Hybrid Multiple Criteria Decision Analysis in Evaluation of Business Ideas

by Entrepreneurs in Incubation Centers

DOCTORAL THESIS

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ÖZET

KULUÇKA MERKEZLERİNDE GİRİŞİMCİLER TARAFINDAN ÖNERİLEN İŞ FİKİRLERİNİN DEĞERLENDİRİLMESİNDE HİBRİT ÇOK KRİTERLİ KARAR ANALİZİ

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İşletme Kuluçka merkezleri Pakistan gibi gelişmekte olan ülkelerde yeni bir fenomen olarak ortaya çıkmaktadır. Bu çalışma yeni başlangıç işletmelerinin kuluçka merkezlerinde değerlendirilmesi ve sıralanması işlemini kolaylaştırmak için geliştirilmiştir. Çalışma, kuluçka merkezlerine gelen iş tekliflerinin ilk tarama işlem sürecini ele almaktadır. Bu ilk tarama süreci yardımıyla başlangıç düzeyli işletme fikirlerinin gelecekteki başarısızlık oranlarının azaltılmasına yardımcı olunması hedeflenmektedir. Yeni iş fikirlerinin seçimi ve değerlendirilmesi için çok kriterli bir karma karar verme yöntemi ile karar verme süreci için bir çerçeve önerisi getirilmiştir. İzleyen adımları içeren sekiz aşamalı bir model önerisi getirilmiştir: ilk komitenin belirlenmesi, karar kriterlerinin belirlenmesi, kriterlere göre düzenlenmiş başvuru formu oluşturulması, başvuruların incelenmesi, başvuru sahiplerine düzeltmelerin iletilmesi, kriterlere ilişkin komite üyelerinin ikili görüşlerinin alınması, kriterlere ilişkin önem derecelerini göstermek üzere AHP tartılarının hesaplanması ve TOPSIS yardımıyla başvuruların sıralanmasıdır.

Pakistan'da hali hazırda bulunan kuluçka merkezlerinden derlenen bilgi kartları ve geçmiş çalışmalar yardımıyla dokuz tane kriter belirlenmiştir. Hibrit çok kriterli karar verme sürecinin tamamında önerilen dokuz kritere göre iş fikirleri sıralaması gerçekleştirilmiştir. Çalışmada biri kriterlere eşit ağırlık verilmesi diğeri ise AHP yardımıyla elde edilen kriter ağırlıkları kullanılmıştır, elde edilen ağırlıklar projelerin nihai sıralamasını elde etmek için TOPSIS'de değerlendirilmiştir. Ek olarak, önerilen model, kara vericilerin kriterlerini ve iş ortamı değiştikçe bu kriterlere verilen önem derecesinin değişmesine de olanak vermektedir. Çalışmada önerilen iş fikirlerinin sıralanması yöntemi, nihai proje/iş fikri seçim kararı verilirken herhangi bir komite üyesinin diğerlerine göre olası hakimiyetini de kısmen önleyecektir.

Anahtar Sözcükler: Kuluçka Merkezi, AHP, TOPSIS, Çok Kriterli Karar

Abstract

HYBRID MULTIPLE CRITERIA DECISION ANALYSIS IN
EVALUATION OF BUSINESS IDEAS BY ENTREPRENEURS IN INCUBATION
CENTERS

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Anadolu University Institute of Social Sciences, December 2020

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Business incubation centers are a new phenomenon in developing countries like Pakistan. This research was made to facilitate the public sector business incubation in Pakistan in evaluation and ordering of the new startup businesses. The study facilitates the incubation centers for the initial screening of the business proposals. It is purposed that this initial screening will help to reduce the future failure rate of the startup businesses.

A total framework for the decision-making process using a hybrid multiple criteria decision-making method is proposed for the selection and evaluation of the new business ideas. An eight-step model was proposed beginning with the formation of the committee members, identification of the criteria, creation, and presentation of the pre-structured application form based on the recommended criteria, checking the applications for their completeness, informing the applicants about any discrepancy, getting the pairwise judgments from the committee regarding criteria, getting the weights through AHP, and finally ranking the projects based on the TOPSIS.

A set of nine criteria were identified through the scorecards gathered from the Pakistani business incubation centers and through previous studies. The whole process of hybrid multiple criteria decision making is used based on these nine criteria for the final ranking of the projects. Two types of analysis are done, one by using equal weights, and the other analysis uses AHP to get the weights, and then these weights are applied to the TOPSIS to get the final ranking of the projects. Furthermore, the proposed model allows the decision makers to change their criteria and the importance given to these criteria as the business environment changes. The proposed method of ordering the business ideas in this study will partly prevent a possible dominancy of a committee member over others for the final decision selection.

Keywords: Incubation Centers, AHP, TOPSIS, Multiple Criteria Decision analysis

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ETIK ILKE VE KURRALARANN UYGUNLUK BEYANNAMESI

Bu tezin bana ait, özgün bir çalışma olduğunu; çalışmamın hazırlık, veri toplama, analiz ve bilgilerin sunumu olmak üzere tüm aşamalarında bilimsel etik ilke ve kurallara uygun davrandığımı; bu çalışma kapsamında elde edilen tüm veri ve bilgiler için kaynak gösterdiğimi ve bu kaynaklara kaynakçada yer verdiğimi; bu çalışmanın Anadolu Üniversitesi tarafından kullanılan "bilimsel intihal tespit programı"yla tarandığını ve hiçbir şekilde "intihal içermediğini" beyan ederim.

Herhangi bir zamanda, çalışmamla ilgili yaptığım bu beyana aykırı bir durumun saptanması durumunda, ortaya çıkacak tüm ahlaki ve hukuki sonuçları kabul ettiğimi bildiririm.

MUDASSAR HUSSAIN
DATE: DECEMBER 16, 2020

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Chapter 1 Introduction

Our decisions represent the fundamental tool we use when we confront different challenges, opportunities, and uncertainties of our life (John, Ralph, and Keeney 1999). Whatever the outcome is, good or bad, for our decisions or it is made consciously or unconsciously, there are some basic patterns to make it. Some of the decisions are quite simple need not so much effort, but those are the exceptions, most of our decisions are complex, and tough to find out the best solution among the set of solutions. These decisions may not only affect our families, co-workers, our friends but a lot of other known and unknown. High stakes and serious consequences are involved with tough and complex decisions which in turn leads us to a state of anxiety, confusion, doubts, errors, embarrassment, and even total loss. The pressure and the gravity of the situation and other circumstances also lead us to make our decisions hastily, or sluggishly or too randomly leaving us in the hands of luck for the good result of our decision. It is only afterward we realize that better decisions could have been made but till that time it is too late. The likelihood of making good decisions not only depends upon what are we going to decide but also how we are going to decide. The probability of choosing the best course of action for the problem can be raised if we learn to use the good decision-making process that in turn save our time and money and decrease the chances of loss and making poor choices (John et al. 1999). These scholars describe the way how the decision can be made with a smart choice among the set of solutions.

According to John et al., (1999), even a complex decision can be analysed and solved by considering the set of eight elements which they abbreviated as PrOACT, the acronym for "problem, objectives, alternatives, consequences, and trade-offs" and other three are uncertainty, risk tolerance, and linked decisions. Each decision is needed to satisfy or solve some basic problems. Reaching the best solution mainly depends on how you define the problem. A poor definition of the problem leaves the whole process of the decision making on the stake with undesirable outcomes. The best way to start defining the problem is to answer what triggered the decision. Usually, the problem definition contains some type of constraints that further reduce the range of alternatives. Questioning about the constraints and boundaries of your problem focuses the attention of the decision makers on specific alternatives. Further, the division of the problems into their relevant components increases the surety that our problem statement focuses on the

right goal. Defining the right decision problem also elaborates on what other decisions influence the current decision and vice versa. So, the context of the decision will indicate that you are on the right track.

The decision requires to meet some of the goals to satisfy the decision problem. These goals or objectives are the foundation for the evaluation of the alternatives. In other words, these objectives are your decision criteria. The identification of your criteria leads you to avoid making a biased or unbalanced decision. Setting the criteria for your decision makes your direction clear at the outset because they are used to evaluate and analyse your alternatives.

Next, to knowing about your objectives are to put your efforts in to how you can satisfy these objectives of your decision. You may have a different course of action that can be used to pursue your goals. This set of different courses of action is the alternatives. Identify as many alternatives as you can with your best effort.

After defining the decision problem and relevant objectives and identifying alternatives the next step is to choose the best among the alternatives that will fulfil your objectives related to your decision problem. The best way to choose among the alternatives is to first find out the consequences of each of the alternatives over each of your objectives. If you fail to evaluate the consequence of each alternative on the objectives, you will see it in the future when maybe you would not be happy to see it. Writing the consequences and then identifying the inferior alternatives based on these consequences will save your effort and time to keep your focus on the relevant alternatives.

One of the alternatives with no clear-cut dominance over each other has been identified next step is to make a trade-off. You need to trade-off when each alternative has some advantages over others concerning objectives under consideration.

One of the methods used in the process of choosing among the alternatives is through voting. The voting method represents the social choice procedure used in deciding what is a favourable outcome. There are different types of voting methods that can be used in the selection of the alternative. Each voting method has its processes and results in different outcomes. The most common type of voting method used is the simple majority voting or the plurality voting method in which the alternative which gets the majority number of votes are taken as a winner candidate. In the case of two alternatives,

the absolute majority is deemed as one of the most used methods. In this method, the alternative who gets more than half of the votes of total votes is the winning candidate.

The other method used is Condorcet's method in which the candidate is chosen as a winner candidate if he defeats all other candidates in pairwise comparison (Straffin and Taylor 2006). This Condorcet winner criterion is one of the criteria which should be met by all type of social choice procedures when realizing the outcome. The Borda count method is another method for social choice in which each alternative is given a weight according to their relative position concerning other alternatives. In the end aggregate, the Borda score is calculated. The alternative having the maximum Borda score is taken as the best alternative (Fraenkel and Grofman 2014).

All the voting methods have some basic assumptions that should be fulfilled by each of them to avoid perverse results. For example, every social choice procedure results in choosing the best alternative among the set of alternatives, if all the voters vote for a given candidate the social choice procedure must reflect this if there is a unique winner the voting method should also result in this best candidate as an outcome, any positive change in the preference list should be reflected by every social choice procedure, any addition or deletion of the irrelevant alternative inside the set of alternative should not have any effect on the selected alternative or in the preference list. All of these assumptions should be qualified by each of the procedures for social choice.

Choosing candidates through voting methods is easy when there is only one criterion based on which candidate is chosen. But when the number of criteria is more than one there need some other methods for the selection of the alternative. The methods used are known as multiple criteria decision-making methods.

MCDM breaks the decision problem into small pieces, these small components are weighted through some objective or subjective judgments, the components are then aggregated into a single piece to represent the holistic view of the decision problem. Then decision-makers can evaluate all the alternatives through a systematic process (Mardani et al. 2015).

1.1. Research Motivation

Pakistan has a population of 200 million of which 64% are below 30 years and the youth, aged between 15-29 years, constituting 29% of the total population. Approximately four million young people are becoming part of the working-age

population every year in Pakistan (Ahmad 2018). Small-medium enterprises contribute about 30% of the GDP of Pakistan (Zafar and Mustafa 2017). There is a drastic need that the government should focus on how they will manage this young population in the labor force. The creation of a venture has a multiplier effect on job creation. Pakistan needs more to focus on venture creations than job creation because a single venture requires multiple skilled personnel and hence multiple jobs are created in turn. The country needs facilitators who will encourage and assist the youth of Pakistan to start their businesses. The concept of business incubation centers is one of these facilitators which try to convert a lot of job seekers into a lot of job providers.

Business incubation centers in public sector universities are a recent phenomenon in Pakistan. The Higher Education Commission (HEC) Pakistan aids public sector universities for the establishment of basic infrastructure and supporting facilities for the new entrepreneurs and researchers who want to establish business ventures. There are thirty university-level business incubation centers listed on the HEC website.

The main objectives of University Level Business incubation centers in Pakistan are:

1. Highlight the importance of entrepreneurship among the youth
2. Creation of the links between academia and industry
3. Provide facilitation for the commercialization of viable research and innovation.
4. Contributing to economic growth through employment generation from the new start-up businesses.

Universities are responsible to provide premises with general facilities to the new start-ups. But before doing anything the entrepreneurs' ideas need to be evaluated first. The selection and the evaluation of new business ideas require a comprehensive approach depending on various criteria. Each criterion needs to be weighted properly, depending on the personal judgment of the practitioners and academicians, to select the most viable business idea that will have less risk of being fallible in the future.

The main purpose of this study is to provide a system of selection and evaluation that will provide a strong foundation over which a strong building in the shape of new business will be constructed that will have less chance to be shacked in a risky environment.

1.2. Research Significance

This research will facilitate the incubation centers to properly evaluate and select the new entrepreneurs' ideas using the hybrid multiple criteria decision-making. First, the criteria are identified by a systematic review of the literature further some basics criteria are identified by evaluating the scorecards of the incubation centers used in Pakistan. 10 projects are taken with 9 different criteria categorized into three groups, namely, financial criteria, marketing criteria, and resource needed criteria. Analytic hierarchy process is used to obtain the weights of each criterion these criteria weights are further used in the TOPSIS to obtain the final ranking of the alternatives. In the end, the Borda count method is suggested to the committee members to finally decide which idea proposed by the entrepreneurs is suitable in the current setting. This approach will try to convert the subjective judgments of the decision-makers in the committee to priorities the projects in an objective way.

1.3. Research Objectives

The objectives of the research include:

Recommend a hybrid multiple criteria decision-making method to the business incubation centers for the evaluation of business ideas of the new entrepreneurs.

1.4. Research Questions

Q1. What are the key criteria for the selection and evaluation of student's business ideas?

Q2. How the hybrid multiple criteria decision-making method will be used to facilitate the business incubation centers to evaluate the ideas proposed by new entrepreneurs.

1.5. Thesis Structure

The first chapter of the thesis is Introduction that is constituted of the brief background of the topics discussed in the thesis, research motivation, the significance of the research, research objectives and the research questions, and the structure of the thesis.

The second chapter is about the brief history of decision analysis, the types of decision analysis, the elements of the decision analysis, how the decision is made under ignorance, and uncertainty.

The third chapter describes the different voting methods, and how the alternatives are chosen under these different voting methods

The fourth chapter is about project management and the different dimensions of project management which are a necessary part of complex projects. Each dimension itself generates its output and together they are a necessary part of completing the projects successfully.

The fifth chapter is about the multiple criteria decision-making. Special focus is on the Analytic hierarchy process and the TOPSIS, both are used to create a hybrid multiple criteria decision-making method for assisting the business incubation centers to evaluate and select the business ideas.

The sixth chapter is about the theoretical background of entrepreneurship and its different concepts

The seventh chapter is about the research methodology used in this thesis. It contains the framework for our decision-making model. It also consists of our criteria and the scale used to measure them

The eighth chapter is about results and discussion of our application of the AHP and TOPSIS to get the final ranks of the projects. Two analyses were done to get the two different types of ranks. One analysis uses equal weights. On the other hand second analysis uses the weights generated through AHP

Chapter 2 Decision Analysis

2.1. Introduction

Decision analysis can be understood by looking at decisions and analyses separately and briefly. A decision is about finding the best solution for a problem whereas analysis is breaking the decision problem into smaller parts so that each of these smaller parts can be focused separately to find the solutions for these problems that in turn are integrated to solve the main decision problem (Goodwin and Wright 2004). Decision analysis is a procedure based on a logic that requires harmonizing different types of competing factors. These procedures form the decision structure based on the decision maker's preferences, values, and uncertainties in the decision problem. The basic purpose of these procedures is to form a basic structural model of the decision problem that can easily be calculated and manipulated for objective translation of the decision problem (Edwards, Miles, and Von Winterfeldt 2007). (Keeney, L. 1982b) defines the decision analysis as "*A formalization of common sense for decision problems which are too complex for informal use of common sense*". To formalize a common sense about the decision problem requires a strong foundation based on systematic procedures, methodology, and philosophy expressed in terms of axioms based on a logic that helps out analysing the difficulties associated with the decision problem.

It is not easy to decide about complex problems until someone will follow some systematic methods to decide. The decision about complex problems is surrounded by a lot of factors *first*ly they may involve multiple objectives based on the maximization of the benefits and the minimization of the cost. So it is difficult to find the solution that will achieve multiple objectives so we need to trade-off between these objectives offered by the different alternatives. *Secondly,* the decisions involve some type of uncertainty and the choice among the alternatives is dependent upon the nature of the decision-maker about risk-taking. A decision-maker can be the risk averter and the risk-taker hence the alternative chosen to solve the problem may greatly vary from one decision-maker to another. Thirdly the decision problems vary in their structure. Some decision problems require sequential decisions to be made and require a different type of alternatives for each decision. The complex structure of the decision problem requires fully understand all possible alternatives available or to generate new alternatives to solve the problem.

Finally, a decision problem involves different stakeholders with different levels of risk-taking behaviour. So each of the stakeholders can have different types of preferences for solving the same problem.

2.2. Rationality and Bounded Rationality

Many social scientists regarded human decisions making very important concepts to their respective fields. Problem-solving models and models of choices are key to the fields of economics, cognitive psychology, management sciences, politics, system engineering, and the theory of education. The decision making although being so important, yet few theorists have studied how human beings actually go about making decisions. By definition, decision-making is task-oriented so is a large portion of human behaviour which makes decision-making and problem-solving very important to social scientists. Decision making is one of the complex tasks in organizations. The top management is also involved in making long term strategic decisions. Mid-level Managers are, on a daily basis, making decisions on tactical matters. This is a common task of all the managers whether they are in top management positions or mid-level management positions. The task of decision-making ranges from simple to complex. The important concept in decision making is rationality in decision making. The concept of rationality has attracted many philosophers and social scientists for example role of rationality in social action is studies by Max Weber whereas other scientists like Grayling studied the effect of emotions on the quality and degree of rationality.

Decision making can be defined as *choosing the best among the alternatives*. This entails a process of reaching some decisions through reasoning and logic. Rational decision making is a process of reaching decisions through logic and reasons (Sophn, 2002). The rational decision-maker makes the choice that optimizes its utility and consists of complete, transitive, and continuous preferences. So, decision making is the process through which decisions are reached. A typical Classical economic choice theory of decision making has elaborated this process clearly.

The model of Classical economic choice theory can be sketched as follows (Soelberg, 2010).

1) Given that the decision-maker is in a real-world task environment, he is exposed to the number of alternatives decision choices from which he has to choose.

2) There is a set of consequences attached to each choice, each of these consequences represents the environmental response to these choices. Traditionally economic theory predicts three types of consequence-estimation methods:

    i) Under certainty, in which decision-maker can attach a unique consequence to each of the alternatives

    ii) Under stochastic risk in which decision-maker, for each of the alternatives, can specify a set of possible consequences with some independent probability measures.

    iii) Under uncertainty in which decision-maker can predict the set of finite possible consequences for each alternative but is unable to know the likelihood of occurrence of these consequences.

The main premise of rational choice theory is that individual actors in society have their own preferences in decision making and these choices collectively make social behaviour. The theory, therefore, focuses on the determinants of individual preferences. This theory makes three key assumptions about the preference of decision makers (actors) i.e. 1) perfect knowledge-the rational choice theory assumes that decision makers/actors have complete information about the alternatives. 2) Completeness-if there is a set of two alternatives a and b, a decision-maker can prefer a over b, or b over a or remain indifferent about both of these preferences. All pairs of alternatives can be compared with each other. 3) Transitivity i.e. if the alternative a is preferable over b and b is preferable over c then a is preferable over c. Full rationality demands the unlimited cognitive capabilities of a decision-maker. Full rational theory portrayed an actor as a mythical hero who has full information about the alternatives and knows all mathematical problems and regardless of how difficult these problems are they have the extraordinary computational capability to solve these problems immediately (Reinhard, 1999). Human beings are totally different from this idealistic full rational man. It has certain limitations to its cognitive capabilities. Due to these limitations of an actor he cannot make the decision like that idealistic rational man. This notion is stated by the concept of bounded rationality which is simply the idea that not only some consistent overall goal and the properties of the external world determine the choices made by the decision makers but also knowledge of the external world that decision makers have or have not, their ability or inability to evoke the knowledge when it is needed, to work out the consequences of their choices, to conjure

up possible course of actions, to cope with uncertainty and to adjudicate among their competing desires. Due to these limitations of actors, the rationality is bounded. Rational behavior is determined not only by the external world environment but also by the inner environment of actors' minds, both the content and processes of their memory (Simon, 1999). The theory of bounded rationality deals with both procedural rationality and substantive rationality. The procedural rationality is related to the quality of the process of decision making and to understand it needs the theory of the psychology of decision-makers. Whereas the substantive rationality is about the quality of the outcomes and to create understandability about it needs the theories of goal and the external environment.

2.3. History of Decision Theory

In the field of literature, history has a very important role. Literature develops over time. There are three different phases of the history of decision theory. Starting from the ancient Greek period or the Old period; as in almost every discipline the old period starts from the ancient Greek period, the second is the Pioneering period and the third phase is known as the Axiomatic period. To understand the history of decision theory we must start from the old or the ancient Greek period. Though there is no evidence that Greeks has developed a theory of rational decision making like many other areas they have just identified the area of decision making as a further investigable phenomenon

Ancients Greeks have laid the cornerstone for the scientist to come to investigate the area of decision making. Though they identified the area of decision making there is no evidence that they have developed any rules to make a decision. In Greek literature, one can only find what is right and what is wrong or what to do and what to avoid other than that no rational decision-making models are available in the Greek literature related to the decision. Fifteen hundred years of the Greek period has little or no contribution to the history of decision theory.

The second development phase of the history of decision is known as the Pioneering phase and it started in 1664. At that time, a Frenchman who was interested in gambling raises the question that "What is the likelihood of getting at least one pair of sixes if a pair of fair dice is thrown 24 times?"

On the basis of this question, Blaise Pascal and Pierre de Fermat started to exchange letters that were related to probability theory. They started to solve the problem exactly

through mathematical solutions rather than through empirical evidence by throwing the dice much time.

They did not try to give an approximate answer. This historical event led to the development of modern probability theory. In 1657, on the basis of this conversation between Pascal and Fermat, Christian Huygens who was a famous scientist in the field of physics and astronomy, wrote the first book in this field of probability.

In 1662 a famous book named "Port-Royal Logic" was written by Antoine Arnauld and Pierre Nicole, also considered as one of the breakthroughs in the Pioneering phase of decision theory history. Port-Royal Logic contains the first clear formulation of the principle of maximizing expected value

Frank Ramsey is one of the pioneers of the modern decision theory also known as the Axiomatic period. He wrote a paper, "Truth and Probability" in 1926 and published in 1931. His paper is known as one of the two starting points of the Axiomatic period

The second starting point was Neumann and Morgenstern's book Theory of Games and Economic Behaviour and in particular the publication of the second edition in 1947. When both of them published the first edition of the book in 1944, they were unaware of the paper of Ramsey. In his paper, Ramsey has introduced eight axioms for how rational decision makers ought to choose among uncertain prospects. The second edition of the book by Neumann and Morgenstern also introduced a set of axioms for how rational decision makers ought to choose among lotteries.

Many books and papers have been written and published in the 1950s that make this decade the golden period for decision theory. "The Foundations of Statistics" is the most famous book on this issue written by Leonard Savage in 1954. In this book, the author has introduced another influential axiomatic analysis of the principle of maximizing expected utility

2.4. Decision Making in Organizations

The decision making is one of the complex tasks in organizations because its effect can be seen in a number of lives. Management theorists have a consensus upon the most important of decision making. Making sound decisions is a crucial skill at every level in the organization. The organizational decisions nowadays are made by groups, teams, and committees. The group decision making can range from democratic, consensus to consultative decision making. Each one representing its own privileges of decision

making. In the consensus decision making the team leader, with its members of the team, identify the problems and define a certain course of action to solve the problems. Each alternative course of action is evaluated by the leader and the group member and attempts to agree upon a single course of action to solve the problem (Fred C, 2011). Organizational studies actually define decision making as a process. They are taking rationality as a variable that can be evaluated from the outside. Decision making is the series of steps the rational decision-maker follows when he makes the decision (Ogue, 2013). The process of rational decision making has certain assumptions and characteristics which seem unrealistic in the practical environment. Some of the assumptions are that:

1. The decision-maker has a clear and unambiguous understanding of the problem at hand and their objectives in relation to these problems
2. A complete search of the alternative course of actions and their respective outcomes are feasible and is carried out.
3. The evaluation of each alternative is objectively made in relation to the outcomes they generate. And the alternatives which provide the best outcome is selected
4. Continuous and objective monitoring is carried out to determine the success of desirable outcomes in relation to the chosen alternative.
5. The rational decision-making model does not refer to the filtering and constraining influences of the organizational paradigm on the decision process as a whole.
6. The significant effect of the political environment is totally ignored in the rational decision model.

All these steps and assumption looks plausible until the rationality is working in certain situations. What happened if uncertainty and ambiguity arise in the situation? Organizational decisions are full of these uncertain and ambiguous conditions where the outcome of any decisions cannot be attributed to the full likelihood of occurrence of the consequences to a specific course of action. Choices are frequently made with little consideration of the preferences. Decision makers routinely ignore their own, fully conscious preferences in making decisions. They follow the rule, standard operating procedures, traditions, organizational cultural norms, and even the advice or action of others. Individuals and organizations know to some extent that their preferences are

conflicting with others, yet they do little to resolve these inconsistencies among their preferences. One of the ways in which individual and organizations develop a goal is by considering and interpreting their action which they take to achieve these goals. And one important character of the good actions is that they lead to the development of new preferences which is against the assumption of the classic rationality theory of stable preferences. That's why managers might well view decision making somewhat less as a process of deduction and somewhat more as a process of gently disappointing predeterminations of what is going on (James G., 1991). Other studies showed that manager did not act according to the suggested normative rules, the inability to handle the risky situations are due to lack of information that also suggests the bounded rationality (Ari, 2006).

One of the problems in rational decision-making is Heuristics. These are mental shortcuts. They are the mechanism that lets us jump over the conclusion instead of taking any detailed logical reasoning. The outcome may or may not be biased. Biasness falls under the domain of substantive rationality whereas heuristics come under the realm of procedural rationality. In other words, the process that does not help us in making sense of alternatives, situations, variables, etc. is heuristic. Gigerenzer, one of the researchers, put his incredible effort into studying the simple heuristics holds that these mechanisms make us smart and are diffuse in our brain. Simple heuristics are fast and frugal in the sense that they need little time and information in making decisions. These heuristics are also present in the organizational environment. In organizations, some of the decisions are needed to be quick with little information available. Based on these assumptions and conditions it is clear that the rational decision-making model hardly describes how the decisions are made in the organizations. But an interesting question posed on this model is whether organizations should strive to follow these procedures prescribed by this model because it is argued that it actually restricts creativity and even the inappropriate alternatives should remain inside the paradigm. But the important criticism is that this model does not make decision makers aware of the subconscious filtering and constraining effect of their existing belief on the decision-making process. This model gives the impression that it is possible to address the alternatives and their respective outcomes comprehensively and sequentially. But in real organizational and individual decision making there are certain limitations on the human, like time constraints, financial

pressure as well as human's cognitive limitations on information processing capabilities. Knowing all of these limitations why rationality seems such a powerful character for individual and group decision making. One reason for this is that actions that have a rational decision procedure at its back can protect the initiator from criticism. The second reason is a means-end relationship has a powerful imprint on our life, even we are being rewarded for it. The last reason is that delays in decisions and actions can be justified by an extensive search for information on a possible alternative course of action and their outcome. In organizations decisions, subject to limitations, require the bounded rationality to follow. Managers are not seeking the optimal outcomes through choosing a specific course of action rather the satisfying or which meet or exceed their aspiration level. The more effective decisions can be made by considering structural, processual aspects, and cultural attributes as a whole in the organization (Loizos Th., 1994).

Structural Aspects of decision-making group are: the individual within the group should come from a varying background which will create the different viewpoints and helps in enhancing the potential of interpretation of a group, the group can be divided into the subgroup that can discuss the issue independently and then comes together to share their views, outside consultation can be arranged time to time keeping in view the complexity of the problem.

Processual Aspects include the encouragement of debates inside and outside the decision-making group and critically and systematically asking of the viewpoint about the task at hand, democratic or consensual decision-making process should be adopted and availability of suitable information system shows that the organizational activities and performances are monitored.

Cultural Aspects are one of the important factors which allow effective decision making in organizations. The organizational culture should be transformed into a learning organization. These organizations are skilled in creating, acquiring, and transferring knowledge and creating behavioral change based on new knowledge. The organizational culture must support its employees and should encourage raising new ideas and solutions to the problems which then can be evaluated with respect to different criteria.

2.5. Normative and Descriptive Decision Theory

There is a clear distinction between how people make a decision and how they ought to make the decision. The descriptive decision theory looks at how people make decisions.

What are the psychometric variables that affect the decision making how cultural and personal variables influence the way the decider decides about a decision problem? On the other hand, the normative decision theory considers how people should make decisions. What are the common consideration and logical steps that decision-makers should follow to act rationally while encountering a decision problem? This thesis follows the normative decision theory. The reason behind to follow is because how the decision is made differ from culture to culture and time to time whereas the normative decision theory overcomes this variability and stands across the cultures and time. Secondly, the normative decision theory can be used to teach the people how can then act rationally while deciding about something. Descriptive decision theory requires to identify the reasons why people behave as they behave in any situation, and the reason may change from person to person while normative decision theory provides them the logic of how to make the rational decision making (Peterson 2009)

2.6. Elements of Decision Analysis

the decision problem can be analyzed by a set of eight elements. 5 of these elements can be applied to every decision despite their complexity. The last three elements can affect when the decision problem is too complex and includes uncertain and risk factors into consideration (John et al. 1999). These eight elements are listed below

1. Problem
2. Objectives
3. Alternatives
4. Consequences
5. Trade-offs
6. Uncertainty
7. Risk tolerance
8. Linked decisions

2.6.1. Problem

Defining a decision problem is itself a decision problem which needs to dig deeper and systematically, Stating the right decision problem influences the choice of the alternatives. The generation of new alternatives and listing the existing alternatives

depends upon the consideration of the decision problem. If we focus on the wrong decision problem, it will generate a totally wrong set of alternatives to be considered thus deviating a decision-maker from its main goal. For example, your organization needs a software package for direct mailing to potential customers. The actual problem may not be what is the best package for the direct mailing but how can we efficiently send the direct mails to the prospective customers. The solution may be to outsource your direct mailing services rather than to buy a new software package. A good problem statement can be defined by considering the number of factors. It mainly starts by writing what we think about what the problem is then we will make some questions, then we test these questions, and, in the end, we refine it. You can start by asking questions about what triggers the basic problem, what are the timing and occasion of this trigger what the link of a trigger with the decision problem is. the other factor is the consideration of the constraints that in turn will reduce or change our list of relevant alternatives. It is very important to consider the effect of other decisions on the decision problem at hand and vice versa. Not looking at these effects will make the decision problem prone to fail for the best choice of alternative. The question of making other relevant decisions as to the part of a given decision or dealing with the given decision separately from the other relevant decision is the crucial question for looking into the decision problem more accurately. After getting knowledge and reviewing these above questions next part for the refinement of a decision problem is to ask other people's perspectives about the given decision problem. This not only tells you what others think about the problem but may also change your own perspective.

2.6.2. Objectives

Every decision problem is concerned to achieve something. This is known as the objectives of the decision problem (Edwards et al. 2007). The universal definition of objectives does not exist (Keeney and Raiffa 1993). The objectives give us direction so we can put ourselves into a better state in the decision-making process. After the decision problem is properly structured the next step is to list down the important objectives that must be achieved to solve the problem. The identification process of objectives requires a systematic process. It is an art for the decision-maker to clearly identify the objectives. The five steps below can assist in the identification process of the objectives.

1. All the concerns you are expecting from the decision should be written down. Do not worry about disorganization or if the two concerns reflect the same thing. If the group is involved in the decision-making process first get the individual list from each decision-maker then try to make the whole list so that no one will be influenced by the thoughts of others.

2. Try to convert your list of concerns into brief objectives. The easiest way to do this is to phrase your concerns into two words of a verb and an objective. For example, if your concern is to provide your employees with an environment where they can work without any stress the brief objectives can be written as reducing stress.

3. Establishment of fundamental objectives by separating means and ends. The means objectives are those objectives that drive us toward the end objectives. We can make a distinction between means objectives and the end objectives by asking just a simple Why to achieve this objective question. To answer the why questions for the means objectives will take us to the ends objectives. For example, to minimize the stress level of employees is a means objective. Why is it to minimize the stress level of employees so important? because it will make them work effectively and efficiently. Why is working effectively and efficiently so important? Because it will reduce the cost of the product. Why is the reduction in cost so important? because it is the prime objective of the organization. That is how a simple why question can lead us from the means objectives to the main objective. Separating the means objectives from the main objectives will help us to find out the alternatives that can best serve us to reach our decision. The means objectives can generate a wide range of alternatives and these alternatives can be selected and evaluated only by the fundamental objectives.

4. Give the meaning to each objective. Know we have the complete list of fundamental objectives. The next step is to give each objective its respective meaning so everyone will know what it actually is to strive for. The objectives can be misunderstood differently by different people or may be attributed to different meanings in a different context. So, it is important to elaborate on the fundamental objectives by giving them proper meaning so that every person understands the objective in the same manner.

5. Objectives must be tested by evaluating different alternatives. If the resulting alternative will satisfy you in terms of achieving your main decision problem then you have correctly stated and understood the respective objectives, if not, then you need to find out what is missing and unclear in stating your objectives.

6. Following these five steps can help in the identification and generation of the objectives that are relevant to your decision problem.

2.6.3. Alternatives

Alternatives are the actions or options we choose to meet our objectives. Two important things should be noted, first that we cannot choose an alternative that we have not considered and second the alternative that we have chosen cannot be better than that of the best in the set of alternatives. There are a lot of mistakes decision makers are making while choosing the alternatives. One of the common mistakes done is to choose the alternative which is chosen before in a similar decision problem. Another mistake is to choose the alternative that comes first to your knowledge. For example, you are going to choose among the diapers for your first newborn baby. You saw an advertisement about pampers and you choose to buy it. You could have found another diaper if you have investigated a little deeper about the different criteria associated with choosing your required diaper. The solution proposed by others can also lead to poor decisions. It is the common tendency of the people to act according to the person's wishes for whom they have some special place or for whom they have a perception that they can decide best according to their experience.

There are some techniques for the generation of the alternatives although generations of these alternatives need just deep thoughts, effort, and time. These techniques are briefly discussed below.

1. Use objectives as a direction for identifying alternatives. Just like means objectives leads us to fundamental objectives. These fundamental objectives, in turn, leads us back to the means of generating the alternatives. For the generation of alternatives from the fundamental objectives, we need to ask *how questions.* how can you achieve the fundamental objective? How will you minimize the stress among the employees? One answer may be by providing them the time to spend with their family. How can we give them the time to spend with the family? The answer may be by providing

them free air tickets for some recreational time with their family or by changing the working time so they can spend more time with their family. Two alternatives are generated by just asking the how question.

2. A list of alternatives is limited by constraints. Some of these constraints are real and some are assumed. Assumed constraints are just a mental play and should not be considered while generating alternatives. Real constraints should be tackled thoughtfully. One way to deal with the real constraints is to find out the other ways to subdue the effect of constraints. The other way is to think about the alternatives as if the real constraints do not exist. Once alternatives are identified, the evaluation of the alternatives will lead us to the suitability of the alternative. If the alternative is good enough to be considered, try to find out what are the ways to make these alternatives feasible.

3. A decision-maker should set its goals as high as possible. Setting higher aspirations will lead a decision-maker to think more broadly and open new doors of thinking optimally.

4. Consultation with others is a good thing, but before doing it you must first think yourself about the possible alternatives. This strategy will not shut your own creative ideas down by the thinking and suggestions of others. Most of the time our ideas could not flourish because they are buried by the ideas posed by others before they could get mature.

5. Ask others for suggestions after you state and understand your decision problem and possible alternatives first. This will not only make you understand how the same decision problem and its possible solution is viewed by others from a different perspective but also will identify other alternatives that you have skipped. These differences are the result of the unbiasedness of others toward the decision problem which you lack due to the emotional attachment to the situation. On the other hand, the discussion with others, by keeping your mind open, will stimulate further explanation and question-answer sessions with others which will benefit you for further investigation and deeper understanding of your decision problem and the alternative you are considering.

6. Don not simultaneously generate and evaluate the alternatives. First, you need to generate and identify the alternatives. List them first and then evaluate them. During

the process, you may have considered the bad or irrelevant alternative. Do not try to overcome them first because it will damp your creativity. The irrelevant and bad alternatives can be eliminated from the list by evaluating them after. Evaluation is the process which results in shortening the list of alternatives. In the beginning, you need a broad range of alternatives so include as many alternatives as possible.

2.6.4. Consequences

After setting your objectives and identifying and generating your alternatives, the next stage in decision analysis is to attribute consequences to each alternative so you can compare them with each other (John et al. 1999). In case there is no uncertainty we can simply attribute consequences to each alternative and choose the best among them. But in most cases, the quantification of consequences is difficult due to the uncertainty of the events. In this case, we can assess the possible consequences of each alternative by estimating the probabilities associated with each alternative (Keeney, L., 1982). If the assessment process of consequences goes well, then the decision about choosing the alternatives will also go well (John et al. 1999).

Initially, there is no need to go into the small details of your consequences that each alternative has. Rather you need just a good precision in describing the consequences. These descriptions must be accurate, complete, and precise otherwise it will lead you to a totally different choice that you did not wish for. You can generate a consequence table that specifies different objectives of your decision-making in the rows of the matrix and the column of the matrix represents alternatives at hand. A consequence table looks as follows.

Table 2-1: Consequence Table

Objectives	ALTERNATIVES			
	A	B	C	D
W	C_{WA}	C_{WB}	C_{WC}	C_{WD}
X	C_{XA}	C_{XB}	C_{XC}	C_{XD}
Y	C_{YA}	C_{YB}	C_{YC}	C_{YD}
Z	C_{ZA}	C_{ZB}	C_{ZC}	C_{ZD}

Where A, B, C, and D represent alternatives, W, X, Y, and Z represent objectives, and $C_{WA...}$ C_{ZD} represents the consequences of each alternative with respect to the objectives.

You can build a good consequences table by following the four logical steps.

1. Put yourself into the future while determining the consequences for each alternative. Despite choosing an alternative, imagine that you have chosen it before. Think about how you feel, what type of comfort or distress you will encounter after choosing this alternative. This imagination will not only attract your attention to the immediate consequences but also you can foresee the long-term consequences of the alternative.

2. Write the words and numbers for each consequence which will better describe each one of them. The description may consist of hard data and subjective judgment. These descriptions may give you some extra objectives that you may not have considered earlier, so update your list of objectives. Each one of your descriptions should reflect all of your objectives. Your objectives should be used as a checklist to describe descriptions of your consequences.

3. Make a pairwise comparison between the alternative based on the description of consequences specified as the pros and cons of the alternatives. If in any comparison any alternative seems inferior to others eliminate it until only one alternative remains at the end, if not then continue to the next step.

4. The remaining alternatives should be arranged in such a way that on the left side you should write each of the objectives and on the top write down each alternative. That will create a matrix. Fill this matrix with the consequence description that you have created in step two. One important thing in describing consequences in the consequence matrix is to use common terminology so a comparison can be made easy. The description will use both quantitative and qualitative words. Now again make the pairwise comparison. If one alternative emerges as a clear superior to others then you have made the decision otherwise you need to tradeoff between them.

2.6.5. Trade-off

In the previous steps, you have refined your list of alternatives by eliminating the poor choices. Now you may encounter a problem where some alternatives compete with others in some objectives and the others compete in some other objectives. We need to make a tradeoff among the objectives in order to select the best alternative among the set of alternatives. This trade-off requires giving up some of the objectives to get more of the

other objectives. The number of trade-offs you are going to make depends upon the number of objectives and the alternatives under consideration. If the objective is just one, the trade-off is simple to choose one alternative that competes with other alternatives, but this is a rare case. How can you make of the trade-off? First, you can see the alternative who dominates the others in some objectives but are not worse than others in some other objectives. It means the given alternative dominates the other. So, you can eliminate the dominated alternatives from the list. You can use the consequence table to get the dominated alternatives. It can be used if the alternatives are fewer, but if there are a lot of alternatives and objectives you need to convert the consequence table into another table that shows their respective ranks. The ranks can be obtained by looking at the objectives and the alternatives that fulfil these objectives. Working one objective at a time you can rank your alternatives in order of their importance of fulfilling the respective objective. Comparing the ranks, you can find out the dominated alternatives. do it until you find out the one alternative at the end as a clear choice. If this method does not help, try an even swap method where you eliminate the objectives one by one. According to this method if all the alternatives are similar in some objectives then these objectives become irrelevant for further analysis. In this method, we equate the alternatives in an objective and compensate for the change in other objectives. We repeat the whole process until we get one dominating alternative.

2.7. Risk, Uncertainty, and Ignorance

Before proceeding to different techniques for making a decision under risk, uncertainty, and ignorance we need to describe them briefly. A well-known writer, Peterson (2009), describes each of the terms as a risk is a condition or event where we know the probabilities or likelihood of occurrence of possible outcomes. Whereas, under ignorance, we do not know the probabilities or even they do not exist. Uncertainty encompasses both the condition of risk and ignorance or it can generally be used as a synonym for ignorance. for this thesis, the term uncertainty and the risk are used as a synonym Not knowing the probabilities does not mean that decision under ignorance is impossible. We just need to think logically if one alternative dominates the others in terms of its outcome. The rule of dominance is quite a handy tool for decision-makers deciding under ignorance. A good example of a decision under ignorance is a first heart transplant. Dr. Christiaan Barnard offered a dying patient, Mr. Louis Washkansky, a first heart

transplant. Mr. Louis Washkansky, 55 years old, got several severe heart attacks. And his chance of survival from the next attack was almost zero. Before transplantation. Dr. Barnard had experimented for about 7 years on the animals and he was quite sure about what to do on the human side. Dr. Barnard clarified the pros and cons of the operation to his patient. The patient gave his consent and was operated on successfully. The dr. Barnard's decision to go or not to go for the operation was a decision made under ignorance, but his decision can be justified in how he decided to go for the operation. A decision matrix can elaborate it clearly.

Table 2-2: decision under ignorance

	METHOD SUCCESSFUL	METHOD DOES NOT WORK
Operation	live	Death
No operation	death	Death

It is clear from the decision matrix that Dr. Barnard took the right decision. if the method failed and if the operation is not done have the same outcome of death. But if the method works there is a chance of survival for the patient. In that case both the dr. and the patient had made the right decision. Nowadays the decision about heart transplant remains no longer the decision under ignorance. We have now the known probabilities for success and failure for a heart transplant.

2.7.1. Decision making under risk

Until now we have discussed how we can choose the best among the alternatives when the consequences are known. But what if the consequences are not known and there is uncertainty regarding the consequences of the alternatives. these complex problems add up a new layer of uncertainty into the decision making. In an uncertain condition, you are not 100% sure what will be the consequences, instead, you know what the consequences may be. Under risk, a good decision should be distinguished from the good consequence and the bad consequences. All we need to know is a sometimes a good choice may lead to bad consequences and bad choices may lead to good consequences. All that matters, in an uncertain condition, is that are you following the good decision process or not? A good decision process includes some strategies to overcome the limitations posed by the uncertainty. First, we need to create a risk profile that will elaborate on what type of uncertainties are involved in the situation, what is the possible

outcome of these uncertainties, what are the probabilities of occurrence of these outcomes, and the end what is the impact of these uncertainties on the decision problem. We can create a payoff table that will include the state of nature i.e.., the events that are out of control of decision-makers, and the respective alternatives. the probabilities can be created based on historical data and our subjective estimate. These probabilities are used to calculate make uncertain events clearer and to calculate the possible outcome of the alternatives. let us assume that you have $1200 to invest. After searching you come to three alternatives to invest namely, Coca-Cola, Hyundai, and Nestle. You face the two uncertain conditions of the market i.e.., Bullish and Bearish. Based on the historical data you concluded that if these two uncertain events come to play then your profit will be different in both conditions. This situation can be elaborated in the payoff table as follows

Table 2-3: Payoff Table

	State of Nature (Uncertain Events)	
Shares	***Bullish (U1)***	***Bearish(U2)***
Coca-Cola	$2500	$1100
Hyundai	2300	1200
Nestle	2050	1500

If the payoff table is only one piece of information you have you can choose Nestle if you are a risk averter. At least you can make a profit of 300 if the market follows the bearish trend. If you are a risk-taker then Coca-Cola will be the best option for you. But you may come to know through historical records of investment kept by investment agencies that share price in the stock market increase 70% and decreases 30% over the previous 10 years. Combining the data available in the payoff table and probabilities based on the historical data we can calculate the expected payoff of purchasing shares of three companies. These expected payoffs are also known as Expected Monetary value. The expected payoff table for the three options can be generated as follows that will assist us in deciding which option is the best in an uncertain situation.

Table 2-4: Expected Monetary Value

Coca-Cola			
State of nature	**payoff**	**Probability(P$_i$)**	**Expected Payoff value**
Bullish	2500	0.7	1750
Bearish	1100	0.3	330
Total			**2080**
Hyundai			
Bullish	2300	0.7	1610
Bearish	1200	0.3	360
Total			**1970**
Nestle			
Bullish	2050	0.7	1435
Bearish	1500	0.3	450
Total			**1885**

Expect Monetary value (EMV) can be calculated by the following formula

$$EMV= \sum [(P(U_i).V(A_i, U_i)]$$ Equation 2-1

EPV= expected payoff value, $P(U_i)=$ is the probability of uncertain event/ state of nature, $V(A_i, U_i)$. value of Alternative for a given state of nature. The EMV will change with the probabilities assigned to the state uncertain events and hence over choice will change accordingly.

Another method to reach a decision of which share should be bought is calculating expected opportunity loss. Opportunity loss tells us the gain which investors will lose due to the uncertainty of the event. For example, if you choose Hyundai and the bullish market exists, in the end, you are going to lose $200, Table 2.7-4, because you do not choose Coca-Cola. And all of this loss is due to the uncertainty pertained during the decision process.

Table 2-5: Opportunity Loss

	State of Nature (Uncertain Events)	
Shares	**Bullish (U1)**	**Bearish(U2)**
Coca-Cola	$0	$400
Hyundai	200	300
Nestle	450	0

When the state of nature is included in the opportunity loss table, we can get the expected opportunity loss. The main aim of the investor by using this method is to minimize the expected maximum regret. The expected opportunity loss for all of the three options can be calculated as follows.

Table 2-6: Expected Opportunity Loss

COCA-COLA			
State of nature	**payoff**	**Probability (P_i)**	**Expected Payoff value**
'Bullish	$0	0.7	0
Bearish	400	0.3	120
Total			**120**
HYUNDAI			
Bullish	200	0.7	210
Bearish	300	0.3	90
Total			**300**
NESTLE			
Bullish	450	0.7	315
Bearish	0	0.3	0
Total			**315**

According to this table, the maximum expected opportunity loss you will bear is by selecting the Nestle shares. So, you should choose Coca-Cola because it offers a minimum expected opportunity loss of $120. Both Expected monetary value and expected opportunity loss will give you the same results for selection among the alternatives. Another method in an uncertain situation where probabilities are known is the **Decision Tree.** it is a pictorial representation of all the alternatives and their respective outcomes. A decision tree consists of a box, nodes, and branches. Each of them represents the expected outcome, alternatives, and probabilities of the events. The decision tree for our investment decision is depicted in figure 1. The square box represents our decision and the branches out of this square decision represent our alternatives. the circle represents the expected monetary value or expected payoff of each of the alternatives. the branches emerging from these circular nodes represent the probability of each uncertain event. The numbers, at the right end of the decision tree, represent the total payoff, in each state of nature, for each alternative

The crux of the decision tree analysis starts by backward induction. Where each of the payoffs is combined with the probabilities of different uncertain events that result in the expected payoff value for each of the options that provide the basis for the comparison and the final choice among the alternatives.
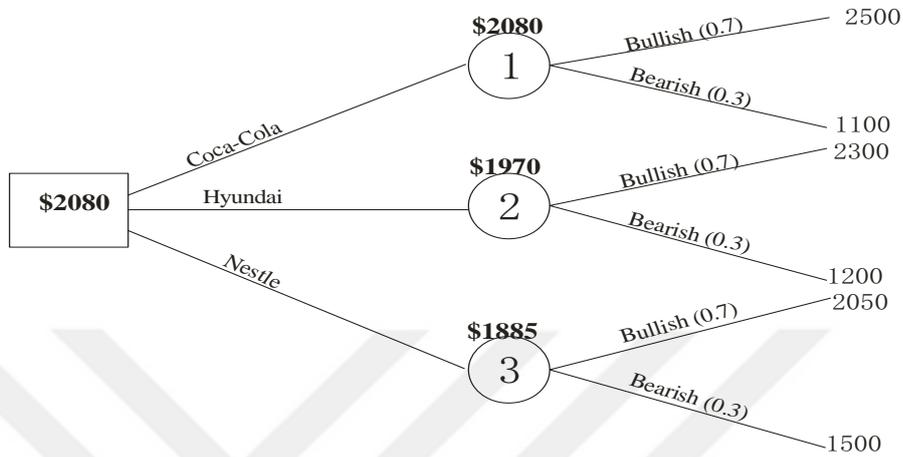
Figure 2-1: Decision Tree for Investment Decision

2.8. The Decision under Ignorance

2.8.1. Principle of dominance

Under ignorance, the decider knows about the alternatives at hand, the state of nature that he is facing, and the possible outcomes. What he does not know is the probability of these possible outcomes. As discussed earlier in table 2, the dr. knew about the possible outcome and which alternative is dominant over other alternatives based on the possible outcomes. The principle of dominance is a generally accepted principle where all the dominated acts should not be considered while making a decision. an alternative is dominant over other alternatives if and only it is at least better than other alternatives $_{in}$ all states of nature. There are two types of dominance i.e., weak dominance and strong dominance. weak dominance exists where one alternative is at least as good as other alternatives in all states of nature. Strong dominance exists where one alternative is better than other alternatives at least in one state of nature and is at least as good in the other state of nature. Let us assume x_i and x_j are two alternatives, α shows the dominating relationship between alternatives. ᾱ shows the relationship between the alternatives that

they are at least as good as other alternatives, S_k and S_l be the state of nature. $V(x_i, S_k)$ and $V(x_i, S_l)$ be the value of outcomes of two alternatives in two states of nature, respectively.

Weak dominance $= x_i \bar{\alpha} x_j$ if and only if $V(x_i, S) \geq V(x_j, S)$ in every state of nature

Strong dominance $= x_i \alpha x_j$ if and only if $V(x_i, S_k) \geq V(x_j, S_k)$ in every state of nature and with respect to some other state S_l, $V(x_i, S_l) > V(x_j, S_l)$

2.8.2. Maximax, Maximin, and Minimax

2.8.2.1. Maximax

Maximax represents the maximization of the maximum gain. This approach is also known as the best of the best approach because we first identified which payoff under a certain state is best and then we choose the best among these best payoffs. This technique is usually adopted by the risk-taker or the person who or optimistic. Under Maximax, we choose the alternative which gives us the best possible payoff. We compare each of the state of nature for each alternative to choose which state of nature is giving maximum gain for each alternative. Once the best payoff is selected for each alternative under each state of nature. Then we choose the maximum of these gains. To understand this technique let us look back at the example in table 2.7-2

Table 2.7.6: Maximax approach

PAYOFF TABLE			
	State of Nature (Uncertain Events)		Maximum payoff
Shares	Bullish (U1)	Bearish(U2)	
Coca-Cola	$2500	$1100	2500
Hyundai	2300	1200	2300
Nestle	2050	1500	2050

for each of the alternative Bullish market provide the maximum payoff. Once the maximum payoff is identified then you have to choose the maximum of these maximum payoffs. In this case, the maximum payoff column represents maximum gains. Under this column payoff for the Coca-Cola is higher than the rest of the alternatives. so, we will choose Coca-Cola as the best option under the Maximax approach.

2.8.2.2. Maximin

Maximin is the conservative approach to decision making. The nature of the decision-maker who chooses this strategy is risk averter. Under this approach decider

first, shortlist the worst payoffs for each alternative, and then choose the maximum of the worst payoffs. This is why this approach is also known as the best of the worst. Let us look at how it is decided under the maximin approach which choice is the best one.

Table 2-7: Maximin Approach

PAYOFF TABLE			
	State of Nature (Uncertain Events)		**Worst payoff**
Shares	*Bullish (U1)*	*Bearish(U2)*	
Coca-Cola	$2500	$1100	$1100
Hyundai	2300	1200	1200
Nestle	2050	1500	**1500**

The bearish market provides the worst payoffs for each alternative as compared to the bullish market. Among these worst payoffs, the best payoff is $1500 provided by Nestle. So, the decider should choose Nestle as an alternative under the maximin approach.

2.8.2.3. Minimax regret

Table 2.7.8: Minimax regret Table

OPPORTUNITY LOSS TABLE			
	State of Nature (Uncertain Events)		**Maximum regret**
Shares	*Bullish (U1)*	*Bearish(U2)*	
Coca-Cola	$0	$400	400
Hyundai	200	300	**300**
Nestle	450	0	450

The term regret means the opportunity loss as discuss in elaborated in Table 5. Under the minimax regret approach, the opportunity loss table is used to calculate the maximum opportunity loss for each alternative under each state of nature. Then we choose a minimum of these maximum regrets.

The maximum regret column shows the maximum opportunity loss for each alternative under the Bullish market and the Bearish market. The minimum regret among the maximum opportunity loss for each alternative is $300. So, you should choose Hyundai as an option under the minimax regret approach.

Chapter 3 Voting Methods

Every system is composed of three basic ingredients i.e., input, process, and output. The same is the case with every voting system that is composed of some inputs from the voters who vote for some alternatives/candidate, some process or procedures involved in the selection process, and the outcome as a winning candidate. The inputs by the voters are processed through voting methods that can be called social choice procedures. The outcome of the voting system is the result of the procedure used for evaluating the alternatives (Wallis 2014). Each of the voting systems may result in a different outcome. Some of the social choice procedures/ voting methods and assumptions/axioms that are used to evaluate these voting methods are briefly discussed below.

3.1. Majority and Plurality

As a simple case, assume that there are two candidates for running an office. The candidate who gets more than half of the votes is deemed to get the absolute majority. but if the candidates are more than two then the absolute majority can sometimes harder to achieve (Wallis 2014). For this, some other approximations are used one of them is the plurality method which is also known as the first-past-post method. In this method, the candidate who gets the simple majority is the winner. For example, if there are three candidates X, Y, and Z who are contesting each other for running an office. If there are 80 voters, then for the absolute majority one of the contestants needs more than 40 votes. If X, Y, and Z gets 30, 25, and 25 respectively then none of them get the absolute majority and nobody wins. But in the case of the plurality method X wins because he gets the simple majority. one of the biggest problems with this method is the selection of an unpopular candidate due to the division of the votes. In the above example, only 30 voters are in favor of candidate W whereas approximately 62% of the voters are not in his favor.

3.2. Condorcet's Method

This method gets its name after Marquis de Condorcet (1743-1794), a French philosopher and mathematician, although this method can be traced in the literature written in the thirteenth century by Roman Llull. The procedure of the Condorcet method chooses an alternative among different alternatives if and only the former will defeat the rest of the alternatives (Straffin and Taylor 2006). The Condorcet method uses a one-on-one comparison of alternatives. If an alternative succeeded every other alternative in a

one-on-one competition, then the alternative is known as Condorcet winner. We can elaborate on it by an example. Assume there are four candidates, W, X, Y, and Z each candidate is ranked in some order by 21 people. The ordered ranking of the candidates is shown in the table below

Table 3-1: Preference list for Condorcet Method

VOTERS			
5	**3**	**6**	**7**
W	W	Y	X
Y	X	X	Z
X	Y	Z	Y
Z	Z	W	W

At a first glance, it looks like that W should be the winner because it is ranked by 8 voters as the most preferred candidate but when we look carefully we came to know that 13 people ranked W as the least preferred candidate. So, the candidate W is not the Condorcet winner. Let us make a one-on-one comparison of the alternatives.

Table 3-2: One-on-One Comparison of Alternatives

W and X	**W and Y**	**W and Z**
8 preferred W over X 13 preferred X over W	8 preferred W over Y 13 preferred Y over W	8 preferred W over Z 13 preferred Z over W
X and W	X and Y	X and Z
13 preferred X over W 8 preferred W over X	10 preferred X over Y 11 preferred Y over X	21 preferred X over Z 0 preferred Z over X
Y and W	**Y and X**	**Y and Z**
13 preferred X over W 8 preferred W over X	11 preferred Y over X 10 preferred X over Y	14 preferred Y over Z 7 preferred Z over Y
Z and W	**Z and X**	**Z and Y**
8 preferred W over Z 13 preferred Z over W	0 preferred Z over X 21 preferred X over Z	7 preferred Z over Y 14 preferred Y over Z

According to Condorcet method Y wins because it defeats all other alternatives in a one-on-one contest. At first look, it looks strange because only 6 people ranked Y as the first choice. When we look at other alternatives none of them defeat all other alternatives in a one-on-one contest.

3.3. The Borda Count

This social choice procedure was created in 1781 by Jean-Charles de Borda, a French mathematician, and physicist. Charles pointed out the main misconception about the plurality voting at the time when the notion was held by the people that "the plurality of voices indicates the will of the electors". He said this notion is true in the case where two candidates contest each other but failed as the number of contestants increases more than two (Weber 1995). Charles proved that statement by an example where contestants split their majority votes resulting in getting the plurality of votes by the minority candidate and thus winning the election. As a solution, Jean-Charles de Borda proposed "election by order of merit". This method looks at the intensity of an alternative regarding its position in the preference list compared to the other alternatives. Each alternative gets some point according to their relative position with respect to other alternatives. The alternative at the bottom of the preference list gets zero points and each other alternative gets the point according to the k-1 rule where k is the position of an alternative in the preference list from bottom to up. the alternative at the highest position gets the maximum point. The aggregation of all the points of the alternative ranks the respective alternative. The alternative with the maximum aggregate point/ Borda score is the winner (Fraenkel and Grofman 2014).

Let's elaborate on the Borda count method by the previous example. The Borda score (BS) for each and plurality of the alternative in the preference list is written at the top of each alternative in the preference table according to the rule of k-l.

Table 3.3.1: Preference for Borda Count

VOTERS			
5	**3**	**6**	**7**
W $^{BS=3}$	W $^{BS=3}$	Y $^{BS=3}$	X $^{BS=3}$
Y $^{BS=2}$	X $^{BS=2}$	X $^{BS=2}$	Z $^{BS=2}$
X $^{BS=1}$	Y $^{BS=1}$	Z $^{BS=1}$	Y $^{BS=1}$
Z $^{BS=0}$	Z $^{BS=0}$	W $^{BS=0}$	W $^{BS=0}$

The aggregate of Borda scores for each alternative is as follows.

W= 3*5+3*3+0*6+0*7 = 15+9= 24

X= 1*5+2*3+2*6+3*7 = 5+6+12+21 = 44

Y= 2*5+1*3+3*6+1*7 = 10+3+18+7 = 38

Z= 0*5+0*3+1*6+2*7 = 6+14 = 20

According to the Borda count method X is the winner because the aggregate Borda score is highest as compared to the Borda scores for the rest of the alternatives.

3.4. The Hare's Voting System

This method was introduced by Thomas Hare, a political scientist, in 1861. This voting system is also recognized by other names such as "single transferable vote system" or "instant runoff voting" the key difference between the two is the former uses a specific quota for winning the later uses a simple majority to be deemed as a successful candidate. This voting system is used in many countries for the election of suitable candidates in public offices. These countries include Ireland, Australia, Northern Ireland, Malta, etc., This voting system requires the voters to rank the alternatives according to their 1st, 2nd, 3rd choices, and so on. A minimum quota known as Droop quota, in case of single transferable voting, is required to achieve by the candidate for winning (Doron and Kronick 1977). This quota can be determined by following equation

q= {number of voters/ (number of candidates to be elected+1)} +1

if the voting is held for many candidates then the candidates who acquire the votes equal to the predetermined quota will be selected. Any candidate who gets the votes more than the quota in the first choice will redistribute the excess of the votes to the second-choice candidate. In case none of the candidates obtains the votes equals to the quota then the votes of the candidate with the least number of votes will be transferred to the second-choice candidate. Thus, the least count vote candidate will be eliminated. This process will continue until all the required candidates are selected. In case the 2nd choice candidate is the same person who has been eliminated then the votes will be transferred to the third-choice candidate and so on.

Let's continue with an example of 21 voters vote for 4 candidates W, X, Y, Z. Among these four candidates, 2 are being elected for two positions. The Droop quota will be as follows

q = {21/(2+1)}+1 = 8

the vote distribution is shown in the following table

Table 3.4.1: Preference Ordering of Voters for Hare's System

Preference Ordering of Voters				
No. of Votes	1st Choice	2nd Choice	3rd choice	4th choice
7	X	Y	X	Y
6	Y	W	W	W
5	W	X	Z	X
3	W	Z	Y	Z

we know *W* that gets the 8 first-choice votes and thus is selected as a victor candidate for an office. None of the other candidates gets first choice vote equals predetermined quota. So, the candidate with the least count of first-choice votes will be eliminated and its votes are transferred to the 2nd choice candidate. Candidate Y receives the least count of the vote so it will be eliminated, and all of its 6 votes have to be transferred to the 2nd choice candidate i.e., Y, but as Y has been eliminated earlier these 6 votes will be transferred to the 3rd choice candidate X. Now X has 13 votes in total. So the next elected candidate will be X. Although the hare's voting system tries to overcome the representation issue as posed by the plurality system but this system is prone to create the perverse result even if the actual count of the votes increases for some of the candidates (Doron and Kronick 1977).

3.5. Axioms

The different social choice procedure has a different desired outcome. For comparison of each method, certain properties should be taken into consideration. There are five major properties of any social choice procedure and each of the methods should be relatively compared on the basis of these properties (Straffin and Taylor 2006). These properties are enumerated and briefly discussed as under.

1. The Always-A-Winner Condition (AAW)
2. The Condorcet Winner Criterion
3. The Preto Condition
4. Monotonicity
5. Independence of Irrelevant Alternatives

3.5.1. The always-a-winner condition

The social choice method is said to satisfy the always-a-winner condition if at least one candidate is chosen as the winner with any sequence of the preference list

3.5.2. The Condorcet winner criterion

If there is a unique winner as disclosed by the Condorcet method, then every social choice procedure will meet this criterion only if this Condorcet winner is also the only choice disclosed by this other social choice procedure.

3.5.3. The Preto condition

The voting methods may produce different results than what the voters prefer at first glance. This condition measures fairness in the voting system. It states that if every person prefers one alternative over the other then the social choice procedure should also produce the same result i.e. it should select the winner the same person who is preferred by all the voters.

3.5.4. Monotonicity

Monotonicity reflects the notion that if there are some positive changes in the preferences with respect to some alternatives the social choice procedure should reflect these positive changes. If some of the voting methods behave contrary to this positive change in the preferences this voting method is non-monotonous in nature. For example, if the preferences of voters change for an alternative X the voting method should reflect this change of the preference otherwise the perverse result will violate the criterion of monotonicity of the voting method (Austen-Smith and Bamk 1991).

3.5.5. Independence of irrelevant alternatives

The term "independence of irrelevant alternatives" was first used by Arrow in 1951. According to Arrow (1963), if the voters are going to choose among the alternatives in set S in a fixed environment should be independent of any other alternative that is not part of a given set of alternatives (S).

> He describes these criteria as "Let R1..Rn and Ŕ1…. Ŕn be two sets of individual orderings and let C(S) and C'(S) be the corresponding social choice functions. If, for all individuals i and all x and y in a given environment S,

xRiy if and only if x R/ y, then C(S) and C (S) are the same (independence of irrelevant alternatives)" Arrow (1963).

Chapter 4 Project Management

4.1. What is the Project and Project Management?

According to Maylor (2010), 'Life is one big project.' The trick is in managing it. One of the biggest questions is what constitutes projects and what does not. The basic understanding of the projects shows that every task that has a beginning and an end date is deemed to be considered as a project. But is the case so simple? there are many other activities and tasks that qualify this definition but still, they are not considered as a project, for example, the inspection team is putting his effort in the production department for checking the quality of products, time consumed on the production of the product the necessary labor requirement for producing the product on time and the required resource allocation each day in the production process. Each of these activities and documentation needs some specific type of resources and competencies and each of these processes has some beginning and end time. Each of these processes requires the same type of effort and resources for each day and there is no uniqueness in effort and output each time. All these tasks are routine works and are considered as operations rather than projects.

According to Institute (2013) "*A project is a temporary endeavour undertaken to create a unique product, service or result*". In this definition, the temporary nature of the task means it will have some specific date to start and an end with some specific and unique outcome or deliverable. What makes the difference in project and operation is the uniqueness of the task. If the task is recurring with the same outcome it cannot be said a project rather it will be termed as operation. Projects can range from simple to complex in nature. Simple projects require simple resources to execute without much conflict, on the other hand, complex projects require multidisciplinary resources that in turn poses a conflict in resource allocation (Jr. et al. 2011).

British Standard(2000) defines the project as a set of activities coordinated in such a way that will result in achieving some specific performance objectives, these activities have some specific starting and end dates and are performed under the constraints of time, cost, and performance.

Great Britain (2005) defines projects as the temporary management environment created to produce a predefined outcome or result with the help of predefined resources and within some specific time frame.

All these definitions are common in the specificity of the tasks with some unique deliverables that are to be completed within a specific time.

All the projects need to be managed in some specific fashion. Project management and general management have common many of the processes but due to the varying nature with the unique outcome of the project make it different from the general management in the sense that specific nature of the project requires a specific type of competencies in conflict and change management. These conflicts result due to resource allocations. The resource is to be used by different units in the organization which in turn requires some manageable skills to allocate these resources in such a way that will not produce the schedule difference in the projects. Every project has some specific requirements that are to be managed with some specific knowledge, tools, and skills. The use of these specific knowledge, tools, and skills in a way to meet the project requirement is known as project management (Institute 2013). PMBok 5th edition identifies 47 process categories into 5 process groups that need to be managed for successful completion of the projects. Further, ten knowledge areas are used to group each of these 47 processes, each one representing a different professional field. These ten knowledge areas are depicted as under.
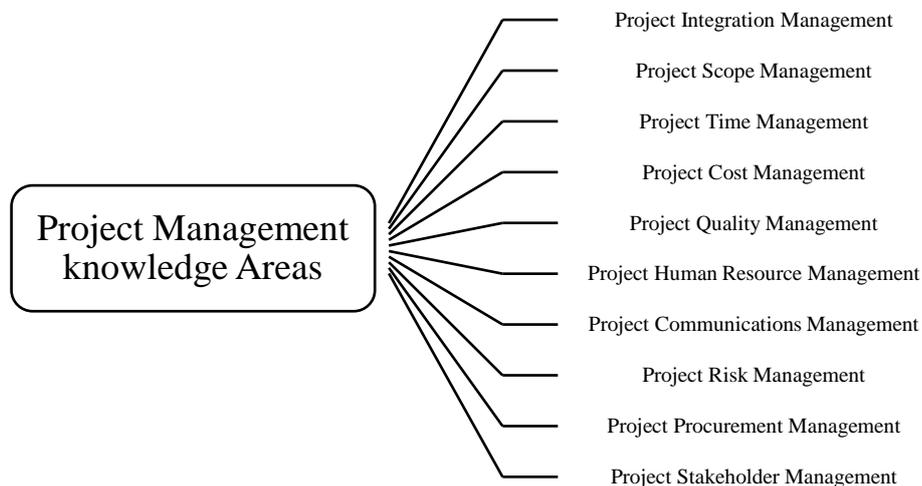
Figure 4-1: Project Management Knowledge Areas

These ten knowledge areas represent the different types of competencies needed for the successful completion of the project. Each of these sets of competencies is required to be fully coordinated during the life cycle of the project. These ten project management knowledge areas are briefly discussed as under

4.2. Project Management Knowledge Areas

4.2.1. Project integration management

The project integration management starts with identifying and combining those types of processes and activities that are used to unify and coordinate the other processes in five process groups (Institute 2013). From initiation to the closure of the projects, there are different choices that need to be made during resource allocation, trade-offs among conflicting objectives. These choices are also useful in the management of interdependencies of the processes of each knowledge area. The provision of an overall coordination scheme is the fundamental of the integration management that ensures the intactness of the whole project. The project integration management is composed of different processes where the output from each process becomes the input for the other processes, these output-input relationships make the project work in a coordinated fashion.

4.2.2. Project scope management

The project scope management ensures that within the projects only the relevant activities are taken into consideration. It also ensures that none of the irrelevant work is included inside the project. The term scope can be referred to as product scope and project scope. Product scope constitutes all the characteristics that the final product must have whereas the project scope refers to all the necessary activities that are to be performed to achieve the final result or product. The project scope management includes the processes such as plan scope management, collect necessary requirements, define the scope, create WBS, validate scope, and controlling the scope. Each of these processes has some inputs and outputs. Each of the outputs of each process is used as the input to the other processes.

4.2.3. Project time management

Project time management is one of the essential parts of project management. It includes all the processes that are required to ensure the timely completion of the project. It starts with documenting all the policies and procedures for planning, executing, and controlling the time for the project activities. After this, activities are identified, predecessors and successors of each activity are documented, resources for each activity are identified and time duration for each activity with the necessary resource usage are written down and at the end, a complete schedule for each activity is documented. Finally,

all monitoring and control procedures are defined to see everything is going according to the planned schedule.

4.2.4. Project cost management

One of the scarce resources used in the project is money. The cost associated with the successful completion of the project is one of the factors that in turn influence other knowledge areas of the project management. The inefficient management of cost itself can pose a serious threat to the successful completion of the project. According to the Institute (2013), project cost management involves all the activities that are required to ensure that the project will be completed within a given cost. The first of the process involves planning the cost management which includes the process of identifying the key policies and procedures for planning, managing, and controlling the cost. It includes all the documentation necessary from an initial estimate of the cost to the final controlling process for identification of any deviation from the planned cost. After the cost plan is developed the next step is to estimate the cost for each activity in monetary terms. After the estimation of the cost for each activity, the budgeting activities are performed for the aggregation of this individual cost. This step is necessary to produce the cost baseline that is needed to be authorized by the sponsor. During the execution of the project, the actual cost documentation is necessary to monitor everything is going according to the planned cost. The controlling process usually encompasses any change needed to update the cost baseline.

4.2.5. Project quality management

Quality is defined as the sum of characteristics of the product that makes it able to satisfy the expressed and implied needs of the customer

Project quality management includes the processes and activities that ensure that the outcome delivered satisfies the requirement for which the project was undertaken. The basic outcome of the project quality management is the satisfied stakeholders because it complements the project management in the sense that both result in satisfied customers and the prevention over the inspection. Prevention over inspection means that the project team and all other stakeholders agree that the cost of preventing the mistakes is much lesser than the cost of correcting the mistakes. Hence quality management has a direct effect not only on the stakeholder's satisfaction but also on the cost of the project. The

project quality management encompasses three main processes of plan quality management, quality assurance, and quality control (Institute 2013). The plan quality management consists of all policies, procedures, and documentation of planning how the project outcome and deliverables will meet the quality standards and how the quality assurance and quality control processes will be executed in order to comply with the project requirements. The quality assurance ensures that project requirements are met, and the result of the quality control processes demonstrates that the project is producing what is it intended for. In fact, quality assurance is the audit procedure to ensures the above-mentioned processes. On the other hand, quality control is the monitoring and recording process that checks the actual quality activities with the planned quality activities. It identifies any deviation of the actual results from the planned results.

4.2.6. Project human resource management

The human resource is one of the non-financial resources without which the assurance of the project's success is inconsiderable. In the context of project management, human resource is the project team working on the project with some roles and responsibilities. The management of the project team requires extensive skills and competencies of a project leader. the project manager must have special communication skills, to indoctrinate the project policies and procedure to the project team, to set the behavioural standards among the team members, and must teach them the way they behave in case of any conflict between them. A satisfied team is crucial to project success. The project human resource management encompasses the processes of planning human resource management, acquiring the project team and developing the project team, and at the end managing the project team. (Institute 2013). During the first step of the project human resource management, a plan is developed for the identification of the necessary roles and responsibilities, a set of competencies, how and to whom the reporting will be made, and how the conflict between the team members will be managed. The basic inputs to this process are the project management plan, resources required for each activity, the factors related to enterprise comprising of organizational structure, organizational culture, available human resource in the organization, the procedures and policies for administering the human capital, the requirement for the dispersion of the human resource based on geography, and the prevailing market condition. The organizational process assets are another process in managing the human resource on the projects and comprised

of the current standards and descriptions of the roles for the project team, the historical archives for the use of the human resource on the previous similar projects, and the conflict resolution procedures for the project team. Key processes used to produce the human resource plan includes the organizational structure and chart, expert judgments, formalized meetings, and networking.

4.2.7. Project communication management

Communication is one of the essential elements of project management which goes around from the initiation phase of the project to the closure phase. Project managers can be deemed to be a leader by having two necessary characteristics of visibility i.e., physical appearance as a leader and through the communication of the organization's policies and procedures, the performance and appraisal system, etc. (Baker and Baker 2000). The project communication management consists of all the processes that are required for the timely dissemination, storage, and reception of the project information. These processes are used to create, disseminate, retrieve, store, manage, monitor, and properly disposing of the information to the relevant stakeholders (Institute 2013). Three main processes are used for project communication management i.e., plan communication management, manage communication, and control communication. In the planning communication management, all the stakeholders and the required information for these stakeholders are identified. The organizational resource for communication is also identified so that the necessarily mean of communication is recognized and used. The tools and techniques used for planning communication are the analysis of communication requirements of the stakeholders, the identification and availability of technology for communication, models, and methods for communications, and the meetings with the project team to discuss with them the efficient way for updating and communicating the project information to the stakeholders.

4.2.8. Project risk management

Every project may encounter at any stage of its life cycle some threats or opportunities. Both have some impacts on the project. Threats have a negative effect if it occurs and the opportunities will have a positive effect on the project if it is exploited. Risks are these uncertain, negative, or positive impacted events. So, the risk is an event that may happen in the future and have some calculated probabilities of occurrence and

have some impact that can result in some change in the time, cost, scope, or quality of the project (Wysocki and K 2009). Risk management is the systematic steps for planning, identifying, analysing, responding, and controlling the risks. Planning risk management is the documentation for the project team that tells them how to respond to the threats to and opportunities for the project (Guy and De Furia 2008). So, any document which tells how to carry out the risk management activities is part of the risk management plan. The purpose of the risk management plan is to ensure that all the stakeholders have been informed about the risk associated with the project and the responses intended to deal with these risk factors and the proper agreement of all stakeholders is taken for these risks. Identification of the risk is the process where the risk is formally recognized with all its characteristics. The main benefit of this identification process is to keep inform the project team about any anticipated event and its full categorization.

4.2.9. Project procurement management

Projects require to maintain relationships with the people involved outside of the project organization. There exist certain types of relationships with the people outside the project for the acquisition of the people, material, equipment, and other facilities. This relationship requires a formal contract for the execution of agreements. Project procurement management deals with these formal contractual relationships with the people outside of the project team. The bidding process for the materials, equipment, and people are necessary for the development process of the budget. It starts by identification of the necessary resources for the project that is to be acquired from outside. After the resource's identification, the vendors are required to be identified that can provide the resources at the right time, right place, and at the right price. The best vendor is chosen through checking the reference, bid comparisons, verification of the delivery dates (Baker and Baker 2000). The project procurement management includes all the processes for contracting the outside vendors and executing change management processes arising during the execution of the procurement of materials, people, equipment, and etc. Institute (2013), defines the procurement management process as one using the processes of planning procurement management, conducting procurement, controlling procurement, and closing procurement. In planning procurement management details of the prospective vendors, decisions about the project procurements approach for the procurement is documented. The key benefit of the planning procurement process is to create a document

about what is required to be purchased from outside, how it will be acquired, from whom it will be acquired, and at what time it will be purchased. The process of conducting procurement includes the identification of the sellers, organize the bidding process, and selecting the appropriate vendor. When the project is executed the controlling process for the procurement plays an important role to ensure that the materials, people, equipment, and other outside demands are available at the required time and cost. If any unexpected events will deviate the procurement process the controlling mechanism will execute the change processes and will try to put the process on the right track. In the end, the procurement requires to be closed. In the procurement closing process, the key documents used as inputs are a project management plan that specifies the requirements for the closing of the procurement process. The other input to this process is procurement documents. All the procurement documents are needed to be collected and properly indexed. The catalog for all the schedules, cost, quality, payments, inspections, and changes in the procurement is done during this process. All of this is archived as a historical record that can be used for future projects in the estimation process.

4.2.10. Project stakeholder management

There is a lot of living and non-living things that are affected by or can affect the project positively or negatively, all of them are known as the stakeholders to the project. Project stakeholder management requires to identify all these people, groups, or organizations. The purpose of this identification is to properly evaluate their expectations of the project deliverables and to engage them effectively in decision making. The project charter is one of the documents that states the key stakeholders that can affect the project outcome and to whom the project outcome or deliverables can affect. The outside stakeholder can be identified through procurement documents. Other factors that can affect the process of identification of the stakeholders include the organizational culture, standards, rules, and regulations by the government or industry. Besides these, stakeholders can be identified by the people who are specially trained and are subject matter experts. After the identification of the stakeholders, the analysis of their impact on the project and the project's impact on them is analyzed through comprehensive documentation of their needs, interests, and expectation in the project. This documentation is used to formulate the strategies for the stakeholder's involvement during the whole project life cycle. All these processes of identification of the needs,

interests, and expectations with the actionable strategies to manage them are covered in the document known as the plan stakeholder management. The plan stakeholder management has the key purpose of creating a favorable relationship between the project team member and other stakeholders in order to meet their expectation level within the project boundaries (Institute 2013). When the project has been executed the management of the stakeholder is needed to communicate the actual results of the project's activities, so the consensus is developed between the project organization and the stakeholders. This communication and engagement process will create certain types of output in the form of updating the project documents, execution of the change management process, updating the project management plan, and updating the organizational process assets including the resolution reports about the issues, historical archives, stakeholder's feedback, project reports, and etc. after managing the stakeholder the next and final step is to monitor and control the project stakeholder's in order to excel the working relationships between the project team and stakeholders. The controlling process will update the strategies prepared in the stakeholder management plan. The key benefit of the controlling process is that it ensures the active participation and engagement of the stakeholders and in the creation of the environment where stakeholders can easily become a part of the change process resulting due to the evolution of the project activities and their results.

4.3. Project Life Cycle

As discussed earlier every project has a start and end date. The project life cycle elaborates on the phase segmentation of the project from start to end. As the projects range from simple to complex, each phase of the project life cycle can be seen more clearly in the complex projects rather in simple projects the phases can overlap each other making it difficult to divide the project into phases (Westland 2006). The phases of the projects may be sequential in nature where the output of the predecessor phase becomes the input for the successor phase. But in some cases, the phases can be overlapping. Phase can be defined as the collection of the activities with specific deliverables that differentiate it from the rest of the project activities and deliverables. Typically, there are four phases of the project namely

1. Initiation,
2. Planning,

3. Execution,
4. Closure.

The phases of the project should not be mixed with the project management process groups. A phase is a logical segmentation of the project where the specific deliverables are produced in each phase by employing the project management process groups. A single-phase project is depicted[1] as follows
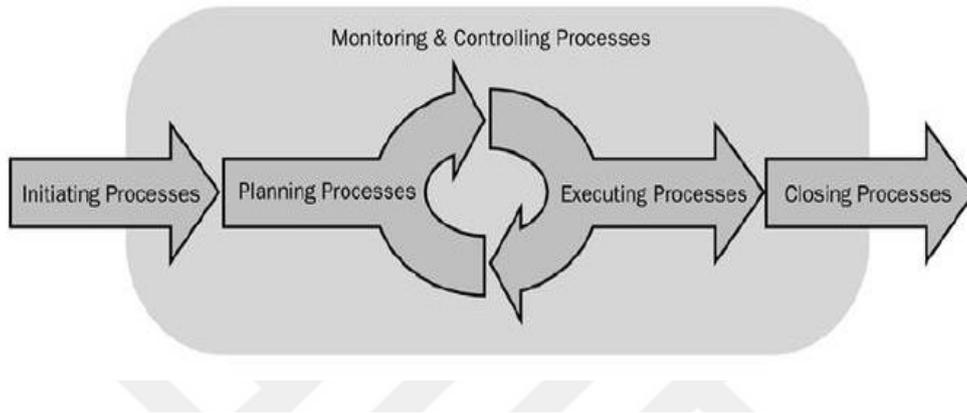
Figure 4-2: Example of Single-Phase Project

A phase can use all the project management process groups to produce the deliverables or can use a few of them that are necessary. The projects are divided into phases for the specific focus of the management to produce unique results or deliverables. A project can be just a single-phase as depicted above or a group of many phases as depicted[2] below.

Figure 4-3: Example of Three-Phase Project

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[1] This figure is taken from the book A guide to the project management body of knowledge (PMBOK® guide, 2013. PP: 41).

[2] This figure is taken from the book A guide to the project management body of knowledge (PMBOK® guide, 2013. PP: 42).

4.4. Project Management Process Groups

Each of the phases is using the five project process groups. As discussed above, (Institute 2013), divides the whole project management into 47 processes that are further grouped into five process groups:

1) Initiating,
2) Planning,
3) Executing,
4) Monitoring and Controlling
5) Closing
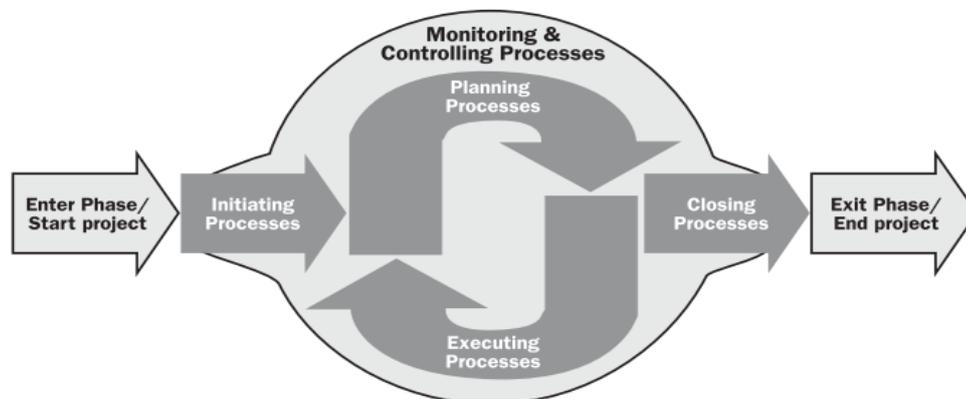
Figure 4-4: Project Management Process

Each of these process groups has a distinct type of deliverables produced at the end of each process which is used by the subsequent processes as an input. Monitoring and controlling process is one that is used during the whole of the project and in each processes group. The subsequent change in the work scope, time, cost, or quality is determined through this monitoring and controlling process that in turn can change the project management plan for the execution of the project. The output produced during each process group is the linkage to other process groups providing the integration platform to work the whole of the project as a single unit. Each of these process groups is briefly discussed as follows providing the general framework for the entire project.

4.4.1. Project initiation process

Each new project or phase of the project requires formal authorization from the sponsor for its execution. The process group which deals with this formal authorization for the start of the project or phase is termed as the project intuition process. During this

process, a lot of activities are performed. The initial scope of the project and the resources required are identified and committed, respectively. The identification of the key influential stakeholders and their expectations is the key to this process that in turn defines the scope, time, cost, and quality of the project. The selection or hiring of the project manager is also key to this process group. This process usually generates two types of documents i.e., the stakeholder's register and the project charter. When the project charter is approved by the sponsor/ client, the project is formally authorized to start. The purpose of this process group is to form a consensus among the stakeholders and the purpose of the project. The interaction with the stakeholders reflects that their expectation is fully captured in the project charter. Any change in the project charter is carried out before the approval. the project charter includes the requirement of the project competencies, the initial cost of the project, the time required to complete the project, key risks that need to be managed, and the quality or expectation of the project.

4.4.2. Project planning process

The project planning process answers to the when, where, what, who and how the project activities are done. It covers all processes required to ensure that all the strategies and activities are identified for smoothly running the project. It provides confidence to the stakeholders that the project team members know what to do, how to do, when to do, and by whom to do the project activities. The concrete document that is the output to this process group is the project management plan that requires inputs from the planning process of the other ten knowledge areas. The project management plan gets the input from the scope management process, schedule management process, cost management process, human resource management process, risk management process, procurement management process, and stakeholder management process. All the plan from the other processes is grouped in a single document known as the project management plan. This planning process is not a one-time process rather it is an iterative process using continuous feedback from other processes and is continuously updating the project management plan. The monitoring and controlling process is providing this feedback to update the project document. Any change in the plan in other process requires the formal authorization from the sponsor that in turn create the interactive process with the stakeholders that everything included as an update in the project management plan is meeting the expectation of the stakeholders.

4.4.3. Execution process

The execution process includes all the processes used in the actual performance of the project. The actual information about the project performance is collected during this process and are communicated to the relevant authorities in the chain of command. This information tells about the current status of the project regarding their cost and schedule. The expected cost of completion and expected time of completion of the project can be estimated using the regular record of these two types of actual data. This data provides the measures for the efficiency and effectiveness of the project and can be used to update the cost baseline and schedule baseline. The key processes involved in this process group includes managing and directing the project, performing quality assurance, acquisition, development, and management of the project team, communication management, conducting the procurement, and management of stakeholder engagement.

4.4.4. Controlling process

Controlling is the process of ensuring that everything is on track. It is mainly done by the comparison of the actual results with the planned results. Any deviation of the actual results from the planned results shows is we behind or before the planned activities and requires corrective actions for that deviation. The complexity of the control system is dependent upon the complexity of the project. Simple projects need simple control processes and complex projects need a sophisticated control system (Horine 2009). The purpose of the control is to produce a sense of accountability to prevent even small mistakes to become a bigger one. The project manager needs a good information management system to check the progress of the project. Because too complex control system using tight control processes is time taking and costly whereas the too simple control system poses the risk that some important information may be not available at the right time. Devising any control system simply requires the answer to three questions, the first question is regarding the data collection-what type, who, how, and when the data will be collected? secondly what type of analysis we will perform on the collected data? thirdly what type of reports will be produced and to whom it will be communicated? According to the Institute (2013), the key controlling process used are in all the knowledge areas except human resource management. For example, the project scope control needs that all the deviations from the planned work are duly authorized after the integrated change process that means that the required consent of the responsible parties

is obtained before doing corrective measures. For controlling the schedules different types of tools and techniques for example for performance reviews with which dates for an actual start, planned start, actual finish, and planned finish are compared and based on this information estimated time to complete the project is calculated. For this, different methods can be used such as trend analysis, critical path method, critical chain method and earned value techniques.

4.4.5. Closing process

To formally close the project or phase of the project requires to end all the activities in all the process groups. The closing process requires extensive skills as after this the project results are going to be handed over to the clients and is the time to lay off the project team that requires to communicate with them very carefully. The closing process includes all the activities that ensure that each task is complete in each process group and the result of the project is obtained for which it was undertaken. the result of closing the project or phase means that

- Formal consent of the sponsor or client is taken to close the project
- Document for the lesson learned is archived
- Organizational process assets are updated
- Review for the post-project or post phase is conducted
- All the documents are stored in the information system as a historical record
- The performance of team members is done, and the resources are released.

Chapter 5 Multiple Criteria Decision Making

All those decisions that have different criteria/ objectives for evaluating the alternatives need a special type of treatment and the process to solve this decision is known as a multi-criteria decision-making process (MCDM). A plethora of decisions are faced by the people in daily life, however, the decision problems can be classified into four categories (Roy, 1981), i.e. the choice problems, the sorting problem, the ranking problem, and the descriptive problems. The most important consideration that the researcher should take is the weighting of each criterion that is used in ranking the alternatives and hence is complimentary for the final choice. These weightings represent the ordinal or cardinal values attributed by the decision makers to the criteria for showing their relative importance. These weighting methods can be classified into three categories (Wang and Luo 2009); "subjective weighting methods, objective weighting methods, and combination weighting methods". In subjective weighting methods, the decision maker's preferences are used as a basis for the criteria weights. These weights are based on the judgment of the decision-maker about the relative importance of the criteria. AHP, ANP, SMART, SIMOS, and Delphi are a common example of subjective weighting methods. On the other hand, the objective methods use some mathematical methods to calculate the weights of the criteria without involving the decision makers' preference about these weights. Least Mean Square (LMS), TOPSIS and Multi-objective optimization is the common example of objective weighting methods. The combination weighting method is the hybrid form of weighting methods that uses multiplication and additive synthesis (Zardari, N. H., Ahmed, K., Shirazi, S. M., & Yusop 2015).

All the methods cannot be applied to every problem and it is difficult to justify the choice of each method of weighting. The choice of appropriate multi-criteria decision making can be made by looking at different perspectives. The choice can be made by considering the data and parameters of methods that show you how much modeling effort do you need. In other words, by looking at the required input information we can choose which method is good for the given problem as well as considering the outcome and the level of detail you need (Ishizaka and Nemery 2013). For example, if for each criterion the respective utility function can be known the best method is MAUT, but if not, there are other methods to use. For the pairwise comparison of the alternatives and the criteria, AHP and MACBETH are good methods to be considered. The only difference between

these two methods is that AHP uses a ratio scale for the pairwise comparison while MECHBETH uses an interval scale. On the other hand, if criteria are dependent ANP can be used for pairwise comparison. It is up to the decision makers to know what type of scale is better for a particular decision problem

5.1. Analytic Hierarchy Process

Analytic Hierarchy Process (AHP) uses the pairwise comparison on the ratio scale which best fits with the ranking and sorting problems. Originally developed by (Saaty 1980), the AHP decomposes the complex problems into its components. The AHP uses the overall goal of the decision process and chooses the best among the alternative based on the competing criteria. The AHP structure the problem in a hierarchy where the goal is on the top of the hierarchy and the alternatives are at the lowest level, the descendant to the goal in the hierarchy is the criteria and sub-criteria based on which the alternatives are evaluated. Then the pairwise comparison matrix is developed by using a scale that shows how much one criterion is preferred over the other, in such a way that each element in the lower level is compared by using the elements in the immediate upper level. Use the priorities obtained from the comparisons to weigh the priorities in the level immediately below. Do this for every element. Then for each element in the level below add its weighted values and obtain its overall or global priority. Continue this process of weighing and adding until the final priorities of the alternatives in the bottom-most level are obtained (Saaty 2008). These priorities are the scores that are used to rank the criteria and the alternative in order of their importance. After the decision is structured into hierarchy three types of priorities are established: the priorities for criteria with respect to the goal, the priorities of alternatives with respect to each element of the criteria known as the local alternative priorities, and the global alternative priority that is the priority of alternative with respect to all criteria and resulting into the overall priorities of alternatives with respect to the overall goal (Ishizaka and Nemery 2013).

5.1.1. Steps of AHP

1) clarify your ultimate goal
2) Identification of decision criteria and sub-criteria:
3) Identification of the alternatives

4) Putting goal, criteria, and alternatives in the hierarchy so that goal is at the top followed by criteria and sub-criteria and then alternatives are at the bottom of the hierarchy.

5) Perform analysis by pairwise comparison so that each lower-level items are compared with respect to the items at the next upper level.

6) Synthesize the results so that the global priorities can be obtained.

7) Make the decision based on the values of global priorities

The hierarchical structure of the process looks like that:
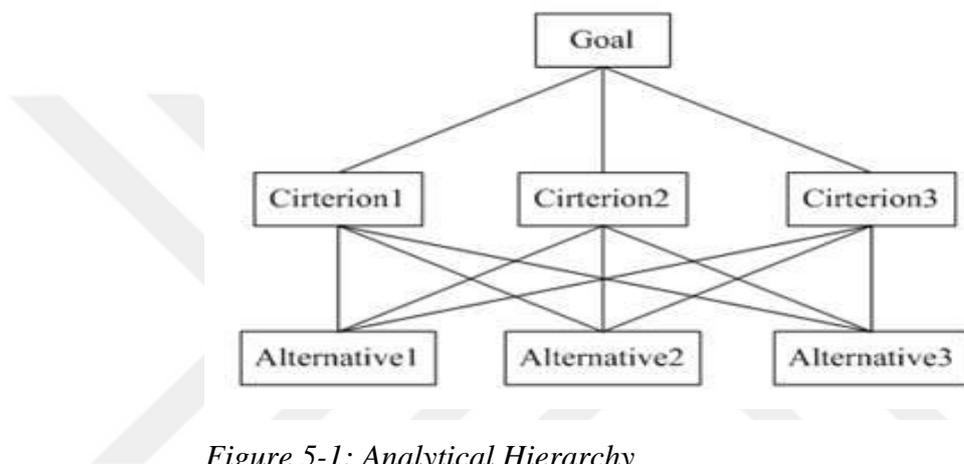
Figure 5-1: Analytical Hierarchy

The analysis section of the process consists of different mathematical procedures. Each one of them is described as follows.

Let assume that there is a set of alternatives A= a_1, a_2, ……a_n, and another set of criteria C=c_1, c_2, c_3,….c_m. their respective weights with respect to the items in the next level of the hierarchy can be obtained pairwise comparison. These pairwise comparisons are made because the human mind can easily evaluate the pairs rather it is difficult for the human mind to give weights to the number of criteria at once (Saaty 1997). The pairwise comparisons are made by asking how much important is one element with respect to another element? By using this scale not only gets the answer on the same scale but it also facilitates the psyche of the decision-maker. Working one pair of elements at a time gives the decision-makers a lot of time to think completely and precisely the relative importance. A scale is needed for these comparative measurements. The scale used by the Saaty in the analytical hierarchy process is known as a Saaty scale. This scale measures the importance of one of item with respect to another by using the scale of 1 to

9 is shown in the table.

Table 5-1: Saaty's Scale

INTENSITY OF IMPORTANCE	DEFINITION	EXPLANATION
1	Equal Importance	Two activities contribute equally to the objective
3	Moderate Importance	Experience and Judgements slightly favor one activity over another
5	Strong Importance	Experience and Judgements strongly favor one activity over another
7	Very Strong	An activity is favored very strongly over another, its dominance is demonstrated by practical examples
9	Extreme Importance	The evidence favoring one activity over another is of the highest possible order of affirmation.
2,4,6,8	Intermediate Values	Used to represents a compromise between the priorities listed above.

Measuring the pairwise comparison matrix $A_{N \times N}$ results in a weight matrix $X_{N \times 1}$ that can be represented as follows

$$
A_{NxN} = \begin{pmatrix} W_1/W_1 & W_1/W_2 & \dots & W_1/W_n \\ W_2/W_1 & W_2/W_2 & \dots & W_2/W_n \\ \dots & \dots & \dots & \dots \\ W_n/W_1 & W_n/W_2 & \dots & W_n/W_n \end{pmatrix} \quad X_{Nx1} = \begin{pmatrix} W_1 \\ W_2 \\ \dots \\ W_n \end{pmatrix}
$$

and then,

$$
\begin{pmatrix} W_1/W_1 & W_1/W_2 & \dots & W_1/W_n \\ W_2/W_1 & W_2/W_2 & \dots & W_2/W_n \\ \dots & \dots & \dots & \dots \\ W_n/W_1 & W_n/W_2 & \dots & W_n/W_n \end{pmatrix} \begin{pmatrix} W_1 \\ W_2 \\ \dots \\ W_n \end{pmatrix} = \lambda \begin{pmatrix} W_1 \\ W_2 \\ \dots \\ W_n \end{pmatrix}
$$

These matrices represent the eigenvector problem $AX=\lambda X$ and can be solved to get the priority vector that represents the weights for each element under consideration. With the same method, we will get the weights for each criterion with respect to the goal and the alternatives with respect to each criterion. After weights are obtained now synthesize these weights to get the global priority. For synthesis, multiply the weights for each alternative with the weights of each criterion. The result will give us the global priority of the alternatives with respect to the goal. For ranking purposes, the comparison matrix $A_{N \times N}$ is first normalized by summing up the weights of each column and dividing each

weight with this sum. After the normalized matrix is obtained then perform the whole process as discussed in the case of matrix $A_{N \times N}$.

Two additional steps are done in AHP: consistency check and sensitivity analysis. After completion of the comparison matrix. Each matrix is checked for consistency. Any inconsistency can arise in the matrix because of possible contradiction in the entries. This contradiction may be the result of lack of information, poorly defined problems, distraction in the concentration, or uncertain nature of the information. The matrix of pairwise comparison is said to be consistent if the rule of transitivity and the rule of reciprocity is satisfied. A tolerable limit for the consistency of the comparison matrix is not clear (Ishizaka and Nemery 2013). Several methods have been developed to check the consistency of the matrix but the most commonly used is one developed by (Saaty 1997) which is based on the eigenvalue method. The consistency ratio is calculated by using the consistency index based on the eigenvalue. If the consistency ratio is equal to zero, the matrix is said to be consistent. The acceptable level for inconsistency is up to 10%. Sensitivity analysis, on the other hand, checks the sensitivity of the results by slight modification in the input information. It creates different scenarios by manipulating the input values and checking their impact on the ranking outcomes of the alternatives. If the ranking remains the same after modification the results are said robust otherwise the results are sensitive.

As far as criteria formulation is concerned Keeny & Raiffa (1976) have suggested five principles that should be met. These five principles include completeness, decomposability, non-redundancy, operationability, and minimum size.

1.1.1. Application of analytic hierarchy process

AHP can be used from the macro-level to the individual micro-level of the multiple criteria decision-making process. At a macro-level, the AHP was successfully used in conflict resolution between South Africa and Northern Ireland (Saaty 1990). Saaty & Zoffer (2012), also tried to apply the AHP for the Palestinian and Israelis conflict in the middle east in a very novel fashion. They tried to apply the AHP by identifying critical issues that impede the resolution of the conflict. These issues were taken as the criteria for AHP. The AHP used, in this study, concessions made by each party and evaluating the results through actual and perceived benefits and the costs by each party. The methodology not only structures and formulate the problem but also provide a healthy

55

environment for the discussion between the concerned parties who were emotionally charged about the difference of opinion regarding solutions to the conflict.

The work of Subramanian & Ramanathan (2012), suggested that the AHP is applied broadly in two problem areas i.e., macro and people-oriented problems which means complex and managerial problems respectively. These two researchers reviewed the papers based on the application of AHP in operation management. They concluded that the major applications of AHP are done in the production area than the service area. The major sectors include logistics and supply chain, selection of the best outsourcing unit, allocation of the resources, and the strategic decisions related to manufacturing.

Singh (2016), applied the AHP in the selection of different projects. In his study, he used four main criteria: strategic alignment, cost, financials, and general. Each of the main criteria is further divided into sub-criteria. The main goal of the study projected evaluation and selection.

Meziani & Rezvani (1988), applied the AHP in selecting the optimal financial instrument in foreign investment. The hierarchical structure was made by optimal financing instrument as a primary goal of the study. The second level of the hierarchy constitutes the type of asset about which financing is required. The assets are categorized as a high-level asset and low-level asset based on how much financing is required for the assets. Assets with a cost higher than 50 million dollars are considered as high-level assets otherwise it is categorized under low-level asset. Each category of assets is further divided into two categories based on the nature of the finance needed i.e., fixed assets and liquid assets. Each of these categories for high-level assets and low-level assets is evaluated based on the four criteria: 1) borrowing cost, 2) interest payment, 3) foreign exchange risk, and 4) country risk. The alternative modes of financing were local loans, international loans, international bonds, and international finance.

Farid, Ahmad, & Alam (2015), used AHP to rank the main challenges experienced by stakeholders in Pakistan. Seventeen challenges were categorized under five dimensions i.e., software, cultural, institutional, technical, and personal. The most ranked challenge was software interface design followed by lack of software quality assurance policy. The third challenging factor was the literacy rate.

5.1.2. Pros and cons of the analytic hierarchy process

The main advantage of using AHP is a multi-criteria decision-making method is it is easy to use the process for weighting criteria and ranking alternatives. Due to its hierarchical structure, it is scalable so can adjust in size to encompass decision-making problem (Velasquez and Hester 2013). AHP is not a too much data-intensive method like MAUT which requires a very precise and detailed level of data for solving the problem.

The main disadvantage of AHP is that it does not consider the issue of the interdependence of criteria and alternatives. Due to the pairwise comparison, it is prone to the effect of inconsistency in weighting criteria and ranking the alternatives. One of the most important criticisms of AHP is its tendency to show rank reversal if one of the new alternative added is nearly similar to the existing alternatives, due to this the final rankings can completely or partially reverse (Velasquez and Hester 2013). The final ranks of alternatives consider the full aggregation method that can compensate for the bad scores of criteria with the good scores of the criteria. The scale used in the AHP is limited to a 9-point scale which also poses a threat to the internal validity due to the difficulty in differentiating two near points on the scale.

5.1.3. Aggregation of judgments

The judgments by different decision-makers need to be aggregated at the end. The aggregation depends on the number of factors, including either the decision-makers are acting as a unit or they are assumed to make the judgments individually. The methods used for each case is different (Forman and Peniwati 1998), i.e. aggregation of individual judgments (AIJ), and aggregation of individual priorities (AIP). AIJ is used when a group itself is behaving as an individual and each decision-maker loses his individuality while deciding in the group. The other method is useful when each decision-maker is treated as an individual. Another decision in an aggregation process is which mathematical procedure should be adopted for the aggregating individual judgments. Is the arithmetic mean best or the geometric mean? The answer to this question depends on which method, AIJ or AIP, is used for aggregating the judgments made by the decision-makers.

Forman & Peniwati (1998), demonstrated that when individual judgments are used for aggregation by assuming the group of decision-makers as a unit then geometric mean is the best procedure to be considered for aggregation. If individual priorities are used for aggregation (AIP) then we can choose either arithmetic mean or geometric mean. Both

are good when the weight assigned to each decision-maker is the same. If the decision-makers differ in weights than weighted geometric mean is the good option for aggregation in AIJ, while in AIP, either weighted arithmetic mean or weighted geometric mean can be used for aggregation. The same thing is demonstrated by Krejčí & Stoklasa(2018) where he demonstrated that if the weighted arithmetic mean is used on the local priorities then it will violate the principle of reciprocity. But, in the case of using weighted geometric-mean, it maintains the assumption of reciprocity. Moreover, he identified that using weighted geometric mean rules out the need for normalization of the pairwise comparison judgments. But when the weighted arithmetic-mean is used then the technique used for normalization of local priorities can affect the ratios of global priorities.

5.1.4. Rank reversal

Rank reversal is one of the problems encountered by MCDM's methods. It refers to the change of ranking due to the modification in over decision matrix due to the addition or deletion of the alternatives or addition and deletion of criteria (Maleki and Zahir 2013). Maleki & Zahir (2013) reviewed 61 research articles in 18 journals. These research papers are written about the rank reversal and its possible causes. About 41.1% of contributors were from the USA, 17.8% were from Canada, the Netherland and UK contributed 6.8% each, constituting 72.5% in total. Belton & Gear (1983) were the first who observed that when an alternative is added to the list of alternatives then the ranking of the alternatives would reverse than the ranking before adding the alternatives. they first rank the three alternatives, A, B, and C, based on three criteria, a, b, and c, by using AHP. The ranking before addition showed that A outranked B. But when alternative D was added and was exactly the same as of alternative B, the ranking reverse in the case of A and B. Belton & Gear (1985) observed that this phenomenon is the result of normalization technique used in the process.

Belton & Gear (1985) suggested that rank reversal could be avoided if the decision matrix is normalized by using the best number in each column of the matrix. Later Saaty (1994), accepted this and called this modified AHP an *ideal AHP* that can be used to preserve the ranks. One of the clear observations noted by Belton & Gear (1985) was that these rank reversals usually occurred when the copy of an already existed alternative is introduced into the process. Barzilai & Boaz (1994), demonstrated that rank reversal can

be prevented if we use a non-normalized decision matrix for the prioritization and we use geometric mean or weighted geometric mean for the aggregation.

Moreover, Finan & Hurley (2002), pointed out that the deletion of wash criteria i.e., the criteria that have equal importance for all of the alternatives could have a different effect on the overall ranking. The different effect on overall ranking depends on the level of criteria in the hierarchy to which this wash criterion belongs. If the wash criterion belongs to the first level of the criteria in the hierarchy then the deletion of the wash criterion does not have any effect on the overall ranking of the alternative but if the wash criterion belongs to the sub-criteria level then deletion may change the overall rank of the alternatives.

5.2. TOPSIS

TOPSIS was Originally developed by Hwang & Yoon (1981). TOPSIS (a technique for order preference by similarity to ideal solution) is a multi-criteria decision-making method in which the alternatives are ranked based on their relative distance from the ideal solution. Two types of ideal solutions are calculated at first i.e., positive ideal solution (PIS), and negative ideal solution (NIS). The alternative whose distance is closest to the positive ideal solution and the furthest to the negative ideal solution is ranked first. .It is a simple technique in which the preference matrix is created based on the criteria from which the alternatives are being evaluated. There are six steps to rank the alternatives through TOPSIS. Each step is discussed below.

Step 1**:** preparing the decision matrix based on the set of alternatives $A=\{A_i \mid i= 1,.....n\}$, and the set of criteria $C=\{C_j \mid j=1,......,m\}$, both of these sets are used to measure the ratings of each alternative based on each criterion by another set that can be called a decision matrix or performance rating matrix and is denoted as $X=\{X_{ij} \mid i=1,.....,n$ and $j=1,.....,m$. the decision matrix can be depicted as under

Step 2: calculate the normalized decision matrix.

Why do we need to normalize? As the different criteria may have different scales to be measured normalization is necessary to descale every criterion. Different attributes are measured in different units that pose difficulty in the calculation. So, we need to convert the whole of the values of each attribute into some dimensionless structure where these attributes can be compared with each other. Normalization is the method to change the values of the attributes into dimensionless scale making it easier to further process the

data (ÇELEN 2014). There are different normalization techniques used to make the data scale-less. The four types of normalization techniques are as follows (ÇELEN 2014).

5.2.1. Vector normalization

$$r_{ij}(x) = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{n} x_j^2}} \quad , \quad i = 1 \dots, n, j = 1 \dots, m \qquad \textit{Equation 5-1}$$

5.2.2. Linear scale transformation

Linear scale transformation using max and min values of a specific attribute C_j for all the alternatives

For normalizing the benefit attributes and cost attributes respectively following equations are used.

$$r_{ij} = \frac{x_{ij} - x_j^{min}}{x_j^{max} - x_j^{min}} \qquad \textit{Equation 5-2}$$

$$r_{ij} = \frac{x_j^{max} - x_{ij}}{x_j^{max} - x_j^{min}} \qquad \textit{Equation 5-3}$$

Linear scale transformation using the maximum value for the C_j attribute. In this method, the maximum value in the normalized decision matrix for the specific attribute is computed then each value of that criteria is divided by the maximum value of those criteria for all alternatives. Mathematically it can be demonstrated as follows for the benefit and cost attribute respectively

$$r_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \qquad \textit{Equation 5-4}$$

$$r_{ij} = \frac{1/x_{ij}}{\sum_{i=1}^{m} (1/x_{ij)}} \qquad \textit{Equation 5-5}$$

$$r_{ij} = \frac{x_{ij}}{x_j^{max}} \qquad \textit{Equation 5-6}$$

$$r_{ij} = 1 - \frac{x_{ij}}{x_j^{max}} \qquad \textit{Equation 5-7}$$

Linear scale transformation using the sum of the attribute. In this method, specific values of the jth attribute are divided by the sum of the values that attribute for all alternatives. The mathematical expressions for benefit and cost attributes are as follows

all these normalization methods are used to make the different attributes comparable. The choice of the normalization method can affect the ultimate outcome of the TOPSIS method.

Step 3: The weights for each criterion is required for this step. The weights can be obtained by the subjective judgment of the decision-maker or different other methods can be used to get the weights for each criterion. After the normalization of the matrix, we need to multiply all the values in the matrix with the weights assigned to each criterion.

$$v_{ij} = w_j \times r_{ij}$$
Equation 5-8

Step 4: This weighted normalized decision matrix is used to calculate the positive ideal solution (PIS) and negative ideal solution (NIS). The maximum value of each weighted normalized criteria is referred to as the positive ideal solution and the minimum of the value of each weighted normalized matrix criteria is termed as the negative ideal solution. For the calculation of PIS and NIS, we divide all the criteria into two categories. Benefit criteria and the cost criteria. For PIS calculation more of the benefit attributes are better and the lesser of the cost attributes are the better. For NIS lesser of the positive attributes and more of the cost, attributes are used for the calculations.

The positive ideal solution and the negative ideal solution are represented below respectively

$$PIS = \{v_1^+(x), v_2^+(x), v_3^+(x), \ldots \ldots v_m^+(x),\} = \{(max_i v_{ij}(x)| j \in j_1), (min_i v_{ij}(x)| j \in j_2)\}| i = 1, \ldots, n$$
Equation 5-9

$$NIS = \{v_1^-(x), v_2^-(x), v_3^-(x), \ldots \ldots v_m^-(x),\} = \{(min_i v_{ij}(x)| j \in j_1), (max_i v_{ij}(x)| j \in j_2)\}| i = 1, \ldots, n$$
Equation 5-10

Step 5: After calculating PIS and NIS, calculate the distance of weighted normalized inputs 'v_{ij}' from the PIS and NIS using Euclidean distance. This will calculate the distance of each alternative from the positive ideal solution and the negative ideal solution.

The mathematical representations for the separation measures from PIS and NIS are shown below respectively.

$$D_i^* = \sqrt{\sum_{j=1}^m [v_{ij}(x) - v_j^+(x)]^2} \quad i = 1, \ldots, n$$
Equation 5-11

$$D_i^- = \sqrt{\sum_{j=1}^{m}\left[v_{ij}(x) - v_j^-(x)\right]^2} \quad i = 1, \ldots, n \qquad \qquad \textit{Equation 5-12}$$

Step 6: After the separation measure the relative proximity to the ideal alternative is calculated

$$C^* = \frac{D_i^-}{(D_i^* + D_i^-)}, \quad i = 1 \ldots \ldots n \qquad \qquad \textit{Equation 5-13}$$

Step 7: Rank the alternatives according to the values calculated in step 5. The bigger the value the better the alternative.

5.2.3. TOPSIS application

Behzadian, Khanmohammadi Otaghsara, Yazdani, & Ignatius (2012), have made an extensive study on the application of the TOPSIS. He reviewed 266 scholarly articles from 103 journals. And classified these research articles based on the application areas. He identified nine application areas where TOPSIS was applied since 2000. Four categories that constitute about 73.2% of the research articles belong to (1). supply chain management, (2)design engineering and manufacturing system,(3) Business and Marketing management, and (4) Health, safety, and environmental management.

In supply chain management fuzzy TOPSIS was applied, in most of the cases, for the selection of the best supplier based on different criteria (Chen, Lin, and Huang 2006), the choice of the best location for the plant, based on the linguistic information given by the decision-makers about criteria (Yong 2006), the suppliers' performance regarding the environmental concerns about waste management, hazardous factory emissions and complying with the environmental regulatory, involvement in the going green projects and the training of the staff regarding these concerns (Awasthi, Chauhan, and Goyal 2010)

The review by Behzadian et al. (2012) mentioned that about 23% of the research papers were related to automation, robotics, mechatronics, and product design. Cost-benefit attributes were used in the selection of e-service providers by Kahraman & Yasin (2007). They used hierarchical TOPSIS for the selection and evaluation of the e-service providers. The hierarchical TOPSIS used by Kahraman & Yasin (2007) take hierarchies for computation without using pairwise comparison. Chu & Lin (2003), uses fuzzy TOPSIS for the selection of robots for handling the materials in the factory. Both subjective and objective criteria were used for the evaluation process. Subjective criteria consisting, the interface between man and robot, a service contract with the vendor, and

flexibility for programming. objective criteria are taken into consideration. Objective criteria consist of the cost of purchase, the accuracy of positioning of the robots, and the load which each robot can carry. Malekly, Meysam Mousavi, & Hashemi (2010), use quality function deployment with TOPSIS to choose the best design for the superstructure bridges. The quality function deployment was used to transform the bridge requirements to the quantitative data useful for design requirements. Once the criteria are developed using the method the alternative designs for the bridges were ranked based on the weighted criteria defined in the linguistic terms in the fuzzy environment.

Business and marketing-related articles reviewed by Behzadian et al. (2012) constitute 23.2% of the total literature. The main focus of these research articles was to rank, evaluate, and select the organization based on their performance. Different financial institutions and instruments are evaluated based on their financial risk, growth, financial ratios, and environmental impact. Aydogan (2011) used the hybrid MCDM method by combining rough AHP with fuzzy TOPSIS for measuring the performance of firms in the Turkish aviation industry. Feng & Wang (2000), developed a conceptual model for performance evaluation of airlines by using the grey relation analysis and TOPSIS. The model incorporates the financial and ratios for evaluation of the performance of the firms. Then overall performance is categorized under production, marketing, and management department for recognizing how much each department is contributing to overall performance and what department is responsible for the low performance.

Chapter 6 Entrepreneurship

6.1. Entrepreneurship

The researchers are divided on the single definition of entrepreneurship (Cunningham and Lischeron 1991). There is no single definition of entrepreneurship on which different researchers are agreed upon (Iversen, Jørgensen, and Malchow-Møller 2008). For the agreed definition of entrepreneurship requires studying six schools of thought who have their own set of beliefs regarding entrepreneurship. The basic difference between these six schools of thought is based on what ingredient of entrepreneurship they have focused on. These six schools of thought can be categorized based on their study on the personal characteristics and traits of the entrepreneurs, the entrepreneurs as the opportunists, how entrepreneurs are managing the activities, how the entrepreneurs are reassessing and adapting themselves. These six schools of thought and what are the key differentiating factors among these six schools of thought about entrepreneurship are presented as follows.

Table 6-1: Entrepreneurial School of Thoughts

Entrepreneurial approach	Characteristics
"Great person" school	The entrepreneur has an intuitive ability – a sixth sense – and inborn traits and instincts.
Psychological characteristics school	Entrepreneurs are driven by unique values, attitudes, and needs.
Classical school	The central characteristic of entrepreneurial behavior is innovation, and the entrepreneur is therefore creative and discovers new opportunities.
Management school	Entrepreneurs are organizers of an economic venture; entrepreneurs are people who organize, own, manage and assume the risk.
Leadership school	Entrepreneurs are leaders of people; entrepreneurs have the ability to adapt their style to the needs of the people.
Intrapreneurship school	Entrepreneurship skills can be useful in complex organizations; intrapreneurs who develop independent units to create markets and expand services.

Source: (Cunningham and Lischeron 1991): 46

6.1.1. The "Great Person" school of thought

This school of thought is considered as an entrepreneur as a person with inborn and innate qualities. They are of the view that entrepreneurs are those people who have the qualities that are inborn. According to them, entrepreneurial qualities and competencies cannot be learned. Their inborn qualities of inspiration and presentation of the ideas to others and their convincing power make them different from others. These entrepreneurs have a high level of self-esteem, vigor, and persistence. They tend to remain independent and successful.

6.1.2. Psychological school of thought

Unlike the "Great Person" school of thought, the psychological school of thought takes the entrepreneurs as a person who has a specific attitude and values toward their normal life and work. These specific attitudes and values are learned through the social structure, like family, society, and environment, of the entrepreneurs. These specific values and attitudes stimulate the person to act in another way when they are encountered with the situation. The main personal qualities of these entrepreneurs include 1) personal values like dignity, honesty, avoiding immoral or unethical behaviour, 2) inclination to take the risk, 3) need for achievement.

6.1.3. Classical school of thought

This school of thought considers the entrepreneur as a person who undertakes some undertaking by assuming the risk and uncertainty to gain the profit. Early in the 16th century, this word was used specifically for the Frenchmen who were leading military expeditions. After that, this word encompassed the person who used to build the infrastructure for the military in form of building and roads, forts, and bridges. After that, the term entrepreneur was used for the person who was trying to innovate something new and had the propensity to bear the risk and uncertainty for this.

6.1.4. Management school of thought

The management school of thought considers a person as an entrepreneur if he, in addition to assuming the risk for gaining the profit, uses the other managerial competencies of planning, organizing, budgeting, and controlling (Fayol 1916). According to them, an entrepreneur creates the venture and manage it besides assuming the risk and uncertainty to gain the profit. According to them, these managerial

competencies can be learned through classroom activities. These activities may consider how to develop the formal business plan, how the proper chain of commands can be developed, how the conflict arising among the group members can be tackled, and how the controlling process can be developed to monitor the performance.

6.1.5. Leadership school of thought

According to this school of thought, the entrepreneur must have the competency to direct and lead the other person for the common goal. Unlike the management school of thought, which focuses on the technical side of managing people, the leadership school of thought focuses on the non-technical side of managing the people. The entrepreneurial leadership has the ability to change their strategies according to the situation, they have the ability to set the goal and have the skill to motivate the persons to achieve these goals. Unlike successful managers who just focus to complete the task by involving and managing the people, the entrepreneurs prove themselves as a mentor by providing their subordinates the trade secrets and developing them accordingly by assessing their needs.

6.1.6. Intrapreneurial school of thought

This school of thought the entrepreneur as the person who provides the necessary freedom to other units of the organization so the people working inside these units can act themselves as an entrepreneur. Each unit is empowered to make its own decisions so the relevant opportunities can be created or exploited. Without becoming the owner, these entrepreneurs implement their ideas by delegating and developing the entrepreneurship process within each unit of the organization. The basic reason for evolving this school of thought is the lack of innovativeness and competitiveness in the organization. The building block of the intrapreneurial school of thought is the development and empowerment of semi-autonomous unit where the people can act as an entrepreneur by themselves. It not only focuses on the building of the autonomous groups of people but also it provides the coordinating facilitation among the group of people, so each group is strategically directed to achieve the common goal. So intrapreneurial school is the team-building model where each team coordinates with each other for creating the opportunities and solving the problem.

6.2. Entrepreneurial Alertness

According to Kirzner (1979), entrepreneurial alertness is the quality of identifying market opportunities when the common man is unable to recognize them. According to him the change in the prices is creating constant disequilibrium in the economy. This change in the price is creating opportunities for entrepreneurs to exploit and gain profit. According to him the knowledge about the change in the prices make the entrepreneurs buy the products at low cost and sell them at a high price. The aspects of this psychological alertness can be viewed in two perspectives, 1) behavioral aspect and, 2) cognitive aspect (Frese and Gielnik 2014).

Kaish & Gilad (1991), examine the entrepreneurial role regarding information and information-seeking. Discovering the opportunities and identification of resources to exploit these opportunities are the basis of entrepreneurship. The main difference between the managers and the entrepreneurs can be viewed by the information-seeking behavior of both of them, how differently they are using the information, and how they are evaluating and analyzing the information. The basic finding of Kaish & Gilad (1991) revealed that these differences are minimized over time by the success and experience of the entrepreneurs.

The other researchers like Baron (2004), Baron & Ensley (2006) focused on the cognitive side of entrepreneurial alertness. The cognitive aspect reveals how the information collected is related among themselves, how the pattern recognition among the different components of the information can lead to opportunity recognition. Finding the connection between seemingly unrelated dots can give rise to the identification of the need for the new product or services. Creativity and the positive effect that include both the long-lasting feeling such as happiness and depression and short-lasting feeling such as sadness, angriness and enjoyment contributes to the firm-level innovation (Baron and Tang 2011) including the are the basis how entrepreneur process the information and identify the new opportunities. Gielnik et al. (2014), identified that both the behavioral aspects and cognitive aspects are mandatory for the successful identification of the opportunities and the successful innovation of the product and services.

6.3. Business Planning

Business planning is considered one of the biggest tools for the successful operation of the business. It is a written document that elaborates on the current and future state of

the business (Honig 2004). There are two schools of thought who have different viewpoints about business planning and its role in the survival of business ventures. One is a proponent of the view that the planning before the initiation of business is crucial to surviving in the competitive environment and the planning provides the basis to mitigate the change of mortality of the new start-up businesses(Castrogiovanni 1996). Boyd (1991), analyses the effect and correlation of the strategic planning on the nine different performance measures and concluded that there is a modest correlation between the initial strategic planning and the performance of the business ventures. Three main functions of the business planning identified by Castrogiovanni, (1996), are 1) the business plan depicts that a lot of effort has been made by the entrepreneur on the business idea and it is feasible to survive in the environment and show the commitment of the entrepreneur to his idea, 2) business plan provide the learning capability as the pre-information is gathered about different stakeholders involved in the business, and finally, it makes the operation and the business process to work efficiently

The opponent of the business plan thinks that the planning process is time-consuming and the entrepreneur should invest its time in other areas of organizing their business and acquiring the resources needed to operate the business. Carter et al.(1996) categorized three nascent entrepreneurs 1) who have started the business, 2) who gave up, and 3) who were still trying. The entrepreneurs who have started the business were involved in practical activities of acquiring the needed assets and resources for their business operations and form the legal entity of their businesses as compared to those who gave up and at the same time of their activities, they were just preparing the business plan. More, the researchers found that planning is a fixed and rigid process and hinders the flexibility which is needed in an uncertain environment.

6.4. Financial Capital

Starting a new business requires financial capital which reflects the need for the resources that are used to operate the business, acquire the equipment and material and avoid the risk of not paying the expenses (Frese and Gielnik 2014). Ho & Wong (2007) argued that the decision about financial capital is the most important factor that can limit entrepreneurship. Entrepreneurship can be enhanced by making easy access to financial capital (De Mel, McKenzie, and Woodruff 2008). Entrepreneurial efforts are neither affected by the discovery of the opportunities nor the creation of the opportunities by the

entrepreneurs (Edelman and Yli–Renko 2010). The theories of the discovery of opportunity reflect the notion that opportunities are already present in the environment and the entrepreneurs are just discovering it while the theories of creation reflect the notion that opportunities are created by the entrepreneurs' action (Alvarez and Barney 2007). According to Alvarez & Barney (2007), entrepreneurship is not explained from a purely economic perspective.

Researchers found out that the entrepreneurs are not focusing fully on debt financing, they use bootstrapping methods to fulfill their requirement of financial capital. The bootstrapping method used the techniques such as delayed payments to the creditors, minimizing the role of account receivable build-ups, outsourcing the resources (Brinckmann, Grichnik, and Kapsa 2010)

6.5. Entrepreneurial Orientation

Entrepreneurial orientation reflects the overall firms' processes, practices, and behavior to act as an entrepreneur. These firms seek to discover and create opportunities that other firms cannot. These firms do it by aligning every component of the organization to act entrepreneurially. The five properties of autonomy, innovativeness, risk-taking, competitive aggressiveness and proactivity make the entrepreneurial firms different from the other firms (Lumpkin and Dess 1996). The overall strategic stance of the firm contributes to the perception of the managers. These perceptions are real in nature, and the firm admits the existence of these perceptions, and these perceptions are not just formed after the success or failure (Robinson et al. 1991).

Chapter 7 Research Methodology

7.1. Proposed Decision Analysis for Project Evaluation

The proposed decision analysis is composed of a series of steps to select and evaluate the business proposals by new entrepreneurs in the public sector business incubation centers in Pakistan.

Step 1: The committee will consist of members who have relevant knowledge about finance, marketing, general management, and project management. This committee will meet before the three months of the date when the new starters are required to submit their applications for the business incubation centers.

Step 2: The committee will identify and select the required criteria for the selection and evaluation of the projects proposed by the new starters. The identification and selection of the criteria will use the brainstorming or Delphi technique.

Step 3: A pre-structured application form will be presented to the applicants based on the number of recommended criteria. Each applicant is required to put the relevant information about their proposed projects in the application form with a number of calculations related to the proposed cash outflows and inflows. There will be specific guidelines to fill the application form including the monetary valued criteria and some subjective criteria for which the respective scales are provided to fill the form accordingly.

Step 4: After application forms are submitted to the business incubation centers a designated staff will check all the forms for their completeness in terms of relevant criteria.

Step 5: If any discrepancy is found the concerned applicants will be informed about this. After the complete application forms are gathered, a meeting will be called for the committee to proceed further.

Step 6:   The committee will proceed to give the pairwise score for each criterion in the prescribed form.

Step 7: These scores will be processed through the Analytic Hierarchy Process (AHP) to get the respective weights for each criterion.

Step 8: After getting the weights, TOPSIS will be applied to get the final ranks for each of the proposed projects by the applicants.

the depiction of our eight-step decision process is as follows
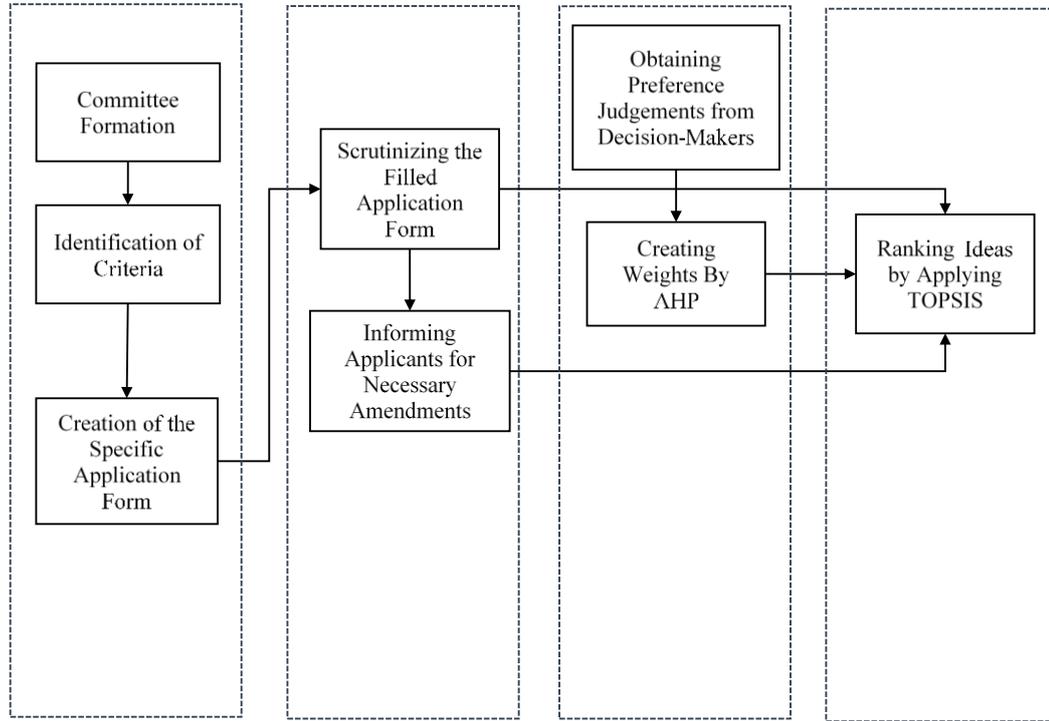
Figure 7-1: Proposed Decision Analysis Process

7.2. Criteria for Selection and Evaluation of New Business Ideas

Information about ten projects proposed by the new entrepreneurs to the business incubation centers were obtained based on the nine criteria. These criteria are further grouped into three categories namely financial criteria, marketing criteria and resource needed criteria. AHP survey form is created based on these nine criteria. The data will be collected from the Decision-makers on this AHP survey form. This survey form will compare each criterion pairwise on 9-point Saaty's scale. After the response is collected then AHP will be used to create the weights for each criterion that will further be processed through TOPSIS to get the final ranks of the projects. The nine criteria categorized into three groups are as follows.

Table 7-1: Project Evaluation Criteria

Groups	Criteria
Financial criteria	
F1	Initial Investment
F2	Return on Investment (ROI)
F3	Net Present Value
F4	Payback Period
Marketing Criteria	
M1	Perceived Value
M2	Market Share
M3	Innovativeness
Needed Resources	
R1	Long term resources
R2	Short-term Resources

7.2.1. Initial investment

represents the money, in Pakistani rupee, required to execute the business idea and include the initial amount for incorporating the business, initial operational cost, and cash at hand. It also includes the money value of other fixed assets and current assets offered by the entrepreneur inside the business on his behalf.

7.2.2. Return on investment

represents the net profit (gross profit less all the expenses) divided by the initial investment. It is used to measure the operating benefit or the efficiency of the investment. It is calculated as a percentage and shows how much percent of the investment is

converted into the net profit. ROI is simply the comparison of the profit or loss produced by the given investment. The regular way to calculate the ROI is to subtract all the expenses from the revenue generated by the investment and then dividing the net value by the investment.

There are two inputs to calculate the ROI, first, we must know the net income which is the difference of gross income less total expenses made, and the second is the total investment needed to generate this net income or loss.

The formula used to calculate the return on investment is

ROI= (net income/total investment) *100

7.2.3. Net present value

represents the present value of future inflows less the present value of future outflows. It is based on the notion that a dollar today is more worth than a dollar in the future that means the value of the money usually depreciates overtime. And for comparing different cash flows at different points of time require to get their value on a common point of time. the required rate of return is used as a discounting factor to find the present or future value of the cash flows on a specific date. The value of net present value ranges from negative to positive representing the loss and benefit, respectively. The negative value of the net present value shows that the present value of future cash outflows is greater than the present value of the future cash inflows. On the other hand, the positive NPV represents that the present value of future cash inflows is greater than the present value of future outflows. This criterion directs the managers or the decision makers for the selection or rejection of the proposed project.

The formula used to calculate the net present value of the future cash flows are:

NPV=$\{\sum_0 t$(future cash inflows)$/(1+i)^t\}$-$\{\sum_0 t$(future cash outflows)$/(1+i)^t\}$

7.2.4. Payback period

represents the total number of years, months, and days to get back the initial investment required for the new venture. The lesser the time of the recovery the better is the efficiency of the proposed project. For example, if there are two projects with the same initial investment of Rs. 300,000. If one projects take 3 years two recover this investment and the other takes 4 years for the full recovery of this investment through its

operation, then the first project is better than the other in term of the payback period. It is calculated as follows

7.2.5. Perceived value

of our services is the cost-benefit analysis made by the customer as compared to our competitors. The higher the perceived value higher the number of potential customers. Perceived value is generally defined as what a customer gets in terms of quality, utility, and benefit and what they give in terms of price, time, and other sacrifices. Perceived value is an abstract concept that can be operationalized as a unidimensional construct and as a multi-dimensional construct. As a unidimensional concept, the perceived value can be defined as what is given and what is taken as a trade-off by acquiring and using products or services. In other words, the unidimensional construct of the perceived value focuses on what benefit a customer gets and what sacrifice he makes in order to avail of the product or service. The multi-dimensional construct focuses on different dimensions of the value and includes social value, emotional value, functional value. The social value represents the ability of the product and services which will increase the social self-concept. The emotional value represents the satisfaction or benefits derived from the feeling generated by the product or services. The functional value represents the perceived reduction in the cost as compared to the competitor. For this research, perceived value is measured on the basis of the percentage of the lower cost offered by the proposed project as compared to the cost offered by the highest competitor in the relevant industry. It is measured on a scale of 0 to 5. The scale used is as follows

Table 7-2: Scale for Perceived Value

Perceived Value	<=1	>10%	>20%	>30%	>40%	>50%
scale	0	1	2	3	4	5

7.2.6. Market share

Market share represents what percentage of the total market a business venture captures. The researchers concluded that there is a positive relationship between the market share and the profitability of the firm. The higher the market share higher the profitability of the firm depending upon the firm's concentration, the growth rate of the

industry, and the firm size. The market share is computed as the percentage of the business captured as compared to the overall competitors in the industry.

The scale used for measuring the market share is as follows.

Table 7-3: Scale for Market Share

Market Share	>2%	>4%	>6%	>8%	>10%
Scale	1	2	3	4	5

7.2.7. Innovativeness

Innovativeness refers to the idea that how much the proposed product and services are novel in nature. There are four levels of innovation 1) there is a continuous improvement in the existing product and services this type of innovation is known as incremental innovativeness, 2) the innovation is made significantly to the existing product and services this type of innovation is known as sustaining innovation, the third level of innovation requires the total disruption of the existing market and is known as disruptive innovation and the last level of innovation is when the innovation changes the whole of the industry and is known as radical innovation.

Table 7-4: Scale for Innovativeness

LEVEL OF INNOVATIVENESS	LEVEL 2	LEVEL 2	LEVEL 3	LEVEL 4
Scale	1	2	3	4

7.2.8. Resource needed

Resource needed includes the long-term resources and short-term resources, long term resources include property, plant and equipment, furniture, and fixtures. Whereas the short-term resource includes the cash at hand, temporary outsource resources and etc.

Table 7-5: Resource Needed

RESOURCES NEEDED	LOW	MEDIUM	HIGH
Scale	1	2	3

Chapter 8 Results and discussion

Two different sets of analyses are done for our study. One of the studies uses equal weights for each criterion to rank the projects. Another analysis requires each committee member to give the scores on the prescribed AHP survey form to get the weights for each criterion. These two analyses show how the ranking of the ten projects are changed when the weights are considered equal and when the weights are obtained through the pairwise comparison of the nine criteria.

The nine criteria are categorized under three broad categories i.e., financial category, marketing category, and resources needed for the projects.

A four-member committee was formed with the necessary competencies regarding their exposure to different projects and their relevant skills in multiple criteria decisions making. A brief introduction of the four-member committee is as follows:

1. Professor Dr. Fikret ER

   Fikret Er, He is author of several books and articles on Project management and Decision Analysis.

2. Professor Dr. Harun Sönmez

   Harun Sönmez, He is author of Decision analysis and Statistics books.

3. Associate Professor Sinan Aydın

   Sinan Aydın, He is Industrial Engineering graduate, He's has finished several small and large size projects and author of several books on Data mining

4. Assistant Professor Şenay Lezki

   She is studying on mainly Decision making and She has already authored books on Decision making and Project Management.

The overall competency of the committee members is very high since all of them teaches the relevant subjects on under graduate and graduate level for several years. They have also been involved in many committees to make several decisions in Anadolu University

An AHP survey was created with the nine criteria (see Appendix 1). Each member of the committee was required to score these nine criteria based on the pairwise comparison by using Saaty's Scale. This scale requires inputting the score on a 1-9 scale.

Table 8-1: Saaty's Scale

Intensity of Importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
3	Moderate Importance	Experience and Judgements slightly favor one activity over another
5	Strong Importance	Experience and Judgements strongly favor one activity over another
7	Very Strong	An activity is favored very strongly over another, its dominance is demonstrated by practical examples
9	Extreme Importance	The evidence favoring one activity over another is of the highest possible order of affirmation.
2,4,6,8	Intermediate Values	Used to represents a compromise between the priorities listed above.

8.1. Comparison Matrix

The score by each of the committee member is as under

Professor Dr. Fikret ER									
Comparison matrix									
Step 1	Criteria	F1	F2	F3	F4	M1	M2	M3	R1	R2
	F1	1	6	6	7	8	6	7	8	8
	F2	1/6	1	5	5	1	3	3	4	3
	F3	1/6	1/5	1	1/3	1/5	1/2	1/3	1/5	1/4
	F4	1/7	1/5	3	1	1/5	1/3	1	1/3	1/5
	M1	1/8	1	5	5	1	4	1	2	4
	M2	1/6	1/3	2	3	1/4	1	1	1/2	1/2
	M3	1/7	1/3	3	1	1	1	1	1/2	1/2
	R1	1/8	1/4	5	3	1/2	2	2	1	2
	R2	1/8	1/3	4	5	1/4	2	2	1/2	1
		2 1/6	**9 2/3**	**34**	**30 1/3**	**12 2/5**	**19 5/6**	**18 1/3**	**17**	**19 4/9**

Professor Dr. Harun Sönmez									
Comparison matrix									
Step 1	Criteria	F1	F2	F3	F4	M1	M2	M3	R1	R2
	F1	1	6	7	8	7	7	6	7	6
	F2	1/6	1	3	3	1	2	2	2	1
	F3	1/7	1/3	1	1/2	1/4	1/3	1/3	1/4	1/2
	F4	1/8	1/3	2	1	1/5	1/4	1/3	1/3	1/5
	M1	1/7	1	4	5	1	2	2	1	4
	M2	1/7	1/2	3	4	1/2	1	2	2	2
	M3	1/6	1/2	3	3	1/2	1/2	1	1/2	1/3
	R1	1/7	1/2	4	3	1	1/2	2	1	1/5
	R2	1/6	1	2	5	1/4	1/2	3	5	1
		2 1/5	**11 1/6**	**29**	**32 1/2**	**11 2/3**	**14**	**18 2/3**	**19**	**15 1/4**

Associate Professor Sinan Aydın									
Comparison matrix									
Step 1	Criteria	F1	F2	F3	F4	M1	M2	M3	R1	R2
	F1	1	2	3	6	4	5	3	4	5
	F2	1/2	1	5	3	1/2	2	3	2	3
	F3	1/3	1/5	1	1/2	1/4	1	1/3	2	1/3
	F4	1/6	1/3	2	1	1/5	1/3	1	1/3	1/4
	M1	1/4	2	4	5	1	3	4	4	2
	M2	1/5	1/2	1	3	1/3	1	2	2	1
	M3	1/3	1/3	3	1	1/4	1/2	1	1	1/2
	R1	1/4	1/2	1/2	3	1/4	1/2	1	1	1/6
	R2	1/5	1/3	3	4	1/2	1	2	6	1
		3 1/4	**7 1/5**	**22 1/2**	**26 1/2**	**7 2/7**	**14 1/3**	**17 1/3**	**22 1/3**	**13 1/4**

Assistant Professor Şenay Lezki									
Comparison matrix									
Step 1	CRITERIA	F1	F2	F3	F4	M1	M2	M3	R1	R2
	F1	1	7	5	5	4	5	6	5	3
	F2	1/7	1	1/2	1/3	1/2	1/2	1/3	1/4	1/5
	F3	1/5	2	1	1/2	1	2	1/3	1/5	1/3
	F4	1/5	3	2	1	1/5	1/2	1/3	1/2	1/3
	M1	1/4	2	1	5	1	5	3	2	1
	M2	1/5	2	1/2	2	1/5	1	1/3	1/5	1/5
	M3	1/6	3	3	3	1/3	3	1	1/3	1/2
	R1	1/5	4	5	2	1/2	5	3	1	1/2
	R2	1/3	5	3	3	1	5	2	2	1
		2 2/3	**29**	**21**	**21 5/6**	**8 3/4**	**27**	**16 1/3**	**11 1/2**	**7**

As different criteria are measured on the different scale so we need to create a unitless matrix which can represent the score of these criteria, for this purpose a normalized matrix for each of these comparison matrices was created. The individual weights for each criterion are drawn by averaging the normalized score for each criterion.

8.2. Normalized Matrix

Professor Dr. Fikret ER										
Normalization									**Importance**	
Step 2	**CRITERIA**	**F1**	**F2**	**F3**	**F4**	**M1**	**M2**	**M2**	**R1**	**R2**	**wi**
	F1	0.4628	0.6218	0.1765	0.2308	0.6452	0.3025	0.3818	0.4697	0.4113	0.4114
	F2	0.0771	0.1036	0.1471	0.1648	0.0806	0.1513	0.1636	0.2348	0.1542	0.1419
	F3	0.0771	0.0207	0.0294	0.0110	0.0161	0.0252	0.0182	0.0117	0.0129	0.0247
	F4	0.0661	0.0207	0.0882	0.0330	0.0161	0.0168	0.0545	0.0196	0.0103	0.0362
	M1	0.0579	0.1036	0.1471	0.1648	0.0806	0.2017	0.0545	0.1174	0.2057	0.1259
	M2	0.0771	0.0345	0.0588	0.0989	0.0202	0.0504	0.0545	0.0294	0.0257	0.0500
	M2	0.0661	0.0345	0.0882	0.0330	0.0806	0.0504	0.0545	0.0294	0.0257	0.0514
	R1	0.0579	0.0259	0.1471	0.0989	0.0403	0.1008	0.1091	0.0587	0.1028	0.0824
	R2	0.0579	0.0345	0.1176	0.1648	0.0202	0.1008	0.1091	0.0294	0.0514	0.0762
		1	1	1	1	1	1	1	1	1	

Professor Dr. Harun Sönmez										
Normalization									**Importance**	
Step 2	**CRITERIA**	**F1**	**F2**	**F3**	**F4**	**M1**	**M2**	**M2**	**R1**	**R2**	**wi**
	F1	0.4553	0.5373	0.2414	0.2462	0.5983	0.4970	0.3214	0.3668	0.3939	0.4064
	F2	0.0759	0.0896	0.1034	0.0923	0.0855	0.1420	0.1071	0.1048	0.0656	0.0963
	F3	0.0650	0.0299	0.0345	0.0154	0.0214	0.0237	0.0179	0.0131	0.0328	0.0282
	F4	0.0569	0.0299	0.0690	0.0308	0.0171	0.0178	0.0179	0.0175	0.0131	0.0300
	M1	0.0650	0.0896	0.1379	0.1538	0.0855	0.1420	0.1071	0.0524	0.2626	0.1218
	M2	0.0650	0.0448	0.1034	0.1231	0.0427	0.0710	0.1071	0.1048	0.1313	0.0881
	M2	0.0759	0.0448	0.1034	0.0923	0.0427	0.0355	0.0536	0.0262	0.0219	0.0551
	R1	0.0650	0.0448	0.1379	0.0923	0.0855	0.0355	0.1071	0.0524	0.0131	0.0704
	R2	0.0759	0.0896	0.0690	0.1538	0.0214	0.0355	0.1607	0.2620	0.0656	0.1037
		1	1	1	1	1	1	1	1	1	

Associate Professor Sinan Aydın

Normalization										Importance
Step 2	CRITERIA	F1	F2	F3	F4	M1	M2	M2	R1	R2	wi
	F1	0.3093	0.2778	0.1333	0.2264	0.5492	0.3488	0.1731	0.1791	0.3774	0.2860
	F2	0.1546	0.1389	0.2222	0.1132	0.0686	0.1395	0.1731	0.0896	0.2264	0.1474
	F3	0.1031	0.0278	0.0444	0.0189	0.0343	0.0698	0.0192	0.0896	0.0252	0.0480
	F4	0.0515	0.0463	0.0889	0.0377	0.0275	0.0233	0.0577	0.0149	0.0189	0.0407
	M1	0.0773	0.2778	0.1778	0.1887	0.1373	0.2093	0.2308	0.1791	0.1509	0.1810
	M2	0.0619	0.0694	0.0444	0.1132	0.0458	0.0698	0.1154	0.0896	0.0755	0.0761
	M2	0.1031	0.0463	0.1333	0.0377	0.0343	0.0349	0.0577	0.0448	0.0377	0.0589
	R1	0.0773	0.0694	0.0222	0.1132	0.0343	0.0349	0.0577	0.0448	0.0126	0.0518
	R2	0.0619	0.0463	0.1333	0.1509	0.0686	0.0698	0.1154	0.2687	0.0755	0.1100
		1	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	

Assistant Professor Şenay Lezki

Normalization										Importance
Step 2	CRITERIA	F1	F2	F3	F4	M1	M2	M2	R1	R2	wi
	F1	0.3714	0.2414	0.2381	0.2290	0.4580	0.1852	0.3673	0.4354	0.4245	0.3278
	F2	0.0531	0.0345	0.0238	0.0153	0.0573	0.0185	0.0204	0.0218	0.0283	0.0303
	F3	0.0743	0.0690	0.0476	0.0229	0.1145	0.0741	0.0204	0.0174	0.0472	0.0541
	F4	0.0743	0.1034	0.0952	0.0458	0.0229	0.0185	0.0204	0.0435	0.0472	0.0524
	M1	0.0928	0.0690	0.0476	0.2290	0.1145	0.1852	0.1837	0.1742	0.1415	0.1375
	M2	0.0743	0.0690	0.0238	0.0916	0.0229	0.0370	0.0204	0.0174	0.0283	0.0427
	M2	0.0619	0.1034	0.1429	0.1374	0.0382	0.1111	0.0612	0.0290	0.0708	0.0840
	R1	0.0743	0.1379	0.2381	0.0916	0.0573	0.1852	0.1837	0.0871	0.0708	0.1251
	R2	0.1238	0.1724	0.1429	0.1374	0.1145	0.1852	0.1224	0.1742	0.1415	0.1460
		1	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	

For each of the comparison matrix, we need to calculate the consistency of the judgments. The matrix of judgments is said to be consistent if they follow the idea of the theory of transitivity and the theory of reciprocity. The theory of transitivity is met if one criterion is preferred over the 2nd criterion and the 2nd criterion is preferred over the 3rd criterion then the 1st criterion should be preferred over the third criterion with its relative proportion. The theory of reciprocity is met if one criterion is twice as important as the 2nd criterion then the judgment should reflect that the 2nd criterion is half as important as the 1st criterion. The consistency ratio for each of the individual decision matrix was calculated. It was found that all the decision matrices are consistent. The consistency for each of the decision-maker is calculated by using the following procedure.

First, we calculate the value for λ_{max} with the following formula (Özdemir 2002)

$$\lambda_{max} = \frac{1}{n} \sum_{i=1}^{n} \frac{\sum_{j=1}^{n} a_{ij} w_j}{w_i}$$

Equation 8-1

$$CI = \frac{\lambda_{max} - n}{n-1}$$

Equation 8-2

Then we calculate the consistency index which is the difference of λ_{max} and the

The number of criteria used is divided by the number of criteria minus one.

CI is used to calculate the consistency ratio which is used to measure the consistency of decision-makers' judgments in the comparison matrix. Comparison matrix's judgments are considered consistent if the value of consistency ratio is below 10%. consistency ratio (CR) is calculated by the following formula.

$$CR = \frac{CI}{RI}$$

Equation 8-3

Where RI is the random consistency indices which have its own value for the number of criteria used in the analysis up to 10, and its values are shown below (Saaty 1980)

Table 8-2: Random Consistency Indices

n	2	3	4	5	6	7	8	9	10
RI	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.51

Source: Saaty (1980)

8.3. Consistency of Comparison Matrix

Professor Dr. Fikret ER					
	$a_{ij}w_j$	$a_{ij}w_j/w_i$			
F1	4.5997	11.1816	**lmax=**	10.0740	
F2	1.5029	10.5898			
F3	0.2365	9.5725	**CI=**	0.1342	
F4	0.3334	9.2208	**CR=**	0.0926	**Consistent**
M1	1.3443	10.6758			
M2	0.4859	9.7261			
M2	0.5229	10.1749			
R1	0.8193	9.9446			
R2	0.7299	9.5795			
Professor Dr. Harun Sönmez					
	$a_{ij}w_j$	$a_{ij}w_j/w_i$			
F1	4.3365	10.6705	**lmax=**	10.0794	
F2	0.9913	10.2995			
F3	0.2810	9.9725	**CI=**	0.1349	
F4	0.2782	9.2803	**CR=**	0.0930	**Consistent**
M1	1.3105	10.7620			
M2	0.9182	10.4168			
M2	0.5202	9.4333			
R1	0.6761	9.6023			
R2	1.0659	10.2771			
Associate Prof. Sinan Aydın					
	$a_{ij}w_j$	$a_{ij}w_j/w_i$			
F1	3.0079	10.5155	**lmax=**	10.0392	
F2	1.5058	10.2190			
F3	0.4745	9.8809	**CI=**	0.1299	
F4	0.3988	9.7888	**CR=**	0.0896	**Consistent**
M1	1.8342	10.1339			
M2	0.7690	10.1053			
M2	0.5783	9.8226			
R1	0.5038	9.7200			
R2	1.1187	10.1665			

Assistant Professor Şenay Lezki					
	$a_{ij}w_j$	$a_{ij}w_j/w_i$			
F1	3.4038	10.3834	**lmax=**	10.0582	
F2	0.3003	9.9042			
F3	0.5312	9.8104	**CI=**	0.1323	
F4	0.5053	9.6488	**CR=**	0.0912	**Consistent**
M1	1.4580	10.6037			
M2	0.4105	9.6026			
M2	0.8379	9.9765			
R1	1.2949	10.3510			
R2	1.4958	10.2432			

8.4. Overall Comparison Matrix

After the consistency check for each comparison matrix. An overall group decision matrix is created which is the aggregation of the individual judgments. For the aggregation purpose geometric mean was used.

overall comparison matrix as a geometric mean of aggregation of the individual judgments is as follows.

Table 8-3: Overall Comparison matrix

Step 1	criteria	F1	F2	F3	F4	M1	M2	M2	R1	R2
	F1	1.0000	4.7381	5.0100	6.4022	5.4711	5.6924	5.2436	5.7850	5.1800
	F2	0.2111	1.0000	2.4746	1.9680	0.7071	1.5651	1.5651	1.4142	1.1583
	F3	0.1996	0.4041	1.0000	0.4518	0.3344	0.7598	0.3333	0.3761	0.3433
	F4	0.1562	0.5081	2.2134	1.0000	0.2000	0.3433	0.5774	0.3689	0.2403
	M1	0.1828	1.4142	2.9907	5.0000	1.0000	3.3098	2.2134	2.0000	2.3784
	M2	0.1757	0.6389	1.3161	2.9130	0.3021	1.0000	1.0746	0.7953	0.6687
	M2	0.1907	0.6389	3.0000	1.7321	0.4518	0.9306	1.0000	0.5373	0.4518
	R1	0.1729	0.7071	2.6591	2.7108	0.5000	1.2574	1.8612	1.0000	0.4273
	R2	0.1930	0.8633	2.9130	4.1618	0.4204	1.4953	2.2134	2.3403	1.0000
		2 1/2	11	23 4/7	26 1/3	9 2/5	16 1/3	16	14 5/8	11 6/7

The normalized matrix for the overall comparison matrix is as follows

Table 8-4: Normalized Overall Comparison Matrix

Step 1	criteria	F1	F2	F3	F4	M1	M2	M2	R1	R2
	F1	0.4029	0.4342	0.2125	0.2431	0.5828	0.3481	0.3261	0.3958	0.4372
	F2	0.0850	0.0916	0.1050	0.0747	0.0753	0.0957	0.0973	0.0968	0.0978
	F3	0.0804	0.0370	0.0424	0.0172	0.0356	0.0465	0.0207	0.0257	0.0290
	F4	0.0629	0.0466	0.0939	0.0380	0.0213	0.0210	0.0359	0.0252	0.0203
	M1	0.0736	0.1296	0.1268	0.1898	0.1065	0.2024	0.1376	0.1368	0.2007
	M2	0.0708	0.0585	0.0558	0.1106	0.0322	0.0611	0.0668	0.0544	0.0564
	M2	0.0768	0.0585	0.1272	0.0658	0.0481	0.0569	0.0622	0.0368	0.0381
	R1	0.0696	0.0648	0.1128	0.1029	0.0533	0.0769	0.1157	0.0684	0.0361
	R2	0.0778	0.0791	0.1236	0.1580	0.0448	0.0914	0.1376	0.1601	0.0844
		1	1	1	1	1	1	1	1	1

The consistency for the overall comparison matrix is as follows

Table 8-5: Consistency of Overall Comparison

	$a_{ij}w_j$	$a_{ij}w_j/w_i$			
F1	3.73758	9.9445	**lmax=**	9.5076	
F2	0.87559	9.6194			
F3	0.35049	9.4293	**CI=**	0.0634	
F4	0.36924	9.1032	**CR=**	0.0438	**Consistent**
M1	1.41354	9.7558			
M2	0.59912	9.5141			
M2	0.58891	9.2904			
R1	0.731	9.3917			
R2	1.01209	9.5198			

The normalized matrix gives the weights of the individual criterion relative to other criteria. As the matrices by the individual decision-maker are consistent so is the consistency of the overall matrix. The consistency ratio for the overall comparison matrix is 0.043757<0.1 which shows that the group decision matrix is very well consistent.

The final ranking of the criteria is drawn from the overall weights drawn on the basis of the normalized matrix is as follows.

The ranking of the criteria based on their aggregated score of the individual

Table 8-6: Rank of Each Criterion with Respect to Its Weight

CRITERIA	CODE	WEIGHTS	RANK
Initial Investment	F1	0.375845	1
Return on Investment (ROI)	F2	0.091023	4
Net Present Value	F3	0.037170	9
Payback Period	F4	0.040562	8
Perceived Value	M1	0.144892	2
Market Share	M2	0.062972	7
Innovativeness	M3	0.063389	6
Long term resources	R1	0.077835	5
Short-term Resources	R2	0.106313	3

judgments of the four decision-makers shows that the investment required initially to start the business is one of the most important criteria for selection and evaluation of the projects followed by how the projects are perceived by the customers. The third most important criterion for the selection of the projects is the need for the short-term resources by the entrepreneurs which shows that the liquid assets are more important than the long-

term resources that are ranked as no. 5. Innovativeness is estimated to rank on no. 6 followed by the market share. The payback period and the net present value of the future cash flows are the least important criteria, respectively, among the nine criteria used for this study.

The graphical representation of the importance of the criteria by their categories shows that financial criteria are most important sharing approximately 55% of the total importance among nine criteria. The marketing criteria is the 2nd most important category among the three categories having approximately 27% of the total weight. The reason behind their overall categorical importance is due to the criteria of initial investment and the perceived value that are the two top-most criteria among the nine criteria, respectively.
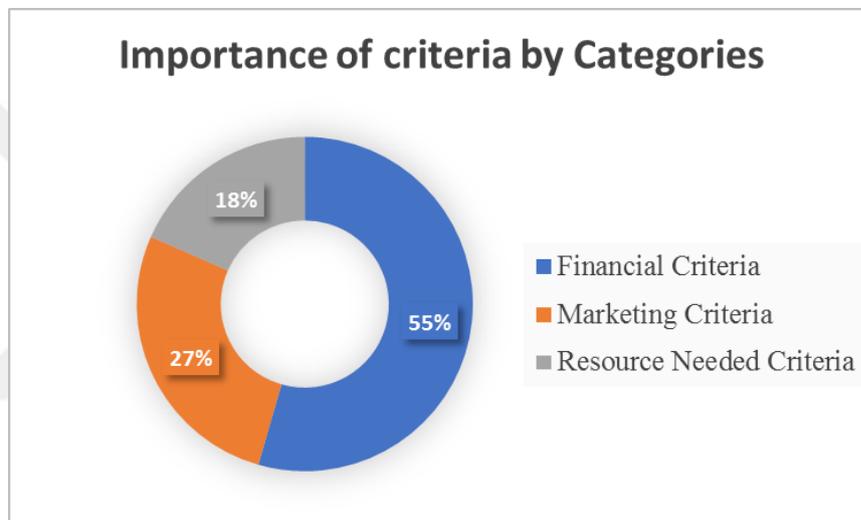
Figure 8-1: Importance of Criteria by Category

After the weighting is done by using AHP the next step was to process the data through TOPSIS. Two analyses are done through TOPSIS, one considers the equal weights and the other used the weights estimated through AHP in the previous steps.

8.5. Applying TOPSIS

The inputs gathered regarding the projects based on the nine criteria are as follows.

Table 8-7: TOPSIS Input Decision Matrix

	F1	**F2**	**F3**	**F4**	**M1**	**M2**	**M3**	**R1**	**R2**
Project1	35000	129	7800	3.25	4	5	2	1	2
Project2	48000	125	7941	8.26	3	4	1	2	1
Project3	39146	124	8385	8	2	2	3	3	3
Project4	39621	131	8786	8	3	1	2	2	1
Project5	47067	124	6946	8	5	4	3	1	2
Project6	32158	128	8552	7	3	4	2	1	2
Project7	51546	128	10284	7	2	5	2	1	2
Project8	40144	124	7567	11	1	1	2	3	1
Project9	35212	105	7589	9	2	2	3	2	1
Project10	35990	119	7433	9	3	5	3	1	2

Initial investment and the net present value of cash flows (NPV) is measured in Pakistani Rupees (PKR). The payback period of the projects is measured in months. While perceived value, market share, innovativeness, the long-term resource needed, and the short-term resource needed is measured on the prescribed scale.

First, we use the TOPSIS on the above matrix by using the equal weights of 1/9 for each criterion. First, we calculated the normalized matrix to make the matrix unitless for further calculation. The formula used to create the normalized matrix is as follows

$$r_{ij}(x) = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{n} x_j^2}} \quad , \quad i = 1 \dots, n, j = 1 \dots, m$$

Equation 5-1

The results for the TOPSIS for equal weights are as follow

Table 8-8: Overall Normalized Decision Matrix

	F1	**F2**	**F3**	**F4**	**M1**	**M2**	**M2**	**R1**	**R2**
project1	0.2710	0.3292	0.3016	0.1273	0.4216	0.4336	0.2649	0.1690	0.3482
project2	0.3716	0.3190	0.3071	0.3235	0.3162	0.3468	0.1325	0.3381	0.1741
project3	0.3031	0.3165	0.3243	0.3134	0.2108	0.1734	0.3974	0.5071	0.5222
project4	0.3067	0.3344	0.3398	0.3134	0.3162	0.0867	0.2649	0.3381	0.1741
project5	0.3644	0.3165	0.2686	0.3134	0.5270	0.3468	0.3974	0.1690	0.3482
project6	0.2490	0.3267	0.3307	0.2742	0.3162	0.3468	0.2649	0.1690	0.3482
project7	0.3991	0.3267	0.3977	0.2742	0.2108	0.4336	0.2649	0.1690	0.3482
project8	0.3108	0.3165	0.2926	0.4309	0.1054	0.0867	0.2649	0.5071	0.1741
project9	0.2726	0.2680	0.2935	0.3525	0.2108	0.1734	0.3974	0.3381	0.1741
project10	0.2786	0.3037	0.2875	0.3525	0.3162	0.4336	0.3974	0.1690	0.3482

After calculation of the normalized decision matrix, the weighted normalized decision matrix was calculated with the following formula

$$v_{ij} = w_j \times r_{ij}$$

where v_{ij} weighted normalized matrix, which is the product of weights w_j and

Table 8-9: Weighted Normalized Decision Matrix

	F1	**F2**	**F3**	**F4**	**M1**	**M2**	**M2**	**R1**	**R2**
project1	0.0301	0.0366	0.0335	0.0141	0.0468	0.0482	0.0294	0.0188	0.0387
project2	0.0413	0.0354	0.0341	0.0359	0.0351	0.0385	0.0147	0.0376	0.0193
project3	0.0337	0.0352	0.0360	0.0348	0.0234	0.0193	0.0442	0.0563	0.0580
project4	0.0341	0.0372	0.0378	0.0348	0.0351	0.0096	0.0294	0.0376	0.0193
project5	0.0405	0.0352	0.0298	0.0348	0.0586	0.0385	0.0442	0.0188	0.0387
project6	0.0277	0.0363	0.0367	0.0305	0.0351	0.0385	0.0294	0.0188	0.0387
project7	0.0443	0.0363	0.0442	0.0305	0.0234	0.0482	0.0294	0.0188	0.0387
project8	0.0345	0.0352	0.0325	0.0479	0.0117	0.0096	0.0294	0.0563	0.0193
project9	0.0303	0.0298	0.0326	0.0392	0.0234	0.0193	0.0442	0.0376	0.0193
project10	0.0310	0.0337	0.0319	0.0392	0.0351	0.0482	0.0442	0.0188	0.0387

normalized decision matrix r_{ij}. equal weights are used for this analysis. As we have nine criteria, we use 1/9 as a weight for all of the criteria. Each column of the normalized decision matrix is multiplied with the respective weights of the criteria that are equal to

1/9. The weighted normalized decision matrix calculated with the above formula is as follows:

After calculation of the weighted normalized decision matrix, positive ideal solution and the negative ideal solution for each of the project is calculated by using the Equation 5-9 and Equation 5-10

$$PIS = \{v_1^+(x), v_2^+(x), v_3^+(x), \ldots\ldots v_m^+(x), \} =$$
$$\{(max_i v_{ij}(x)| j \in j_1), (min_i v_{ij}(x)| j \in j_2)\}| i = 1, \ldots., n$$

$$NIS = \{v_1^-(x), v_2^-(x), v_3^-(x), \ldots\ldots v_m^-(x), \}$$
$$= \{(min_i v_{ij}(x)| j \in j_1), (max_i v_{ij}(x)| j \in j_2)\}| i = 1, \ldots., n$$

The results for PIS and NIS is as follows:

Table 8-10: Positive Ideal Solution

F1	F2	F3	F4	M1	M2	M3	R1	R2
0.0277	0.0372	0.0442	0.0141	0.0586	0.0482	0.0442	0.0188	0.0193

Table 8-11: Negative Ideal Solution (NIS)

F1	F2	F3	F4	M1	M2	M3	R1	R2
0.0443	0.0298	0.0298	0.0479	0.0117	0.0096	0.0147	0.0563	0.0580

After this the distance of each measure from the positive ideal solution and the negative ideal solution is measured with the help of the Equation 5-11and Equation 5-12

$$D_i^* = \sqrt{\sum_{j=1}^m [v_{ij}(x) - v_j^+(x)]^2} \quad i = 1, \ldots., n$$

$$D_i^- = \sqrt{\sum_{j=1}^m [v_{ij}(x) - v_j^-(x)]^2} \quad i = 1, \ldots., n$$

The distance of each measure from the positive ideal solution is as follows:

Table 8-12: Distance from the PIS

Project1	Project2	Project3	Project4	Project5	Project6	Project7	Project8	Project9	Project10
0.0595	0.1285	0.1771	0.1290	0.0788	0.0917	0.1030	0.1919	0.1294	0.0867

The distance from the negative ideal solution is as follows:

Table 8-13: Distance from NIS

Project1	Project2	Project3	Project4	Project5	Project6	Project7	Project8	Project9	Project10
0.2037	0.1347	0.0861	0.1342	0.1844	0.1715	0.1601	0.0713	0.1338	0.1764

After we have calculated the value of the distance of each measure from its positive ideal solution and negative ideal solution, the next step is to calculate the relative proximity to the ideal solution with the help of Equation 5-13

$$C^* = \frac{D_i^-}{(D_i^* + D_i^-)}, \quad i = 1 \ldots \ldots n$$

The relative closeness to the ideal solution for our decision matrix is as follows with the corresponding ranking of the projects.

Table 8-14: Relative closeness and Ranking of Projects

Projects	Relative Closeness	Rank
Project1	0.774093	1
Project2	0.511855	6
Project3	0.327045	9
Project4	0.509899	7
Project5	0.700588	2
Project6	0.651464	4
Project7	0.60848	5
Project8	0.270776	10
Project9	0.508239	8
Project10	0.670425	3

In our analysis of projects with equal weights, project1 is ranked as the top-most project with regard to the nine criteria that are used for the selection and evaluation of the projects followed by project 5 which secured the 2nd largest value for the relative closeness to the ideal solution. The analysis shows that project1 is the closest to the positive ideal solution with the value of 0.0595 which is the lowest value among the rest of the projects' value for the distance from the PIS. Results also show that the project1 secures the highest value for the distance from the negative ideal solution with the value of 0.2037. TOPSIS usually ranks the projects in order of how close the projects are to the positive ideal solution and how far it is from the negative ideal solution.

Our second analysis uses the weights generated through AHP by utilizing the inputs from our four decision makers. The results by using the weights determined through AHP is as follows.

8.6. Normalized Decision Matrix for Analysis 2

Table 8-15: Normalized Decision matrix for Analysis 2

	F1	F2	F3	F4	M1	M2	M2	R1	R2
project1	0.2710	0.3292	0.3016	0.1273	0.4216	0.4336	0.2649	0.1690	0.3482
project2	0.3716	0.3190	0.3071	0.3235	0.3162	0.3468	0.1325	0.3381	0.1741
project3	0.3031	0.3165	0.3243	0.3134	0.2108	0.1734	0.3974	0.5071	0.5222
project4	0.3067	0.3344	0.3398	0.3134	0.3162	0.0867	0.2649	0.3381	0.1741
project5	0.3644	0.3165	0.2686	0.3134	0.5270	0.3468	0.3974	0.1690	0.3482
project6	0.2490	0.3267	0.3307	0.2742	0.3162	0.3468	0.2649	0.1690	0.3482
project7	0.3991	0.3267	0.3977	0.2742	0.2108	0.4336	0.2649	0.1690	0.3482
project8	0.3108	0.3165	0.2926	0.4309	0.1054	0.0867	0.2649	0.5071	0.1741
project9	0.2726	0.2680	0.2935	0.3525	0.2108	0.1734	0.3974	0.3381	0.1741
project10	0.2786	0.3037	0.2875	0.3525	0.3162	0.4336	0.3974	0.1690	0.3482

8.7. Weighted Normalized Decision Matrix for Analysis 2

The weights used for the calculation of the weighted normalized decision matrix is taken from the weights calculated through AHP as a group decision matrix. These weights are then multiplied with the normalized decision matrix calculated earlier. Column wise operation is done to create the weighted normalized decision matrix. The overall weights for the nine criteria are as follows

Table 8-16: Criteria Weights

Criteria	F1	F2	F3	F4	M1	M2	M3	R1	R2
weights	0.3758	0.0910	0.0372	0.0406	0.1449	0.0630	0.0634	0.0778	0.1063

Table 8-17: Weighted Normalized Decision Matrix for Analysis 2

	F1	F2	F3	F4	M1	M2	M2	R1	R2
project1	0.1019	0.0300	0.0112	0.0052	0.0611	0.0273	0.0167	0.0132	0.0369
project2	0.1397	0.0290	0.0114	0.0133	0.0459	0.0219	0.0083	0.0264	0.0185
project3	0.1140	0.0288	0.0120	0.0128	0.0306	0.0109	0.0250	0.0396	0.0554
project4	0.1153	0.0304	0.0126	0.0128	0.0459	0.0055	0.0167	0.0264	0.0185
project5	0.1370	0.0288	0.0099	0.0128	0.0764	0.0219	0.0250	0.0132	0.0369
project6	0.0936	0.0297	0.0122	0.0112	0.0459	0.0219	0.0167	0.0132	0.0369
project7	0.1500	0.0297	0.0147	0.0112	0.0306	0.0273	0.0167	0.0132	0.0369
project8	0.1169	0.0288	0.0108	0.0177	0.0153	0.0055	0.0167	0.0396	0.0185
project9	0.1025	0.0244	0.0109	0.0145	0.0306	0.0109	0.0250	0.0264	0.0185
project10	0.1048	0.0276	0.0106	0.0145	0.0459	0.0273	0.0250	0.0132	0.0369

Relative closeness to the ideal solution and Ranking of the projects

Table 8-18: Ranking Projects in Analysis 2

Projects	Relative Closeness	Rank
project1	0.77592	1
project2	0.485628	7
project3	0.349565	9
project4	0.565443	6
project5	0.664765	4
project6	0.70317	2
project7	0.440319	8
project8	0.345111	10
project9	0.573685	5
project10	0.685652	3

Table 8-19: Comparison of Ranks

	Project 1	Project 2	Project 3	Project 4	Project 5	Project 6	Project 7	Project 8	Project 9	Project 10
RANK 1	1	6	9	7	2	4	5	10	8	3
RANK2	1	7	9	6	4	2	8	10	5	3

In the case of the second analysis, project1 is ranked 1 but contrary to the results of analysis1 the second most important project is project6 instead of project 5. A major difference can be seen in the case of project 7 where the rank is changed from 5 to 8 by using equal weights and the weights determined by AHP. Among the 10 projects,

project1, project3, Project8 and Project 10 yields the same results of the ranks. All other projects are ranked differently by using different weights in analysis 2 as compared to the analysis1 where equal weights of 1/9 is used for each criteria.

8.8. Discussion

In Pakistan, Business incubation centers usually decide about the new start-up ideas through committees. Committees ask the new entrepreneurs open-ended and close-ended questions after they have presented their ideas. Some of the public sector business incubation centers use scorecards that contain criteria for scoring the new startup ideas. The staters' idea is evaluated based on the total of the score they secured based on these criteria. The committee members usually have one dominating person who can dominate the whole of the group decisions.

Pakistan with diverse types of resources is getting a 40% share of its total gross domestic product from small medium enterprises. Pakistan, with a population of 200million approximately, has 62% of its population less than 30 years old. On average 4 million people are becoming part of the population. Over 0.9 million people per year are becoming part of the workforce if the current labour participation rate and unemployment rate remain the same. If the government wants to improve the current participation rate and the unemployment rate, an estimate of 1.3 million people will become part of the workforce in Pakistan. To overcome this problem, the government of Pakistan needs to facilitate young people in establishing their businesses. The establishment of the new ventures has a multiplier effect on the reduction of unemployment because it turns the people from jobseekers to the job-creator.

The high probability of the new business failures within a few years needs to evaluate the business at the initial level to reduce the rate of failure of the new start-up businesses. The rate of failure can be reduced if the business entrepreneurs know, at the initial stages, prerequisites about their internal and external factors.

The objective of the research was to provide the framework for the initial evaluation of the new start-up business. The incubation centers are one of the sources that can provide the necessary aid to start-up businesses by providing the management skills, training, provision of the office spaces, collaborating with the investors, and, in some incubators, providing financial assistance. The success of the new start-up is highly dependent on the initial screening of the business proposals proposed by the new

entrepreneurs. Good market analysis with the projected cash flows, the estimated rate of return on the investment, initial investment needed to start the business, offering novel product or services with the fair share of the market, and the availability of the long-term and short-term resources are the key information that depicts how much the new entrepreneurs are aware of the internal and external prerequisites for starting their businesses. Our proposed model will assist the incubation centers for the initial evaluation of start-up businesses

Our hybrid multiple criteria methods use the subjective judgments of the decision makers and convert them into weights for each criterion. In practice, each criterion has its own significance, and this significance can vary from time to time. using AHP for creating weights of the criteria encompasses the quality two reflect the change in the importance of the criteria over time. the weights can also change due to the change in the members of the committee. The AHP weights used for our study are not static so the change in the significance of the criteria over time or change in the preferences of the committee members or change in the members of the committee is reflected in the AHP weights.

Using the hybrid multiple criteria decision making will eliminate the risk of dominating the whole decision process by one of the dominant persons in the committee. Conversion of the preferences into a specific output ensures the indifference of the members of the committee regarding the final outcome of the decision process.

The hybrid multiple criteria method accounts for the variability in the significance of the criteria which voting methods are unable to ensure. Using the voting methods as a sole method for the selection of the new business ventures just shows the decision-makers' preferability of one alternative over another. Voting methods neglect the significance of the evaluation criteria in the decision process. In the real world, each criterion for the evaluation of business projects has its significance. This significance can be shown in terms of their weights. The voting methods without using some other multiple criteria decision method are hard to reflect this significance.

Our stepwise method for the selection and the evaluation of the new start-up businesses ensures that the prescribed application form consisting of the details about criteria can be filled by applicants itself, hence it decreases the burden over the committee

members to use the extra human resource to fill any necessary details regarding the business proposals.

8.9. Future Work

The criteria set that is used in this study can be easily generalized to other problems in such projects proposed by entrepreneurs. The future study can be done to categorize the projects based on some common grounds and then identify the category-specific criteria for each category. So, when the entrepreneur proposes some business initiative; We will be able to categories their projects and then specific criteria based on the categories can be applied on evaluation of the projects. Further more, if necessary criteria for the projects can be identified based on the ten knowledge areas of the project management. Each project can be evaluated according to the criteria identified based on the ten knowledge areas. This approach will integrate all the dimensions of the projects, and hence, the criteria identified will give the complete picture of the proposed projects.

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Appendix 1

AHP Survey

Purpose of the Study:

The purpose of the study is to provide the hybrid multiple criteria decision-making method for the selection and evaluation of the projects proposed by the new entrepreneurs in the Business Incubation centers

How to Answer the Questionnaire:

This questionnaire provides the 9 criteria. Each of the criteria is compared with the rest of the criteria through pairwise comparison using the Saaty's Scale. The Saaty's Scale is based on a 0-9 scale. The respondent can mark the number on the scale he or she deems how much important is one criterion over the other criterion. The Saaty's scale is provided below

Table 0-1: Saaty's Scale

Intensity of Importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
3	Moderate Importance	Experience and Judgements slightly favor one activity over another
5	Strong Importance	Experience and Judgements strongly favor one activity over another
7	Very Strong	An activity is favored very strongly over another, its dominance is demonstrated by practical examples
9	Extreme Importance	The evidence favoring one activity over another is of the highest possible order of affirmation.
2,4,6,8	Intermediate Values	Used to represents a compromise between the priorities listed above.

A total of nine criteria grouped into three categories will be used for project evaluation purposes

Table 0-2: Project Selection Criteria

Groups	Criteria
Financial criteria	
F1	Initial Investment
F2	Return on Investment
F3	Net Present Value
F4	Payback Period
Marketing	
M1	Perceived Value
M2	Market Share
M3	Innovativeness
Needed Resources	
R1	Long term resources
R2	Short-term Resources

Criteria 1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	✓ 7	8	9	Criteria 2

For example, if a decision-maker very strongly prefers criteria 2 over criteria 1 then he will mark 7 on the side of criteria 2

Table 0-3: Pairwise Comparison for Criteria

	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
Initial Investment	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	F2
F1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	F3
F1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	F4
F1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	M1
F1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	M2
F1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	M3
F1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	R1
F1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	R2
Return on Investment (ROI)	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	F3
F2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	F4
F2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	M1
F2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	M2
F2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	M3
F2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	R1
F2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	R2
Net Present Value	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	F4
F3	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	M1
F3	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	M2
F3	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	M3
F3	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	R1
F3	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	R2
Payback Period	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	M1
F4	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	M2
F4	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	M3
F4	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	R1
F4	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	R2
Perceived Value	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	M2
M1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	M3
M1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	R1
M1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	R2
Market Share	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	M3
M2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	R1
M2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	R2
Innovativeness	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	R1
M3	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	R2
Long term resources	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	R2

Appendix 2

Name of the Project: Get Ready Tours

BACKGROUND

Neelum valley, the blue jewel of Kashmir is one of the most visited regions in the north of Pakistan. It is located 90km away from Muzaffarabad, the capital of Azad Jammu and Kashmir. It is famous for its natural beauty, the sky-touching mountains covered with white snow, and flowing blue rivers at the bottom of these mountains. The whole valley is surrounded by greenery. The reflection of the blue colour sky on the blue color flowing rivers and lakes with many shades of nature make this land to look like a heaven on the earth.

Having no airport facility for the tourists, they have to manage by roads. To enjoy every moment and to watch the splendidness of this valley you must either know before which areas you must go to, or you need a complete tour guide.

SCOPE OF THE OPERATIONS

Initially, Our company will offer its services to the District Neelum northeast part of the Muzaffarabad, Azad Kashmir. The main touristic areas include:

- Upper Neelum.
- Kutton Jagran Valley
- Sharda
- Kel and Arrang Kel
- Ratti Gali Lake
- Toabutt

INITIAL INVESTMENT

The company will be registered online with the security and exchange commission of Pakistan. The initial fee calculated for incorporating a company online is Rs. 1000 for the capital value of Rs. 100,000. The estimated cost of making a website for our company is Rs. 10000. The initial advertisement cost is Rs. 10000. Contingency cost of Rs. 14000 is saved for unforeseen events. Space, other assets, and utilities are provided by the Business Incubation Centers. All the transportation and hoteling for the operation of the business is outsourced.

The total estimated initial investment of Rs. 35000 is needed for this project.

RETURN ON INVESTMENT (ROI)

ROI_{year1} = 129%

Budgeted Cost for One Person

Cost Description for one person	Amount (Rs.)
Transportation Cost For 1 Person Per Days:	5000
Fuel Cost For 1person Per Day	4000
Drivers Cost Per Day	1500
Tour Guide Cost Per Day	1500
Miscellaneous Expenses	1000
Accommodation Cost Per Day	4000
Service Charges Per Person	**1000**
Professional Photographer's Cost	2000
Total Cost	**20000**

Budgeted Cost for 3 Persons

Cost Description For 3 Person	Amount (Rs.)/ day	3 days cost(Rs)
Transportation Cost For 1 Person Per Days:	5000	15000
Fuel Cost For 1person Per Day	4000	12000
Drivers Cost Per Day	1500	4500
Tour Guide Cost Per Day	1500	4500
Miscellaneous Expenses	1000	3000
Accommodation Cost Per Day	12000	36000
Service Charges Per Person	**3000**	**9000**
Professional Photographer's Cost	2000	6000
Total Cost	**30000**	**90000**
Cost Per Person Per Day	10000	30000

Projected Operations and Cash Flows

	projected 3 person & 3 days tour											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2021				4	3	3	2	2	1			
2022					6	8	12	9	7			

	projected cash inflows											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2021	-35,000	0	0	12,000	9,000	9,000	6,000	6,000	3,000	0	0	0
2022	0	0	0	0	18,000	24,000	36,000	27,000	21,000	0	0	0

NET-PRESENT VALUE of cash flows for two years period at 12% required rate of return is as follows

$$\text{NPV}_{year1} = \quad \text{PKR 7,800}$$
$$\text{NPV}_{year1-2} = \quad \text{PKR 112,030}$$

PAYBACK PERIOD

An initial investment of 35000 is estimated to be recovered in 3 months and 25 days

PERCEIVED VALUE:

Neelum is one of the Most crowded touristic places in Kashmir. On Average 750,000 tourist visit it every year in the summer. The transportation and accommodation are the biggest problems in the area. Now many of the real estate investors are working there to grab this opportunity. In the peak times, homes of the local population are also rented out for the tourists' stay. Out local contacts with the private transporters and the hotels and the local community make it possible that we can get rid of this problem if we carefully plan the trip. Most of the Tourists belong to the high- and mid-income level group. Without a tour guide, you cannot see a complete picture of nature in these areas. And a professional photographer is one who is always available to the tourists to capture their precious moments. Rs. 30,000 is a justified cost for three days trip.

MARKET SIZE

On average 750,000 tourists are visiting these above-mentioned places. About 4% of these tourists are using the services of the private tour operators constituting 35000 people. With our profit margin for one person, if the whole tourists are covered by our service the company can earn Rs. 35million a year. Only capturing 4% of the tourists using tour operators can benefit the company with Rs. 1.4 million a year.

INNOVATIVENESS

Our local contacts with the transporters and the hotels and our low service charges have made it possible that we can offer our services to the customers at lower prices. We are offering the same services but with approximately 35% less cost to the customers. The innovative level for these services are significantly novel that put this project in the second level of novelty.

LONG TERM RESOURCE NEED

Full time working personal Computer.
Company office (after 6 months)
Company website
B2B interactive software and communication channel.

SHORT TERM RESOURCE NEED

Cash at hand
24/7 working office boys.

Appendix 3

Project Name: EV-Org

Project Background:

Ev-Org is an event planning and management company. Based on the group of 4 students 2 from the management science department of the University of Azad Jammu and Kashmir and 2 from the arts and science department of the same university. The trend of organized events is the recent phenomenon in the locality of Muzaffarabad, Azad Kashmir. Being a capital city of Azad Jammu and Kashmir, Muzaffarabad is the center for any political and social event. Approximately 7 years before all the events are organized by the members of the community by themselves by outsourcing catering and

Target Market

The target market includes the corporate market and the social market. Inside the corporate market, our company will engage in the event planning for quarterly, semi-annually, and annual formal gathering of the employees and the gathering of the employees and the customers of the company. Besides these business corporates, our company will engage in the event management process of the non-government organizations for fundraising and social awareness programs.

The social market event planning and management include the planning and management for anniversary parties, weddings, and birthdays. In Muzaffarabad and convective areas, the trend for social events is increasing over time that in-turn is becoming one of the lucrative markets for the event management firms.

Besides these corporate and social markets, our firm will provide the services to the political gathering in the vicinity of Muzaffarabad and connective areas.

Scope of the Operations

Our event management firm will provide the services in the vicinity of Muzaffarabad and its connective areas. The selection of the venue will be the prime responsibility of the customers and all the cost negotiation for the venue selection will be borne by customers.

Our services will include:

1. Decoration of the stage for the event.
2. Lightening services

3. Seating arrangements

4. The time management for the specific events.

5. Provision of professional photographers and the movie makers

6. To provide catering and refreshment services.

7. The closing of the whole event.

Initial Investment

The initial investment with the cost descriptions are as follows

Cost Description	Cost (Rs)
Online registration of the company	1000
Website design	10,000
Marketing	10,000
Contingency	20,000
Social Media Promotion	7,000
Total Cost	48,000

All the goods and services will be outsourced except for the decoration of the primary location.

Cost Distribution for an Event

Cost Description for Corporate Event (4 Hours)	Cost (Rs)
Decoration of the stage for the event. • Backdrops (4.5m * 10m) Rs. 6000 • side columns (6m) Rs. 4000	10,000
Lightening services	5000
Seating arrangements	1000
service cost by organizer	**6000**
Temporary workers (10)	10000
Provision of professional photographers and the movie makers	5000
To provide the catering and refreshment services/ 50 person	16000
The closing of the whole event	2000
Total	**55,000**

Cost Description For Marriage Events (4 Hours/ 2 Days Each)	Cost (Rs)
Decoration of the stage for the event. 1. Backdrops (2.5m * 3m) Rs. 4000 2. Side columns (3m) Rs. 2000 3. Flowering Rs. 5000	11,000
Lightening services	5000
Seating arrangements	2000
service cost by organizer	5000
Temporary workers (3)	6000
Provision of professional photographers and the movie makers	10000
To provide the catering and refreshment services/ 50 person	
The closing of the whole event	2000
Total	**41,000**

Cost Description For Birthday Events (4 Hours)	Cost (Rs)
Decoration of the stage for the event. 1. Backdrops (2.m * 2.5m) Rs. 3000 2. side columns (3m) Rs. 2000 3. Balloons Rs. 1000 4. Flowering Rs. 2000	8,000
Mini lightening services	2000
Seating arrangements	2000
service cost by organizer	3000
Temporary workers (2)	2000
Provision of professional photographers and the movie makers	3000
To provide the catering and refreshment services/ 30 person	6000
The closing of the whole event	2000
Total	**28,000**

Cash flows

	Average projected cash flow											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2021	-48,000		0	4,000	4,000	8,000	4,000	4,000	8,000	4,000	8,000	16,000
2022	0	4,000	8,000	16,000	12,000	12,000	16,000	12,000	8,000	8,000	4,000	4,000

	Average Monthly Events											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2021				1	1	2	1	1	2	1	2	4
2022	0	1	2	4	3	3	4	3	2	2	1	1

Return on Investment

Return on Investment $(ROI)_{year=2021} = 125\%$

Net present Value: cash flows are discounted at a 12% rate of return for two years of operation.

$NPV_{2021} = PKR\ 7,941.01$
$NPV_{2022} = PKR\ 95,315.64$

Payback period

8 months and 8 days after the first operation of the business

Perceived Value

All of the types of events for which planning and management services are offered are inherently valuable to the customers. the cost of the events is justified in terms of their importance to the customers

Market share:

The total population of district Muzaffarabad is 650,370, according to the Census of 2017. According to Azad Kashmir statistical book 2019, on average of five years, 5500 marriages are happening each year in district Muzaffarabad. 294 NGOs are registered in district Muzaffarabad.

Innovativeness:

There are approximately 4 event management companies working in Muzaffarabad. we will offer our customers the interactive tool on over website where they can select and visualize the theme of the indoor and outdoor designs we offer. These efforts make continuous improvement in the existing services provided by other competitors.

Long term resources needed

A complete office with the necessary resources is needed where we can personally and virtually manage to communicate with our clients.

Short term resources needed

Temporary skilled and unskilled human Resource is needed to manage different parts of the event.

Appendix 4

Decision-Makers Pairwise Preferences

Left Criterion	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Right Criterion
Initial Investment	9	8	7	✱	5	4	3	2	1	2	3	4	5	6	7	8	9	Return on Investment
Initial Investment	9	8	7	✱	5	4	3	2	1	2	3	4	5	6	7	8	9	Net Present Value
Initial Investment	9	8	✱	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Payback Period
Initial Investment	9	✱	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Perceived Value
Initial Investment	9	8	7	✱	5	4	3	2	1	2	3	4	5	6	7	8	9	Market Share
Initial Investment	9	8	✱	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Innovativeness
Initial Investment	9	✱	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Long term resources
Initial Investment	9	✱	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Short-term Resources
Return on Investment (ROI)	9	8	7	6	✱	4	3	2	1	2	3	4	5	6	7	8	9	Net Present Value
ROI	9	8	7	6	✱	4	3	2	1	2	3	4	5	6	7	8	9	Payback Period
ROI	9	8	7	6	5	4	3	2	✱	2	3	4	5	6	7	8	9	Perceived Value
ROI	9	8	7	6	5	4	✱	2	1	2	3	4	5	6	7	8	9	Market Share
ROI	9	8	7	6	5	4	✱	2	1	2	3	4	5	6	7	8	9	Innovativeness
ROI	9	8	7	6	5	✱	3	2	1	2	3	4	5	6	7	8	9	Long term resources
ROI	9	8	7	6	5	4	✱	2	1	2	3	4	5	6	7	8	9	Short-term Resources
Net Present Value	9	8	7	6	5	4	3	2	1	2	✱	4	5	6	7	8	9	Payback Period
Net Present Value	9	8	7	6	5	4	3	2	1	2	3	4	✱	6	7	8	9	Perceived Value
Net Present Value	9	8	7	6	5	4	3	2	1	✱	3	4	5	6	7	8	9	Market Share
Net Present Value	9	8	7	6	5	4	3	2	1	2	✱	4	5	6	7	8	9	Innovativeness
Net Present Value	9	8	7	6	5	4	3	2	1	2	3	4	✱	6	7	8	9	Long term resources
Net Present Value	9	8	7	6	5	4	3	2	1	2	3	✱	5	6	7	8	9	Short-term Resources
Payback Period	9	8	7	6	5	4	3	2	1	2	3	4	✱	6	7	8	9	Perceived Value
Payback Period	9	8	7	6	5	4	3	2	1	2	✱	4	5	6	7	8	9	Market Share
Payback Period	9	8	7	6	5	4	3	2	✱	2	3	4	5	6	7	8	9	Innovativeness
Payback Period	9	8	7	6	5	4	3	2	1	2	✱	4	5	6	7	8	9	Long term resources
Payback Period	9	8	7	6	5	4	3	2	1	2	3	✱	5	6	7	8	9	Short-term Resources
Perceived Value	9	8	7	6	5	✱	3	2	1	2	3	4	5	6	7	8	9	Market Share
Perceived Value	9	8	7	6	5	4	3	2	✱	2	3	4	5	6	7	8	9	Innovativeness
Perceived Value	9	8	7	6	5	4	3	✱	1	2	3	4	5	6	7	8	9	Long term resources
Perceived Value	9	8	7	6	5	✱	3	2	1	2	3	4	5	6	7	8	9	Short-term Resources
Market Share	9	8	7	6	5	4	3	2	✱	2	3	4	5	6	7	8	9	Innovativeness
Market Share	9	8	7	6	5	4	3	2	1	✱	3	4	5	6	7	8	9	Long term resources
Market Share	9	8	7	6	5	4	3	2	1	✱	3	4	5	6	7	8	9	Short-term Resources
Innovativeness	9	8	7	6	5	4	3	2	1	✱	3	4	5	6	7	8	9	Long term resources
Innovativeness	9	8	7	6	5	4	3	2	1	✱	3	4	5	6	7	8	9	Short-term Resources
Long term resources	9	8	7	6	5	4	3	2	1	✱	3	4	5	6	7	8	9	Short-term Resources

Prof. Dr. Ahmet BR

Criterion	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Criterion
Initial Investment	9	8	7	**(6)**	5	4	3	2	1	2	3	4	5	6	7	8	9	Return on Investment
Initial Investment	9	8	**(7)**	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Net Present Value
Initial Investment	9	**(8)**	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Payback Period
Initial Investment	9	8	**(7)**	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Perceived Value
Initial Investment	9	8	**(7)**	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Market Share
Initial Investment	9	8	7	**(6)**	5	4	3	2	1	2	3	4	5	6	7	8	9	Innovativeness
Initial Investment	9	8	**(7)**	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Long term resources
Initial Investment	9	8	7	**(6)**	5	4	3	2	1	2	3	4	5	6	7	8	9	Short-term Resources
Return on Investment (ROI)	9	8	7	6	5	4	**(3)**	2	1	2	3	4	5	6	7	8	9	Net Present Value
ROI	9	8	7	6	5	4	**(3)**	2	1	2	3	4	5	6	7	8	9	Payback Period
ROI	9	8	7	6	5	4	3	2	**(1)**	2	3	4	5	6	7	8	9	Perceived Value
ROI	9	8	7	6	5	4	**(3)**	2	1	2	3	4	5	6	7	8	9	Market Share
ROI	9	8	7	6	5	4	**(3)**	2	1	2	3	4	5	6	7	8	9	Innovativeness
ROI	9	8	7	6	5	4	**(3)**	2	1	2	3	4	5	6	7	8	9	Long term resources
ROI	9	8	7	6	5	4	3	2	**(1)**	2	3	4	5	6	7	8	9	Short-term Resources
Net Present Value	9	8	7	6	5	4	3	2	1	**(2)**	3	4	5	6	7	8	9	Payback Period
Net Present Value	9	8	7	6	5	4	3	2	1	2	3	**(4)**	5	6	7	8	9	Perceived Value
Net Present Value	9	8	7	6	5	4	3	2	1	2	**(3)**	4	5	6	7	8	9	Market Share
Net Present Value	9	8	7	6	5	4	3	2	1	2	**(3)**	4	5	6	7	8	9	Innovativeness
Net Present Value	9	8	7	6	5	4	3	2	1	2	3	**(4)**	5	6	7	8	9	Long term resources
Net Present Value	9	8	7	6	5	4	3	2	1	**(2)**	3	4	5	6	7	8	9	Short-term Resources
Payback Period	9	8	7	6	5	4	3	2	1	2	3	4	**(5)**	6	7	8	9	Perceived Value
Payback Period	9	8	7	6	5	4	3	2	1	2	3	**(4)**	5	6	7	8	9	Market Share
Payback Period	9	8	7	6	5	4	3	2	1	2	**(3)**	4	5	6	7	8	9	Innovativeness
Payback Period	9	8	7	6	5	4	3	2	1	2	**(3)**	4	5	6	7	8	9	Long term resources
Payback Period	9	8	7	6	5	4	3	2	1	2	3	4	**(5)**	6	7	8	9	Short-term Resources
Perceived Value	9	8	7	6	5	4	3	**(2)**	1	2	3	4	5	6	7	8	9	Market Share
Perceived Value	9	8	7	6	5	4	3	**(2)**	1	2	3	4	5	6	7	8	9	Innovativeness
Perceived Value	9	8	7	6	5	4	3	2	**(1)**	2	3	4	5	6	7	8	9	Long term resources
Perceived Value	9	8	7	6	5	**(4)**	3	2	1	2	3	4	5	6	7	8	9	Short-term Resources
Market Share	9	8	7	6	5	4	3	**(2)**	1	2	3	4	5	6	7	8	9	Innovativeness
Market Share	9	8	7	6	5	4	3	**(2)**	1	2	3	4	5	6	7	8	9	Long term resources
Market Share	9	8	7	6	5	4	3	**(2)**	1	2	3	4	5	6	7	8	9	Short-term Resources
Innovativeness	9	8	7	6	5	4	3	2	**(1)**	2	3	4	5	6	7	8	9	Long term resources
Innovativeness	9	8	7	6	5	4	3	2	1	2	**(3)**	4	5	6	7	8	9	Short-term Resources
Long term resources	9	8	7	6	5	4	3	2	1	2	3	4	**(5)**	6	7	8	9	Short-term Resources

Prof. Dr Harun Sönmez

Criterion	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Criterion
Initial Investment	9	8	7	6	5	4	3	X	1	2	3	4	5	6	7	8	9	Return on Investment
Initial Investment	9	8	7	6	5	4	X	2	1	2	3	4	5	6	7	8	9	Net Present Value
Initial Investment	9	8	7	X	5	4	3	2	1	2	3	4	5	6	7	8	9	Payback Period
Initial Investment	9	8	7	6	5	X	3	2	1	2	3	4	5	6	7	8	9	Perceived Value
Initial Investment	9	8	7	6	X	4	3	2	1	2	3	4	5	6	7	8	9	Market Share
Initial Investment	9	8	7	6	5	4	X	2	1	2	3	4	5	6	7	8	9	Innovativeness
Initial Investment	9	8	7	6	5	X	3	2	1	2	3	4	5	6	7	8	9	Long term resources
Initial Investment	9	8	7	6	X	4	3	2	1	2	3	4	5	6	7	8	9	Short-term Resources
Return on Investment (ROI)	9	8	7	6	X	4	3	2	1	2	3	4	5	6	7	8	9	Net Present Value
ROI	9	8	7	6	5	4	X	2	1	2	3	4	5	6	7	8	9	Payback Period
ROI	9	8	7	6	5	4	3	2	X	2	3	4	5	6	7	8	9	Perceived Value
ROI	9	8	7	6	5	4	3	X	1	2	3	4	5	6	7	8	9	Market Share
ROI	9	8	7	6	5	4	X	2	1	2	3	4	5	6	7	8	9	Innovativeness
ROI	9	8	7	6	5	4	3	X	1	2	3	4	5	6	7	8	9	Long term resources
ROI	9	8	7	6	5	4	X	2	1	2	3	4	5	6	7	8	9	Short-term Resources
Net Present Value	9	8	7	6	5	4	3	2	1	X	3	4	5	6	7	8	9	Payback Period
Net Present Value	9	8	7	6	5	4	3	2	1	2	3	X	5	6	7	8	9	Perceived Value
Net Present Value	9	8	7	6	5	4	3	2	X	2	3	4	5	6	7	8	9	Market Share
Net Present Value	9	8	7	6	5	4	3	2	1	2	X	4	5	6	7	8	9	Innovativeness
Net Present Value	9	8	7	6	5	4	3	X	1	2	3	4	5	6	7	8	9	Long term resources
Net Present Value	9	8	7	6	5	4	3	2	1	X	3	4	5	6	7	8	9	Short-term Resources
Payback Period	9	8	7	6	5	4	3	2	1	2	3	X	5	6	7	8	9	Perceived Value
Payback Period	9	8	7	6	5	4	3	2	1	2	X	4	5	6	7	8	9	Market Share
Payback Period	9	8	7	6	5	4	3	X	1	2	3	4	5	6	7	8	9	Innovativeness
Payback Period	9	8	7	6	5	4	3	2	1	2	X	4	5	6	7	8	9	Long term resources
Payback Period	9	8	7	6	5	4	3	2	1	2	3	X	5	6	7	8	9	Short-term Resources
Perceived Value	9	8	7	6	5	4	X	2	1	2	3	4	5	6	7	8	9	Market Share
Perceived Value	9	8	7	6	5	X	3	2	1	2	3	4	5	6	7	8	9	Innovativeness
Perceived Value	9	8	7	6	5	X	3	2	1	2	3	4	5	6	7	8	9	Long term resources
Perceived Value	9	8	7	6	5	4	X	1	2	3	4	5	6	7	8	9		Short-term Resources
Market Share	9	8	7	6	5	4	X	1	2	3	4	5	6	7	8	9		Innovativeness
Market Share	9	8	7	6	5	4	X	1	2	3	4	5	6	7	8	9		Long term resources
Market Share	9	8	7	6	5	4	3	X	2	3	4	5	6	7	8	9		Short-term Resources
Innovativeness	9	8	7	6	5	4	3	2	X	2	3	4	5	6	7	8	9	Long term resources
Innovativeness	9	8	7	6	5	4	3	2	X	3	4	5	6	7	8	9		Short-term Resources
Long term resources	9	8	7	6	5	4	3	2	1	2	3	4	5	X	7	8	9	Short-term Resources

Assoc. Prof. Sinan Aydın

Criterion	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Criterion
Initial Investment	9	8	α	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Return on Investment
Initial Investment	9	8	7	6	α	4	3	2	1	2	3	4	5	6	7	8	9	Net Present Value
Initial Investment	9	8	7	6	α	4	3	2	1	2	3	4	5	6	7	8	9	Payback Period
Initial Investment	9	8	7	6	5	α	3	2	1	2	3	4	5	6	7	8	9	Perceived Value
Initial Investment	9	8	7	6	α	4	3	2	1	2	3	4	5	6	7	8	9	Market Share
Initial Investment	9	8	7	α	5	4	3	2	1	2	3	4	5	6	7	8	9	Innovativeness
Initial Investment	9	8	7	6	α	4	3	2	1	2	3	4	5	6	7	8	9	Long term resources
Initial Investment	9	8	7	6	5	4	α	2	1	2	3	4	5	6	7	8	9	Short-term Resources
Return on Investment (ROI)	9	8	7	6	5	4	3	2	1	α	3	4	5	6	7	8	9	Net Present Value
ROI	9	8	7	6	5	4	3	2	1	2	α	4	5	6	7	8	9	Payback Period
ROI	9	8	7	6	5	4	3	2	1	α	3	4	5	6	7	8	9	Perceived Value
ROI	9	8	7	6	5	4	3	2	1	α	3	4	5	6	7	8	9	Market Share
ROI	9	8	7	6	5	4	3	2	1	2	α	4	5	6	7	8	9	Innovativeness
ROI	9	8	7	6	5	4	3	2	1	2	3	α	5	6	7	8	9	Long term resources
ROI	9	8	7	6	5	4	3	2	1	2	3	4	α	6	7	8	9	Short-term Resources
Net Present Value	9	8	7	6	5	4	3	2	1	α	3	4	5	6	7	8	9	Payback Period
Net Present Value	9	8	7	6	5	4	3	α	1	2	3	4	5	6	7	8	9	Perceived Value
Net Present Value	9	8	7	6	5	4	α	2	1	2	3	4	5	6	7	8	9	Market Share
Net Present Value	9	8	7	6	5	4	3	2	1	α	3	4	5	6	7	8	9	Innovativeness
Net Present Value	9	8	7	6	5	4	3	2	1	2	3	4	α	6	7	8	9	Long term resources
Net Present Value	9	8	7	6	5	4	3	2	1	2	α	4	5	6	7	8	9	Short-term Resources
Payback Period	9	8	7	6	5	4	3	2	1	2	3	4	α	6	7	8	9	Perceived Value
Payback Period	9	8	7	6	5	4	3	2	1	α	3	4	5	6	7	8	9	Market Share
Payback Period	9	8	7	6	5	4	3	2	1	2	α	4	5	6	7	8	9	Innovativeness
Payback Period	9	8	7	6	5	4	3	2	1	α	3	4	5	6	7	8	9	Long term resources
Payback Period	9	8	7	6	5	4	3	2	1	2	α	4	5	6	7	8	9	Short-term Resources
Perceived Value	9	8	7	6	α	4	3	2	1	2	3	4	5	6	7	8	9	Market Share
Perceived Value	9	8	7	6	5	4	α	2	1	2	3	4	5	6	7	8	9	Innovativeness
Perceived Value	9	8	7	6	5	4	3	α	1	2	3	4	5	6	7	8	9	Long term resources
Perceived Value	9	8	7	6	5	4	3	α	1	2	3	4	5	6	7	8	9	Short-term Resources
Market Share	9	8	7	6	5	4	3	2	1	2	α	4	5	6	7	8	9	Innovativeness
Market Share	9	8	7	6	5	4	3	2	1	2	3	4	α	6	7	8	9	Long term resources
Market Share	9	8	7	6	5	4	3	2	1	2	3	4	α	6	7	8	9	Short-term Resources
Innovativeness	9	8	7	6	5	4	3	2	1	2	α	4	5	6	7	8	9	Long term resources
Innovativeness	9	8	7	6	5	4	3	2	1	α	3	4	5	6	7	8	9	Short-term Resources
Long term resources	9	8	7	6	5	4	3	2	1	α	3	4	5	6	7	8	9	Short-term Resources

Assist. Prof. Seray Lezhi

Appendix 5

R-code to generate TOPSIS Results (using AHP weights)

```
MyTopsis<-function(decision=NULL,weights=NULL,impacts=NULL){
  #Establish a performance matrix----
  decision=decision
# attributes for different matrices
  if(missing(weights))
    stop("'weights' must be a numeric vector")
  if(missing(impacts))
    stop("'impacts' must be a character vector")

  if(length(weights) != ncol(decision))
    stop("length of 'weights' is not equal to number of columns")
  if(length(impacts) != ncol(decision))
    stop("length of 'impacts' is not equal to number of columns")
  if(! all(weights > 0))
    stop("weights must be positive numbers")
  if(! is.character(impacts))
    stop("impacts must be a character vector of '+' and '-' signs")
  if(! all(impacts == "+" | impacts == "-"))
    stop("impacts must be only '+' or '-' sign")


  #Normlize the decision matrix----
  Normalized_Matrix<-t(t(decision)/sqrt(colSums(decision^2)))
  Normalized_Matrix

  #calculate the weighted normalized decision matrix----
  weights=weights

  weighted_Matrix<-t(t(Normalized_Matrix)*weights)
  weighted_Matrix



  #Calculate the positive ideal(PIS) and negative ideal solution(NIS----
  #maxi<-apply(weighted_Matrix,2,max)
  PIS<-as.integer(impacts == "+") * apply(weighted_Matrix, 2, max) +
    as.integer(impacts == "-") * apply(weighted_Matrix, 2, min)
  PIS
  #mini<-apply(weighted_Matrix,2,min)
  NIS<- as.integer(impacts == "-") * apply(weighted_Matrix, 2, max) +
    as.integer(impacts == "+") * apply(weighted_Matrix, 2, min)
  NIS
  #Calculate the separation Measure Positive separation meassure (PSM),Negative sepatation
Measure (NSM)----
  #it is calculated by measuring the sqrt of sum of (each of criteria row-PIS or NIS)
  #=SQRT((SUM((M2-Q2)^2+(N2-R2)^2+(O2-S2)^2)))

  PSM<-sqrt(rowSums(t(t(weighted_Matrix)-PIS)^2))
  PSM
  NSM<-sqrt(rowSums(t(t(weighted_Matrix)-NIS)^2))
  NSM
  #Calculate the relative closeness to the ideal solution----
  #Rank the prefernce order----
  relative_closeness<-NSM/(PSM+NSM)
```

```
    relative_closeness
     #Ranking: for decesding order use - singn with the data
   Rank<- rank(-relative_closeness)

   return(list(NORMALIZED.MATRIX=Normalized_Matrix,
           WEIGHTED.MATRIX=weighted_Matrix,


           RELATIVE.CLOSENESS=relative_closeness,
           RANK=Rank))

}
# decision= the file in csv format containing your criteria in the coloumns and alternatives in rows
#weights should be a vector containing the elements equal to number of criteria
#impact= a character vactor equal to the number of criteria, "+" sign represent the benefit criteria
and "-" represents the cost criteria (whose minimum value is beneficial for evaluating project)
setwd("d:/r")
myfile<-read.csv("my_projects.csv")
row.names(myfile)<-
c("project1","project2","project3","project4","project5","project6","project7","project8","project9","proje
ct10")
impact<-c("-","+","+","-","+","+","+","-","-")
weightage<-c(0.376,0.091,0.037,0.041,0.145,0.063,0.063,0.078,0.106)
Mytopsisresults<-MyTopsis(myfile,weightage,impact)
Mytopsisresults
write.table(Mytopsisresults,file = "a.csv",sep = ",",row.names = TRUE, col.names = TRUE)
```

Curriculum Vitae

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Academic Qualification

Institute	Degree	Key courses	year
COMSATS(Islamabad)	MS (project Management)	• Advance project management • Project constraints management • Risk and quality management, • Software project management • Quantitative techniques • Statistical inferences	2013-2015
University of AJ&K	MBA (Finance)	• Financial Management • Marketing Management • Human resource management • Cost Accounting	2010-2012
University of AJ&K	BSc	• Statistics • Economics • Geography	2006-2008
ICAP	CA (Foundation)	• Financial Accounting • Business Mathematics and Statistics • Business Economics	2005-2006

EXPERIENCE:

1. Lecturer in University of Azad Jammu and Kashmir since May,2016

2. Two-year research experience for Ph.D. thesis titled" Hybrid Multiple Criteria Decision Analysis in Evaluation of Business Ideas by Entrepreneurs In Incubation

3. One-year research experience for MS thesis research project titled "Cost Overrun Factors in Post-Earth-Quake Construction Projects of Azad Kashmir"

4. Eight months experience as a sole distributor of Amir Rice Trader in district Muzaffarabad

5. Two-month practical experience as an internee in Meezan bank (pvt) limited Madina market branch, Muzaffarabad, Azad Kashmir.