and chaotic systems must be treated as uncertain.

It has been demonstrated that under true uncertainty, some future results or consequences could have no probability ratios assigned to them, so the probability theory barely stands to interpret outcomes under true uncertainty. Table 1 illustrates this case.

Table 1: True Uncertain Situations

	A	B
A	1	-1
B	-1	1

In such a case, if a person is asked to choose between the alternative based on the probability theory, the expected outcome becomes as follows:

$$E(x) = P(A) * G + P(B) * G$$

The resulting gain is the same for both outcomes. From the given information, there is no basis for someone to choose A over B or B over A.

2.4 Sources and Limitations of Uncertainty that Lead to Failure of the Decision Making Process

As we know, knowledge is always incomplete, yet decisions must be made. As discussed earlier, decision uncertainty is equivalent to the likelihood of making the incorrect decision. Understanding uncertainty within our predictions and decisions is truly based on how the decision maker understands and relates risk to the uncertain situation. According to Wallingford (1997), "Consideration of uncertainty within the decision process attempts to quantify our lack of sureness, and thereby provides the decision maker with additional information on which to base a decision." He also indicates that when we investigate the sources of uncertainty, it enables the decision-maker to identify the uncertainties that mostly influence the final outcome and focus resources efficiently to understand the sources and importance of uncertainty within the decisions we make. He states that as per the Figure D it is clear that uncertainties arise at every stage in the decision process. According to Wallingford, "Uncertainties can be expressed in a number of different ways, both qualitative and quantitative (1997):

- *Deliberate vagueness* – 'There is a high chance of breaching'
- *Ranking without quantifying* – 'Option A is safer than Option B'
- *Stating possible outcomes without stating likelihoods* – 'It is possible the embankment will breach'
- *Probabilities of events or outcomes* – 'There is a 10% chance of breaching'
- *Range of variables and parameters* – 'The design flow rate is 100 cumecs +/- 10%'
- *Confidence intervals* – 'There is a 95% chance that the design flow rate lies between 90 and 110."

There are many different types of uncertainty implicit within any decision analysis, most of which can be categorized under two simple headings (Wallingford 1997)

- Natural variability
- Knowledge uncertainty

An overview of how uncertainties arise and the means as to how to deal with them is given in Figure D, which also helps us to understand the importance of uncertainty within the decision making process.

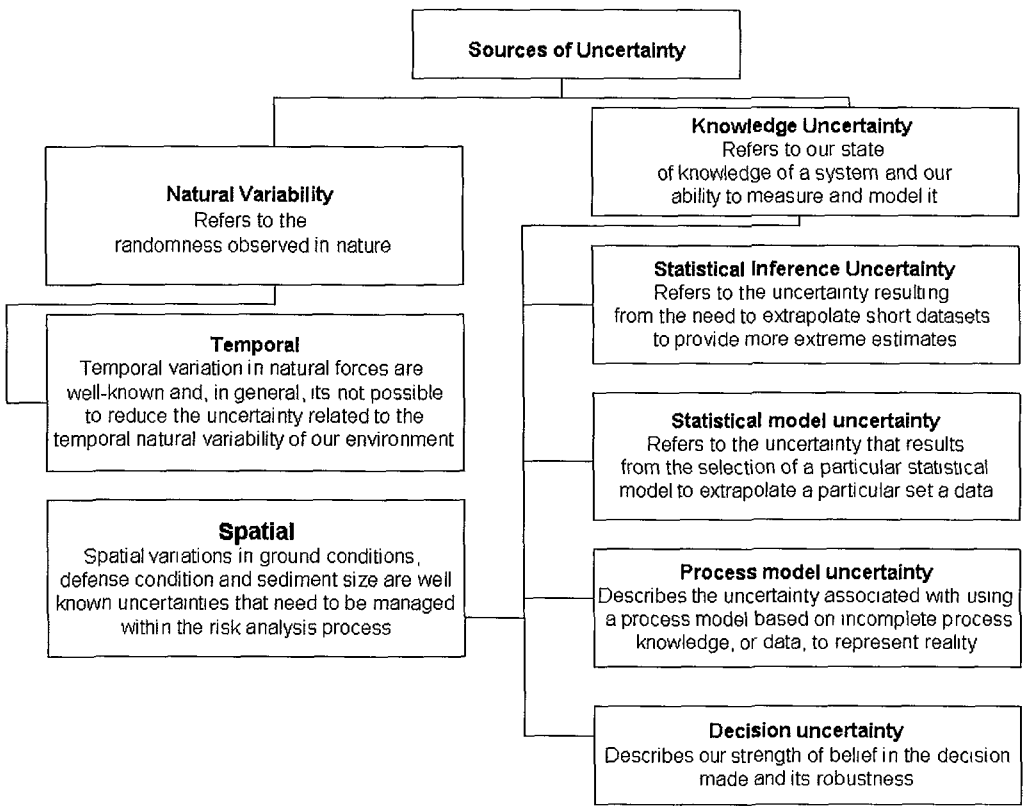


Figure D: - Sources of Uncertainty Involved in each step of Decision Making (Wallingford 1997)

Understanding the sources and importance of uncertainty within the decisions we make is a key driver in making more informed choices. However, when it comes to

problems where uncertainties arise at every stage in the decision process, statistical approaches and classical decision theories will be struggling to provide outcomes.

2.4.1 Quantitative Techniques: Failure towards meeting Uncertainty Challenges in Pure Uncertain Environments

There has been substantial development in quantitative decision approaches over the years to tackle threats and problems posed by uncertainty. Examples include: probability theory, expected utility theory by Von Neumann and Morgenstern (1947), prospect theory by Kahnemann & Tversky (1979), etc. Even the role of judgment has been used extensively in an to attempt to deal with such problems. Hastie (2001) contributed valuable insights to the role of judgment in uncertain environments. His focus was to mainly illustrate how people combine desires and beliefs to choose a course of action. According to Hastie (2001), the prime question for researchers in the field of judgment is the processes by which obscure, uncertain outcomes can be inferred. Hastie (2001) indicates that "good decisions are those that effectively choose means that are available in the given circumstances to achieve the decision-maker's goal." These quantitative approaches, moreover, explain the complexity of uncertain problems and provide approaches that capture the decision process, particularly under uncertainty.

A continuum of uncertainty and certainty clearly focuses on a wide range of decision problems that fall in different situations from deterministic to pure uncertainty and further limitations of decision approaches that are being used under uncertainty.

2.4.2 Continuum of Pure Uncertainty and Certainty

According to Kreitner (1995), there are two extreme cases in which decision analysis models fall. The knowledge that we have about the outcome of our actions is what it is dependent on. As we can see in Figure E the there are two extreme cases on the right "pole", which is the Deterministic Model, and the left 'pole" is pure uncertainty. In between these extremes falls the Probabilistic Model. He indicates that uncertainty varies based on the knowledge of the situation.

Ignorance	**Risky Situation**	**Complete Knowledge**
Pure Uncertainty	**Probabilistic Model**	**Deterministic Model**

Figure E: - Continuum of Pure Uncertainty and Certainty (Kreitner 1995)

The likelihood of the occurrence of an event is measured using probability as an instrument. If we were to express uncertainty in terms of probability, pure uncertainty would have flat probability, which means it's equally probable whereas a deterministic outcome/event would have a probability of 1. The decision maker has no knowledge whatsoever, not even about the likelihood of occurrence for any state of nature in decision making under pure uncertainty; in situations like this, the behavior of the decision maker is based solely on the attitude towards the unknown. (Kreitner 1995)

Limitations of Decision Making under Pure Uncertainty: Biswas (1997) identified the following prime sources for uncertainty;

1. Decision analysis, in general, assumes that the decision maker faces a decision problem where he or she must choose at least or at most one option from a set of

options. In some cases, this limitation can be overcome by formulating the decision making under uncertainty as a zero-sum, two-person game.

2. In decision making under pure uncertainty, the decision-maker has no knowledge regarding which state of nature is "most likely" to happen. He or she is probabilistically ignorant concerning the state of nature; therefore, he or she cannot be optimistic or pessimistic. In such a case, the decision maker invokes consideration of security.
3. Notice that any technique used in decision making under pure uncertainties, is appropriate only for the private life decisions. Moreover, the public person (i.e. you, the manager) has to have some knowledge of the state of nature in order to predict the probabilities of the various states of nature. Otherwise, the decision-maker is not capable of making a reasonable and defensible decision.

2.4.3 Need for Novel Approach under Uncertain Situations

Green stated that "decision uncertainty is a state of rational doubt as to what to do. Recognizing uncertainty within our decisions is fundamental to understanding why certain options are preferred over others. Also, uncertainty is natural, and that for all important decisions, there exists a greater or lesser extent of uncertainty surrounding the selection of a particular course of action. Recognition of decision uncertainty therefore poses two important questions" (Green 2001): "*What does knowledge of uncertainty say about the choices made? and What does knowledge of uncertainty say about the type of options that should be preferred?*

In understanding these questions and their answers, a much more informed and responsive decision making process can be engaged. In addition, such decision problems do not have well-defined boundaries, which is why actions taken for a particular problem area may result in a noticeable impact over other areas (Churchman 1967). This makes decision making more complex in such situations. This makes rational choices according to a classical decision approach extremely efficient (Sabne 2006). According to Sabne (2006), it is difficult for decision makers to select optimal or good outcomes with such a level of uncertainty and nature of crisis. Principles of the bifurcation theory represent pure uncertainty situations in a most appropriate way.

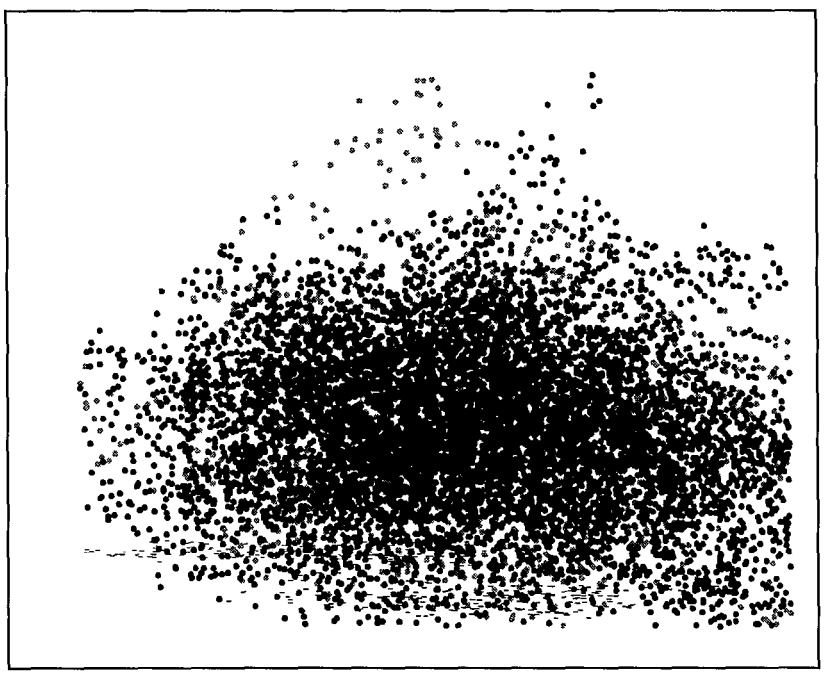


Figure F: Probability Distribution illustrating Complexity of a Pure Uncertain Decision

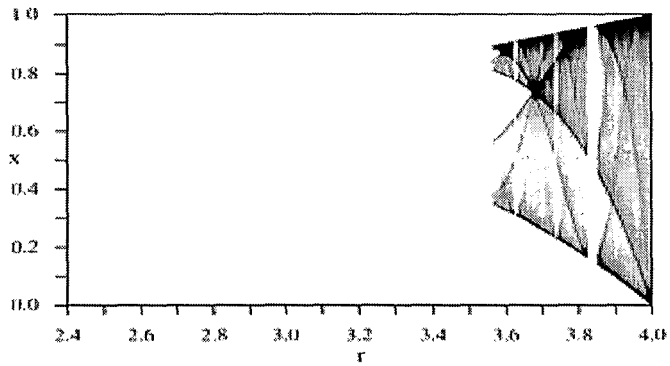


Figure G: Logistic Map of Bifurcation Theory (Crawford 1989)

Crawford (1989) postulates that the possible long-term values a variable of a system can obtain is a function of a parameter of the system which can be shown in a bifurcation diagram. A good example of a bifurcation diagram is the logistic map: r as a parameter is shown on the horizontal axis of the plot, and the density of the possible long-term population values of the logistic function is shown on the vertical axis. The bifurcation diagram shows the forking of the possible periods of stable orbits from 1 to 2 to 4 to 8, etc. We can see that r remains finite even if the periods go to infinity. The orbits become chaotic when r is greater than 3.57 (approximately). The importance of the chaos theory in very simple non-linear systems is demonstrated as an interesting example through this bifurcation diagram (Refer Encyclopedia of Mathematical Sciences). This clearly indicates the system or environment where infinite numbers of alternatives exist, and each one of them is equally likely.

2.5 Difference between TDM and RDM

Extensive literature indicates a lack of approaches that capture decision processes under uncertainty.

Table 2: Difference between TDM and RDM (Sabne 2006)

	Traditional Decision Making	Reverse Decision Making
Ontology of the problem domain	The problem domain is generally defined as a bounded structure formed on premises based in determinism or constructivism	The problem domain may be defined following a variety of constructs based on empiricist to rational or any other foundation as is most appropriate to the problem.
Teleology	Most traditional decision models follow a rational teleology, assuming that future states are strongly grounded in present conditions.	Allowance is made to accommodate a variety of teleological structures, including formative and transformative teleological perspectives acknowledging that the future is not always recognizable in the present
Epistemology	Traditional methods are formed strongly on empiricism foundations relying strongly on existing knowledge and experience.	Epistemologically, a pragmatic view is taken that dictates that understanding may only be reduced through action. Within this construct, other epistemic models can be adopted.
Uncertainty	Uncertainty must be eliminated, whether through bounding that eliminates aleatory components or through assumptions of uniformity.	Uncertainty is accepted as a condition of complex situations that may not be reducible. Irreducible uncertainty must be absorbed by the decision making process.
Emergence	Emergent conditions must be absorbed in the initial decision and/or goal attainment plan.	Emergent conditions are absorbed in the process for goal attainment which is viewed as a continuous form of planning.
Process		
Definition of Alternatives	Decision alternatives are predicted	Decision alternatives are predetermined based on desired goal.
Nature of Solutions	Solution alternatives are generally defined in sufficient detail to ensure that an alternative evaluation is possible and feasible attainment can be determined.	Alternatives, if any, are stated as value premises. The manner in which the value premise is generated (states or design) is allowed to emerge. The states may vary over the course to attain the value premise.
Stability of alternatives	In a dynamic environment alternatives will be unstable.	The value premise remains stable for most conditions.
Alternative Selection	Alternatives are selected according to a rational evaluation of alternatives.	The value premise is selected based on choice, not evaluation and comparison of alternatives. The end state that will generate the value premise may be selected from a variety alternatives, but is generally allowed to emerge over the goal attainment process.
Goal Attainment	Goals are attained based on a predefined set of actions or plan, which is derived directly from the definition of the end-state or alternative.	Goals are attained through a continuous process of actions (or actions sets) that are adjusted based on an evaluation of events deriving from the problem

		environment.
Failure	Failure is generally defined by a failure to attain an end state (design) or for any action to meet expected outcomes or contributions.	Failure is defined by a failure to attain a value premise (capability). The failure of actions throughout the process is expected and does not constitute failure in the decision process.
Termination	The process ends when the decision outcome is known or the goal attainment plan is no longer representative of actions being taken.	The process ends when (a) a value premise is attained, (b) a decision maker's actions become ineffective, and a value premise is no longer judged to be tenable.

2.6 Role of Actions and Confidence in Reverse Decision Making

The actions taken by a decision maker have a significant impact while choosing or making decisions under classical decision theory. In such cases, the outcome of the decision revolves around the decision maker's actions during the decision process.

Pollock (2002) demonstrated the influence of actions while making rational choices in decision theory. Actions could be ordinary if a decision is routine, such as going to a movie or buying a gift. Actions taken can be non-routine if the decision is uncertain, as in opening a new business venture, buying a stock, etc. Many philosophers assume that decision makers choose actions that maximize expected 2-values in classical decision theory and assume this to be an effective approach, which Pollock calls "*the optimality prescription*". The defense of the optimality prescription must rest upon showing that it leads to the right choices in decision theory against which Pollock puts a strong argument, stating that it should be replaced by a prescription that evaluates actions in terms of a more complex measure than expected-values (Pollock 2002). In the classical approach, it is assumed that the task is to choose an action from a set *A* of *alternative actions.* The actions are to be evaluated in terms of their outcomes. It is assumed that the possible outcomes of performing these actions are partitioned into a set *(0)*. Further, if we consider the probability PROB (O/A) of each outcome it is conditional on the performance of each action. Finally, assuming a utility-measure U (0) by assigning a numerical utility value to each possible outcome, the expected value of an action is defined to be a weighted average of the values of the outcomes, discounting each outcome by the probability of that being true if the action is performed (Pollock 2002).

$$EV(A) = \sum_{O \in O} U(O) \cdot PROB(O/A)$$

The crux of the classical decision theory is that actions are to be compared in terms of their expected-values. In addition, the rationality in these theories determines choosing an action which is optimal, in other words, choosing the option that has higher expected-value (Pollock 2002). However, under uncertain situations, actions taken by a decision maker may not necessarily result in optimal solution or rational choice, but lead towards the decision maker's goal (Sabne 2006). Beech and Connolly (1980) state that the usual way is to begin with an analysis of the decision problem, then the selection of a suitable action in regards to the desired goal and the implementation of the action selected (Figure H). In contrast, under uncertain conditions, the action may not lead to a feasible outcome as there are anomalous events occurring. These events stem from internal or external changes, but there is a chance that these events can also occur from the realization that the earlier decision was defeasible, and its implementation is not resulting in the desired outcome. This so-called conditioned response is seldom an effective way to deal with complex situations (Beech & Connolly 1980).

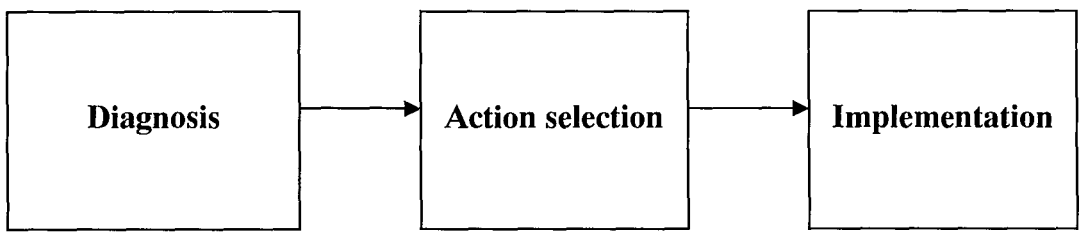


Figure H: Role of Actions in Decision Making

RDM is assigned to counter or respond based on the type of feedback from the decision environment. Decision makers consistently take actions to maintain a decision path. Decision makers either take these actions based on previous experience or try to fine tune them from previous decisions that they have made to achieve the desired goal

(Sabne 2006). Selected actions result in a change in the decision maker's confidence (in either a positive or negative way). Decision makers keep implementing workable courses of action for subsequent events to maintain their confidence and motivation at a high level. If the decision environment reacts with negative events, the decision maker's confidence starts decreasing; a point will be reached when the confidence level hits a threshold, and a new path is selected to achieve his/her desired outcome, or potentially, a new outcome will be chosen. This is the process of Reverse Decision Making where decision makers move back and forth to achieve their desired outcome (Sabne 2006). In situations, where for example, equally probable alternatives exist or decision problems which involve chaos and complexity exist, decision makers prefer a course of action based on the feasibility of goal attainment rather than looking for an optimal solution, which has a high expected utility of outcome (Sabne 2006). In most uncertain situations, the decision makers' selected action will be influenced by the level of confidence that they have in their chosen course of action. For instance, Rehman's work (2002) indicates that the decision to perform an act is determined mainly by the level of confidence and the motivation (desire) to perform that act which, in turn, is the reflection of decision makers' status and environmental constraints of concern.

Rehman's equation states that:

Decision = Confidence + Motivation

D = C + M

A decision can be supported with a positive value of confidence, whereas a negative value opposes the decision to a degree of its magnitude. For example, a decision maker with a positive baseline confidence would sustain several negative effects before

opposing that particular decision. On the other hand, decision makers with a negative baseline confidence would need greater motivation to take a decision of this kind; therefore, it would be a purely motivation driven decision. In this case, several positive effects would be needed to increase the overall confidence.

$$C = C0 + \Delta C\,0$$

Where,

C = Confidence $-\infty \leq C \leq \infty$

$C0$ = Baseline confidence $-\infty \leq C0 \leq \infty$

$\Delta C0$= Change in confidence $-\infty \leq \Delta C \leq \infty$

Here, confidence is a function of the sequence of events that take place in the decision environment and the sequence of actions that the decision makers take. In effect, the actions are used to support confidence.

$$\text{Confidence} = F(\text{Events, Actions})$$

$$C = f(E, A)$$

This clearly demonstrates the role of confidence in the decision process and how the decision maker's actions can be impacted by the change in confidence index ($\Delta C0$). Further, we can certainly demonstrate the impact of confidence over the action with RDM through an experimental study. The Theory of belief along with few other models, were also considered as an alternate theory to Rehman's work. However, based on past work, this model is a better fit for the conceptual model due to its consistency to the objectives of this work and the ability to be operationalized. Belief theory was rejected as an option due to the difficulty in differentiating between its dimensions. Rehman is the only author who has empirically demonstrated the impact of changes in confidence

on decisions. Rehman has applied this confidence and motivation model to guide decision making in complex military models; in other words situations of high uncertainty. Other researchers have illustrated the role of action and confidence in decision making, for example: Kahneman & Tversky (1979), and Redford (1977). Rehman's model is, however, unique because it includes desire and motivation in determining the outcome of the decision and captures the applicability of the model in scenarios where decision outcomes are equally probable.

2.7 Literature Summary

From the literature, it is clear that the classical decision theories fail to address adequately how decisions are made in chaotic, complex environments, and they potentially provide weak guidance on how decisions should be made in the presence of dynamic, uncertain conditions.

Reverse Decision Making is formulated to take care of uncertainty, including aleatory uncertainty through the process of establishing relevant goals and the manner in which these are attained without attempting to reduce the uncertainty or bounding the problem in such a manner that the uncertainty is eliminated (Sabne 2006). Reverse Decision Making and Goal Attainment involve a process in which decision makers make an initial decision based on a desired goal (value premise), which is very much inspired by their desire (motivation) and confidence to achieve that particular outcome. The desired state or decision may be considered as the end point towards which the decision maker directs decision-making (McFarland 1979) and what they would like to see as the final outcome. This has been demonstrated at the proof of concept level in RDM; also some exciting implications have been demonstrated such as:

1) The quality of the decision cannot be assessed based purely on its correspondence with actual future events, and
2) The desired outcome is as much an imposition of the decision makers' preferences and confidence that these will be achieved as it is a prediction of what the decision makers' expect to transpire in the future (Sabne 2006).

Sabne indicates that we take actions to achieve an outcome which has a strong influence on the attainment of a desirable state in RDM, but then no matter what course

of action is taken; there is the same degree of uncertainty as in the original decision, related to the desirable outcome. Sabne also concluded that RDM is intended to represent how decisions are effectively made and desirable states attained in complex situations, situations that incorporate high levels of aleatory uncertainty and where knowledge is incomplete. The construct does not rely on "overcoming" the effects of uncertainty and incompleteness, but rather on accepting these conditions. RDM is intended to provide guidance for the decision making process as it applies to the immediate or long term course of actions (Sabne 2006).Applications of RDM with Real World Example: Case studies indicate that RDM has a strong applicability to real world problems. Studies of real world situations include the following:

1) Bhopal Gas Tragedy
2) Three Mile Island Incident ,1979
3) WorldCom Disaster
4) BPL Wireless from Rise to Fall.

Many uncertain situations exist where RDM can be applied and demonstrated. From literature, it is apparent that RDM is capable of dealing with complex situations in a better way, i.e. situations in which there is a high degree of uncertainty. The uncertainty may be caused for a variety of reasons, such as the size of the problem, the interrelatedness of problems, the incorporation of multiple perspectives, and dynamic environments. It also supports the identification of prime factors or parameters which drives the decision maker's behavior and choices during decision making and their impact on RDM. The prime factors are Actions and Confidence Index of the decision

maker. There might be other similar factors and situations, such as crises, which impose temporal conditions and impact the RDM decision process.

3. CONCEPTUAL RESEARCH MODEL

3.1 Background from the Proof of Concept to New Action Based RDM

Based on an analysis at the exploratory level, RDM has demonstrated how traditional theories fail to address decisions when they are made in complex environments, and they potentially provide less focus on how appropriate decisions can be made in dynamic, uncertain conditions (Sabne 2006). RDM relies on an anticipatory rather than predictive structure for decision making. In conditions where knowledge is vague and future events are highly uncertain, it forces the decision making process and then becomes anticipatory (Sabne 2006). The anticipatory criterion has been validated at the exploratory level. For instance the decision quality assessment can not be undertaken based on actual future events, and secondly, the desired choice of the decision maker is more of an imposition of preferences and confidence in attaining a goal as it is a prediction of what one expects to transpire in the future (Sabne 2006).

Confidence plays a larger than life role in the RDM process. Rehman (2002) demonstrated how a decision is a summation of confidence in a particular alternative and motivation to achieve that desired alternative (Refer Literature Review). In addition, Rehman also validated how change in confidence levels (+ve or –ve) causes variations in the decision choices, and these variations can be calculated by measuring the difference between two confidence indexes as $C = C + \Delta Co$.

Although RDM captured this confidence driver, exploratory studies omitted the impact of decision maker's act or actions on the decision process, an important factor in the RDM process. It can be hypothesized that there is a logical consistency between decision makers' variations in confidence and the sequence of events. It is clear that the

variations can be measured or seen only by analyzing decision makers' actions and, consequently, changes in actions due to confidence. The attainment of a desirable outcome is ultimately strongly influenced by the actions that are taken to achieve the outcome. However, the course of action that is taken suffers from the same degree of uncertainty as the original decision (Sabne 2006). The conceptual design of RDM must be tested including the role of actions and, defined to the extent in which it captures the decision maker's approach in aleatory situations. The model (Figure I) shows that, RDM is assigned to counter or respond based on the type of feedback from the decision environment. Decision makers consistently take **actions** to maintain a decision path. Decision makers either take these actions based on previous experience or try to fine tune them from previous decisions that have been made to achieve the desired goal (Sabne 2006).

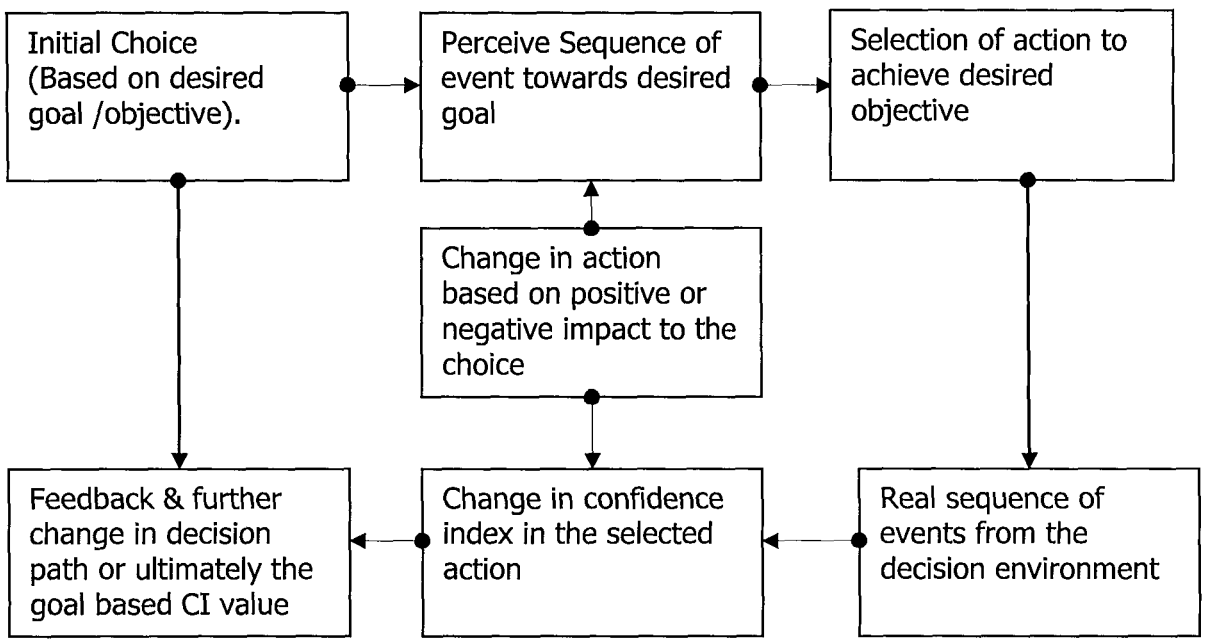


Figure I: Proposed Conceptual Action Based RDM Model

Selected actions result in a change in the decision makers' confidence (in either a positive or negative way). The decision makers' keep implementing workable courses of action for subsequent events to maintain their confidence and motivation at a high level. If the decision environment reacts with negative events, the decision makers' confidence starts decreasing and a point will be reached when the confidence level hits a threshold, and a new path is selected to achieve their desired outcome, or potentially a new outcome will be chosen. This is the process of Reverse Decision Making where decision makers move back and forth to achieve their desired outcome (Sabne 2006). On the type of feedback from the decision environment, decision makers consistently take actions to keep up their decision path in RDM. Decision makers either take these actions based on previous experience or try to fine tune them from their previous decisions that they made to achieve the desired goal (Sabne 2006). The process of change in events and actions will continue without the necessity to change a goal or end-state. However, at any point in time, the combination of the confidence level and desire (motivation) might change to a degree that the originally defined end-state or goal might have to be altered.

This conceptual RDM design, which is to be tested, will be able to capture the radical impact of the decision makers' actions on the RDM process and also positive or negative changes in confidence due to those actions.

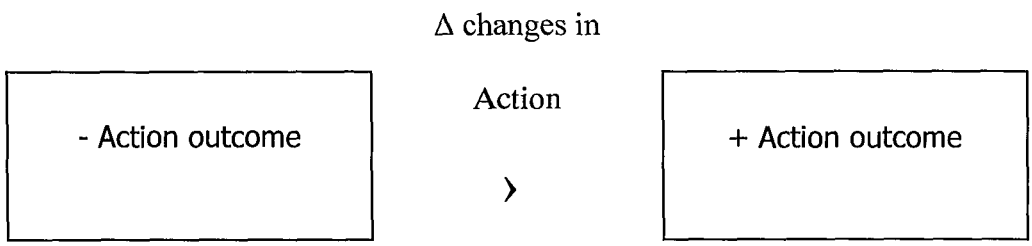
3.2 Research Hypotheses

There are various hypotheses which can be tested and validated, such as the proposed conceptual design of RDM. The focus of the current research is to identify the impact of decision makers' actions and also variations in confidence through the RDM process. The research parameters can be tested based on following hypotheses:

Hypothesis I

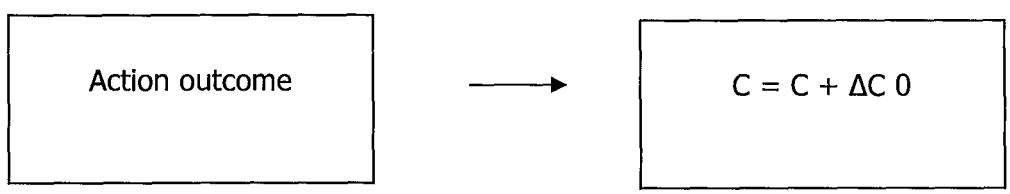
It is proposed that decision makers take actions to manage their confidence in attaining a desired outcome or goal. It has been shown that confidence decreases in environments where the decision maker encounters negative events. Consequently, it can be hypothesized that

H1: The number of actions taken by decision makers will increase as the number of negative events encountered increases.



Hypothesis II

H2: Furthermore, actions taken by decision makers lead to changes in confidence, i.e. there is a relationship between action outcome and confidence.



4. RESEARCH METHODOLOGY

4.1 Different Types of Research Methods

Cantrell stated that traditional research design is divided into three basic research paradigms positivism (quantitative, scientific approach), interpretivism and qualitative (Neill 2006 originally by Cantrell 2000). The objective in quantitative research is to determine the relationship between an independent variable and a dependent or outcome variable in a population. Quantitative analysis includes experimental, Quasi-Experimental, and Non-Experimental Studies.

Interpretivism is critical of positivism because it seeks to collect and analyze data from parts of a phenomena and, in doing so, positivism may miss important aspects of a comprehensive understanding of the whole. Interpretivism proposes that there are multiple realities, not a single reality of a phenomena and that these realities can differ across time and place (Neill 2006 originally by O'Brien 2000). Unlike quantitative analysis, qualitative analysis includes various research types (Neill 2006).

Table 3: Various types of Research Studies

Case study	Attempts to shed light on a phenomenon by studying in-depth a single case example of the phenomena. The case can be an individual person, an event, a group, or an institution.
Grounded theory	Theory is developed inductively from a corpus of data acquired by a participant-observer.
Phenomenology	Describes the structures of experience as they present themselves to consciousness, without recourse to theory, deduction, or assumptions from other disciplines

Ethnography	Focuses on the sociology of meaning through close field observation of sociocultural phenomena. Typically, the ethnographer focuses on a community.
Historical	Systematic collection and objective evaluation of data related to past occurrences in order to test hypotheses concerning causes, effects, or trends of these events that may help to explain present events and anticipate future events. (Gay, 1996)

Our current research project is based on a quasi-experimental study. The purpose is to verify proposed hypotheses. Data is collected using an Excel based experimental model that explicitly focuses on the relationship between action outcome and the change in confidence index in RDM. The participants were from engineering and business fields were asked to participate in a computer based experiment. The participants were required to partake in a computer-based simulated experiment

4.2 Participants

The basis of the thesis was to discern differences in the actions taken by the decision makers and then identify patterns. 60-80 samples were targeted for this study as this size was deemed sufficient to recognize the patterns. Sabne (2006) identified patterns from a sample size of 26 cases. To provide additional date for hypothesis 1, which compares the number of action taken for adverse and beneficial environmental conditions, the targeted number of cases was increased to 60-80. 71 cases were obtained, which lies in this range. The samples were selected from graduate students from engineering and business majors. Student societies and faculty contacts were used to

form a list of eligible students. An email was sent out to these eligible students. It also included a request to forward the email to other students to participate in the experiment.

In Engineering students came from the following areas

1) Aerospace
2) Environmental
3) Electrical
4) Computer

Other departments included the following students:

5) MBA Samples from Marketing Majors
6) IT majors
7) Finance majors at Old Dominion University.

It is critical to mention that only first or second semester graduate students were considered for the experiment. The samples were not only from different education background but also from different cultural backgrounds. The sample size and respective geographic regions are given in the Figure J.

Number of Samples	Country
19	American
13	European
9	Oriental
5	Nepali
4	Pakistani
21	Indian
71	

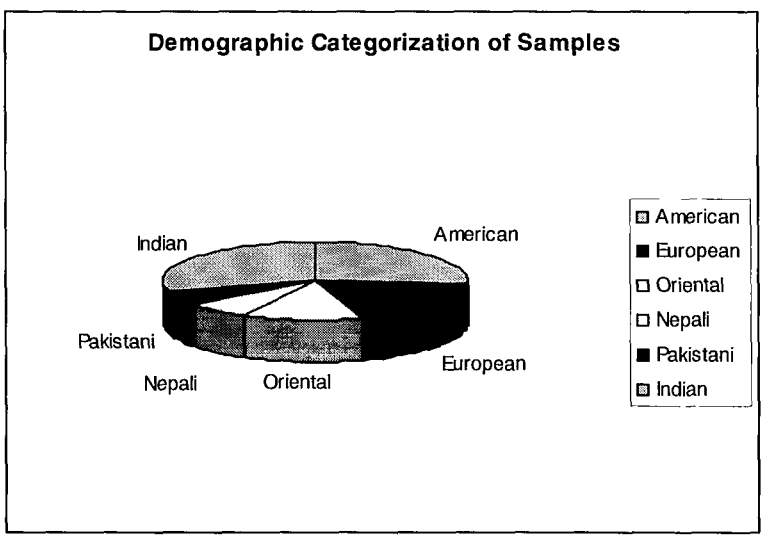


Figure J: Demographic Distribution of Experimental Data

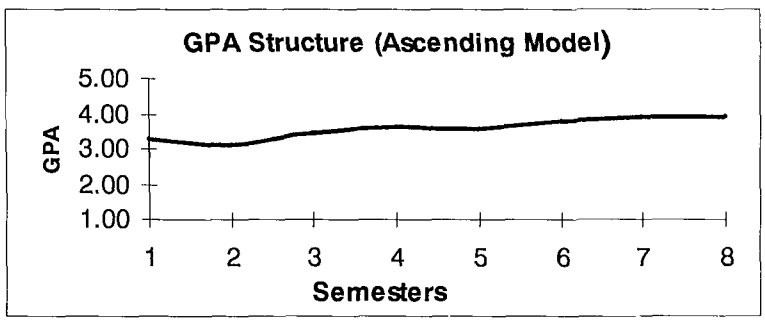
No formal training was given to the participants for the experiment. An instruction sheet was provided to the participants, which gave them a detailed description of the computer based Excel model. All participants were ensured that their identity would be kept confidential and their individual experimental outcomes would not be used in any manner that could reflect back on their participation. The duration of the experiment was designed to take approximately 20-30 minutes. The experiment was conducted at the Webb Center and Perry Library at Old Dominion University and George Mason University.

4.3 Experimental Design

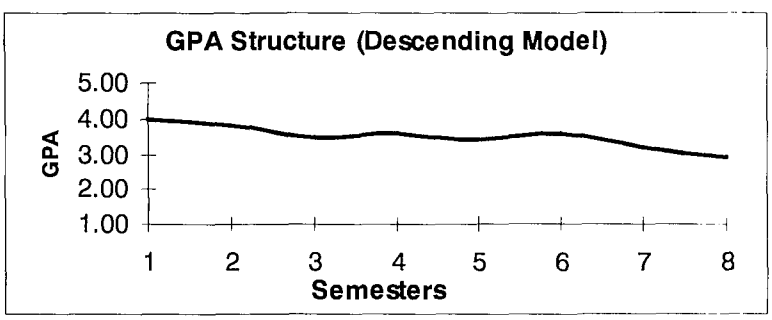
The experiment was designed based on a hypothetical scenario of a new techno MBA program. The scenario consisted of a sequence of 8 semesters, covering a span of two years. The scenario was generated by considering a hypothetical educational committee and an academic environment at American universities. The decision alternative and program options were created based on hypothetical criteria and were generally available to all MS students at the university. The intent was to have a scenario which closely resembles real conditions of students. Three Excel-based decision models were designed, i.e. random, ascending and descending. These three models were distinguished based on the GPA structure. Ascending was designed in a fashion where the GPA goes from low to high during each semester, providing consistently positive feedback to the decision maker. Descending was designed so that the GPA fall from high to low, providing consistent negative feedback to the decision maker and the random

model was designed with an inconsistent GPA structure, providing random feedback to the decision maker.

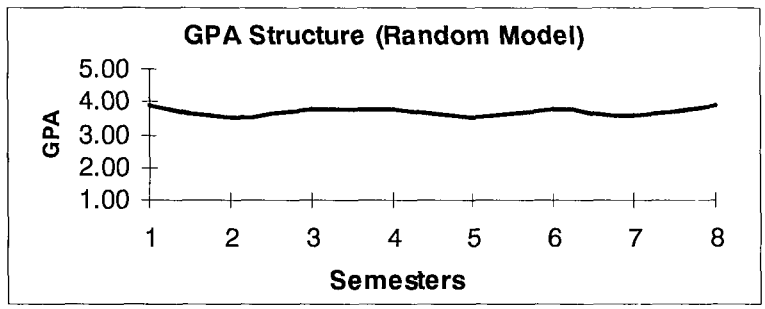
The sequence of events generated for the scenario mainly involved a trade-off between the GPA (Grade Point Average) and the three majors of the Techno MBA graduate program. Students were asked to choose a concentration based on the given choices and scenario. Based on participants' choices, a predefined GPA score and other information related to the programs of study was given back to them, which would impact the students' confidence level in attaining their goals. The GPA structures used for random, ascending and descending models are given in figure A, B, C.



Graph A: Ascending Model GPA Structure



Graph B: Descending Model GPA Structure



Graph C: Random Model GPA Structure

Samples were randomly asked to choose one of the three existing models and go through the experimental process. The experiment was structured to iteratively allow the participant to take actions based on the information that was given and outcomes they faced after choosing the decision alternative during each semester from fall'06 to summer'08. A questionnaire was designed to track the decision process that participants followed during the experiment, and a survey was also collected at the end to check their consistency in objectives and their decision goal. Based on the semester, the participants' confidence and decision paths were tracked and measured. Details of the sample data can be found in the Appendices.

4.4 Procedure for the Experiment

Participants were asked to read the instruction sheet regarding how to perform the experiment. Each participant was to execute the simulation. The experimenter assisted the participant in case the participant had any questions or if any clarification was needed in regards to the instruction sheet or the experiment itself.

The experiment was performed as follows:

1) Each participant was considered a decision maker in the scenario.
2) Each participant was asked to read the scenario in the first round (fall'06 semester).

3) The participant was required to select his/her long term goal (value premise).
4) The participant was then asked to opt for one of the available majors in the Techno-MBA program for instance A, B or C. The choice between majors A, B or C was assumed to correspond with the final goal although the goal could be attained in some measure by any of the three majors.
5) The participant was then asked to rate his /her confidence index in terms of achieving his/her semester objective.
6) After selecting an option and rating their confidence index, the participant received feedback as a mid-semester result in the form of his/her GPA.
7) The participant was then given a choice to take actions to improve his/her mid semester result. Four predetermined choices of action were offered, along with one more option where each participant could state the action of his/her choice (in the form of "Other- please specify).
8) The participant was then asked to rate his /her new confidence index based on the chosen action. Delta is calculated to see the difference in Confidence indices, which was later utilized to support hypothesis II.
9) As there were 3 models, we determined whether actions were taken by participants in the descending and ascending models and if there were changes. We tried to find out if there was a change or shift from one action to the other action (irrespective of what was the action) more in one model more than the other, which was utilized to support hypothesis I.

10) After receiving the end-of-semester result the participant was given a choice to re-evaluate their chosen field in the next semester, this was required to observe if there was a change in decision path or alternative.

11) At the beginning of each semester, each participant was asked to rate the new CI to track his /her confidence in his/her chosen alternative or major.

12) The process from 4 to 10 is repeated for all 8 semesters and compared with proposed hypotheses. At the end of the experiment, participants were asked to complete a short survey to track the validity of the experiment and gain more insights on how the experiment could be improved for future research in RDM.

13) The results collected from the experiment were compiled and used for the result analysis.

5. RESULT

The prime purpose of this extended RDM study was to empirically illustrate the radical impact of Action outcome and Confidence Index (two important RDM parameters) on the RDM process, while achieving desired outcomes under uncertainty.

Hypothesis I:

Our first hypothesis was focused on a comparison between two of the new RDM experimental models, i.e. Ascending and Descending. We wanted to see if decision makers increased the frequency of action taken in the negative environment with detrimental conditions, as opposed to decision makers in fairly positive environments who are expected to not change their actions as frequently. The study supported this hypothesis (refer to Figure M). Decision makers in the descending model showed greater variations in terms of actions as compared to the decision makers subjected to ascending model (refer Figure I). However, due to uncertainty built into the scenario, it was not possible to predict which model leads towards better or optimal outcome at the end of the process. So further research will help us identify more strength from the conclusion we presently have.

Hypothesis II:

The second hypothesis proposed that the action outcomes during the sequence of events in RDM lead to changes in decision makers' confidence in their chosen decision paths. From the experiment, it can be determined that all three models (Random, Ascending and Descending) strongly support this hypothesis. The experimental design posed some limitations in terms of predetermined outcomes and limited the number of choices. Nevertheless, outcomes were random and had offered the liberty to the decision

makers to choose their own actions using the action number five, which was "Others, please specify".

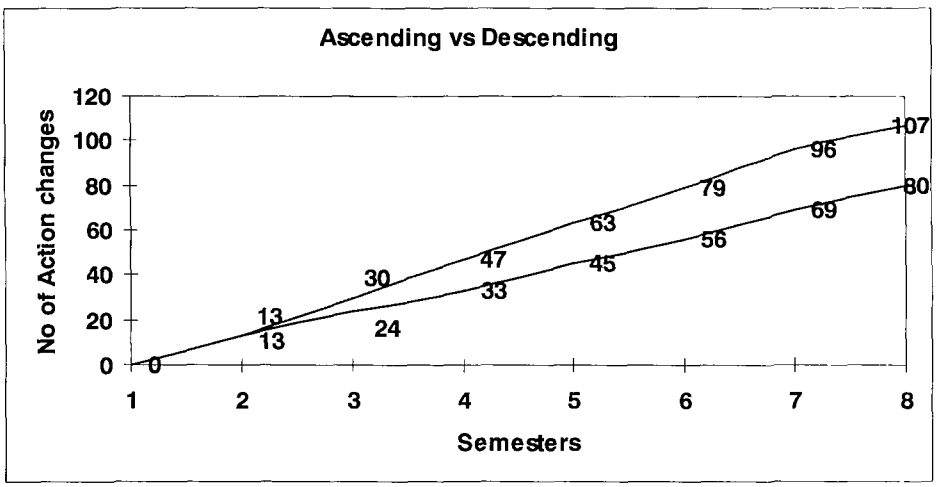
Hypothesis II is, therefore, accepted. The limitations in terms of offering a wide range of potential alternatives, confidence indexes and outcomes would be possible to generate with more simulated models, but can not replicate real situations fully in a simulated experimental environment.

5.1 Discussion of Results

With a sample size of 70, this application-based RDM study primarily focused on identifying high level pattern types that demonstrate the manner in which action selection and action outcome affects the decision maker. Several possibilities can be predicted based on these patterns. The first possibility would be a strong comparison between the three experimental models, i.e. ascending, descending and random. The scope is limited to the comparison of the action parameter for the two models, ascending and descending; few variations are seen based on positive and negative outcomes. This would indicate that the action outcomes do have an impact on confidence, which causes changes in action selection. The majority of the samples in ascending and descending did appear to follow what was expected Samples from the ascending model clearly demonstrated less number of changes due to positive outcomes in the RDM decision process (see summary table below) compared to the descending RDM model.

Table 4: Summary of action variation for ascending and descending

Model Semesters	Changes In Action Ascending	Changes In Action Descending
1	0	0
2	14	13
3	12	17
4	10	13
5	13	16
6	12	16
7	13	17
8	12	11



Graph D: Cumulative Graph for Hypothesis I

It was found that samples from both models had the same number of changes at the beginning of the process simply because the decision makers' actions were not affected as much by the initial negative response. However, with more negative outcomes for the descending model, the gap widened, and decision makers changed their actions more frequently than decision makers with positive outcomes. These changes have been plotted cumulatively in the graph (see Graph D). Therefore, decision makers with the descending model and negative outcomes changed their actions 107 times (cumulative) <

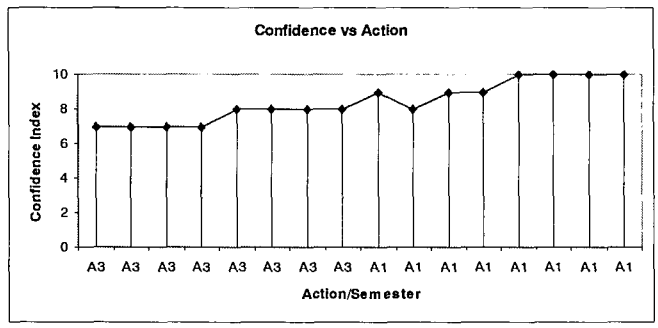
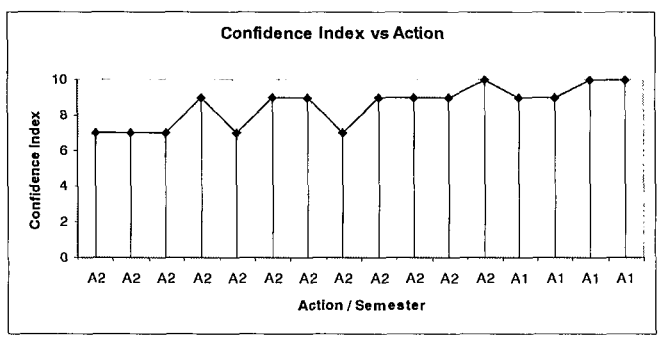
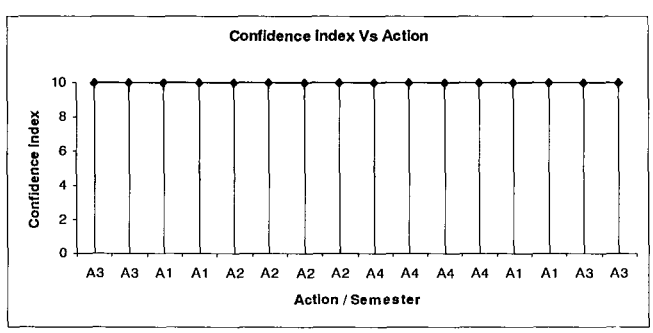
80 times, with positive outcomes in the ascending model. Hence, it validates Hypothesis I.

For Hypothesis II Apart from identifying the impact of action outcome on confidence and ultimately on the decision alternative, broad prototypes of behavioral patterns for random, ascending and descending models could be formed. Let's start with the ascending model; about 23 samples were collected randomly for the ascending model (see below)

Ascending Samples	2,5,8,11,14,17,20,23,26,29,32,35,38,41,44,47,50,53,56,59,62,65,68,

In order to demonstrate the correlation it was decided to measure the confidence variation, which is plotted on the Y axis, as it was a dependent variable and action outcome on X axis, as it was an independent variable. Based on careful observations of samples of the ascending model, these are the categories of patterns:

Prototype I pattern basically falls in category I, where samples showed consistent increase in their confidence with a positive action outcome. In other words, in the Techno-MBA program with every passing semester, the samples' confidence boosted because of the increase in their GPAs (see sample 11, 23, 35, 47, 56, 65, 68). The graph in category I clearly demonstrated the variations in confidence, with a positive action outcome.

Category	Patterns
Type I	
Type II	
Type III	

Graph E: Hypothesis II

Category II reflected types of samples which had random increase in their confidence index as positive outcomes occurred (see graph II), meaning due to changes in

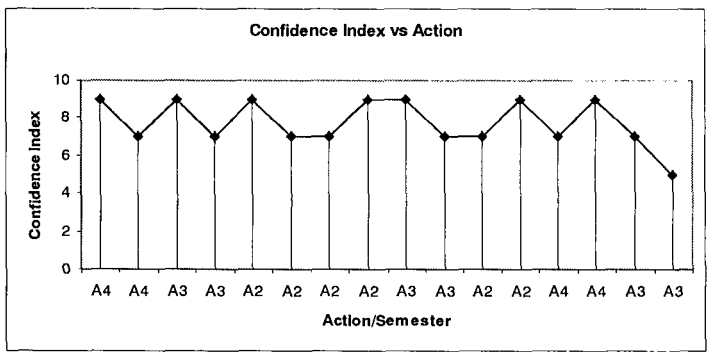
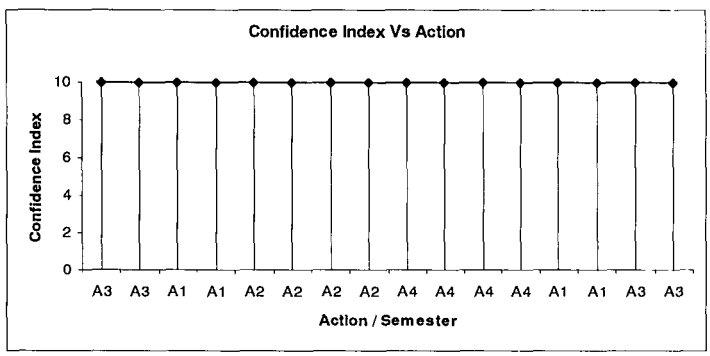
the decision environment, and even with positive action outcomes, all the time they had some fluctuation (both positive, negative) in their confidence indexes. Therefore, at the end, some random variation types of patterns were received (see samples 32, 38, 41, 44, 53). Category III samples did not have any impact of action outcome on their confidence index. This is primarily because of the sample's inability of exhibiting real behavior in a simulated environment. Nevertheless this type of category can definitely be considered as one of the behavior types where the decision maker exhibits a steady pattern, due to positive action outcome (Refer samples 26, 29, 59, 62, 70). Additionally, some samples exhibited patterns in which there was a sudden increase or drop in confidence, and it steadied after a while until the end of the process. We can not really categorize those as they do not have fixed patterns of variation.

For Random Model we received approximately 24 samples as listed below.

Random Samples	1,4,7,10,13,16,19 ,22,26,28,31,34,37,40,43,49,46,52,55,58

Approximately 24 random samples were collected for a total of 71 samples. Based on observation and detail analysis, the following categories of patterns were found. Random samples did show a clear impact of the outcomes over the confidence index of each decision maker (sample); however, the variations were due to the more randomly assigned GPA (refer to sample graphs). In terms of patterns, we came up with two broad categories. Category I shows a very obvious random pattern where the confidence index fluctuates every semester, illustrating a zigzag pattern (see samples 1,4,7,16,22,26,28,31,34,40,43,55). Category II of behavior included samples that did not show any impact of random outcome over confidence index (see samples 58, 52, 49, 19). Again, this is due to the simulated experimental environment. There were samples whose

behavior could not be categorized as they demonstrated random changes in behavior. Nevertheless, all types of samples clearly supported our Hypothesis II by showing the impact on the confidence index due to the random outcome.

Category	Patterns
Type I	
Type II	

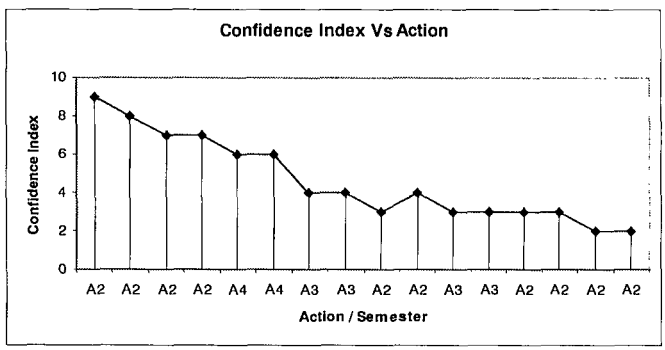
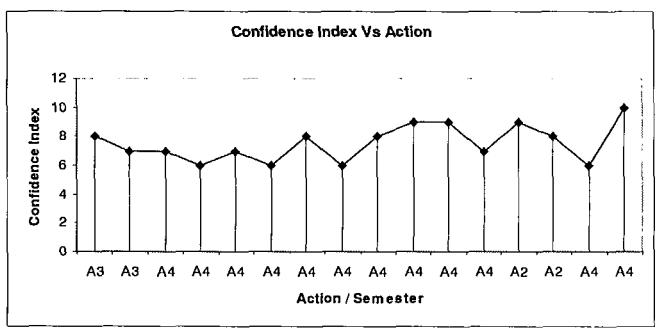
Graph E: Hypothesis II

Descending model included the following samples for the experimental study:

Descending Samples	3,6,9,12,16,18,21,24,27,30,33,36,39,42,45,48,51,54,57,60,63,66,69

About 23 descending samples were collected so that there were an equal number of samples to compare with the ascending model for the verification of hypothesis I.

Similar to other two models, samples (decision makers) in the descending model also exhibited correlation between confidence and action outcome. The action outcome being a negative outcome in terms of a low GPA resulted in a strong variation in the confidence index and supported Hypothesis II. In terms of behavioral categories, two types of descending patterns were found as shown below:

Category	Patterns
Type I	
Type II	

Graph E: Hypothesis II

The Type I pattern demonstrated behavior where, due to a negative result from the actions, the confidence index in the selected path gradually dropped down to a lowest point where the decision makers decided to change path (see samples 24, 48, 51, 60, 66,

69). However, from the perspective of Hypothesis II, the pattern clearly supported the correlation.

Type II pattern displayed random change in the confidence index due to a negative action outcome, but did not have the gradual decrease in confidence during the process. Samples in this category followed the zigzag pattern, and there was an overall decrease in confidence at the end of the process due to consistent negative action outcomes (see samples 3, 9, 12, 15, 18, 21, 27, 42, 45, 54, 57, 63). Therefore, this supported the Hypothesis II statement.

6. CONCLUSION

6.1 Conclusions from the research study

The prime goal of the RDM study is to verify the framework that has been built for RDM at the level of proof of concept and further identify the parameters that play a pivotal role in this decision making process. Similar to the prototype model in the proof of concept, this new revised RDM model also suggests that in an uncertain, complex environment, decision makers do not necessarily follow rational choices, but choose the alternative on the basis of what they think is a feasible option and take actions to achieve their desired goal with certain amount of confidence. Rehman (2002) developed a logical equation where the decision is a sum of confidence and motivation (D=C+ M), and he used this as a basis to identify an agent's behavior. In the proof of concept, this equation was used to identify RDM, and now this study is an extension to verify the impact of action outcome which, in turn, affects the confidence index of the decision maker and causes dynamic variations in the selection of the decision alternative.

The confidence index has been identified as a pivotal factor that influences the decision makers' perceptions towards their decision choices. In this study in addition to the sequence of events in the proof of concept, the action outcome in the decision environment, which is not predictable, had a strong impact on the confidence index and overall RDM process. The bulk of samples in all three models reacted in some manner to the positive or negative outcomes. In all cases, confidence served to inform whether a change in the decision occurred or not. Seventy samples were sufficient to generate the patterns. A similar evidence was supported and demonstrated such as uncertain or

complex situations progress; subsequent actions and their (positive or negative) outcomes result in an updated confidence index for the decision maker.

Through the new, revised experimental design for all three models (random, ascending and descending), several broad categories of behavioral patterns were identified and overcame the proof of concept limitation, i.e. the action loop which threw some light on a few fresh research findings. For instance, with positive action outcomes, we saw the decision makers' change their actions fewer times than while coping with negative outcomes. The scope of the experiment did not allow the comparison of all three models with each other except for ascending and descending

It was hypothesized and demonstrated that the decision makers in real situations take actions to manage their confidence index, and their action outcomes have a strong impact on the confidence index of the decision makers' particular decision path. It can be argued to some extent that this reliance on the confidence index to guide decision making under uncertainty has a potential to be fallible but, in general cases, this may be applicable. Nevertheless, an understanding of the RDM process and its pivotal parameters should however allow for an improvement of overall decision making in the future. Ultimately, rational methods have repeatedly failed to represent real world decision makers' approaches under uncertain, complex situations, and so far, their capability to deal with uncertainty and incomplete knowledge or information is still in question. To sum up, there still exists many hidden aspects of RDM which need to be researched and further clarified to qualify as a robust decision making structure. The scope for future research should the address importance of the real world environment rather than simulated studies and provide more advanced experimental designs where an

array of unlimited action choices are available for decision makers, which will ultimately help to increase a robust correlation between various RDM components.

6.2 Limitations and Future Implications

An Exploratory study of RDM was completed, but with extensive limitations, and it indicated that with future research, it would be possible to overcome many of those proposed shortcomings. Some of the strong limitations were eliminated through the newly designed RDM experiment, such as the capability for the decision makers to take actions, the small sample size to generalize RDM findings, a detailed survey to validate the authenticity of decision makers' answers, etc. RDM is still in its rudimentary phase and open to limitations with new experiments and findings. Hopefully, with further research in the future, it will be possible to address these present shortcomings.

One of the prime limitations is still with the action loop in the RDM experiment. Even though samples were provided with the ability to take actions, decision makers still had only partial control to take actions and manage their confidence index in the experiment, i.e. experiment incorporated predetermined actions and their outcomes, leaving decision makers with very little control over the action outcome. With future research, it could be possible to significantly contribute to the action loop in RDM by feeding extensive action choices and random outcomes based on more equipped experimental design. However this does not mean that the experiment is not strong enough to validate premises and proposed hypotheses. Yes it did offer the liberty to the decision maker to take action of his/her own choice. It did not weaken the contribution of this study towards identifying radical changes of action and confidence index.

A second limitation refers to the scope which is narrowly defined with only three decision models, i.e. ascending, descending and random. As the scope was limited, there could not be a comparison between the three models with each other, and random model findings could not be used to the extent that there was a comparison of it with ascending and descending models. However, the intention behind the quasi-experimental study was to test proposed hypotheses and demonstrate the potential impact of actions on RDM, which was accomplished.

A few more limitations exist, based on the competitiveness of the experimental model or simulation which simulated random possibilities of outcome, but they were predetermined and could not produce thousands of random outcomes which are feasible in pure uncertain situations. Arguably, responses in such an experiment may not genuinely reflect real decisions, not needed since the imperative of success and failure, risk, human behavior etc. can never be fully replicated. Nevertheless, earnest attempts were taken to create a scenario that would be familiar to the participants to minimize this effect. Also, non-experimental study approaches, like case studies or grounded theory applications, may illustrate important findings that experimental studies would not be able to capture.

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APPENDIX A

HYPOTHESIS I & II ANALYSIS

HYPOTHESIS I & II ANALYSIS

Descending Samples

Semesters	Fall 06	Sp07	Su07	Sull07	Fall 07	Sp08	Su08	Sull08	
Samples and their Actions									
1	0	0	1	0	1	0	1	1	S3d
2	0	1	1	0	0	0	0	0	S6d
3	0	1	0	1	0	1	1	1	S9d
4	0	1	1	1	0	1	1	1	S12d
5	0	1	0	0	1	0	1	0	S15d
6	0	0	1	1	1	0	1	1	S18d
7	0	0	1	0	1	0	1	1	S21d
8	0	1	1	1	1	0	1	1	S24d
9	0	0	1	1	1	1	1	0	S27d
10	0	1	1	0	1	1	1	0	S30d
11	0	1	1	1	1	1	1	1	S33d
12	0	0	0	1	1	0	1	0	S36d
13	0	0	1	0	1	1	0	1	S39d
14	0	1	1	1	1	1	0	0	S42d
15	0	1	1	0	0	1	1	0	S45d
16	0	0	0	1	1	1	1	0	S48D
17	0	0	1	1	1	1	1	0	S51D
18	0	1	0	0	0	1	0	0	S54D
19	0	0	0	0	0	1	0	1	S57D
20	0	1	1	1	1	1	0	0	S60D
21	0	0	1	1	1	1	1	0	S63D
22	0	1	1	0	0	1	1	1	S66D
23	0	1	1	1	1	1	1	1	S69D
	0	13	17	13	16	16	17	11	

Ascending Samples

Semesters	Fall 06	Sp07	Su07	Sull07	Fall 07	Sp08	Su08	Sull08	
Samples and their Actions									
1	0	1	0	1	0	0	1	1	S2a
2	0	1	1	0	1	0	0	1	S5a
3	0	1	1	0	1	1	1	1	S8a
4	0	0	1	0	0	0	1	0	S11a
5	0	0	1	0	0	1	0	1	S14a
6	0	1	0	0	1	0	0	0	S17A
7	0	1	1	0	0	1	1	0	S20A
8	0	1	1	1	1	1	1	1	S23A
9	0	0	1	0	1	0	1	1	S26A
10	0	1	0	0	1	0	0	1	S29A
11	0	1	0	1	1	1	1	1	S32A
12	0	0	0	1	1	0	0	0	S35A
13	0	1	1	0	0	0	0	0	S38A
14	0	0	0	0	0	0	1	0	S41A
15	0	0	0	1	0	1	0	0	S44A
16	0	0	0	1	0	0	1	1	S47A
17	0	1	1	1	1	1	1	1	S50A
18	0	1	0	0	1	0	1	0	S53A
19	0	0	0	0	0	1	1	1	S56A
20	0	1	1	1	1	1	0	0	S59A
21	0	1	0	0	0	1	0	0	S62A
22	0	0	0	0	1	0	0	0	S65A
23	0	0	1	1	0	1	1	0	S68A
	0	13	11	9	12	11	13	11	

Changes in Actions in Terms of Action Number (Descending Samples)

Semesters	Fall 06	Sp07	Su07	Sull07	Fall 07	Sp08	Su08	Sull08	
Samples and their Actions									
1	4	4	2	2	3	3	4	2	S3D
2	3	5	2	2	2	2	2	2	S6D
3	4	2	2	4	4	3	4	2	S9D
4	1	3	4	2	2	3	4	1	S12D
5	4	2	2	2	4	4	2	2	S15D
6	2	2	3	2	3	5	2	1	S18D
7	1	1	2	2	4	4	2	4	S21D
8	1	4	2	2	4	4	2	3	S24D
9	4	4	2	2	4	3	2	2	S27D
10	3	4	1	1	3	4	2	2	S30D
11	3	3	2	1	4	1	4	1	S33D
12	2	2	2	4	2	2	4	4	S36D
13	4	4	2	2	3	4	4	3	S39D
14	3	2	3	2	3	3	3	3	S42D
15	2	2	4	2	2	2	4	2	S45D
16	3	3	3	2	3	2	4	4	S48D
17	2	2	4	3	2	3	2	2	S51D
18	4	2	2	2	2	1	1	1	S54D
19	2	2	2	3	2	2	4	3	S57D
20	3	2	3	2	4	3	3	3	S60D
21	3	2	3	5	2	1	4	4	S63D
22	4	2	3	3	3	2	4	3	S66D
23	2	4	3	2	4	3	4	1	S69D

Changes in Actions in Terms of Action Number (Ascending Samples)

Semesters	Fall 06	Sp07	Su07	Sull07	Fall 07	Sp08	Su08	Sull08	
Samples and their Actions									
1	3	2	2	4	4	4	2	3	S2A
2	4	3	2	2	3	3	3	1	S5A
3	2	3	2	2	4	3	4	3	S8A
4	3	3	2	2	2	3	4	4	S11A
5	3	3	2	2	2	4	4	3	S14A
6	3	2	2	2	4	4	4	4	S17A
7	3	3	4	2	2	2	4	3	S20A
8	2	4	4	3	2	5	1	3	S23A
9	3	3	2	2	2	3	2	1	S26A
10	3	2	2	4	2	4	2	3	S29A
11	4	2	2	1	2	4	1	2	S32A
12	1	1	1	2	1	1	1	1	S35A
13	1	2	1	1	1	1	1	1	S38A
14	2	2	2	2	2	2	1	1	S41A
15	3	3	3	2	2	1	1	1	S44A
16	4	4	4	3	3	3	1	4	S47A
17	2	4	2	1	2	5	1	3	S50A
18	2	3	3	3	4	4	3	3	S53A
19	2	2	2	2	2	5	1	3	S56A
20	4	2	3	2	4	2	2	2	S59A
21	3	2	2	2	2	4	2	2	S62A
22	3	3	3	3	1	1	1	1	S65A
23	2	2	3	4	4	3	2	2	S68A

APPENDIX B

SUMMARY CHART OF ALL SAMPLES

Summary Chart of all Samples

Sample 1R				Semesters				
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	7	6	6	5	7	6	7	8
Action	3	4	3	2	2	4	3	4
Confidence after action	7	6	6	6	6	6	7	9
Concentration	A	A	A	A	A	A	A	A
Sample 2A				**Semesters**				
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	9	9	9	7	7	7	9	7
Action	3	2	2	4	4	4	2	3
Confidence after action	9	9	9	9	9	9	9	9
Concentration	B	B	B	B	B	B	B	B
Sample 3D				**Semesters**				
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	5	5	5	5	7	5	3	3
Action	4	4	2	2	3	3	4	3
Confidence after action	9	3	3	5	5	5	3	3
Concentration	B	B	B	C	A	A	B	B
Sample 4R				**Semesters**				
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	7	5	7	5	7	7	7	5
Action	4	3	2	3	2	1	4	4
Confidence after action	7	5	7	5	7	7	5	4
Concentration	B	B	B	B	B	B	B	B
Sample 5A				**Semesters**				

Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	7	9	10	10	9	10	9	9
Action	4	3	2	2	3	3	3	1
Confidence after action	7	9	9	10	10	9	10	10
Concentration	C	C	C	A	A	A	A	A
Sample 6D				**Semesters**				
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	7	9	9	9	9	9	9	9
Action	3	5	2	2	2	2	2	2
Confidence after action	9	9	9	9	9	9	9	9
Concentration	B	B	B	B	B	B	B	B
Sample 7R				**Semesters**				
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	9	7	9	7	9	9	7	7
Action	2	2	2	2	2	2	4	2
Confidence after action	9	9	7	7	9	9	7	9
Concentration	B	B	B	B	B	B	B	B
Sample 8A				**Semesters**				
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	7	2	9	9	9	9	9	9
Action	2	3	2	2	4	3	4	3
Confidence after action	9	2	9	9	9	9	9	9
Concentration	C	C	C	C	C	C	C	C
Sample 9D				**Semesters**				
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence	7	8	9	9	6	6	8	7

before action								
Action	2	2	2	4	4	3	4	2
Confidence after action	7	8	7	6	6	6	6	7
Concentration	B	A	C	C	A	B	B	B

Sample 10R				**Semesters**				
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	9	9	9	9	9	9	9	9
Action	4	4	2	2	1	4	4	3
Confidence after action	9	9	9	9	7	9	9	9
Concentration	C	C	C	C	C	C	C	C

Sample 11A				**Semesters**				
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	9	8	9	9	9	10	10	10
Action	3	3	2	2	2	3	4	4
Confidence after action	9	9	9	9	10	10	10	10
Concentration	A	A	A	A	A	A	A	A

Sample 12D				**Semesters**				
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	9	7	5	7	7	7	3	7
Action	1	3	4	2	2	3	4	1
Confidence after action	9	7	5	7	7	7	5	7
Concentration	A	A	C	A	A	A	B	A

Sample 13	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	9	9	9	9	9	9	7	7
Action	4	2	2	2	3	4	4	4

Confidence after action	9	9	9	3	9	9	7	7
Concentration	A	A	A	A	C	C	B	A
Sample 14	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	9	9	9	9	9	9	9	9
Action	3	3	2	2	2	4	4	3
Confidence after action	9	9	9	9	9	9	9	9
Concentration	A	A	A	A	A	A	A	A
Sample 15	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	7	7	5	3	5	7	7	3
Action	4	2	2	2	4	4	2	2
Confidence after action	5	7	7	7	7	5	5	5
Concentration	A	B	B	B	A	A	A	A
Sample16	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	8	9	9	7	7	8	5	9
Action	3	2	2	2	2	4	2	3
Confidence after action	9	9	9	7	7	5	5	7
Concentration	A	C	C	C	C	C	C	C
Sample 17	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	10	10	10	7	8	9	10	10
Action	3	2	2	2	4	4	4	4
Confidence after action	8	10	10	8	10	8	10	10
Concentration	B	B	B	B	B	B	B	B

Sample 18	Semesters							
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	7	7	5	7	3	3	5	3
Action	3	2	3	2	3	5	2	1
Confidence after action	7	7	7	6	3	3	5	3
Concentration	B	B	C	C	C	B	B	A
Sample 19	**Semesters**							
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	7	7	8	7	7	7	7	7
Action	3	2	4	3	4	2	2	2
Confidence after action	7	7	7	7	7	7	7	7
Concentration	B	B	B	B	B	B	B	B
Sample 20	**Semesters**							
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	9	9	9	9	9	9	9	9
Action	3	4	2	2	2	4	3	3
Confidence after action	9	9	9	9	9	9	9	9
Concentration	C	C	C	C	C	C	C	C
Sample 21	**Semesters**							
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	8	9	7	8	8	7	5	8
Action	1	1	2	2	4	4	2	4
Confidence after action	8	8	8	7	5	6	6	7
Concentration	A	A	A	A	A	A	C	A
Sample 22	**Semesters**							
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II

Confidence before action	8	9	8	7	9	9	9	6
Action	1	3	2	2	2	4	2	3
Confidence after action	5	9	9	6	9	9	9	9
Concentration	A	C	C	A	A	A	B	B

Sample 23	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	7	9	9	9	8	9	9	10
Action	2	4	4	3	2	5	1	3
Confidence after action	9	9	9	8	9	9	10	10
Concentration	C	C	C	C	C	C	C	C

Sample 24	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	9	9	7	7	7	7	5	5
Action	1	4	2	2	4	4	3	3
Confidence after action	9	7	7	7	7	7	5	5
Concentration	A	A	A	A	A	A	A	A

Sample 25	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	9	7	7	5	5	7	3	5
Action	2	2	3	2	4	3	4	3
Confidence after action	7	7	6	3	5	5	3	7
Concentration	B	A	A	A	A	A	A	A

Sample 26	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	9	9	9	9	9	9	9	9
Action	3	3	2	2	2	3	2	1
Confidence after action	9	9	9	9	9	9	9	9

Concentration	A	A	A	A	A	A	A	A
Sample 27	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	9	10	10	8	9	10	9	9
Action	4	4	2	2	4	3	2	2
Confidence after action	8	10	8	8	9	10	9	9
Concentration	B	B	B	B	B	B	B	B
Sample 28	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	9	9	9	7	9	7	7	7
Action	7	3	2	2	3	2	4	3
Confidence after action	4	7	7	9	7	9	9	5
Concentration	A	C	C	C	A	A	B	C
Sample 29	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	9	9	9	9	9	9	9	9
Action	3	2	2	4	2	4	2	3
Confidence after action	9	9	9	9	10	9	9	9
Concentration	B	B	B	B	B	B	B	B
Sample 30	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	9	7	7	7	7	7	9	7
Action	3	4	1	1	3	4	2	2
Confidence after action	7	7	7	7	7	7	7	7
Concentration	A	A	A	A	A	A	A	A
Sample 31	**Semesters**							
Conditions	**Fall**	**Spring**	**Sum 07**	**Sum 07 II**	**Fall**	**Spring**	**Sum**	**Sum**

(order as per charts)	06	07			07	08	08	08 II
Confidence before action	8	9	8	7	9	9	9	6
Action	1	3	2	2	2	4	2	3
Confidence after action	5	9	9	5	9	5	9	9
Concentration	A	C	C	A	A	A	B	B
Sample 32	**Semesters**							
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	7	10	10	10	8	10	10	7
Action	4	2	2	1	2	4	1	2
Confidence after action	8	9	10	10	10	10	10	10
Concentration	B	B	B	B	B	B	B	B
Sample 33	**Semesters**							
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	9	9	7	9	9	7	7	9
Action	3	3	2	1	4	1	4	1
Confidence after action	9	7	9	9	7	7	9	9
Concentration	A	A	A	A	A	A	A	A
Sample 34	**Semesters**							
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	5	5	7	3	7	7	3	3
Action	2	4	2	2	4	3	4	3
Confidence after action	5	5	5	5	7	7	3	9
Concentration	A	C	C	C	A	A	A	C
Sample 35	**Semesters**							
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	7	7	9	10	10	10	10	10

Action	1	1	1	2	1	1	1	1
Confidence after action	7	7	9	10	10	10	10	10
Concentration	C	C	C	C	C	C	C	C
Sample 36	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	7	7	7	9	7	7	7	7
Action	2	2	2	4	2	2	4	4
Confidence after action	7	7	7	9	7	7	7	7
Concentration								
Sample 37	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	10	10	10	10	10	10	10	10
Action	3	2	2	2	2	3	4	3
Confidence after action	10	10	9	9	9	10	9	10
Concentration	C	C	C	C	C	C	A	C
Sample 38	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	9	7	9	9	9	9	9	9
Action	2	2	1	1	1	1	1	1
Confidence after action	9	7	9	9	9	9	9	9
Concentration	A	A	A	A	A	A	A	A
Sample 39	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	9	9	9	9	7	9	9	9
Action	2	3	2	3	4	2	4	3
Confidence after action	9	9	9	9	7	9	9	9
Concentration	C	C	C	C	C	C	C	C

Sample 40	Semesters							
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	7	7	7	9	9	9	7	7
Action	2	3	2	3	4	2	4	3
Confidence after action	9	7	7	9	9	9	9	10
Concentration	B	B	B	C	C	C	C	C
Sample 41	**Semesters**							
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	7	7	7	9	9	9	9	10
Action	2	2	2	2	2	2	1	1
Confidence after action	7	9	9	7	9	10	9	10
Concentration	B	B	B	B	B	B	B	B
Sample 42	**Semesters**							
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	10	8	8	9	7	6	8	9
Action	3	2	3	2	3	3	3	3
Confidence after action	9	7	7	8	7	7	7	7
Concentration	B	B	C	C	C	C	C	C
Sample 43	**Semesters**							
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	8	7	7	8	8	9	9	6
Action	3	4	4	4	4	4	2	4
Confidence after action	7	6	6	6	9	7	8	10
Concentration	B	B	B	B	B	B	B	B
Sample 44	**Semesters**							
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II

Concentration	B	B	C	C	C	B	B	B
Sample 49	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	10	10	10	10	10	10	10	10
Action	3	1	2	2	4	4	1	3
Confidence after action	10	10	10	10	10	10	10	10
Concentration	C	C	C	C	C	C	C	C
Sample 50	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	7	9	9	9	9	9	9	9
Action	2	4	2	1	2	5	1	3
Confidence after action	7	9	9	9	9	9	9	9
Concentration	C	C	C	C	C	C	C	C
Sample 51	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	9	7	6	4	3	3	3	2
Action	2	2	4	3	2	3	2	2
Confidence after action	8	7	6	4	4	3	3	2
Concentration	B	B	B	A	A	B	B	B
Sample 52	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	7	7	8	7	7	7	7	7
Action	3	2	2	2	2	4	4	1
Confidence after action	7	7	7	7	6	7	7	7
Concentration	C	C	C	C	A	A	A	A
Sample 53	**Semesters**							
Conditions	**Fall**	**Spring**	**Sum 07**	**Sum 07 II**	**Fall**	**Spring**	**Sum**	**Sum**

(order as per charts)	06	07			07	08	08	08 II
Confidence before action	7	8	8	9	9	9	7	10
Action	2	3	3	3	4	4	3	3
Confidence after action	7	7	9	7	9	9	9	10
Concentration	A	C	C	C	C	C	C	C
Sample 54	**Semesters**							
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	7	9	7	7	5	7	7	7
Action	4	2	2	2	2	1	1	1
Confidence after action	9	9	9	7	3	7	3	5
Concentration	B	B	C	A	A	A	A	A
Sample 55	**Semesters**							
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	8	7	5	5	7	7	6	5
Action	4	4	4	3	3	3	4	4
Confidence after action	7	7	7	5	7	7	6	5
Concentration	C	C	C	C	C	C	C	C
Sample 56	**Semesters**							
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	7	9	9	9	9	9	9	9
Action	2	2	2	2	2	5	1	3
Confidence after action	7	7	9	9	9	8	9	10
Concentration	C	C	C	C	C	C	C	C
Sample 57	**Semesters**							
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	9	9	9	9	9	9	7	9

Action	2	2	2	3	2	2	4	3
Confidence after action	7	7	7	6	6	7	7	7
Concentration	C	C	C	C	A	A	A	A
Sample 58	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	7	7	7	7	7	7	7	7
Action	2	2	2	2	2	4	4	1
Confidence after action	7	7	7	6	6	7	7	7
Concentration	C	C	C	C	A	A	A	A
Sample 59	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	7	7	7	7	7	7	7	7
Action	4	2	3	2	4	2	2	2
Confidence after action	7	7	7	7	7	7	7	7
Concentration	B	B	B	B	B	B	B	B
Sample 60	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	10	8	8	9	7	7	8	8
Action	3	2	3	2	4	3	3	3
Confidence after action	9	7	7	8	7	7	7	7
Concentration	B	B	C	C	C	C	C	C
Sample 61	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	7	7	8	8	9	9	8	8
Action	3	3	2	2	4	3	4	4
Confidence after action	7	7	7	9	9	9	7	9
Concentration	A	C	C	C	A	A	A	A

Sample 62	Semesters							
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	9	9	9	9	9	9	9	9
Action	3	2	2	2	2	4	2	2
Confidence after action	9	9	9	9	9	9	9	9
Concentration	B	B	B	B	B	B	B	B
Sample 63	**Semesters**							
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	7	7	7	9	7	7	7	7
Action	2	2	3	5	2	1	4	4
Confidence after action	7	7	8	9	7	9	7	7
Concentration	B	B	B	B	B	B	B	B
Sample 64	**Semesters**							
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	7	7	7	7	7	7	7	7
Action	3	4	1	2	3	1	3	1
Confidence after action	7	7	7	7	7	7	7	7
Concentration	A	A	A	A	A	A	A	A
Sample 65	**Semesters**							
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II
Confidence before action	7	7	8	8	9	9	10	10
Action	3	3	3	3	1	1	1	1
Confidence after action	7	7	8	8	8	9	10	10
Concentration	A	A	A	A	A	A	A	A
Sample 66	**Semesters**							
Conditions (order as per charts)	Fall 06	Spring 07	Sum 07	Sum 07 II	Fall 07	Spring 08	Sum 08	Sum 08 II

Confidence before action	8	7	6	6	5	5	3	3
Action	4	2	3	3	3	2	4	3
Confidence after action	7	7	7	5	5	5	4	2
Concentration	A	A	B	B	B	B	C	C

Sample 67	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	7	9	7	9	7	7	7	3
Action	1	4	2	2	3	3	4	3
Confidence after action	7	9	9	7	7	7	7	5
Concentration	C	C	C	C	A	C	C	C

Sample 68	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	7	7	7	8	9	9	9	10
Action	2	2	3	4	4	3	2	2
Confidence after action	7	7	8	8	9	9	9	10
Concentration	A	A	A	A	A	A	A	A

Sample 69	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	9	7	6	5	4	3	3	2
Action	2	4	3	2	4	3	4	1
Confidence after action	7	6	5	4	4	3	3	2
Concentration	C	C	C	A	A	C	C	C

Sample 70	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	9	7	8	8	9	9	8	8
Action	3	3	2	2	4	3	4	4
Confidence after action	9	7	7	9	9	9	7	9

Concentration	A	A	C	C	A	A	A	A
Sample 71	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	7	7	7	7	7	7	7	7
Action	4	2	3	2	4	2	2	1
Confidence after action	7	7	7	7	7	7	7	7
Concentration	B	B	B	B	B	B	B	B

VITA
SWATEE PAITHANKAR

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Objective:

Seeking a position as a junior level engineer while using my technical and managerial expertise for the greater success of the organization

Education:

Master of Science – Engineering Management,
Old Dominion University, Norfolk VA, GPA 3.81, Dec 2007
Bachelor of Engineering - Electrical Engineering,
A.I.S.S.M.S, Pune, India, GPA 3.45, Dec 2003
Courses- Logistics & Supply Chain Management, Operations Research, Risk Management, Quality systems Design, Computer Networking, Digital Signal Processing, Computer Simulation and Modeling, Microcontrollers and Micro Computers I & II, Power Electronics Circuit Design I & II, Systems Engineering

Skill Set:

- **Programming Languages**: SQL, PL/SQL, C
- **Microsoft Office Tools**: MS Access, MS Project, MS Visio, MS PowerPoint, Excel, Word
- **Web Technologies**: JavaScript, HTML, Flash, Dream weaver
- **Databases**: SQL Server, MySQL
- **Operating Systems:** MS DOS, Windows 97/98/2000/2003/XP,UNIX

Professional Experience:

Intern, Information Systems Intermodal Department, Norfolk Southern, Norfolk, VA (Feb-May 2007)

- Generated inventory reports for domestic and international sites with respect to intermodel systems of Norfolk Southern using SQL
- Managed various departmental databases regarding intermodel systems by compiling data using tools like Excel, Macros etc
- Managed and supported additional responsibilities of providing logistics and administrative support to the interdepartmental events like 'safety week' (Norfolk Southern)

Administrative and Managerial Assistant (Graduate Assistant), Career Switchers, Old Dominion University, (Jan 2005–Dec 2005)

- Tasks involved managing and maintaining databases of the Career Switcher Participants
- Generating, handling and managing the Logistics for various Career Switcher events
- Responsibilities included managing office, maintaining call logs, and provide information for the programs provided under Career Switcher
- Attending Teaching Conferences

Academic Counselor, NIIT, Pune India (April 2004-June 2004)
- Providing right guidance to take a career path in the IT industry based on the career path
- Maintaining the database, managing office and maintaining call logs
- Organizing various events and participating in career fairs

Customer Care Representative, AT&T, Convergys, Pune India, (Jan 2005- April 2005)
- Evaluating the problems generated in the AT&T handset and following the insurance procedure
- Troubleshooting any technical complication in the network and providing remedy for physical and technical damage to the phone

Research Experience:

Thesis, Reverse Decision Making, Old Dominion University, (Sept 2006-Oct-2007)
- Verified the concept called Reverse Decision Making using experimental techniques
- Analyzed the role of action and confidence in decision making process
- Considered the risk perspective of the decision maker
- Designed an experimental study using Microsoft office tools to demonstrate the radical impact of confidence and action in Reverse Decision Making

Projects and Proposals:

Effective Sensor Technology and Deployment for Bio-Defense, EVMS (Jan06-May06)
- Analyzed the diagnostic data obtained from subjects available at the Sentara Norfolk general Hospital Emergency Department
- Hypothetical scenario analysis and risk mitigation strategies had been generated for deployment of sensors which identified pathogen outbreak and surveillance data
- Theoretical case had been created which demonstrated the effect of the technology on operation of a health system, potential use and military, civil and commercial installations and effects on emergency response plans

Graduate Assistantship, Old Dominion University, (Jan 2006-Jan 2007)
- Extensive research on a proposal for Pharmaceutical care management
- Designed a website for NEXUS and Systems Engineering Conference
- Worked on a proposal for Project Management using MS project
- Managed and maintained various databases for Student Support Systems

Coach Guidance System: Indian Railways, A.I.S.S.M.S Pune University India (June 03-Dec 03)
- Studied the existing system and its flaws
- Tasks involved designing the entire PCB layout for this application and implementing it
- Implemented coach guidance system to make it application oriented and accessible for common traveler
- Made critical use of the display system which used a microcontroller with internal memory and was programmed for the user to display data
- Simplified the communication between the railway system and the traveler using the couch guidance system

Confidence before action	7	7	7	10	9	9	7	9
Action	3	3	3	2	2	1	1	1
Confidence after action	5	7	10	7	9	9	7	9
Concentration	A	A	A	A	A	A	A	A
Sample 45	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	7	9	7	5	5	7	7	5
Action	2	4	2	2	2	4	2	2
Confidence after action	7	7	7	5	7	3	7	7
Concentration	A	C	B	B	B	B	B	B
Sample 46	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	7	7	7	7	7	7	9	9
Action	2	2	2	3	4	1	3	4
Confidence after action	7	7	7	7	7	7	7	9
Concentration	B	B	B	C	C	C	B	B
Sample 47	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	5	6	6	7	9	9	10	10
Action	4	4	4	3	3	3	1	4
Confidence after action	5	6	8	8	9	9	10	10
Concentration	A	A	A	A	A	A	A	A
Sample 48	**Semesters**							
Conditions (order as per charts)	**Fall 06**	**Spring 07**	**Sum 07**	**Sum 07 II**	**Fall 07**	**Spring 08**	**Sum 08**	**Sum 08 II**
Confidence before action	8	7	7	5	4	3	3	3
Action	3	3	3	2	3	2	4	4
Confidence after action	7	6	5	4	4	3	3	3