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EFFECTIVE STRATEGIC BUSINESS PROBLEM ANALYSIS THROUGH ALGEBRAIC METHODS AND MECE FRAMEWORK

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Abstract:
This article proposes a new method for solving complex business problems by combining algebraic methods with MECE principles. MECE stands for Mutually Exclusive, Collectively Exhaustive, and it emphasizes the importance of dividing a problem into non-overlapping and comprehensive parts. The algebraic method involves using mathematical equations and symbols to represent variables and relationships in the problem.
The article argues that by combining these two approaches, businesses can gain a deeper understanding of complex problems and develop more effective solutions. The algebraic method helps to structure the problem and identify key relationships, while MECE principles ensure that all possible causes and solutions are considered. The article outlines a step-by-step guide for applying this combined method. The article also includes a case study to illustrate how this method can be used in practice.
This article provides a valuable framework for businesses looking to improve their problem-solving capabilities. By combining algebraic methods with MECE principles, businesses can gain a more structured and comprehensive approach to solving complex problems.

Keywords: Algebraic methods, MECE principles, Problem-solving, Complex problems, Business case

INTRODUCTION

The scope of this study is the problem analysis process for finding the optimal solution, which will be implemented for typical problems such as cost minimization and profit maximization. The context of the problems consists of the basic theory of the problems, and the problem results are more complex and actual. It will cover various methods to solve a system of linear equations, especially for special cases or certain conditions that haven't been described in a general algebraic method. Both problems above can be solved by vast methods, but our study will only focus on finding the best solution based on the problem constraints by utilizing the simplex method. This study uses model development based on the definition by ASEM, where the model will be created using an algebraic equation with decision variables and will try to find the best solution to the stated problem.
This study focuses on problem solving based on algebraic methods in the broader context of engineering economic analysis. The main purpose of this study is to provide enhancements to reduce the cost and time consumption of the problem solving process. Another purpose is to make engineering economic analysis problems easier for students or users without an engineering economic background. Additionally, the result of the process is expected to enable the decision maker to choose the best solution that satisfies the constraints.

1.1 Purpose of the Study

The objective of this qualitative research is to establish a case for a new class of problems in business and industry and to develop a comprehensive problem analysis methodology with a special emphasis on problems in business. Problems are not constant or repetitive in nature. They are chiefly of two types: ill-defined and special cases. Ill-defined problems are erratic in nature and symptoms are far from the cause. These symptoms may affect one or many elements of the business organization or its environment. It is possible that effects are intertwined and scattered. At times, the problem is so complex that the decision maker may not be clear about the problem. On the other hand, there are many repetitive problems that businesses face. Techniques or algorithms are available to solve them. But even if a special case is solved, it may not lead to a solution of the original problem. The cause and effect factor is perhaps not considered and there is no a priori function between decision and problem. The known techniques do not cover these scenarios. This method aims to fill these gaps and provide a guide to the decision maker and problem solver.

The foregoing statement of MECE principles and their implications in problem analysis already establishes a case for a systematic methodology. In the following sections, we have substantially addressed the "how" part of these principles. An astute reader will see the implications and ideas may be floating with the section titles only. This is the broad stroke methodology that is needed to solve the real problems. Last but not least, we have utilized algebra at many places to explain the concepts. The methodology is contained in the principles and practice would need the problem solver's intuition to translate it into questions and answers.

1.2 Scope of the Study

Key emphasis of the proposed study is to offer an alternative solution algorithm to resolving complex problems in business. The problems under consideration are well structured in nature and often come in the form of an equation. Traditional method of solving such problems involves interpreting the equation into a model, which will then be manipulated in order to get a solution. In proposing algorithmic method to problem solving, it is argued that the nature of problem can still be expressed as an equation. But in order to avoid extensive model building and manipulation, a more efficient solution can be derived by manipulating the equation into a certain form. Then the nature of the problem will dictate the form of the equation, the different forms will warrant different types of solution. An equation involving conditional proposition can be displayed in a truth table; a function of optimization problem can be expressed as Lagrange Multiplier equation etc. The abundance of problem types and corresponding equation forms do give rise to confusion as to which method should be employed. An alternative algorithm would aim to match problem equation with the various method forms in order to find an efficient solution. An immediate application of this alternative method of problem solving would be to teaching quantitative methods to first year undergraduate students. More often than not, the immediate emphasis to student is to understand method, rather than the nature of problem that method is supposed to resolve. It is not uncommon for students to be confused as to when a certain method should be employed. A method of the above manner could serve to illustrate to students with simple problems, the nature of the problem equation and the method in which the equation is manipulated to obtain the answer. Given the rather algorithmic nature of the method, it is arguable that computer aided learning tools can also be produced to help complement student learning.

THEORECTICAL FRAMEWORK

Algebraic Method (As shown in Table 2)

1. Overview of Algebraic Method

A problem can be attributed to the action which caused the undesired result. Hence, locating the action in terms of transformation is key to the problem cause. The problem can also be viewed at the end of the transformation as a difference to the result it was meant to achieve. [1]

The implementation of policy or decision is supposed to shift from the present to the future condition, from one scenario to another. This shift in decision is in the form of an action or series of actions and is termed as transformation. A problem occurs when there exists an undesirable difference between two future conditions of the same scenario. Hence, a problem is defined as the failure to reach the desired second condition of the scenario from the first one. This definition is well-suited to cause and effect analysis. [2]

AMA uses its own way to define a problem, where a problem is viewed and defined as the deviation of what is compared to what it ought to be. With an additional dimension, the state is defined to have two conditions: present and future. The future is viewed as a static condition, whereas the present condition is dynamic. [3][4]

2. Definition of Algebraic Method

In the algebraic method, a problem is identified by using several variables and then constructing a model of the problem with the use of mathematical equations or a system of equations using the variables. The model constructed should represent the true nature of the problem and must be well understood by the problem analyst. In our above-stated problem, the variables are revenue, cost, and profit; the revenue itself has 2 types which are increasing revenue with an increasing profit rate and the simplification of revenue to the trade-off with cost to increase the profit rate. Then, a model construction is started with constructing an equation for each type of variable and then combining them to form an equation that represents a change of profit at the end of the period. This system of equations can be constructed to a matrix or a simpler form such as this case to a linear equation between the variables with the change of profit as the slope. [5]

Algebraic method is widely known as a method which is applied for solving mathematical equations or linguistic sentences. However, the usage is extended into many key areas and one of it is a problem analysis in business. Suppose a problem occurs on how to speed up the profit rate of a company within a 2-year period from now. The ways to increase profit are quite a few and always involve a trade-off between long-term and short-term effects. Profit itself is a resultant of revenue and cost, an increment of profit can be achieved by increasing revenue, reducing cost, or both. To construct a clearer view of the problem, the algebraic method is used. [6]

3. Application of Algebraic Method in Problem Analysis

Using algebraic method, this problem and its causes can be expressed by functions. Let Y be the sales volume, X be the time elapsed since the product was introduced. Then the problem is to find the function Y=f(X). Assume that a major cause of low sales volume is the product being overpriced, where consumers feel it doesn't give them value received for money. This value perception can be represented by a utility function. Consumers will only buy the product when marginal utility equals marginal cost, where cost can be expressed as an MSK function. Combine these functions and perform market analysis will make it clear how price is affecting sales and the level of sales which will affect price, while considering alternatives in pricing strategy. This analysis provides a clear understanding of cause and effect and problem areas and can serve as a basis for practical countermeasures. This method integrates the previous analysis of a problem regarding sales data using regression analysis for curves and best fit lines, but is more flexible and still multiplies the tasks' effectiveness. The function will be often represented in graphical form using charts and graphs which provide visual aids. [7]

Imagine that people have been tasked with examining the reason behind the decrease in sales of a recently launched product. The traditional method of problem analysis involves collecting a substantial amount of information and sifting through it until the main problem areas become visible. However, this approach is time-consuming and requires a significant amount of effort, and there is a possibility that it may only provide a superficial understanding of the problem. [8]

This method provides the bridge between the problem analysis and the best practices for problem solution. All problems can be represented by relationships that are expressed by mathematical equations. This fact is one of the most important ideas of the method. When the analytic expression, such as cost functions, revenue functions, and performance functions, are built, use the operations of algebra and calculus to manipulate them. By doing this, it is possible to analyze the structure of problems deeply. [9]

4. Benefits of Using Algebraic Method

Higher-quality problem decomposition follows logically to better quality of solution. Good problem decomposition leads to the structured representation of the problem, which is the MECE tree. As is already clear, the process of transforming the unorganized problem into the structured tree forces us to consider all possible paths at least once, and once only. This inherently reduces the chance of oversight and hence leads to a comprehensive analysis. With regards to the solution phase, the MECE tree serves as a roadmap for identifying the various methods and possible solutions available at each level of the problem. This ensures that no stone is left unturned in the search for a solution. The nature of the MECE tree structure also simplifies the process of backtracking. Often we will find that a solution method is not appropriate, yet still salvage some of the work already done. This can be achieved with little waste of time and effort using the MECE tree. Finally, once a solution has been found, the MECE tree provides a clear way to trace back to the original problem, proving that the solution does indeed resolve the problem. This typically involves following one of the bottom level cause and effect chains up to the top. Overall, the use of algebraic method will add value to the analytical phase of the problem-solving process. [10]

Table 1. Overview of Algebraic Method

Reference	Key Points	Description of Algebraic Method	Benefits of Algebraic Method
[1] Heras-Saizarbitoria et al., 2022	A problem can be viewed as the difference between a desired and undesired state.	Uses mathematical equations to represent relationships between	Provides a structured approach to problem analysis.

		variables affecting a problem.	
[2] Katsaliaki et al., 2022	A problem arises when there's a gap between desired and actual future conditions.	Equations model the transformation from current to future state.	Allows for in-depth analysis of problem structure.
[3] Rahmanifar et al., 2023	Defines a problem as a deviation from the expected outcome.	Focuses on revenue, cost, and profit with variables and equations.	Improves problem decomposition leading to better solutions.
[4] Hauk et al., 2022	Algebraic methods are well-suited for solving mathematical equations.	Equations represent relationships between variables in a problem.	Provides a clear visual representation through charts and graphs.

MECE Principles (As shown in Table 2)

1. MECE Principles in Problem Analysis

Mece Principle helps in breaking down a complex problem into simple elements. The acronym MECE, having been coined at the "center" of a problem, represents an important quality that enables systematic problem solving. A problem can be broken down into multiple distinctive constructs when there is existence of a list of items under a common category. Mece Principle is needed to identify all the possible causes to the problem. Because, if the causes were not identified well, the problem cannot be solved effectively. Mece Principle gives a proper structure that helps in classifying and storing the information regarding the causes. An effective classification ensures that no cause is overlooked and every cause is assigned to only one category. This helps in avoiding confusion in the later stages and it enables clear identification of the causes during problem solving. Mece helps in identifying the comparison factors. This helps in comparing the causes or the alternative solutions to the problem. When the comparison factors are derived from the cause, it also ensures that the comparison is relevant and no irrelevant comparison factors are used. Finally, an effective problem solution requires a good evaluation of the cause and the result of the cause towards the problem. Mece Principle provides a good framework for this evaluation to be done. An evaluation tree can be drawn to evaluate the cause, and effects matrix can be used to compare the cause and the alternative solutions. [11]

2. Meaning of MECE Principles

If the MECE test is not passed, then it indicates that the problem has either been oversimplified or is not fully understood. If the MECE test is passed, then it becomes easier to create a structure for organizing the information and obtaining the solution. The structuring of the problem solution is the most important part of the problem analysis, as can be seen below. [12]

This principle states that if a problem is to be divided into sub-problems, then the division should be: 1. Mutually exclusive: This means that no two subproblems have any solution in common. In simple words, if A and B are two subproblems, then A's solution should not even partially solve problem B. 2. Collectively exhaustive: This means that the sub-problems should comprise all the possible ways of solving the original problem, with no overlap and no gap. In other words, we should not miss anything, and the union of all subproblems should solve the original problem and nothing more. [13]

3. Importance of MECE Principles in Business Case Analysis

MECE, an acronym, stands for Mutually Exclusive, Collectively Exhaustive. This is fundamental to help solve a problem in a logical way. MECE is a systematic analysis of a problem that uses a structured process similar to a decision tree. A decision tree is a graphical representation of the possible solutions to a problem. MECE forces the analysis to divide the problem into a set of separate and distinct components, then to create a solution for each part. MECE is being used in many fields to solve the problem, by using this method, it helps to solve the problem in an efficient way and reduce the occurrence of a problem from being repeated. MECE is a step-by-step approach in problem solving. MECE analysis is a very logical and step-by-step approach to help break down the details of a given problem. MECE will also provide a structured way to solve a problem and help to monitor the problem-solving progress easily. This is especially useful in a business case analysis where it will require a clear step and result for each problem and challenge faced. MECE also helps to distribute the work to members in a team and specialize the task to a person that is an expert in the specific area of the problem. This is effective as by solving each part of the problem and challenges faced, the overall problem-solving will decline down to the problem that was solved earlier. [14]

Table 2. MECE Principles

Reference	Key Points	MECE Definition	Importance of MECE Principles
[5] Wardat et al., 2023	MECE ensures no overlap or gaps when dividing a problem into sub-problems.	Mutually Exclusive: Sub-problems have no common elements. Collectively Exhaustive: Sub-problems encompass all aspects of the main problem.	Ensures a comprehensive analysis and avoids overlooking crucial aspects.
[6] Bandyopadhyay et al., 2021	MECE helps structure complex problems for better decision making.	Divides problems into distinct categories that leave no room for ambiguity.	Provides a logical step-by-step approach to problem solving.
[7] Closser et al., 2024	MECE helps identify all possible causes of a problem.	Ensures no cause is overlooked and each cause is assigned to a single category.	Leads to a more effective evaluation of causes and solutions.
[8] Rasheed et al., 2024	MECE facilitates the creation of a clear roadmap for problem solution.	Helps identify comparison factors for evaluating causes and solutions.	Simplifies backtracking and revising solutions if necessary.

Integration of Algebraic Method and MECE Principles (As shown in Table 3)

This step in total is the basis for Wood's discourse in the whole book. Basically, what the author is trying to do is combine two problem-solving methods to improve the method of analysis in business cases. MECE principles are a method employed to break down a large and complex problem into smaller and less complicated problems, eventually finding a solution to each. The results of these solutions are then combined to solve the larger problem. This method uses a tree structure to visualize the steps taken in the problem-solving process. MECE principles ensure that the steps taken do not overlap, and that all steps taken are necessary. It stresses the fact that there is always one right answer for every problem, and the goal is to eliminate confusion and reach that answer. MECE is probably most familiar to Economics students, as their diagrams are MECE structures. Algebraic methods are similar to microeconomics and algebra itself – to sum up business school most simply. These methods are "the use of symbols to represent numbers and quantities in formulae and equations," and "the construction of formulas and the manipulation of these formulas in a precise algebraic sense to obtain an overview of the problem and its solution." This is mainly used in basic business mathematics, but it is the systematic approach to representing the situation that can be a useful tool in problem analysis. Wood sees that MECE principles are essentially systematic and logical steps in problem solving, and by finding a way to represent these steps symbolically, this will improve the method and provide greater insight. He has coined this a "general theory method," and will cover more into detail on this by using the example of the car and gas problem in section 7. With step 4.1, the author has introduced his intentions for the rest of the book and has set the platform for the theories and arguments to come. [15]

1. Understanding the Intersection of Algebraic Method and MECE Principles

MECE is an approach to segment a case into various important parts to avoid overlap and ambiguity. An example would be the division of a market framework into mutually exclusive and completely exhaustive segments, such that no customer can buy products that correspond to two different segments, and there are no products customer can buy that will not be in some segment. This is a very powerful tool for structuring algebraic word problems, some of which are highly complex and fraught with possibilities for confusion of the real issue with extraneous information. Given the nature of algebra, quite often the result of an algebraic analysis will depend on how the problem is formulated and thus clarity on the true issues is crucial. MECE can also be applied in many cases to segment the solution process, organising it into parts that are easier to handle and where again there is no overlap of methods and no ambiguity as to which method applies to which part. [15]

A customer's wider marshalling regions could be abridged to mathematical notations or relationships, which afford a structure for analysing the assets involved and unequivocally showing how they affect each other. For example, the cause and effect association between sales of certain product and sales of a complementary product could be symbolised by a system of equations. Algebra is particularly useful for handling problems of optimisation and finding solutions of systems of equations can lead to the establishment of more or less concrete decision rules. For example, recently the marketing manager of a certain firm was able to increase sales of its product "A" from 8000 to 10000 units per month by spending an extra $500 on advertising. He was interested in deciding whether to further increase the sales of "A" by a price reduction $0.50 per unit. This sort of problem can be addressed with an objective of maximising the effectiveness of advertising dollars, the price reduction being a secondary tactic. [16]

2. Advantages of Combining Algebraic Method and MECE Principles

In the current global competitive business environment, specific methods are necessary to help young entrepreneurs sift through complexity and tension and make astute and timely decisions. Which is really an integrated set of problem-solving tools; a collection of methods that help to structure, add insight to a potentially confused situation, take decisions, and implement precise objectives. MECE (mutually exclusive and collectively exhaustive) on the other hand, is taken directly from algebra. It is a rigidly defined way of partitioning a set, helping to clarify and enumerate all possibilities. This can be done in two ways, by dividing the situations into pairs of alternatives, or by dividing the situations into specific, constrained variables. For two branches of mathematics to have compatibility to such a high degree outside the scope of maths is truly an uncommon event. One such illustration of algebraic method and MECE principles combining is found in game tree decision making. Games and decisions are broken down into trees of sequences of decisions. It is the best tool a game theorist has to outline possibilities in a compact and organized manner. Drawing game trees can often prove to be an unclear and complex process, and the result may not help much in actually making decisions. At this point, the decision-maker has often skipped a crucial analysis of his/her choices and has ended up trying to make an overall decision with no solid springboard. By defining one variable for making each move, and another for the choice that would play out in the event of revisiting the initial decision, the game tree can be succinctly summarized in an algebraic matrix. This can greatly increase the accessibility of the analyzed information and can sometimes even show the decision-maker that the game has an obviously bad/superior outcome. This tool is simply too good for the effort and precision it requires, and in a rather sad turn of events for the game tree, often makes it redundant. [17]

Table 3. Integration of Algebraic Method and MECE Principles

Reference	Key Points	Benefits of Combining Methods	Example of Integration
[9] Antons et al., 2023	MECE structures the problem, while Algebra allows for manipulation of variables.	Improves clarity and facilitates identification of the true issues.	Segmenting a market framework (MECE) and then using equations to analyze relationships between customer segments (Algebra).
[10] Rusche, 2023	MECE breaks down problems, and Algebra helps find optimal solutions.	Algebraic analysis results depend on problem formulation, so MECE ensures clarity.	Optimizing advertising spend through equations after segmenting customer base using MECE.
[11] Ding et al., 2024	MECE avoids overlap and ambiguity, while Algebra provides a precise approach.	Game tree decision making can be represented as an algebraic matrix for better analysis.	Representing game choices and outcomes with variables and using them to form a matrix.
[12] Bodha et al., 2023	MECE ensures all possibilities are considered, and Algebra allows for finding the best solution.	MECE helps structure complex problems like resource allocation for optimization problems.	Using MECE to identify factors affecting power grid optimization and then applying equations to find the best solution.

RESEARCH METHOD

This research investigates the potential of a combined approach using the Algebraic Method and MECE principles for complex business problem analysis. The methodology employed here focuses on a theoretical framework development through literature review and a practical demonstration via a case study.

Recent Researches Analysis: Many academic databases, including Springer, Elsevier, IEEE Xplore, Wiley, Taylor & Francis, Emerald, Sage, and Google Scholar from 2020 to 2024, were thoroughly searched by using keywords like "Algebraic Method", "MECE principles", "Business Problem Solving", and "Decision Making".

- A comprehensive review of relevant scholarly literature will be conducted to explore:
  - Existing applications of the Algebraic Method in business problem solving.
  - The use of MECE principles for problem analysis and decision making.
  - Theoretical foundations for integrating these two approaches.

Selection Process: Titles and abstracts will be screened to identify relevant studies. Selected articles will undergo a full-text review to ensure alignment with the research focus.

Development of the Combined Method:

- Based on the literature review findings, a step-by-step guide for applying the combined Algebraic Method and MECE principles will be developed.
- This guide will outline the process of:
  - Problem definition and decomposition using MECE principles.
  - Identifying key variables and relationships within the problem using the Algebraic Method.
  - Utilizing algebraic equations and models to analyze the problem structure.
  - Developing and evaluating potential solutions based on the combined analysis.

Case Study:

- To demonstrate the practical application of the combined method, a real-world complex business problem will be selected as a case study.
- Data collection for the case study may involve reviewing company documents, conducting interviews with key personnel, or gathering secondary data from relevant sources.
- The developed step-by-step guide will be applied to the chosen case study, showcasing the problem-solving process and potential benefits of the combined approach.

Evaluation:

- The effectiveness of the combined method will be evaluated based on its ability to:
  - Clearly structure and define the complex business problem.
  - Identify key factors and relationships influencing the problem.
  - Generate comprehensive and well-founded solutions.
- The case study analysis will serve as a preliminary assessment of the method's potential value.

This research method emphasizes a theoretical foundation built upon existing literature and a practical illustration through a case study. The findings will contribute to the development of a novel problem-solving framework for complex business scenarios.

FINDINGS

1. Step-by-Step Guide to Applying Algebraic Method with MECE Principles

Begin by defining the problem in the form of a question. Before moving ahead, it is important to understand what you are looking for. By defining the problem, we can then identify the goals we want to achieve. In this case, we formulate the question based on the given case. For instance, the questions are like "What is the effect of the changing price of cigarettes on consumers?" or "How can we increase the sales of a book?". These questions are then developed to be the parameters of the analysis. Make sure your questions are not vague and only have one interpretation. After we define the problem, we then define the scope of the problem or the boundaries of the analysis. This is important to prevent us from "wasted analysis". Wasted analysis occurs when we find that the questions are different or we confuse one question with another. This can be a result of having no boundaries in the problem and no references that show us the questions. [18]

Step 1: Define the Problem

This process can also be used to define the system when we are modeling a real-world problem. The system is the part of the real world we wish to model to help solve the problem. Often, the system can be defined with a boundary, and a system is generally a specific part of the real world. [19]

Compare the current and desired situation in order to find the differences and form the problem, and a plan can be made to achieve the desired situation. A problem can usually be narrowed down to one sentence. Try to suggest the steps that will lead to generate a plan.

Secondly, we can define the desired situation. It is here that we first decide if a problem is worth solving.

Firstly, state the current situation. This is a brief outline of the problem and its causes. In some cases, it is difficult to differentiate between the problem and the current situation. To differentiate a problem and the current situation, consider the difference the problem has made. If it hasn't made a difference, it isn't a problem. If the causes are not yet known, we can use a problem with an unknown cause. The cause, of course, is the difference between the current situation and the desired situation, i.e. the problem.

The problem definition is the most important step in problem solving. Often, if a problem is not correctly defined, it can be difficult to solve and can be a costly mistake. A problem is a difference between the actual situation and the desired situation. A problem can be solved if a plan can be made for resolving the difference. Allocating resources to resolve the problem should achieve the desired situation from the current situation. Hence, we need to define what the problem is. This can be achieved using the following process.

Step 2: Identify the Relevant Factors

Identification of factors may involve data collection and may lead you to end up making certain assumptions. Note down all the assumptions and constraints. These assumptions may later prove to be important at the stage of clarifying the problem and constraints. [20]

It is better to construct a mental or written outline of all the factors and their relationships to each other. For this purpose, we can use the fishbone tool.

Identify the relevant factors. This step may seem easy, but it is very crucial. In this case, it is divided into 3 stages:

Once again, apply the MECE principle to identify all factors that will affect these sub-factors of the main factor. For example, the cost of gardening can be affected by the availability of utilities such as water and electricity, and security can be affected by the law and order situation in surrounding areas.

Identify sub-factors of each main factor. This can be referred to as the "Breakdown of cost structure." For example, variable costs such as the cost of gardening and security, and fixed costs such as repairs and maintenance work.

Identify the main factors that keep these housing society maintenance costs higher than similar housing societies' maintenance costs. This can be referred to as the "Cause of higher maintenance costs."

Step 3: Formulate Algebraic Equations

The term "algebra" is used in this paper in a liberal sense to encompass all shorthand symbolism by which we express logical relations with numbers. In addition to familiar equations and inequalities, it includes such diverse forms as linear and matrix algebra, network notation, and logical analysis. In optimization problems, constrained or unconstrained, the entire problem from its data to its unknown solution can often be expressed as a single symbolic statement of the form maximize $Z = cTx$ subject to a set of conditions $Ax \leq b$. At other times, especially in games and multistage decisions, it is more appropriate to analyze the problem in fragments, each fragment leading to separate equations and the whole to a system of interrelated equations. Whether the problem is to be stated in the form of a programming model, equation system, or something else, is a matter of individual choice, but it is essential for the logic of subsequent analysis that the algebra chosen be faithful to the data and clearly oriented to the solution. [21]

At this point, a problem solver can often benefit greatly by interposing a diagram between the problem and its immediate algebraic formulation. In the case of an allocation or investment problem, for example, a simple tabular display can often serve to coordinate the data in the problem and lead directly to the algebra to follow. The tabular display can take many forms, but the cells of the table should represent homogeneous units for the decision variable in succeeding equations. If the decision variable xij represents the quantity of some resource i invested in some activity j, then the cell (i,j) of the table should represent the activity with its cost, profit, or what have you, in terms of one unit of i. Then xi, the ith row of the table, will be a vector whose jth component is xij, and the subsequent equations can generally be written by inspection of the table. The table is meant only to aid the formulation process, and when one becomes sufficiently adept at formulating algebraic equations, no tabular aid will be needed. [22]

General Formulation: Start by introducing a general formulation for optimization problems.
"Optimization problems, both constrained and unconstrained, can often be expressed in a single symbolic statement using linear algebra and matrix notation. For example:
Maximize $Z = c^T x$
Subject to:
$Ax \leq b$
Where:
Z represents the objective function to be maximized.
c is a vector of coefficients for the decision variables.
x is a vector of decision variables.
A is a matrix of coefficients for the constraints.
b is a vector of constraint values.
Marketing Case:
"In the marketing case study, the relationship between sales figures (MF1) and promotional efforts (TF), customer satisfaction (S), price (P), product quality (Q), and competition level (C) could be modeled as:
MF1 = f(TF, S, P, Q, C)

Further break down the factors into sub-factors and represent their relationships using additional equations. For instance, customer satisfaction could be a function of price and quality:

S = g(P, Q)

Operations Case:
"In the operations case study, the cost increase due to efficiency loss and production mistakes could be represented as:
Total Cost Increase = 3E + 5M
- Where E represents the efficiency loss and M represents the number of production mistakes.
- Introduce additional equations to represent the relationship between efficiency loss, employee motivation, and outsourcing costs.

Step 4: Solve the Equations
As a first example, consider the equation $s = 16t^2$. This equation is a relationship between a certain distance s and the time t taken to cover that distance by a moving object. We may or may not know the value of t, but if we wish to determine t, the equation gives us a method: squaring, then multiplying by 16. This gives us $s/16 = t^2$ and finally we extract the value of t by taking the positive square root $t = (s/16)^{(1/2)} = 1/1^2.s^{(1/2)} = 1/4.s^{(1/2)}$. [23]
Suppose the equation has only one unknown: The solution (if it exists) is a sequence of identities transforming the equation into the form x = a, where a is a known constant. These identities determine a sequence of operations on x and on numbers, leading to the value x = a.
Each equation derived from the problem manifests certain relationships among the knowns. The solution for the equations is a process of finding a certain value of the unknowns which satisfy the equations. The solution may or may not exist, and may or may not be unique. In any case, the equation gives us a way to relate the unknowns to each other and to the data given in the problem.
This step delves into the actual process of solving the equations formulated in Step 3. We will demonstrate the application of solution techniques using specific examples from the case studies.
Case Study 1: Marketing Problem
Scenario 1: Assuming the sales team's effort (TF) is increased while keeping other factors constant, we can analyze the impact on sales figures (MF1) using the equation:
MF1_new = f(TF_increased, S, P, Q, C)
Compare MF1_new with the original MF1 to assess the effectiveness of increasing promotional efforts.
Scenario 2: If the focus is on improving product price and quality, the equation becomes: MF1_new = f(TF, S_improved, P_improved, Q_improved, C)
Analyzing S_improved might involve a sub-equation like: S_improved = g(P_improved, Q_improved)

Depending on the specific function f, solving this equation might involve techniques like regression analysis, optimization algorithms, or sensitivity analysis to determine the optimal combination of price and quality improvements.

Case Study 2: Operations Problem Cost Minimization:
The goal is to minimize the total cost increase represented by:
Minimize: 3E + 5M
This may require setting up constraints based on available resources, production capacity, and quality standards. Linear programming techniques can be employed to find the optimal values of E and M that minimize the cost while satisfying the constraints. **Efficiency Analysis:** Analyzing the impact of employee motivation (M) and outsourcing (O) on efficiency loss (E) might involve an equation like: E = h(M, O)
Techniques like regression analysis or statistical modeling can be used to determine the relationship between these variables and find ways to improve efficiency.
General Techniques: System of Equations: If the problem involves a system of equations, techniques like substitution, elimination, or matrix operations can be used to solve for the unknowns.
Optimization Algorithms: For more complex problems involving constraints and multiple objectives, optimization algorithms such as linear programming, non-linear programming, or genetic algorithms can be employed to find the optimal solution.
Step 5: Analyze and Interpret the Results
Begin this step by reaffirming the problem and the major factors involved. This is an often overlooked and crucial step. To complete the analysis MECE-ly, the alternative ways to define the problem, and the factors affecting each way, should have been worked through in a logical and hierarchical manner during step 1 and 2. Now compare the results to the situation in real life. Often the differences are as or more important than the actual numerical results. Do the results make sense? If not, it may be necessary to go back to step 3 and revise the equations. This may be difficult and time consuming, but it is generally better to get equations which are a model of the real situation before moving on. Interpreting the results might involve looking for patterns in the solution. For example, do certain types of input result in an extremely high output? This might suggest that it is advantageous to get those inputs, just a small increase could lead to a lot more output. Or perhaps factor A has very little effect on the output, doing anything to try and effect a change in A may be a waste of time. An understanding of a set of equations can also be obtained without solving them, for example a large system of equations might contain lots of redundant repetitions so the set is actually relatively simple to solve. At the end of this step a decision needs to be made as to whether the model is good enough and sufficient for the next step, a decision can always be made to go back to a previous step and revise the work. If the decision is yes, then progress to step 6. [24]
Once the equations are solved, it is crucial to analyze and interpret the results within the context of the business problem and the MECE framework.

Case Study 1: Marketing Problem
- Analyze the changes in MF1 under different scenarios.
- Evaluate which strategy – increasing promotional effort or improving product price and quality – has a more significant impact on sales figures.
- Consider the cost-benefit analysis of each approach.
- Relate the findings back to the initial problem and the MECE breakdown of factors influencing sales figures.

Case Study 2: Operations Problem
- Evaluate the optimal values of E and M obtained from the cost minimization problem.
- Analyze the impact of employee motivation and outsourcing on efficiency and production mistakes.
- Translate the mathematical findings into actionable insights for improving operational efficiency and reducing costs.
- Consider the limitations of the model and potential real-world factors not captured in the equations.

General Interpretation:
- Validity of the Model: Assess whether the mathematical model accurately reflects the real-world business problem.

- Sensitivity Analysis: Analyze how changes in input variables affect the output. This helps in understanding the robustness of the solution and identifying critical factors.
- Decision-Making: Based on the analysis, provide recommendations and insights to support informed decision-making.

By thoroughly analyzing and interpreting the mathematical results, we can bridge the gap between theoretical calculations and practical solutions for complex business problems. This ensures that the insights gained from the algebraic analysis can be effectively translated into actionable strategies for achieving business objectives.

Step 6: Develop and Evaluate Solutions

Building upon the groundwork laid in the previous steps, Step 6 focuses on leveraging the combined power of the Algebraic Method and MECE principles to develop and evaluate potential solutions for the complex business problem.

6.1. Solution Development:

- **MECE-driven Brainstorming:** Utilize the MECE framework to brainstorm a comprehensive set of solutions. This involves:
  - **Identify Categories:** Break down the problem into distinct, non-overlapping categories based on the MECE analysis conducted in Step 2.
  - **Generate Solutions within Categories:** Brainstorm potential solutions within each category, ensuring they address the specific issues identified in that category.
  - **Consider Inter-category Solutions:** Explore solutions that might bridge gaps or create synergies between different categories.
- **Algebraic Modeling:** For each potential solution, translate relevant aspects of the problem and solution into algebraic models or equations. This might involve:
  - **Identifying Key Variables:** Pinpoint the critical variables influencing the solution's effectiveness (e.g., cost, resources, market share).
  - **Building Equations:** Develop equations that represent the relationships between these variables within the context of the solution.
  - **Scenario Analysis:** Utilize the models to explore different scenarios and predict potential outcomes of each solution. This allows for a more informed evaluation.

6.2. Solution Evaluation:

- **MECE-based Evaluation:** Evaluate each solution through the lens of MECE principles:
  - **Mutual Exclusivity:** Ensure solutions address distinct aspects of the problem and don't overlap in functionality.
  - **Collectively Exhaustive:** Confirm all relevant categories and potential solutions within the problem space have been considered.
  - **Cost-Benefit Analysis:** Conduct a cost-benefit analysis for each solution using the algebraic models. This involves:
    - Estimating the costs associated with implementing the solution (e.g., financial resources, time investment).
    - Quantifying the potential benefits of the solution using the developed models (e.g., increased revenue, improved efficiency).
    - Comparing costs and benefits to identify the most cost-effective solution.
- **Multi-criteria Decision Making:** Consider additional factors beyond cost and benefit. This might involve:
  - **Alignment with Business Objectives:** Ensure the solution aligns with the organization's overall strategic objectives.
  - **Implementation Feasibility:** Evaluate the practical feasibility of implementing the solution (e.g., resource availability, employee buy-in).
  - **Risk Assessment:** Analyze potential risks associated with each solution and develop mitigation strategies.

6.3. Selection and Refinement:

Based on the combined evaluation using MECE principles, cost-benefit analysis, and multi-criteria decision making, select the most promising solution(s). The algebraic models can be further refined at this stage to optimize the chosen solution(s) by:

- **Sensitivity Analysis:** Perform sensitivity analysis to understand how changes in key variables might affect the solution's outcome. This helps identify areas for potential adjustments.
- **Fine-tuning the Model:** Based on the sensitivity analysis, refine the algebraic models to optimize the solution for the desired outcomes.

This step emphasizes a structured approach to solution development and evaluation. By combining the strengths of MECE principles and the Algebraic Method, businesses can generate a comprehensive set of solutions and make informed decisions based on a deeper understanding of the problem and potential outcomes.

2. Case Studies Analysis

This case is a clear demonstration of the effectiveness of breaking down a problem into parallel structures in order to allow clear answers and with a complex method in terms of easy-to-understand questions and answers.

Using substitution of variables, Anand showed that the 2 sets of scenarios would allow the solution to the regrettable actions being the difference between the 2 option variables and thus would lead to a comprehension of whether the problem was still not price. Finally, comparing the different options with the original product led to a clear solution to the first two scenarios and thus a determination of whether it was, in fact, the problem with the product. This complex analysis was too much for the client to understand, but the partitioning and formation of clear answers in a complex problem would allow various points to revisit and the possibility to stop if at any point in time the data did not reflect the predictions.

Unfortunately, a tie between the two options led to another 2 scenarios but now of realised and regrettable actions and thus another 2 scenarios in between. The product should or should not be pulled off the market provided 2 linear equations.

Under the assumption that the product was actually fine and should not be pulled off the market, a comparison between the price and a similar product could ascertain whether the problem was the price or the product's price relative to similar products. The best case would be a price x and a highest attainable product price. Substituting x for a low value but not 0 and x for the highest value where the product is still considered comparable. This creates a linear inequality in the first scenario, a similar calculation with a weighted version of price and comparing this with a value of the product against other products creates a minimisation of the difference between the two prices and is a partial equation in the second scenario. Both scenarios would lead to the best value option.

Anand showed a 2*2 matrix can be formed with the grid showing the 2 options for whether the product should be pulled off the market or not and the 2 options for whether it was a problem with the product's quality or the product's price. This generated 2 mutually exclusive scenarios.

The first case study examines the application of the algebraic method in the context of the marketing mix. The problem involved an unsuccessful healthy food product which, although being well received in terms of taste and quality, had lost money and was to be pulled off the market. The cause of the problem was considered to be pricing, but before changing this, the client wanted to be sure that it was the problem with price that caused the product to fail.

The case studies that Anand has written lend real depth to what can otherwise often appear to be too theoretical or ethereal. The first case study provides an excellent illustration of the use of the MECE principle in breaking down a problem into disparate and parallel structures and then solving each of these mini problems.

Case Study 1: Application of Algebraic Method with MECE Principles in Marketing

Problem: Marketing P is experiencing declining spare parts sales despite a strong reputation for quality.

MECE Breakdown:

Main Factors Affecting Sales (MF1):

- Sales Team Effort (TF): Demotivation, lack of effectiveness
- Customer Satisfaction (S): Dissatisfaction with price and quality
- Competition Level (C): Weak compared to substitutes

Sub-Factors of Customer Satisfaction:

- Price (P): Perceived as too high
- Quality (Q): Meets expectations but not exceeding

Algebraic Formulation:

- Sales Function: MF1 = f(TF, S, P, Q, C)
- Customer Satisfaction Function: S = g(P, Q)

Step 4: Solve the Equations:

Scenario 1: Increasing Sales Team Effort (TF):

- Quantify the relationship between TF and MF1, potentially using historical data and regression analysis.
- Model the impact of increased effort: MF1_new = f(TF_increased, S, P, Q, C)
- Compare MF1_new with the original MF1 to assess the potential sales increase and its cost-effectiveness.

Scenario 2: Improving Price and Quality:

- Analyze the relationship between P, Q, and S. This could involve surveys, market research, or conjoint analysis to understand customer preferences and price sensitivity.
- Model the impact of price and quality improvements on customer satisfaction: S_improved = g(P_improved, Q_improved)
- Analyze the subsequent effect on sales: MF1_new = f(TF, S_improved, P_improved, Q_improved, C)
- Evaluate the cost implications of improving price and quality, including potential impact on profit margins.

Step 5: Analyze and Interpret the Results:

- Compare the effectiveness of both scenarios in increasing sales figures (MF1).
- Analyze the cost-benefit trade-offs of each approach, considering the investment required for increased sales effort versus price and quality improvements.
- Identify the optimal strategy based on the company's goals and resources.
- Consider external factors like competitor actions and market trends that might influence the chosen strategy.
- Develop a plan for implementation, including specific actions to improve sales team motivation, adjust pricing strategies, or enhance product quality.

Additional Considerations:

- Explore the impact of competition (C) on sales. Can Marketing P leverage its quality reputation to differentiate itself from competitors even with a higher price point?
- Consider incorporating marketing mix modeling techniques to quantify the relationships between various marketing inputs and sales outcomes.

In order to simplify the situation: let MF1 be the sales figure of the spare parts, TF the effort by the sales team in promoting the product; customer satisfaction, price and product quality; and C the competition level. From the situation it is clear that the client is pretending MF1 to be increasing. But we must satisfy the assumption of improvement. So we decide to let P1 be the set of more promoting effort and P2 be the improving the improvement of product price and quality. These two actions are taking in the hope of selling the product to the customers. On the other hand to prevent the decrease of satisfaction level to the present global situation, one of the set of actions must prevent the decline in the satisfaction level. Choosing the strongest quality of action and results and taking into account the weak competition, it is taking C to prevent the increase of compare. This is the cause of the situation is taking any M2. Now the problem can be stated as how to direct the P and Q to increase MF1. [25]
Marketing P has been struggling for a long time with spare part sales. It is a very good company for making spare parts but until now the sales of the product was deteriorating. As a consultant you are hired to help the company improve sales of their spare parts. After analyzing the present situation of the spare part sales you found that there is a drastic drop on the sales figure for the last 5 years. The sales team are demotivated as their effort in promoting the product is not parallel with the result, customers are dissatisfied with the product

price and its quality and also weak competition compare to other substitute products the market are the main problems of the sales.
The marketing problem is a common type of business case. The case is simple to understand, but takes careful thought to solve. It is just this sort of problem that the algebraic method and the MECE principle were made to solve.

Case Study 2: Application of Algebraic Method with MECE Principles in Operations

Problem: A retail company is facing declining revenues due to increased competition, leading to cost-cutting measures that negatively impact efficiency and quality.

MECE Breakdown:

- Main Issue: Declining Revenues
- Contributing Factors:
  - Increased Competition
  - Cost Increases:
    - Efficiency Loss (E): $3 per unit
    - Production Mistakes (M): $5 per unit
  - Cost-Cutting Measures:
    - Reduced Employee Motivation
    - Increased Outsourcing
- Consequences:
  - Lower profit margins
  - Employee turnover
  - Declining customer satisfaction

Algebraic Formulation:

- Cost Function: Total Cost Increase = 3E + 5M
- Efficiency Function: E = h(M, O) (where O represents the level of outsourcing)

Step 4: Solve the Equations:

Cost Minimization:

- Formulate constraints based on production capacity, quality standards, and budget limitations.
- Use linear programming to minimize the cost function (3E + 5M) subject to the defined constraints. This will provide optimal values for E and M.

Efficiency Analysis:

Analyze the relationship between employee motivation, outsourcing level, and efficiency loss using regression or statistical modeling techniques.
Identify the main drivers of efficiency loss and potential solutions to improve it.

Step 5: Analyze and Interpret the Results:

- Evaluate the effectiveness of cost-cutting measures in light of the cost minimization results. Are the savings from outsourcing offset by the increased costs due to efficiency loss and production mistakes?
- Assess the impact of employee motivation on efficiency and identify strategies to improve it, such as incentive programs, training, or improved work environment.
- Analyze the feasibility and potential impact of alternative cost-reduction strategies, such as process optimization, technology investments, or supply chain management improvements.
- Consider the long-term consequences of cost-cutting on customer satisfaction and brand reputation.

Additional Considerations:

- Analyze competitor pricing and product offerings to identify potential areas for differentiation and competitive advantage.
- Explore the potential for automation or process improvement to enhance efficiency without compromising quality.
- Consider the impact of economic conditions and industry trends on the company's revenue and cost structure.

By applying the Algebraic Method and MECE principles, both case studies can benefit from a structured approach to problem analysis and solution development. The mathematical formulations allow for a quantitative assessment of the problem and potential solutions, while the MECE framework ensures a comprehensive consideration of all relevant factors. This combined approach can lead to more informed decision-making and ultimately contribute to improved business performance.

At the same time, the increase in quality control can be addressed by comparing the mistakes to a loss in revenue. The difference in the production of mistaken units can be compared to the rate of mistakes with the marginal change on the production of units showing how the mistakes were double what they wanted to spend. The mistake in quality control was due to the increase in production of mistaken units, so it can be compared to the increase in production, and since they want to decrease this part of production, the best method is to use the marginal case to find how to best stop production of mistaken units. By combining these two analyses, the company can determine the best way to make a $5 cost difference, and it can be shown that in both cases, the best method is to simply stop doing what was changed from the better quality production. [26]

Solution: The cost issues were seen as a problem in efficiency and quality control. Using a systematic algebraic analysis, it was determined that the best way to combat the $3 cost increase was by improving efficiency. The root cause of the efficiency loss was determined to be a lack of employee motivation and increased outsourcing to cut costs. By using another cause and effect diagram, it was determined that outsourced production was a mistake due to the increased costs in the long run, and the employee motivation issues were a result of inadequate incentive and punitive measures. The cost difference can be looked at as a difference in the incentive for efficient work and money lost due to mistakes. An incentive can be compared to the cost increase, for the employees an incentive is only half as much, so there is a (3-1) = $2 incentive. This shows that the difference in the outsourced work was not actually better but seen as a cost-cutting measure. By letting x = number of units and solving for a cost minimization, the company can determine how many units they need to produce and how to best split the work between outsourced and in-house work. [27]

The operations problem: A company within the retail industry has seen declining revenues over the past several years. Margins have dropped, employee turnover is on the rise, and customer satisfaction is declining. Increased competition from overseas competitors is seen as the biggest issue, but efforts to counter this with pricing strategies have only made the situation worse. A cause and effect diagram helped to organize the issues, and it was determined that the increased competition had caused several issues with overall product cost. A loss in efficiency was calculated to lead to a $3 cost increase per unit, and mistakes in production were calculated to lead to a $5 cost increase per unit. These costs, totaling an estimated $80 million loss in profit, were determined to be the driving force behind the price decreases aimed at maintaining market share.

DISCUSSION

1. Limitations and Challenges

Challenges in implementing MECE principles are to construct the correct framework and ensuring the analysis goes to deeper insight rather than just structured superficial insight. This step needs an expert in problem structuring, as the nature of MECE is a framework should not have overlapped and uncovered areas. It will also need experts to change the simple question into more specific questions that lead to structured and deeper insight questions. The last challenge is to maintain the analysis goes according to the framework and avoid any unrelated analysis. [28]

For certain cases, the analysis also needs complex formulation that is too costly and time-consuming. This method also cannot be used for broad cause and effect analysis that using its framework will create too complicated mathematical model. The last problem is the analysis has no additive feature that is difficult to do re-evaluation when the model changed.

The limitations of using the algebraic method in business case analysis are found due to its nature of a mathematical approach, which will not always correspond to the real-world business situation. The main issues are that the method is not intuitive and difficult to understand by various decision-makers to the extent they cannot review or provide feedback to the analysis. On the other hand, some decision-makers are unfamiliar with mathematical analysis, so they do not trust the result of the analysis, which will lead to poor decision implementation. It is also possible that the result of the analysis has to be understood by another analyst, so they cannot make a decision about the analysis.

2. Limitations of Algebraic Method in Business Case Analysis

This algebraic method has certain limitations; so the proponents in favor of algebraic thinking need to be careful and conscious of the cons of following an algebraic approach. First and foremost, a limitation emanates from the cost consideration. Companies are not ready to spend huge costs in terms of both money and time needed for finding the correct algebraic formulation of the business problem. A lot of data is needed and very rigorous and complex computations are to be done. This act might require the companies to employ technical analysts and operation researchers on a large scale, which will unnecessarily increase the manpower and administrative costs for the company. Second comes the limitation due to a lack of management understanding of algebra. Expensive and successful business decisions are seldom made by a single manager. Usually, the manager will discuss with his colleagues and superiors. Also, communication links are very much complex these days and a decision problem may involve a chain of communication links, all of which will involve different people. [29]

3. Challenges in Implementing MECE Principles with Algebraic Method

This method still faces a lot of resistance and misunderstanding in the business community. The MECE principle essentially calls for a complete disaggregation of the problem into its basic components and then solving these components and aggregating the solutions to solve the entire problem. Usually, in business cases, this kind of analysis is mistaken for a piecemeal approach to solving the problem. While incidence of the MECE principle is still low, many cases will not be ripe for analysis with MECE and the algebraic method, and will require weighing other methods in a tradeoff analysis. Full utilization of the principle necessitates that MECE and non-MECE methods be separated in this manner. Full understanding of MECE is still a long way to go for the business community and educators. [30]

Implementing the MECE principle with the algebraic method poses several challenges, such as applying the principle of one level above and one level below, and the necessity to frame the problem with the principle of being exhaustive in this category. The principle of one level above and one level below states that the problem can be analyzed by moving one level up and one level down from the problem level. Generally, managers have a tendency to dig too deeply into a problem than required or to jump to a solution that is not well thought out and hence not suitable. This principle ensures that the manager is at the right level for analyzing the problem, and it also helps in making a decision to stop analysis before too many resources are spent. [31]

CONCLUSION

Firstly, this paper provides a practical methodology for the application of algebraic techniques in business problem solving. At the heart of this approach is the identification of the minimum number of variables needed, and the writing of a system of equations and/or inequalities to represent the problem. However, for this methodology to be applied successfully, clients/students must develop an understanding of the algebraic techniques involved. Schools of management and administration should consider including algebra as part of the curriculum, and as a prerequisite for courses in decision making. Instructional tools such as workbooks or software may need to be developed as an adjunct to algebra instruction, in order to provide students an opportunity to sharpen their algebraic problem-solving skills. An interactive online course would be one example of an effective way to guide students through the problem analysis process. [9]

Future research by the author will focus on developing software designed to engage students in the problem analysis process. The software will begin with an elementary discussion of the MECE principles and proceed to using concrete examples to illustrate problem analysis techniques. These are linked step-by-step to their algebraic counterpart, emphasizing the conversion of qualitative statements to quantitative models. Students are then provided exercises to complete, with feedback on their progress and an analysis of their performance. This software will be tested with students in both business and mathematics courses, at a variety of levels, to gauge its effectiveness in teaching problem analysis techniques. [32]

Summary of Findings

The primary objective of the third research phase was to test situation construction using a situation described by a case-writer from written or verbal material. It was hypothesized that by asking appropriate questions, the completions could be made to correspond to the situation described. It was recognized that if this could be achieved, the method would yield a detailed and accurate problem model. The results of the experiment were inconclusive due to experimental difficulties discussed later. An analysis of the memory traces of the subjects, however, disclosed a significant finding. This was that with none of the subjects was it possible to identify a precise point at which a shift in situation construction occurred. This appeared to show that they could solve the second problem without switching from the model of the first. It has been shown in previous research that errors in problem solving are frequently due to the use of an incorrect model, and it is possible that this finding could be a significant contributory factor to the discrepancy between correct use of the method and actual problem solution shown in the earlier study. Although no definite conclusion can be drawn without testing the method under better conditions, this finding suggests that one way of improving the method could be to get the subject to compare his model with the model of the problem provided at each stage. Also, the data (there is no room here to describe it adequately) caused a modification of the method of progression. Steps of progression and regress and middle path movements were only used in the second problem, and it was found that none of these types of action were made in the expected direction. This finding is not directly relevant to the earlier study, but being clear evidence of a specific error, it will be of use in refining the method for future use. [33]

Recommendations for Future Research

The MECE way of thinking is especially relevant to the decision sciences. The authors are convinced that there is considerable potential for cross-fertilization between the academic discipline of decision analysis and the tools and techniques that are taught and used by business schools and consultants. Unfortunately, we perceive a gap between the academic discipline and the practitioners, which opens up in part because success in the academic discipline is measured by publication in journals rather than impact on a decision.

The authors' personal experience with the illustrative case and other research projects in the business-government sector suggests that conventional management science often crowds out the more theoretical MECE way of thinking about a problem, especially for the top management who is the ultimate user of the researcher's findings. The specific decision recommendations at the end of an MECE analysis may not differ much from those of a conventional approach, but the structuring of the problem and findings in a MECE framework aid the decision maker's understanding and hence increase the likelihood of implementation. This leads to the following recommendation.

One of the most important issues facing business today is to plan and monitor the implementation of findings and recommendations of research projects. So far, there has been an abundance of good ideas, tools, and techniques in the field of management science that unfortunately remain unimplemented. This implementation gap reflects the tendency of researchers to leap too quickly from formulating a problem to synthesizing an answer, too often ignoring the analytical steps needed to structure the problem and its relative importance, from which the research might generate a useful solution.

THEORETICAL IMPLICATIONS

This research on combining algebraic methods with MECE principles has several theoretical implications for the field of business problem-solving:

- **Enhanced Understanding of Problem Complexity:** This approach offers a new lens for analyzing complex problems. By combining the structured nature of algebra with the thoroughness of MECE, it could lead to the development of more nuanced theories about problem categorization and solution development.
- **Bridging the Gap Between Qualitative and Quantitative Approaches:** Traditionally, business problem-solving relies on separate qualitative (MECE) and quantitative (algebraic) methods. This research suggests a framework for integrating them, potentially leading to a more unified theory of business problem-solving.
- **MECE Refinement:** The application of algebra could expose limitations or gaps in traditional MECE application. This research could pave the way for refining MECE principles to better account for quantitative relationships within problems.

PRACTICAL IMPLICATIONS

This research also offers several practical benefits for businesses:

- **Improved Decision-Making:** By providing a structured approach to identify key relationships and analyze all potential solutions, this method can equip businesses to make more informed decisions when facing complex situations.
- **Enhanced Communication and Collaboration:** The use of a common framework (combining algebra and MECE) can facilitate clearer communication and collaboration among team members with different backgrounds (quantitative vs. qualitative).

- **Development of More Effective Solutions:** By ensuring a comprehensive understanding of the problem and all potential solutions, this combined approach can lead to the development of more effective solutions with a higher success rate.
- **Identification of New Research Areas:** The practical application of this method might reveal areas where further research is needed. Businesses may discover limitations in their data or current understanding of certain variables requiring further investigation.

In conclusion, this research on the combined application of algebraic methods and MECE principles has the potential to significantly improve business problem-solving practices. It offers theoretical advancements in understanding complexity and practical benefits for businesses seeking to make better decisions and develop effective solutions.

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