

SCORING CARD METHODOLOGIES FOR STARTUPS EVALUATION: A MACHINE LEARNING BASED APPROACH

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ABSTRACT

Startup companies need more support in order to anticipate at early stages their market competition and sustainability perspective finding alternative strategies to establish a balance between profitability, growth and control. Investors should be easier convinced if the Balanced Score Card reflects that current market, product and human capital status and allows predicting their performance in short or long term. To react to ever-changing market conditions, startups need to accept the investment to new technologies including artificial intelligence (AI). This paper proposes a Machine Learning approach for formulating the KPIs of the Balanced Scorecard for startups using an analytical hierarchal process and a learning-based classification system. The main innovation of this approach is that it allows collection of multiple source data for identifying the performance indicators, and it provides a flexible framework for selecting the right Machine Learning classifier to evaluate their performance.

Keywords: The startup, Discounted Cash Flow, Scoring card, Discounted Value, Real Options Valuation, Relative Valuation, Berkus Method, Machine Learning

1. Introduction

1.1 Background information

The technological trend has created numerous opportunities for the startups as well as the existing enterprises. The existing businesses must integrate new technology into their functionality to ensure that they can fully meet the market needs. On the other hand, startups need to ensure that they venture the available resources in profitable business activities.

Indeed, unconventional wisdom of production, marketing, and retaining customers (York 2018), and a high potential consumer conversion rate (Wang et al., 2020) are fundamental prerequisites for a startup business to be established and remain relevant in the market. On the other hand,

startups tend to struggle with budget issues when it comes to production and marketing or maintain a consistent pace before they achieve a business establishment to be able to compete with big companies (Huang et al., 2018).

To address the above challenges, we propose that startup companies can benefit from using performance measurement systems such as the Balanced Score Card (BSC), especially during their early stages. They need support in order to better understand their business, as well as find a balance between profitability, growth and control. On the other hand, every attempt in literature to propose a performance management tool tries to strongly associate it to the actual business sector of the startup. Such tools assume prior knowledge of the business sector (e.g. technology, pharmaceuticals, agricultural, financial domain, etc).

To react to ever-changing market conditions, startups need to rely heavily on artificial intelligence (AI), Machine Learning (ML) technologies and Big Data analytics (Óskarsdóttir et al., 2019). AI/Machine Learning and Big Data have various capabilities that will provide an entrepreneur with insights into consumer behavior. The technology can help startups in marketing, operations, customer services, advertising, inventory management, but also performance management. Startups need a performance management tool that is able to apply learning from the beginning of a startup. The tool should incorporate a model which learns, processes and visualizes how performance management evolves through the different stages of development. The learning should be based on automated techniques; hence Machine Learning can guide this based on supervised and unsupervised learning techniques.

1.2 Statement problem

Some critical challenges are experienced when venture capital investors value the startups using the traditional mechanism. Some of the traditional methods that are applied in the evaluation of the startups include;

- ✓ Risk Factor Summation Method
- ✓ Comparable Transactions Method
- ✓ Berkus Method,
- ✓ Scorecard Valuation Method
- ✓ Book Value Method
- ✓ Discounted Cash Flow method
- ✓ Liquidation Value Method

✓ Venture Capital Method

The advancement in the technological realm has resulted in startups using artificial intelligence and Big Data. AI and Big Data have been very useful for startups in very many ways. Traditional approaches in helping the startups are experiencing various challenges ranging from low productivity, time-consuming, high costs, and inadequacy in business skills. Vital business operations, such as screening of start-up ideas, company valuations, and assessment of the startup operations, have been limited when traditional evaluation methods are used (Huang et al., 2018). These critical challenges tend to be experienced where there are limitations in technology penetration.

To ensure challenges associated with traditional evaluation approaches are addressed, startups need to be more aware of innovation. There is a need for new techniques that minimize operating costs and improve productivity and product quality (Gozman et al., 2018). A profitable venture can be established through well-structured and justified scoring card methodologies for startup evaluation.

1.3 Objectives and Research Questions

The core objective that needs to be achieved is to ensure that the startup has a justified scoring card, which can gauge whether the venture is profitable and viable. Hence, we are investigating the contribution of Machine Learning and Big Data technologies to enhancing scoring card methodologies. The research hypothesis that we are opting to is that Machine Learning technologies allows the startup stakeholders to build different growth models. ML offers the capability of applying unsupervised learning techniques for key performance indicators of a selected scoring card method without being biased on domain – specific circumstances.

- Will a ML-based scoring card method help then the stakeholders to know when/how to change strategies as they mature and reach new stages of development?
- Do all scoring card methodologies fit to startup evaluation, any business sector and any size of the startup business?
- Startups lack or at some point they run out of resources and managerial expertise/support. How Machine Learning-based scoring card methods can help startups to invest intelligently resources and make decisions related to management, customer focus, human resources, venture capital and innovation strategies?

The aforementioned research questions are some of the issues that we seek to address in the next sections of this paper.

2. Literature Review

2.1 Entrepreneurial process

For a startup company, marketing is the growth factor in establishing brand value in the target area of operations. AI and Big Data are crucial to this objective since they can help the business identify and reach out to the right market for product launching, hence desirable marketing return (Gozman et al., 2018). Startups can utilize the technology capabilities to understand customers' needs. Customers' needs can then be leveraged into developing a product that can be bought (Huang et al., 2018). All this cycle is called an Entrepreneurial Process.

The Entrepreneurial Process follows progressively four phases: a) opportunity identification, b) creating a business plan, c) assessing resources requirements, and d) managing the resulting enterprise. How well this is achieved it is measured by the potential resistance that the startup faces in the marketplace before the innovative product is introduced to the market. Additionally, the entrepreneurial process needs to be connected to an innovation strategy. For example, Wallas' four-stage strategy model consists of: Preparation, Incubation, Illumination, and Verification (York 2018). This connection helps to determine how innovative products can be created to meet the market needs in the long term.

2.2 Traditional Valuation Methods

A valuation is an approach that is adapted to measure the firm's worth in terms of assets. It is the numerical depiction of how much cash an investor needs to loan for the value to make a financial return. There are numerous approaches to decide the estimation of an organization or a resource.

In contrast to developed organizations, new ventures and start-ups have some regular qualities which make valuation strategies less relevant. These attributes in detail; the absolute first and essential thought is new businesses have no previous history, and the greater part of valuation strategies rely upon it. The following one is that a large portion of new pursuits causes negative working benefits for an exceptionally prolonged period, and they too have almost no income at the principal stage (Wang et al., 2020). The third angle is that since banks are not anxious to change their cash on new companies, child step1 adventures exceptionally rely upon private value firms. This implies that new companies need to acquire costly cash. The last thought is a large number of new pursuits don't endure.

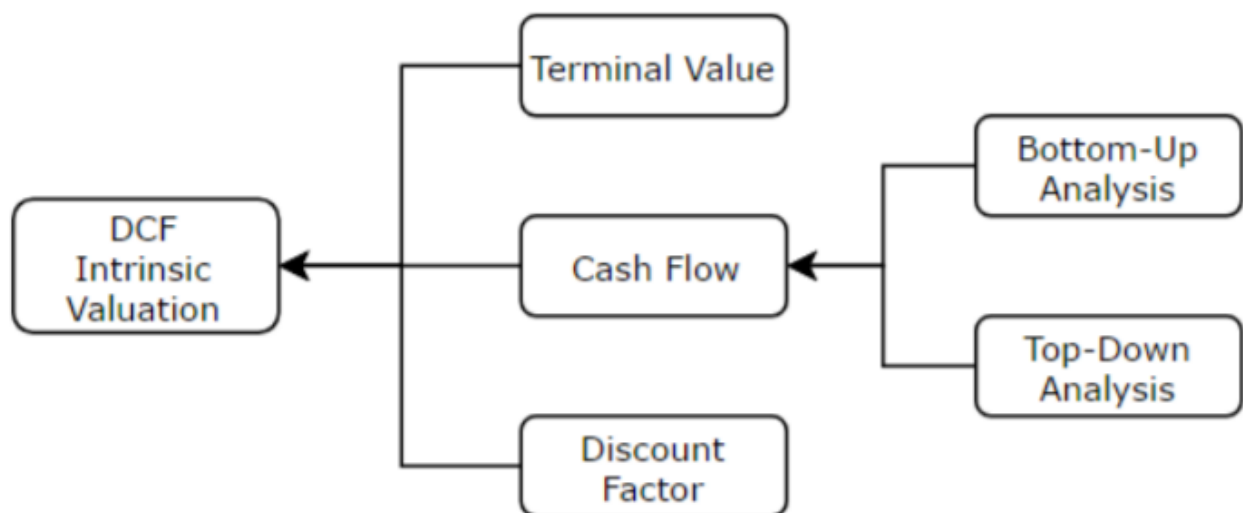
All in all, new companies have high default risks (Huang et al., 2018). In this way, although models for esteeming stable organizations can be utilized to valuation gradual step organizations, it is difficult to specify that traditional techniques help speculators and investees arrive at exact

inborn incentives for new companies. Some of the methods that can be used in evaluating start-ups based on literature are outlined below;

2.2.1 Discounted Cash Flow (DCF) Method

Every asset tends to have intrinsic value when there is the generation of cash flows associated with risks. DCF includes discounting cash flows for the possible present value. After the calculation and the cost are lower than the calculated value, it can be concluded that equity may result in profit (Wang et al., 2020). People tend to buy equity when there are high chances of financial or positive returns. A few examinations exhort the DCF approach for fire up valuation. There is demonstrated practice for DCF application in new businesses that they guarantee esteeming beginning phase adventures is material by communicating the singular beta coefficient explicitly for the firm. DCF is the most pertinent technique among others (Akdağ 2017). To figure future incomes, two methodologies are utilized. One is a base-up methodology, while the other is a top-down investigation (Huang et al., 2018). In a bottom-up approach, expected sales are established, and possible earnings and revenues are derived. In the top-down approach, the product's total market is determined, which is then broken down to the possible company earning or revenue. Figure 1 provides a summary regarding the use of the DCF approach;

Figure1: DCF valuation inputs



Source: (Akdağ 2017)

2.2.2 Real Options Valuation (ROV) Method

The real Option Valuation (ROV) method is useful in that it provides that investors a chance to assess an upside for risk potential. One of the main commitments of ROV to the DCF is that it presents an occasion to notice potential gain or disadvantage development at beginning phases. ROV gives an option to contribute yet not a speculator's commitment (Wang et al., 2020). On account of a choice, if the venture fizzles, the financial specialist doesn't have an obligation. Be that as it may, if investee triumphs, speculator advances further interests to profit potential gain potential. This is a great fit for new businesses that convey immense potential just as gigantic risk (Cotei& Farhat 2017). The ROV strategies have unmistakable highlights that can be reduced as scientific and mathematical techniques. For additional investigation on the ROV, the approach requires developing a complex mathematical or numeric model on the target organization.

2.2.3 Relative Valuation (RV)

The relative valuation will be the organization's valuation by looking at how much a market pays for comparative organizations. Referenced methodologies have recently centered around the future estimation of organizations by assessing projections (Akdağ 2017). These methodologies may benchmark market organizations, yet it doesn't exclusively mirror economic situations (Wang et al., 2020). Nonetheless, RV mirrors the market accurately by looking at costs of comparable resources on the lookout. The strategy to follow is less mind-boggling than past ones. Exchange esteems, and market cost of different organizations is taken from the market, and these qualities are scaled to normal factors, for example, incomes, profit, or explicit area products. The last advance is computing a commonplace numerous that financial specialists are happy to contribute. It is referenced that a similar methodology is the most straightforward technique for valuation practice (Huang et al., 2018). A firm zeroing in on a protected innovation valuation is referenced that tantamount methodology is anything but difficult to compute regardless of whether the market isn't level-headed. In short, the strategy is utilized broadly since it is anything but difficult to execute, yet it accompanies inconveniences that make this procedure less appropriate and liked.

2.2.4 Berkus Method

It is expressed in the book that not many beginning phase adventures can arrive at the starting objective. Hence, subjective valuation is essential for financial specialists to evaluate the progress of the group. The subjective poll, notwithstanding that, is an apparatus for estimating estimation of beginning phase unsafe beginning up (Wang et al., 2020). Dave Berkus, a heavenly attendant speculator, recommends a scorecard model to satisfy this need. Contrasted with different methodologies, the Berkus Valuation approach is only for beginning phase pre-income

new companies. Speculators who like to go with ordinary valuation approaches miss the insights that less than one out of many new businesses meet their gauge incomes.

2.3 Machine Learning

Machine Learning is the creation of models or templates from datasets using computer systems. In addition to the definitions of Learning that have been formulated over the last ten years, various relevant definitions of Machine Learning have been given (Michalski et al, 2013). This relates to the notion of a cognitive system which is a physical or technical information processing system with the properties of learning, reasoning, perception, decision making, communication, action, etc. It can use two basic properties:

- a. Gaining knowledge during interaction with the environment.
- b. Improving the execution of actions with repetitions (i.e. improving its performance).

Humans observing their environment and trying to create simplified (abstract) representations, construct various models, using processes based on inductive learning and induction methods. In addition, humans can create various new structures called patterns. The process of creating such patterns and models from different sets of data is called machine learning. Furthermore, the type of feedback for learning is related to the nature of learning problems that ML programs face. Machine learning includes three distinct categories of learning:

- a. supervised learning: learning a new function from examples of input and output data
- b. unsupervised learning: learning input patterns without giving specific output values,
- c. reinforcement learning: use of observed types of feedback (rewards or reinforcements) to learn an (almost) optimal state about the environment

In supervised learning there are two types of problems (learning tasks) (Michalski et al, 2013). The first is classification, in which models for predicting distinct classes are created. In the second, which is regression, numerical value prediction models are created. The most basic algorithms in supervised machine learning include concept learning, decision trees, instance-based learning, Bayesian learning, interpolation or regression, neural networks, and support vector machines.

In unsupervised learning, the system discovers pattern itself from input data and tries to cluster them in specific categories or profiles of data. It is very useful in correlation or clustering problems. Reinforcement learning techniques are very useful in planning problems, testing in a

trial-and-error mode which sequence of actions are best for each state. It keeps learning the best action plan for each state until it reaches the optimal goal at the end.

2.3.1 Machine Learning algorithms

There are different classes of algorithms that aim to create a classification model and categorize the snapshots in a control set. Each algorithm is based on separate quantitative measures, so that it analyzes the data set differently and construct different classification models. Some basic models are (Patel et al, 2015):

- a. decision trees (e.g. ID3 and C4.5)
- b. probabilistic categorizers (e.g. Naive Bayes)
- c. discrete categorizers (e.g. linear logistic regression).

The basic execution steps are two. First, the learning stage in which the classifier algorithm constructs the classifier and analyzes the set of training data. Secondly, the classification stage in which the accuracy of the constructed algorithm is evaluated, using accuracy estimation methods. Before using any algorithm for categorization or regression the data to be used in the respective method should first be "prepared" to be entered in the respective algorithm. The basic steps of this process are the following:

- Data cleaning: management of incomplete-erroneous values and pre-processing of data in order to reduce noise
- Relativity analysis: removal of irrelevant values (outliers)
- Data transformation: generalization of data

Then, a cross validation stage is conducted to assess the performance of a system based on machine learning. This system is called upon to adapt its model as best as possible to the training data.

Machine Learning algorithms are categorised into the following sets:

- a. Decision Trees, which try to predict as accurately as possible the value of the variable they model based on the values of the imported variables (Gareth et al, 2017).
- b. Random Forest, which consists of many parallel decision trees and combines their predictions providing better results than simple decision trees.

- c. Bayesian networks, a type of a probabilistic graphical model that can be used to build models from data, as well as link a set of variables to probability relationships (Scutari et al, 2019).
- d. Support Vector Machines, which classify both linear and non-linear data using non-linear imaging techniques (or else hyper planes) to transform the original training data into higher dimensions.
- e. Clustering, which groups objects that have similar characteristics using unsupervised learning techniques (Everitt et al, 2011). The k Nearest Neighbor (kNN) classifies data points using a distance metric (it selects the closest point in the n – dimensional space to classify it).
- f. Neural Networks (NN), whose network of neurons are formulating nested layers of objects called sigmoids. The degree of interaction with the environment or else the knowledge collected from it is determined by the sigmoid weights (Gurney, 2004).

3. A Machine Learning-based scoring card method

We are proposing a Machine Learning – based performance evaluation method for startups which relies on the following principles:

- a. startup should successfully grow through a cycle of “building - measuring - learning”
- b. they should develop a “Minimum viable product or service” as early as possible
- c. their stakeholders should start learning about the performance of the product or service as early as possible
- d. their stakeholders should start receiving customer or internal feedback as early as possible.

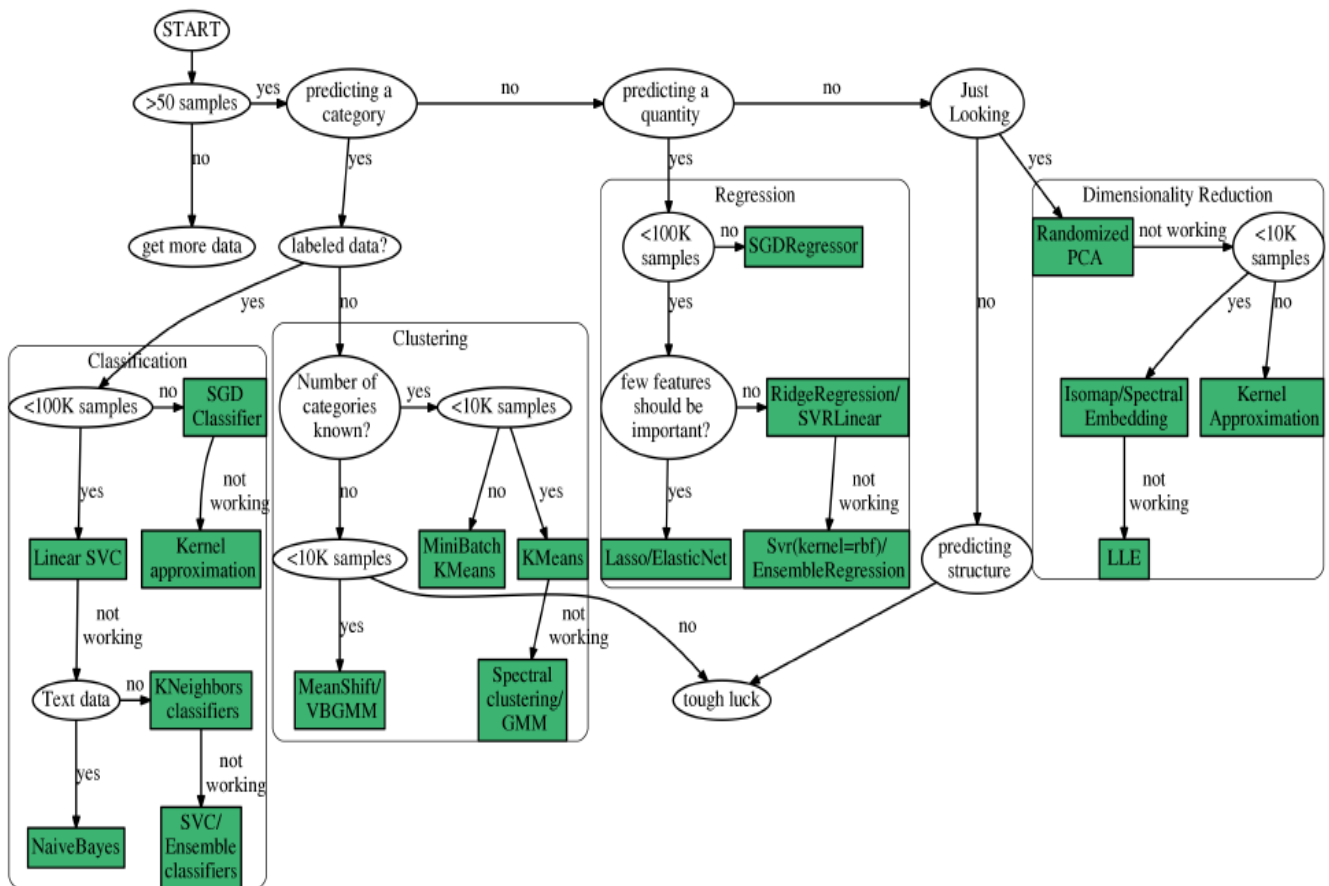
The contribution of a Machine Learning – based performance evaluation method to startups can be multifold:

- Setup a benchmark of a continuous learning and performance measurement processes.
- Startups can enable the learning very early discovering/predicting market demands and how to gain customers.
- Start the sales process already in the initial stage to gain market knowledge to feed the model.

- Distinguish different market segments and measure which segments are the most profitable in order to put effort there.
- Monitor customer usage of their product/service - learn about customer behavior and the most important issues to improve.
- Update the staff regularly about the outcome of the performance measures to increase staff motivation and receive feedback.

Selecting the correct Machine learning algorithm remains a challenge and depends on multiple factors. Scikit-learn (2020) provides a visual wizard to facilitate the selection (Figure 1). The figure includes representative set of algorithms, but more algorithms can be added.

Figure 1. Scikit-learns guide of choosing an estimator (scikit-learn, 2020)

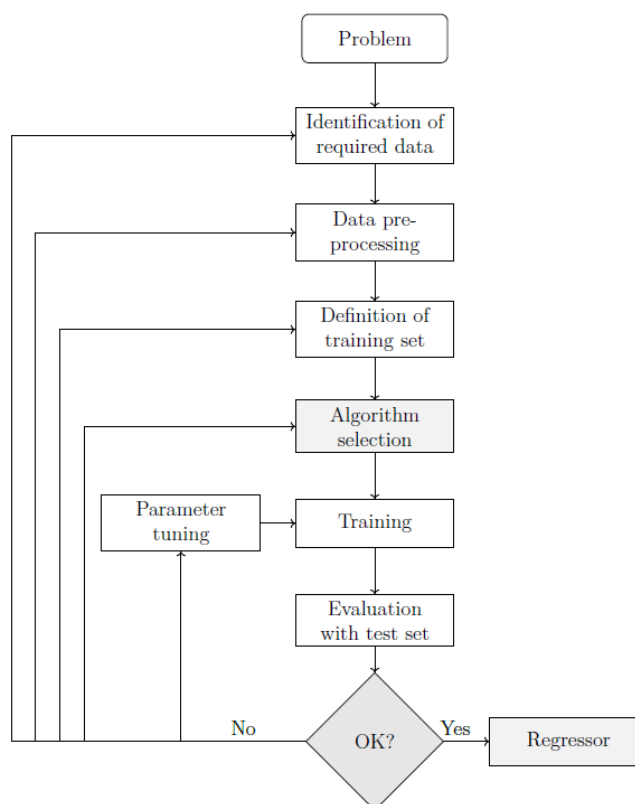


3.1 Scoring card KPIs

We are proposing three KPIs which should formulate a Balanced Scorecard (BSC) for a startup. The KPIs are associated to three areas, *team, product and marketing conditions* which together are linked to the objectives of the startup whose performance is measured in the BSC. The process of selecting a machine learning algorithm is elaborated in the following diagram and considers the following steps:

1. Collection of source data from relevant sections of the business for the KPIs
2. Split the data into testing and training sets
3. Data cleaning and transformation to a suitable format
4. Apply the ML selection heuristics (Figure 1) to find the most suitable algorithm
5. Algorithm execution and optimisation

Figure 2. Scikit-learns guide of choosing an estimator (scikit-learn, 2020)



Based on this process, the model proposes the intermediation of a Machine Learning algorithm to predict the contribution of identified source data to each of the KPIs. As it is elaborated in Figure 3, the KPI of Team takes as input the value of the technical skills, soft skills, prior success and reference data. These data can be generated in multiple forms (e.g. in association to the HR system). The ML algorithm calculates the corresponding weights and provides a projection of the Discounted Value. Similarly, product classification seeks to identify the current and future value of the product adjusting the weights for the final derivation of the KPI value. Market conditions consider customer satisfaction surveys/feedback and market share.

Figure 3. Evaluation of the BSC KPIs based on the mediation of a Machine Learning classification algorithm



Another layer of machine learning execution is required to cluster the derived discount values into groups of team, product and market related conditions which formulate the predicted balanced scorecard. The clusters identify situations in which the startup may enter into different growth areas of positive or negative results from a financial or market perspectives and these will affect the investors' decisions.

Figure 4. Clustering of the Discounted Values – accurate prediction of the balanced scorecard



4. Conclusion

Evaluation of a startup from its early stages of development regarding its sustainability and profitability with sophisticated AI-based tools has become a necessity. Partly due to the weakness of the traditional valuation scorecard methods to process the vast amount of data while lay into different aspects of the business, and due to continuous need of learning the global market, the customer user and adjust to their changing needs.

Performance evaluation is an important component of startups' sustainability and associated prediction strategies. This paper proposes a Machine Learning approach for formulating the KPIs of the Balanced Scorecard for startups using an analytical hierarchal process and ML-based classification system. The main innovation of this approach is that it allows collection of multiple source data for identifying the performance indicators, and it provides a flexible framework for selecting the right Machine Learning classifier to evaluate their performance.

The classifier drives the supervised or unsupervised learning process per case and this can occur at different stages of the startup. Subsequently, the classification system uses unsupervised learning algorithms to formulate different growth strategies which are finally reported to the startup stakeholders and investors.

In the future this framework can be evaluated into real examples of startups which are either belonging to different business sectors or are running already in different stages of development.

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