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Brief History of the Research Wing of Aadim National College, Kathmandu, Nepal

Aadim National College established its Research Wing in 2022 to foster a culture of academic inquiry, innovation, and evidence-based learning among students and faculty. Since its inception, the Research Wing has actively encouraged interdisciplinary research by organizing seminars, workshops, and research methodology training sessions. It has played a pivotal role in facilitating student-led research projects, faculty publications, and collaborations with academic institutions. Over the years, the Wing has contributed significantly to enhancing the academic profile of the college by promoting scholarly engagement and creating platforms for knowledge dissemination through journals, conferences, and community-based research initiatives.

Aadim National College (ANC) has recently taken a significant first step toward launching its own academic journal, marking a milestone in its journey of institutionalizing research. However, this development builds upon a strong foundation of prior initiatives that have long underscored the college's commitment to research and academic excellence. Before the idea of a journal was formalized, ANC had actively engaged its faculty members and students in various research-oriented activities. The college organized numerous research-based sessions, seminars, and workshops that provided essential training on research methodology, proposal writing, and data analysis. These events not only equipped participants with the necessary skills to conduct academic research but also cultivated a scholarly environment where critical thinking and inquiry were encouraged. Through these initiatives, ANC laid the groundwork for a vibrant research culture, setting the stage for more structured and institutionalized outputs like the college journal. This progression reflects ANC’s dedication to fostering intellectual growth and contributing meaningfully to academic discourse.

We believe Research is not merely about gathering data or proving hypotheses; it is a dynamic and transformative process that opens doors to new knowledge, drives innovation, and empowers individuals and communities. It encourages curiosity, deepens understanding, and equips learners with critical thinking and problem-solving skills. By engaging in research, we not only contribute to the academic world but also create practical solutions for real-life challenges, fostering progress and meaningful change in society.

Message from the Principal of Aadim National College

It is with great pride and excitement that we unveil the inaugural issue of the Aadim Journal of Multidisciplinary Research (AJMR). This first edition showcases pioneering student, faculty & research Scholars' research spanning Information Technology, Management, and Social Sciences—fields that are integral to addressing the complex challenges and opportunities of our time.

Our contributors have demonstrated exceptional intellectual rigor and creativity. In the IT section, you will find innovative explorations of emerging technologies and their applications. The Management section offers strategic insights and case studies that illuminate best practices in leadership, entrepreneurship, and organizational development. In Social Sciences, scholars delve into the societal dynamics and human factors that shape our communities.

I extend my heartfelt congratulations to every author, supervisor, and editorial team member whose dedication has brought AJMR to life. Your collaborative spirit and commitment to excellence have set a high standard for future issues.

As Nepal strives for sustainable growth and development, a strong research culture is paramount. AJMR embodies our institution's mission to foster curiosity, interdisciplinary dialogue, and evidence-based solutions. I encourage readers—students, educators, policymakers, and practitioners alike—to engage with these articles, build upon these findings, and contribute to the broader conversation.

May this first issue of AJMR inspire you to pursue your own research endeavors and reinforce Aadim National College's role as a hub of scholarly innovation.

Mr. Shankar Prasad Sharma
Principal
Aadim National College,
Chabahil, Kathmandu, Nepal

Editorial Message

It is with great pride and enthusiasm that we present this edition of the *Aadim Journal of Multidisciplinary Research (AJMR)*. This journal represents not only the scholarly spirit of our institution but also our firm commitment to promoting a vibrant culture of academic research and intellectual inquiry.

Aadim National College has long recognized the importance of research as the foundation for progress in education, society, and policy-making. Through this publication, we aim to provide a platform for students, faculty, and independent scholars to share their original insights, critical reflections, and innovative findings across a range of disciplines.

This edition brings together diverse perspectives and well-researched articles that explore relevant issues, challenge assumptions, and propose new directions for future exploration. Each contribution has undergone a rigorous peer-review process, ensuring academic integrity and quality.

We express our sincere gratitude to all the authors, reviewers, editorial team members, and supporters who have made this publication possible. Let this journal serve as a stepping stone for further research, discussion, and discovery within our academic community and beyond.

We welcome your readership and invite you to join us in nurturing a research-driven culture at Aadim National College.

Editor-in-Chief
Dr. Surendra Shrestha
Dean, Science of Technology
Nepal Open University.

Table of Contents

The Impact of Data-Driven Approaches on Cyber Security Awareness in Nepal's Digital Landscape

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Abstract

Nepal's increasing reliance on digital platforms has heightened the risks posed by cyber threats such as phishing, malware, and data breaches. Despite growing internet penetration, cyber security awareness remains low among individuals and organizations, leading to significant vulnerabilities. Traditional methods of enhancing awareness, including generic training programs and reactive policies, have proven insufficient to address the evolving nature of cyber threats. These approaches lack personalization and fail to leverage advancements in technology for targeted and proactive solutions. This study aims to explore the impact of data-driven approaches, including machine learning, behavioral analytics, and personalized training, to improve cyber security awareness in Nepal's digital landscape. The objectives include identifying gaps in existing awareness, analyzing successful global strategies, and recommending actionable, localized solutions. Through leveraging secondary data, the study compares strategies from countries with similar challenges and assesses their applicability to Nepal. The novelty of the research lies in its focus on adapting globally proven data-driven methods to the unique context of Nepal, considering its infrastructure limitations, digital literacy levels, and cultural factors. Findings highlight the effectiveness of personalized training and real-time threat monitoring in enhancing awareness. Recommendations emphasize collaborative efforts between government, organizations, and cyber security firms to implement tailored, data-driven strategies, fostering a more resilient digital environment in Nepal.

Keywords—Cyber security Awareness, Data-Driven Strategies, Digital Literacy, Cyber Threat Mitigation, Nepal Digital Landscape

Introduction

There has been an emergence and rapid growth in the use of Digital media in Nepalese market over the few years due to the increasing connectivity of internet, mobile devices and transition in the preference of the consumers from traditional method of business such as electronic business like E-commerce, E-banking etc. Various government programs like the Digital Nepal Framework have enhanced the country's efforts to get digitalized [1]. But this has been made possible by the development of internet-based platforms which have compounded the problem of cyber security threats [2]. Phishing, malware

attacks, hacking amongst other cyber threats are increasing in frequency because most people and organizations are not well equipped with cyber security skills. However, attacks such as phishing particularly on the side of financial institutions and users of online banking services have increased with client information being at high risk [3]. Nevertheless, the threats keep on increasing, and the overall consciousness of cyber threats and cyber threats protection among ordinary Nepali people and Nepalese companies is still low. Most of the users remain ignorant about simple measures when it comes to cyber security for instance, recognizing fake emails or the use of hard to guess passwords [4]. Largely, research indicates that various organizations such as Small Medium Enterprises rarely adopt sound security measures mainly because they lack sufficient capital and human resource expertise in the field. This lack of awareness puts Nepal at a disadvantage because a number of criminals are willing to take their opportunity and exploit the lack of prevention and general knowledge [5]. Thus, the implementation of data-oriented solutions as a means to increase the cyber security level is obligatory. Machine learning, behaviour analysis, and cyber security education stemming from users data and experience have therefore acted successfully internationally [6]. Thus these strategies can work in the Nepali context in order to raise awareness and modify people's behaviour in the digital environment [7]. Nepal consequently can develop the awareness campaigns regarding vulnerabilities which can help the population to minimize the increasing risks of cyber threats for individuals and organizations.

Research Questions:

- How can data-driven approaches be implemented in Nepal to address current cyber security awareness gaps?
- What barriers and challenges exist in implementing these approaches in Nepal?

The paper is arranged as follows. Section II existing work are discussed. In section III proposed method are provided. In section IV findings and summary are provided. Conclusion and further research are provided in section V.

Literature Review

A. Cyber security Landscape in Nepal

Despite the emergence of cyberspace in Nepal, the field is relatively young, and resources are scarce, which hampers the country's efforts to improve its cyber security situation. With the recent adoption of technology, new threats continue to emerge while others frequently encountered include; phishing, ransomware, fraud related to financial transactions, and data theft [8]. For instance, Nepalese banking sector has equally been prone to cybercrime where there are many cases of phishing against online banking customers. Lack of effective organizational security framework, and poor appreciation of the general public towards cyber security are some of the challenges that worsen the issue. Unfortunately, though the government has made some attempts at paving the way, including the creation of the National Information Technology Policy, the state of cyber security is still in its infancy [9].

B. Data-Driven Approaches in Cyber security

Analytical methods are becoming indispensable in combating cyber threats. One is the use of machine learning for threat pattern recognition is used to scan through the large incoming stream of data for tell-tale signs of a cyber-threat. These algorithms can identify a phishing email, report a

malicious website and prevent an unusual user behavior hence stop a breach before it happens. Other key functions include data analyse for monitoring user activity as well. It can also reveal threats from employees since their activities are recorded in an electronic format [10]. Behavioural analysis based security awareness training provides educative content that is dependent on the traditional and technical activity of the user thus makes awareness campaigns more effective. For instance, if for days a user has been liking on those links known to be malicious, then the system may recommend a lesson on how to avoid such websites. Such approaches make use of big data and AI to look for and prevent cyber threats more quickly than conventional methods.

C. Global Case Studies

Such programs have already been adopted by countries with comparable digital environments, for instance, in India and Sri Lanka. India's Cyber Swachhta Kendra has given a native real time malware and AntiVirus monitoring and response system including Machine Intelligence for threat detection and notification to the users [11]. Sri Lanka, via its Cyber Security and Incident Response Teams, has incorporated data analytics into proceedings to increase user knowledge, conducts surveillance on users' and behaves online to post alerts and relay personalized counseling to at-risk users [12]. The aforementioned samples illustrate how the use of data analysis might be facilitative of increasing awareness of cyber security in nations possessing emergent digital landscapes [13].

D. Awareness Challenges

A number of descriptive and comparative assessments have been made to measure the effectiveness of the cyber security awareness programmers conducted in Nepal in the past, and these studies highlight disparities in both methodology and results owing to Nepalese context and its digital realities. For example, Biz Serve IT recently introduced a non-commercial program for youths by which students engaged in applying practical sessions run by professionals in cyber security. This experience emphasized not only the significance of gaining the Thus, this initiative showed that people with more practical experience and those who work within communities can accurately raise awareness among the younger generations [14]. Also, the process of framing the National Cyber Security Policy in Nepal has involved the stakeholders to spread education and awareness domain wise thereby pointing towards a strategic method of educating the general population about policies. As found out by the studies done, lack of cyber security awareness results to higher risks hence calling for an enhanced educational approach that would involve utilization of information.

The best interventions often incorporate a combination of attention-grabbing topics like simulations and case studies which appeal to learners and bring about enduring behavioral modifications. However, the combination with artificial intelligence, as well as training adapted to the concrete local threats and challenges, can additionally strengthen awareness campaigns [15]. The main concern is that the population of Nepal is still not well informed of cyber threats and their company counterparts have not prioritized cyber security education either. This means that a big number of users are not aware of simple things such as password protection, which may make them Vulnerable to hackers. Further, most organizations, especially the small one fail to embrace Information Security since its expensive while attracting the right talent is also a challenge. This lack of awareness only increases the overall cyber security threat level, and it

makes it very important to develop concrete, empirically-based procedures that will enable overcoming this gap.

Research Methodology

Descriptive research method will be employed in the study for assessing the current level of knowledge if cyber security in the Nepalese context and emerging data-based strategies implemented by organizations across the world. Meeting this research gap, comparative analysis will be employed to analyse cyber-security strategies used in countries that are experiencing similar conditions as that of Nepal and the results will then be compared. Some of the secondary data sources will be as follows the government data research papers on Nepalese organization cyber security usage Cyber security organization reports from Nepal. In addition, certain theoretical analytic case based on the countries where data oriented approaches were applied will be also considered. Data analysis method in this study shall include content analysis to establish trends and comparative analysis to establish the applicability of these strategies in Nepal.

1. Research Design: Mixed-Methods Action Research
    a. Approach: Sequential exploratory design (qual → QUAN) with participatory elements
    b. Justification: Combines local stakeholder insights with measurable outcomes
2. Nepal-Specific Sampling Strategy
    a. Target Populations:
        i. Financial sector: 5 commercial banks (Kathmandu Valley + Pokhara)
        ii. Academia: 3 technical colleges (IOE, Purbanchal, Pokhara University)
        iii. Government: 15 IT officers from key ministries
        iv. General public: 200 smartphone users (stratified by age/digital literacy)
3. Data Collection Methods:
    a. Baseline Assessment:
    b. Cyber security Literacy Audit:
        i. Localized phishing simulation (Nepali-language emails/SMS)
        ii. Public WiFi vulnerability testing at 10 hotspots
        iii. Analysis of Nepal CERT incident reports (2019-2023)
    c. Intervention Phase:
    d. Data-Driven Tools Implemented:
        i. Nepali-Language Dashboard:
            1. Visualizes real-time cyber threats specific to Nepal
            2. Integrates with Nepal Rastra Bank's security alerts
        ii. Gamified Learning App:
            1. "CyberSuraksha" mobile app with scenario-based training
            2. Incorporates local fraud cases (e.g., SIM swap scams)
        iii. Community Radio Campaigns:
            1. 15-minute weekly programs in Nepali/Newari/Maithili
            2. Based on trending threat data from monitoring
    e. Evaluation Methods:
        i. Quantitative:
            1. Pre/post knowledge tests (validated Nepali version)
            2. Behavioral metrics from app usage analytics
            3. Reduction in reported incidents (compared to control groups)
        ii. Qualitative:
            1. Focus groups with female digital borrowers (addressing gender gap)
            2. IT manager diaries documenting implementation challenges

3. Policy roundtables with NTB and ISP representatives

4. Data Analysis Framework:
   a. Quantitative Analysis:
      i. Spatial analysis of threat patterns using QGIS
      ii. Predictive modeling of high-risk districts
      iii. Network analysis of attack vectors
   b. Qualitative Analysis:
      i. Thematic analysis of local media reports on cybercrime
      ii. Institutional ethnography of bank security teams
      iii. Discourse analysis of social media cyber security conversations
5. Ethical Considerations:
   a. Local IRB approval from participating universities
   b. Data sovereignty protocols for cross-border threat data
   c. Community advisory board with DIGITAL Nepal representatives
6. Implementation Timeline:
   a. Phase 1 (3 months): Baseline study + tool localization
   b. Phase 2 (6 months): Pilot in 2 banks + 1 college
   c. Phase 3 (3 months): Nationwide scaling with telecom partners
7. Validation Approach:
   a. Member checking with Nepal Computer Association
   b. Comparison with regional benchmarks (Bangladesh, Sri Lanka)
   c. Longitudinal tracking of behavioral changes

This methodology addresses key Nepal-specific challenges:

1. Multilingual digital literacy barriers
2. Cross-sector coordination needs
3. Infrastructure limitations outside urban centers
4. Cultural trust factors in technology adoption

E. Research Design

Secondary research will be relied upon for the descriptive study, and would encompass government reports of Nepal (for instance, Ministry of Communication and Information Technology), articles published by academic philosophers on cyber security and data mindedness, industry reports from companies like Kaspersky, Cisco and other firms, and case studies of countries with similar contexts regarding data awareness for cyber security. In the proposed research, the quantitative method of data analysis that will be used is content analysis which will help in coming up with important results such as trend analysis, research findings and general themes from the secondary data. Content analysis entails a study of text material with a view of identifying patterns, common themes and hidden messages. When it comes to content analysis for this study, the publications from community and academic, industrial reports and case studies of countries with similar digital ecosystem will be considered. The first activity will focus on the collection of secondary data which means that data collected from other sources will be reviewed and summarized to provide the relevant information concerning the current level of cyber security awareness in Nepal. This also involved consideration reportage from the Nepalese Ministry of Communication and Information Technology that will shed light on the current state of cyber security policies, initiatives in raising public awareness as well as achievements and setbacks of the country. Furthermore, literature review will also be performed in order to collect some evidence about how other countries have implemented data-driven approach and whether it may be adaptable in Nepali context according to the

findings of existing academic papers and journal articles. Next, secondary data from industries and journals from ITU and other global cyber security organizations will be collected to understand the current trends and measures in the cyber security field. These reports encompass statistical data, tendencies in cyber threats, and assessments of current awareness programs, with which these priorities will reveal standard problems in awareness deficiencies.

F. Cyber security Awareness in Nepal

The current level of cyber security awareness in Nepal can be described as low – people rarely have enough knowledge about it, and practice even less. This paper seeks to reveal that, even though the country is rapidly going digital, the use of internet, candidate devices, and mobile devices has grown, the aspect of cyber security is not well developed. There have been efforts from government and private sector to make people aware of cyber security, but these have not been consistent nor comprehensive enough to capture all the people. Studies completed secondary data surveys also suggest that a large percentage of the population of the general public in Nepal has limited or poor basic awareness of cyber security. Among the SC reports that have been taken from Ministry of Communication and Information Technology (MoCIT) of Nepal, majority of those users are with little knowledge of basic cyber security knowledge like how to detect phishing attempts, protecting oneself/own information, and choosing an appropriate password. Most of the time, people lose their hard earned money to fraudsters, hackers and cybercriminals through phishing, online scams and financial fraud because they cannot discern fake activities online. The general population has low digital literacy levels, in addition to which most people have not had proper education on cyber security. The same grim depiction of cyber security can be painted for organizations, especially Small Medium Enterprises: Small companies are especially vulnerable to cyberattacks: Most organizations currently lack a specialized cyber security team and often weaker information security protocols than larger companies is shown in fig 1.

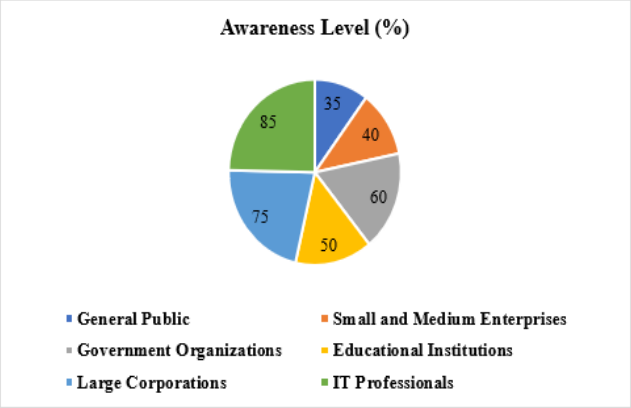

Fig. 1. Cyber security Awareness level in Nepal

A recent reports reveal that majority of enterprise in Nepal still lack advanced security measures like firewalls and even those few who acquire tools like antivirus programs they are not using them effectively with the best security protocols and measures in place. Small Medium Enterprise bear the brunt of security threats such as data breach, malware attacks and insider threat the reasons being that Small Medium Enterprises rarely perform a security audit of their firm or train their employees on security issues. Additionally, cyber security policies are not well implemented, and the rules are often violated meaning that best practices are not uniformly followed. The main issue that exist in Nepal in terms of cyber security is low level of awareness and improper continuous training. As it was earlier mentioned both the individuals and organizations are not privileged to current, reliable cyber security education, hence the relative vulnerability to new emerging cyber threats. Furthermore, there is no awareness campaign developed and implemented for

different areas to educate the population how to address the threats which are common in the Nepali digital environment. Hence awareness programs are general and hardly address specific cybercrime related issues in Nepal. Such a state of affairs requires public attention and the creation of relevant empirical-based cyber security awareness campaigns.

G. Data Driven Approaches

There is a lot of potential that can be achieved with the help of data science approaches to promote cyber security awareness in Nepal through integrating concepts of data science and utilize the data, and investigate the behavioural patterns of users and provide them with accurate security measures. These approaches utilize data analytics and real-time monitoring, machine learning to enhance cyber security practice among the populace and firms. Machine learning algorithms have the capability of herein helping identify areas of security risks and predicting the possible threats. When given large sets of data from the user's activities, the machine learning models can learn from these user activities and clearly identify patterns that can raise a red flag for phishing, malware or even a possible suspect insider threat. For instance, if the user tends to click on the links that look shady, or accesses the namely unsecured site, machine learning algorithms can alert the observer to such activity and give an instant feedback or even a warning.

Thus in Nepali context, it is possible to come across such mischievous attacks like mere phishing or con scams which are frequently witnessed here, by following such systems effectively. User behavior analytics means the process of monitoring activities of specific users or teams in an organization. Based on discovering what specific activities users perform within digital systems, User behavior analytics has potential to detect behaviors that are endangering the system, for example when individuals set poor passwords or share confidential data. This information can be applied in creating availing cyber security training that target perception gaps unless they are serving as part of general training. Given that, in most cases, the knowledge of the use of digital tools and the ability to navigate the internet is limited for at least 40% of the population in Nepal, hence, User behavior analytics can present a good way of education that would not include useless general information and inherent principles and rules of digital usage one should learn but would target the major issues a certain user faces or has already encountered and could solve or avoid not being familiar with. This learning could be beneficial for personal cyber security training since platforms may identify the user and determine their learning style and their exposure to the risks. Data analytics can create programs to give warnings at any threat to the users or the administrators to minimize on the attacks. A survey among the Nepalese students and employees reveals that they and other people is interested in cyber security issues, as the knowledge void can be filled by machine learning, behavior analysis, and individualized learning.

H. Barries and Challenges in Nepal

The process of using data driven supporting measures to spread cyber security awareness in Nepal has several major challenges and hurdles that can be attributed to the infrastructure, lack of knowledge, culture and regulatory issues. Another reason that must be considered in Nepal is the relatively weak development of digital infrastructure. Internet connection is gradually improving, but problems remain, especially in the rural areas, where fast internet connection cannot be guaranteed. Such systems can hardly be implemented in real-time monitoring

arrangements or in continuous cyber security education, for example, through the use of persuasive data. Further, most organizations especially the SMEs are unable to implement complex technology such as the machine learning models or behavior analytics because of reasons such as financial limitations and outdated IT structure. One of the biggest challenges, perhaps the biggest challenge of all is low level of Computer literacy in the general population. There is a low literacy level of cyber security among the populace of Nepal especially those in the rural areas due to low level of computer literacy. They not only lack awareness among members of society, but also in businesses where the employees may not be in a position to discern legitimate emails and scams, phishing attempts, malware, or any other type of cyber-attack. If these basic requirements are poorly fulfilled, data-driven interventions will be far from providing effective solutions to increase cyber security awareness.

Lack of adoption of cyber security measures is also instigated by cultural aspects. Some of the challenges include; Nepalese user's negligence towards digital security since most users do not perceive cyber threats as imminent. Moreover, reliance on conventional approaches and face-to-face communication can also be the barrier for using digital security practices. Therefore, even if there are statistically informed strategies, there will likely be evoke significant resistance from human and/or organizations. The cyber security regulation in Nepal is emerging, and the policies have not progressed towards data-supported security. Challenges may consist of infrastructure problems, lack of computer usage skills, cultural barriers and regulatory factors; all of which should be overcome in the process of implementing technology.

Result and Discussion

Analysis of the findings identified the following: In Nepal, there exists a critical lacking of basic knowledge and practice concerning cyber security among not only the public but also organizations. Machine learning techniques, behavior analytics and person-centric training are outlined as promising solutions to enhance cyber security awareness, regardless of infra-structure and policy constraints.

I. Findings

Nepal too can employ machine learning, behavioural analysis to name but a few, as data background driven cyber security actions. The developed strategies are useful for risk detection in the network, making notifications, and enhancing cyber security awareness. Nevertheless, the practical application of these strategies in Nepal may be problematic because of the infrastructural limitations in Nepal, outdated technology, policy gaps and culture in the IT sector is shown in table 1.

TABLE 1. FINDINGS ON DATA-DRIVEN CYBER SECURITY AWARENESS STRATEGIES IN NEPAL

Findings	Description	Implication for Nepal
Low Cyber security Awareness	Significant gaps in cyber security knowledge among	Urgent need for targeted awareness programs.

	the general public and organizations.	
Effectiveness of Data-Driven Approaches	Machine learning and behavioral analytics have been successfully used to improve cyber security awareness globally.	These strategies can be adapted to improve Nepal's cyber security awareness.
Challenges in Digital Literacy	High levels of digital illiteracy among the population.	Requires tailored educational initiatives and training programs.
Infrastructure Limitations	Limited internet connectivity and outdated technological infrastructure in rural areas.	Need for investment in digital infrastructure to support advanced cyber security tools.
Regulatory Gaps	Lack of comprehensive cyber security laws and data privacy regulations.	Stronger regulatory frameworks are needed to support data-driven cyber security initiatives.
Public-Private Partnerships	Collaboration between government agencies, cyber security firms, and organizations enhances awareness efforts.	Encourages the development of cost-effective, scalable cyber security solutions.

J. Comparative Analysis

The comparative analysis compares effective data-based cyber security approaches in other countries and determines their applicability to the Nepali environment. For Instance, the Indian and Sri Lankan context, with similar digitisation levels, have employed machine learning to forecast cyber threats and behavioural analytics to enhance user consciousness. These are mainly focused on numerous particularized resources regarding training and exact threats to give efficient solutions to the particular weakness. On the other hand, some of the key issues that adversative Nepal comprises a low level of digitalization, low cyber security literacy, and inadequate policies. Nevertheless, experiences of such countries seem to prove how such nations have benefited from establishing Public-Private Partnerships, integrated and targeted education activities, and building on existing facilities. The analysis comparing these approaches also finds out practical strategies to fill the existing gaps in the Nepali context and empower the domestic populace with data.

K. Recommendations

For effective implementation of cyber security in Nepal and especially in addressing the problem of awareness, initiatives need to be instituted by the government together with relevant organizations and cyber security firms that embrace data analysis approach. Different government departments should extend expertise on improving digital services across the country particularly for the rural areas to support the

many new and complex cyber security measures including the use of clinical machine learning and behavioural analytics. The ones requesting coverage extension across the states with high speed internet as well as executing national cyber security strategies shall influence these. The government should also enhance cyber security policies such as data protective laws, to compel various forms of companies to employ sound cyber security measures. Another way is to create a national cyber security awareness program still in conjunction with the cyber security firms to pass more information about threats, risks and safe practices online.

Cyber security firms have a crucial part in this endeavor because they offer solutions that are affordable according to the Nepalese context. They can help the government to establish cyber security monitoring tools and a mechanism based on machine learning algorithms that will recognize cyber threats. These firms can also provide cyber security awareness training sessions to companies on how best they can identify cyber threats. They should engage with the government agencies to coordinate general awareness on cyber security to the public and organizations to create awareness on new threats as well as the most appropriate measures to take. Cybercrime Organizations especially the small and medium enterprises should be urged to adopt data-based practices cyber security in partnerships between the public and private sectors. Small boosts in cash subsidies or tax preferences may be offered to businesses in exchange for their implementing high-level cyber-security arrangements within organizations. It strongly suggests that organizations should establish employee training programs, improve their digital skills, and promote more cooperation to improve Nepals cyber security and consequently decrease the number of threats.

Conclusion and Future Work

The application of quantitative measures to promote cyber security in Nepalese institutions is an outstanding solution to tackle the increasing cyber threats. By employing machine learning techniques, behavioral analysis and flexible approaches to learning, the above-mentioned strategies may enrich ways Nepalis and organizations understand and address cyber threats. However, for these approaches to be implemented, the following barriers need to be addressed; infrastructure constrains, lack of computer literacy, and policy constraints. In the future, all stakeholders including the government, cyber security companies and organizations should cultivate an environment that encourages data driven solutions, access to and the creation of affordable tools, and awareness about cyber security risks prevalent in the society.

For future research several measures can be taken as lo next steps from the findings of present study: First, it is needed to work on national cyber security strategy that includes scientific approaches and methods. This should involve enhancing curriculum development and implementation of cyber security education in school, colleges and other institutions making a knowledgeable society. Collaboration between public and private sectors, real-time monitoring systems, and adaptive learning models can enhance cyber security awareness and resilience in Nepal, addressing infrastructure gaps and enhancing cyber security training.

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Comparative Analysis of Multiple Linear Regression with L1 and L2 Regularization for Stock Price Prediction

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Abstract

This research explores the application of L1 (Lasso) and L2 (Ridge) regularization techniques within multiple linear regression frameworks for predicting stock prices in the ACLBSL segment of the Nepal Stock Exchange (NEPSE). A key challenge in stock price prediction over fitting is addressed by incorporating regularization methods that penalize model complexity. Through hyper parameter tuning, optimal alpha values of 0.9541 for Lasso and 0.4715 for Ridge were identified. These values led to improved model performance, reducing Mean Squared Error (MSE) to 514.12 and 521.02, respectively.

The study's findings reveal that Lasso regression not only enhances prediction accuracy but also performs effective feature selection by shrinking less significant coefficients to zero. This enables a more interpretable and simplified model without sacrificing performance. In contrast, Ridge regression retains all features with reduced coefficient magnitudes. The results indicate that Lasso regression is more effective in identifying and leveraging key predictors, thereby providing better generalization to unseen stock price data.

This research contributes to the ongoing efforts in financial modeling by demonstrating that regularization techniques can substantially improve the robustness and reliability of predictive models in the context of NEPSE, providing valuable insights for investors and analysts.

Keywords—Stock Price Prediction, Lasso Regression, Ridge Regression, Regularization, NEPSE, Multiple Linear Regression.

Introduction

Stock price prediction is a challenging task with significant implications for financial markets and investors. Various machine learning models have been applied to this problem, each with its advantages and drawbacks. This research discusses the relevant studies and research that have contributed to the understanding of stock price prediction techniques. This research addresses the problem of optimizing regularization parameters for Lasso and Ridge regression models to enhance the predictive performance of stock prices and to identify the

optimal alpha values for L1 and L2 regularizations that yield the lowest prediction errors and highest R-squared scores, thereby providing a reliable model for stock price prediction. The findings from this research will guide the application of regularization techniques in financial modeling and contribute to the development of robust predictive models in the stock market domain.

This research introduces the fundamental concept of multiple linear regressions, a powerful tool for modelling the relationships between dependent and independent variables. The results offer insights into the significance of various factors and their influence on stock prices. Performance of L1 and L2 regularization has been accessed with hyper parameter optimization for the ACLBSL dataset. L1 Regularization Adds the absolute values of the coefficients to the loss function, which can shrink some coefficients to zero, effectively performing feature selection and simplifying the model. L2 Regularization Adds the squared values of the coefficients to the loss function, which discourages large coefficients but does not shrink any coefficients to zero, thus keeping all features but with reduced impact.

The main contributions of this research are as follows:

1. **Comparative Evaluation of Regularization Techniques**: This study performs a comparative analysis of L1 (Lasso) and L2 (Ridge) regularization techniques within the framework of Multiple Linear Regression (MLR) for stock price prediction, focusing on their respective strengths in feature selection and model stability.

2. **Hyper parameter Optimization for Predictive Accuracy**: The research applies systematic hyper parameter tuning to identify optimal alpha values for L1 and L2 regularizations, resulting in models with minimized prediction error and maximized R-squared values.

3. **Application to Real-World Financial Data**: Using the ACLBSL stock dataset, this work demonstrates the practical application of regularization techniques to enhance predictive performance in a real-world financial context.

4. **Insights into Feature Importance**: Through L1 regularization, the study highlights the most influential predictors affecting stock prices, offering insights that are valuable for financial analysts and investors.

5. **Contribution to Robust Financial Modeling**: The findings contribute to the broader field of financial modeling by illustrating how regularization can improve generalization, reduce overfitting, and increase the interpretability of stock price prediction models.

Problem Statement

The prediction of stock prices is a complex task due to the volatile nature of financial markets. Over fitting is a common issue in machine learning models, where the model performs well on training data but poorly on unseen test data. Regularization techniques such as L1 (Lasso) and L2 (Ridge) are employed to mitigate over fitting and improve model generalization. This occurs when a model is too complex and captures not only the underlying patterns in the training data but also the noise. This results in high accuracy on the training data but poor generalization to new, unseen data. Regularization techniques like L1 and L2 add a penalty to the loss function based on the magnitude of the coefficients, which discourages overly complex models and helps to prevent over fitting.

L1 and L2 regularization are effective for preventing over fitting by penalizing large coefficients and promoting simpler models. However, they do not directly address under fitting; instead, other strategies must be employed to increase model complexity and improve fit to the data.

Objectives

The objectives of this study is to implement multiple linear regression and evaluate the effectiveness of L1 (Lasso) and L2 (Ridge) regularization techniques by identifying optimal regularization parameters (α).

Background Study

Stock price prediction is a significant area of interest in both academic research and financial practice, driven by its potential economic impact. Traditional approaches like fundamental and technical analysis have been foundational but struggle to capture the dynamic and nonlinear nature of financial markets. The Efficient Market Hypothesis (EMH) historically guided these methods, positing that stock prices follow a random walk and are thus unpredictable. To address these limitations, modern research increasingly adopts machine learning (ML) techniques, leveraging their ability to handle complex patterns in data. Regularization methods such as L1 (Lasso) and L2 (Ridge) are integral in enhancing the robustness and generalization of ML models. L1 regularization aids in feature selection by shrinking coefficients to zero, whereas L2 regularization penalizes large coefficients, mitigating over fitting risks.

This research focuses on applying multiple linear regression (MLR) with L1 and L2 regularization to predict stock prices. Findings demonstrate that optimizing these regularization parameters significantly improves model performance by reducing over fitting and enhancing predictive accuracy. By integrating diverse data sources and sophisticated algorithms, this approach holds promise for advancing stock price prediction in financial analytics.

Literature Review

Stock price prediction has long been a central challenge in financial modeling due to its inherently noisy, nonlinear, and volatile nature. Traditional econometric models, such as Autoregressive Integrated Moving Average (ARIMA) and Generalized Autoregressive Conditional Heteroskedasticity (GARCH), have been foundational in financial time series forecasting (Hamilton, 1994). However, these models often struggle with capturing nonlinear patterns present in stock market data.

With the rise of machine learning, more advanced models such as decision trees, support vector machines, and ensemble techniques like Random Forests have gained popularity for financial prediction tasks (Yang et al., 2014; Aldridge, 2010). Recent studies have demonstrated that integrating regularization techniques into regression-based models significantly enhances their generalization capabilities by mitigating over fitting.

Saud and Shakya (2021) explored the effects of the L2 regularization parameter in Ridge regression for stock price prediction using historical data. Their findings indicate that the appropriate selection of the regularization parameter significantly improves the model's ability to generalize on unseen data. Similarly, Uniejewski (2024) examined the use of regularization in electricity price forecasting and concluded that both L1 and L2 techniques help control model complexity and enhance predictive

stability, particularly in volatile domains like energy and finance.

Moreover, Jia, Anaissi, and Suleiman (2023) introduced a novel deep learning model incorporating regularization layers to forecast stock prices. Their ResNLS model demonstrates how advanced neural architectures, when combined with regularization, can capture complex temporal dependencies in financial datasets. Extending this line of inquiry, Sarkar and Vadivu (2025) proposed an ensemble deep learning framework utilizing Variational Autoencoders (VAE), Transformer, and LSTM networks. The study highlighted that regularization within deep architectures not only prevents over fitting but also contributes to more robust and interpretable financial models.

These studies collectively support the application of L1 (Lasso) and L2 (Ridge) regularization in financial prediction models. L1 regularization is especially effective for feature selection by driving some coefficients to zero, simplifying the model (Wang et al., 2017). On the other hand, L2 regularization provides enhanced stability by shrinking all coefficients uniformly (Xu & Li, 2019). The growing consensus in the literature advocates for hyperparameter tuning to identify optimal regularization strengths, as this significantly affects model performance in terms of both accuracy and robustness.

Methodology

Stock prices are influenced by numerous market factors such as trading volume, price fluctuations, and transaction frequency. In real-world financial datasets like NEPSE's ACLBSL data, these features often exhibit multicollinearity—where independent variables are highly correlated—which can reduce the reliability of predictions in standard Multiple Linear Regression (MLR) models. For instance, in our dataset, "Total Traded Amount" and "Total Traded Shares" tend to move together, leading to unstable coefficient estimates and poor generalization on unseen data.

To address this, the proposed method applies **L1 (Lasso)** and **L2 (Ridge)** regularization to the MLR model, which helps mitigate over fitting and multicollinearity. **Lasso regression** is particularly effective in selecting only the most relevant predictors by shrinking some coefficients to zero, thus simplifying the model. **Ridge regression**, on the other hand, distributes the penalty across all coefficients and is better suited when all input features are potentially useful but suffer from collinearity. In this research, the optimal alpha values for L1 and L2 regularization were determined using **GridSearchCV**, enabling a data-driven approach to tuning.

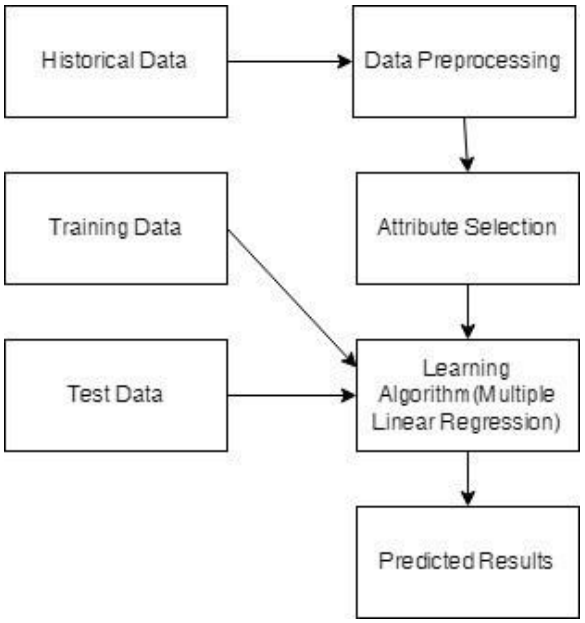

Figure 1: Flowchart detailing the methodology for stock price prediction.

Data Collection

Historical stock data from the Nepal Stock Exchange (NEPSE) is collected for the study. The

dataset used during this study is ACLBSL dataset collected from web scrapping and the dataset used for this study is loaded and cleaned to ensure there are no missing or inconsistent values. The independent variables and the dependent variable are identified and separated. For this study, the features include 'Total Transactions', 'Total Traded Shares', 'Total Traded Amount', 'Max. Price', and 'Min. Price', while the target variable is 'Close Price'. Instances of two year have been captured for the purpose of analysis from 2019-01-07 to 2021-12-29. The simple architecture of dataset used for analysis is shown below;

Data preprocessing

This step involves cleaning the data, handling missing values, and normalizing the data to ensure consistency. The methodology for this research follows a structured process as depicted in Figure above.

Attribute Selection

Relevant features, such as total transactions, total traded shares, total traded amount, maximum price, and minimum price, are selected for the analysis. After selecting relevant attributes, the dataset is divided into training and testing sets to validate the model performance. Here, 80

Learning Algorithm

To ensure that the features are on a similar scale, feature scaling is performed. This Multiple Linear Regression (MLR) A Multiple Linear Regression model is trained on the training data. MLR is a simple and interpretable model that helps establish a baseline for the prediction of stock prices. The model coefficients and intercept are extracted to understand the relationship between the features and the target variable. The equation for the regression model is given by:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n$$

Where: - y is the dependent variable (closing price). - β_0 is the intercept. - $\beta_1,\beta_2,...,\beta_n$ are the coefficients of different independent variables.

The independent variables in this model include: - Total number of transactions - Total traded shares - Total traded amount - Maximum price - Minimum price Thus, the closing price acts as the dependent variable.

Lasso Regularization

L1 regularization, also known as Lasso (Least Absolute Shrinkage and Selection Operator), is applied to the linear regression model to handle over fitting by penalizing the absolute values of the coefficients. This tends to produce sparse models with fewer non-zero coefficients, effectively performing feature selection.

$$J(\theta) = \frac{1}{m}\sum_{i=1}^{m}\left(\text{Cost}(h_\theta(x^i), y^i) + \frac{\lambda}{m}\sum_{j=1}^{n}|\theta_j|\right)$$

Ridge Regularization L2 regularization, or Ridge regression, penalizes the squared values of the coefficients. Unlike Lasso, Ridge regression does not enforce sparsity but can handle collinearity among features more effectively.

$$J(\theta) = \frac{1}{m}\sum_{i=1}^{m}\left(\text{Cost}(h_\theta(x^i), y^i) + \frac{\lambda}{m}\sum_{j=1}^{n}\theta_j^2\right)$$

Multiple linear regression models with L1 (Lasso) and L2 (Ridge) regularization are applied. The optimal values for the regularization parameters (α) are determined using GridSearchCV.

Error Calculation The models are evaluated using metrics such as Mean Absolute Error (MAE), Mean Squared Error (MSE), Root Mean Squared Error (RMSE), and Rsquared (R^2) to compare the performance before and after regularization.

Mean Absolute Error (MAE) :

MAE measures the average magnitude of the errors between predicted and actual values, without considering their direction. It provides a straightforward measure of prediction accuracy. The formula for calculating mean absolute error is shown below.

The Mean Absolute Error (MAE) is calculated using the following formula:

$$\text{Mean Absolute Error (MAE)} = \frac{1}{n}\sum_{i=1}^{n}|y_i - \hat{y}_i|$$

Where: - y_i are the actual values, - $\hat{y}_i$ are the predicted values, - n is the number of observations.

Mean Squared Error (MSE): MSE measures the average of the squares of the errors between predicted and actual values. It gives a higher weight to larger errors, thus emphasizing the significance of significant deviations.

The Mean Squared Error (MSE) is calculated using the following formula:

$$\text{Mean Squared Error (MSE)} = \frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2$$

Where: - y_i are the actual values, - $\hat{y}_i$ are the predicted values, - n is the number of observations. Root Mean Squared Error (RMSE): RMSE is the square root of the MSE. It provides an error metric on the same scale as the original data, making it more interpretable in the context of the data.

Root Mean Squared Error (RMSE) =

$$\sqrt{\frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}$$

R-squared (R^2) Score:

R^2 measures the proportion of the variance in the dependent variable that is predictable from the independent variables. It provides an indication of the goodness of fit of the model.

$$R^2 = 1 - \frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}{\sum_{i=1}^{n}(y_i - \bar{y})^2}$$

Where: - y_i are the actual values, $\hat{y}_i$ are the predicted values, - $\bar{y}$ is the mean of the actual values, - n is the number of observations

The performance of each model (MLR, Lasso, and Ridge) is evaluated using Mean Absolute Error (MAE), Mean Squared Error (MSE), Root Mean Squared Error (RMSE), and R-squared (R^2) metrics on the testing data. These metrics provide insights into the accuracy and generalization ability of the models.

Predicted Results

The models' predictions are compared to actual stock prices to assess their accuracy and reliability. This approach ensures a systematic and rigorous analysis of the stock price prediction models, aiming to reduce over fitting and improve generalization.

Hyper Parameter Tuning

GridSearchCV is employed to perform hyper parameter tuning for both Lasso and Ridge regression models. This involves specifying a range of alpha values and using cross-validation to determine the best alpha that minimizes the error metrics.

Implementation Details

The implementation of this study involved several steps, using Python and relevant libraries such as pandas, scikit-learn, and matplotlib. The detailed description of activities performed at different phases are explained below:

Data Preparation

First, the dataset has been loaded and extracted the relevant and the target variable. Split the data into training and testing sets. The dataset is split into training and testing sets using an 80-20 ratio. This ensures that the model can be trained on one portion of the data and evaluated on another to assess its performance on unseen data.

```
1. from sklearn.linear_model import Linear Regression, Lasso, Ridge
2. # Multiple Linear Regression
3. model = Linear Regression()
4. model.fit(X_train, y_train)
5. # Lasso Regression
6. lasso = Lasso(alpha=0.1)
7. lasso.fit(X_train, y_train)
8. # Ridge Regression
9. ridge = Ridge(alpha=0.1)
10. ridge.fit(X_train, y_train)
```

The head of dataset is shown below;

	S.N.	Date	Total Transactions	Total Traded Shares	Total Traded Amount	Max. Price	Min. Price	Close Price
0	1	2021-12-29	34	696.0	842596.0	1227.0	1205.0	1227.0
1	2	2021-12-28	48	1322.0	1575896.8	1227.0	1180.1	1227.0
2	3	2021-12-27	45	1023.0	1256329.0	1285.2	1204.0	1204.0
3	4	2021-12-26	43	2051.0	2510045.0	1239.8	1194.2	1238.8
4	5	2021-12-23	41	1153.0	1390142.0	1221.0	1181.1	1200.0

Figure 2: structure of the dataset

Model Development

Built and trained multiple linear regression, Lasso, and Ridge regression models. The implementation of model development using multiple linear regression, lasso and ridge regularization model is shown below.

```
1. from sklearn.linear_model import Linear Regression, Lasso, Ridge
2. # Multiple Linear Regression
3. model = LinearRegression()
4. model.fit(X_train, y_train)
5. # Lasso Regression
6. lasso = Lasso(alpha=0.1)
7. lasso.fit(X_train, y_train)
8. # Ridge Regression
9. ridge = Ridge(alpha=0.1)
10. ridge.fit(X_train, y_train)
```

Hyperparameter Tuning

The optimal alpha value for Lasso is determined using GridSearchCV, which tests a range of alpha values to find the one that minimizes the Mean Squared Error (MSE) on the validation set.

GridSearchCV is similarly used to find the optimal alpha value for Ridge regression, which balances the bias-variance trade-off to minimize over fitting and improve generalization.

The following Python code demonstrates how to use grid search with cross-validation to find the optimal hyper parameters for Lasso and Ridge regression using ‘scikit-learn‘:

```
1. # Lasso Regression Grid Search
2. param_grid_l1 = {'alpha': np.logspace(-4, 1, 50)}
```

```
3. grid_search_l1 = GridSearchCV(Lasso(), param_grid_l1, cv=5,
4. scoring='neg_mean_squared_error',n_jobs=-1)
5. grid_search_l1.fit(X_train, y_train)
6. best_alpha_l1= grid_search_l1.best_params_['alpha']
7. # Ridge Regression Grid Search
8. param_grid_l2 = {'alpha': np.logspace(-4, 1, 50)}
9. grid_search_l2 = GridSearchCV(Ridge), param_grid_l2, cv=5,
10. scoring='neg_mean_squared_error',n_jobs=-1)
11. grid_search_l2.fit(X_train, y_train)
12. best_alpha_l2 = grid_search_l2.best_params_['alpha']
```

Model Evaluation

The performance of the multiple linear regression model was assessed both before and after applying regularization techniques (L1 and L2). Key evaluation metrics included Mean Absolute Error (MAE), Mean Squared Error (MSE), Root Mean Squared Error (RMSE), and R-squared (R^2). These metrics provided a comprehensive understanding of the model's accuracy and its ability to generalize to new data, demonstrating significant improvements post-regularization.

```
1. from sklearn.metrics import mean_absolute_error, mean_squared_error, r2_score
2. import numpy as np
3. from sklearn.linear_model import Lasso, Ridge
4. # Predict using the trained Linear Regression model
5. y_pred = model.predict(X_test)
6. # Calculate error metrics
7. mae = mean_absolute_error(y_test, y_pred)
8. mse = mean_squared_error(y_test, y_pred)
9. rmse = np.sqrt(mse)
10. r2 = r2_score(y_test, y_pred)
11. # Print error metrics
12. print(f'MAE: {mae}, MSE: {mse}, RMSE: {rmse}, R²: {r2}')
13. # Lasso Regression with the best alpha from grid search
14. lasso_best = Lasso(alpha=best_alpha_l1)
15. lasso_best.fit(X_train, y_train)
16. mse_lasso = mean_squared_error(y_test, lasso_best.predict(X_test))
17. # Ridge Regression with the best alpha from grid search
18. ridge_best = Ridge(alpha=best_alpha_l2)
19. ridge_best.fit(X_train, y_train)
20. mse_ridge = mean_squared_error(y_test, ridge_best.predict(X_test))
```

Result Analysis

The research aimed to compare the effectiveness of L1 and L2 regularization techniques on a predictive model for stock price prediction using metrics such as Mean Absolute Error (MAE), Mean Squared Error (MSE), Root Mean Squared Error (RMSE), and R-squared (R^2) score.

The regression line obtained after Multiple Linear Regression (MLR) is shown below, where a comparison of actual vs. predicted closing prices using Linear Regression is illustrated. The dots represent the predicted closing prices compared to the actual closing prices, with the line indicating the ideal prediction line. The close alignment of the points to the red line demonstrates the accuracy of the model.

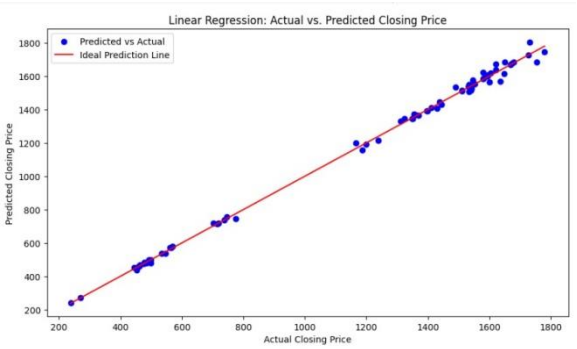

Figure 3: Linear Regression actual vs redicted

Stock price prediction is a complex regression task characterized by high variance and potential multicollinearity among predictors. Traditional **Multiple Linear Regression (MLR)** models can fit historical stock price data well but may suffer from overfitting when applied to unseen data, especially in high-dimensional settings. This issue often arises when the model captures noise in the training data rather than the underlying trend.

To address this limitation, **regularization techniques** such as **L1 (Lasso) and L2 (Ridge)** have been employed. These methods introduce a penalty term to the loss function that constrains the magnitude of the coefficients, thereby improving the model's generalization ability. L1 regularization encourages sparsity by shrinking some coefficients to zero, effectively performing variable selection. In contrast, L2 regularization distributes the penalty uniformly, reducing model complexity without eliminating features.

The current analysis presents a comparative evaluation of these three models—standard Linear Regression, Lasso Regression, and Ridge Regression—using actual vs. predicted plots and residual diagnostics. These visualizations provide insights into the predictive accuracy and error distribution of each model. The red lines in the scatter plots represent ideal predictions (where predicted values exactly match actual values), while residual plots highlight how errors are distributed across the prediction space.

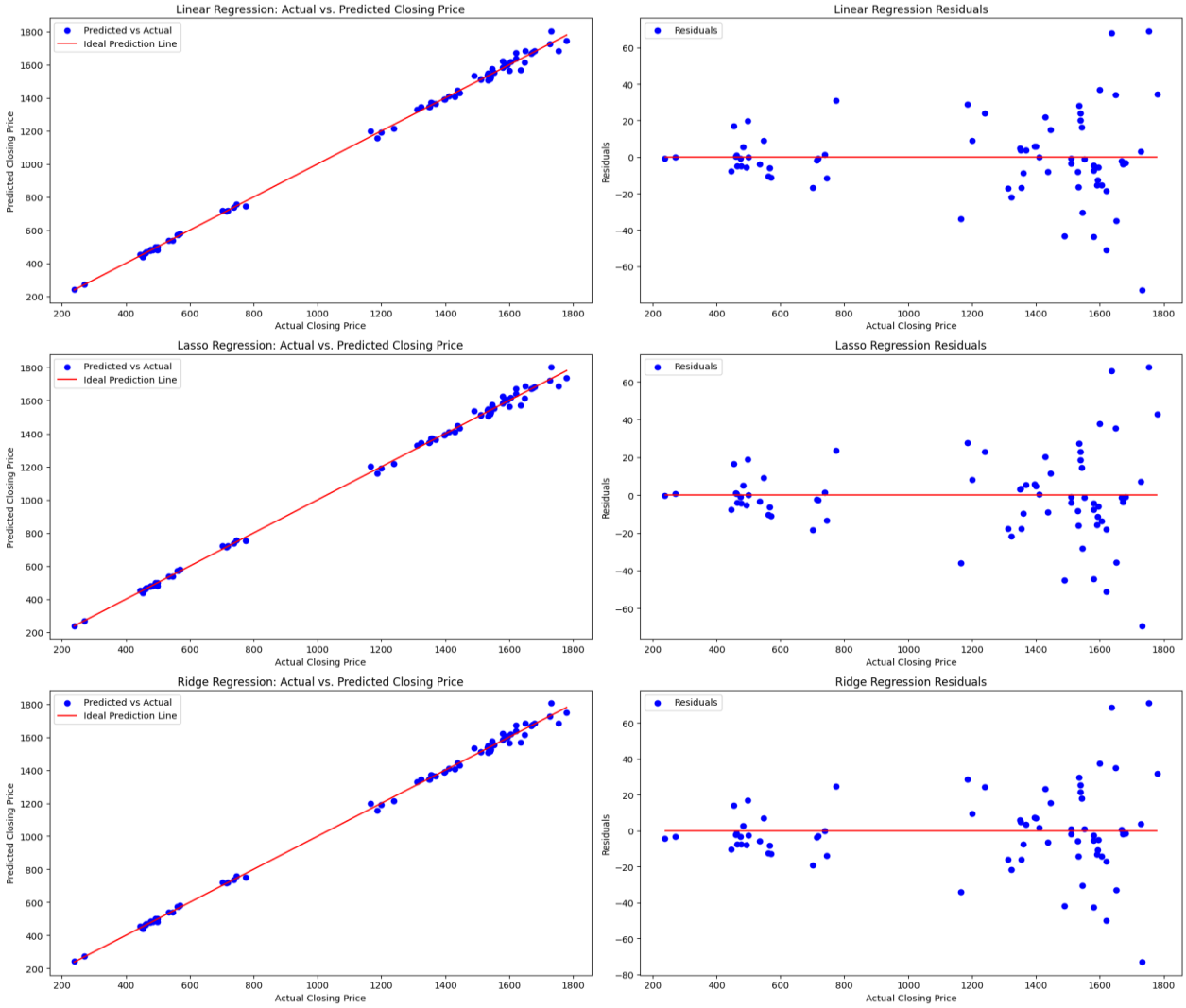

Figure 4: Result analysis

The evaluation parameter before and after the hyper parameter optimization for L1 and L2 regularization is shown in table below;

SN	**Evaluation Parameter**	**Before Regularization**	**After L1 Regularization**	**After L2 Regularization**
1	Mean Absolute Error (MAE)	15.7273	15.5872	15.65948
2	Mean Squared Error (MSE)	523.8600	514.120	521.0197
3	Root Mean Squared Error (RMSE)	22.88798	22.6742	22.826
4	R-squared (R^2) Score	0.99773	0.99777	0.9977495

Table 1: Comparison of Evaluation Parameters before and after Regularization

L1 regularization achieved the lowest MAE, indicating better performance in minimizing the average magnitude of errors compared to L2 regularization. L1 regularization resulted in the lowest MSE, suggesting it effectively reduced the squared differences between predicted and actual values. Similar to MSE, L1 regularization led to the smallest RMSE, indicating better accuracy in predicting the stock prices with smaller deviations from the observed values. All regularization techniques maintained high R-squared scores close to 1, indicating excellent model fit and strong predictive capability.

L1 regularization generally outperformed L2 regularization in terms of MAE, MSE, and RMSE metrics, suggesting it may be more suitable for this predictive modeling task. All regularization methods maintained very high R-squared scores, indicating robust model performance and high explanatory power of the model. The optimized value of alpha after regularization for L1 regularization is 0.95409and for L2 regularization is 0.4714866, indicating that these values minimized prediction error in the stock price prediction model.

Conclusion

Regularization is a critical component in building robust machine learning models, particularly for regression tasks like stock price prediction. By carefully tuning the regularization hyper parameters, such as the alpha values for L1 and L2 regularization, we can significantly improve the model's performance and generalization. The research provides a framework for optimizing these hyper parameters and demonstrates how to evaluate the effectiveness of each regularization technique using MSE as a performance metric.

Applying L1 and L2 regularization to the multiple linear regression models for stock price prediction resulted in improved performance metrics. Specifically, L1 regularization (Lasso) with an optimal alpha of 0.9541 yielded the lowest Mean Squared Error (MSE) of 514.12, indicating a slight improvement over the model without regularization (MSE: 523.86). The Mean Absolute Error (MAE) and R-squared (R^2) scores also showed slight enhancements with L1 regularization. Similarly, L2 regularization (Ridge) with an optimal alpha of 0.4715 also reduced the MSE to 521.02. These findings demonstrate that regularization techniques can effectively improve model performance by reducing over fitting, leading to more accurate and generalizable predictions.

Future Recommendation

It is also recommended to further explore the tuning of hyper parameters and potentially combining regularization techniques with more complex models like GRU, LSTM, or Transformer networks to see if they can improve the predictive performance even further. To enhance stock price prediction models, future work should integrate alternative data sources like social media sentiment, news feeds, and macroeconomic indicators. Advanced machine learning techniques such as RNNs, LSTMs, GRUs, and Transformer networks can be explored for capturing temporal dependencies and complex market dynamics. Implementing real-time data processing and prediction systems can support high-frequency trading strategies.

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Optimizing BERT for Nepali Text Classification: The Role of Stemming and Gradient Descent Optimizers

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Abstract

This study investigates the use of BERT for classifying Nepali news articles, addressing the specific challenges associated with Nepali as a low-resource language in natural language processing (NLP). While traditional text classification methods have proven effective for high-resource languages, they often fall short in capturing the contextual nuances necessary for accurate classification in Nepali. To address this gap, a pre-trained BERT model was fine-tuned on a balanced dataset of Nepali news articles sourced from various outlets. The study examined the effects of different preprocessing techniques, such as stemming, and optimization algorithms including Adam, AdamW, and Momentum, on classification performance. Experimental results demonstrate that the combination of stemming and the AdamW optimizer yielded the best performance, achieving a weighted accuracy of 93.67%, along with balanced macro precision, recall, and F1-scores of 0.94. These findings underscore the effectiveness of advanced optimization strategies—particularly AdamW—in enhancing model performance.

Keywords—BERT, Natural Language Processing, Nepali News Classification, Stemming, AdamW.

1. Introduction

Text classification is a fundamental Natural Language Processing (NLP) task that assigns predefined categories to text based on its content. By automating the organization of large-scale textual data, it plays a vital role in managing today's information-driven world. For instance, news platforms use classification to sort articles into domains like politics, sports, technology etc. This capability powers diverse applications from streamlined content management to personalized recommendations enhancing how users and systems interact with vast amounts of data (Kowsari et al., 2019; Minaee et al., 2021).

Traditional text classification methods primarily depended on manual rules or keyword-based approaches. While simple to implement, these techniques fail to capture the deeper semantic and contextual nuances of language. For example, relying solely on keywords can lead to misclassification, particularly when dealing with complex or ambiguous expressions. The advent of machine learning introduced more advanced models like Support Vector Machines (SVM), Naive Bayes, and decision trees, which improved classification by learning linguistic patterns from data. However, these models still relied on hand-engineered features such as bag-of-words or n-grams—that treat text as mere word frequencies

without understanding meaning. Consequently, they perform poorly on polysemy or sentences where context determines interpretation (Gasparetto et al., 2022).

Recent advancements in deep learning, particularly neural networks and transformer architectures, have revolutionized text classification (Fields et al., 2024). Models like BERT (Bidirectional Encoder Representations from Transformers) leverage bidirectional context to interpret word meanings with remarkable precision, eliminating the need for manual feature engineering. Pre-trained on vast text corpora, BERT captures intricate semantic relationships, enabling state-of-the-art performance in understanding nuanced language (Garrido-Merchan et al., 2023).

Despite the success of advanced NLP models, their application to under-resourced languages like Nepali remains challenging. Limited labeled datasets, scarce pre-trained embedding's, and a lack of specialized linguistic tools hinder the development of accurate classification systems. This study investigates the adaptation of transformer-based models specifically BERT for Nepali news classification under such constraints. By fine-tuning BERT on a curated Nepali news corpus, we aim to develop a robust classification framework capable of addressing the linguistic nuances and resource limitations unique to Nepali. The primary objective of this study is to evaluate the impact of stemming techniques and optimizer selection (Momentum, Adam, and AdamW) on BERT's performance for text classification. Through comparative analysis of accuracy, precision, recall, and F1-score, we aim to identify optimal configurations for effective model tuning.

2. Related Theories and Models

2.1. Transformer

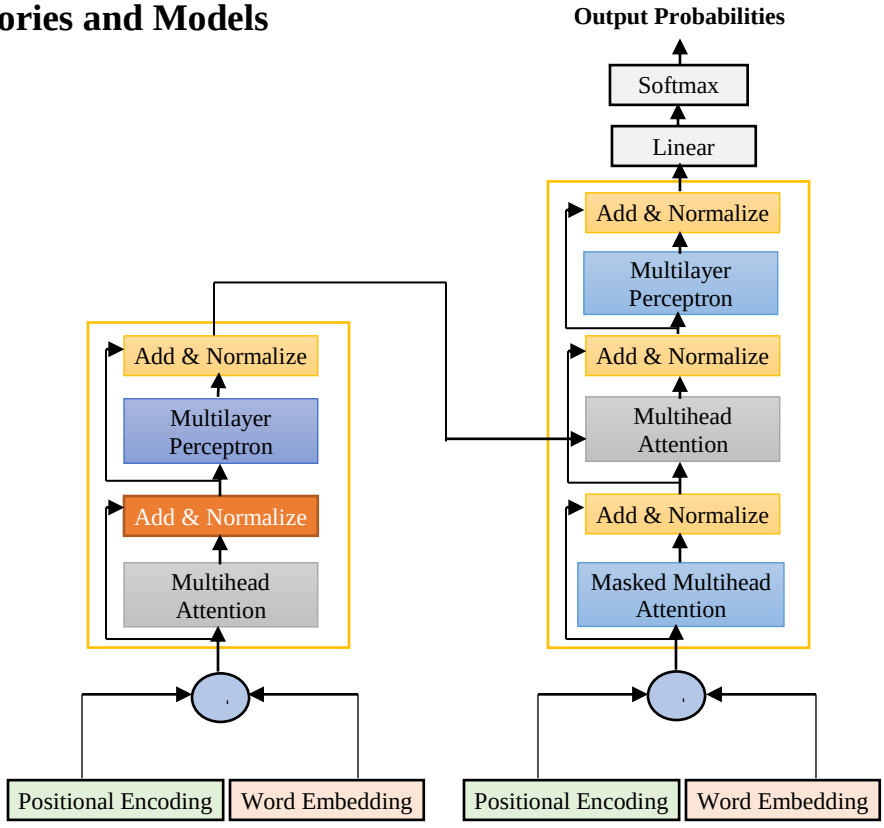

Figure 1: Architecture of Transformer

The Transformer architecture employs stacked encoder-decoder layers with self-attention mechanisms to effectively map input sequences to output sequences (Vaswani et al., 2017). Identical encoder layers process the input sequentially, while decoder layers iteratively generate outputs by attending to both the final encoder representation and previous decoder states. Figure 1 illustrates this architecture.

Word embeddings provide dense, low-dimensional vectors that capture meaning by placing similar words closer in vector space. Popular techniques like Word2Vec (with CBOW and Skip-Gram models) generate such embeddings effectively. For sequential data, positional embedding is essential—especially in parallel-processing models like Transformers—to retain word order information. Without it, Transformers would treat reordered sentences (e.g., "The cat sat on the mat" vs. "The mat sat on the cat") as identical. Common implementations, such as Sinusoidal Positional Encoding, explicitly encode token positions to address this limitation.

$$p(k,2i) = \sin\left(\frac{k}{n^{\frac{2i}{d}}}\right) and\ p(k,2i+1) = \cos\left(\frac{k}{n^{\frac{2i}{d}}}\right) \quad (1)$$

Where, k is position of word in the input sequence, d is dimension of output embedding space, i is dimension index ($0 \leq i < d/2$), n is user defined scalar value which set to 10,000 in original paper (Vaswani et al., 2017) and p(k,j) is function for mapping position k of input sequence to index (k, j) of positional matrix.

The Transformer encoder, introduced by Vaswani et al. (2017), stacks multiple identical layers (originally six) to progressively refine input sequences into richer contextual representations. Each layer contains two key components: (1) a multi-head self-attention mechanism that captures global dependencies between all words in the sequence, and (2) a feedforward neural network that further processes these representations. For training stability, both components employ residual connections and layer normalization, which mitigate vanishing gradients and accelerate convergence.

The encoder's multi-head self-attention mechanism dynamically models relationships between all input sequence tokens, enabling each word to interact with and weigh the importance of every other word as formalized in Eq. (2). This approach captures long-range dependencies and nuanced contextual patterns by computing adaptive attention weights, unlike traditional methods that process words in isolation.

$$Attntion(Q,K,V) = softmax\left(\frac{QK^T}{\sqrt{d}}\right)V \quad (2)$$

Where, Q is query, K is key, V is value and d is dimensionality of key vector.

The self-attention mechanism represents each input word using three vectors: queries (Q) to seek relevant context, keys (K) to identify matching patterns, and values (V) to provide content for synthesis. The model computes attention scores by comparing queries to keys, then weights the corresponding values to generate context-aware representations. Multi-head attention extends this by running multiple parallel attention heads, each capturing distinct linguistic relationships (e.g., syntax, long-range semantics). Their combined output, formalized in Eq. (3), creates a richer understanding of the input sequence by integrating diverse contextual perspectives.

$$\begin{aligned} &Multihead(Q,K,V) \\ &= concat(h_1, h_2 \dots \dots h_k)W_0 \\ &h_i = Attention(QW_i^Q, KW_i^K, VW_i^V) \end{aligned} \quad (3)$$

Where, all W are weight matrices

The Add & Normalize layer in Transformers integrates residual connections and layer normalization to stabilize deep networks.

Residual connections (inspired by ResNet) enable direct gradient flow by adding the original input to transformed outputs as illustrated in Eq. (4) (He et al., 2016) mitigating vanishing gradients. Layer normalization standardizes activations for smoother training. Together, they enhance information preservation across layers in both encoder and decoder stacks, ensuring robust gradient propagation—a key innovation for training deep architectures effectively.

$$y = f(x) + x \tag{4}$$

Where, $f(x)$ is target function.

To compute the gradients, we calculate the partial derivative of the loss function with respect to the input x, as shown in Eq. (5). From the equation we can observe that even if gradient of ∂f(x) diminishes the overall gradient will not vanish due to an additional ∂L/∂y.

$$\frac{\partial L}{\partial x} = \frac{\partial L}{\partial y}\frac{\partial y}{\partial x} = \frac{\partial L}{\partial y}\left(\frac{\partial f(x)}{\partial y} + 1\right) \tag{5}$$

Layer normalization then standardizes these combined outputs, maintaining stable activations and accelerating convergence. Together, these operations form a robust foundation that enables Transformers to learn efficiently despite their depth and complexity. This is achieved using Eq. (6).

$$\hat{x}_i = \frac{x_i - \mu_i}{\sigma_i + \varepsilon} \tag{6}$$

After normalization, it is passed through a multilayer perceptron, which typically consists of a linear layer followed by a ReLU activation layer. This network introduces non-linearity and captures complex patterns in the data. The Decoder in Transformers mirrors the Encoder but integrates masked multi-head attention to enforce autoregressive generation. During training, this mechanism prevents the model from accessing future tokens by masking positions beyond the current step ($j > i$). Specifically, future token attention scores are set to $-\infty$, forcing their softmax outputs to zero. This ensures the model generates text sequentially—relying only on past and current tokens—and maintains causality in predictions.

The transformer computes scores for every word in the vocabulary, with higher scores indicating greater likelihood of being the next word in the sequence. These scores are processed by a linear layer (acting as a classifier) whose dimension equals the vocabulary size. Finally, a softmax layer normalizes the scores into probabilities between 0 and 1, as given by Eq. (7).

$$\sigma(z_i) = \frac{e^{z_i}}{\sum_{i=1}^{k} e^{z_i}} \tag{7}$$

2.2. Bidirectional Representations from Transformer (BERT)

Devlin et al. (2019) introduced BERT, a model designed to pretrain deep bidirectional representations from unlabeled text. Unlike previous approaches, BERT jointly conditions on both left and right context across all layers, enabling it to capture comprehensive word context from surrounding words. This bidirectional architecture makes BERT highly effective for a wide range of natural language processing (NLP) tasks. BERT stacks multiple Transformer encoders, each utilizing self-attention mechanisms to dynamically weigh word importance, capturing intricate linguistic patterns. There are two main steps in BERT: pre-training and fine-tuning.

BERT's pretraining phase leverages two unsupervised objectives to develop its robust language understanding capabilities. The model first employs Masked Language Modeling (MLM), where it randomly masks 15% of input tokens and learns to predict them based on contextual clues, thereby mastering word-level

semantics and syntactic relationships. Simultaneously, through Next Sentence Prediction (NSP), BERT analyzes pairs of sentences to determine their original sequential relationship, cultivating an understanding of discourse-level connections. This dual-task approach - combining fine-grained word analysis with broader textual comprehension - enables BERT to construct rich, bidirectional representations that surpass traditional language models in capturing linguistic subtleties. The resulting architecture forms a versatile foundation that can be fine-tuned for numerous downstream NLP applications while maintaining strong contextual awareness.

Following pre-training, BERT undergoes task-specific fine-tuning using labeled datasets tailored to particular NLP applications like text classification, named entity recognition, or question answering. During this phase, the model's pre-trained parameters are carefully optimized through supervised learning on domain-specific data, enabling it to adapt its broad linguistic knowledge to specialized tasks while maintaining its deep contextual understanding. This two-stage training approach - combining general-purpose language pretraining with targeted fine-tuning - allows BERT to consistently achieve state-of-the-art performance across diverse NLP benchmarks, often surpassing previous task-specific architectures. The BERT architecture comes in two primary variants distinguished by their model depth: BERT-Base and BERT-Large. BERT-Base employs a 12-layer transformer block architecture, while BERT-Large utilizes a more complex 24-layer structure.

2.3. Stemming

Stemming is a basic NLP technique that simplifies words to their root form by cutting off prefixes and suffixes (e.g., "running" → "run"). It enhances text processing efficiency in tasks like search and sentiment analysis by grouping word variants. However, stemming can yield incorrect roots (e.g., "business" → "busi") because it uses rule-based trimming rather than deep linguistic analysis. Common algorithms like the Porter and Snowball stemmers vary in their truncation intensity. Though less precise than lemmatization, stemming is favored for its speed and simplicity in handling large datasets.

A Nepali Stemmer is an NLP tool that reduces words to their root forms by removing suffixes and inflections, which is particularly challenging due to Nepali's complex morphology involving conjugations, gender agreements, and derivational suffixes (Upadhyaya et al., 2021). Unlike English stemmers, Nepali stemmers often use rule-based or machine learning approaches customized for the language's grammar (e.g., “□ □ □ □”, “□ □ □ □” and “□ □ □ □ □” stemmed to “□ □”) . While essential for tasks like search and text classification in Nepali, current stemmers face difficulties with exceptions, compound words, and dialects.

2.4. Gradient Descent Optimizers

2.4.1. Momentum

Momentum enhances gradient-based optimization by calculating an exponentially weighted average of past gradients, which is then used for weight updates as shown in Eq. (8) instead of relying solely on the current noisy gradient. This approach helps the optimization algorithm follow a smoother, more direct path toward the minimum while reducing vertical oscillations, leading to faster and more stable convergence (Ruder, 2017).

$$v_t = \beta v_{t-1} + (1-\beta) dw_t$$
$$w_{t+1} = w_t + \alpha v_t \quad (8)$$

2.4.2. Adaptive Moment Estimation (Adam)

Adam is an advanced optimization algorithm widely used in deep learning that combines the benefits of momentum and adaptive learning rates. It works by computing exponentially decaying averages of both past gradients (first moment, like momentum) and squared gradients (second moment, like RMSProp). These estimates are used to adaptively adjust the learning rate for each parameter as shown in Eq. (9), allowing for faster convergence and better handling of sparse gradients. Adam also includes bias correction to account for initialization effects in the early stages of training (Ruder, 2017).

$$\begin{aligned} v_t &= \beta_1 v_{t-1} + (1-\beta_1) dw_t \\ s_t &= \beta_2 s_{t-1} + (1-\beta_1) dw_t^2 \\ w_{t+1} &= w_t + \frac{\alpha}{\sqrt{s_t + \epsilon}} v_t \end{aligned} \tag{9}$$

2.4.3. Adam with Weight Decay (AdamW)

In standard Adam, L2 regularization, often implemented as weight decay, is added to the loss function, which can affect the adaptive learning rates, potentially hindering optimal convergence. AdamW decouples weight decay from the gradient update step, applying it separately after the gradient update, leading to more stable training and better generalization, especially for large models (Loshchilov & Hutter, 2019).

3. Related Works

Delvin et al. (2019) introduced Bidirectional Encoder Representations from Transformers (BERT), a pre-trained language model based on transformer architecture that excels at capturing contextual relationships between words in a text sequence. This model achieved state-of-the-art performance across multiple natural language processing (NLP) tasks, particularly in text classification. The study demonstrated that fine-tuning BERT for specific downstream tasks led to substantial performance improvements.

Alam et al. (2020) fine-tuned multilingual transformer models for Bangla text classification across multiple domains, including sentiment analysis, emotion detection, news categorization, and authorship attribution. Their approach achieved state-of-the-art performance on six benchmark datasets, surpassing previous methods by 5–29% in accuracy across different tasks.

Shaheen et al. (2020) evaluated multiple transformer-based models—including BERT, RoBERTa, DistilBERT, XLNet, and M-BERT—alongside strategies such as generative pretraining, gradual unfreezing, and discriminative learning rates to achieve competitive classification performance. Their work established new state-of-the-art results. When comparing architectures, the study demonstrated that transformers, with their attention mechanisms, outperform LSTMs in identifying classification-relevant aspects, particularly in long documents.

Subba et al. (2019) compared the performance of Recurrent Neural Networks (RNNs) and Multilayer Neural Networks (MNNs) for Nepali news document classification. Their experiments showed that RNNs consistently outperformed MNNs, achieving a peak accuracy of 63% compared to MNNs' 48%. Notably, while MNNs exhibited significant variability with accuracy dropping as low as 4.3%, RNNs maintained more stable performance, with their lowest accuracy at 59%.

Singh (2018) performed a comparative study on Nepali news classification, evaluating traditional machine learning algorithms against deep learning approaches. The study assessed traditional classifiers—including Logistic Regression (LR), Support Vector Machine (SVM), Multinomial Naive Bayes (MNB), Bernoulli Naive Bayes (BNB), K-Nearest Neighbors (KNN), and Multi-Layer Perceptron

(MLP)—against deep learning models such as Recurrent Neural Networks, LSTM, GRU, and Adaptive GRU architectures. All models utilized Word2Vec embeddings for text representation.

Timilsina et al. (2022) developed NepBERTa, a specialized BERT-based model trained on the largest monolingual Nepali corpus to date – containing 0.8 billion words from 36 major Nepali news sources. Their results demonstrate that NepBERTa substantially enhances performance across multiple NLP tasks, particularly in news classification, by effectively utilizing this rich linguistic dataset.

Munikar et al. (2019) leveraged BERT for fine-grained sentiment analysis of Nepali text, utilizing the Stanford Sentiment Treebank (SST) dataset. Their findings reveal that BERT surpasses conventional approaches—including convolutional and recursive neural networks—in detecting subtle sentiment nuances in Nepali language. This work highlights BERT's versatility, extending its effectiveness beyond news classification to broader NLP applications.

Joshi et al. (2019) performed a systematic evaluation of deep learning approaches for Hindi text classification, comparing CNN, LSTM, and attention-based architectures. The study also assessed multilingual embeddings, BERT and LASER, for this morphologically rich, low-resource language. Using translated English datasets, their work revealed transformer models with attention mechanisms consistently outperformed traditional CNN/LSTM approaches, offering important insights for processing Devanagari-script texts.

Dai et al. (2022) investigated transformer-based approaches for long document classification, tackling key computational challenges in processing extended texts. The study systematically compared two efficient strategies: (1) sparse attention, which reduces computational costs by focusing on token subsets, and (2) hierarchical encoding, which processes documents through segmented analysis. Their work not only demonstrated performance improvements across multiple datasets but also provided actionable guidelines for implementing these methods in long-document classification tasks.

Thapa et al. (2024) developed specialized transformer models for Nepali language processing by pre-training BERT, RoBERTa, and GPT-2 architectures on a newly compiled large-scale Nepali corpus. Their evaluation using the Nep-gLUE benchmark – covering diverse NLP tasks including text classification, sentiment analysis, and text generation – revealed these models substantially outperformed existing solutions. This work demonstrates the critical importance of language-specific pre-training for achieving state-of-the-art performance in low-resource languages like Nepali.

Maskey (2022) investigated auto-encoding transformer models (DistilBERT, DeBERTa, and XLM-R) for Nepali text classification, demonstrating their effectiveness in capturing linguistic nuances for tasks like sentiment analysis and news categorization. Through comparative evaluation, the study revealed these transformer architectures significantly improve classification accuracy over traditional approaches, underscoring their value for low-resource language processing.

4. Methodology

Figure 2 illustrates the schematic framework of the methodology employed in this study. The following subsections provide a concise overview of each component.

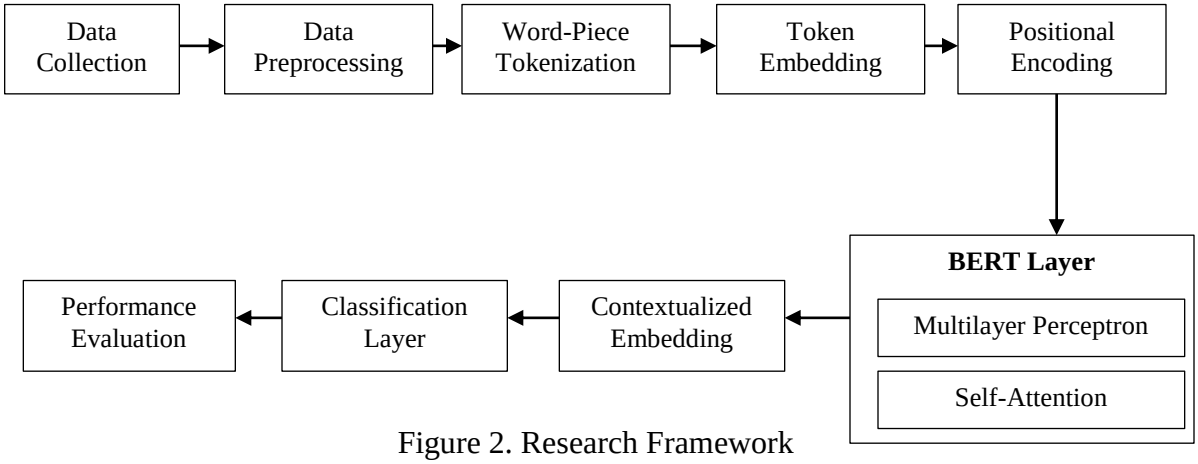

Figure 2. Research Framework

4.1. Data Collection

The research dataset was constructed by merging publicly available data from GitHub (Neupane, 2022) with articles scraped from prominent Nepali news platforms, including Ratopati, Ekantipur, Onlinekhabar, and Techpana. Initial analysis revealed a significant class imbalance, with categories like politics and sports containing disproportionately higher numbers of articles compared to underrepresented domains such as technology and education. To mitigate potential model bias and improve classification accuracy for minority classes, a uniform sampling approach was implemented. This involved selecting 2,500 articles from each of the six target categories—business, education, sports, health, technology, and entertainment—resulting in a balanced dataset of 15,000 articles for training.

4.2. Data Preprocessing

The scraped news data, comprising a mix of digits, English characters, and special symbols, underwent rigorous cleaning to retain only linguistically relevant Nepali text. The preprocessing pipeline included the following steps: Removal of Non-Nepali Elements, Whitespace Standardization, Stop Word Removal, Stemming, Lemmatization, Category Mapping of News articles. The balanced dataset was partitioned into training and testing subsets, following an 80-20 ratio. This division allocates 80% of the data for model training and reserves 20% for testing.

4.3. Hyperparameter Settings

In this study, we investigated the effect of different optimization algorithms on the performance of a BERT-based text classification model, keeping all other hyperparameters constant. Specifically, we compared the Adam, AdamW, and Momentum optimizers. A batch size of 32 was chosen to balance computational efficiency with generalization, and the number of training epochs was fixed at 3 to allow adequate learning while minimizing overfitting. For Adam and AdamW, a learning rate of 2e-5 and weight decay regularization were used. The Momentum optimizer was configured with a learning rate of 0.03 and a momentum value of 0.9. By holding all other hyperparameters fixed, this study aimed to isolate and analyze the impact of the optimizer on convergence speed, training stability, and classification accuracy in the context of news article categorization.

4.4. Performance Measures

The news classification strategies investigated in this research are evaluated using accuracy,

precision, recall, and F1-score which are formulated as below.

$$accuracy = \frac{Number\ of\ correct\ predictions}{Number\ of\ total\ predictions} = \frac{TP+TN}{Total} \quad (11)$$

$$\text{Weighted Average Accuracy} = \sum_{i=1}^{N} w_i \times \text{Accuracy}_i \quad (12)$$

Where, N is the total number of classes, w_i is the weight of class i, calculated as the proportion of true samples for class i in the dataset and Accuracy_i is the accuracy for class i.

$$\text{Precision} = \frac{\text{True Positive}}{\text{True Positive+False Positive}} \quad (13)$$

$$\text{Macro Precision} = \frac{1}{N} \sum_{i=1}^{N} Precision_i \quad (14)$$

$$\text{Micro Precision} = \frac{\sum_{i=1}^{N} \text{True Positive}_i}{\sum_{i=1}^{N} (\text{True Positive}_i + \text{False Positive}_i)} \quad (15)$$

Where, N is the total number of classes and $Precision_i$ is the precision for class i.

$$\text{Recall(Sensitivity)} = \frac{\text{True Positive}}{\text{True Positive+False Negative}} \quad (16)$$

$$\text{Macro Recall} = \frac{1}{N} \sum_{i=1}^{N} Recall_i \quad (17)$$

$$\text{Micro Recall} = \frac{\sum_{i=1}^{N} \text{True Positive}_i}{\sum_{i=1}^{N} (\text{True Positive}_i + \text{False Negative}_i)} \quad (18)$$

Where, N is the total number of classes and $Recall_i$ is the recall for class i.

$$\text{F1 Score} = \frac{2*\text{Precision}*\text{Recall}}{\text{Precision+Recall}} \quad (19)$$

$$\text{Macro F1 Score} = \frac{1}{N} \sum_{i=1}^{N} F1\ \text{Score}_i \quad (20)$$

$$\text{Micro F1 Score} = \frac{2*\text{Micro Precision}*\text{Micro Recall}}{\text{Micro Precision+Micro Recall}} \quad (21)$$

Where, N is the total number of classes and $F\ Score_i$ is the F1 for class i.

4.5. Tools Used

This research was implemented using Python and various libraries within the Google Colab environment, which offers free GPU support for machine learning tasks. Key tools included Pandas for data manipulation, scikit-learn for preprocessing and evaluation, Hugging Face Transformers for BERT-based text classification, and PyTorch for model training and data handling.

5. Results and Discussion

This study explores the use of BERT for Nepali news classification, combining various optimizers (Momentum, Adam, and AdamW) with stemming techniques to analyze their impact on model performance. The evaluation metrics included weighted average accuracy, macro-averaged precision, recall, and F1-score, enabling a comprehensive assessment of how stemming and optimizer selection influence the effectiveness of transformer-based models. These experiments highlight the interplay between text normalization strategies and optimization algorithms in enhancing BERT's capability for multilingual text classification tasks, offering practical insights for improving NLP workflows in low-resource languages.

Table 1. Performance of Various Models

Metric / Model	Weighted Avg. Accuracy	Macro Recall	Macro Precision	Macro F1
BERT-Momentum	87.87	0.88	0.88	0.88
BERT-St-Momentum	86.57	0.87	0.87	0.87
BERT-Adam	92.7	0.93	0.93	0.93
BERT-St-Adam	92.63	0.93	0.93	0.93
BERT-AdamW	91.87	0.92	0.92	0.92
BERT-St-AdamW	93.67	0.94	0.94	0.94

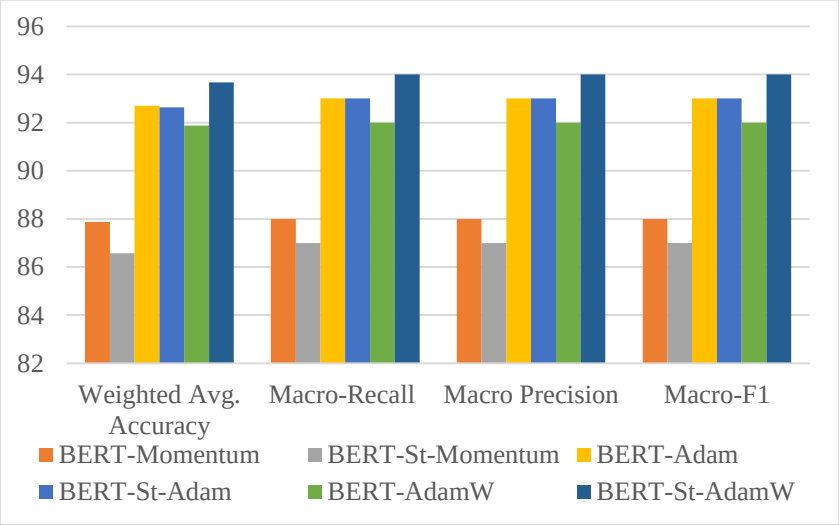

Figure 3. Performance of Various Models

For Model 1 (BERT with Momentum optimizer), Categories 2 (Sports) and 5 (Entertainment) achieved the highest classification accuracies at 92% and 93%, respectively. In contrast, Category 0 (Business) recorded the lowest accuracy at 78%, with 12% of its samples misclassified as Category 4 (Technology), likely due to semantic similarities between business and technology-related content. Additionally, 6% of samples from Category 1 (Education) were misclassified as Category 3 (Health), suggesting an overlap in terminology between educational and health-related topics. In the case of Model 2 (BERT with Stemming and Momentum), improvements were observed across several categories. Category 5 (Entertainment) achieved the highest accuracy at 95%, while Categories 0 (Business) and 4 (Technology) showed notable improvements, reaching accuracies of 87% and 88%, respectively. Despite these gains, misclassifications persisted—7% of Category 1 (Education) samples were misclassified as Category 0 (Business), and Category 3 (Health) attained an accuracy of 81%, with 10% of its samples misclassified as Category 4 (Technology). Based on the above observations, stemming did not improve performance when used with the Momentum optimizer, as evidenced by the slight decline in accuracy and other evaluation metrics compared to Model 1. This suggests that stemming may cause minor information loss, as reducing words to their root forms can eliminate important linguistic features.

For Model 3 (BERT with Adam), Category 5 (Entertainment) achieved the highest accuracy at 98%, followed by Category 3 (Health) at 96% and Category 1 (Education) at 95%, demonstrating the model's effectiveness in distinguishing these categories. Category 0 (Business) attained an accuracy of 84%, though it experienced notable misclassifications into Category 4 (Technology) at 6% and Category 1 at 3%, indicating some feature overlap. Category 2 (Sports) achieved 92% accuracy, with minor confusion involving Categories 1 and 4. Similarly, Category 4 (Technology) reached 91% accuracy, but with some misclassification into Categories 0 and 1. For Model 4 (BERT with Stemming and Adam), Categories 5 (Entertainment) and 3 (Health) achieved the highest accuracies at 98% and 96%, respectively, followed closely by Category 2 (Sports) at 95% and Category 4 (Technology) at 94%. However, Category 0 (Business) continued to pose

challenges, with a lower accuracy of 80% and significant misclassifications into Category 4 (13%) and Category 1 (3%). Category 1 (Education) achieved a solid 93% accuracy, though it exhibited minor misclassifications into Categories 0 and 3.

In Model 5 (BERT with AdamW), Categories 1 (Education) and 4 (Technology) achieved the highest accuracies at 96%, closely followed by Categories 2 (Sports) and 5 (Entertainment) at 95%. Despite these strong performances, Category 0 (Business) remained challenging, with an accuracy of 78% and significant misclassifications into Category 4 (11%) and Category 1 (4%). Category 3 (Health) achieved a solid accuracy of 91%, though it showed minor misclassifications into Categories 1 and 4. Whereas in Model 6, Category 0 (Business) achieved an accuracy of 91%, with minor misclassifications into Category 4 (6%). Category 1 (Education) followed with 93% accuracy, showing slight misclassifications into Category 0 (3%) and Category 3 (2%). Categories 3 (Health), 4 (Technology), and 5 (Entertainment) recorded the highest accuracies at 95%, 96%, and 96%, respectively, demonstrating the model's strong capability to effectively differentiate these categories.

The results clearly show that the AdamW optimizer outperformed both Momentum and Adam across all evaluation metrics. Models trained with AdamW consistently achieved higher weighted average accuracy, macro precision, macro recall, and macro F1-score compared to those using Momentum, and slightly outperformed models using Adam. Adam also demonstrated superior performance over Momentum in every metric, underscoring its effectiveness as an optimizer. These findings highlight AdamW as the most effective optimizer for training deep learning models in text classification tasks, with Adam as a strong alternative. The impact of stemming on model performance was mixed. For models using the Momentum optimizer, stemming led to a slight decline in performance, suggesting sensitivity to information loss. In contrast, stemming had minimal impact on models using the Adam optimizer, with metrics remaining largely stable. Notably, stemming enhanced performance when paired with the AdamW optimizer, indicating that advanced optimizers like AdamW can better leverage the simplified input resulting from stemming. This suggests that stemming is most beneficial when used alongside optimizers capable of effectively managing reduced linguistic complexity, particularly AdamW, and to a lesser extent, Adam.

6. Conclusion

The study conducts a detailed examination of optimizer efficacy and stemming influences on text classification models. Findings reveal that Adam and AdamW optimizers markedly outperformed Momentum, demonstrating consistently superior weighted average accuracy, macro precision, macro recall, and macro F1-scores across all experimental setups. While AdamW achieved marginally better results than Adam, both optimizers emerged as ideal choices for training deep neural networks in NLP tasks.

Stemming slightly diminished performance when paired with Momentum and showed minimal impact with Adam. However, AdamW models experienced significant performance gains when stemming was applied, suggesting this technique enhances outcomes specifically when combined with optimizers adept at managing simplified data structures, such as AdamW's adaptive gradient mechanisms.

The optimal configuration integrated stemming with AdamW, achieving 93.67% weighted

accuracy and balanced metric performance. This combination exhibited strong generalization and operational efficiency, positioning it as a practical solution for Nepali news categorization. Notably, Adam also delivered robust results regardless of stemming, reinforcing its versatility in text classification workflows. These insights underscore the importance of aligning stemming with optimizer selection to maximize model effectiveness.

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Scenario of Poverty in Nepal

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Abstract

Poverty is a multidimensional issue that demands multidimensional solutions. While significant progress has been made, millions continue to suffer from deprivation. Addressing poverty requires a blend of sound economic policies, targeted social programs, and a global commitment to equity and justice. Only through a deep understanding of both its conceptual foundations and empirical manifestations can effective and enduring solutions be crafted.

Keywords—Poverty, Income, Poverty line

Introduction

Generally, the poor are those whose expenditure (or income) falls below a poverty line. Poverty is a social problem. Sociological interests in poverty centers around the ideas of the 'culture of poverty' and the effects of 'place' on poverty. In sociological explanation the role of culture, power, social structure, and other factors that are rarely out of control of the individual are the main forces of poverty. Poverty is a multi-dimensional concept. There are mainly four approaches to define and measure the poverty; monetary approach, capability approach, social exclusion approach and participatory poverty approach (Laderchi at al. 2003). All these approaches have their own dimensions and concerns to define and measure the poverty. Poverty is the state of one who lacks a certain amount of material, possessions or money. There are other different definitions of poverty.

There are various scholars define to poverty in various way. According to Haralambos (2010) poverty is a social problem. Similarly, it is found to have defined in various ways on the basis of various theories. From a Marxian perspective, poverty in capitalist society can only be understood in terms of the system of inequality generated by a capitalist economy. From this perspective, the state in capitalist society reflects the interests of the ruling class, government measures can be expected to do little except reduce the harsher effects of poverty (Haralambos 2010). Similarly, the positive feedback theory shows how the various circumstances of poverty reinforce each other and so maintain the system. The culture of poverty theory claims to show how a distinctive subculture develops within the situation of poverty and so perpetuates the system (Haralambos 2010).

Max Weber argues that the poverty of the old, sick, handicapped and single parent families is largely working-class poverty. Social class rather than personal disability, inadequacy, or misfortune accounts for poverty (Haralambos 2010). Poverty is generally of two types: absolute poverty and relative poverty. Absolute poverty refers to the condition characterized by severe deprivation of basic human needs including food, safe drinking water, sanitation facilities, health, shelter, education, and information which are not being met to support a minimum level of physical health (Haralambos 2010).

Relative poverty is defined contextually as economic inadequacy in the location or society in which people live. When people do not enjoy a certain minimum level of living standards are determined by the government (and enjoyed by the bulk of the population) that vary from country to country. It is socially defined and dependent on social context. Hence, relative poverty is a measured as the percentage of population with income less than some fixed proportion of median income. For much of history, poverty was classified largely unavoidable as traditional modes of production were insufficient to give an entire population a comfortable standard of living (Haralambos 2010).

Poverty remains one of the most persistent and complex challenges in both developing and developed nations. Despite global economic progress, poverty continues to affect millions, shaping access to health care, education, employment, and basic human dignity. This article explores the conceptual frameworks used to define poverty and examines empirical realities drawn from global statistics and case studies.

Approaches Poverty to Measuring

Poverty is a multidimensional concept. According to (Laderehi, Saith and Stewart 2003) there are mainly four approaches to define and measure the poverty: first, monetary approach. The monetary approach to poverty measurement was pioneered by the seminal work by Booth and Rowntree in the late 19^{th} and early 20^{th} centuries. They pointed the objective assessment of poverty predefined by the external observer but they also created individualistic view of poverty, meaning that poverty could be defined with respect to an individual's circumstances, disregarding the role of society and the individual's social influences. This view of poverty was consistent with the perception of poverty as a social ill rather than a disadvantaged situation.

The second is capability approach. Capability approach defines poverty as a deprivation of capabilities as lack of multiple freedoms people value and have reasons to value. Nussbaum argues that there should be a "list" of core capabilities and Sen (1993) argues that the capabilities should be selected in the light of the purpose of the study and the values of the referent population, and that their selection should be explicit and open to public debate and security. This approach draws attention to much wider range of causes of poverty and options for policies than the monetary approach. The capability approach rejects monetary income as its measure of well-being, and instead focuses on indicators of the freedom to live a valued life. In this framework, poverty is defined as deprivation in the space of capability approach, or failure to achieve certain minimal or basic capabilities, where 'basic capabilities' are 'the ability to satisfy certain crucially important functioning up to certain minimally adequate levels' (Sen 1993).

It emphasizes on well-being that is seen as the freedom of individual. Therefore, poverty must be related to the human freedom and quality of life in an individualistic way that can be achieved through certain capabilities development (ibid).

Third is social exclusion approach. Social exclusion is a process. It can involve the systematic denial of entitlements to resources and services, and the denial of the right to participate on equal terms in social relationships in economic, social, cultural or political arenas.

Social Exclusion

This concept was developed in industrialized countries to describe the processes of marginalization and deprivation that can arise even within rich countries with comprehensive welfare provisions (Laderchi, Saith and Stewart 2003). The European Union defines social exclusion as a: 'process through which individuals or groups are wholly or partially excluded from full participation in the society in which they live' (European Foundation, 1995). Social Exclusion leads to a focus on distributional issues the situation of those deprived relative to the norm generally cannot improve without some redistribution of opportunities and outcomes whereas monetary poverty and capability poverty can be reduced through growth without redistribution (Atkinson 1998).

Finally, last one is participatory approach. Participatory Poverty Assessments (PPA) pioneered by Robert Chambers. This approach's main aims are getting people themselves to participate in decisions about what it means to be poor, and the magnitude of poverty (Chambers 1994). The practice of participatory poverty assessments evolved from PRA defined as 'a growing family of approaches and methods to enable local people to share, enhance and analyze their knowledge of life and conditions, to plan and to act' (Laderchi, Saith and Stewart 2003). It suggests providing opportunity to people to participate in decisions about what it means to be poor, and the magnitude of poverty' (Chambers 1994).

Monetary Approach of Measuring Poverty

The monetary approach to the identification and measurement of poverty is the most commonly used. It defines poverty with a shortfall in consumption (or income) from some poverty line. This approach identifies poverty as a shortfall in consumption or income. The approach sets a poverty line as defined by a threshold income below which a person is considered to be poor. The most common poverty line is the $1.25 a day, set by the World Bank. The main assumption made by this approach is that consumers' objective is to maximize their utility and that the ensuing welfare can be measured by their total consumption. And a proxy of consumption is their total expenditure or income.

An income below what is considered necessary to consume a minimum Sociology of Poverty basket of basic goods would then be defined as the poverty line. The use of a monetary approach to poverty can be justified in two quite different ways: first, the minimum rights approach, where a certain basic income is regarded as a right without reference to utility but rather to the freedom of choice it provides (Atkinson 1989 cited by Laderchi, Saith and Stewart 2003). Secondly, the use of a monetary indicator is often invoked not because monetary resources measure utility, but because it is assumed it can appropriately proxy other aspects of welfare and poverty. The monetary approach is the most commonly used which identifies poverty as a shortfall in consumption (or income) (Laderchi, Saithand Stewart 2003). This approach sets a poverty line as defined by a threshold income below which a person is considered to be poor. The valuation of different components of income or consumption is done at market prices, which requires identification of relevant market and the imputation of monitory values for those items that are not valued through the market (ibid). It

defines poverty as an individual aspect and measures the level of poverty with respect to the capacity of expenditure and fulfilling the minimum amount of food (in calories), shelter and clothes.

Further, this approach disregards social resources that are of great importance in determining individual achievement in some fundamental dimensions of human well-being such as health and nutrition. It has also been emphasized that this approach is addressed to individual's achievements; social interactions and interdependence are considered from the mechanical point of view appropriately scaling household resources to take account different household structures.

Historical Background of Monetary Approach

The monetary approach to poverty measurement was pioneered by the seminal work by Booth and Rowntree, who studied poverty in London and York, respectively, in the 19^{th} and early 20^{th} centuries (Laderchi, Saith and Stewart 2003). Booth's study of the east end of London, in 1887, was prompted by widespread rioting by the poor, which socialists explained at the time by the claim that one-third of the population was poor. Booth used informants, not direct enquiry among the poor. He categorized people into eight social classes, four of which represented different degrees of poverty (ibid).

Rowntree's work has been described as the first scientific study of poverty. Rowntree defined a poverty line by estimating monetary requirements for a nutritionally adequate diet together with estimated needs for clothing and rent. Those below this line were defined as in primary poverty (ibid). Both Booth and Rowntree agreed on some important issues - views which are shared by most economists adopting a monetary approach today. Booth and Rowntree created an individualistic view of poverty, meaning that poverty could be defined with respect to an individual's circumstances, disregarding the role of society and the individual's social influences.

This view of poverty was consistent with the perception of poverty as a social ill, rather than as a disadvantaged situation. This created the idea of the undeserving poor; those who were poor by own will and who, quite clearly, did not deserve the help or assistance of society or the State. The deserving poor, on the other hand, where assisted by charitable interventions designed to help the individual.

The Monetary Approach to Poverty: Strengths and Weaknesses

The Monetary Approach proposes a method that sees income (or consumption) as equivalent (or, at least, as the best possible proxy measure) of well-being. To what extent can this assumption be sustained? In a complex world, where human interactions and social behavior differ greatly between countries and even within countries, an approach that tries to uniform global population and the understanding of poverty seems to be inexperienced.

The highly debated "Less than 1.25 US$ a day" poverty line is maybe one of the most extreme examples of this approach and its limitations. In the past, some of the poverty reduction policies that were applied were not correct, even in the eyes of the Monetary Approach. But the microeconomic theory underlying the Monetary Approach also poses some restrictions and limitations to the understanding of poverty.

Social relations are left aside, and other types of welfare are not considered. These failures make the Poverty Line and other Monetary Approaches an often-misleading instrument. Understanding well-being in a more realistic way seems to be the

first task to correct some of these problems. However, the theory underlying this understanding of poverty seems to leave little room for this. Most of the causes of poverty are results of long processes of social, political, economic and cultural power relations. The evolution in time of such processes might be more insightful than trying to understand poverty at a single point in time through income. The Monetary Approach has led to some useless policies that tried to attack poverty by attacking effects instead of causes of poverty.

Hence, these policies have had little or no effect, and today poverty and inequality seem to be defeating most of the efforts of development agencies and governments. However, the monetary approach shouldn't be disregarded as useless.

The methodologies show clear economic inequalities that can help us understand economic poverty. By considering this and by using other instruments that complement these methodologies (rather than trying to replace them), a better measurement and understanding of poverty can be reached. All the methodologies are supposed to be measuring the same: poverty. But as long as we don't agree on and understand what poverty is, we won't be able to attack it. Before engaging in a battle against poverty, we have to know our enemy... otherwise, the battle might turn out to be against the poor instead of against poverty.

Monetary Approach in Nepal

The latest poverty identity card distribution is based on the monetary approach. The measurement of poverty is carried out on the basis of one's income and the card is distributed. National Planning Commission measures poverty on the basis of income and consumption capacity according to which one is addressed as poor when he has no ability to consume food equal to 2144 calorie.

Thus, till today the measurement of poverty, we are carrying out is based on only one dimension that is income and consumption capacity. Further, understanding the poverty on the basis of income and identifying poor as those having a minimum of yearly income 19 thousand two hundred and forty-three rupees. According to the 2010-11 NLSS, an individual in Nepal is considered poor if his/her per capita income total annual consumption is below Rs. 19,243.

Case Study

Manamaya Gurung 'Shrestha' 27 years was born in Banepa municipality of Kavre district. Her family did not have sufficient land on its own then they escaped from there and come to Kathmandu for searching work. Her husband is illiterate and she has studied till class three in government school. Her husband earned living of his family by working as a gateman on small private institution. Manamaya herself is also working in as a part time in two houses. They have two daughters and they are studying in public school. She has admitted her daughters in the public school because she cannot afford for the private schools.

Manamaya says that the earning from mere working in others' houses is not enough to pay room rent and join hand and mouth thus she is not able to afford the quality education for her children. Manamaya, with her husband hardly have a monthly income of 15 thousand but not as regular income, if sometimes they get sick or unable to work for any other reason, the salary cuts down in day wise which is bitter for them while their expenditure is nearly 18 thousand. They have to pay rent of 2500 in a month for a one small room. Manamaya's husband also has to send money for his parents in village too at least

2000 per month. Her husband could not bear all responsibility for her family because it was very hard for them to join their hand and mouth daily. Because of less income they could not afford money for health checkup if not serious case. When serious case occurs anyone among them the expenses harms in next month and they have to request their supporter for borrowing money. She told such moments came many times in her life when her children were too small and she told that till then she was getting support from others because she refunded all borrowing money how far she could as soon as possible. Further, she has to cancel buying meat, stop giving money to her husband's parents in village, and bring cheapest vegetables and so on. The part of entertainment is as a dream or very far for them. Due to inter-caste marriage she suffered many social problems such as not being accepted in their guthi puja, rituals and in festivals. Other members and relatives dominate her as lower caste and ignore especially in rituals and festivals.

While seeing the case study of Manamaya, monetary approach only cannot capture the complex realities of poverty in everyday realities. According to the poverty line on monetary approach in Nepal, those who earn 19243 annually are above the poverty line. While seeing in this way, the annual income of Manamaya is around 1 lakh 80 thousand. But her family has no enough capability of spending on lodging, flooding, health, quality education and entertainment. Her daughters could not get quality education because she could not spend enough for that. They are not able to get proper health checkup while they get sick. Seeing through the capability approach, this is also poverty. Similarly, she has been excluded from the society in various ways due to her inter caste marriage. While seeing through social exclusion approach, this is also the poverty. Similarly, they say themselves poor though they have a good carning. They feel as if they are poor because they cannot spend enough for their, lodging-fooding, quality education and health which lacks their recognition in the society. From this, what can be clear is that the monetary approach cannot capture the complex realities of poverty in everyday realities.

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Structural Barriers for Development of Nepal Analyzing Political, Economic, and Institutional Obstacles

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Abstract

Nepal has been facing developmental impediment for a long. Nepal is a least developed country designed by United Nation in 1971 and has the same developmental position since that time about 54 years. Nepal has huge potentialities for achieve of its national interests and augment of its position. Nevertheless, the economic growth is not improving, security is in vulnerable, and development is in stagnation. Consequently, Nepal is bearing high international trade deficit and debt of annual interests. Being a least developed country, Nepal has been challenging with several non-traditional security threats.

The objective of the article is to unveil the reasons of developmental impediments of Nepal for a long critically. The article has attempted to elucidate political structural, institutional structural, economic, procedural, and policy of developmental obstacles. Furthermore, potentialities for augment its developmental position and the consequences of development impediment have also been disclosed.

Philosophy of constructivism and analytical interpretive approaches are applied.

Qualitative research design is adopted, mainly phenomenology and history qualitative methodology is employed. Development and peace theory is considered. Secondary and few primary qualitative data have been collected.

Key Words—Developmental impediment, Reason of impediment, state position and development.

Introduction

Nepal is a member country of South Asian Association of Cooperation Committee lies between giant countries China and India. It has very beautiful geographical construction includes flat areas, hills and mountains. World highest maintain Everest is stand its north border.

These regions offer diverse landscapes and climates, contributing to Nepal's rich biodiversity. It is 23 times smaller than India and 68 times smaller than China. It is 93rd largest country in the world. Chinas and India's economic growth are rapidly enhancing. India's and China's gross development production is augmenting 6.5 % and 4.5 annually (International Monitory Fund, 2025) respectively. The people of Nepal have been waiting eagerly and striving to promote their position and address their non-security threats for a long. Although Nepal's economic growth rate annually is only 2% even People have struggled and amended political notion. The Active

Monarchy replaced by democratic regime with constitutional monarchy in 1990. Again, constitutional monarchy abolished and established republic regime in 2016. Nevertheless, People desires and national interests are not achieved.

Political instability leads economic retardation and economic retardation brings political instability. These two conditions are interlinked directly and indirectly in progressing of Nepal. Economic retardation drives backward all indicators where society is compelled to bear all kinds of difficulties and problems. The major social problems are bearing by people of Nepal yet to address are international trade deficit, debt, physical safety, poverty, insecurity, crimes, human trafficking, human disappearance, road unsafety, unhealthy food supply, low quality medicine supply, border encroachment, trade blocked, high morbidity rate, corruption, lack of accountability, lack of access of quality services on time, weak system for quality functional education and health services, pollution, inequality, outflow of capital and human resource, and violence against women. Furthermore, Youths have not been believing the better future of the country therefore they have been leaving the country every month.

There are several reasons of such difficulties due to stagnation of development of Nepal. The developmental indicators: economic indicators; gross domestic product, gross national income, gross national product and social indicators; literacy rate, life expectancy, infant mortality rate, human development index, unemployment rate poverty rate are proved Nepal is the same position the least developed country for 54 years.

Development depends on honestly collection of revenue and distribution of that prudently to achieve national interests and to address social problems. How Nepal has been practicing these that fix the position of Nepal. Fifty-four years in a same position is not a short time. There should be some major and minor national and international reasons to be such position for a long. There are some majors' domestic and international reasons of sluggishness of progress of Nepal. This study attempted to disclose those reasons and way to enhance state position through the article. Phenomenological and historic qualitative designs is employed.

Philosophy of structuralism and constructivism are considered to explore political and social ontology of the state. Political and bureaucratic structure are examined. Partial developmental policy is analyzed by the study.

An analysis was conducted on the approach of the peace and development. This approach emphases importance of development for social security and for national identity. Development includes various aspects of human's life economic growth, social development, environments development and demographic development. Development and peace are interlinked. Development is not possible without peace and peace is not present without development. Healthy human's life is not possible without those both. According to Delgado, development is "supporting the provision of basic social services, such as health, education and social safety nets, can instill greater confidence in governments. It may also help build government capacity, accountability and legitimacy (Wolff, J., & Witt, A., 2019). How is Nepal's basic social services like health, security, education, government capacity, accountability and legitimacy? Writer is not going to analyze deeply on those issues but this article focuses on the reasons of impediment of development of Nepal for a long time. When discussing the development of a state, there should be questioned of leader capacity, resources, institutional structural arrangement, national

planning, procedural capacity, executive process or honestly implementation, service delivery, policy, international interference, exploitation of resources, quality education, quality health service, capital outflow and legal provision of the state. Regime can be authoritarian and totalitarian. Various types of ideologies and institutions can be found in authoritarianism where leader do not always rule completely arbitrarily and can have a strong institutional underpinning of ideology (O'Neill, P.H., 2007). Where is erroneous to be developed of Nepal? Why the progress of Nation is in stagnation for such long time is a query of the writer.

Qualitative primary and secondary data are employed. More secondary data from report of reputed organizations, journals, news, books and articles are employed. Rational and empirical judgments are made.

Key Arguments

The world is divided into fourth categories by UN social and economic council. The list of the least developed countries (LDCs) is decided upon by the United Nations Economic and Social Council and, ultimately, by the General Assembly, on the basis of recommendations made by the Committee for Development Policy. The basic criteria for inclusion require that certain thresholds be met with regard to per capita GNI, a human assets index and an economic vulnerability index. (UN, 2022). Development includes economic growth such as income, GDP, utilization of resources, advancement of technology, infrastructure development. Readability, accessibility, and formatting consistency in the document. The three criteria (human assets, economic vulnerability and gross national income per capita) are assessed by the Committee for Development Policy every three years to categories countries (UN). All States have their national interests almost the same such as territorial integrity, security, independency and prosperity, some states have more than that interests, is acquire, sustain and exercise hegemonic power. It is sometime hazardous to other states for their protection. Hence, all states have been striving to achieve their national interests in this capitalist world order. Nepal is one of the striving states to achieve its national interests.

Nepal's Situation and Thresholds of Development

Nepal is one of the least developed countries among 46 countries. There are 33 Africans, nine Asian, one Caribbean and three Pacific countries in the least developed countries. Nepal has been listed as a least developed country in 1971. It has been confronting several political reformations, social transitions, economic up down and domestic conflict since that time. Democratic government was established by democratic movement in 1990 abolishing active monarch after 19 years of categorized as a least developed country. Prime ministers have been changed 28 times since democratic regime started. Most of the time Nepali congress has been leading the government. Hence, Nepal's progress has been in stagnation for 54 years.

Nepal's Situation and Thresholds shown by the Tables

Table A: National Income and Human Assets Index

1. **National Income (GNI) per capita*** ***(Values in USD)***

Category	Value	Thresholds	Inclusion	Graduation
Group	1,300	1,088	1,306	1,305
Nepal	1,300	–	–	–
LDCs	1,307	–	–	–
Developing Countries	9,358	–	–	–

Sources: UN Development Index 2022

Table B:

- *Thresholds*: Minimum GNI for LDC classification.
- *Inclusion/Graduation*: Values required to enter/exit LDC status.

2. Human Assets Index (HAI)*

Category	Index	Thresholds	Inclusion	Graduation
Group	76.3	≤60	≥66	≥66
Nepal	76.3	–	–	–
LDCs	59.6	–	–	–
Developing Countries	88.0	–	–	–

Sources: UN Development Index 2022

Notes:

- *Thresholds*: LDCs typically score ≤60.
- Nepal's HAI (76.3) exceeds both inclusion and graduation thresholds (≥66).

Table C : Social Index and Threshold (Health and Education)

Indicator	Value	Index	Source
Under-five mortality rate	27.3	89.5	UN IAG for Child Mortality Estimation
Lower secondary education completion rate	72.3	69.3	UNESCO
Prevalence of stunting	26.7	51.6	UNICEF/WHO/World Bank Joint Child Malnutrition Estimates
Adult literacy rate	71.2	61.5	UNESCO
Maternal Mortality Rate	174	85.8	UN IAG for Maternal Mortality
Gender parity index for lower secondary education completion	1.1	100.0	UNESCO

Sources: UN Development Index 2022

Nepal has thresholds on economic, education, health, environment and development to reach in the position of developing state. It has ranked 145th out of 193 countries in the United Nations Developmental Programmer's (UNDP). Human developmental index (HDI) for 2025 with a score of 0.622. The Politic is a pillar to stand a state in rights direction and for move forward. Nepal has been facing political transformation since modern age and has been bearing social transition and economic immobility. There are numerous internal political structural, institutional, economic, policy level, procedural and behavioral reasons and external contemporary and historic reasons are behind the developmental impediment of Nepal.

Contemporary Reasons are:

Political Structure/ Instability

Political structure very much matter to a state progress. Four levels political hierarchies a large political structure is made by the constitution of Nepal in 2015. Excessive budget has been spending for management of this structure such as administration, budget, staffing, infrastructures, buildings and other facilities leads shortage of budget for the developmental and fulfilment of basic requirement of entire society. After promulgation of new constitution, political structure is one of the key reasons of debt of Nepal. Nepal has billions debt and its interest to be paid annually. Nepal' political structure is unaffordable and unreasonable gigantic. Because a small country is divided into seventh provinces with eight governments, ministries and administrations including federal government. There are same ministries in the federal government. At present, the number of provincial ministries across the country stands at about 69 (Sharma, 2021). Upper house, lower house, federal parliament executive body (government), provincial parliaments, provincial executive bodies' government's ministries, and local governments are structured by constitution of Nepal.

About thirteen constitutional commissions are structured by the constitution. The presidents and members of them are paid and provided other facilities by the state. Some of the commissions are unnecessary. The functions of the commissions can be performed by ministries, security system, justice system and office of the district administrations. It is also a financial burden for least developed country like Nepal.

Expenditure for such large political structure is beyond the capacity of the country.

Allocation of developing budget to run these parliaments, governments, commissions and administrations have been leading cause of lack of budget to develop the country and also to address public problems such as biological and physical requirements. Nepal has been facing political instability for a long which leads uncertainty of implementation of plan. Developmental plans are not completed and developmental budget has not been spending for a long in each fiscal year due to political structure, instability and ambiguity of responsibilities is one of the key reasons of developmental stagnation.

Enormous Number of Bureaucrats & Civil Servants:

Bureaucratic management for public services is also randomly organized. Public services in health, education, social services, agriculture, and security, financial and for facilitate to business and industries are significant but, there are over recruitment on administration. Unskilled and unnecessary recruitment is heighted financial weight to a state (Ghimire, 2024). About 1, 39,000 civil servants' posts have been created. Use of modern technology can minimize the number of staff in communication, security and administration. Road light can be used to control traffics but it is not considered. Each ministries have unnecessary staff in departments, unites, centers and divisions. These are also avoidable. Unnecessary ministries are also established. The ministry of health & population, ministry of youth & sports, ministry of women children & senior citizen and ministry of labor employment & social security can be included within the ministry of social welfare. Only division of each will be sufficient to perform their responsibilities. Furthermore, the human resources in the branches, divisions, departments, centers and unites of the ministries have added the burden to the state. There are department, center, unite, division in various levels under the ministry of Agricultural but the outcome of that production and real service to producers are tiny according to expenditure. Administrative works are complicated to follow and to get support of the public services. Dissemination of information is unclear and not reachable to the people of remote areas due to power centralized to distribute budget to get support to start business. Real farmers are out of help and assist therefore they could not escape from poverty generation to generation.

Huge amount of budget goes for salaries and allowances therefore it has been failing to invest in productive fields such as to establish and run industries and to produce basic requirements goods and foods therefore it has been bearing high amount of trade deficit and youths' migration. Nepal's developmental budget for the fiscal year 2024-25 as initially proposed, was NPR 1, 860.3 billion which is decreased by 9% (NBSM, 2024).

Inaccuracy in Collecting Revenue

Development only possible if revenue is collected as maximum as possible logically. Nepal is unable to collect revenue effectively. Huge amount of revenue is not collected by the government such as Nepal lose 57 Rs bilion tax from the telecom Ncell (Shrestha, 2023, Jan 13)

electric bills from industries, import tax, sale tax, export and import tax, rent from market places and so on. It is said, up to 70% tax in the border has not been collected. The commitment to collect revenue honestly is seemed very fragile.

Development Budget is Insufficient

The proposed budget in 2082/83 is 19 billion, 64 million 11hundrads thousands. 60% budget goes to administrative work, salaries allowances, and facilities to formers, actors and bureaucrats. Only 20% budget is for development 20% for financial managements to return interest and loan. That 20 % developmental budget is also not used honestly and logically within fiscal year. The budget for establishment of business (start up support) is only one million in fiscal year 2081/ 2082. It has limited time to inform. Interested persons could not access information within the given time period if they lived in remote district /areas. The import-to export ratio remains significantly imbalanced, with 88.60% of total trade being imports and only 11.40% exports (The Himalayan times, 22 Feb, 2025). Budget for industries is also insufficient to mitigate trade deficit. Unemployment is remained 10.7 (world Bank 2024) in Nepal. On the one hand unemployment youths roaming without job and leaving the countries to find job in foreign land on the other hand developmental budget is insufficient and the allocated budget is also not spent because the developmental projects are postponed and delayed to complete.

Poor Planning and Delay Implementation/ Completion

Inappropriate developmental Plan is next cause of developmental impediment. Lack of prioritization & assessment of Physical Constructions is noticeable. Lack of prioritization of physical development and lack of honesty in the implementation of constructions are experienced. Nepal has been spending lot of capital for physical constructions borrowing money from international financial institutions but the utility of construction has not been studied and appraised adequately for its usefulness and outcome before construction. One example, a former secretory of ministry of finance told in a seminar about 20 airports are useless after completed. More than 18 billion has been spent for rail ways establishment but it is worthless because the performance for it is not visible according to spending. Residents have no safety roads, no healthy ventilated and safe house to live, children have no safe and facilitated school and library to study, unemployment rate is high due to lack of professional training, education and industries, public have been facing sanitation problem, lack of health services, lack of safe drinking water, foods and shortage of nutritious food to eat but money is spending to build up useless airports, tower and large play hall. Prioritization of infrastructure or physical development is significant for state's progress. By which it is possible to minimize the social problems and prevent further spending such as healthy sanitation and food supply prevent diseases, healthy person works hard and spending in education enable society for moral survive which helps to minimize crimes and insecurity and support to improve indicators to move state upward.

Honesty in Implementation is poor. Piece of example amongst several incomplete projects; The Prime Minister had promised to complete a bridge within two years, the people of Udayapur would be able to cross the bridges between Khotang and Bhojpur by motor vehicle in 2015. However, even after four and a half years, the bridges, whose foundation stones were laid, have not even been completed by 20 percent and are in a state of disrepair (Rai 2018). Timely and properly implementation of developmental plan is

very weak in Nepal. Nepal also fails to spend allocated budget for development each year. In the current fiscal year, 2023/24, the government could not spend Rs 129.44 billion of the amount allocated for development expenditure (Paudel, July 11, 2024). Duplication of various programs and lack of interlink among them is also an obstacle for a progress.

Low quality infrastructure remains state undeveloped because it needs repair and rebuild soon. Which leads shortage of budget due to allocation of budget for same work each year. Quality construction of road, buildings, schools, irrigation canal, water supply, shelters, hospitals, universities, libraries and bridges save the lives and save the money of coming fiscal year. That capital can be used for an advance technology, other developmental projects, social welfare, health services, new invents and other more productive fields.

Corruption, Commission and Spend Unreasonably

Corruption and commission have been practiced. It is a leading cause of stagnation of progress of Nepal. Transparency International's 2024 Corruption Perceptions Index gave Nepal a score of 35 (Transparency International, 2024). Which scored 180 countries on a scale from highly corrupted 0 to hundred is very clean. It is indicated one of the corrupted countries. The budget is not spending prudently reasonably and profitably. Corruption and commission are substantial for progress retardation of the country. National wealth reach to individual due to corruption and that individual spend unreasonably for fulfilment of their unlimited desires (Ghimire, 2018). That leads scarcity of fund for require fields. A sub-committee under the Public Accounts Committee of the Parliament has prepared a report that there is at least 10 billion rupees of corruption in the Pokhara Regional International Airport (Mahara, 2025, Apr.27).

Unlimited facilities of formers officers, leaders/ national actors without evaluation of income is in practiced. The budget for security, living cost and other facilities of former very important persons have been spending without evaluating income and economic status. Social expenditures are also distributed without appraising income sources and without evaluating economic status. 'Social expenditures are provided by the state to those who find themselves in adverse circumstances; unemployed, elderly, poor and disabled, (O'Neil, 2007, P. 81). Allowances distributes without evaluating economic situation encourage to spend unreasonable. Norms and values of democracy is not followed therefore election is very costly recent year which force leaders to collect wealth involving in immoral activities. Public properties are privatized by power holders misusing power instead of use for public benefits like industries, agricultural farms, agricultural experiment and training center, park, training center, playground and plantation to produce fruits and wood.

Unproductive Education /Capital Outflow

Practicable education and useful training are productive. education always fulfil demand of national human resources but in Nepal parents spend huge amount of family fund, students spend long time and energy, the result of expenditure in education is seemed unemployment, poverty, no job available according to their academic qualification, due to that student are compelled to bear frustration then leave the country for find job to foreign land. Useless education increases unemployment and poverty.

Investment for education in foreign countries is another cause of capital outflow from the country. Huge amount of capital of Nepal is being spent to

be educated in foreign land. Nepalese students have spent nearly Rs 56.83 billion rupees on foreign education in the first six months of the current fiscal years (Edusanjal, 4 Feb, 2025). Outflow of the capital for foreign education is increasing every month. Ghimire (2024a) discusses contemporary instances of illicit financial activities, including illegal transactions through Currency Smuggling, Hundi, and the involvement of banks and business entities in illegal capital flights from Nepal to abroad.

Health Status and Aboard Treatment

Nepalis have been suffered by strange nervous system diseases, heart diseases and cancer in vital organs brain, liver bile duct, adrenal gland foreign ant pancreases. Non-communicable disease (NCDs) is rapidly increasing. It is increased by more than 70%. Family who has possibilities to uplift medium class to upper medium and upper medium to rich classes (businessman, owner of industries, other economically raising families, leaders) have been spending enormous amount of money to get treatment of strange new form of non- communicable diseases, nerve diseases, vital organ's diseases in foreign countries specially in India. Non-communicable diseases pose a significant health burden in Nepal according for substantial portion of death and outpatient care. A recent study indicates that NCDs are responsible for 60% of all deaths in Nepal (National Health Research Council, Nepal, 2020). Health problem and health status is one of the leading causes of poverty in Nepal. Nepal NCDI Poverty Commission analyzed the state of NCDs and injuries in Nepal reports that the burden of NCDs and injuries in terms of disability and death in Nepal has more than doubled over the past 25 years (Nepal Health Research Council, 2018).

Inappropriate Policy and Lack of Commitment in Implementation

Only an applicable, functional, appropriate implementable and strong policy for development uplifts nation. The policy for educations, health services, social benefits, physical development, agricultural production, establishment of industries, policy for international trade and foreign policy are not supporting to move state forward. Political parties are providing responsibilities and distributing power and authority to an incapable, non-export persons instead of persons who are capable to understand the root of the problems of the society and committed to address national and social problems. The evaluation system of professionals and bureaucrats is not seeming impartial and reasonable. Encouragement and award to good performants is aso questionable. Therefore, they are not able to perform their job's responsibilities accurately, adequately, efficiently and honestly. Inappropriate fiscal policy, unproductive spending, irresponsible spending, lack of accountability, imbalance distributions of budget, misuse of power are other barriers of state retardation in developing for long about 54 years. Nepal is unable to exist from the gray list and European black list for more than 10 years. Which has been influencing tourist business in Nepal. Tourism is a potential part for economic growth but prerequisites for that has not been considered and managed. Policy for exist from gray list and black list is not proposed yet.

Development depends on ability and commitment of leaders and bureaucrats. Problem of empowerment and inclusion, cooperation and collaboration, coherent and integration among different developmental institutions, unites, departments fields is also a noticeable in Nepal's governance system such as among local government, provincial government, federal

government, among different developmental and social welfare ministries, professional organizations and other social institutions. Capacity of local leaders to lead according to interest of people and goals of constitution is seemed not a competitive in some cases. The success of local level panning depends upon the complementary action taken by the local, regional, and national agencies, non-governmental organizations, civil society and local level beneficiaries. Thus, there is a need for developing institutional mechanism and methods through which interaction and coordination can take place (Rijal, 2011, p100).

Mentality of leader is seemed they have desire to have praises and credits for the developmental work therefore they distract developmental ideas of opposition. It is listened in discussion; budget is not allocated for important construction and development in the areas where opposition leader is win in the election. Misuse of power is also an obstacle for development.

International Influence for Developmental Impediment

Development of a state is highly influenced by international order, international system, policy, international relations, international interests, allies, intention and other states behavior. Nepal has been facing trade blocked, political interference, market expansion, territorial encroachment (from the south 60 thousand hectors and from the north 60 hectors lands are encroached) , trade deficit, EU black list, resources exploitation (unequal Indo-Nepal hydro agreements) low compensation of land for construction of hydro projects on borders of three rivers Koshi, Gandaki and Karnali, and the flooding by the constructions of the projects have been damaging of cultivated lands, residentials areas and losing of people, properties and animals each year.

Leaders have been facing life threatening situation. History is very scary due to assassination of royal family, doubtful assassination of political leaders. Youths' migration is augmenting due to lack of opportunities in the country and foreign country's attractive policy like offer for study, work and diversity Visa program. Nepal is highly vulnerable country to save life and resources due to direct & indirect, ground and underground international activities. Generally, international activities and issues to disturb state development are interference in internal affairs, mental pressure, assassination of idealistic and patriotic leaders/actors', disunite society, resources exploitation, border encroachment or disputes, border insecurity, human trafficking, drug Trafficking, illegal immigration/ immigration, transnational crime, settlements of refugees, trade blocked, financial crime, cyber-crime, support of rebels/ terrorists and international support to anti-government movement. Most of these influences and interferences have been faced by Nepal.

Possibilities of Promotion of Nepal

Nepal has naturally strong position to be developed. These are population, working population 15 to 64 age group is 78.2% (World Health Organization, 2023), natural resources (airable land, water), climate, natural sceneries, cultural and religious heritages and forest. Instead of all these potentialities for development, Nepal has been a least developed country listed by UN for about 54 years. Many other countries have changed their position from least developed to developing countries for example Botswana (1994), Cabo Verde (2007), Maldives (2011), Bhutan (2023) (UN,2023) and other too. Development is a process of positive change in health, economic, physical development, security and environment through collecting capital honestly, distributing it prudently making policy

effectively. Affordable political structure, and bureaucratic arrangement, economic growth, security, quality affordable health services and quality education promotes state's position. Furthermore, the position can be promoted by delivery of better services, procedural transparency, prevention corruption, working and formatting policy genuinely and a commitment of implementation of all plans on time. Countries are eligible to enter or leave the LDC category if they meet the defined inclusion or graduation thresholds of the criteria (UN) or indicators (economic, social and others). Almost all above mentioned reasons are amendable to elevate social and economic indicators for promotion of Nepal least developed to developing country?

Consequences of Developmental Impediment is influence on national Identity, security, conflict, instability, immorality/ corruption, foreign interference and dignity of residents. The responsibility of national advancement is of all sectors and levels authorized or unauthorized power, professionals, stakeholders, and civilians for their own dignity and security.

Conclusion

Nepal has been failing to collect revenue adequately. Distribute of the budget is not productive. Nor Nepal able to make policy genuinely in all developmental sectors neither implement plan satisfactory on time. Delayed and low-quality constructions sluggish the development.

It has failed to prevent corruption, outflow of capital and human resources. The country has been failing to utilize capital in productive fields such as education, health, quality beneficial physical development, organic productions sufficiently, establishment of industries and security (food, road, control of crime, human trafficking) effectively. Huge amount of budget has been allocating to non-profitable sectors such as administrative sectors, benefits and allowances. Consequently, the country is compelled to bear high debit and its interest, high trade deficit, development sluggishness, unemployment and poverty. It is remaining as a key cause of other serious non- traditional problems.

There is high potentiality to achieve national interests and enhance its position. These are natural resources and human resources, if they utilized resources prudently, farsightedly, reasonably and honestly. The vision for improvement, ability, independency and commitment of responsible authority are significant to move state forward from least developed to developing countries. The position of Nepal in international arena can be augmented through visionary leadership, organize affordable political structure and bureaucracy reasonably, collection of revenue correctly legitimately, prioritization of physical constructions, quality physical development, quality, applicable and productive professional education, investment to quality health services, emphasis on agricultural production, produce and supply healthy & organic foods, prevent capital outflow, control corruption, stop misuse of capital and human resources, prevent crime, border demarcation, control unhealthy production and trade and through responsible spending, distribution of budget rationally and introduce essential technologies.

Nepal has been bearing time to time ethnic, religious and regional conflicts. Which can worsen the situation of development of Nepal. Nepal is in vulnerable position for ethnic, religious, class and regional conflicts. Conflict due to such divided mentality is difficult to exterminate. Exercise of inclusion, justice, independency and equality opportunity can

prevent such conflicts. Maintain of border security and clear demarcation of border are other key functions of Nepal to prevent encroachment of territory and prevent the border crimes. Most of the reasons of impediment of development of Nepal is amendable. Some international reasons, pandemic and natural disaster are manageable.

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Post-Retirement Challenges: A Study of Gurkha's Families

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Abstract

This article explores the difficulties faced by retired Singapore Gurkhas and their families when they return to Nepal after many years of service abroad. Unlike British or Indian Gurkhas, this study focuses only on those who served in Singapore. It provides background information about the Gurkhas and collects data through interviews and other sources. The study highlights the emotional, social, and practical challenges experienced by the retirees and their families. It emphasizes the need for policies and support systems to help them live a dignified and comfortable life after retirement.

Keywords—Retirement, Gurkhas, Sugauli Treaty, Khukuri and Reintegration

Introduction

This article examines the multifaceted challenges faced by retired Singapore Gurkhas as they reintegrate into Nepali society after prolonged service abroad. It highlights the issues related to social adjustment, economic stability, and access to support systems. The Gurkhas are respected soldiers from Nepal known for their bravery and loyalty. They have served in the British and Indian armed forces for more than 200 years. Famous for their motto, "Better to die than be a coward," and their traditional curved knife called the Khukuri, Gurkhas have played important roles in major conflicts like both World Wars and continue to take part in peacekeeping missions worldwide (BBC, 2010). Their service started after the Sugauli Treaty of 1816, which allowed them to join the British Indian Army. After India gained independence in 1947, an agreement between Britain, India, and Nepal ensured the continuation of Gurkha regiments in both countries. The British also deployed Gurkhas to other regions such as Singapore, Malaysia, and Hong Kong (Low, 2015).

One important example of their contribution is the Singapore Gurkha Contingent, which was formed in 1949 as part of the Singapore Police Force. These Gurkhas protect key government buildings and the homes of top officials. They serve as a paramilitary force to help maintain internal security, with around 1,850 officers. Since Singapore's independence, the Gurkhas have played a crucial role in keeping peace and security in the region, while continuing their proud military traditions (Gurung, 2021).

Despite their dedicated service, Gurkhas from both the British Army and Singapore Police face several difficulties after retirement. These include problems with pension payments, limited access to healthcare, family separation, and challenges reintegrating into Nepali society. Singapore Gurkhas, in particular, struggle with limited citizenship and residency rights after serving for 27 years. British Gurkhas have citizenship but face ongoing issues with their pensions. This research focuses on these post-retirement problems and highlights the need for fair policies and support for these veteran soldiers and their families. Gurkha soldiers have served bravely in the British and Indian armies for over 200 years (Adhikari et al., 2013). However, many face serious problems after retirement, such as money issues, trouble adjusting to society, mental health struggles, and pension or citizenship disputes. This research highlights these challenges to raise awareness among policymakers and the public. It aims to help improve support, policies, and welfare programs for retired Gurkhas (Gurung, 2021).

Methods

The study employed a qualitative approach using a descriptive method. Research was conducted in Imadol, involving 10 retired Singapore Gurkhas, 5 Lahurenis (wives of retirees), and 4 children of the retirees. Interviews were carried out respectfully and in accordance with ethical guidelines. The researcher used purposive and convenience sampling to choose participants, since only a small number of retired Singapore Gurkhas live in Nepal. Because the researcher had easy access to them, this method made it simpler to collect data. Interviews were used as the main method to understand the problems faced by the retirees and their families.

Life Course Theory and Gurkha Retirement

Life Course Theory, often referred to as the life course perspective, is a framework used to examine how people's lives are shaped over time by their experiences, societal structures, and historical events. Widely applied in social sciences, it emphasizes the connection between an individual's personal journey and the larger social and economic environment they live in. Rather than viewing life as a fixed sequence of stages, this theory highlights the variety and timing of life events that people encounter, recognizing that each person's path is unique. This approach differs from the concept of the "life span," which focuses more on biological aging and tends to remain consistent across generations (Giele & Elder , 1998).

When we apply this theory to the Gurkhas, it offers valuable insight into their lives before, during, and after military service. Typically raised in the hill regions of Nepal, Gurkhas grow up within strong cultural and disciplinary traditions. They undergo highly competitive recruitment processes to join either the British Army or the Singapore Police. Once selected, they dedicate many years to disciplined service, often gaining recognition for bravery and commitment. However, the end of their service brings different outcomes. British Gurkhas may resettle in the UK, while Singapore Gurkhas are required to return to Nepal. These transitions, shaped by broader historical and policy contexts, can greatly influence their identity and adjustment process after retirement (Glen Holl. Elder, 1994).

Life Course Theory also shows how early life conditions and institutional decisions impact later stages. Many Gurkhas join the military with limited formal education, leaving them with few job opportunities post-retirement. Pension policies have historically been unequal—

especially for those who retired before 1997—resulting in financial insecurity for many. Prolonged periods away from family contribute to emotional strain and difficulty in reintegrating into society (Dannefer, 2003). While some British Gurkhas settling in the UK struggle with language barriers and employment, Singapore Gurkhas returning to Nepal often face reverse culture shock, finding it difficult to adapt after decades in a highly structured environment. These varied outcomes illustrate how personal adaptation in later life is deeply influenced by earlier life experiences and the availability of support systems (Settersten & Falletta , 2005).

Post-retirement Challenges

One of the most pressing issues for retired Gurkhas, particularly those from Singapore, is pension inequality. While British Gurkhas are allowed to settle in the UK after retirement, Singapore Gurkhas are required to return to Nepal, where securing stable employment is often a challenge. Many attempt to open small businesses or migrate to other countries, but these options are difficult due to high financial costs and limited access to resources (Subedi, 2019).

Equally concerning is the transition from military to civilian life. After spending decades in disciplined and confined barrack environments, especially in Singapore, many Gurkhas experience reverse culture shock upon returning to Nepal. They often struggle to reconnect with family and adapt to the economic and social realities of their home country. This sudden loss of social status and identity associated with military service can lead to emotional distress and confusion (Gurung & Jones, 2020; Thapa, 2019). Moreover, the contractual nature of service for Singapore Gurkhas prevents them from pursuing legal avenues to claim retirement benefits, unlike their British counterparts. Though some advocacy groups are pushing for better post-retirement support, meaningful policy reforms have yet to be realized (Limbu, 2020).

Repatriation Policy and Citizenship Rights

Unlike British Gurkhas, Singapore Gurkhas are subject to the repatriation policy, which requires that once they end their service, they go back to Nepal regardless of the time spent in Singapore. The approach starkly contrasts with that of other foreign workers in Singapore, usually allowed to stay if long-term relationships have been established with the country. Retired Singapore Gurkhas have no similar right to permanent residence or citizenship, and after decades spent abroad, they encounter problems of reintegration into Nepalese society (K.C., 2019).

The repatriation policy and lack of residency options for retirees benefit the Singaporean Gurkha Contingent carriers to develop many cases of helplessness in the obtainability of dissipated resources through outlasted years of service. Although the Singapore government has slightly reached the Gurkha Contingent by bringing welfare programs for active troops offers extended support to no retired Gurkhas. This policy enhances the economic insecurity that these retirees face, with many of them currently in a situation of finding no means of subsistence for themselves and their families upon their return to Nepal.

Healthcare Challenges for Retired Gurkhas

Many retired Gurkhas face healthcare challenges, mainly due to the extremely demanding nature of their military service. Upon their return to Nepal, Singaporean Gurkhas have limited access to healthcare and rely on costly private care services (Gautam & Adhikari, 2021).

Evaluation of the Policy

The post-retirement healthcare needs of Gurkhas received little attention from either Singapore.

Singaporean Gurkha finds themselves terribly short of health services in Nepal. Quite a huge gap exists between the coverage offered to aging veterans that solicit ongoing treatment services for injuries sustained or other conditions due to active service.

Advocacy Rights and Benefits

Singapore Gurkhas demanded greater recognition for their sacrifices and a life beyond military service with dignity. Nonetheless, most advocacy activities have tended to be reactive, whereas legal assistance has not always done much to address the basic issues (Parker, 2015; Limbu, 2020).

Policy Evaluation

Due to the lack of any reliable proactive amendments by the Singapore Gurkhas, many still found their remaining existence difficult. Other than legal reform being long and tedious, the voices of Gurkha veterans remain unheard in policymaking processes.

Experiences of Reintegration

The retired Gurkhas must return to their Homeland after their 27 years of service in Singapore. Not only must they, their families join them. The children of Gurkhas aren't given the right to live in their 'Birth Country'. They must leave Singapore after their fathers' retirement and lead their lives outside Singapore. As Singapore carries along very strict rules and regulations, those who marry a Singaporean are eligible to stay back in Singapore, and those whose jobs are recognized by the Singapore Government are also eligible to stay back in Singapore. However, they are seen rarely.

According to a respondent (a retired Singapore Gurkha),

> *After 27 years of service in Singapore, returning to Nepal feels both familiar and foreign. There is pride in having served honorably,* having *earned respect, pensions, and experiences that few back home can understand. But reintegration is not as simple as we think. The pace of life is slower here in Nepal. The skills honed in military life, discipline, leadership, and tactical operations don't directly translate into the civilian world. In Singapore, we were part of something bigger, respected, and needed. In Singapore, rules and systems worked. In Nepal, bureaucracy and inconsistency are frustrating. All in all, we feel unwanted here, and also we still aren't able to showcase our skills that we've accumulated from a foreign land*.

According to another respondent (a wife of retired Gurkhas),

> *As the wife of a Gurkha (military personnel), life has always been one of waiting. We are to manage the household, raise the children, and maintain ties with the community. The return to Nepal after 27 years feels permanently feels like a reunion to our roots, but also an adjustment. There can also be emotional distance. We leave some of our close friends behind. As we are prohibited from working beyond the close camp in Singapore, living with the military families and cutting off almost totally with the motherland, and again reintegrating back seems like a shift in life with unknown people being the closest ones. We are solely dependent on our husbands. We once left Nepal to live in Singapore and left Singapore to live in Nepal. With retirement comes a more settled family life. They dream of traveling together, building a home, or engaging in community service*.

Loss of Identity

For many children of Gurkha soldiers, born and raised in Singapore, the return to Nepal after their father's retirement is not just a change of location, it is a loss of identity. In Singapore, they grew up in a country that spoke fluent English, and followed a different education system and social environment. They are tied to Singaporean parks, schools, food courts, and friendships. Even though they were never eligible for Singaporean citizenship, they felt emotionally and culturally rooted there as they were born and raised there. But once their father's service ends, they are to leave Singapore. In Nepal, these children often feel different. Their accents, clothes, behavior, and even their values seem different. They are sometimes labeled as "foreign-returned," or "Badeshi," misunderstood by their friends, or even teased for their different ways of speaking or thinking. They often carry a dual identity crisis, not Singaporean enough to stay in Singapore and not Nepali enough to fully feel at home in Nepal. Some try hard to adapt to the Nepali language, changing their dress, hiding their Singaporean habits. Others hold on to their old identity, staying quiet, isolated, or spending time online reconnecting with Singaporean culture. For these children, the journey is deeply personal. While their parents may see the return to Nepal as coming back to their roots, for the children, it often feels like a disconnection from everything that made them feel like themselves.

According to the respondent (a child of a retired Gurkha),

> *I was born in Singapore, but I'm not Singaporean. Now I live in Nepal, but I don't fully feel Nepali either. So who am I, really? I* didn't *know how to read or write in Nepali when I arrived. I struggled to make friends. I missed my school, my teachers, and my home in Singapore. It felt like someone had erased my world overnight. It's like being homesick for a home that doesn't want you.*

Lack of Career Continuity

One of the most challenging transitions for retired Singapore Gurkhas is the abrupt halt in their professional identity. In Singapore, they served in an elite police force. Their lives were structured. They held positions of authority, followed clear chains of command, and earned steady, dignified incomes. But once their service ends, usually around the age of 45, they face a harsh reality back home: there is no system in place to continue their careers in Nepal**.** Despite decades of experience in security, logistics, discipline, and crisis management, they often find that their skills don't translate easily into Nepal's job market. Many apply for jobs in private security firms, embassies, or international NGOs, but competition is high, age becomes a barrier, and the pay is often a fraction of what they used to earn. The lack of career continuity often leads to a loss of identity, self-worth, and purpose. There's also frustration in seeing other international veterans say, retired British Gurkhas receiving pensions, support programs, and structured reintegration pathways. Many Singapore Gurkha retirees feel forgotten by both governments. Some attempt to start small businesses or community projects, while others rely on their pensions and focus on family.

According to a retired Singapore Gurkha,

> *For 27 years, I served Singapore with pride and* discipline. *But after retiring and returning to Nepal, I felt forgotten—just a man with memories. I tried to stay active and even start a business, but age and a broken system made it nearly impossible. We received no support, no guidance—our value seemed to end with our service. Some of us work for our communities, others migrate*

abroad. Whether in Nepal or elsewhere, we continue to serve. That's who we are—even during the 2072 earthquake and recent floods, we gave our best.

Economic Disruption

Returning to Nepal marks a major financial shift for many retired Singapore Gurkhas. In Singapore, life was stable—salaries were reliable, living costs manageable, and services efficient. However, back in Nepal, despite having some savings and pension, they face unexpected expenses. Building homes, educating children, and accessing healthcare prove costly and unpredictable. Inflation, corruption, and weak financial systems complicate planning, and investments offer poor returns. Socially, they're often viewed as wealthy returnees, leading to added pressure and constant financial requests. While some adapt by starting small businesses or helping in communities, others live cautiously on savings. According to a respondent (a retired Gurkha) :

I returned to Nepal expecting financial security, but the economy here is unpredictable. Despite having a pension and savings, costs are higher, and money doesn't go as far as it did in Singapore. There's no clear structure or accountability—expenses rise quickly with little return. Children's education is especially costly, as many pursue A Levels to match their Singaporean schooling, and few can afford to continue to university.

Education Disruption

For the children of retired Singapore Gurkhas, returning to Nepal doesn't just mean changing homes, it often means a complete break in their education. Raised in Singapore's structured, internationally recognized education system, these children are used to modern facilities, student-centered learning, fluent English instruction, and a well-paced curriculum. They develop critical thinking skills, creative expression, and digital literacy from an early age. But when their father retires and the family relocates to Nepal, they are into an entirely different system, often with outdated syllabi, memorization methods (theory-based rather than practical), a different academic calendar, and limited resources. Many feel a language barrier, are socially isolated, and experience a loss of confidence. According to the respondent (a child of a retired Gurkha), he is facing challenges in adjusting to school in Nepal. He says:

I did well in school in Singapore because I knew the language and system. But in Nepal, I struggled a lot—especially with reading and *writing Nepali. I was lucky not to have to study Nepali because of my O Levels, but my sister, who is in grade 9, has a hard time with Nepali and social studies, even with a tutor. Our accent makes it difficult to communicate with teachers and classmates. Sometimes, I couldn't understand what the teacher was saying. Though I was a good student before, now I just focus on getting through each day.*

Rebuilding Social Connections

For the wives of Gurkha soldiers, the return to Nepal is a bittersweet homecoming. While their husbands served in uniform, these women built quiet but deeply rooted lives in Singapore, raising children, managing homes, forming close friendships within the tight-knit Gurkha quarters, and contributing meaningfully to the social fabric of their small expatriate community. Though most of them weren't formally employed due to visa restrictions, they filled their days with purpose parenting, volunteering in community events, attending temple gatherings, organizing women's circles, and supporting one another like extended family. But with retirement comes

departure. And with departure comes loss**,** not just of a place, but of people. After retirement, women face a triple challenge, like rebuilding social connections in a community that may not understand their lifestyle or mindset. Adapting to a slower, less structured life after years of an organized routine. Wrestling with an urge to do something meaningful after decades of being seen only as a homemaker. Some take up local entrepreneurship, starting home-based businesses or small shops. Others get involved in social work or women's cooperatives. According to the respondent (a wife of a retired Gurkha), she is feeling disconnected after returning to Nepal and says:

> *In Singapore, I didn't have a job, but I had a life—friends, routines, and a close community. Now in Nepal, my homeland feels unfamiliar and lonely. I miss the support of my friends and the simple moments we shared. Though I was busy without working in Singapore, here the days feel long and empty. I want to feel useful again—maybe start a business or learn something new. Some of us are slowly reconnecting in Nepal, meeting at gatherings and trying to rebuild that sense of community.*

Citizenship and Legal Status

Children of Gurkha soldiers serving in Singapore are born in the country, live there for most of their childhood, and are often more fluent in English than in Nepali. However, they do not receive Singaporean citizenship or permanent residency**,** no matter how long they live there. This is because their fathers are on special employment contracts, and their status in Singapore is tied to their fathers' service in the Gurkha Contingent. Once their father retires, the entire family, including children born and raised there, must leave the country. Gurkha families are excluded from applying for permanent residency or citizenship, even though they may have spent decades in Singapore. Some children describe the experience as one of statelessness, while they may legally hold Nepali citizenship, emotionally and culturally, they feel dislocated. They often struggle to fit into Nepali society and carry a sense of loss and confusion well into their teenage or adult years. Many children of Gurkha retirees carry a deep sense of injustice for themselves, but for their fathers, who served Singapore loyally for decades. They feel that their family's sacrifice is not fully acknowledged by the system that benefited from their service. According to a respondent (a child of a retired Gurkha):

> *I was born in Singapore. I went to school there. My childhood was there. But when my father retired, I had to leave because I'm* not *a citizen. I never really understood how you could grow up in a place and still not belong to it. In Nepal, they say I'm from Singapore. In Singapore, they say I'm Nepali. So, where do I really belong? My father risked his life for Singapore. He stood guard, wore the uniform with pride. And still, they wouldn't let me stay the child he raised while serving their country*.

Discussion

The return of retired Gurkhas and their families from Singapore to Nepal marks a significant transition not only geographically, but also emotionally, socially, and psychologically. While it is often perceived as a proud homecoming, it is in fact a journey filled with unexpected struggles. Behind the respectable image of disciplined soldiers and financially secure returnees lies a reality marked by disconnection and displacement. Returning to Nepal after 27 years in Singapore is more than a change in location, it is a shift in culture. While many Gurkhas return with pensions and savings, these financial

resources are not enough to sustain a life in Nepal. The cost of building a new home, educating children, and adapting to a new lifestyle in a more expensive Nepal can drain resources. Also, without career continuity, retired soldiers often find themselves with limited opportunities. Wives, having spent decades without employment, often feel the urge to contribute economically but lack the experience, confidence, or support to do so. Meanwhile, the rising expectations of children's education and lifestyle also put additional stress on the family. The career of a Gurkha soldier ends with retirement, but purpose does not retire. Many former soldiers crave a sense of usefulness, leadership, or community contribution. However, a lack of pathways for reintegration into local industries, governance, or civil society leaves them feeling unproductive. Many Gurkhas and their families find themselves out of sync with local norms, values, and ways of life. In Singapore, they lived in a clean, organized, and relatively egalitarian environment with access to modern services and a tight-knit Gurkha community. Back in Nepal, they often feel disconnected from both rural and urban societies. They are perceived as "foreign" in their own land, leading to social isolation. Perhaps one of the most invisible yet damaging challenges is the mental health toll on Gurkha families. Depression, anxiety, and restlessness are common, though rarely talked about due to stigma. Wives experience loneliness after leaving behind their support networks in Singapore and often feel emotionally isolated in communities where they lack peers. Children, especially those born in Singapore, face identity crises and adjustment anxiety**,** struggling to adapt to an unfamiliar society that expects them to blend in immediately. For children raised in Singapore's world-class education system, moving to Nepal presents a major educational setback. They transition from progressive, student-centered learning environments to often under-resourced, rigid, and language-divided schools in Nepal.

Although ethnically Nepali, many children born abroad speak limited Nepali. Upon returning, they face a language barrier struggle in school, unable to express themselves fluently, and often excluded socially. Even wives, who may have become more comfortable with English or a Singaporean lifestyle, find it difficult to re-engage with local dialects and social codes. One of the most painful aspects of the return is the loss of deep, emotionally intimate friendships that were formed in Singapore. In Gurkha quarters, women formed sisterhoods, families supported each other, and children played in safe, multicultural communities. Back in Nepal, many retirees and their families feel like outsiders even in their own extended families or hometowns. The return of Gurkha families to Nepal is often celebrated with pride and respect, but beneath the surface lies a broad area of unspoken challenges. From mental health struggles to educational derailments, from economic uncertainty to identity loss, and lack of government support, this transition is a deeply human experience that deserves attention, empathy, and support.

The challenges faced by retired Gurkha families can be meaningfully understood through the lens of Life Course Theory, which emphasizes how individual life is shaped by historical context, social structures, transitions, and personal choices. Life Course Theory highlights key principles: timing of events, linked lives, agency, and historical time/place, all of which are related to the experiences of Gurkha families (Glen H. Elder, 1994). After serving for over two decades in a foreign land, retired Gurkhas return to Nepal during middle or late adulthood. Their spouses, who lived as dependents for years without formal work, face an abrupt shift in roles. The linked

lives principle is especially visible in the children's experience. Although the father's employment path shaped the family's migration and lifestyle, children born in Singapore must detach from their social and cultural surroundings due to institutional policies. Their life path is significantly influenced not by their own decisions, but by their father's retirement.

The theory's focus on historical time and place also shows how Gurkha families' lives in globalized, disciplined institutions like the Singapore Police Force, only to return to a Nepal with weaker welfare structures. This shift from high-structure to low-structure environments creates an unsettling contrast, affecting their ability to maintain continuity across life stages. The theory emphasizes human agency. The Gurkha families' ability to act on their goals is limited by state policies, lack of support systems, and social norms.

Conclusion

Gurkhas are known worldwide for their bravery, discipline, and loyalty, serving in foreign lands for over 200 years. Whether under the British Army or Singapore Police, they have earned great respect. But when they return to Nepal, many face a difficult and lonely reality. After years of honorable service, they come back to a country with little support—no proper programs to help them adjust, no counseling, and few job opportunities. This sudden change from a structured military life to an unsupported civilian life often leaves them feeling forgotten. Their families also struggle. Wives who gave up careers to support their husbands abroad find it hard to adjust and find meaningful roles in Nepal. Their children, born and raised overseas, face language barriers, identity problems, and challenges fitting into schools and society. Even though some pension reforms have helped British Gurkhas, many still live with financial pressures due to rising costs and limited income. Singapore Gurkhas, who get smaller pensions, face even greater uncertainty. The Nepali government needs to take responsibility by creating better support systems—offering pensions, job training, and mental health care, and educational help for Gurkha families. Gurkhas represent Nepal's pride, and their return should be the start of a respected and supported new life, not the end of their story. Without proper support, many struggle alone to rebuild their lives after service.

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