The Relevance of Decision Tree to Organisations in Nigeria

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Abstract: The objective of this study was to explore decision tree as a viable tool for decision making through viable graphical demonstrations, identifying and measuring assumptions within given environmental limits and ranking of priorities or options is a modern tool that can be simplistically implemented or made complex with statistical probabilities and with consideration that action taken would be comprehensive and dynamically evolving. Business decisions are usually conclusions of a two-way thinking or more. The ideal situation can be varied to get a basic scenario or the best scenario and this can be captured graphically or visually by the decision tree model which is an all-encompassing management decision tool. A Desk review research method was employed in this expository study. The study found out that decision tree models, though is an internal decision making tool, the usage can be externalized and included in financial statements and other reports as part of the sensitivity analysis and as a build-up of the financial package, investment decisions, sensitivity analysis, cost analysis and financial ratio analysis as key business areas The study concluded that the usage of decision trees in modern management is limitless and can be in a simpler form without mathematical colouration or laced with probabilistic statistical effects.

Keywords: C4.5, CART, Decision Tree, Probabilities, Ratio Analysis, Sensitivity Analysis, Uncertainties

1. Introduction

1.1. Introduction

Decision tree is really a living visual tool, virtually or expressly used in either personal or business decisions and incorporates both qualitative and quantitative data analysis. Business decisions requires elements of precision and consideration of uncertainties leading to risk-taking which could be of varying degree and dimensions, thus the need to utilise effective tools in arriving at optimizing conclusions cannot be over-emphasized. As part of data science, decision trees can identify business value for an organization and then communicate it to stakeholders as actionable insights in a very clear manner. [8].

In a highly computerized and volatile business environment, internally and externally, the assurance of consideration of all factors is essential as a guarantee of success. Thus, the introduction of a logical tree full of conditions and conclusions in arriving at an ideal decision suitable for intricate processes particularly with decision problems that are interconnected and chronological in nature.

Business decisions are never a one way affair and in most cases requires a deep consideration of alternative actions and picking on the one that will give optimum value to all the stakeholders, or in extreme situation not taking any decision and this decision making will be better served by a management team that may not all be mathematically inclined or scientifically grounded to utilise many theories but a visual graphical representation of each course of action will do a lot of good to simplify the presentation of decisions and generate almost instant reaction since the comparative results will visibly speak for itself., thus the need to present or re-present decision tree model as a viable tool for business decisions in an environment full of uncertainties like Nigeria since the decision tree has the capability of helping management with clarifications far better than any known analytical tool, with the options, risks, objectives, fiscal rewards, and information demands are involved in an investment challenge and has to be deployed in years ahead.

According to [9] decision three has three properties which are alternatives, uncertainties and clear objectives and all of these three can be made into a mathematical model that makes use of estimates and probabilities to calculate probable outcomes with defined uncertainties, then it becomes a handy in modern business as a viable tool. The main objective of this

article is to explore ways in which decision trees and analysis can be deployed as a tool of business decisions and specifically considering the investment models, cost models, sensitivity models and financial ration analysis models. The decision tree learning algorithm will give the output as a decision tree with each branch having a decision made at each step, and the decision tree construction starts at the root node and splits the remaining nodes constantly irrespective of the decision tree learning algorithm which will give the output as a decision tree with each branch having a decision made at each step. [25]

Hypothetically, this article will examine whether decision tree is really relevant to the business world of today and why cant we do away from exploring the understanding and application of the decision tree as a tool of decision making particularly under uncertainties.

1.2. Brief History of Decision Trees

According to Ritschard (2013) Belson in 1959 in the task of developing relevant predictors published his work around decision tree as a simple way of working things out instead of the sophisticated statistical methods. However, the first regression tree was invented in 1963 by Morgan and Sonquist as they describe the first regression tree algorithm, Automatic Interaction Detector (AID), which produced a tree of binary splits that predicted a numeric target, given categorical predictors without imposing any statistical assumption and selection of only useful selector relevant to the model being considered. [17].

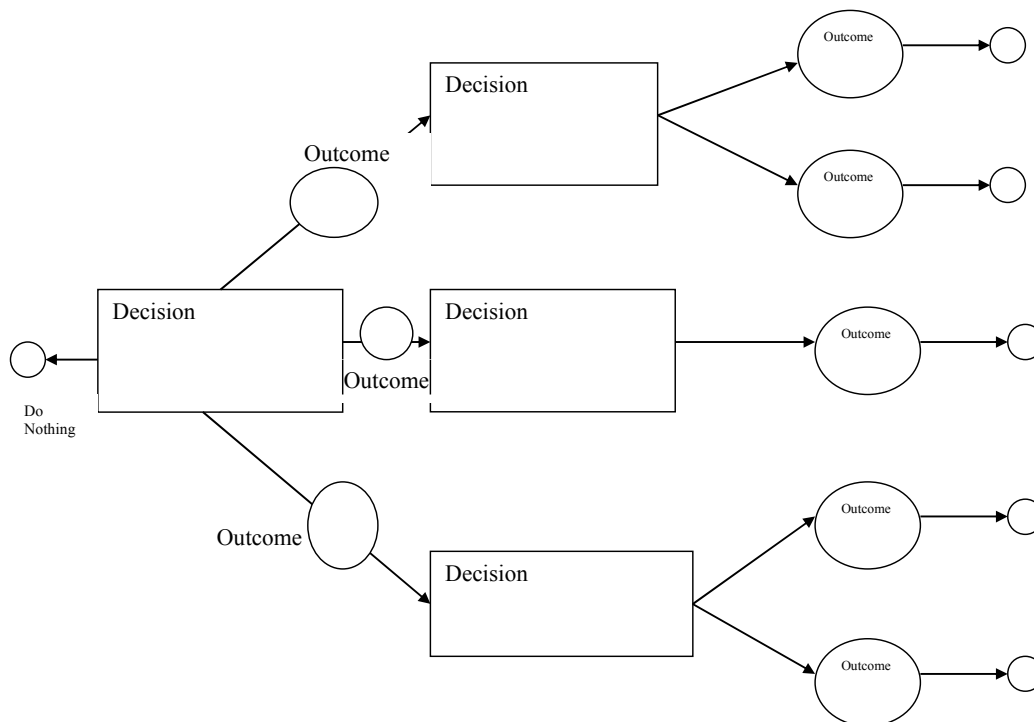One of the earliest publications on decision tree was by Hunt (1966) when decision tree methods were used to model the human concept of learning. Quilan (1975) model for performing decision tree analysis with his first algorithm for decision tree creation called the Iterative Dichotomiser 3 (ID3) and it came with the idea of creating the smallest, most efficient decision tree possible using the principles of Occam's razor. Quilan developed this position further with the creation of Algorithm 4.5 and Algorithm 5.0. (Sverdlov & Akpara, 2018; [34].

2. Literature Review and Theoretical Framework

2.1. Conceptual Review

A Decision Tree Analysis (DTA) is a visual representation of the numerous alternative solutions to a problem. When making a decision, the style of illustration is frequently decisive. A decision tree does not provide management with the solution to an investment problem; rather, it assists management in determining which alternative to pursue at any given point in time..

Decision analysis is a method of addressing and analyzing major business decisions that is methodical, quantitative, and visual. The Decision Tree Analysis is a diagram that shows a series of decisions and their probabilities of occurring. It's just a graphical representation of decision-making amid competing alternatives and limited and finite resources in the form of a tree. [17] defined a decision tree as a graphical depiction of decisions and their qualitative and quantitative implications and for any decision involving decision tree, there are three conditions that must be present and they are objectives, uncertainties and risks. [28, 31].

Source: Researchers Concept (2021)

Figure 1. Decision Tree Concept.

2.2. Terminologies Used

The decision tree uses a variety of terminologies, concepts, and terminology, with the Root Node being one of them. The Root Node compiles the entire sample, which is then separated into multiple sets of homogenous variables. A decision node is a sub-node that branches out into new possibilities. The value or terminal node is the ultimate node that shows the outcome that cannot be further classified. The numerous options available with the decision tree maker are denoted by a branch. Splitting is the partition of an accessible choice (represented by a node or sub-node) into several sub-nodes, whereas pruning is the opposite of splitting, in which the decision tree builder can remove one or more sub-nodes from a certain decision node. [15, 29].
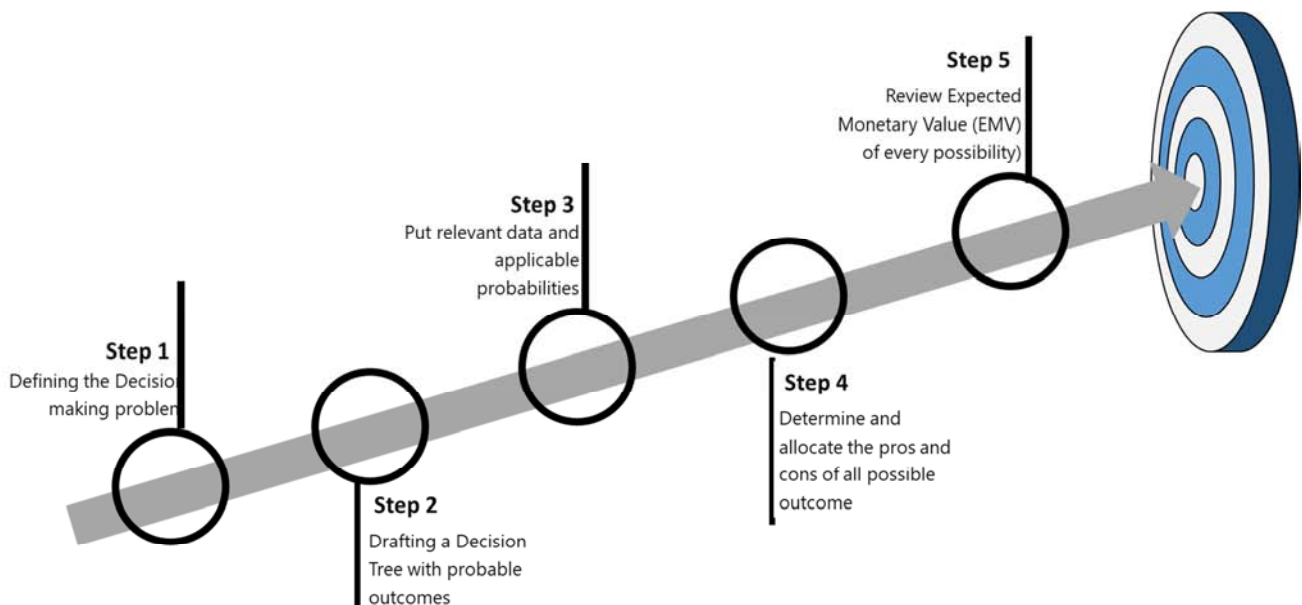
2.3. Steps in Decision Tree Analysis

Determine the decision you want to make or the problem you're trying to solve. This should be the decision tree's primary heading. Choose between utilizing a pre-made decision tree template or starting from scratch with any of the tools available.

Write down the many alternatives for addressing the problem or making the decision on the branches of the decision tree you are creating. Analyze these variables further to find the risks and rewards associated with each alternative using a risk-reward analysis.

Allow each decision path to be color-coded to aid visualization and comprehension. Prioritize each alternative based on the associated risks and rewards, determining which alternative option has the least risks and the most rewards. Allow other team members to participate before coming to a conclusion, especially if there are cross-functional teams. Agree on the conclusion and the optimal or best decision, and communicate appropriately.

Source: Researchers Concept (2021)

Figure 2. *Decision Tree Analysis Steps.*

2.4. Advantages of Decision Tree Analysis

Decision tree depicts the most suitable project or solution in the face of all uncertainties.

The toll introduces ease of classification and data interpretation because their results are simple to read and comprehend without the need for statistical expertise. The data can also provide useful information on the chances, costs, and alternatives to various tactics.

Decision trees require less effort for data preparation than other decision techniques, as users can create new variables with the ability to predict the target variable without having to perform complex calculations, and they can also create data classifications without having to perform complex calculations. Another advantage of decision trees is that after the variables have been generated, they require less data cleansing. Missing values and outliers have less impact on the data in the decision tree. Unlike typical data pre-processing processes, the pre-processing phases in a decision tree making model need less code and analysis.

2.5. Theoretical Review

2.5.1. Decision Making Theory

Leonard Savage's in 1954 through his book as presented in "The Foundations of Statistics" is credited with the best-known normative theory of choice under uncertainty, particularly in economics and the decision sciences. Though there was an attempt in 1926 by Frank P. Ramsey where he proposed that a different set of axioms can generate almost the same result. Savage focused on the mathematical analysis

of rational belief and desire and advancement of Bayesianism in statistics. This theory develops a general framework of decision making under uncertainties and noted for his role in developing of personal probabilities in decision making by invoking the hypothesis of subjective expected utility maximization to forge a link between empirically measurable preferences and hidden beliefs and desires. [4]

Decision making theory is a theory of how rational individuals should behave under risk and uncertainty. So, we can say that decision-making denotes the formulation of general policy for the management of an organisation which may be business organisation or administrative organisation.

2.5.2. Expected Utility Theory or Bayesian Decision Theory

Leonard Jimmie Savage in the 1950s. Richard Price.

In decision theory, expected utility is the expected value of an action to an agent, computed by multiplying the value of each conceivable action outcome by the chance of that outcome occurring, and then summing those amounts. Expected utility is a notion that is used to explain actions made in risky situations. When considering various courses of action, traditional decision theory suggests that the action with the greatest predicted utility should be chosen.

The expected utility theory from the outset is held out much as a theory of rational choice, or overall preferences amongst acts, as it is a theory of rational belief and desire. In economic theory, the expected utility hypothesis is a well-known idea that serves as a guide for making decisions when the result is unknown. Based on their risk appetite and preferences, the theory suggests which alternative reasonable individuals should take in a complex circumstance.

3. Application of Decision Trees

3.1. Models of Decision Trees

There are many applications of decision trees and the list could be as many as all the facets of business decisions ranging from technical to operational decisions, health and safety, environmental analysis, operational risk analysis and financial decisions. However, this article's focus is on four direct financial decisions.

3.1.1. Model 1 – Investment Decision

Investment decisions are by far the most difficult and critically important decisions facing entrepreneurs and are usually carried out with varying degree of risks and returns portfolio. Each of these risks which can be low, medium or high and returns which can be short-term or long term are rationally linearly correlated. (Hespos & Strassmann, 1965). Decision tree is suitable for investment analysis because of its mathematical appeal and high visibility requiring little technical effort at interpretation. The usage of decision tree is far easier than the traditional statistical approach. [6, 12].

A good business decision involves certain level of uncertainty which will involve three kinds of analysis, probabilistic, risk and sensitivity. [11]

The first step in investment analysis is to define the desired investment plan and identify all the viable decision alternatives. The next task is to draw a decision tree with decision points and chance events which will lead to the data analysis as a prelude to reaching conclusions.
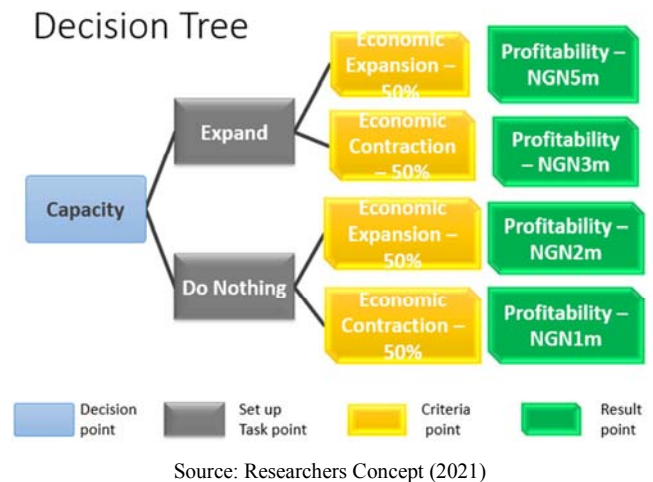

Source: Researchers Concept (2021)

Figure 3. Investment Decision Tree Model.

3.1.2. Model 2- Sensitivity Analysis

Decision tree is strategic in making decisions about the underlying assumptions guiding decisions which can be cost or investment. The sensitivity analysis requires making a base case with clearly spelt out assumptions which can then be individually varied to see the impact before a conclusion is reached. The sensitivity can be in terms of cashflow or other uncertainties. The inherent visual communication makes the sensitivity scenario analysis very clear and unambiguous in choices associated with changes in key assumptions and the likely outcomes as shown in Figure 4 below.
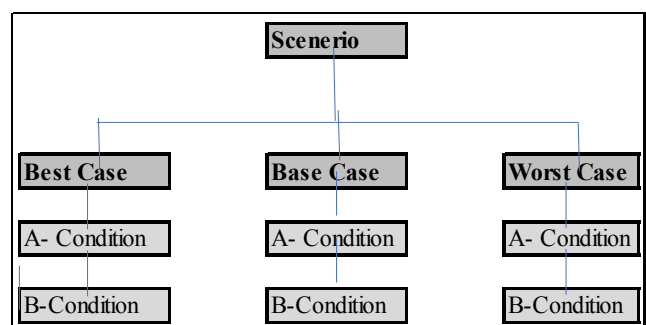

Source: Researchers Concept (2021)

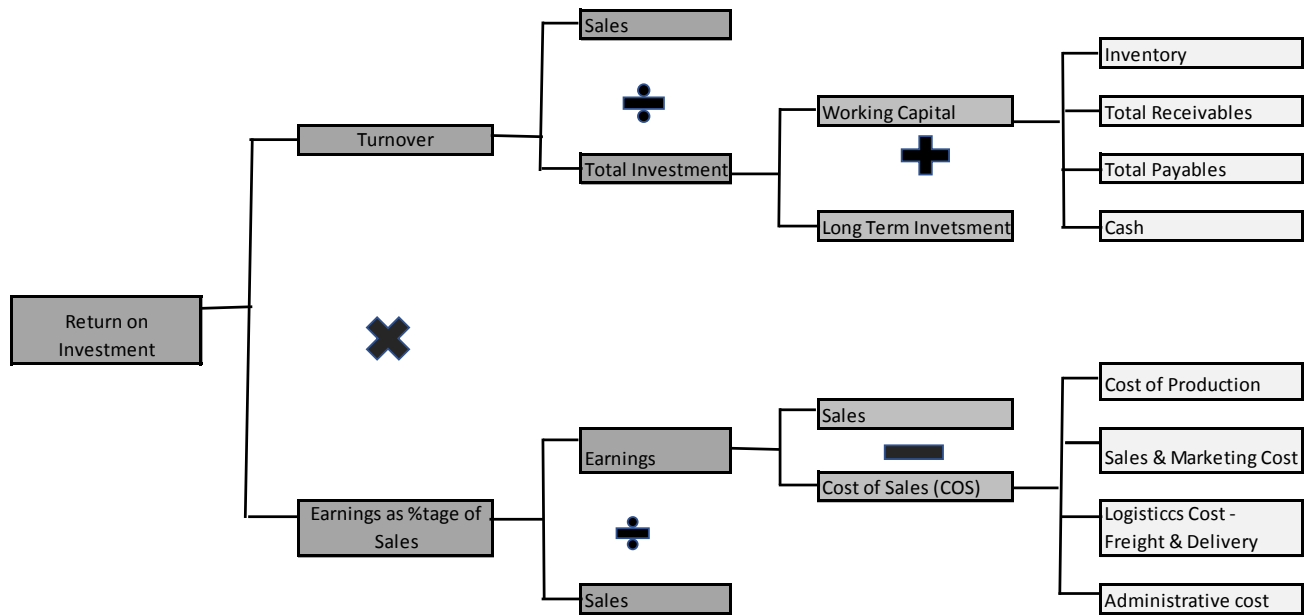*Figure 4. Sensitivity Analysis.*

3.1.3. Model 3 – Cost Analysis

The Du Point Analysis of Return on Investment tree will be used as a focal point in the demonstration of the usage of decision tree for cost analysis or the impact of cost on investment. The Return on Investment (ROI) as a good measure is broken down.

An organisation depending on her elections, usefulness and usage can calculate different types of costs that shows the diversity of her operations and based on the ultimate user

of such cost calculated whether it is for fresh acquisition, give a price quote or as a basis for design or re-design of improvements in existing product with an extreme option of

not altering existing scenario based on decision tree visual analysis. [32]

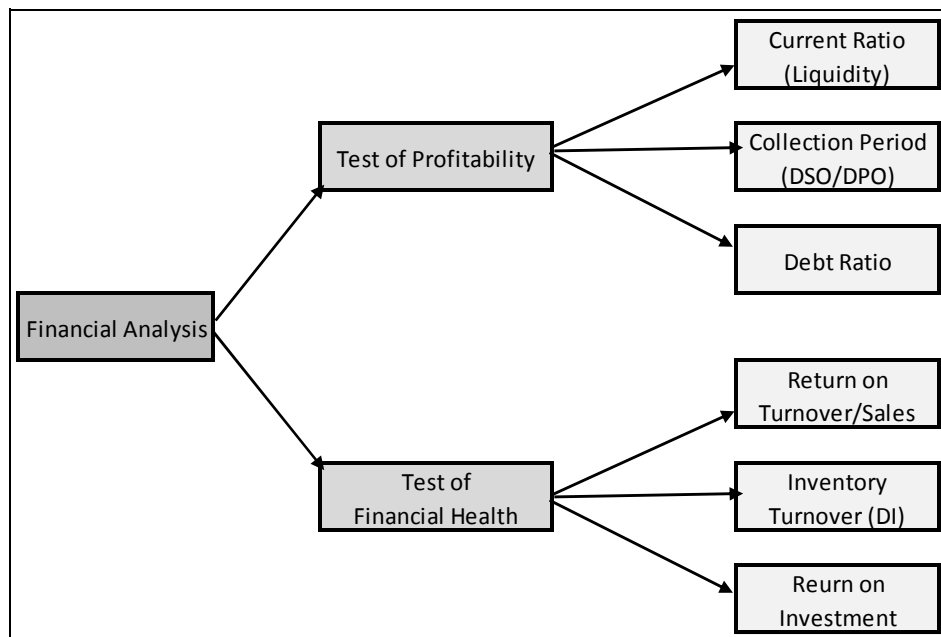Source: Researchers Concept (2021)

Figure 5. Cost Analysis Decision Tree Model.

3.1.4. Model 4- Financial Ratio Analysis

Determination of financial performance through the usage of financial ratios has been a focal point and one that has many literatures [7].
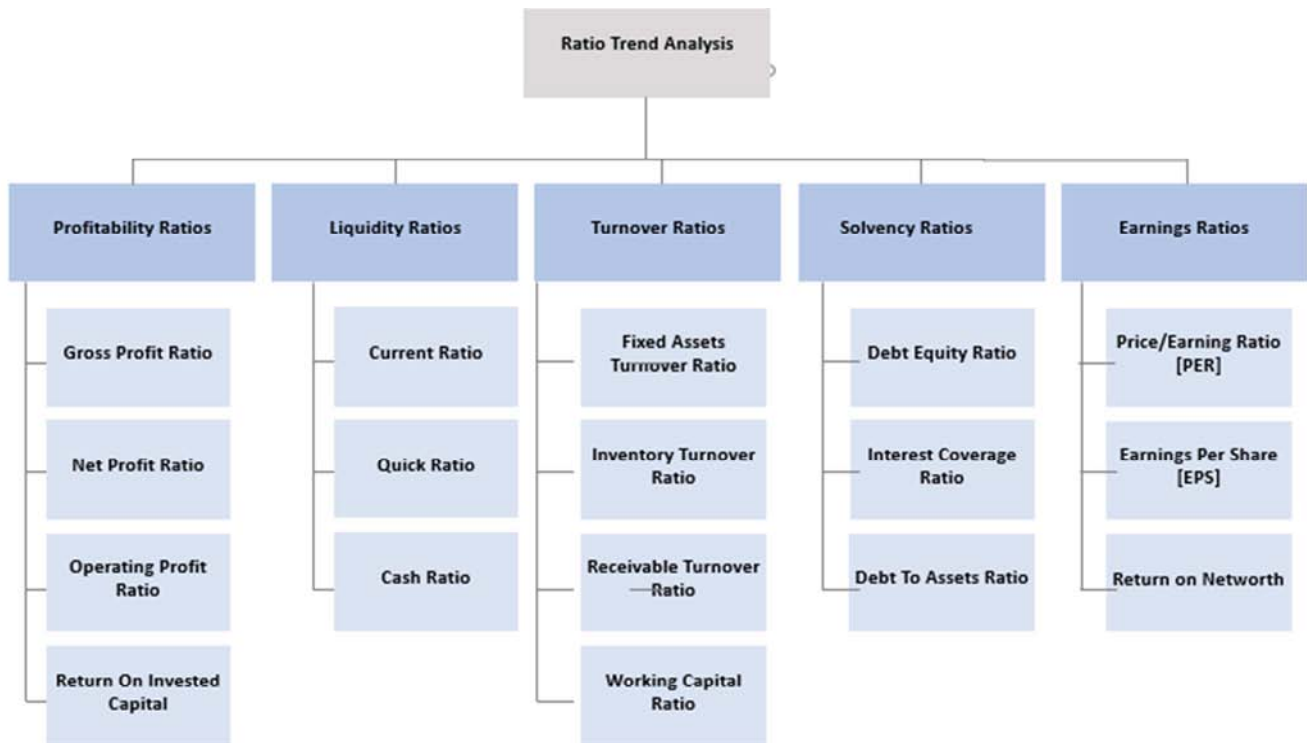
Financial ratios are created to track company performance and make comparative judgments about such performance, financial ratios are created using numerical values taken from financial statements to gain meaningful information about a company. This is done by combining the three basic financial statements: balance sheet, profit or loss account, and cash flow statement. With five main classifications of liquidity ratios, Leverage ratios, Efficiency ratios, Profitability ratios and market value ratios. [1, 16].

Source: bankofinfo.com (2021); Researchers Concept (2021)

Figure 6. Financial Analysis Decision Tree Model 1.

Figure 7. Financial Analysis Decision Tree Model 2.

3.2. Decision Tree Algorithms

The ID3, C4.5, C5.0, CART, CHAID and QUEST algorithms are the most popular and commonly used decision tree algorithms but there are numerous others not as popular as these ones listed here.(Batra & Agrawal, 2018). ID3 (Iterative Dichotomizer 3) was developed by Ross Quinlan in 1986 as a machine learning algorithm which could be used for data classification and forecasts. ID3 tree is constructed in two phases of tree building and tree pruning with data sorted at every node during the tree building phase to choose the best splitting single attribute [23]. C4.5 algorithm (statistical classifier) is an extension of Quinlan's earlier ID3 algorithm and uses gain radio for feature selection and to construct the decision tree with the ability to handle continuous and discrete feature. [2, 30]. C5.0 algorithm is an extension of Quinlan's C4.5 algorithm that introduces variable misclassification costs by developing classifiers that help reduce misclassification costs rather than the high error toll found in C4.5 algorithm. [3]

CART (classification and regression tree) introduced by Breiman et al in 1984 can be explained as a predictive algorithm used in machine learning that explains how a target variable's values are predicted based on other values and each fork is split in a predictor variable and each node at the end has a prediction for the target variable. [5]. CHAID (chi-squared Automatic Interaction Detector), developed in South Africa by Gordon V. Kass (1980), as an algorithm technique rely on the use of adjusted significance testing and apply for detection of interaction between variables and can be used to graphically

display multivariate relationship with a very simple to interpret tree structure as the output. [27], Loh and Shih (1997) developed the Quick Unbiased Efficient Statistical Tree (QUEST) algorithms, to overcome the deficiencies of CART by splitting most statistically significant input identified at every node and based on the statistical significance the optimum split point is selected before pruning is done to prevent the decision tree from overgrowing and untidy. [10, 14].

3.3. Applicability of Decision Tree in Nigeria

In Health and safety issues,[20] established that the decision tree algorithm application is suitable for analysing the dataset on breast cancer disease obtained from the radiotherapy and oncology department of the Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto state, Nigerian. The study affirmed that decision tree could be used for health management as the model results accuracy were well above 80%. [19] also established the relevance and applicability of decision tree using the decision tree data mining algorithm to forecast causes of road traffic accidents, its prevalent locations and time of occurrence along Kano to Wudil highway. [33] also used decision tree algorithm on motorcycle accidents in Lokoja metropolis of Kogi state in the North central geopolitical zone of Nigeria and concluded that motorcycle accident severity prediction system as developed has the capacity to serve as a tool that can be used to minimise the enormous challenges faced by FRSC, and negatively affecting the country economy, in curtailing motorcycle accident.

With regards to business decisions, [22] in a panoramic view of the application of decision tree in calculating the

Expected Monetary Values in order to select the right decision amongst the alternatives where the results showed that decision tree is an indispensable tool in entrepreneurial growth and national development as it helped to foster business by increasing productivity and expansion of financial base, making the researchers to recommend entrepreneurs to adopt and adapt to the use of decision tree for tremendous increase in their enterprise and economy growth and development. [13] also highlighted decision tree usefulness as a data miner for credit loan processing. [24] also applied decision tree to industrial training of organisations. [21] also confirmed decision tree as a new data mining application that can be used to assess the impact of organisational culture on Nigeria's banking industry performance. [26] in his research on the Nigerian economy employed a decision tree statistical learning approach to find links between real GDP growth rates and financial depth measures including stock market turnover ratio, credit availability to the private sector (CPS), and macroeconomic broad money supply (M2) relative to GDP.

4. Conclusion

By using the decision Tree technique to choose the best option, we may create a new product. What the study shows is that it is considerably more valuable to us to take the time to get the proper product to market. Even if it costs us less, it is preferable to improve our existing products rather than launch a new product that fails. Because they clearly lay out the problem so that all options may be observed, discussed, and questioned, Decision Trees are an effective technique of decision making. It provided a framework for quantifying the importance of outcomes and the likelihood of obtaining them. Assist us in making the best selection possible based on our current knowledge and best guess alternatives.

Because they function well with noisy or missing data and can simply be ensembled to generate more robust predictions, decision trees are one of the most extensively used machine learning models. Furthermore, you can immediately visualize your model's learnt logic, making it a popular model in fields where model interpretability is critical.

5. Recommendation

Decision tree consciously or unconsciously are being utilised in most management and economic decisions as opportunity cost of any forgone action is paramount to business decisions. However, the conceptual models will still require lots of field-testing and validation with the view of making those models as templates that will be freely available and included as part of project management summaries, annual financial statements of companies and deployed internally in cost efficiency management. Thus, the need to isolate each of the models and go further down exposing detailed characteristics of each model and their limitations as a tool to measure the effectiveness of existing business support programs.

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