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Editorial

The Journal of Business and Social Sciences (JBSS) is a multidisciplinary, double-blind peer-reviewed journal published annually by the Centre for Research and Publication (CRP) at the Hetauda School of Management & Social Sciences (HSMSS). Now in its fifth volume, JBBS, provides a platform for scholarly research in various fields from business and social sciences.

Over the past few years, the Journal of Business and Social Sciences (JBSS) has industriously contributed to contribute to academic discourse by publishing articles both from faculty within and outside our institution. It's immeasurably pleasing to see a remarkable increase in audience and article submissions, particularly from our faculties. CRP reliably works to improve on publication process ensuring an efficient and satisfying experience to both researchers and readers. This issue presents eight diverse articles from management and social sciences. With support from college management, faculties, and editorial team, we have published our fifth volume and hope this support continues in the future. We highly appreciate the contribution from our faculties and authors from outside our institutions for making this issue possible, particularly in a tight time frame.

Lastly, we offer heartfelt gratitude towards Principal Puran Joshi, Vice Principal Ram Pandit Khanal, Director of Planning and Development Dipesh Joshi, Academic Director Pradyumna Upadhyaya, Head of General Management Krishna Gopal Shrestha, and Department Heads for their motivation, encouragement, and support to the continuation of JBBS. We look forward to the journal's role in advancing academic knowledge and inspiring minds in the future..

Regards

Centre for Research and Publication

Hetauda School of Management & Social Sciences

About the Journal

Aims and Scope

Journal of Business and Social Sciences (JBSS) is a multidisciplinary double blind peer-reviewed journal of Hetauda School of Management and Social Sciences. JBSS is the platform for original research works in the field of social sciences, education, economics, accounting, finance, marketing, management, literature, statistics, culture, psychology, medicine, public health, science and so other related issues on business and social sciences. The nature and scope of the journal is to serve the authors, readers, reviewers, academicians, practitioners, policy makers and students through prompt publication of significant advances in any branch of business and social sciences. JBSS ensures to disseminate the results of research to the public throughout the world, in a fashion that conveys their significance for knowledge, culture, and daily life. The future plan of the journal is to make JBSS international.

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Publication Frequency

The journal will be published annually.

Peer-Review Process

JBSS follows double blind peer-review process. The manuscript is submitted for review to minimum two experts from the panel of peer review and editorial board. A key convention in the publication of research is the peer review process, in which the quality and potential contribution of each manuscript is evaluated by one's peers in the scientific community. Like other scientific journals, APA journals utilize a peer review process to guide manuscript selection and publication decisions. Toward the goal of impartiality, the majority of APA journals follow a masked review policy, in which authors' and reviewers' identities are concealed from each other. Reviewer identities are never shared unless the reviewer requests to sign their review.

The action editor scans the paper to gain an independent view of the work. This "quick read" provides a foundation for the more thorough reading that follows it by no means determines the final decision, but does parallel how authors can expect many reviewers (and readers) to approach their papers. First, the editor scans the paper from beginning to end for obvious flaws in the research substance and writing style. If problems show on the surface, a deeper reading is likely to uncover other matters needing attention. After this initial examination of the manuscript, the action editors, as well as any peer reviewers, will follow these general guidelines; read the abstract whether it is conclusion –oriented abstracts or not, examine the full manuscript, scan the paper headings, check for plagiarism, scan the references, scan the tables and figures and so other basis developed on expertise of the reviewer.

Open Access Policy

This journal provides immediate open access to its online content on the principle that making research freely available to the public supports a greater global exchange of knowledge.

Message from the Principal

It is my great pleasure to introduce our fifth volume of Journal of Business and Sciences (JBSS). It exclusively meant to showcase the research and writing talent of our faculties, enhancing academic and professional development. I am assured that JBBS will help both our students and faculties in advance their knowledge and building competency locally and globally. The holistic advancement of our faculties is essential to meet our mission, as it helps them to shine as an educator and an academician in Nepal.

In today's world, every academic institution, industries, and government should focus on research activities. JBSS represents a significant step forward in promoting scientific research among our students and faculties I am confident that this journal will not only elevate the quality of our faculties but will also contribute to the academic world. I acclaim our dedicated faculties, who continuously putting efforts to improve the educational experience of our students, for the betterment of our students. I acknowledge the contributors and editorial board for their efforts in bringing out this latest volume of JBSS.

At Hetauda School of Management and Social Sciences, we are committed to providing contemporary, and quality education. As principal, it is my privilege and pleasure to share that our institution is continually dedicated in educating the nation at the best of its ability. Our core focus remains on empowering students and faculties with knowledge, wisdom, experience, essential life values, equipping them for success both at the academic level and in today's competitive marketplace.

I extend my best wishes to all contributors and readers of this volume. I also invite and encourage all the faculties to contribute and collaborate to raise JBSS to international standards reflecting the excellence we strive for at our institution.

Regards,

Principal

Puran Bahadur Joshi

Hetauda School of Management and Social Sciences

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Abstract

The foundation of this study is the effect that HRM strategies have on the high-performance outcomes of financial institutions in Nepal, as measured by organizational performance. While productivity, quality, and innovation are variables of high-performance outcomes, recruitment and selection, training and development, performance appraisal, career planning, remuneration, employee participation, and job design are variables of HRM practices. The job design in this study has a significant sensitivity to organizational success in terms of high-performance, followed by employee participation and remuneration structure, according to an analysis of the beta coefficient. However, every other factor including career planning, training and development, and recruiting and selection has a favorable effect on the high-performance results of organizational performance. However, the impact of career planning, training and development, and recruiting and selection on high-performance outcomes is negligible. This research work suggested that to improve the performance levels of financial institutions, it is essential to invest sufficient funds for completing HRM practices, based on the scope of business.

Keywords: HRM practices, Productivity, Quality, Innovation, Performance outcomes

Introduction

The current business era is characterized by globalization, which increases the potential for businesses to offer high-quality goods and services. Nevertheless, this potential also comes with a high level of competition for entrepreneurs, who must contend not only with domestic rivals but

also with global corporations. In today's market economy, the growing global rivalry has put more emphasis on customer satisfaction, speed of work, and business flexibility, which has generated obstacles for all kinds of enterprises. The competitive pressures that managers currently deal with will persist in the future as demands for organizational excellence increase. In order to accomplish such excellence, the core components of human resource management such as productivity, innovation, learning, high-quality work, teamwork, and reengineering need to be prioritized. In fact, in today's fast-changing economic environment, every organization's role must have a positive impact on organizational performance. HRM is responsible for managing an organization's most valuable resource, human capital. Adequate human capital management helps to achieve corporate goals (D'Aveni, 1994; Jackson & Schuler, 1995; Baird & Meshoulam, 1998; Otoo, 2019). Human resources (HR) are critical in the service industry, which depends largely on employee skills and competencies. To respect these abilities and competencies, the organization must establish consistent HRM procedures that define greater organizational outcomes (Delery & Doty, 1996; Rotea et al., 2023).

Proper resource management may ensure an organization's success and efficiency (Pradhan & Shrestha, 2022). The efficient handling of human resources in the organization and its operation is the primary focus of management, and it is the reason for organizational success and sustainability (Shrestha, 2022; Shrestha & Prajapati, 2023). According to Adhikari (2005), despite shifts in political and economic interests over the past ten years, there hasn't been a noticeable change in HR policies and practices at the company level. Nepal is currently only beginning to create its human resource management system. Managers in Nepal do not prioritize human resource planning and practices. The academics who study human resource management and its connection to performance take a variety of approaches. Guest (2002) outlined three popular methods for identifying the primary ways that HRM may improve the corporate and strategic fit models. In undeveloped countries such as Nepal, the human resource function is evident only in those firms that are knowledge-based or heavily reliant on technology. HR management must be effective in order for businesses to perform well (Shrestha & Prajapati, 2023).

Not unexpectedly, academics and practitioners alike welcomed the early study on HR practices and organizational performance with great excitement, and the statistics seem notable and authoritative (Richardson & Thompson, 1999). However, scholars in this field (Huselid, 1995; Guest, 2005) have identified some of the shortcomings of the study methodology used thus far, and a growing body of criticism has been directed towards the early work, which was almost entirely composed of quantitative data subjected to statistical analysis. The dependability of the data, the data's lack of breadth and depth, and the conceptual framework that the research was conducted within are the three areas of criticism about the assessment of HR policies and practices.

Few studies have been conducted in the Nepalese environment thus far by some scholars attempting to link company success with human resource practices. Gautam (2008) discovered that because of its national culture, Nepal has a higher level of affective commitment than other types of commitment. According to Adhikari and Muller (2001), there are advantages and disadvantages to transferring Western-style HRM recommendations to developing nations. The majority of managers and policymakers in Nepal are not persuaded by the advantages of investing in human resources. Specifically, the idea that individuals ought to be viewed like precious things is still not

widely accepted. This discipline has not been recognized as a research area by Nepalese academicians and scholars. The issues presented in this study pertain to examining the influence of human resource management practices on superior performance outcomes within financial sector entities. However, the common research issues of this study consist of what is the current status of the HRM practices in banking sectors in Nepal, what is the effect of HRM practices on behavior outcomes of banking sectors of Nepal, and what is the impact of moderating variables in between HRM practices and behavioral outcomes of financial institutions in Nepal? Therefore, the present study focuses on assessing the human resource practices in the financial institutions of Nepal. This study also attempts to find out the relationship between the adoption of such practices and their impact on performance.

Literature Review

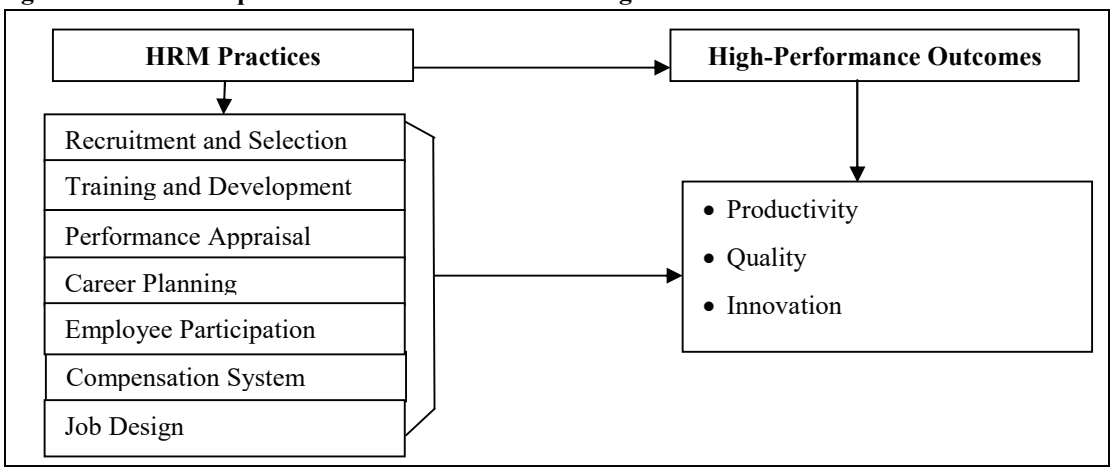
Theoretical underpinning relating to relationship of HRM with High-Performance

The literature emphasizes the importance of HRM in generating successful organizational performance outcomes and management (Garengo et al., 2022). Guest (1997) contended that little light is shed on how HRM practice and policy translate into excellent performance by either the descriptive or the strategic models. Researchers believe that HRM is only a small portion of the explanation for high-performance and propose that greater performance is likely when all of the subsystems, including the HRM subsystems, are in sync and mutually supportive. The descriptive approach places greater emphasis on employees' active participation in order-negotiating. On the other hand, organizational psychology is the source of the normative approach. It is assumed that effective HRM procedures draw on workers' dedication and motivation. The salient characteristics of this methodology are that HRM offers a logical amalgamation of various behavioral theories and elucidates the correlation between HR practices and high-performance outcomes of financial institutions. McDuffie (1995) established a foundation for the connection closely associated with expectation theory. Guest (1997) created a typology that illustrates the connection between HR procedures and organizational success based on this foundation. Numerous empirical research has been conducted to establish a connection between HR practices and financial, performance, behavioral, individual, and HRM outcomes. Researchers have maintained a relationship in this study between HRM practices and organizational success as measured by high-performance outcomes consisting of productivity, quality, and innovation.

Research Framework

HRM practices affect employee abilities by acquiring and developing a company's human capital. Therefore, the evaluation of the empirical literature focuses on an earlier study assessing the relationship of HRM practices with employee high-performance in anticipation of an estimating model that centers on these dependent variables. This study attempts to establish a connection between how organizational performance is affected by HRM practices and high-performance consequences. Recruitment and selection, training and development, performance reviews, career planning, pay, employee involvement, and job descriptions are all components of human resource management that have a positive effect on employee performance in terms of high-performance outcomes such as productivity, quality, and innovation. This study framework is based on the research scope provided by Guest (1997).

Figure 1: Relationship between HRM Practices and High-Performance Outcomes



Research Methods

Research Design

In order to analyze the numerous difficulties highlighted, this study used a descriptive, co-relational, and causal comparative research methodology. For the objective of gathering facts, conceptualizing, describing, and operating in quest of sufficient information regarding HRM practices and organizational performance in terms of high-performance outcomes in Nepal, the descriptive research design is employed. In order to determine the connection between HRM practices and organizational performance, this study has also used a correlation research approach. The research design used here is the same as that used in other studies, such as Guest, 1997. HR procedures create work environments that enable employees to receive the most information possible, delegate decision-making authority, and be inspired to meet company objectives (McDuffie, 1995; Wright et al., 1997).

Sources and Nature of Data

Primary sources, such as questionnaires, were used to gather the data and information required to meet the research's objectives. Ten financial institutions comprised the commercial banks, development banks, finance companies, and micro-finance companies from which the study's data were gathered. Three areas of data were gathered for this survey study: high-performance outcomes, human resource practices, and respondent details. The questionnaire was created using previous research that Guest, 1997, had done. This research essentially considers the normative theory of the relationship that exists between HRM practices and the high-performance results of financial institutions.

Population and Sample Size

The researcher administers the tools with the assistance of friends and expert recommendations. The responders were given a thorough explanation by the researcher of the study's goal and every feature of the questionnaire. The respondents who were chosen include workers who hold various positions in head office and branch offices across the nation, including management, officer, and

assistant positions. They are made aware that any information they submit will be handled in confidence and used solely for research. Ten financial institutions consisting of commercial banks, development banks, finance companies, and micro-finance companies are considered as samples for analysis in this study. 405 (89.01%) of the 455 questionnaires that have been sent have been fully completed and returned and these copies are used in the study.

Measurement of HRM Practices and high-performance outcomes

Recruitment and selection, training and development, performance appraisal, career planning, remuneration system, employee participation, and job design are the seven items that make up the measurement of HRM practices in this study. Its foundation is Huselid's normative theory of HRM practices (1997). Employee productivity, quality and innovation are among the high-performance outcomes that are taken into account while measuring the effectiveness of the organization. The foundation of this research work is Guest's (1997) normative theory of HRM practices and high-performance outcomes.

Results and Findings

HR procedures are now seen as a crucial part of management in the modern company environment. The primary obstacle that firms will likely face in the future is the constant pursuit of a competitive edge. There is growing contention that organizations that possess the ability to obtain and employ scarce, valued, and unique resources will be the most equipped to tackle this challenge (Barney, 1991). Guest (2000) posited that a shift towards a behavioral model may lead us to consider the relationship between employee perception and behavior, as well as individual or group performance outcomes that impact unit performance and ultimately company performance.

The high-performance outcomes are regarded as the dependent variable (Y) in this research study, and the HR practices bundle is regarded as the independent variable (HRP). The regression formula has been utilized as:

$Y = a + bHRP + e$

$= 29.912+0.251\ HRP$

T = (17.322) (17.272)

P = (0.000) (0.000)

R= 0.520, R^2 = 0.392, Adjusted R^2 = 0.383, F- Value= 64.21

P - value for overall significance = 0.000

It has a R^2 of 0.392. This indicates that the model only accounts for 39.2% of the total variation; the remaining portion is explained by factors not examined in this study. The total p-value is 0.000, and the F-value is 64.21. Given that the F-value is significant at the 5% level of significance, the multiple regression model employed in this study is thus adequate and fit.

The computed p-value for the variable HR practices bundle is 0.000, indicating significance at the 5% level of significance. Thus, the HR practices bundle is a significant predictor of high-performance outcomes. Thus, it can be said that this variable significantly and strongly influences the high-performance outcomes of Nepal's financial institutions.

Discussion and Conclusion

Many businesses recognize the importance of human resources in gaining a competitive advantage in today's highly competitive global business environment. Financial institutions are not the exception. Therefore, this study investigated the impact of HRM practices on high-performance outcomes of such institutions by using a multiple regression model. When looking at the beta coefficient, the sensitivity of a single variable job design to organizational performance is highest when looking at employee participation and remuneration structure. However, every other factor including career planning, training and development, and recruiting and selection has a favorable effect on the high-performance outcomes. However, the effects of career planning, training and development, and recruiting and selection on the behavioral consequences of high-performance outcomes are negligible. Therefore, as compared to other variables, these three HR practices are not very important predictors of high-performance outcomes of financial institutions.

In conclusion, the study discovered that all aspects of HR practices, including recruitment and selection, development and training, performance reviews, career planning, pay scales, employee involvement, and job designs, positively influence high-performance outcomes that affect organizational performance across the board. However, in terms of employee productivity, quality and innovation of high-performance; job design, employee participation, and compensation system variables have a significant impact on high-performance outcomes of financial institutions; in contrast, recruitment and selection, training and development, and career planning have minimal impact on high-performance outcomes of financial institutions. This study's main goal was to assess how best HR practices affected the high-performance outcomes of organizational performance that Pfeffer (1994) and Guest (2002) had defined. The researcher postulates that the following practices—recruitment and selection, training and development, performance appraisal, career planning, remuneration system, employee participation, and job design are related to organizational success based on Guest (2002). System-based recruitment and selection, training and development, career planning, performance appraisal, compensation system, employee participation, and job design all positively contribute to high-performance outcomes as indicated by nominal degrees of employee productivity, quality and innovation, according to regression coefficients of these activities. This could imply that Nepalese financial institutions look for qualified applicants in order to hire them. This suggests that the financial institutions in Nepal may enhance employee productivity, quality and innovation by investing a substantial sum of money in selecting the right candidates. This result is in line with those of Huselid (1995) and Guest (1997).

Implications

A few specific criteria related to HRM practices were considered in this study in order to gather input from employees at the managerial and assistant levels of a chosen group of financial institutions. Additionally, the productivity, quality and innovation of specific financial institutions' workers have been used to quantify high-performance outcomes. The goal of this study is to preserve the relationship and correlation between the variables related to HRM practices and the high-performance outcomes of financial institutions.

The entities within the manufacturing, distribution, and service sectors have experienced considerable transformation due to the emergence of novel scientific advancements and the

application of such knowledge within the realm of commerce. For Nepalese organizations, the World Trade Organization's growth has presented both opportunities and threats. This study may shed light on the relationship between HRM practices and high-performance outcomes in the financial institutions of Nepal. The efficacy and caliber of the financial sectors business organizations offer their clients determine a great deal of their success. Taking these opinions into account, it is anticipated that this study will be beneficial in examining HRM practices in the financial sectors and how they affect the company and worker performance. In order to improve future organizational performance, top management, functional managers, and HRM managers will find the study's findings beneficial in designing their HRM practices within a strategic situation of finance institutions at both micro and macro levels. This study would be supportive for the managers to make decisions to maintain high-performance outcomes of financial institutions in Nepal.

Research Limitations

The study is guided by appropriate research methodologies to come up with suitable findings. However, there are some important limitations under this study, which in the cross-sectional data used in this study prevents the time lag effects of the factors from being seen. The majority of the study's data were gathered via surveys from primary sources. As a result, the respondents' unique perceptions determine the validity of the results. Because every business has a different environment, the components of human resource high-performance outcomes considered in this study might not be equally applicable in every case. The study's characteristics related to human resource practices could not accurately reflect all firms, and it is limited to the manufacturing and service industries. As a result, the study's findings might not apply to every business unit.

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Autocorrelation and Heteroscedasticity in Regression Analysis

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Abstract

In the world of econometrics and time series analysis, autocorrelation and heteroscedasticity are two statistical issues that analysts often encounter when modeling data. Both phenomena can seriously undermine the reliability of regression results if left untreated, leading to biased conclusions and faulty predictions. Autocorrelation and heteroscedasticity are important considerations in any regression analysis, especially when explaining with time series analysis. Both phenomena undermine the accuracy of the model if left unaddressed. By applying the appropriate tests and corrective measures, such as Generalized Least Squares or robust standard errors, analysts can ensure that their models remain reliable, leading to more valid inferences and better decision-making. In practice, detecting and correcting for it should be a standard part of the model validation process to avoid incorrect conclusions and improve the robustness of the results.

Keywords: Autocorrelation, Heteroscedasticity, Regression analysis, Durbin- Waston test, Goldfeld-Quandt test, serial correlation coefficient

Introduction

A statistical technique known as an autocorrelation is used to determine if the variables in the prediction model have a correlation that varies with time. When the prediction model's autocorrelation assumption is met, the disturbance values are auto correlatedly paired rather than independent pairs. Checks for autocorrelation that may develop as a result of successive observations made over time and their relations.

The residuals' inability to remain independent across observations is the root source of this issue. The goal of the autocorrelation test is to display the connection between observation members arranged temporally or spatially. In addition, it tests whether the confounding error in a linear regression model are correlated. An autocorrelation problem arises when there is a correlation. The balance is not independent from one observation to the next, which leads to this issue.

It is common in time series data, where observations are often dependent on past values. For instance, a country's GDP in one year may be strongly related to its GDP in the previous year. If it exists, using Ordinary Least Squares (OLS) regression can lead to misleading statistical inferences.

As a result, there are several approaches for figuring out whether it exists. Durbin Watson (DW) test is a frequently used technique to identify autocorrelation in multiple linear regression. It is

most frequently employed. This article explores these two concepts, their impact on regression models, detection methods, and solutions to correct them.

Literature Review

Kim (2019) explored that Multiple linear regression analysis findings are distorted by multicollinearity. The statistical insignificance of the regression coefficients and the widening of their confidence intervals are caused by the multicollinearity-induced inflation of their variances. If the variance inflation factor and condition number are greater than 5 to 10 and 10 to 30, respectively, then multicollinearity is found. Added that the creation of a trustworthy multiple linear regression model is made possible by the diagnosis of multicollinearity and the removal of multicollinear explanatory variables.

Baum and Lewbel (2019) explained that Heteroskedasticity can be used to construct instruments using estimators in the absence of external instruments. Astivia and Zumbo (2019) explored that high heteroskedasticity can be effectively addressed through the application of the bootstrap procedure. This technique can be used to calculate p-values and confidence intervals in instances where a researcher deals with small sample sizes.

Mukherjee and Laha (2019) described that Durbin-Watson test, which is commonly used for first-order autoregressive schemes, can be applied in small sample sizes to guarantee the validity of the collected information. Shrestha (2020) discussed that on identifying the characteristics of the visitors' destination satisfaction and how these elements affect their decision to return to Nepal. This study sent self-administered questionnaires to a sample of visitors, using the survey approach for data gathering. To identify important parameters associated with destination feature satisfaction, an exploratory factor analysis utilizing principal component analysis and varimax rotation was conducted. A probit model was examined using the maximum likelihood approach to examine the influence of visitors' satisfaction with their desire to return. Yin (2020) explained that estimation of autocorrelation is frequently challenging in instances where researchers deal with small sample sizes. The Durbin h test for autocorrelated error terms can be applied in instances where a researcher is dealing with a small sample size.

Youssef (2022) explored that majority of econometric models have issues with heteroscedasticity, multicollinearity, and autocorrelation. A summary of these issues, their causes, and methods for detection, testing, and minimization are provided in their work. The OLS approach is predicated on a number of norms, and if these presumptions hold true, we are left with estimates that are efficient, unbiased, and have less variation than other approaches. They talk about these issues as follows: First, the multicollinearity issue Second: The autocorrelation issue Variation Heteroscedasticity ranks third. The inference for several widely used estimators is presented in their paper, including the normality test for residuals, the correlogram of residuals, the coefficient covariance matrix, and variance inflation factors. The LM test for serial correlation, the Harvey heteroskedasticity test, and the estimated and actual residuals.

Literatures about this theory can be found in any standard text books, reference book and monographs of autocorrelation and heteroscedasticity, for instance we refer a few; Dobson & Basnett (2008), Kaufman (2014), Ye & Sun (2018), Fox (2008) etc. As this work explores these two concepts, their impact on regression models, detection methods, and solutions to correct them. These are two distinct concepts in regression analysis and time series analysis.

Method and Discussion

Let us consider the multiple regression equation get the form

$$Y_i = a + bX_i + e_i \quad \text{(i)}$$

Where a = Y_i- intercept
b = slope of regression line
X_i = independent variable
Y_i = dependent variable
e_i = errors or disturbance term

Estimated error value is the difference between observed (Y_i) and estimated ($\hat{Y}_i$) values of the dependent variable for a given value of X_i .

$$e_i = Y_i - \hat{Y}_i \quad \text{(ii)}$$

Here,

Y_i = observed value

$\hat{Y}_i$ = estimated value

The fundamental assumptions of the linear regression model regarding errors or disturbance are usually distributed with mean zero and variance σ^2 i.e. $e_i \sim N(0, \sigma^2)$ and the covariance between them are zero. So, the following are fundamental assumptions:

(i) e_i is normally distributed
(ii) $E(e_i) = 0$
(iii) $E(\sigma^2) = \sigma^2$
(iv) $E(e_i e_j) = 0$ for i ≠j i.e. covariance is zero.

This suggests that the influence of the error term occurring at one period does not carry over to another period, observations are taken across time. Assume for the moment that we are researching the consumption function. In error term in time series missing data indicates that changes in consumption brought on by marriage ceremonies or other events are just momentary, affecting the current month's consumption. When we talk about cross-sectional statistics, we mean the model that says about the disruption of one family's consumption due to a relative's visit has no impact on the consumption of other households.

However, this presumption is false in actuality. When dealing with time series data, it is reasonable to assume that a significant number of random and independent components that are present during one period will partially or completely persist into subsequent periods. As a result, variables that were previously thought to be random begin acting permanently, which results in auto-correlation between subsequent disturbances. Stated differently, it may be said that if the least square estimator fails to satisfy or

$$E(e_i e_j) \neq 0 \text{ for } i \neq j \quad \text{(iii)}$$

The relationship between e_i and e_j, gives auto correlation. The series is auto correlated if

$E(e_i, e_j) \neq 0$ for i ≠j, otherwise, it is not correlated.

We have been discussing the independence of the errors, which is one of the fundamental assumptions of the regression model. Because a residual at any given point in time may tend to be comparable to residuals at adjacent points in time, this assumption is frequently broken when data are gathered over successive periods of time. As a result, it would be more probable for positive residuals to follow positive residuals and for negative residuals to follow negative residuals. We refer to this kind of residual pattern as auto-correlation or serial correlation. When a collection of data exhibits significant auto correlation, one may seriously question the validity of a fitted regression model.

Correlation between two time series data such as $e_1, e_2, \cdots\cdots e_{10}$ and as $e_2, e_3, \cdots\cdots e_{11}$, where the previous is the latter series lagged by one time period, is auto-correlation.

Causes of Auto-Correlation

There are several causes responsible for auto-correlation:

(i) **By removing explanatory variables**: An error term in one period may have a relationship with the error terms in other periods because in economics, one variable is affected by a large number of factors. If we have excluded the explanatory variables, the error term indicates the effect of omitted variables. As a result, absent explanatory factors lead to the auto correlation issue.

(ii) **By mis-lead of the mathematical model**: The second cause in autocorrelation is the mis-lead of the relationship between dependent variable and explanatory variables. So, care should be taken to specify it.

(iii) **By mis-lead of the true random:** The presence of measurement error in the disturbance term makes it potentially auto-correlated. The serial disturbances will auto-correlate if the explanatory variable is measured incorrectly because there is no way to fix it.

Effect of Auto-Correlation

When economic time series are used in many cases, the independence error term, may not hold. Let us consider the two variable regression model of the following form

$$Y_t = a + b_1 X_t + e_i \quad \text{(iv)}$$

Where t is the time series data and u_t has five order regression as

$$E(e_t, e_{t+s}) \neq 0, \text{ and } s \neq 0 \quad \text{(v)}$$

The error terms are generated as follows:

$$e_t = \rho\, e_{t-1} + \varepsilon_t, \; -1 < \rho < 1 \quad \text{(vi)}$$

ρ is the coefficient of auto correlation and ε_t is the stochastic disturbance, satisfies the ordinary least square (OLS).

$E(e_t) = 0$

E (ε_t^2) = var (ε_t) = σ^2

E (e_t, e_{t+s}) = cov. (e_t, e_{t+s}) $= 0$ for s $\neq 0$

When e_t and e_{t+s} are not independent, so define

$\rho = \frac{\text{cov.}(e_t, e_{t-1})}{\text{var}(e_t)} = \frac{\sum_{t=2}^{n} e_t e_{t-1}}{\sum_{t=1}^{n} e_t^2}$ as the first order autocorrelation coefficient of the e-series. Similarly, for the variable linear regression model

Y_t = a + $b_1 X_t + b_2 X_2 + e_i$

$\rho^2 = \frac{\text{cov.}(e_t, e_{t-2})}{\text{var}(e_t)} = \frac{\sum_{t=2}^{n} e_t e_{t-n}}{\sum_{t=1}^{n} e_t^2}$ is the second order auto correlation coefficient of the e-series.

$\rho^s = \frac{\text{cov.}(e_t, e_{t-s})}{\text{var}(e_t)} = \frac{\sum_{t=s+1}^{n} e_t e_{t-s}}{\sum_{t=1}^{n} e_t^2}$ is the s^{th} order of the e-series. If s =0, then ρ = 1. The zero-order autocorrelation coefficient is constantly unity

Detection of Auto-correlation- Durbin-Watson Test

The Durbin Watson statistic is a test statistic that was created by statisticians Durbin and Watson to identify the existence of autocorrelation in the residuals. The correlation between each residual and the residual for the time period right before the one of interest is measured by this statistic. The Durbin Watson statistic is used to determine if the error terms are independents or serially correlated (auto correlated). The Durbin Watson statistic has the following definition:

$$d = \frac{\sum_{t=2}^{n} (e_t, e_{t-1})^2}{\sum_{t=1}^{n} e_t^2} \qquad \text{(vii)}$$

where e_t in time t.

To better know what the Durbin-Watson statistic is, we need to examine the composition of the 'd' statistic presented in equation (vii).

The numerator $\sum_{t=2}^{n} (e_t, e_{t-1})^2$

represents the squared difference in two consecutive residuals. The denominator represents the sum of the squared residuals,

$$\sum_{t=1}^{n} e_t^2$$

Since the value of d-statistic from e_t depends on the given X's, unlike the t, F or χ^2 tests, there is unique critical value of it, which will lead to the rejection of the acceptance of the null hypothesis that there is no first-order serial correlation in the disturbance e_t.

Durbin and Watson derived a lower bound d_L and an upper bound d_U . If the computed value of d-statistic lies beyond the critical values, then there is company of positive or negative serial correlation. The values of d_L and d_U depend only on the number of observations and the number of explanatory variables k.

Range of d

The limits of d are 0 and 4 that can be derived as:

The Durbin-Watson Test is

$$d = \frac{(e_t - e_{t-1})^2}{e_t^2} = \frac{\sum e_t^2 + \sum e_{t-1}^2 - 2\sum e_t e_{t-1}}{e_t^2} \quad \text{(viii)}$$

Since, $\sum e_t^2$ and $\sum e_{t-1}^2$ differ in only one observation, they are approximately equal. So,

$\sum e_t^2 = \sum e_{t-1}^2$ in (viii), get

$$d = \frac{\sum e_t^2 + \sum e_t^2 - 2\sum e_t e_{t-1}}{e_t^2} = \frac{2\sum e_t^2 - 2\sum e_t e_{t-1}}{e_t^2} = 2\left[1 - \frac{\sum e_t \sum e_{t-1}}{\sum e_t^2}\right] = 2\{1-\rho\},$$

where ρ is coefficient of auto correlation

$$\frac{\sum e_t \sum e_{t-1}}{\sum e_t^2}$$

Or, $d = 2[1-\rho]$ (x)

Where $-1 \leq \rho \leq 1$

Nature of First Order Auto correlation

(i) $\hat{\rho} = 0$ or d=2, then there is no first order auto correlation. So, errors are statistically independent.

(ii) $\hat{\rho}$ = +1 i.e. d = 0, then there is perfect positive auto correlation in the residuals

(iii) If $\hat{\rho}$ = -1 i.e. d = 4, then there is perfect negative correlation among successive residuals

(iv) If $\hat{\rho}$ > 0, then d< 2 (i.e. closer is d to zero) in such a case there is greater evidence of positive correlation auto correlation.

(v) If $\hat{\rho}$ < 0, then d > 2 (i.e. closer is d to 4), in such a case there is greater the evidence of negative auto correlation.

In order to determine whether the errors terms are statistically independent or auto correlated, the steps for testing auto correlation by Durbin-Watson test statistic are as follows.

Step 1: Setting the null hypothesis and alternative hypothesis

Null hypothesis Ho: $\rho = 0$. There is no first order positive (or negative) auto correlation between the error terms.

Alternative hypothesis H□: p > 0. There is first order positive auto correlation between error terms. In other words, they are dependent means that they are positively auto correlated.

Alternative hypothesis H□: p <0. There is first order negative auto correlation between the error terms.

Alternative hypothesis H□: p≠0.There is significant evidence of auto correlation.

Step 2: Compute Durbin Watson test statistic d under H is

$$d = \frac{\sum_{t=2}^{n} (e_t - e_{t-1})^2}{\sum_{t=1}^{n} e_t^2}$$

Step 3: Finding out the critical d_L and d_U values at appropriate level of significance at particular sample size and variables.

Step. 4: Comparing the computed value of d with critical d_L and d_U values.

Choice for positive autocorrelation

(i) When d <4- d_L , d is significant and the null hypothesis H_0 is rejected and the alternative hypothesis H_1 that there is positive first order auto correlation.

(ii) When d > 4- d_U is not significant then the null hypothesis Ho is not first order positive auto correlation.

(iii) When d_L <d< d_U, test is inconclusive.

Choice for negative autocorrelation

(i) When d>4-d1, d is significant and null hypothesis Ho is alternative hypothesis H

(ii) When d<4-du, d is not significant and null hypothesis Ho then there is no negative auto correlation.

(iii) When 4-du <d<4- d_L, then test is inconclusive, the result does not have a common application.

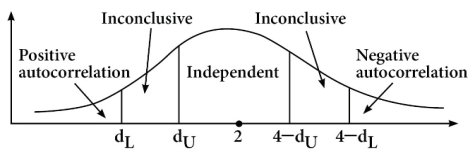
Choice for two-tailed case

(i) When 4- d_L<d<d_L , then d is significant and rejecting H_0 to accept H1 gives auto correlation.

(ii) When d_U <d < 4- d_U, then d is not significant and accepting H_0 gives no auto correlation.

Figure 1 shows the distribution of 'd' statistics is approximately

centered around the value d = 2.



Distribution of d-statistics

Method of Removing Auto-correlation

If auto correlation exits, we may attempt to remove it by transforming the data (say X and Y) into new variables (say X' and Y') and then applying the method of least squares. We shall explain here the case where the it is removed. A method that is used to remove it is to transform the variables as follows.

Let the regression equation

$$Y = a + b_1X + e \quad \text{(xi)}$$

and first order autocorrelation coefficient is

$$\rho = \frac{\sum_{t=2}^{n} e_t . e_{t-1}}{\sum_{t=1}^{n} e_t^2} \quad \text{(xii)}$$

Let Durbin- Waston test shows there is presence of auto correlation in the series. Then, to remove auto correlation, data are transformed from given variables (X and Y) into the new variables (say X' and Y') as follows:

$$X_2 - \rho X_1 = X'_2 \qquad Y_2 - \rho Y_1 = Y'_2$$

$$X_3 - \rho X_2 = X'_3 \text{ and} \qquad Y_3 - \rho Y_2 = Y'_3$$

$$\vdots \qquad\qquad \vdots$$

$$X_n - \rho X_{n-1} = X'_n \qquad Y_n - \rho Y_{n-1} = Y'_n$$

Then, apply the method of least square to y' and x'. After the regression of Y' on X' is found, if there is still auto-correlation remaining repeat this process.

Heteroscedasticity

The term heteroscedasticity describes a scenario in which the residuals' variance varies across all levels of the independent variables. The homoscedasticity assumption, which specifies that the residuals should have constant variance across observations, is broken.

The heteroscedasticity test is a method for evaluating regression models that establishes the variance inequality between the remaining data and other observations. Heteroskedasticity is typically described by the term "non-constant error variance" or by a regression model in which the residual variability varies as a function of an independent variable. Researchers use the ARCH test to see if this model has a heteroscedasticity problem. Because of the non-constant variance, the outcome estimations' variance rises.

The extent of the estimated variance will therefore affect the hypothesis test as the test is predicated on the amount of estimated variance. The theory will become untrustworthy as a result. In large samples, heteroscedasticity white is the consistent variance; the standard error may be used to modify the standard errors of the Ordinary Least Squares.

In the general linear model

$$Y_i = \beta X_i + u_i \quad \text{(xiii)}$$

We assume that E $(u^2 i) = \sigma^2 u$ is fixed for all values of all values of i. The assumption of same variance $((\sigma^2 u)$ of the residuals is known as homoscedasticity and violation of this is known as heteroscedasticity. we illustrate the problem with some examples.

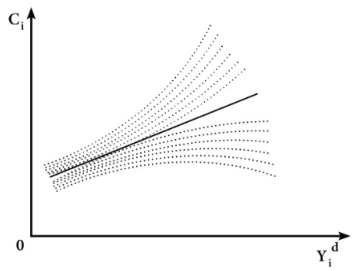
Examples of Heteroscedasticity

Estimation of the consumption function

$$C_i = C_a + cY^d i + u_i \quad \text{(xiv)}$$

Where c is MPC, C_a is autonomous consumption, C_i and Y^di are consumption expenditure and disposable income of the household, u is the stochastic disturbance term. The scatter of C_i and $Y^d i$ generally looks like that given in the Figure 2.

Figure 2.



It is seen that at low levels of income. There is little variability in consumption, but as income increases the dots are more and more dispersed.

Consequences of Heteroscedasticity

Consider the two – variable model, assuming that is no problem other than heteroscedasticity.

$$Y_i = \beta_o + \beta_t X_i + u_i$$

E(u_i) = 0$E(u^2 i) = \sigma^2 i$

$= X_i \sigma_u^2$

function: $x^2 i\, \sigma^2 u$ or $\sqrt{X_i}\, \sigma^2 u$

E ($u_i u_i$) = 0, i ≠ j

The OLS estimator is

$$\hat{\beta}_1 = \frac{\Sigma x_1 y_1}{\Sigma x_i^2} = \beta + \frac{\Sigma x_i u_i}{\Sigma x_i^2}$$

So, E ($\hat{\beta}_1$) = β, so $\hat{\beta}_1$ is an unbiased of β_1 and Var ($\hat{\beta}_1$)

$$= E\left[\frac{x_1 u_1 + x_2 u_2 + \cdots\cdots + x_n u_n}{\Sigma x_i^2}\right]^2$$

$$= \frac{1}{(\Sigma x_i^2)^2} E\,[\, x_1^2 u_1^2 + \cdots\cdots + 2\, x_1 x_2 u_1 u_2 + \cdots] = \frac{\Sigma x_i^2 \sigma_i^2}{(\Sigma x_i^2)^2}$$

Variance of the OLS estimator of β_1, when there is no heteroscedasticity is $\frac{\sigma^2 u}{\Sigma x_i^2}$

Now, suppose E (u_i^2) = $X_i \sigma_u^2$

$$\text{Var}\,(\hat{\beta}_1) = \frac{\Sigma X_i x_i^2\, \sigma_u^2}{(\Sigma x_i^2)^2} = \frac{\sigma_u^2\, \Sigma (x_i - \bar{x})^2 x_i}{(\Sigma x_i^2)^2}$$

$$= \text{Var}(\widehat{\beta_1}) \quad \frac{\frac{n^2\sum X_i^2+(\sum X_i)^2-2n\sum X_i\sum X_i^2}{n^2}}{\sum x_i^2}$$

Where $\hat{\beta}_1$ is the OLS estimator of β_1

So, $\frac{\text{Var}(\widehat{\beta_1})}{\text{Var}(\widehat{\widehat{\beta_1}})} = \frac{n^2\sum x_i^2}{n^2\sum X_i^2+(\sum X_i)^2-2n\sum X_i\sum X_i^2} \neq 1$ (xv)

Hence, Var $(\widehat{\beta_1}) \neq$ Var $(\widehat{\widehat{\beta_1}})$.

Generally, Var $(\widehat{\beta_1})$ < Var $(\widehat{\widehat{\beta_1}})$

Test for Nature of Heteroscedasticity

Let

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_1 X_{2i} + \mu_i$$

And the variance of μ_i is related to variable X_{1i} is given by

$$\sigma_i^2 = f(X_{1i})$$

Or, E (μ_i^2) = f (X_{1i}) where the exact functional form is not known, but if approximate f (X_{1i}), then easy to transform the variables multiplying by

$\frac{1}{\sqrt{f(X_{1i})}}$ and applying OLS to estimate parameters.

Comparison

Autocorrelation is general in time series data, where observations from one period are correlated with observations from previous periods. It can arise due to:

(i) Omitted variables.
(ii) Model misspecification.
(iii) Data with trends or seasonality.

Heteroscedasticity arise when there is unequal variability in the response variable.

(i) Changes in the scale or distribution of the dependent variable over time.
(ii) Presence of outliers or leverage points.
(iii) Non-linear relationships between independent and dependent variables.

Effect on Regression Models

The Ordinary Least Squares (OLS) estimators are impacted by autocorrelation, which renders them inefficient but yet impartial. When autocorrelation is present, standard errors may be overestimated, inflating t-statistics and perhaps leading to erroneous conclusions (such as Type I errors). In OLS regression, heteroscedasticity results in ineffective and perhaps biased parameter estimations. A mistake in the computed standard errors might result in erroneous confidence ranges and hypothesis testing.

Detection Methods

Autocorrelation can be detected from

The Durbin-Watson test for first-order autocorrelation.

The Breusch-Godfrey test for higher-order autocorrelation.

Autocorrelation Function (ACF) plots to visualize patterns over time.

Heteroscedasticity can be detected from

Breusch-Pagan test or White's test.

Residual plots, where plotting residuals against fitted values shows whether the spread of residuals is consistent.

The Goldfeld-Quandt test for testing heteroscedasticity in time series.

Solution

Autocorrelation can be addressed in following way:

Adding lagged variables.

Using Generalized Least Squares (GLS) or Newey-West standard errors to adjust for autocorrelation.

Differencing the data to remove trends.

Heteroscedasticity can be corrected in following way:

Using robust standard errors (e.g., White's robust standard errors).

Applying transformations to the dependent variable (e.g., log transformation).

Employing Weighted Least Squares (WLS), where observations with larger variances receive less weight.

Visual Representation

Autocorrelation can often be visualized using ACF or PACF plots, showing spikes that indicate correlation between residuals at various lags. Heteroscedasticity is typically visualized using a scatter plot of residuals versus fitted values, where a funnel shape suggests increasing variance.

Table1: Summary of Comparison

Feature	Autocorrelation	Heteroscedasticity
Definition	Residuals correlated with their own past values.	Residuals have non-constant variance.
Common in	Time series data	Cross-sectional or time series data
Impact on OLS	Inefficient estimators, inflated t-statistics.	Biased estimators, incorrect standard errors.
Detection	Durbin-Watson test, ACF plot, Breusch-Godfrey test.	Breusch-Pagan test, residual plots, White's test.
Correction Methods	GLS, Newey-West errors, differencing, lags.	Robust standard errors, WLS, transformations.

Conclusion

In conclusion, both autocorrelation and heteroscedasticity can severely impact the validity of regression models, but they do so in different ways and require different approaches for detection and correction.

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A GANs Based Data Synthetic Technique for Enhancement of Prediction Accuracy of Mushroom Classification

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Abstract

In the landscape of machine learning and data-driven decision-making, limited data availability often undermines classification model accuracy. This study pioneers a solution by leveraging Copula Generative Adversarial Networks (Copula GANs) to generate high-fidelity synthetic data, with a focus on mushroom classification. Copula GANs replicate original dataset characteristics, as confirmed by thorough Category Coverage and TV Complement evaluations that validate its ability to accurately emulate category distributions and multivariate dependencies. To substantiate the practical impact, a mushroom classification task employs a decision tree. Results showcase notable accuracy enhancement through the integration of synthetic data with real data. Fine-tuning Copula GAN parameters, exploring feature interpretability, extending the technique to diverse domains, and merging with traditional data augmentation methods are promising future avenues. In essence, this study pioneers Copula GAN-generated synthetic data as a novel solution to data scarcity. The outcomes highlight the efficacy of synthetic data augmentation, advancing the potential of machine learning models across real-world applications.

Keywords: GAN, data synthesis, Copula GAN, mushroom classification, machine learning

Introduction

Mushrooms are the fleshy, edible fruit bodies of several species of fungi that belong to the Basidiomycetes class. They often grow on the surface of the soil or plant-derived materials like straw and wood. Since mushrooms lack chlorophyll, they are not autotrophs, yet they may still be able to obtain the nutrition needed for their growth by degrading complex substrates with their enzymes(Devika & Karegowda, 2021). Out of the estimated 1500,000 species in the world, the number of mushroom species that have been discovered so far is less than 69,000 (Wibowo et al.,

2018). To date, it is identified that 7000 species of mushrooms are edible (Bhatt, 2016)but the remaining are not easily distinguishable as edible or non-edible.Because mushrooms are an essential source of protein and contain several medicinal components, including ones that can even treat cancer, consumption of mushrooms has been rising globally over the past ten years (Kaushik & Choudhury, 2022). A few mushroom species are extremely dangerous, therefore not all of the mushrooms found in nature may be eaten. Generally, family of Agaricus and Lepiota easily found in wild open-area with various shapes, colours and characteristics are poisonous (Wibowo et al., 2018). It has been discovered that certain poisonous mushrooms resemble edible mushrooms quite a bit by physical appearance, therefore, they only are differentiated by one or two distinct traits, such as cap form, gill colour, odour, etc. (Wagner et al., 2021).

Consequently, a lot of researchers are working to develop trustworthy ways to identify if a mushroom is poisonous or not. Traditionally, a method involves boiling mushrooms with rice in a pot, where a change in rice colour indicates the presence of a poisonous mushroom(Ketwongsa et al., 2022). Another traditional approach for identifying poisonous mushrooms involves using a silver spoon to stir a pot of boiling mushrooms; if the spoon changes from silver to black, it is considered an indicator of toxicity. The aforementioned methods, however, are not exact and reliable since certain deadly mushrooms do not react to them and lack standardization and objective quantification, leading to inconsistencies in results between different practitioners. This subjectivity reduces the reproducibility and reliability of the classification process. Furthermore, traditional methods are not adaptable to the evolving understanding of mushroom toxicity or the discovery of new species. As the scientific knowledge about mushrooms expands, the shortcomings of these methods become more pronounced. Their inability to accommodate new information limits their applicability in a rapidly changing field. These methods are prone to false positives and false negatives, leading to misclassification of mushrooms.

The circle under the cap, multi-coloured scales on the cap, and the presence of vivid are the primary physical traits of deadly mushrooms (Ketwongsa et al., 2022). As a result, the intensive study of the precise, reliable and robust methods for the classification of edible and non-edible mushrooms is inevitable. With the development of artificial intelligence last decades, several machine learning and deep learning-based prediction models have been developed to increase classification accuracy. Although these deep learning models have significantly improved in terms of performance, a lot depends on the quality and quantity of the data utilized to train the model. If there is insufficient data or a lot of noise in the data, the prediction accuracy will drastically decrease due to inaccurate learning (Moon et al., 2020). On the other hand, gathering enough good-quality data is costly and time-consuming. Synthetic data can be of considerably greater quality than actual data since they are created rather than gathered or measured(Chatterjee & Byun, 2023). Furthermore, privacy restrictions can be used to ensure that the synthetic data does not expose any significant information, such the clinical records of patients. Along with this, creating diverse datasets for testing and analysis, and data augmentation are additional benefits of synthetic data.

To address the challenges of limited and imbalanced datasets, researchers have turned to Generative Adversarial Networks (GANs) as a promising solution for tabular data synthesis. GANs

are a class of deep learning models that involve a generator network and a discriminator network engaged in a competitive learning process. The generator network aims to produce synthetic data samples that resemble the real data, while the discriminator network attempts to distinguish between real and synthetic data. Through this adversarial training, GANs have demonstrated remarkable capabilities in generating high-quality synthetic data across various domains. This study is concentrated on creating synthetic tabular data using CopulaGAN(CopulaGAN Model — SDV 0.18.0 Documentation, n.d.), TGAN(Xu & Veeramachaneni, 2018), and CTGAN(Xu et al., 2019) which addressed the following research section.

The summary of the contribution follows:

- Addressing Data Limitations: Limited and imbalanced datasets have been a challenge in mushroom classification. This research aim to address this issue by employing a synthetic tabular data generation techniques using CopulaGAN(CopulaGAN Model — SDV 0.18.0 Documentation, n.d.), TGAN(Xu & Veeramachaneni, 2018), and CTGAN (Xu et al., 2019)for improving the classification accuracy of mushrooms.
- Enhanced Classification Accuracy: This study focuses on the application of GANs, specifically CopulaGAN, TGAN, and CTGAN, to create synthetic tabular data. By combining these synthetic datasets with the original data, the study aims to improve the accuracy of mushroom classification algorithms.
- The comparative analysis of various supervised machine learning algorithms for the classification by using the synthetic data, original data, and combined data.

The paper's organization is divided into five sections: The related works, methods for (tabular) synthetic data generation, the existing research on using GANs to synthesize tabular data and the various methods used to do so are also covered in Section 2. Section 3 Provides a summary of the proposed methodology. Analysis and explanation of the results obtained from experiments are discussed in Section 4. The conclusion and additional recommendations for future works are described in Section 5.

Related Work

Mushroom Classification using Deep learning and Machine Learning

The paper by (Sunita & Bishan, 2015) focuses on the use of classification techniques for analyzing mushroom data sets using WEKA. Several methods namely naive Bayes, Bayes net, and ZeroR are used to identify mushrooms and used accuracy, mean absolute error, and kappa statistic for the evaluation of the performance of the classification techniques. The Bayes net outperformed the other algorithms with the highest accuracy, and lowest mean absolute error. Specifically, a fascinating finding arises in the context of mushroom classification, indicating that greater training set sizes lead to enhanced model accuracy.

The paper(Verma & Dutta, 2018) compared three classification algorithms(ANN, Adaptive Neuro-fuzzy inference System (ANFIS), and Naive Bayes) to classify the mushrooms. The performance of the methods is evaluated using accuracy, MAE, and kappa statistics. Their study revealed ANFIS as the superior method, surpassing others in accuracy (99.8769%), MAE (0.0008), kappa statistics (0.9980), with ANN ranking second (accuracy:96.738%, MAE: 0.0338, kappa statistics: (0.9338). This paper also distinguished that as in (Sunita & Bishan, 2015), accuracy increased as the training size increased. In (Ottom et al., 2019) applied several methods neural networks (NN), support vector machines (SVM), decision trees, and k Nearest Neighbors (KNN) to the image dataset of mushroom for classification task. The findings demonstrate that the most accurate method (accuracy is 94%) for identifying mushroom images is KNN and NN's performance (59% accuracy) is not satisfactory due to the problem of data insufficiency during training phase. The (Chitayae & Sunyoto, 2020) compared KNN and Decision Tree methods and the decision tree algorithm has the highest degree of accuracy (91.93%). Further, the paper (Kousalya et al., 2022)used four classification methods such as Naive Bayes, Decision Tree (C4.5), SVM, and Logistic Regression and the decision tree algorithm has the highest degree of accuracy (93.34%) and is faster than the other algorithms. Also, in (Paudel & Bhatta, 2022)the performance of two Reduced Error Pruning (REP) Tree and Random Forest tree-based classification algorithms are compared and Random Forest method beats the REP Tree technique with a value of 100% for accuracy, precision, and recall.

In the research work carried out by (Wagner et al., 2021), natural language processing was used for the creation of primary data that contains 173 species from 23 families as well as secondary data was also generated. The secondary data is employed as pilot data for the classification and various machine learning algorithms, including naive Bayes, logistic regression, linear discriminant analysis (LDA), and random forests (RF), have been evaluated and the RF provided the best results with a five-fold Cross-Validation accuracy and F2-score of 1.0. Furthermore, the pilot data yielded conclusive outcomes, indicating non-linear separability. This finding underscores the opportunity for the use of alternative methods to generate the synthetic data for classification, suggesting the synthetic data has the potential to enhance classification accuracy. The study by (Ketwongsa et al., 2022) used convolutional neural networks (CNN) and region convolutional neural networks (R-CNN)to distinguish between five dominant types of mushrooms and 98.50% and 95.50% accuracy is achieved respectively. In (Alkronz et al., 2019)a multi-layer ANN model is employed to determine if a mushroom is edible or toxic and only 99.25% accuracy is achieved. This due to insufficient training data and the features present in the dataset. Also, in the paper by (Moon et al., 2020), conditional tabular GAN (CTGAN) is used to solve the problem of data shortage for the electric load. The data used for the training is a mixture of generated data and real data. Their results were very outstanding and concluded that CTGAN is one of the effective ways to produce synthetic data.

Having thoroughly reviewed the existing literature on mushroom classification utilizing various machine learning techniques, we now pivot to our proposed research endeavor. Building upon the insights gained from the limitations and trends highlighted in the prior studies, our research seeks

to contribute to the field by leveraging Generative Adversarial Networks (GANs) for the synthesis of enhanced training datasets. As elucidated by the works of (Sunita & Bishan, 2015), (Verma & Dutta, 2018), (Ottom et al., 2019), and others, challenges such as data insufficiency, imbalanced class distributions, and the need for effective feature representation have been recurrent impediments in achieving higher prediction accuracy. Drawing inspiration from recent advancements in GANs for tabular data synthesis (Bourou et al., 2021), we aim to harness the power of GANs to augment our training data with synthetically generated samples that capture the intricate distributions present in real-world tabular data. This innovative approach holds the potential to address the aforementioned limitations, enabling us to achieve a substantial enhancement in the accuracy and robustness of our mushroom classification model. In the subsequent sections, we will delve into the specifics of our GAN-based data synthesis technique, its design, implementation, and the anticipated benefits it brings to the realm of mushroom classification.

GANs for Data Synthesis

GANs is a breakthrough concept in the field of artificial intelligence developed by Ian Goodfellow and his colleagues in 2014(Goodfellow et al., 2014) to create new data samples that resemble a given dataset. A GAN consists of two main components: generator G and the discriminator D. The generator learns to produce realistic data, and the data it generates serves as negative examples for the discriminator. The discriminator learns to differentiate between the fake data generated by the generator and real data, penalizing the generator for creating implausible results. During training, the generator initially generates obviously fake data, prompting the discriminator to quickly detect its falseness. As training progresses, the generator improves, gradually creating output that can deceive the discriminator. Ultimately, if the generator is successful, the discriminator struggles to distinguish between real and fake data, classifying some fake data as real, and its accuracy drops. Both the generator and the discriminator are neural networks, with the generator's output directly connected to the discriminator's input. Through backpropagation, the discriminator's classification informs the generator's weight updates, allowing it to refine its output based on the feedback received from the discriminator. This adversarial nature of GANs leads to a tug-of-war between the generator and discriminator, pushing them to improve iteratively. When the generator becomes skilled enough to generate data that can deceive the discriminator into misclassifying fake data as real, it indicates that the generator has learned to produce realistic samples.

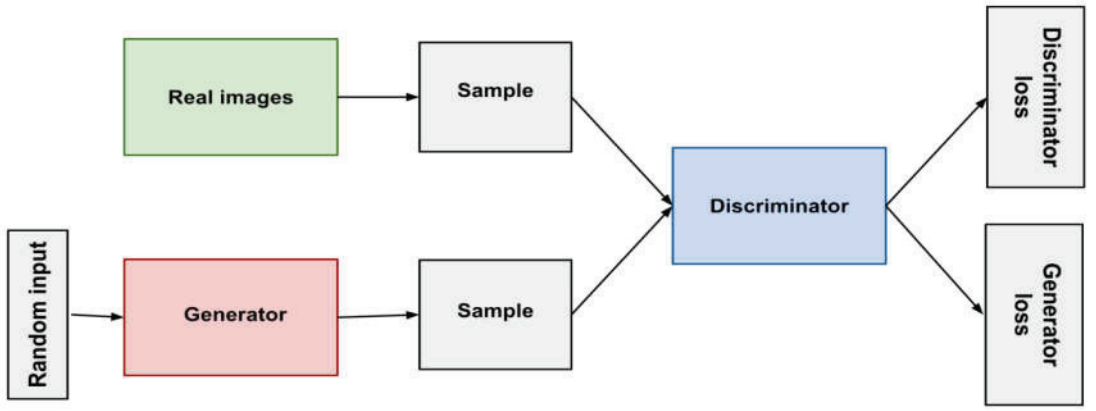

Figure 1 GAN architecture

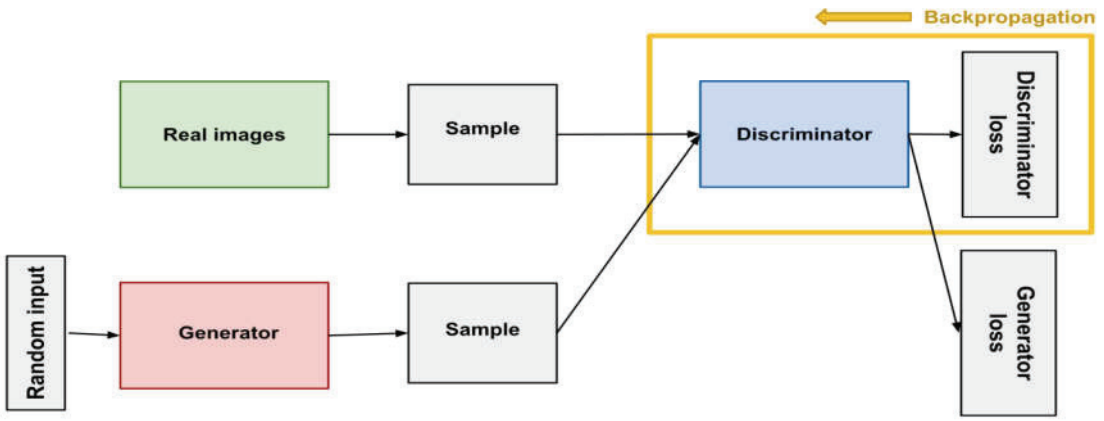

Figure 2 Backpropagation in discriminator training

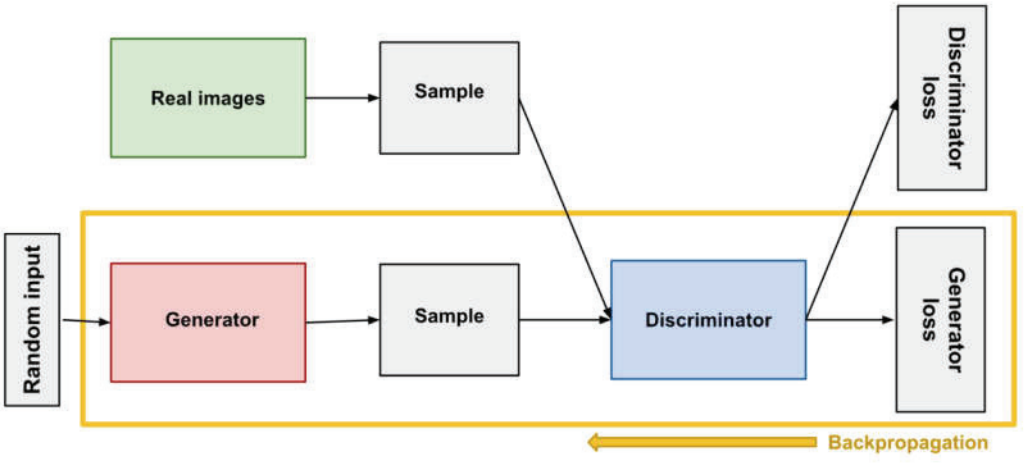

Figure 3 Backpropagation in generator training

The GAN's generative component, denoted as G, grasps the underlying data distribution p(g) in the genuine data space x. By incorporating an input noise variable, G creates novel adversarial instances G(z) designed to mirror the x distribution. The training of Generator G revolves around maximizing the likelihood that the Discriminator D accurately identifies generated examples as authentic, while D's training centers on discerning whether a given sample originates from the real data or has been produced by Generator G. The mathematical formulation of the Vanilla GAN is rooted in the cross-entropy comparison between the actual and generated distributions, and it is expressed as follows(Bourou et al., 2021):

$$\min_G \max_D V(D,G) = \mathbb{E}_{\boldsymbol{x}\sim p_{\text{data}}(\boldsymbol{x})}[\log D(\boldsymbol{x})] + \mathbb{E}_{\boldsymbol{z}\sim p_{\boldsymbol{z}}(\boldsymbol{z})}[\log(1 - D(G(\boldsymbol{z})))]$$

For those looking for further understanding into GANs, we suggest consulting the original paper by(Goodfellow et al., 2014).

GANs for Tabular Data Synthesis

Deep neural networks frequently exhibit inferior performance in contrast to more conventional machine learning techniques such as methods based on decision trees when confronted with tabular data(Borisov et al., 2022). Nonetheless, the reasons behind why deep learning struggles to attain equivalent predictive excellence as observed in other domains like image classification, computer vision, and natural language processing often remain ambiguous. According to (Borisov et al., 2022) the four potential major reasons for aforementioned problem are :

A. ***Low Quality Training Data:*** The quality of data poses a prevalent concern in real-world tabular datasets. These datasets commonly exhibit several issues, such as missing values, outliers, data that is incorrect or inconsistent, imbalance in class distribution due to costly nature of data collection, and they also tend to be relatively small in size compared to the high-dimensional feature vectors derived from the data. While these hurdles impact all machine learning algorithms, a majority of contemporary decision tree-based algorithms possess the capability to internally manage missing values and address variations in variable ranges, achieved by identifying suitable approximations and determining split points.

B. ***Missing or Complex Irregular Spatial Dependencies:*** Spatial correlation is frequently absent among variables within tabular datasets, and the interconnections between features often exhibit intricate and irregular patterns. When dealing with tabular data, it becomes necessary to establish the structure and associations among its features through learning from the ground up. Consequently, the inherent biases employed by well-known models designed for uniform data types, like convolutional neural networks, prove inadequate for effectively representing this particular data category.

C. ***Dependency on Pre-processing:*** A key advantage of deep learning on homogeneous data is that it includes an implicit representation learning step, so only a minimal amount of pre-processing or explicit feature construction is required. However, for tabular data and deep neural networks the performance may strongly depend on the selected pre-processing strategy. Handling the categorical features remains particularly challenging and can easily lead to a very sparse feature matrix (e.g., by using a one-hot encoding scheme) or

introduce a synthetic ordering of previously unordered values (e.g., by using an ordinal encoding scheme). Lastly, pre-processing methods for deep neural networks may lead to information loss, leading to a reduction in predictive performance.

D. ***Importance of Single Features:*** While typically changing the class of an image requires a coordinated change in many features, i.e., pixels, the smallest possible change of a categorical (or binary) feature can entirely flip a prediction on tabular data. In contrast to deep neural networks, decision-tree algorithms can handle varying feature importance exceptionally well by selecting a single feature and appropriate threshold (i.e., splitting) values and "ignoring" the rest of the data sample. Individual weight regularization may mitigate this challenge and motivate more work in this direction.

GAN models have demonstrated significant potential in generating synthetic images and text. Recently, researchers have been exploring the application of GANs for generating tabular data due to their ability to effectively model data distributions, which traditional statistical techniques may struggle with. The process involves creating a synthetic table, Tsyn, from an existing table, Treal, consisting of both a training set, Ttrain, and a test set, Ttest. The GAN model is trained on Ttrain, where the data generator G learns the data distribution for each column in the table T and uses this knowledge to generate synthetic data for Tsyn(Bourou et al., 2021).

A successful data generator G for tabular data needs to address various challenges inherent in real-world tabular data. Notably, T can contain mixed data types, including numerical and categorical columns. The numerical columns can have either discrete or continuous values, requiring the Generator G to learn and generate a mix of data types simultaneously. Additionally, the shape distribution of each column can vary, often following non-Gaussian and multimodal patterns, which can cause vanishing gradient problems when applying min-max transformations.In the context of categorical columns in real-world tabular data, an imbalance problem frequently arises, with some classes having significantly more instances than others. This imbalance can lead to mode collapse and inadequate training of the minor classes. Moreover, the presence of sparse one-hot-encoded vectors can cause issues during the training procedure of the Discriminator D, as it may rely on the distribution's rareness rather than the realness of the values to distinguish real from fake data. To overcome these challenges, innovative techniques and tailored approaches are required to develop an effective and robust GAN model for generating high-quality synthetic tabular data.

Methodology

Dataset Description

The dataset utilized in this study is publicly accessible and has been sourced from The Audubon Society Field Guide to North American Mushrooms. This dataset was contributed by Jeff Schlimmer, a contributor associated with the University of California, Irvine (UCI). For those interested in exploring the dataset further, it is available for access at the following URL: https://archive.ics.uci.edu/ml/datasets.html.

Within this dataset, one can explore into a rich collection of 8124 distinct data points, each offering a unique glimpse into the world of mushrooms. These data set are meticulously organized and characterized by 22 different variables. The focus of this dataset centers on a fascinating array of 23 distinct species of fungi, all of which belong to the *Agaricus* and *Lepiota* families. These species, known for their diverse characteristics and intriguing attributes, fall under the category of nominal data type. Mushroom classification datasets used for distinguishing between edible and non-edible mushroom species possess several characteristic features and attributes. Understanding these dataset characteristics is essential for effectively applying data synthesis techniques using GANs. In below table, the key characteristics of datasets are presented.

Feature	**Meaning**	**Representation in Datasets**
Cap Shape	Shape of mushroom cap	bell=b, conical=c, convex=x, flat=f, knobbed=k, sunken=s
Cap Surface	Texture of mushroom cap surface	fibrous=f, grooves=g, scaly=y, smooth=s
Cap Color	Color of mushroom cap	brown=n, buff=b, cinnamon=c, gray=g, green=r, pink=p, purple=u, red=e, white=w, yellow=y
Bruises	Presence of bruises when touched	bruises=t, no=f
Odor	Scent of the mushroom	almond=a, anise=l, creosote=c, fishy=y, foul=f, musty=m, none=n, pungent=p, spicy=s
Gill Attachment	Attachment of gills to cap	attached=a, descending=d, free=f, notched=n
Gill Spacing	Spacing between gills	close=c, crowded=w, distant=d
Gill Size	Size of gills	broad=b, narrow=n
Gill Color	Color of gills	black=k, brown=n, buff=b, chocolate=h, gray=g, green=r, orange=o, pink=p, purple=u, red=e, white=w, yellow=y
Stalk Shape	Shape of the stalk	enlarging=e, tapering=t
Stalk Root	Type of stalk root	bulbous=b, club=c, cup=u, equal=e, rhizomorphs=z, rooted=r, missing=?
Stalk Surface Above Ring	Texture of stalk surface above the ring	fibrous=f, scaly=y, silky=k, smooth=s
Stalk Surface Below Ring	Texture of stalk surface below the ring	fibrous=f, scaly=y, silky=k, smooth=s
Stalk Color Above Ring	Color of stalk above the ring	brown=n, buff=b, cinnamon=c, gray=g, orange=o, pink=p, red=e, white=w, yellow=y
Stalk Color Below Ring	Color of stalk below the ring	brown=n, buff=b, cinnamon=c, gray=g, orange=o, pink=p, red=e, white=w, yellow=y
Veil Type	Type of veil covering the gills	partial=p, universal=u
Veil Color	Color of the veil	brown=n, orange=o, white=w, yellow=y

Feature	Meaning	Representation in Datasets
Ring Number	Number of rings on the stalk	none=n, one=o, two=t
Ring Type	Type of ring on the stalk	cobwebby=c, evanescent=e, flaring=f, large=l, none=n, pendant=p, sheathing=s, zone=z
Spore Print Color	Color of spore print	black=k, brown=n, buff=b, chocolate=h, green=r, orange=o, purple=u, white=w, yellow=y
Population	Density of mushroom sightings	abundant=a, clustered=c, numerous=n, scattered=s, several=v, solitary=y
Habitat	Environment where mushrooms are found	grasses=g, leaves=l, meadows=m, paths=p, urban=u, waste=w, woods=d

Understanding these characteristic features of mushroom classification datasets is essential for synthesizing realistic and representative synthetic data using GANs. Addressing class imbalance and accurately modelling the complex relationships between the features contribute to the generation of high-quality synthetic mushroom datasets, which can enhance the effectiveness of classification algorithms and promote accurate edible and non-edible mushroom identification.

Tabular Data Generation UsingCopulaGAN

The CopulaGAN(*CopulaGAN Model — SDV 0.18.0 Documentation*, n.d.) model, a modified version of CTGAN available in the SDV open-source library, employs a transformation method based on the Cumulative Distribution Function (CDF) through GaussianCopula. Specifically, CopulaGAN leverages these variations of CTGAN to facilitate data learning. Copulas, rooted in probability theory, depict the associations among random variables. Throughout training, CopulaGAN strives to grasp the data characteristics and structure of the training dataset. Non-numeric and missing data are converted using Reversible Data Transformation (RDT), leading to a completely numerical representation that enables the model to comprehend the probability distributions for each column in the table. Moreover, CopulaGAN endeavors to capture the relationships between the various columns within the table.

Synthetic Data Evaluation

Category Coverage: This measurement assesses the extent to which a synthetic column encompasses all potential categories found within areal column, while disregarding any missing values. The process involves two steps: initially, it determines the count of distinct categories, denoted as "c," existing within the genuine column "r." Subsequently, it tallies the number of these categories that appear in the synthetic column "s." The outcome is a ratio representing the portion of actual categories that have been replicated in the synthetic dataset.

$$\text{score}=\frac{c_s}{c_r}$$

TV Complement: This measurement calculates the resemblance between an authentic column and a fabricated one concerning their shapes, specifically focusing on the marginal distribution or one-dimensional histogram. Designed for discrete, categorical data, this assessment employs the Total

Variation Distance (TVD) to quantify the dissimilarity between the genuine and generated columns. To achieve this, it initiates by determining the occurrence frequency for each category value, subsequently converting it into a probability representation. The TVD metric then gauges disparities in probabilities, as depicted in the provided formula.

$$\delta(R,S) = \frac{1}{2}\sum_{\omega\in\Omega}|R_\omega - S_\omega|$$

Here, ω describes all the possible categories in a column, Ω. Meanwhile, R and S refer to the real and synthetic frequencies for those categories. The TVComplement returns 1-TVD so that a higher score means higher quality.

Decision Tree as a Learning Algorithms

A decision tree is a versatile machine learning algorithm tailored for effectively handling categorical features, which are discrete and qualitative in nature. This algorithm constructs a hierarchical tree-like structure of decisions by recursively partitioning the dataset based on feature values. It begins at the root node and progressively splits the data into branches according to specific feature thresholds. These divisions lead to subgroups, ultimately culminating in terminal nodes where categorical labels or values are assigned. Decision trees excel in scenarios involving categorical features due to their inherent ability to capture complex relationships and interactions between discrete variables. Their interpretability makes them valuable for understanding the decision-making process. Each internal node of the tree represents a decision based on a categorical attribute, while each leaf node corresponds to a class or an outcome. The algorithm is capable of handling nonlinearity and interactions among categorical attributes, making it a valuable tool in tasks such as customer segmentation, recommendation systems, and fraud detection, where understanding intricate categorical patterns is crucial for accurate predictions.

Evaluation of Performance for Machine Learning Models

Accuracy: Accuracy is a widely used performance metric that measures the correctness of a machine learning model's predictions. It calculates the ratio of correctly predicted instances to the total instances in a dataset. While intuitive and easy to interpret, accuracy may be misleading when dealing with imbalanced datasets, where one class has significantly more samples than the other. In such cases, a high accuracy can result from the model simply predicting the majority class. It's essential to consider additional metrics, especially for imbalanced scenarios.

ROC and AUC: The Receiver Operating Characteristic (ROC) curve is a graphical tool that evaluates a model's classification ability across various threshold settings. It plots the true positive rate (sensitivity) against the false positive rate (1-specificity). The Area Under the Curve (AUC) quantifies the overall performance of the ROC curve. AUC ranges from 0 to 1, with a higher value indicating better discrimination between classes. ROC and AUC are valuable for binary classification tasks, helping to assess the model's capability to differentiate between positive and negative instances, regardless of the chosen decision threshold. AUC provides a single scalar value that captures the model's performance across different threshold levels, making it a robust metric for model comparison and selection.

Result and Discussion

The experiments are designed for the investigation of performance, reliability, and validity of Copula GAN for the purpose of generation of synthetic mushroom data. As the main focus of this study involved creating synthetic data through Copula GANs and evaluate the reliability and validity of the data generated. For the aforementioned task, 1500 epochs are used to generate data that closely mirrored the characteristics and distribution of the original dataset. We have generated the synthetic data of the same size as the original dataset because we can compare the distribution of original dataset and to avoid the biasness. A graphical representation of the generator and discriminator loss during training further shed light on the GAN learning dynamics. The plotted loss graph shown in Figure 4 provides a visual understanding of the adversarial competition between the generator and discriminator. The decreasing generator loss and increasing discriminator loss over the training epochs signify a converging process. This convergence suggests that the GAN architecture successfully navigated the intricate task of generating data that aligns more closely with the original distribution. The average data quality of feature ***cap_color*** is the lowest and ***veil-type*** is the highest as can be seen from Figure 5. The quality score of 92 % indicates Copula GANs excel at capturing intricate relationships between multiple categorical variables, making them a promising option for generating data.

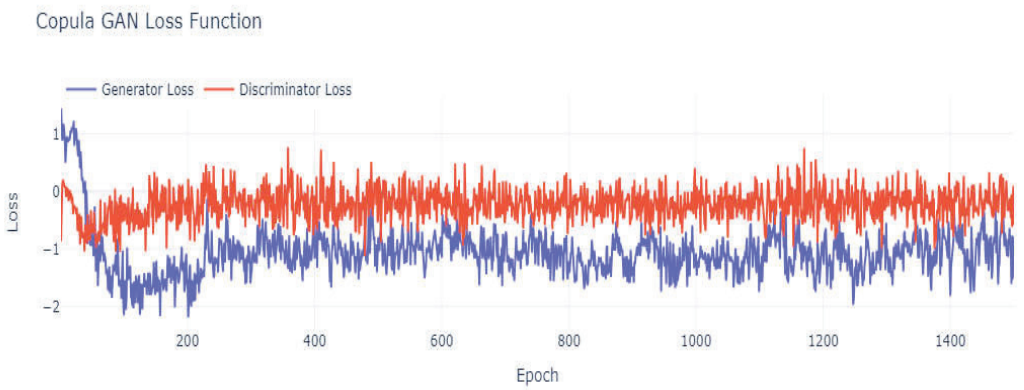

Figure 4 Generator vs Discriminator Loss

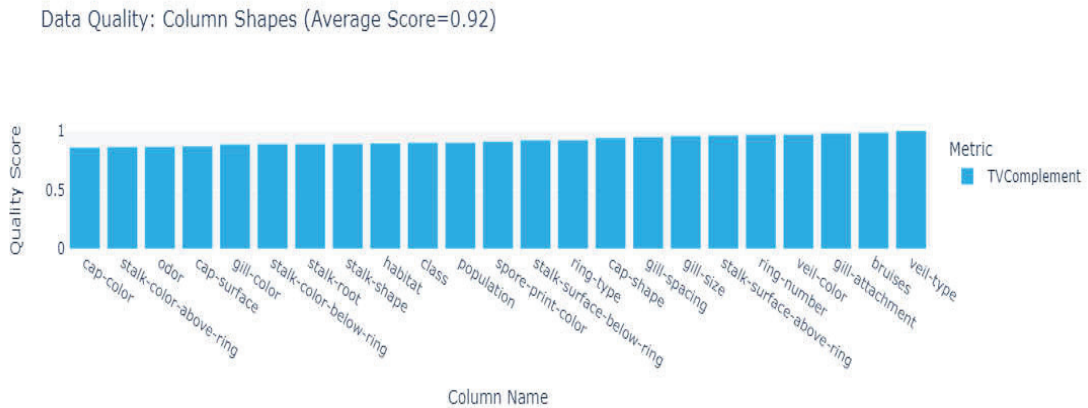

Figure 5 Data Quality of Each Feature

Further, additionally, we used two important measures, Category Coverage and TV Complement, to assess the quality of the generated synthetic data. The achieved average scores of 0.99 and 0.90, respectively, validate the efficacy of our synthetic data. These high scores indicate that the synthetic dataset effectively covers the categories present in the original data and captures the underlying distribution accurately. Accurately replicating the data's natural traits is crucial to ensure that the generated data is valuable for improving classification models.

We used a decision tree model with the Gini impurity criterion to measure the effect of the generated synthetic data on classification accuracy. The model was tested on three distinct datasets: real data only, synthetic data only, and a combined dataset comprising real and synthetic data. The obtained accuracy scores underscore the potential of synthetic data augmentation which can be seen from Figure 6. While the real data achieved an accuracy of 0.99 and the synthetic data achieved 1.0, the combined dataset yielded a remarkable accuracy of 1.0. This outcome accentuates the utility of incorporating high-quality synthetic samples in enhancing the performance of classification models.

Data Type used	**Accuracy**
Real	0.99
Synthetic	**1**
Real + Synthetic	**1**

Figure 6 Accuracy for each type of dataset

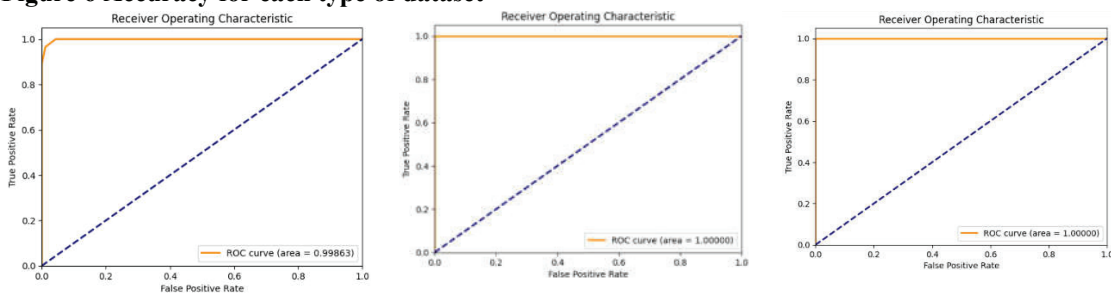

Figure 7 ROC Curve a. Real data b. Synthetic data c. Real+ synthetic data

Conclusion

In this study, we have demonstrated the efficacy of a Copula GAN-based synthetic data technique to enhance the accuracy of mushroom classification. The successful generation of synthetic data that closely replicates the characteristics of the original dataset highlights the potential of generative modelling in addressing the challenges posed by limited data availability. The remarkable evaluation scores for Category Coverage and TV Complement further validate the quality and representativeness of the generated synthetic data.

Our exploration extended to the classification realm, where we employed a decision tree model to assess the impact of synthetic data augmentation. The substantial increase in accuracy achieved with the combined dataset underscores the practical utility of our approach. The convergence of the generator and discriminator loss during training adds an insightful dimension, shedding light on the internal dynamics of the GAN architecture.

As we look ahead, several avenues for future research beckon. Firstly, investigating the interpretability of the features generated by the GAN and their contribution to model performance could unravel valuable insights. Moreover, extending our approach to diverse domains beyond mushroom classification holds promise. Exploring the applicability of Copula GAN-generated synthetic data in other complex classification tasks could pave the way for novel insights and improvements in various fields. Furthermore, the potential of hybrid approaches, combining GAN-generated data with traditional data augmentation techniques, remains to be explored. Such a fusion could harness the strengths of both methodologies to further enhance classification outcomes. In conclusion, our study introduces a robust approach for data enhancement using Copula GAN-generated synthetic data, with promising implications for classification tasks. The groundwork laid herein opens the door to a realm of possibilities for further advancement and innovation in data synthesis and classification methodologies.

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Moksha for Modiaain: A Study of B. P. Koirala's *Modiaain*

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Abstract

Bisheswor Prasad Koirala's Modiaain is a novella written on the war of Mahabharat, the 18 days fratricidal war between Kaurabh and Pandava, in Hindu mythology. The two supreme Hindu religious volumes, Mahabharat and SrimadBhagawat Gita, glorify the war and claim that it was fought for justice and righteousness led by the god, lord Krishna, himself. However, Modiaain, the title character whose husband fought the war from the Kaurabh's side, has her own interpretation of the war as she mentions it to the narrator. She finds the role of Lord Krishna controversial, in the war, as he incites Arjuna for the war to save humanity from irreligiosity. The paper studies the difference between the presentation of these holy text by the gods (Ved Vyas and Lord Krishna) and a common woman (Naari). Several incidents in the novel, as reported by Naari, exposes the effect of the war not only to the warriors but also to their families. Many of them died waiting and crying on the loss of their dear ones- and are still living as degenerated spirit hovering here and there around the battlefield. In its thorough analysis of the events, in the perspective of the renarrative of *Karma* and *Moksha*, the research locates the disparity and questions the mere promise and purpose of lord Krishna behind the war. Clearly, the article focuses on to draw out a new perspective to read and interpret the ideas of these holy texts- not to criticize them in a biased way.

Keywords: Karma, Moksha, Dharma, Mahabharat, Grand narrative, Kauraha, Pandava

Introduction

Modiaan is a novella written by Bisheswor Prasad koirala. It was published in 1980 by SajhaPrakashan. The novel is based on the greatest war in Hindu mythology, the war of Mahabharata. It was typically taken as a "18 days fratricidal war between the son of Dhritarasta and those of his late younger brother, Panadava" (RK. Srinivasa,1986, 17). Though the war

typically fought among the cousins, nevertheless it took the life of many warriors within the family and also the relatives, kins, neighboring kings and their armies. It was the war of mass destruction in which "millions of people had perished" (Hassija, n.d.).The story of the novella revolves around the effect of these deaths on the living ones, particularly to the women of the dead soldiers/ warriors. Among them, the central character of the story, Modiaain, a middle-aged woman who runs a hotel in Darvangga, is center of the major event happened in the story.

Modiaain, at the beginning of the narration, as the narrator witnesses, seems a normal woman like the other women in the locality. However, towards the end, the story unravels to surprising touch. Here, we come to know that she is the not a normal woman, rather she is the ghost of Naari, a woman who died from the pangs of her husband's death in the war of Mahabharat.

Though the war took place thousands of years ago, the spirit of Naari was still there living in a human form at the place where her husband died. This incident poses somecritical questions on the spirit of the war and the ideas witnessed in SrimadBhagawat Gita, and the sermons/ lecture/ moral lesson given by Lord Krishna to Arjun before the war. Both the war of Mahabharat and the Bhagawat Gita writes that the war of Mahabharat is the war of *Mukti*/ *Moksha* (salvation) through *Dharma*, which is only got out of the desireless action/ duty. The combo of duty, *Dharma* and *Moksha* are three main grand narratives the centers the periphery of the war. It is only because of these three guiding principles"the Kuru battlefield being doubled with the powerhouse of Dharma, and even trebled with the transcendent heaven of the Grace of Moksha, for that is the Lord Krishna culminating Magna Carta" (Shrinivasa, 1986, 118).

Of course, these three basic principles simply mean that accomplishing duty is the absolute dharma/ religious act for a person, and it is the only way to make life before and after death blissful. This is why, Arjuna must accomplish his duty by fighting the war and secure fortune in his favor- the throne of Hastenapur upon win and the status of god, moksha, upon loss. Not only Arjuna but also the entire Hindu civilization have faith on these words written and spoken by gods, respectively Vyas and Lord Krishna, of Hindu mythologies. However, this novella, which portrays the war of Mahabahrata through the eye of a common woman, Naari, shows a different picture of the war than these religious texts. Naari and the other women, the wives of the warriors who died in the war of Mahabharata, who died due to pangs of their husbands' death do not acquire moksha as promised. They are still living as a ghost even today on the places where the body of their dead husbands lie.

The present condition of these women show that their soul is in the purgatory. They are not pure enough to acquire Moksha as said by the Lord Krishna before the war. However, the reasons are not clear. As written in Shrimad Bhagawat Gita, they do their duty by letting their husband participate in the war and consequently sacrifice their life for the so- called noble cause. Their death was due to war though they did not participate in it. It raises a lot of questions and invites a necessity of some critical analysis by offering us a chance to perceive the same glorious representation of the war from a perspective of a minority character, who are missed in the mainstream representation.

Understanding Modiaain, the Central Female Character in the Novella

The story of the Modiaain is based on a real-life incident of a young boy, the narrator, when he was on a visit to Darbhangga with his intimate/ well-wisher, Misir Ji. The events in the story are historical- yet mysterious "occurred in *his* world of childhood empathy forty years ago" (2).This historical cum mysterious nature of the events are due to the mysterious character, Modiaain, and her story of the Hadaahaa that creates a surreal existence by casting the shadow of life in the Mahabharat era to the present. The effect of this mystery can be felt in the young narrator's mind who keeps on analyzing his impression on Modiaain and the story she told him throughout the novella.

Modiaain is the title character in the story. Her name comes after the surname of her husband, Modi. She runs a hotel on one side of a big pond, Hadaahaa, facing the Darbhangga train station. With the very first encounter with her, the narrator young mind sensed a kind of mystery in her build. Modiaain has something extra on her physical shape which is not normal to the body of the women of that locality. The writer finds it hard to identify whether her body and face moderately young or aged or both. A kind of unclarity is seen in the narrator's voice as he says "Whether she is really an adult and I feel like she is young or is she really young but seems like an adult. Whatever, she is the mixture of both youth and adulthood" (13).

The description from the narrator portrays some kind of abnormalities in the personality of Modiaain, which creates a kind of foreshadowing for Modiaain's identity that the narrator reveals later. Foreshadowing is a literary technique that hint of the event that will come later in the story. According to Gary Saul Morson, foreshadowing is "an event that indicate (is the shadow of) another event to come" (48). As Morson said, the present description of Modiaainleads to the revelation of her identity soon in the story as she told the story/ history of the pond to the narrator.

Further, the way Modiaain describes the pond, Hadaahaa, also creates a kind of foreshadowing. Hadaahaa was there from the time of Mahabharata. On founding the bone (Haddi/ Haadin Nepali) of the dead warriors (from Mahabharata) there, the pond was named Hadaahaa. It is the center for bathing, and also conducting morning and evening activities by Hindus of the locality. As Misir Ji and the narrator are going to the pond for bathing, Modiaain warns them going against rather deep inside because the pond shows some magical witness and "a powerful deity lives there" (16).

The connection of Hadaahaa with the Mahabharata is only a part of the mystery; still, there has tocome a lot as Modiaain establishes her own belonging to period. The mystery starts unravelling as she starts telling story of Mahabharata to the narrator. During the narration, the narrator remembers, "Modiaain mixed herself up with a woman from Indraprast" (39). She reveals that she is the ghost/ spirit of a Chhatriya girl, Nari. At that time, she was only eight/ nine years but still remembers how they have to pay the cost of that new kingdom. On losing the land, her father had to work as a lower-level security staff but had to return to Hastenapur when Duryodhana took over the kingdom during Pandava's fourteen years of jungle life.

Though her family life was troublesome in Hatenapur, Naari life turned to blissful state. She turned to eighteen and had beauty like queen (42). It is the same beauty that she still possesses in her latest life as Modiaain. She was blessed to marry with a soldier from Kaurabha's army and was happy to get a lovable in- laws. Before the war of Mahabharata, she was in love with her life because her in-

law's home "happiest place than a heaven" (46). However, the happiness was only for a moment. Soon they feel tensed as they heard the rumor of Duryodhana's misbehavior to the messenger sent by Pandava demanding their claim over their kingdom, Indraprast. The rumor was melancholic to the citizens, most importantly to the women, of Hastanapur (49). Nonetheless, people still have some hope- their last ray for the peace- since they have faith on Krishna who can stop the war and bring the same happiness to them as before.

Goodness or Greatness in God

Throughout the story, Modiaain seems to be critical regarding of Krishna. She believes it is Krishna who incites Arjun for the war. In the story, time and again, Modiaain raises question over Krishan role in the war of Bhahabharat. She knows the world appreciate Krishan as the best leader and a diplomat who can easily draw the people in his favour. If he wants, he can easily stop the war and save the life of many people both in and outside the battlefield. With the above reference, she seems to agree that Krishan is a great man- but by heart he is not good. Therefore, in her query about the narrator's future, when he says he want to be a great person, she asks him to be more specific- "what kind of great person you want to be" (17)?

By dividing the great person on various types, Modiaain seems to be raising questions over Krishna notorious role in the war. On one perspective, she seems to agree that he is a great person as society calls him to be. On the other side, she ironically raises the question of him to be a good person. If he were a good person, he would not let the thousands of people die in the war and thousands of another affect by it. Therefore, she immediately explains her belief to the narrator "Great people are of various types. Good people are of only one type. My child, you should not aim to be a great person, better should be a good person" (17). Here, she is inciting the narrator to change his aim from great to be a good man. Maybe, she means to say that all the great person may not be good.

The greatness and goodness in Krishna are associated with the belief of his incarnation as a god. The evidence is witnessed in many Hindu religious texts. Mahadeva Sastri, in The Bhagavat Gita, strongly reiterates the identity of Krishan as "the original creator Vishnu, known as Narayana, wishing to maintain order in the universe, incarnated himself as Krishan" (3). In Hinduism, Krishna is taken as a god, incarnation of the original creator, known as a supreme being who was reincarnated to preserve good in the human world by destroying the evil. A supreme quality of the god is that he/ she possesses goodness or virtue. However, Modiaain statement here ironical to Krishan's personality that though being god he lacks virtue or goodness. This lack of core quality within a god results in destruction. What's more, it would become even more complex to a normal person like the narrator; therefore, she deliberately repeats the idea to him (Lal, 2071).

Lacking the basic instinct what he is really for creates an irony in the personality of Krishna. In her study of irony, Virginia Miller (2019) defines irony as opposition between explicit and implicit and what is said and what is meant (33). The way Miller says Krishna role in the war of Mahabharata just gives an opposite meaning than expected by people and said by the religion's doctrines. The people, during the war of Mahabharata, knew that Krishna has the power of to stop the war. He was the last hope for them. If Krishan were good by heart, he would never let that war happen. A good person may not lie; he/she always do what is good for the society.

Modiaain finds irony in Krishna sense of doing good for the society. Her ideas raise a critical eye on SrimadBhagawat Gita and other religions text that justify Krishna as a god who "without any interest of his own, but with the sole intention of helping His creature he taught to Arjun (Sastri,1901, 4). Here lies the gap between Krishna representation and his activities/ role in the society. Doing good by inciting a calm warrior for fighting and killing innocents questions his image as a savior.Here, the destruction caused by the war downplays its reason that it is incessant for saving people and society from so called evil forces. Creating a grand narrative of evils and raging war against it is an exposed political diplomacy of the rulers since ancient time. As a supreme being and as a ruler Krishna interprets the evil in his own way and rages the war against it and tries to establish people's faith over him (god) and religion. Moreover, his immature (rather selfish) assumption goes otherwise, like the ideas expressed by Michael Mann, his decision of war does not have a rational end or meet (2023). Nonetheless, the decision has some paradoxical outcomes- the death and destruction in the war and their effect aftermath make the society even more chaotic and devilish.

However, his role as a "peace messenger," at the time when the Pandava were in favour of war, may establish his image as a peace-loving person. his attempt for saving humanity on the earth (Pen Bhakti, episode 64, 2020). Later, this benevolent character turns to be malevolent because, according to Naari, though outwardly he continuously talks for reconciliation in the palace, but he is inciting Pandava for war internally (53). In other words, he was not doing it for the humanity but for his own sake: either killing warriors in the name of saving religion or enthroning Pandava in Hastenapur. This very act shatters people faith on him. Though they believe that he is an incarnation of godand has the capacity of reconciling both parties, they doubt on his honesty for doing that because "he was Pandava's relative and always do what benefit them" (52- 53).

Beyond the two palaces, there were other truths regarding the necessity of war, the role of Krishna and the role of Pandava and Kaurabha. Such ideas are not recorded in the holy books: Mahabharata and the Srimad Bhagavat Gita. These are the version recorded by god/ly figures, but it missed the truth seen by the people beyond the palaces. However, the story of Naari/ Modiaain, her family, and other people of the locality of that time had some different things to say regarding these issues. Evaluating their witness, we reach to the conclusion that Draupadi pro war mentality, due to her oath, draws Pandava for the war and as Krishan being pro Pandava support their decision though indirectly. This is how, he become the sole cause of mass destruction of people in that war. As being a god, even though he can fulfill his duty, of course, by killing only evil forces, like Duryodhana and other. But he did not do so. Rather encourage Arjun for the war of mass destruction in the name of Mokshay and Karma.

Reading Under Krishna's Grand Narrative of Karmaand Moksha

Moksha and the *Karma* are the two grand narratives that Krishna uses against Arjun to convince him for the war.As emotion strikes him for seeing his kins, gurus and brothers in the war, Arjundecided not to engage himself in the act of sin of killing brothers (Pranbhupada, 2006, Text 37/38). His passion desire for a separate country vanished. He was swept in the true humanitarian orientation. As a human being he sees the value of life of another human beings, particularly, his own relatives killing whom after all affect their immediate family members but also the coming

generation. Arjun does not want to be remembered by as a destroyer of dynasty to acquire some "goodness of fortune" (Text 36).

When Arjun, time and again, poses some question against Krishna's mission of destroying so-called "irreligiosity from the earth," he uses *Duty*, *Dharma* and *Moksha* as an enchanting force to bind Arjun for the war (Sastri, 1901). The ideas are the core of Lord Krishna philosophy, which represent Geeta as a whole. In his review of Krishna Chaitanya's Mahabharata: A Literary Study, K. R. Srinivasa justifies the use of karma and *Moksha* in Gita as "the Kuru battlefield being doubled with the powerhouse of Dharma, and even trebled with the transcendent heaven of the Grace of *Moksha*, for that is the Lord Krishna culminating Magna Carta" (1986, 118).

In a broader sense, Lord Krishna uses these two concepts such a broader and persuasive way to create a kind of ethical pressure to Arjuna to follow it. In other words, it is what resembles French scholar, Lyotard, concept of grand narrative (Lyotard, 1984). Here, the way Lyotard said Krishna uses karma and moksha as universal truth or moral necessity for the Hindus. First, he tries to persuade on the basis of the karma (duty) that a Kshatriya bound to do. In Hinduism, kshatriya is considered as cast of warriors. While counselling for the war, Krishna targets this identification of Arjuna and persuade him for the war. By birth, Arjuna was a kshatriya; therefore, he must follow the true code of a Kshatriya- that is to wage war against evil (Pen Bhakti, episode 73).

However, this attempt of Krishna is only drawing Arjun for the destruction. In the novella, Naari was listening everything Krishna said to Arjuna just before the war. She said that Krishna is inciting Arjuna for bringing an unnatural death (to the people) by calling it a karma/ duty (66). Arjun knows that being a warrior does not mean that he would rage a war against humanity. Before being a kshatriya, he was a human being, a prince, and so he thinks accordingly. He thought about the destruction of life of his fellow beings as well as all his innocent people who participate in the war. He sensed a humanity is in risk. Thus, he was not ready for his kind of *Duty*/ *Karma*. If being a kshatriya means killing the innocent, he would better live his life by begging than being a part of sin by killing his own family and society.

By associating *Karma* with war, Krishna marks two remarkable profits, personal and social, to Arjuna. Personally, it would do good for him because it would provide him a chance to rule this earth. Similarly, it would also do good for the society since society would always appreciate him for following the path of *Karma* by killing evils and making the society evil free. Krishna's ideas of doing social good by killing people was beyond the understanding from a human being like Arjuna. With his human heart, he counted the loss of the human life that the war would bring. For him, there is no meaning of such a power which comes at the cost of life of many innocents. This humanitarian feelings in Arjuna obviously shows him disinterest in the war. Therefore, Krishna tries to deviate him with the feeling of probable losses in the war. He poses the idea of "desireless action". That is, he asks Arjuna should focus on the war without thinking what profit and loss he would get from it" (Pen Bhakti, episode 73). It would obviously bring fortune in his life. So, Arjuna should not have a choice of not doing the *Karma*/ *Duty* which do good both for society and himself. If he did, it would deviate him from the path of *Karma* which ultimately degrade status in

front of his fellow beings, friends and families. Such a consequence would be disastrous for him not only for this life but also for after life since it blocks his path of salvation/ *Moksha*.

As the concept of *Karma* does not convince Arjuna solely for war, Krishna associates it with the idea of *Moksha*. If Arjuna is not lured to the result of the *Karma*, getting fame and wealth in this world, he must think about his afterlife fate. He connects *Moksha* with the idea of *Karma*, if you avoid karma, you do not get *Moksha*. Shatri reads Bhagavat Gita with the light of ancient Hindu epics Shruti and Smriti. Expressing his ideas on the role of knowledge and *Karma* links then with the *Mokshya*. He says:

> *Against the foregoing view some say: Moksha cannot at all be attained by mereAtmajanananishtha, by mere devotion to Self-knowledge preceded by the reunification of all works. –By what then. - Absolute freedom can be attained by knowledge conjoined with works, such as the Agnihotra, prescribed in the Shruti and the Smriti. This is the conclusive teaching of whole Gita. (16- 17)*

With these ideas, it is clearly understood that knowledge is not only enough for *Moksha*. Better it is a rare combination of knowledge and works, that is *Karma*. In other words, if a person performs good *Karma*/ or if a person does his duty honestly, he will get higher status not only in this life but also get *Moksha* to make his after life better.

Honesty and the eagerness for work is the key to get *Moksha*. However, as the war going to be started, Krishan did not find Arjuna honest. Rather participating in the war with good energy, he remains sad thinking about the result of the war. The result may be horrible- the death of many family members and other innocent by his hand. In the meantime, Krishan tries to solace him that there is no sin in even killing the family while doing a duty. That duty becomes even more important if it is for the peace and truth. Krishna threatens Arjun for the outcome of not doing duty as "abandoning thy duty and fame thou shall incur sin" (17). Such a sin makes his present life worse and after his death it will devoid him of moksha.

Krishna, in his speech to Arjuna, set *Moksha* as an essential condition for judging a person moral duty in their physical duty. It judges whether the person live his/ her life successfully or not. If a person always admire truth and does his/ her duty for truth and justice, they will make this present life better and also qualify a supreme status after death. Such a person will be above than the world general being, and they will get moksha or salvation and acquire a state of godhood. On the opposite of this, those who does not do their *Duty*/ *Karma* will disqualify from acquiring this supreme state of being in their afterlife. Therefore, an inborn warrior like Arjuna do not regret over how many people he would kill in the war. Happiness and sorrow are temporary. They come and go. "Those who are unmoved by happiness and sorrow, those who remain uninfluenced by them, they are worthy of *Salvation*/ *Moksha*" (Pen Bhakti, episode 72).

Krishna further convinces Arjuna that there is no way of expressing sorrow over the present life because "present life is not a complete life" (Pen Bhakti, episode 72). A person does not have only life; he/ she may have more than one life. Birth and death are continual process. We born and dieuntil we qualify for the a supreme life, the life in Baikuntha- the place of Lord Vishnu, from

where we do not have to return to earth, and we are free from this birth and death phenomena. The state of acquiring of this condition is called *Moksha*. Moreover, this war brings *Moksha* not only to Arjuna but also to 'his gurus and elders,' whom he would kill in the war, because their death would be for the noble cause (Pen Bhakti, episode 73). Still, these ideas could not completely touch Arjun heart and affect humanitarian feeling within him. What's more, Krishna changes his rhetoric, and his tone and language seem to be more commanding than persuasive. His language, tone and attitude seem to be forceful as Naari heard him saying "Do, what I tell you. I am your source, I am the receiver of your action, I am your destination" (Koirala, 68).

Here, Krishna establishes himself as the center of the universe, a supreme destination of life. If people do what he wants, then they will meet him and reside inside him. It is the state of *Moksha*. Though gaining such a state not easy, still there are some options for achieving it. However, here, Krishna only marks a single way to Arjuna to get such a state- that is wage a war against the evil powers, and it does not matter even if they are his family (Tilak, part 8). Such an idea from Krishan was beyond the logic of Arjuna. As a mere human being, he does not have an idea/ logic to oppose it. He does not get any other option than to surrender. The idea of Krishan was extra-terrestrial, and Arjuna helpless to deny it. In the novella, Naari describes the condition of Arjuna as"Helpless Arjuna- How can he bear the magical presentation of Krishna for long? Humane feelings in Arjuna slowly decreases." (Koirala, 69).

Here, Naari appreciates this humanitarian feelings of Arjuna. But such a feeling would have to be vanished before Lord Krishna's godly/ magical power, which after all also draws him to the line of the god and lets him forget the human emotions.Lord Krishna knows Arjun was a *Kshatriya* and reminded him that both *Karma* and *Moksha* for this race of people is to fight at the time of need. Krishna doctrine of *Karma* and *Moksha* were the guiding force to Arjuna which resembles Celia Drummond's ideas ofgrand narrative. Defining the term, she writes "grand narrative creates an aura of determinism, in which what is anticipated seems almost an inevitable trajectory of the story as told so far" (2018, 59). The way Celia has said the so-called grand narrative of *Karma* and *Moksha*, though was a practice used by Krishna an ideological way, works with Arjun. The result is that he participated in the way with determination, and his arrow followed the directed shown by Krishna.

However, the promise made by Krishna would never fulfil. Of course, the arrow shot by Arjuna and other warriors "killed millions ofpeople in the war" (Koirala, 70). They were dead and we did not have any ideas what happened to them after death. Maybe, as said may Krishna they might have got salvation/ moksha and may have gone to Swarga/ heaven/ Baikuntha as said my him. Beside the warriors, there were also other millions of lives lost in the war. They were not killed by the war, but they were killed due the destruction of the war. These people may include the public, family, children and wives of the soldiers. What about them? Did Krishna's promise for salvation were nor for them? Such question raises the true meaning of Krishna diction in the Bhagawat Gita.

In the novella, Naari narrates the condition of the family, particularly women/ wives, of the deceased soldiers. They died after the death of their husband and son in the war. They died out of pangs. The pangs were so strong that the women could not bear it and died in sorrow. With the news of the destruction of life in the war, they became unconsciousness, like a dead, and never woke up again. Naari mentions her own condition- "I first died in the Kuruchhetra with the news of

my husband's death. I did not have to wait much for another death. I do not know when I died" (71).

After all, Naari meets a tragic death, but what happened to her soul after her death raises some critical questions over the admonition made by lord Krishna that *Atma(n)*is eternal, when a person dies his *Atma(n)* passes into another body and prepares for a new life (Sastri, 24). Opposite to Krishna words, Naari soul did not get another life- it did not get *Moksha*. It is still roaming at the place where her husband dead bodies lie (Koirala, 73). In Hindusim, generally the astray soul, the soul which remains as it is even after leaving its body, is taken as a bad omen.The soul must meet its fate, a new destination- a new body, for its life. Maybe it is because of the unnatural death, or some unfulfilled desires, Naari soul is hovering at the graveyard of her husband and other relatives.

Whatever happens to Naari is not an individual case. The family, particularly wives, of all the dead warrior meet the same fate. They faced the same tragic end of life, as Naarisaid, "Like me, millions of the women's tortured spirit is hovering in the universe by searching their loved ones" (Koirala, 71). That is, the spirit of the deceased soldiers' wives is still there in the universe. And there is not time limitation for them. There are not possibilities of them getting moksha. They are here not only for now; they do not know how much they would stay here. The reply of Naari "I would stay here forever" confirms the permanency of their status of their soul living as a ghost in their deceased body (Koirala, 73).

Living on the earth with such a condemned spirit of the person is taken as a bad in Hinduism. Like Shrimad Bhagawat Geeta, Ramayan also denies the existence of dead person in the form of spirit as good. Bhanu Bhakta Archarya in his translated version Ramayan, on several occasion accepts the belief that once a person is dead, he/ she should go to heaven. If not, they/ their soul may take another body for rebirth. Whatever, it does not remain as such in the form of the spirit hovering around the earth. For example, in Utterkanda, Sanatkumar Rishi differentiating the after- death life of people killed in the war says "those who are killed by gods goes to heaven, but they have to return back to the earth as effect of their good deeds ends/ whoever killed by *Hari* (Lord Bishnu)get *Moksha,* and they do not have to come to the earth again" (307, slock 86). However, the case of Naari no such thing happened. Her fate of living life for years as a spirit raise a lot of question against Hinduism. As said by Krishna, she had done her duty (*Karma*)by not stopping her husband form joining war. This is what she could do there. Though she knew that her husband would not return from the war, and she would die out of the pangs, she still did not stop him. The reward that she and all other women get doing their duty (*Karma*) really poses some critical eye on Krishna grand narrative that doing duty (*Karma*) honesty ensures heavenly path.

Redrawing the Boundary of SrimadBhagawat Gita

The story of the dead people and their relatives (though dead) waiting for their dear ones still in the present time cross the belief and good rules written in the Hindu mythology, like SrimadBhagawat Gita. It is because these incidents are beyond the normal philosophy written in Hindu mythology, which only possess two normal conditions for birth and death: either one get a new life after death or acquire heaven and win over the normal condition of birth and death. In the Bhagawat Gita, Krishna conforms that he would be responsible for the people who die in the war. He calls Mahabharat a war for truth and for the righteousness, so whoever killed here would directly get the

status of god. In other words, Krishna says that they would acquire moksha in their life. It is the moksha that let them free from the natural bondage of life and death. They would be above such normal rule of nature and enjoys their life the higher state of bless.

However, many people who died during and after the war would not qualify for this higher state. Though they were not directly killed in the war, they died due to war. That is, many people lost their life because their means of living was swallowed up by the war. All these people, including the Naari, died soon the death of their dear ones, but their death did not meet the promise made by Lord Krishna before the war. They are still hankering on the earth guarding the place where the dead bodies of their husband lied. Instead of getting *Moksha*, their soul condemned in the form of spirit. Such condemn state of the soul is denied by the Hindu religion. And if these are the soul of the person who died in the war, fought under the guardianship of the Lord himself, is full of questions. It was unbelievable for the general people and the people who live their life with the principles of such texts. But we have to believe it as Naari, a witness of the war, herself says to the narrator "people can live for ages in the form of spirit. They want be nearby to their loved ones. Some wishes, some unfulfilled desires, immortalize them and make them circle this earth being invisible" (28). Here, we could not neglect it as an idea expressed by a mere spirit of the women. More than that, it is an essential part of the history which was hidden from the mainstream thought. It raises different question on the purity of whole religious faith of Hindus, which is based on these religious texts.

Besides, the incident also draws our attention to the appropriate addressee of these religious texts. Mahabharata and Gita are the storehouse of the moral guidelines in Hindu as well as other cultures. People from all the genders, class and sex and background follow the principles from these texts. But the ideas of *Moksha* did not apply to the female victims of the war. Did Lord Krishan does not address this idea to the female victim or did he not think that females could also be the victim of the war? It also hints towards the fact that Krishna only targets the warriors, who were most probably only males, who help him to accomplish his mission. That is, he only ensures the *Moksha* of the warriors who help him in hisso-called mission of making the world free from irreligiosity. It may prove himself to be a selfish personality, which is not a typical quality of a god. That is, he focuses on providing *Moksha* only to those who help him. As being a god, it is unwise to say that he does not have any clear idea of that result of the war and how it would affect even those who do not participate in it. He was the wisest among even among the great kings of that time and "people even worship him as a reincarnation of god" (Koirala, 52). So, it is an immaturity if we say he was not capable to think about what would happen to the women and the families when their warrior husbands/ sons were killed in the war.

With all these evaluations, the condition of Naari and other women in the war only refer to some new perspective for the study of these religious text that directly comes from the god. It may hint a boundary for the validity for these texts. It is similar to what Salman Rushdie call "Defy gods…It is by defying the gods that human beings have best expressed their humanity" (). Rushdie mention this line in reference to the selfish nature of the Greek gods. Here, in the war of Mahabharat how Krishna can be so selfish and neglect the condition of the women. The way Rushdie says, Krishna action seems to be deliberate, or he was letting people to fight for no reasons, and he was having fun out of that. At the beginning of the war Krishna's activities and the body language did not reflect the gloomy surrounding instead "his control over the Arjuna's chariot, and his carefree and

calm driving, seemed as if that it is not for the war but for fun and merriment" (63). Such a perception of Naari, a lower-class woman of the time, did not neglect the issue as insignificant. It rather encourages us to study the other side of the perspective of the war of Mahabharat and the Bhagavat Gita.

Such a new perception, of course, draw us to the new way of understanding Lord Krishna himself. It after all challenges his established image as a protector of humanity and interprets him as an ambitious personality who does not care the human feeling and only focus on doing what benefits him. It further lets us to conclude that he deliberately creates the war knowing but neglecting its consequence. If so, it obviously questions his own authenticity as the creator and preserver of humanity; and similarly lets us doubt all this words that come for humanity. People, who follow Hinduism, take their spirit for life from such sacred books, but now it really possesses question to them and invite them to rethink over another route of source for inspiration in their life. On the other side, if he is not deliberate, it would still save purity as a god. We cannot blame an unintentional action- even though it is a severe crime. However, still raises other questions like 'who,' 'why'. That is, it may not be a mistake if it may be done by a mere human being since he/she may not have a such a magical power to gauge future. Why does he lack visions to foresee this future catastrophe?Both condition questions either prove him to be a selfish or not being a god at all. If Krishna himself was not a god, then the words in Shrimad Bhagawat Gita was not come from a god. This directly appeals us to think about the validity of the words written in these texts.

Conclusion

The study of Modiaain is important because it gives us a new perspective for looking into the two important heritages of Hindu mythologoy, SrimadBhagawat Gita and Mahabharat. Hindu culture and religious practices find their origin in these texts. These texts witness the activities, speech and the moral guidelines shared to the people by the god himself. It is therefore Hindu societies take these texts as the founding stone for its social structure. The value of the texts is deep rooted in the soul of its devotees. However, when we go through the events narrated by Naari, a common woman witness in the war of Mahabharat, raise different notions against the sacred values of these texts. These texts broadly summarize a single interpretation of a writer or rather "an omniscient writer/ narrator" (Morreall, 1994). Rading the ideas of Morreall we understand that the omniscient writer/ speaker possesses the same trait as omniscient narrator whoknows everything and possess a knowledge like a god.Like an omniscient narrator, the speaker of Bhagavat Gita and the writer of Mahabharata seem to know everything, so theycreate the impression that they are describing all the events in details. Nevertheless, in the deeper level, they lack the vison of an omniscient narratorwho has a power to see character or events completely. Though it is impossible to describe everything of anything for general people/ narrators, it should be possible for the godly figures like them (Lesikar and Petit, 1996). Going through Modiaain's description of the event, we realize that the so-called omniscient narrators'/ writers' description is not objective- rather it is perspective laden.

The one-sided perspective is exemplified through the broader representation of the main warriors' or only kings' ideas in these sacred books. While persuading Arjuna for the war, Krishna ensures him that he would take the responsibility of all the warriors and the noble kings and take them with him in his abode, Baikuntha. It means he confirmed that they would get *Moksha*, which after all grant them the status of god. Here, he missed those common people and the family of the warrior who were also affected by the war. That is, his grand narrative, made from the omniscient self, did not represent the people this which is not center in the war. They neither heard these people pray against war nor grant them salvation/ *Moksha* which they deserve after their death. The pitiful

condition of the people particularly can be felt in Naari comments "No gods pay any attention to the appeal against war made by the women in Bhaarat era (54)". These words by Naari and those of the omniscient narrators' contrast, which draw our mind for something else- a new interpretation of the text- that is, taking these texts as a story than a history.

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Student Result Prediction System using Linear Regression

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Abstract:

The success of an academic institution depends heavily on the performance of its students. A student result prediction system can be beneficial in improving their performance. This study proposes a machine learning algorithm-based Linear regression model to predict the board exam CGPA. The research used a data set of 253 entries, each encoded using one-hot encoding. The Linear regression model was created using 80% of the data set, while the remaining 20% was used to test the model. The results show that the model can accurately predict the final exam's CGPA. This can be useful in identifying students who require additional support and enhancing teaching techniques.

Keywords: Regression model, Student Performance, one-hot encoding, predictive model

Introduction

The academic performance of students is impacted by various factors, including personal, socio-economic, and environmental variables (Kumar & Pal, 2011). Knowledge of these factors and their effect on student achievement can help manage their impact. Educational mining research has recently received a lot of attention. Educational data mining refers to techniques, tools, and research designed to automatically extract meaning from large repositories of data generated by or related to the learning activities of people in an educational environment. Predicting student performance becomes more difficult due to the large volume of data in educational databases (Acharya & Sinha, 2014). The subject of explaining and predicting school performance is widely studied. The ability to predict student performance is very significant in educational institutions. Increasing student success is a long-term goal in all educational institutions. If educational institutions can predict the academic performance of students early before their final exam, extra efforts can be made to organize proper support for low-performing students to improve their studies and help them succeed (Raut & Nichat, 2017).

Data mining helps (Shrivas1 & Tiwari2, 2017) in extracting knowledge from available datasets and should be created as knowledge intelligence for the benefit of the institution. Higher education categorizes students based on their academic achievement. Many factors influence a student's academic performance. The model predicts final exam CGPA based on factors affecting student performance. In this study, a linear regression model is created to predict a student's final CGPA and evaluate their performance.

The objective of this study is to predict the board exam CGPA using various attributes from past records, such as first-term marks, second-term marks, age, gender, and +2 GPA. All these academic and non-academic records are collected from the Management Information System used by the Hetauda School of Management and Social Sciences. This study examines the accuracy of linear regression tasks to predict student results, making it useful in identifying weak students who can be individually supported by educators to improve their performance in the future.

Literature Review

Research was conducted by Baradwaj and Pal (Kumar & Pal, 2011) on a group of 50 students who were enrolled in a specific course program for a period of 4 years (2007-2010). The study analyzed multiple performance indicators like "Previous Semester Notes," "Class Test Notes," "Seminar Performance," "Homework," "General Proficiency," "Attendance," "Lab Work," and "End of Semester Notes" using the ID3 decision tree algorithm. The objective of the study was to assist both instructors and students in understanding and predicting student performance at the end of the semester. Additionally, the study aimed to identify students who require special attention to reduce the failure rate and take appropriate measures for the next semester's examination. The ID3 decision tree was selected as the data mining technique due to its simplicity.

A study (Krishna et al., n.d.) in the International Journal of Innovative Technology and Exploring Engineering used the CART algorithm to predict student performance in a blended learning course. The algorithm categorized students based on their online activities and accurately predicted which students were at risk of failing the course.

In their paper titled "A CHAID-Based Performance Prediction Model in Educational Data Mining," Ramaswami and Bhaskaran (2010) explore the use of the Chi-squared Automatic Interaction Detection (CHAID) algorithm to predict the academic performance of higher secondary school students in India. The authors collected data from 1,000 students across five schools in three districts of Tamil Nadu, which included various factors like student demographics, academic performance, and socioeconomic status. Utilizing the CHAID algorithm, the authors were able to create a predictive model that identified several factors that significantly affected student performance. Furthermore, the authors suggested that this model could be used to develop early intervention programs for students at risk of underperforming.

In a study conducted by Ahmed and Elaraby (Ahmed & Elaraby, 2014), they focused on creating classification rules and predicting student performance in a specific course curriculum based on previously registered student activities. Abeer and Elaraby analyzed data from students who had previously enrolled in the same course program over a span of 6 years (2005-2010), gathering multiple attributes from the university database. This study successfully predicted the final grades

of students to some extent and provided insight to help students improve their performance. It also identified students who required special attention to reduce defective ratios and take appropriate measures at the right time.

Research conducted by Pandey and Pal (2011) used Naïve Bayes classification for data mining to analyze, classify, and predict whether students were high achievers or underachievers. Naïve Bayes classification is a simple probability classification technique that assumes all attributes in a data set are independent of each other. Pandey and Pal conducted their research on a sample of students enrolled in a Graduate Diploma in Computer Applications (PGDCA) program at Dr. R. M. L. Awadh University, Faizabad, India. Their study was able to rank and predict students' grades to some extent based on their previous year's grades. The findings of this research can be used to assist students in their future education in various ways.

Researchers typically use academic and non-academic indicators to conduct academic data mining. These indicators mainly focus on predicting the factors that can affect academic success, rather than predicting the final CGPA. Most of these studies are based on classification algorithms. Therefore, this study aims to fill this gap and attempt to predict the numerical CGPA based on academic data.

Methodology

Data Collection

The dataset for this study was collected from the Hetauda School of Management and Social Sciences in Hetauda, Nepal. This college utilizes a management information system to store academic and demographic records. This system extracts information such as first-term marks, second-term marks, attendance, +2 CPA, age, father and mother's occupation, computer science studies in +2, and gender of BIM and BCA students. The Final Exam CGPA was obtained from the website of Tribhuvan University and used as the dataset label. The dataset includes 253 data with varying attributes, and a comprehensive description of the data is provided in the table.

	Age	HSEB	FirstTerminal	SecondTerminal	Attendance	Gender	FamilyType	FatherOccupation	MotherOccupation	IsComputer	CGPA
0	23	3.040	53	0	80	M	Individual	Mechanic	Business	No	3.00
1	28	2.800	13	0	33	M	Individual	Business	Teacher	Yes	3.00
2	23	2.420	15	30	87	M	Individual	Business	Housewife	Yes	3.00
3	25	0.028	15	0	68	M	Individual	Forester	Housewife	Yes	3.30
4	23	2.780	62	52	78	M	Individual	Factory Worker	Housewife	Yes	3.30
...	...	...	...	...	...	...	...	...	...	...	...
248	23	2.850	45	0	63	F	Individual	NA	Real estate	Yes	3.24
249	22	2.890	55	53	89	F	Individual	Teacher	Housewife	Yes	3.70
250	22	3.190	0	53	63	F	Individual	Business	Housewife	Yes	3.15
251	24	2.490	27	20	72	M	Individual	Driver	Tailoring	Yes	2.94
252	22	2.940	62	0	93	F	Individual	Real estate	Housewife	Yes	3.38

Figure 1: Original Data Set

Data preprocessing:

This dataset provides data on first-term and second-term grades and attendance, which differ based on subject weight and number of classes. The records are converted to a 100-point scale for analysis. To make the data usable for machine learning algorithms, one-hot encoding is applied to all attributes, which converts categorical variables to numerical ones to create a model. Unimportant features have been removed from the original dataset.

	Age	HSEB	FirstTerminal	SecondTerminal	Attendance	Gender_F	Gender_M	IsComp_No	IsComp_Yes
0	23	3.040	53	0	80	0	1	1	0
1	28	2.800	13	0	33	0	1	0	1
2	23	2.420	15	30	87	0	1	0	1
3	25	0.028	15	0	68	0	1	0	1
4	23	2.780	62	52	78	0	1	0	1
...	...	...	...	...	...	...	...	...	...
248	23	2.850	45	0	63	1	0	0	1
249	22	2.890	55	53	89	1	0	0	1
250	22	3.190	0	53	63	1	0	0	1
251	24	2.490	27	20	72	0	1	0	1
252	22	2.940	62	0	93	1	0	0	1

Figure 2: preprocessed dataset

Tools and Algorithm:

The main objective of this study is to predict the results of the board exam based on past records. The total data was split into two parts. 80% of the data was used for model creation, and the remaining 20% was used for training. A linear regression model was used to predict the final CGPA, and this model was ultimately used to predict the final grades of new students. Python programming language was utilized to construct the model.

Model development:

A linear regression model was used to create a model for result prediction. Linear regression (Linear Regression in Machine Learning - Geeks for Geeks, n.d.) is an example of a supervised machine-learning technique that maps data points to the best possible linear functions by gaining knowledge from labeled datasets. It may be used to make predictions using new data.

```
# Split the data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

# Create a Linear Regression model
model = LinearRegression()

# Train the model on the training data
model.fit(X_train, y_train)

# Make predictions on the test data
y_pred = model.predict(X_test)
```

Figure 3: Model Creation

Model evaluation:

In this study, the precision of regression models is measured using Mean Absolute Error (MAE), Mean Squared Error (MSE), and R Squared matrix.

MAE (*Evaluation Metrics for Your Regression Model - Analytics Vidhya*, n.d.) calculates the absolute difference between actual and predicted values, The MAE metric is easy to understand and a lower value suggests higher model performance.

$$MAE(f) = \frac{1}{N}\sum_{i=1}^{N} |f(x_i) \; - \; y_i|$$

The concept of mean squared error (*Evaluation Metrics for Your Regression Model - Analytics Vidhya*, n.d.) involves calculating the squared difference between the actual and predicted values.

$$MSE(f) = \frac{1}{N}\sum(f(x_i) - y_i)^2$$

R-squared (RSME - Root Mean Square Error in Python - Java point, n.d.) is a statistical technique used to determine the quality of a fit. A high R^2 value indicates that the regression model fits the data well. It indicates how well the model can predict the variable's variation.

Figure 4: Model Evaluation

Model Deployment

The model predicts board exam CGPA using past academic and non-academic records.

	Age	HSEB	FirstTerminal	SecondTerminal	Attendance	Gender_F	Gender_M	IsComp_No	IsComp_Yes	PredictedCGPA	ActualCGPA
208	22	2.85	0	0	48	1	0	0	1	2.559811	3.00
6	24	2.92	0	58	62	0	1	1	0	2.682688	3.30
79	23	2.24	22	33	54	0	1	0	1	2.423346	2.70
204	22	2.94	50	58	93	1	0	0	1	3.669827	3.82
117	21	2.56	27	33	77	0	1	0	1	2.592477	2.70

Figure 5: Model testing

Result

For this study, a regression model was developed to predict the Final CGPA. The model was created using 80% of the available data and 20% was used for model evaluation. Python programming was used to build the model. Mean absolute error, mean squared error, root mean squared error, and R squared were assessed as the evaluation metrics.

Table 1: Performance matrix

Matric	Value
Mean Absolute Error (MAE)	0.7122
Mean Squared Error (MSE)	1.2176
R-squared(R2)	0.0992

The table above shows the MEA, MSE, and R-squared values as 0.7722, 1.217 and 0.009, respectively. In this study, the model's predictions have an average deviation of approximately 0.7123 units from the actual values. The average deviation of the model's predictions was 1.2176 squared units, as shown by the mean squared error (MSE) value of 1.2176. The R-squared (R^2) statistic measures the proportion of the dependent variable's variance described by the predictive model (Evaluation Metrics for Your Regression Model - Analytics Vidhya, n.d.). This study shows that R^2 value of around 0.0991, indicating that the model only explains a small portion of the total variation in the target variable.

Conclusion and Discussion

Through evaluation metrics analysis, we can gain a better understanding of our predictive model's performance. Although the model displays some predictive ability, as shown by the MAE and MSE values, the R^2 value indicates a significant amount of unexplained variance in the target variable. This implies that this model could benefit from more improvement or the addition of more features to increase its predictive accuracy.

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e-banking Services and Customer Satisfaction with reference to Nepalese Banking Sector

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Abstract

This study is intended to investigate the impact of e-banking services on customer satisfaction, as this area of research is still in the foundation phase in Nepal. The conceptual framework included five e-banking service dimensions: ease of use, efficiency, reliability, responsiveness, and security as predictors and customer satisfaction as dependent variables. The descriptive and casual-comparative research was conducted with a sample of 232 bank customers actively using e-banking services. A questionnaire survey was an instrument to collect data, and along with descriptive and correlation analysis, the regression analysis was conducted with the use of SPSS and JASP. The empirical result shows a positive and significant impact of e-banking service dimensions on customer satisfaction. The findings show that ease of use, security, efficiency, and reliability have a relatively greater impact on customer satisfaction. However, responsiveness has a weak impact on customer satisfaction. E-banking is an inevitable part of the modern banking system that enhances customer satisfaction and core competencies in the area and provides competitiveness. The banking institutions can focus on maximizing firm value through customer satisfaction, retention, and loyalty through the best e-banking services.

Keywords: E-Banking, Customer satisfaction, Ease in use, Efficiency, Reliability, Security

Introduction

The intense development in communication technology has completely changed the way we live and businesses do their business. Globalization, in fact, is an outcome of the internet that links the entire globe and enables activities in a single click by reducing physical and geographical barriers. Industries of all types exploit modern technologies as a platform to conduct marketing activities. Electronic banking (e-banking) has renovated banking business processes and enhanced efficiencies, accessibility, and comfort in banking services. The application of technological

innovation over the last two decades has drastically altered the way businesses are operated by eliminating geographical, regulatory, and industrial barriers (Zafar et al., 2011).

Singh (2023) has stated e-banking as the practice of providing banking services electronically, either at their place of business or house. Electronic banking provides retail and small-value banking products and services through electronic channels, as well as large-value electronic payment and other wholesale banking services delivered electronically (Abid & Noreen, 2006). Further, Khan (2017) has termed e-banking as the inclusion of internet banking, mobile banking, automated teller machines (ATMs), POS terminals (point of sales), and any online banking services.

The banking industry has always been a leader in applying modern technologies in order to achieve operational efficiencies. This technological innovation in the banking industry has created value for both banks and customers in that it enables customers to perform banking transactions without having to visit a physical bank (Khan, 2017). The development of technology in the financial services industry has been accelerating in recent years and swiftly becoming the norm rather than the exception (Khera et al., 2022).

Zafar et al. (2011) stated that the adoption of technological innovation over the last two decades has considerably altered the way businesses are operated by eliminating geographical, regulatory, and industrial barriers. According to Shamsuddoha (2008), e-banking is transforming the financial services industry by supporting growth, promoting innovation, and enhancing competitiveness. Banking institutions globally benefitted from the use of e-banking services, which have enabled banking institutions to compete more effectively in the global environment by extending their products and services beyond the restriction of time and space (Turban et al., 2004).

The development and adoption of e-banking technology in banks and financial institutions is ever-growing and has been accelerating in recent years, swiftly becoming the norm rather than the exception (Khera et al., 2022). Nowadays, physical branch banking has been replaced by e-banking, whereby customers can obtain service through the internet from their homes or at work rather than physically visiting the branch (Drigă & Isac, 2014; Poon, 2008). This transformation to e-service has provided both banks and customers with several benefits, such as personalized services, transaction security, speed of processing transactions, and overall better service quality (Abdulfattah, 2012). E-banking has forced changes in the patterns and practices of businesses and organizations, including banking institutions. Due to busy work lives, saving in time, effort, and cost, customers prefer performing their banking transactions digitally as e-banking. As consumer satisfaction is the “must-do” act for all types of businesses, it’s the very condition for achieving customer retention and loyalty. The customer-focused strategies and products/services derived from listening to customers assure sustainability.

The banking industry in Nepal has dramatically developed over the last two decades after the entrance of joint venture banks, which are supposed to be leaders of modern banking services, including e-banking practices. In addition, the banking industry has been more competitive,

resulting from tough competition from banking firms and other financial institutions providing similar services (Shrestha, 2018; 2019). To build and maintain market share, the banks rely on the best banking products via innovation and modernization. Due to the growing number of educated and information technology-friendly customers in the Nepalese context, the adoption of e-banking practices is a pro-active measure led by baking institutions aimed at success and survival.

E-banking is the latest but vital in terms of enhanced competitiveness that helps to maintain satisfaction. Over the past two decades, the use of e-banking facilities has been increasing day by day due to customer-perceived benefits. The Covid-19 pandemic also highlighted the application of e-banking services like ATMs, Electronic Funds Transfer at Point of Sale (EFTPOS), Internet banking, SMS alerts, credit and debit cards, and other technological advancements that have enriched the banking landscape in Nepal. This is more convenient, effective, and efficient than the traditional way of banking. In addition, providing various e-banking services has been key to banking institutions in terms of enhancing service quality, addressing changing customer preferences, and improving competitiveness in the market. In Nepal, the banking industry has begun to use e-banking systems in the last decade only. There is an absence of sufficient studies in the area of e-banking services in relation to customer satisfaction. This study aims to investigate and comprehend how the delivery of e-banking services has an impact on customer satisfaction.

Objective of the study

This study's primary goal is to examine how e-banking services provided by Nepalese banking institutions affect customer satisfaction. The following are two study objectives:

1. To determine customer perceptions of e-banking services and satisfaction.
2. To examine the impact of e-banking service delivery on customer satisfaction.

Literature Review

Electronic banking (e-Banking)

E-banking is a blanket term used to indicate a process through which a customer is allowed to carry out personal or commercial banking. According to Salehi et al. (2008), e-banking is an electronic connection between banks and clients to prepare, manage, and control financial transactions. It is a modern banking system with which the customer can perform various transactions over the internet and is supposed to be convenient, reliable, safe, and secure. It promotes paperless/cashless transactions. Awara and Anyadighibe (2014) describe e-banking as the provision of retail banking services via electronic channels as well as large-value electronic payment and other wholesale banking services delivered electronically. The various services included in e-banking are mobile banking, ATMs, debit cards and credit cards, point of sale (POS), electronic data exchange (EDI), electronic fund transfer (EFT), and many others using electronic and telecommunication networks. Electronic banking facilitates the use of computers, phones, and other technologies to facilitate banking transactions without human interaction. In the words of Daniela and Dosoinescu (2004), e-banking is the access of customers to bank services by secure intermediaries without any physical

presence. It has reduced the need to move paper money and coins from one place to another, and humans are no longer required to facilitate every banking transaction**.**

e-banking service quality

Other than product quality, service quality relies on intangible and impalpable interactions between a provider and a user that affect the service user's perceptions. Gronroos (1984) defined quality as a judgment resulting from an evaluation process in which customers compare their exceptions with the service they perceive to have received. Services quality, in the banking industry, can be defined as a measure of how well the level of service provided meets customer expectations, resulting from a comparison between customers' prior expectations about the service and their after perceptions of the actual experience of service performance (Sewaka et al., 2023).

E-service quality is a blend of advanced information technology facilities with banking services that is more effective and efficient than traditional banking systems of rendering services. In the words of Parasuraman, Zeithaml, and Malhotra (2005), e-service quality is defined as the "extent to which a website facilitates efficient and effective shopping, purchasing, and delivery." Many researchers define service quality based on a customer's overall impression of the product or service (Parasuraman et al., 1985, 2005). Similarly, Wolfinbarger and Gilly (2003) define e-service quality as "the beginning to the end of the transaction, including information search, website navigation, order, customer service interactions, delivery, and satisfaction with the ordered product.

e-banking and customer satisfaction

Lustsik (2004) defines e-banking services as a variety of e-channels for doing banking transactions through the Internet, telephone, TV, mobile, and computer. Banking customers' desires and expectations with regard to service are expanding as technology advances and improves. Tse and Wilton (1988) have defined customer satisfaction as a consumer response to the evaluation of the perceived difference between expectations and the final result after consumption. Customer satisfaction can also be described as the feedback of a post-purchase assessment of certain services or products' quality and compared with the expectations of the prior-purchasing stage (Kotler & Keller, 2011).

According to Grönroos (1998), there is a steady and positive relationship that gathers both the e-service quality and customer satisfaction. Indeed, the relationship between quality of service and customer satisfaction is very strong and durable (Parasuraman et al., 1988). The study of Bei and Chiao (2006) recognized a major relationship between the quality of the service and the customer satisfaction degree of customers.

The findings of Hammoud et al. (2018) show that reliability, efficiency, ease of use; responsiveness and communication; and security and privacy all have a significant impact on customer satisfaction, with reliability being the dimension with the strongest impact. Similarly, The findings of Zavareh et al. (2012) indicated that efficient and reliable services, fulfillment, security/trust, site aesthetics, responsiveness/contact, and ease of use have a significant positive relationship with customer satisfaction in internet banking in Iran. Shankar and Jebarajakirthy (2019) found that reliability, along with privacy and security, are the strongest significant predictors of customer satisfaction and loyalty. In line with this, other researchers also revealed that there is a statistically

significant association between the service quality dimension and customer satisfaction concerning e-banking services (Sharma et al., 2020).

The empirical result of Mohamud (2017) revealed a linear relationship between e-banking service qualities, as ease of use, usefulness, and cost directly influence customer satisfaction. The study concluded that service quality dimensions such as security, aesthetics, reliability, responsiveness, and efficiency should not be disregarded in an attempt to obtain better-satisfied customers. Consequently, Firdous and Farooqi's (2017) empirical evidence shows that the internet banking service quality dimensions, namely efficiency, system availability, fulfillment, privacy, contact, responsiveness, and contact, were positively related to customer satisfaction.

Hammoud et al. (2018) investigated the impact of e-banking service dimensions on customer satisfaction in the case of Lebanon. Their findings show that reliability, efficiency, and ease of use; responsiveness and communication; and security and privacy all have a significant impact on customer satisfaction, with reliability being the dimension with the strongest impact. The research findings of Bashirand Zelalem (2020) indicated a significant impact of efficiency, responsiveness, ease, privacy, and commission on satisfaction and significant impact of satisfaction on loyalty. Raji et al. (2021) found a positive and significant impact of electronic banking variables security, transactional speed, ease of use, reliability, and responsiveness on customer satisfaction.

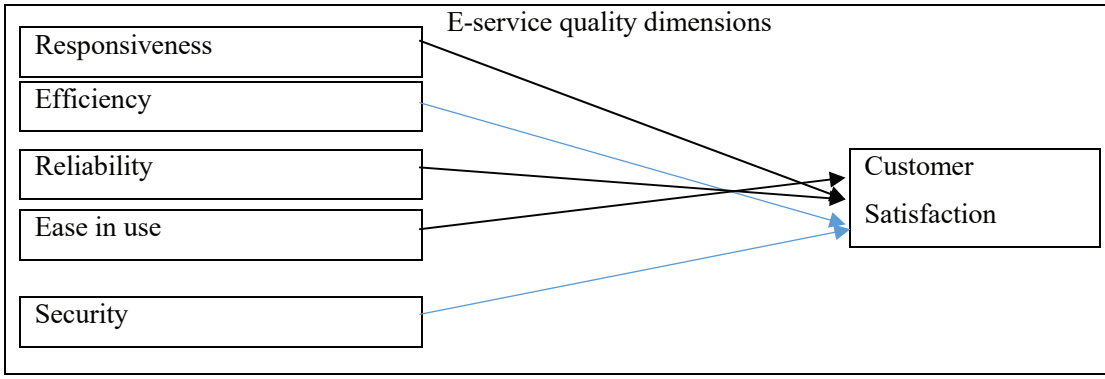
Furthermore, Tetteh (2022) examined the impact of electronic banking service quality on customer satisfaction and customer loyalty. The results show that the dimensions of service quality, namely, convenience, ease of use, accessibility, and affordability, were found to be significant positive drivers of customer satisfaction. In addition, Mwiya et al. (2022) found e-banking dimensions of security, website attribute, privacy, responsiveness, efficiency, fulfillment, and reliability positively affect customer satisfaction. A study result by Sewaka et al. (2023) demonstrated that there is a positive and significant relationship between service quality and customer satisfaction and customer loyalty. Rupal and Singh (2023) revealed a positive impact of e-banking dimensions such as quality of services, reliability, efficiency, responsiveness, security, and privacy, and others on customer satisfaction. Based on these empirical findings, the study intended to examine the effect of e-banking dimensions of ease of use, efficiency, reliability, responsiveness, and security on customer satisfaction in a Nepalese banking context.

Model and hypotheses

The service quality variables identified by Parasuraman et al. (1994) are reliability, responsiveness, competence, accessibility, courtesy, communication, credibility, security, understanding, and tangibility. Service quality leads to overall customer satisfaction. It is one of the service factors contributing to customers' satisfaction judgments and can be considered in multi-level and multi-dimensional terms (Caruna & Malta, 2002). This study has employed five e-banking service quality dimensions, viz. Ease in navigation, efficiency, reliability, responsiveness, and security have been derived from an e-SQ instrument developed by Zeithaml et al. (2000). The conceptual model explains these five e-SQ dimensions as predictors of customer satisfaction.

Figure 1

Conceptual framework of the study



Based on the literature, the following study hypotheses were developed to answer the research objective of investigating the effect of five dimensions of e-banking service on customer satisfaction.

H1: Ease of use has a positive and significant effect on customer satisfaction.
H2: Efficiency has a positive and significant effect on customer satisfaction.
H3: Reliability has a positive and significant effect on customer satisfaction.
H4: Responsiveness has a positive and significant effect on customer satisfaction.
H5: Security has a positive and significant effect on customer satisfaction.

Research Methods

Research Design

This study has employed a descriptive design in order to identify and characterize the qualities of value of interest. Similarly, the casual comparative design was adopted to analyze the effect of e-banking service quality on customer satisfaction.

Population and Sample

The study population of this study is all clients who are familiar with and actively using e-banking services provided by banks and financial institutions. Convenient and snowball sampling techniques were used to reach competent clients who are familiar with e-banking services. A total of 280 questionnaires were distributed with the use of an online survey on the Google Forms platform. Out of the distributed questionnaires, only 248 were returned, and due to response errors, only 232 responses were used for analysis.

Data nature, source, and collection

The database for the study is the primary source to collect opinions from e-banking service users. The questionnaire survey method was the source of data collection. The survey was conducted during September 2023 with the use of Google Forms online software. A purposefully constructed closed-ended questionnaire/statement of e-service quality and satisfaction along with demographic information was applied for the survey after an intensive review of the literature. The questionnaire consisted of three sections: cover letter, respondent demographic profile, and e-banking services

and client satisfaction. The statements related to independent and dependent variables were scaled using a 5-point Likert scale ranging from strongly disagree-1 to strongly agree-5. Table 1 reports details of items and subsequent reliability statistics.

Table 1

Reliability Statistics of the study variables

Code	No. of items	Cronbach Alpha
Ease in use	4	.944
Efficiency	4	.949
Reliability	5	.963
Responsiveness	5	.888
Security	4	.902
Satisfaction	5	.939

The result has shown that all the items used to measure the five dimensions of e-banking and customer satisfaction are highly reliable.

Data Analysis Tools

All collected data were processed and analyzed with the use of SPSS software. The frequency table was utilized to demonstrate respondents' various demographic characteristics. The descriptive analysis included mean and standard deviations of the study variables. Pearson's correlation analysis was used to determine mutual association among the study variables. The linear regression analysis was conducted to investigate the effect of e-banking service quality defined into six dimensions on customer satisfaction. The analysis was a basic inferential statistic to test study hypotheses. The model is described as follows:

$$Y = \beta\ 0 + \beta 1ESE + \beta 2EFF + \beta 3REL + \beta 4RES + \beta 5SEC + \beta 6SPD + e$$

Where,

Y=Customer Satisfaction
ESE= Ease in use
EFF= Efficiency
REL= Reliability
RES= Responsiveness
SEC= Security
SPD= Speed in transaction
Error term = e

Results

The structured questionnaire survey consisted of 232 respondents of various demographic characteristics. Table 2 reports the frequency and percentage of respondent demographics.

Table 2

Respondent demographic profile (N=232)

Demographic variables	Frequency	Percentage
Gender		
Male	142	61.2
Female	90	38.8
Age		
16-25		
26-40	76	32.8
41-60	138	59.5
Above 60	17	7.3
	1	.4
Employment		
Student	62	26.7
Private service	62	26.7
Public service	74	31.9
Self-employed	34	14.7
Education		
Up to Higher secondary	79	34
Bachelors	76	32.8
Masters	72	31.0
Others	5	2.2

Source: Online Survey, 2023

Regarding the gender of the participants, the majority were male, consisting of 142 out of 232 in total. Most of the respondents were between 26 and 40 years old, representing 59.5 percent in total. Similarly, respondents engaged in public service were 74; both students and those working in private organizations occupied 62 respondents. The self-employed persons were 34 in number. Most of the respondents had up to higher secondary and equivalent education, and education with bachelors and masters was 76 and 72, respectively. The demographic characteristics of the respondents are thus diverse. Table 3 depicts basic descriptive statistics and correlation coefficients of the study variables.

Table 3

Descriptive statistics and Pearson's correlations of the study variables

	Mean	S. D.	ESE	EFF	REL	RES	SEC	CS
ESE	3.48	.43	_					
EFF	3.45	.42	.395***	_				
REL	3.43	.45	.263***	.461***	_			

RES	3.47	.49	.216***	.296***	.458***	_		
SEC	3.50	.44	.222***	.330***	.341***	.396***	_	
CS	3.54	.47	.386***	.436***	.437***	.385***	.407***	_

* p < .05, ** p < .01, *** p < .001

The descriptive results depicted in Table 3 show that respondents have considered their moderate agreement in all five e-service quality dimensions, respectively, ease of use, efficiency, reliability, responsiveness, and security, along with customer satisfaction. The correlations among all the study variables are positive and significant. The dependent variable, customer satisfaction, has higher and more significant correlations with efficiency, reliability, and security.

The basic inferential statistics used in the study were linear regression analyses with the purpose of testing study hypotheses. Table 4 shows the effect of the predictors on customer satisfaction and other primary statistics. The results have shown that the regression model used can effectively predict the effects of independent variables on the dependent. The value of R-square is 0.62, which is indicative of the model's power to explain 60% of the variability observed in the target variable. The Durbin Watson statistic of 1.825 also indicates the presence of no autocorrelation in the residuals of the regression analysis used. Similarly, no multicollinearity was found among the independent variables, as all the tolerance as well as VIF values of the analyzed variables are below 1 and 2, respectively.

Table 4

Regression result with collinearity statistics

						Collinearity Statistics	
Model	Unstandardized	Standard Error	Standardized	t	p	Tolerance	VIF
(Intercept)	0.504	0.273		1.849	0.066		
ESE	0.209	0.061	0.200	3.419	< .001	0.826	1.210
EEF	0.182	0.068	0.171	2.666	0.008	0.686	1.458
REL	0.174	0.064	0.179	2.738	0.007	0.664	1.507
RES	0.120	0.056	0.133	2.124	0.035	0.721	1.387
SEC	0.191	0.060	0.192	3.184	0.002	0.780	1.283

Note: R square= 0.62, Adjusted R square= 0.60, F statistic = 25.38, p value = < .001, Durbin Watson =1.825

The regression analysis has indicated that all of the e-service quality dimensions have produced a positive and significant effect on customer satisfaction. Among five dimensions used as predictors of service quality, four dimensions, respectively ease of use (b =.209, p =.001), security (b =.191, p =.002), efficiency (b =.182, p =.008), reliability (b =.174, p =.007) and responsiveness (b =.120, p

=.035), found to be influential on customer satisfaction. Relatively, the responsiveness dimension of e-service quality has a weak impact on customer satisfaction.

Table 5

Hypotheses Test Results Using Job Satisfaction as the Dependent Variable

Hypotheses	Predictor Variables	Relationship		Significance	Decision
		Expected	Reported		
H1	Ease in use	Positive	Positive	Significant	Accepted
H2	Efficiency	Positive	Positive	Significant	Accepted
H3	Reliability	Positive	Positive	Significant	Accepted
H4	Responsiveness	Positive	Positive	Significant	Accepted
H5	Security	Positive	Positive	Significant	Accepted

Based on the empirical results, all the study hypotheses have been accepted.

Discussion

The objective of this study was to determine how customer satisfaction is affected by e-banking services in Nepal. The findings of this study showed mixed results on e-services provided by the banking institutions of Nepal. As almost all the customers agreed moderately, e-services are satisfactory to some extent. The correlation results revealed positive and significant correlations between e-service dimensions and customer satisfaction. The findings of this study support previous studies (Parasuraman et al., 1988; Grönroos, 1998; Bei and Chiao, 2006; Tetteh, 2022), which confirmed a positive relationship between e-service quality and customer satisfaction. Further, as stated by Parasuraman et al. (1988), the relationship between quality of service and customer satisfaction is very strong and durable, which can provide competitive advantages to banks adopting better e-banking products.

The basic inferential analysis used to test hypotheses was regression analysis. The result from regression analysis also revealed a positive and significant impact of all five dimensions of e-banking on customer satisfaction. All five alternative hypotheses were accepted, declaring a positive and significant impact of e-banking dimensions—ease to use, efficiency, reliability, responsiveness, and security—on customer satisfaction. Among the five dimensions used as predictors of service quality, ease of use, security, efficiency, and reliability were found to be more influencing relatively. However, responsiveness was found to be less influential on customer satisfaction.

These findings are consistent with the study of Hammoud et al. (2018), which found a significant impact of reliability, efficiency, and ease of use; responsiveness and communication; and security and privacy on customer satisfaction. The findings have supported the findings of many other studies that revealed a positive and significant effect of various e-banking dimensions on customer satisfaction (Zavareh et al., 2012; Jebarajakirthy, 2019; Sharma et al., 2020; Mohamud, 2017;

Firdous & Farooqi, 2017; Hammoud et al., 2018; Bashir and Zelalem, 2020; Zameni & Abdulwakil, 2021; Tetteh, 2022; Mwiya et al., 2022; Sewaka et al., 2023; Rupal & Singh, 2023).

These results indicated positive and significant linkages of e-banking services with customer satisfaction, but the associations were not strong, and manyfold improvements in e-banking still remain. The authorities need to adopt strategies, policies, and programs that may increase the use of e-banking services. They should focus on enhancing convenient, effective, reliable, and secure transactions of e-banking products. Especially the responsiveness dimension is relatively weak among other dimensions; thus, "customer listening" and quick and continuous "customer care" may lead to better outcomes from e-banking services.

Conclusion

The objective of this study was to examine the impact of e-banking service quality on customer satisfaction in the context of Nepalese banking institutions. The descriptive result has shown respondents have shown their agreement with five e-banking service quality dimensions being fair. The correlation results revealed a moderately positive and significant correlation between the five dimensions of e-banking and customer satisfaction. The empirical result from regression analysis supported all study hypotheses, indicating a positive and significant impact on ease of use, efficiency, reliability, responsiveness, and security. These findings provide insights to banking authorities in enhancing banking service qualities to achieve higher customer satisfaction that would lead to an increase in retention and loyalty rates. Since the study of e-banking and customer satisfaction is a new research area in Nepal, further studies are possible with cross-sectional studies with larger samples.

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The Effect of Profitability, Capital Structure, Firm Size and Asset Growth on Firm Value

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Abstract

A company's primary objective after going public is to maximize wealth for its owners or shareholders by raising its market value. The share market price represents the wealth of the company and its shareholders. It is a reflection of the financing, asset management, and investment decisions made by the shareholders in collaboration with the management team to optimize the company's growth rate and profit margin and to preserve the company's position. The profitability, capital structure, firm size, and asset growth are the major variables that determine its worth. This study aims to collect empirical data on the effect of profitability, capital structure, firm size, and asset growth on firm value in listed microfinance companies in Nepal from FY 2075/76 to FY 2079/80. This study uses a judgmental sampling method with 15 sample microfinance companies listed in the NEPSE with 75 observations. The SPSS was used to calculate the study's data and process it. The results of this study depicted that profitability and firm size had a statistically insignificant effect on firm value whereas capital structure (DER) had significant positive and asset growth (AG) had significant negative effect on firm value of selected microfinance companies in Nepal.

Keywords: Firm value, profitability, capital structure, firm size, asset growth, microfinance companies in Nepal.

Introduction

The growing number of companies indicates that the country's economy is expanding. The rapid development of the globalization era and increment in sophisticated and advanced technology and innovation have supported the economy of the nation. In order to thrive and compete with other businesses, organizations need to keep developing, innovating, and improving their performance because there are an increasing number of companies in the market. Every company has short-term and long-term goals to be achieved. The ability of a business to ensure goal achievement and

business continuity depends on resource mobilization, the firm's performance, and its management team.

Profit maximization is one of the company's short-term objectives. Achieving maximum profit requires the company to improve all aspects of its operations, including productivity growth, raising standards for products and services, hiring qualified personnel, using resources and operational systems effectively and efficiently, comprehending the market, and choosing the best management strategy for the business. A company's long-term objective is to increase its value. High shareholder wealth will come after a high corporate valuation. The company's value is significant to investors and a good indication of the market's perception of the business. Numerous internal and external factors might impact the fluctuations of a company's stock price on the Nepalese stock market. Interest rates, exchange rates, inflation rates, and government policies are examples of external influences that affect a nation's economic circumstances. Company performance is one example of an internal element that might impact a stock's price.

Financial statements of a firm can be used to determine if its performance has increased or decreased. When evaluating a firm, financial statements are crucial since they provide information that can be used to determine whether or not the company is beneficial to the parties that are involved (Hidayat, 2018). This financial report is of interest to both internal and external stakeholders. Internally, company management uses financial reports as a source of information for assessment, appraisal of performance, and future strategy decisions. Financial statements are used by outside parties to assess how well the management of the company is performing. The financial statements will demonstrate strong financial success, which will raise the market price of the company's stock. An increase in the share price will raise the company's valuation and increase the return to shareholders. Investors expect that the company will be able to use the paid-up capital effectively and efficiently if it performs well and produces significant returns. This has the potential to boost investor trust in the company and encourage greater investment.

Numerous studies on firm value have been undertaken by earlier researchers, but the outcomes have been inconsistent. The studies conducted by Husna and Satria (2019) and Radja and Artini (2020) demonstrated that profitability has a significant positive impact on business value. The firm value is not significantly affected by profitability [Stephanie et al., (2021); Santoso & Widjaja, (2021)]. Furthermore, studies by Hirdinis (2019) and Nurdiansari et al. (2021) demonstrated that capital structure has a significant positive impact on firm value. On the other hand, studies by Salauy et al. (2020) shown that capital structure had no significant impact on firm value. Firm size has a major impact on firm value, according to research by [Natsir & Yusbardini (2020); Yusra et al., (2019); Radja & Artini (2020)]. On the other hand, Hermi (2020) revealed that firm size has no significant impact on firm value. While Hutabarat, Fitrawaty and Nugrahadi (2018) found that asset growth does not significantly positively affect firm value, but research by Perwira and Wiksuana (2018)] indicated that asset growth has a significant effect on firm value. In light of the fact that the findings of earlier research on the factors influencing firm value varied, this study will offer factual data addressing the impact of profitability, capital structure, firm size and asset growth on the value of listed microfinance companies in Nepal.

Literature Review

According to Brigham and Houston (2019), the term "signaling" explains how the management of a company instructs investors on how it assesses the company's prospects. According to this view, firm management needs to exercise caution while giving investors the signals they require in the form of information. Investors may receive information from company management that is either favorable (good news) or negative (bad news). The value of a company can rise when management reduces information asymmetry by sending a signal to investors through information disclosure (Lani & Sufiyati, 2019). Investors can use this information to evaluate the company's future growth possibilities.

The agency theory explains the agency relationship. An agency relationship is defined as a legal arrangement in which one or more individuals (the principals) choose another individual (the agent) to do specific tasks on their behalf, according to Jensen & Meckling (1976). There will typically be costs associated with agency relationships between principals and agents, as well as conflicts of interest between managers and shareholders in terms of maximizing corporate value. Therefore, in order to make arrangements for the execution of duties and the transfer of rights from the principal to the agent, managers and shareholders must come to an understanding of a clear and mutually advantageous work contract agreement [Kurniawansyah, Kurnianto & Rizqi (2018)].

Firm value, as it refers to a company's share price, is the price that buyers are willing to pay to acquire the company [Anggraini & My (2019)]. The financial position of shareholders might rise when a company's wealth or worth is maximized. An essential factor in raising the company's worth is its shareholders. They will raise the corporation's stock market worth if they believe the company can add value for them (Hermi, 2020).

Brigham and Houston (2018) defined profitability as a ratio that gives a general picture of how companies use their assets to make a profit. The profitability ratio can be utilized to assess the financial health of a company. A key indicator of managerial effectiveness is optimal profit for the company, which also demonstrates strong financial performance (Jaya, 2020).

The capital structure of the company refers to how it raises funds from both internal and external sources to support current operations and potential future expansion [Natsir & Yusbardini (2020)].

According to Radja and Artini (2020), firm size is an indicator of several firm types, including large, medium, and small businesses. The size of a firm can serve as an indicator of its financial health. Due to their perceived stability, which makes it simpler for companies to attract finance, investors have higher faith in large corporations [Hermi (2020)].

Asset Growth is a ratio that measures the changes (increases or decreases) in total assets owned by a company.

Research Hypothesis

The Effect of Profitability on Firm Value

The ability of a business to make a profit determines its profitability, which in turn influences the business's worth. In order to evaluate how well managers employ the cash they have invested in the company to generate investment returns, investors are highly interested in profitability [Wahlen, Baginski & Bradshaw (2015)]. Businesses that are more profitable will attract more investors to contribute capital to their operations. Investors believe that the management of the company can operate effectively to increase the value of the capital invested in the business. According to studies by Radja and Artini (2020) and Taufan, Rizki and Budianto (2018), profitability has an important positive impact on firm value.

H_1: Profitability has a significant positive effect on firm value.

The Effect of Capital Structure on Firm Value

The capital structure of a firm refers to the share of internal and external funding allocated to the organization's operations and expansion. The percentage of debt used to finance the company's assets is displayed in the capital structure. It is possible for investors to comprehend how to manage risk and return when making investments (Betavia, 2019). An organization's level of debt utilization increases with its degree of leverage. Growing leverage can be a sign of a healthy business since managers who use debt for operating expenses will strive to keep the business afloat. This is a result of creditors keeping a closer eye on the business in regard to its debt-use policies. In order to use debt more prudently for the purposes of the business, management will also use it with a feeling of responsibility. Prior research demonstrated that capital structure has a major positive impact on firm value. [Hirdinis (2019); Patrisia & Sari (2019)].

H_2: Capital structure has a significant positive effect on firm value.

The Effect of Firm Size on Firm Value

A corporation's size can be determined by looking at its company size. Investors will notice that a larger company can better manage its operations to generate higher profits as it grows in size. In order to contend with current and potential economic competition, large corporations are also seen to have greater control over market conditions (Juhandi et al., 2019). Investors will be encouraged to invest in the company by this favorable indication. According to studies by Yusra et al. (2019) and Radja and Artini (2020), firm value is strongly favorably impacted by firm size.

H_3: Firm size has significant a positive effect on firm value.

The Effect of Asset Growth on Firm Value

Companies with increasing assets have the potential to make a greater profit, and as a result, the expansion of their assets may have a positive impact on market attitudes and responses that will help attract investment.

An indication of the company's profitability to investors is its expansion. For investors to demonstrate healthy corporate growth, the company must also be able to yield returns on its investment (Sari and Patrisia, 2019). Prior studies, Perwira and Wiksuana (2018) demonstrated that asset growth has a substantial positive impact on firm value.

H_4: Asset Growth has a significant positive effect on firm value.

Conceptual Framework:

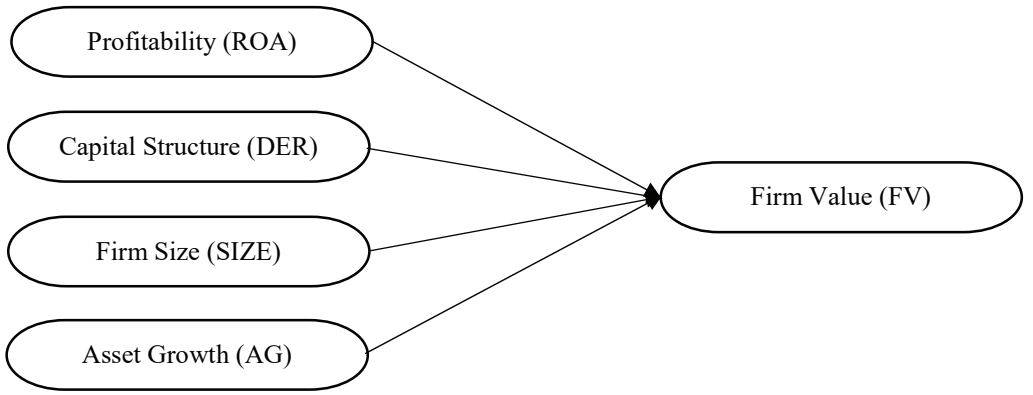

Figure 1. Research framework

This study aims to analyze the effect of profitability, capital structure, firm size and asset growth on the firm value of the sample microfinance companies in Nepal. Therefore, profitability, capital structure, firm size and asset growth are taken as independent variables and firm value is the dependent variable. The expected sign of the independent variables (ROA, DER, SIZE and AG) are positive. It is expected that profitability, capital structure, firm size and asset growth of the microfinance companies positively affect the firm value.

Research Methods

The major objective of this study is to examine the effect of profitability (ROA), capital structure (DER), firm size (SIZE) and asset growth (AF) on firm value (FV) of the listed microfinance companies in Nepal. Thus, this study uses a descriptive and causal comparative research design which is a research study to describe a systematic, factual, and accurate picture according to the facts regarding the characteristics of the research population (Syahza, 2021). There are 57 listed microfinance companies in Nepal (As of mid-July, 2023). This study considers only 15 listed microfinance companies based on a judgmental sampling technique. The data are based on secondary data, which is collected from annual reports of the sample microfinance companies with a total of 75 observations during the fiscal year 2075/76 through 2079/80. Mean and standard deviation are used to assess the level and characteristics of sample microfinance companies. Similarly, correlation analysis is used to examine the relation between profitability, capital structure, firm size, asset growth and firm value of the sample microfinance companies. Likewise,

to investigate the effect of profitability, capital structure, firm size and asset growth on the firm value of the sample microfinance companies, regression analysis is used in this study.

Variables and the operational definitions

Table 1

Study Variables and Definitions

Variables	Measures
Firm value (FV)	Market price per share/Book value per share
Return on Equity (ROA)	Net income after tax/Total Assets
Debt-Equity Ratio (DER)	Total debt/Total equity
Firm Size (SIZE)	Ln (Total Assets)
Assets Growth (AG)	[Total asset(t)-Total asset(t-1)]/Total Asset(t-1)

Table 1 shows the study variables and their operational definitions. The dependent variable of the study is the firm value (FV) and the independent variables are profitability (ROA), capital structure (DER), firm size (SIZE) and asset growth (AG). Investors' opinions and perceptions of a company, described as firm value, are usually related to the stock price of the company. The firm value in this study is proxied using FV. Profitability is the capacity of the business to earn a profit. ROA is used in this study as a proxy for profitability. The capital structure of a firm refers to the proportion of internal and external funding allocated to the organization's operations and expansion. DER is used in this study as a proxy for the capital structure. Firm size is a measure that shows the extent of a company based on its total asset worth. Using the natural logarithm of total assets, the size of the company is determined. Similarly, the ratio labeled "Asset Growth" (AG) illustrates how a company's total assets have changed over time, either positively or negatively.

Empirical Model

The model to be analyzed in the research is as follows:

$$FV = \alpha + \beta_1 ROA + \beta_2 DER + \beta_3 SIZE + \beta_4 AG + \varepsilon$$

Where,

FV = firm value

α = constant

$\beta_1, \beta_2, \beta_3 and\ \beta_4$= coefficient parameters

ROA = Return on assets for microfinance companies during t period

DER = capital structure (debt-equity ratio) for microfinance companies during t period

SIZE = size of microfinance companies during t period

AG = asset growth of microfinance companies during t period

Results and discussion

The data used in this research are cross-section panel data.

Descriptive Analysis

The descriptive analysis was used to determine the characteristics of the study variables. Table 2 presents the descriptive statistics of the dependent and independent variables during 2075/76 to 2079/80. It consists of mean, standard deviation, minimum and maximum.

Table 2

Descriptive Statistics

Variables	Min	Max	Mean	SD
FV	0.00	19.80	5.90	3.28
ROA	-0.35	73.81	2.83	10.32
DER	0.78	8.98	4.29	2.38
SIZE	8.64	10.63	9.57	0.62
AG	-0.22	2.38	0.27	0.40

Note: N=75

Table 2 presents that the firm value (FV) of the microfinance companies ranges from a minimum 0.00 to a maximum 19.80. The mean value and standard deviation are 5.90 and 3.28 respectively. It implies that firm value is less deviated than return on assets and more fluctuated than asset growth, size and debt-equity ratio. The mean value and standard deviation of ROA are 2.83 and 10.32, and it ranges from -0.35 to 73.81. It shows that the return on assets of the microfinance companies is highly fluctuated than other study variables during the study period. In terms of DER, the mean and standard are 4.29 and 2.38, and it ranges from min 0.78 to 8.98. The DER is less fluctuated than the firm value and return on assets of the microfinance companies during the study period. Similarly, firm size (M=9.57, SD=0.62) and asset growth (M=0.27, SD=0.40) are the less fluctuated study variables. The descriptive analysis showed a highly fluctuation in return on assets (ROA) and least fluctuation in asset growth (AGP) of the microfinance companies of Nepal.

Correlation Analysis

The association between study variables return on assets, capital structure, firm size, asset growth and firm value is investigated by using Spearman's correlation coefficient and the results are presented in table 3.

Table 3

Correlation analysis for study variables

	ROA	DER	SIZE	AG	FV
ROA	1				
DER	-0.232	1			
SIZE	0.212	-.650**	1		
AG	-0.092	0.173	-.326*	1	
FV	-0.092	.395**	-0.107	-.345*	1

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 3 revealed that return on assets (ROA), firm size (SIZE) and asset growth (AG) had a negative relationship with firm value (FV). The relationship between ROA, SIZE and FV is statistically in significant. It implies that any changes in ROA and SIZE do not change the firm value. This shows that there is no relationship between profitability, firm size and firm value. However, the asset growth (AG) and firm value had a statistically significant negative correlation, indicating that a rise in AG will reduce the firm value and vice-versa of the microfinance companies of Nepal. Similarly, there is a significant positive correlation between capital structure (DER) and firm value (FV). It indicates that any rise in capital structure (DER) results in an improvement in the firm value of microfinance companies in Nepal.

Regression Analysis

The main aim of the regression analysis is to examine the effect of profitability (ROA), capital structure (DER), firm size (SIZE), and asset growth (AG) on firm value (FV) of sample microfinance companies. The results of the regression analysis are reported in Table 4.

Table 4

Regression Analysis

	Coefficient	Std. Error	t-Statistics	Sig.
Constant	-2.073	9.121	-0.227	0.821
ROA	-0.009	0.04	-0.236	0.814
DER	0.733	0.222	3.306	0.002
SIZE	0.601	0.879	0.684	0.498
AG	-3.33	1.062	-3.136	0.003

R-squared	0.340
Adjusted R-squared	0.281
F-statistics	5.794
F-sig.	0.001

Table 4 indicates the results of the regression analysis of the study. The adjusted R2 is 28.10 percent, which reveals that the variables of profitability (ROA), capital structure (DER), firm size (SIZE) and asset growth (AG) in this study can explain the firm value of 28.10 percent and the remaining 71.90 percent is explained by other independent variables. The value of F-sig. is 0.001, which is less than 0.05, it indicates that the regression model is statistically fit. The regression results also demonstrated that the capital structure (DER) had a significant positive impact on the firm value (FV), whereas asset growth (AG) had a significant negative impact on firm value of selected microfinance companies in Nepal. Similarly, the impact of ROA and AG on FV had an insignificant effect. It indicated that return on assets (ROA) and firm size (SIZE) had no effect on firm value (FV) of the sample microfinance companies in Nepal. It implies that an increase in total assets of the firm does not increase the firm value.

Test of Hypotheses

The results of the hypotheses are presented in Table 5.

Table 5

Test of Hypotheses

Hypothesis	Statement	P-value	Result
H_1	Profitability *has a significant positive effect on* firm value.	0.814	Rejected
H_2	Capital structure *has a significant positive effect on* firm value.	0.002	Accepted
H_3	Firm size *has a significant positive effect on* firm value.	0.498	Rejected
H_4	Asset growth *has a significant positive effect on* firm value.	0.003	Accepted

Table 5 reveals that H_1 and H_3 are rejected, whereas H_2 and H_4 are accepted. It indicates that the profitability (ROA) and firm size (SIZE) have no effect on firm value. Similarly, the capital structure and asset growth have a significant effect on the firm value of the sample microfinance companies in Nepal.

Discussion

This study aims to investigate the impact of profitability, capital structure, firm size, and asset growth on the firm value of microfinance companies in Nepal. The analysis of the results revealed that the profitability (ROA) does not affect firm value significantly. The results are consistent with the findings of Stephanie et al. (2021), Santoso and Widjaja (2021) and Natsir and Yusbardini

(2020). Similarly, the capital structure (DER) has a significant positive effect on firm value, this outcome is inconsistent with the findings of Saluy et. al (2020) and Yusra et. al (2019). Likewise, the firm size had no significant effect on firm value. This finding is consistent with the findings of Hermi (2020) and Dao et. al (2022) and inconsistent with the findings of Husna and Satria (2019), Radja and Artini (2020) and Yusra et al (2019). Similarly, asset growth has a significant effect on firm value, this result is contradicted by the findings of Hutabarat et. al (2018), and Paminto, Setyadi and Sinaga (2016). Microfinance companies play a vital role in uplifting people's living standards and the country's economic growth. This study revealed the effect of profitability, capital structure, firm size and asset growth on firm value. These factors (profitability, capital structure, firm size and asset growth) have a significant role in determining firm value. So, consideration of these factors by the management and Nepalese investors would be a more effective decision.

Conclusion

This study was conducted to examine the effect of profitability (ROA), capital structure (DER), firm size (SIZE), and asset growth (AG) on firm value (FV) of listed 15 sample microfinance companies in Nepal data from 2075/76 to 2079/80.

Based on the results, the Adjusted R-squared value in this study was 28.10 percent, which indicates that the variables of profitability (ROA), capital structure (DER), firm size (SIZE), and asset growth (AG) in this study can explain the value of a company (FV) of 28.10 percent and the remaining 71.90 percent is explained by other independent variables. The F-stat 0.001, which is less than 0.05 indicates ROA, DER, SIZE and AG simultaneously significantly affect the firm value, so that the research model can be used to research hypothesis testing. The results of hypothesis testing and the results obtained from multiple linear regression analysis concluded that the ROA and SIZE had statistically insignificant effects on firm value whereas the DER and AG had a significant effect on the firm value of microfinance companies in Nepal.

Scope for future research

This study focuses on the effect of profitability (ROA), capital structure (DER), firm size (SIZE), and asset growth (AG) on the firm value (FV) of the selected microfinance companies in Nepal. Beside these independent variables, the future researcher can also use ROE, EPS, the NPM as a proxy for profitability. Similarly, macroeconomic variables such as GDP, inflation also can be used, which also affect the value of the firm. This study is only based on secondary data. The future researcher can also use the primary data by using different statistical tools. Likewise, this study only considers data of 5 years with 75 observations. Future researchers can also cover more periods and may increase number of observations.

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Stock Market Responses to Macroeconomic Dynamics

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Abstract

This study aims at examining how the stock market reacts to macro-economic dynamics. Using the annual data set of 28 years from 1995 to 2022, the study employed the OLS Regression model. Macroeconomic variables like Inflation rate, Interest rate, Exchange rate, and Gross Domestic Product were used in this study. The findings suggest that the Nepal stock market is significantly affected by gross domestic product and exchange rate whereas interest is insignificantly negative Nepal stock market. Understanding the way macroeconomic factors affect NEPSE can assist evaluate the state of the economy as a whole and its capacity to provide wealth and prosperity for both venture capitalists and the wide-ranging community.

Keywords: Inflation, Nepal stock exchange, Gross domestic product, Exchange rate.

Introduction

With the trading of 18 securities Nepal Stock Exchange (NEPSE) was founded in the year 1994. Since its inception, NEPSE has evolved to become the sole stock trading platform in Nepal, playing a pivotal role in the nation's economic development. The primary function of NEPSE is to develop the economy of the nation by providing a platform for businesses and investors where the trading of securities can take place to mobilize reserve from the excess segment to the scarcity region. In 2007, NEPSE introduced an automated trading platform, representing a notable technological advancement in the realm of securities trading within the country. Over the years, there has been a notable enhancement in the trading of securities, driven by the adoption of innovative computerized technologies, consequently attracting a growing number of participants, both individual and corporate, from across the nation.

Efficiently developed stock markets can attract foreign direct investment into the local industry, thereby contributing significantly to the overall economic advancement of a country. It is widely acknowledged in the literature that the stock market plays a pivotal role in improving economic growth and nurturing development (Shahbaz et al., 2016). Numerous academic studies have delved into the intricate relationship between various macroeconomic indicators such as the inflation rate,

foreign interest rate, exchange rate, GDP, gold price, and money supply, among others, and their impact, whether positive or negative, on the performance of the stock exchange within a nation. Studies like Kim et al. (2004), Fama (1981), and Wei & Wong (1992) have all underscored the robust correlation between stock prices and macroeconomic variables. By conducting an extensive analysis encompassing G-20 countries and considering numerous variables including stock market turnover, market capitalization, value of stocks traded, GDP, oil prices, inflation rate, foreign exchange rate, and interest rate. Pradhan et al. (2015) have provided empirical evidence supporting the existence of a general long-term equilibrium relationship among those variables, with any deviations promptly rectified through economic growth mechanisms. Through the application of bound testing methodology within the emerging stock market of Malaysia, Bekhet and Mugableh (2012) have identified a significant association between stock prices and macroeconomic variables, highlighting a positive correlation between stock prices and GDP while observing a negative relationship with the M3, producer price index, and inflation as measured CPI, and exchange rate.

Likewise, in the specific context of Nepal, it has been observed that the stock market exhibits a positive response to GDP, inflation rate, and money supply, but conversely reacts negatively to the interest rate according to Karki (2018). Through the utilization of ARDL bound testing, Rana (2021) has unveiled the substantial long-term effects of real GDP growth on the stock market returns, coupled with the detrimental impact of the exchange rate and inflation rate in the Nepalese context. The scholarly investigation posits that policymakers ought to formulate strategic initiatives aimed at accelerating the pace of economic advancement and promoting export-oriented policies to sustain a favorable outlook on the stock market performance. The principal aim of this research endeavor is to scrutinize the prevailing trends in macroeconomic dynamics, such as the inflation rate, interest rate, exchange rate, and Gross Domestic Product in conjunction with the Nepal Stock Exchange, and to assess the stock market responses to these macroeconomic dynamics within the Nepalese setting.

Literature Review

Verma and Bansal (2021) provided evidence that GDP, FDI, and FII have a positive impact on both developing and established countries' stock market while the gold price is negatively related to the stock market. The macroeconomic indicators such as Inflation, money supply and GDP have the same effect on sartorial indices as they do on broad market indices. Bekhet and Mugableh (2012) conducted a study that revealed a significant relationship between stock prices and a group of macroeconomic variables. Their study demonstrated that stock prices exhibit a positive correlation with GDP while displaying a negative correlation with the producer price index, M3, CPI, and exchange rate. In a similar vein, Khan, Abbas, and Indres (2022) conducted their own analysis and observed a negative relationship between inflation, exchange rates, and interest rates, while noting a positive relationship between industrial production and stock market returns. Moreover, they employed Johansen Cointegration, Granger, and Toda Yamamoto (TY) Causality tests to explore these relationships further. Neifar et al. (2021) utilized these tests to show that there is an absence of co-integration between the variables under consideration. Additionally, their findings indicated that there is no causal relationship between macroeconomic factors and stock

returns, except for a unidirectional causal link from the exchange rate to stock prices. Furthermore, through the implementation of Granger non-Causality/Block Exogeneity Wald Tests, it was revealed that both inflation and exchange rate growth Granger cause fluctuations in the UK stock market return. Interestingly, the results of the ADL specification pointed towards a steady long-term effect of all the macroeconomic factors taken into account on the UK stock price. To be precise, the outcomes of the Error Correction Model (ECM) underscored that all the macroeconomic indicators considered play a crucial role in driving the UK stock price towards long-run equilibrium at a rapid pace.

In the context of Nepal, adopting vector auto regression (VAR) and a vector error correction model (VECM), Phuyal (2016) provided evidence that the stock marketplace had a long-run equilibrium association with various elements of macroeconomic variables such as inflation rate, interest rate, and remittance flow. Karki (2018) provided evidence that the stock market reacts positively to the GDP, Inflation rate, and money supply however, it is negatively related to interest rate. The study also stated that there was no co-integrating evidence between macroeconomic variables and the stock market index which suggest that the stock price movement in Nepal is not clarified by the macroeconomic variables. Besides, the study settled that the random walk hypothesis theory is supported in the Nepalese stock market. Using the bound test, Devkota and Dhungana (2019) confirmed that there is long-run relation among the variables. The ARDL investigation discovered that the interest rate is the uttermost defining element for the stock Market Index while the gold price has an insignificant influence on the stock exchange in Nepal. Correspondingly, the exchange rate has an insignificant influence on NEPSE even though Nepal's economy is vastly remittance-based. Similarly, with the same methodology, Rana (2021) revealed that there is a significant long-run impact of real GDP growth and a negative impact of the exchange rate and inflation rate on stock market returns in Nepal. The outcome derived from the process of error correction analysis indicates that when examining short-term discrepancies in a system, there exists a notable speed of adjustment equivalent to 47.57 percent over a single year. This signifies the ability of the system to rectify any imbalances or inconsistencies within a relatively brief timeframe, showcasing its dynamic nature and capacity for self-correction. Acharya (2019) concluded that the interest rate and wholesale price index have more explanatory power than the exchange rate.

Research Methodology

The study used time series data collected from secondary sources with 28 years of the period from 1995 to 2022. The data source includes the historical prices and returns of the stocks listed in the Nepal Stock Exchange NEPSE and some other data from the Central Bureau of Statistics and Nepal Rastra Bank. Macroeconomic variables like Interest rate, Inflation rate, Exchange rate, and Gross Domestic Product were used in this study. NEPSE index was used to measure the stock market whereas CPI was used to measure the inflation rate. Similarly, the US rate was used as measure of exchange rate and average interest rate published by Nepal Rastra Bank was used to measure interest rate. Descriptive statistic as well as inferential statistics was applied. OLS regression model was adopted to establish the causal relationship macro economics variables and stock market.

Econometric model

Model 1: $SM = \alpha + \beta_1 INT + \beta_2 INF + \beta_3 GDP + \varepsilon$

Model 2: $SM = \alpha + \beta_1 INT + \beta_2 INF + \beta_3 EXC + \varepsilon$

Where,

SM=Stock market index, α= constant term, β= Beta Coefficient, INT =interest rate, INF = inflation rate, GDP=Gross domestic product, EXC=Exchange rate, Ɛ =error term

Results and Analysis

Descriptive Statistics

Descriptive statistics of the variables under study for empirical analysis are presented in Table 1. The mean value of NEPSE, Interest rate, Inflation rate, Gross Domestic Product, and Exchange rate are 788.16, 3.99 percent, 6.59 percent, Rs. 16723.93 and 84.038 percent respectively. NEPSE reached a maximum of 2883.4 and a minimum of 163.4 during the study period 1995-2022. The maximum and minimum values of real gross domestic product are 40830 and 4400 respectively. In addition, the maximum and minimum values of interest rate are 10.93 and 0.13 respectively. Moreover, the maximum and minimum values of the inflation rate is 11.24 and 2.278 respectively. Likewise, the maximum and minimum values of the exchange rate during the study period are 125.2 and 51.89 respectively.

Table 1: The descriptive statistics of variables under study

Variables	NEPSE	INT	INF	GDP	EXC
Mean	755.16	3.99	6.59	16723.93	84.04
Maximum	2883.40	10.93	11.24	40830.00	125.20
Minimum	163.40	0.13	2.28	4400.00	51.89
Std. dev	674.71	2.73	2.79	11708.31	20.72
Skewness	1.53	0.95	-0.08	0.60	0.53
Kurtosis	2.33	0.64	-1.28	-1.01	2.33

Note. Inflation rate (INF), Interest rate (INT) and Exchange rate (EXC) is in percentage, NEPSE is denoted in points and Real Gross Domestic Product (GDP) in Rupees.

Correlation Analysis

Table 2: Correlation Coefficient

	NEPSE	EXC	INF	GDP	INT
NEPSE	1	0.849	-0.120	0.850	-0.324

	NEPSE	EXC	INF	GDP	INT
		0.000	0.542	0.000	0.092
EXC		1	-.128	0.939	-0.473*
			0.518	0.000	0.011
INF			1	-0.008	0.053
				0.966	0.789
GDP				1	-0.321
					0.095
INT					1

Note. The first row in each cell represents the correlation coefficient and the second represents the p-value.

Table 2 presents the results of the correlation among the variables under study. EXC and GDP have a very strong positive relationship with NEPSE. Both of the relationships are statistically significant at a 1% significant level. Similarly, inflation and interest rates have a negative relationship with NEPSE. The relationship between inflation and NEPSE is statistically insignificant whereas the relationship between interest and NEPSE is statistically significant at a 10% significant level. The results indicate that when exchange rate and GDP increases the stock market will increase. Interest rate and inflation rate are negatively associated with NEPSE as expected and are weakly associated however the relationship is insignificant.

Test of Multicollinearity

Table 1 presents the results of a test of multicollinearity and confirms that the problem of multicollinearity exists between GDP and Exchange as indicated by the Value of VIF > 10. Similarly, panels B and C of Table 3 reveal that there is no problem of multicollinearity when GDP or EXC are excluded since the variables have VIF< 10.

Table 3: Test of Multicollinearity

Panel A Variables	**Collinearity Statistics including all variables**	
	Tolerance	**VIF**
EXC	0.074	13.452
GDP	0.087	1.167
INI	0.634	11.491
INF	0.857	1.577
Panel B Variables	**Collinearity Statistics excluding GDP**	
	Tolerance	**VIF**
GDP	0.897	0.897
INI	0.894	0.894
INF	0.997	0.997
Panel C Variables	**Collinearity Statistics excluding EXC**	
	Tolerance	**VIF**
EXC	0.984	1.017
INI	0.776	1.288

INF	0.984	1.017

Regression Results

Table 4 presents the coefficient of regression results. Model 1 used a regression model without EXC as the independent variable while Model 1 used a regression model without GDP as the independent variable. The result shows that INF and INT have a negative relationship with NEPSE (β= -26.791 and β= -12.517 respectively. This indicates the increase in INF and INT will lead to a decrease in NEPSE. However, the relationship is statistically insignificant (P-value > 0.05). Likewise, GDP has a positive relationship with NEPSE (β=0.048) indicating the increase in GDP will lead to increase in NEPSE. The relationship is statistically insignificant (p-value < 0.05). The results with model 2 are similar to that of model 1 with the exception of the results of INF. Model 22 shows that INT has a positive relationship with the NEPSE., the relationship is statistically insignificant

Table 4: Regression analysis

Model	Constant	INF	GDP	INT	EXC	F	R square
1	178.799	-26.791	0.048	-12.517		0.001	0.738
		0.300	0.000	0.650			
2	-1770.306	-2.807		24.426	29.110	0.001	0.728
		0.915		0.421	0.000		

Note. The first row in each cell represents regression coefficient whereas second row represent p-value

Discussion and Conclusion

The results of the study reveal a significant relationship between the Gross Domestic Product and the exchange rate concerning the Nepal stock market index. This indicates a substantial interplay between economic indicators and the performance of the stock market in Nepal. Gross Domestic Product, and exchange rate both have a positive significant relationship with the Nepal stock market index. Thus, the improvement of the economic growth of the country triggers the NEPSE to increase. A positive relationship of exchange rate with Nepal stock market index is in contrary with Mehr-un-Nisa and Nishat (2011), Bekhet and Mugableh (2012), Wongbangpo and Sharma (2002). Kyereboah-Coleman and Agyire-Tettey (2008) argued the negative relationship between inflation rate and stock prices exists since high and varying inflation rates generate more uncertainty and thus demand for minimum return will also increase which will reduce the market valuation. Similarly, the negative relationship of interest rate with the stock market is consistent with Hasan and Nasir (2008), Hussainey and Ngoc (2009), Peiro (2015), Devkota and Dhungana (2019) and Rana (2021). As interest rates increase, investors will be reluctant towards the investment in the stock market which causes an increase in the supply of stock as a result that market will fall. Similarly, when the interest rate reduces stock market tends to rise. However, Erdem et al., (2005) and Lobo (2002) found positive relationship between stock market with interest rate.

This study shows how macroeconomic factors affect the NEPSE. Variations in macroeconomic data can raise the level of risk and uncertainty in the stock market. Market players and

policymakers can create better risk management techniques to calm the market during tumultuous times by recognizing and comprehending these relationships. Understanding the way macroeconomic factors affect NEPSE can assist evaluate the state of the economy as a whole and its capacity to provide wealth and prosperity for both venture capitalists and the wide-ranging community.

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