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Editorial

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This third volume 2024, covers different articles from various disciplines of science and society like economics, sociology, computer studies, management, etc. We hope this volume will contribute to generating new knowledge on management, technology, the economy, and the development processes of society as well as the country. We would like to thank all the experts and reviewers like Mr. Ananda K.C, Mr. Arjun Saud, Dr. Ramesh Chandra Timilsena, Dr. Narayan Prasad Timilsena, Dr. Madan Bista, Dr. Bipin Acharya, Mr. Sarbin Sayami, Dr. Suman Kharel, Dr. Keshab Bashyal, and Dr. Bishnu Gautam.

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Financial Literacy of Women: Insights from Fair-Trade Craft Producers, Kathmandu, Nepal

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Abstract

The study emphasized the critical role of fair trading practices in promoting women's economic empowerment in the handicraft sector of Nepal. This study aims to assess women's financial literacy in fair trade activities led by the Association for Craft Producers. This study is anchored on human capital theory. Methodologically the paper looks at the phenomenon objectively and employs scientific methods to generate knowledge. For this, natural data were gathered through administered selfquestionnaires from 101 employed women involved in fair-trade economic ventures under the association of craft products in Kathmandu Valley including home-based and in-house producers. Descriptive statistical tools, such as frequency distribution, tabulation, percentage, and diagrams were used for data analysis. The finding indicates that financial literacy positively affects economic entrepreneurship, employment opportunities, household decision-making process, and overall women's economic empowerment. This paper has approved the notion of both empowerment and capability approach to development. For women's economic empowerment, the supporting key factors such as entrepreneurship, employment, training, education, family support, and organizational backing can escalate financial literacy and economic empowerment. Acquiring the essential skills, training, knowledge, and support in terms of financial issues enables women to meet their socio-economic needs and increase their capacity. The finding could be very useful to planners, policymakers, and womencentric development practitioners to escalate the financial knowledge and support women's

economic empowerment. This study suggests subsequent researchers to conduct similar issues considering longitudinal studies and comparative studies between rural and urban areas.

Keywords: education, economic empowerment, financial literacy, fair trade, household decision-making

Financial Literacy of Women: Insights from Fair-Trade Craft Producers, Kathmandu, Nepal

Women's empowerment has become a top agenda for development in every country, aiming to build a happy, prosperous, equitable, and inclusive. Empowerment, a central theme was practiced in development discourse since the 1980s, including women, marginalized, and disadvantaged to exercise their rights, accessing to resources, and actively participate in shaping society (Luttrell, et al., 2009). Empowerment has different meanings and dimensions under different socio-political contexts that help to improve people's lives (French & Swain, 2008). However, it is a process of both external and internal change, acquiring practical knowledge, skills, resources, and decision-making power (Uddin, 2019). With access to socio-economic opportunities, women can gain confidence, entitlement, and self-esteem, and their voices are heard in households and society. The role of women, therefore, is indispensable for the overall development of the country, however, all the economic contributions of women have not been accounted for properly. Several factors are affecting women's empowerment.

Financial literacy can also play a key role in promoting women's economic empowerment. Financial literacy helps provide women with the knowledge and skills to effectively manage their finances, guide financial decisions, and improve their economic position (Lee & Huruta, 2022). For women's economic empowerment, financial literacy has strategic value and stimulates the horizon of women's capacity to decide what is right and wrong for their individual and communal life. This paper assesses to

economic empowerment of women who are involved in fair trade practices in association with the
Craft Producers (ACP), a non-profit fair-trade organization situated at Ravi Bhawan, Kathmandu, Nepal.

Since 1940 under the banner of 'alternative trade,' the fair-trade movement was practiced aim to boost the businesses of individuals in impoverished communities in the southern regions by purchasing their products at fair prices. Fairtrade was a trading approach that runs under the philosophy of '*Trade not Aid,*' aiming to elevate economic status and improve the living standards of individuals engaged in the production of goods (Biggs & Lewis, 2009; Maharjan, 2024). The first formal 'fair trade' shop was started in the USA by 1958 (Pinsky et al., 2015). In addition, Oxfam, a non-governmental organization (NGO) launched fair trade in the late 1950s by selling crafts made by Chinese refugees in Europe. Since 1984, ACP has been continuously working respecting the principles of social obligation and business priorities. In Nepal, since the late 1980s, the concept of 'Fair Trade' was introduced under the initiation of Fair-Trade Group Nepal (FTGN), a non-governmental organization founded by seven organizations working in handicraft sectors, Association for Craft Producers (ACP), New Sadle, Manushi, Sana Hastakala, Mahaguthi, Kumbeshwor Technical School, Nepal Leprosy Trust (NLT). These founding organizations thought it necessary to establish separate organizations FTG Nepal as the Federation of Handicraft Association of Nepal (FHAN) and the Federation of Nepalese Chamber of Commerce Industries (FNCCI). The ACP one of the founder members of FTGN has

been working as a non-profit organization based on the craft sector (FTGN, 2016; Maharjan, 2024).

Fair Trade Organization (FTO) engages actively aiming to support small-scale producers and increase awareness by changing the rules and practices of conventional international trade (Boto et al., 2013). The FTO produces traditional crafts like stitching, weaving, felt products, pottery, knitting, and block printing, providing opportunities for women to earn money and encouraging to save and use them properly (Schützeichel, 2019). In addition, ACP offers various services to low-income craft producers, primarily women, including design, technical, management, and marketing training, resulting in regular wages.

Financial literacy implies the ability to get detailed financial information including saving, wealth accumulation, consumption, expenditure, exchange, interest rate, risk, and decisions about financial planning (Rice, 2010; Schützeichel, 2019). It implies a general comprehension of basic concepts and risks, which directly influences financial decisions. Knowledge, behavior, and attitude are three measuring dimensions of financial literacy (Nepal Rastra Bank, 2022a). The basic level of financial literacy includes the minimum knowledge or awareness that every person needs to do financial work in daily life. Even though, today, the global marketplace is increasingly risky and becoming more vulnerable owing to deficiency in knowledge, behavior, attitude, skills, and awareness (Thapa & Nepal, 2015). Financial literacy and entrepreneurial orientation are crucial for women's economic

empowerment, as they enhance their financial well-being and enable them to access financial resources effectively (Desai et al., 2024).

Globally, nearly 2.5 billion people lack banking and financial services, the situation being worse in developing countries. Around 67% of people in South Asian countries are excluded from financial services, and over 1 billion children worldwide live in below the poverty with less than 1 % achieving financial literacy (Nepal Rastra Bank, 2022b). In Nepal, the national financial literacy rate stands at 57.9 %, with mean scoring significantly higher (61.8 %) than women (54.3 %). Similarly, the financial knowledge score of men is higher (56.5 %) than women (38.6 %) (Nepal Rastra Bank, 2022a). The figures indicate a persistent gap in education and awareness, especially regarding women's financial knowledge and inclusion. among people regarding the importance of women's education.

Educating women by giving workforce training, skills, and opportunities can ensure them to be financially independent and they can shift their care work into paid work (Malakar, & Sapkota, 2021a). To be economically independent, women need access to financial resources, omitting the socio-cultural, and legal barriers. Although, the level of financial literacy, globally, is low. The study findings of Lee & Huruta (2022) asserted that local wisdom-based financial literacy is an alternative source to promote women's empowerment in local development. The study finding of Kumari et al. (2020) held in Sri Lanka focuses to the underprivileged, and women reveal a reluctance to access banking and

financial services due to lack of their knowledge. Schützeichel (2019) concludes that urban dwellers have higher financial literacy than rural dwellers in Rawanda. In addition, Hendriks & Hendriks (2019) has focused on financial inclusion as a key building block to increase women's economic empowerment and inclusive growth. The study findings of Choudhary & Jain (2023) highlight that post-training financial behavior has significant impacts on women's economic empowerment and financial inclusion. Postmus et al.(2013) conclude a synergetic relation between financial literacy and economic empowerment. In addition, Kuutol et al. (2024) focused on exploring the nexus including three variables such as financial literacy, financial information consumption, and financial well-being by employing a cross-sectional study design using simple random sampling surveying 663 households of Rural Ghana and concluding significant relationships among the variables.

However, the prior studies focused on women's economic empowerment largely ignore the role of financial literacy. The study conducted by Manrique Morteo et al. (2024) aimed to examine the influence of socio-demographic variables on the financial literacy of adult citizens in Mexico and conclude that, firstly, education is a leading factor in influencing financial literacy followed by income. Therefore, this study aims to assess the financial literacy of women working in fair trade activities led by the Association of Craft Producers in Kathmandu Metropolitan City, Rabhibhawan, Nepal. To assess the women's financial literacy, awareness level on economic activities, financial behavior,

knowledge, and decision-making capacity were taken as an independent variable.

Theoretical Framework

Financial literacy implies internalizing and use of financial knowledge, skills, and aptitude toward investment, saving, mobilization, and making rational choices to improve socioeconomic well-being. In development economics, different theories have logically been argued about financial literacy, women empowerment, awareness, and well-being. The human capital theory was propounded and presented by the economists Gary Becker and Theodore Schultz in 1960 (Ranabhat, 2023). Schultz has argued that learning from experience, on-the-job training, and schooling are vital sources to promote human knowledge and confidence. According to human capital theory, people who make investments in their capacity development for example, acquiring quality education, training and mentoring, and coaching scale up are likely to achieve higher income which in turn gears the socio-economic well-being (Ranabhat, 2023). The individual income is the product of human efficiency or capital. The idea is that human capital makes people more dynamic, creative, productive, and economic, which leads to higher income and investment. The value of human capital theory is widely accepted in the field of human resource management and organizational development to increase employee working efficiency, skill, and knowledge as well as higher production productivity (Wuttaphan, 2017).

Economic empowerment helps to achieve a deserving life for women. Empowerment seeks income for a decent life, good health and well-being, quality education, and inclusive participation in the decision-making process (Sen, 2000/2018). The human capital theory, empowerment, and capability approach jointly argued to investment in skills, training, education, awareness, and capacity building that promote the productive capacity of the laborers (United Nations Development Programme[UNDP], 2004/ 2010). Development is the process of increasing people's happiness aiming to attain a long, healthy, and creative life (Malakar & Sapkota, 2021b). For this, financial literacy is viewed as an indivisible wing of human capital theory and economic development. The empowerment approach including human capital theory asserted that an investment in job training, skill, education, and incentives focusing to individual dignity and financial efficacy will escalate the horizon of financial literacy of the workers.

Methodological Approach

Research philosophy is the gateway point of scientific inquiry that outlines the overall study design. This study views the phenomena assuming objective reality and employs scientific methods to acquire knowledge. This study is entirely based on a survey assessing the status of women's financial literacy. The primary data were gathered using a questionnaire method. The respondents were the women who are working in ACP under the FTG, Nepal including in-house producers and home-based producers. In-house producers who regularly come to the office as

regular staff and get all the facilities like insurance, provident fund, etc. whereas home-based do not need to come regularly, can work from home at their convenience and have to come to the office when there is work order and deprived with some facilities like insurance, provident fund enjoyed by other in-house producers. The working women are ill-defined in terms of knitting and stitching, felt. However, the size of working members in these two fields is relatively larger as compared to the remaining sectors. Therefore, 101 producers including both in-house and home-based involved in ACP were taken as a sample employing a purposive sampling technique. The data were organized, edited, checked, and tabulated using Excel and interpreted by using descriptive statistical measures. To maintain academic ethics, informant consent, minimum similarity index, no harm local norms and culture, and personal security were maintained.

However, this paper is limited to a certain sample size of producers working with one of the founder member organizations called ACP among many member organizations of FTGN.

Result and Discussion

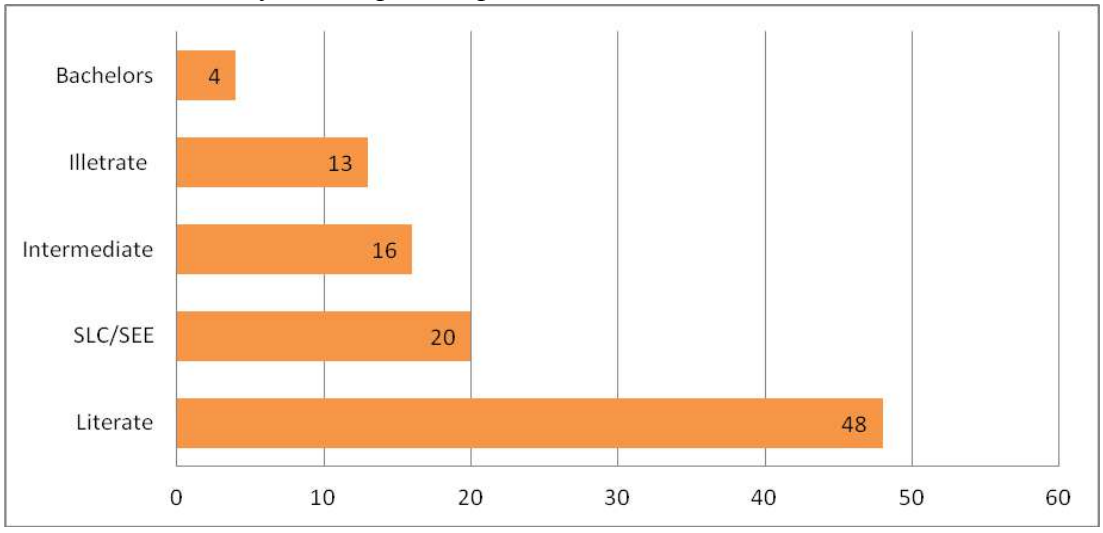
Level of Education

Education is an aggrandizer of human civilization and a source of capital formation. Women's financial literacy is the outcome of literacy and undertaken professions. Women's literacy is a key element of social transformation and economic progress. This study was to examine the level of education that further affects the status of financial literacy in day-

to-day life. Out of 101 respondents, 48 were literate, with 16 studying up to intermediate or +2 level, 20 till secondary level (grade X) and 13 had jobrelated skills but were not able to read or write basic Nepali. The organization in their initial period only gave opportunities to those women who did not have any education as the organization believed those were the women who needed opportunities to prove themselves, they were also able to earn. The level of financial literacy and economic empowerment is significantly higher to those respondents who have higher educational status. The educational level of the respondents is presented in Figure (1).

Figure 1

Educational status of the sampled respondents



Source: Field Survey, 2024

Women's Awareness Level on Daily Economic Activities

Financial literacy does not mean only knowledge of monetary transactions but equally refers to how people respond to their daily purchasing responses. Out of 101, 51 percent of respondents have

frequently asked about purchasing bills while buying different commodities from supermarkets and marts. The overall status of financial knowledge gained by the respondents on different purchasing issues in daily life is presented in Table (1).

Table 1

Level of awareness on different indicators associated to daily buying activities

Statements	**Responses (in %)**	
	Yes	**No**
Recording daily business/household income and expenses and maintained general ledger	28.71	71.29
Issue bill/receipt for any economic transactions	51.49	48.51
Payment of rent, electricity and water bills, children's schools fee, and debts on time	96	4
Role of saving	100	0
Knowledge on how to determine the cost of credit before receiving it	92.08	7.92
Need to avoid high interest rate	80	20

Source: Field Survey, 2024

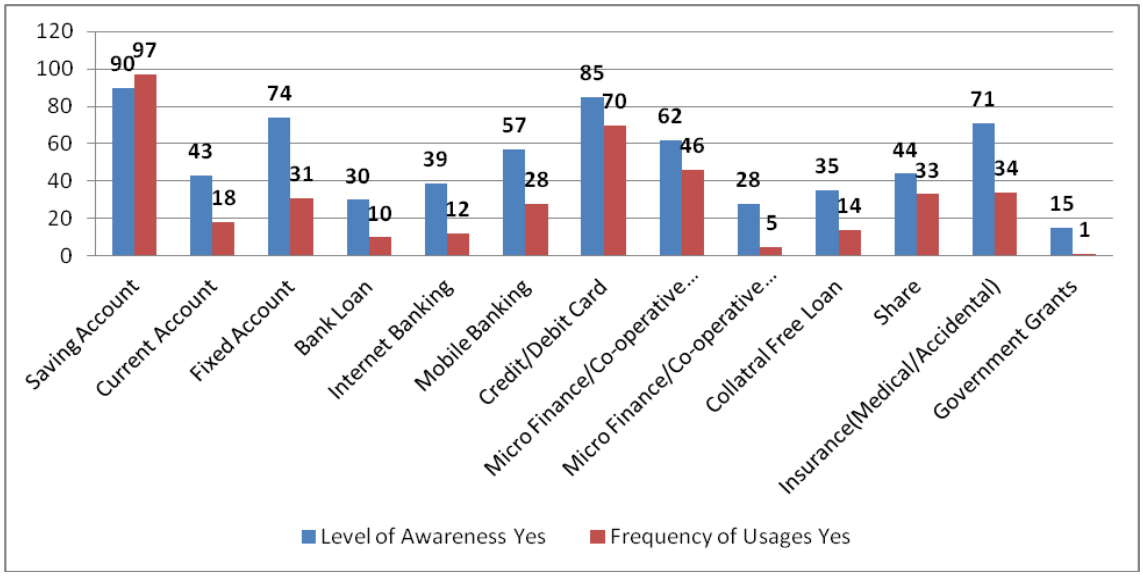
Financial Behavior

To understand the level of financial behavior of women various parameters were set, one of which is the awareness and uses of the financial equipment. The data indicated that women have a high awareness

and use of financial equipment like savings accounts, and credit/debit cards compared to other financial equipment. Out of a total of 101 respondents, 90 individuals reported having awareness of savings accounts, while 97 indicated that they actively use such accounts. Among those who had opened a savings account, 70 respondents were utilizing debit or credit card facilities provided by their banks, despite 85 respondents stating that they were aware of these facilities (Figure 2).

Figure 2

Awareness level and frequency of uses of financial equipment by the respondents



Although producers had opened savings accounts, women's awareness of fixed accounts was high, but usage remained low due to insufficient savings. The use of financial tools such as current accounts,

bank loans, and government grants depended on respondents' needs, leading to fewer women using them. Additionally, the low awareness of these financial tools highlights the lower literacy rates among women. Regarding the awareness of insurance policy, 71 respondents were aware of different types of insurance but only 34 of them have some kind of insurance policy. Out of 13 different measuring indicators, women are highly aware of savings accounts, fixed accounts, use of debit and credit cards as compared to other indicators.

Financial knowledge to save

Income, expenditure, and saving are key variables that are associated to financial empowerment. Saving and its proper mobilization create a conducive environment for further development and capital formation in the economy. Every citizen must have a higher propensity to save what they earn for their better financial security. For this, financial literacy is a ladder whereby ordinary labor forces to high-earning groups save and reinvest in the new sector aiming to generate additional employment opportunities. Savings help individuals become financially independent, reducing dependency on loans and financial aid. It empowers individuals to make decisions based on their preferences rather than financial constraints. Where people save determines the level of financial awareness. Out of 101 sampled respondents, 93 respondents used banks for saving purposes: owing to transfer of the wages or salary by ACP on their respective bank accounts. According to the respondents when they received their salary in cash, they would spend it on the same day or couple of days purchasing goods for themselves and home. Since the

salary had been transferred to their bank account even if they could not top up on savings, they did not use all unless it was very urgent and tried their best to manage using some other means and saved some.

The financial knowledge of the respondents was analyzed based on the ways they used their money. A five-point rating scale was asked to express their opinions ranging from 1 to 5. Considering 1 means 'every time' and 5 means 'never'. The level of knowledge is presented in Table (2).

Table 2

Level of Financial Knowledge on Different Activities (N=101)

Particular/Responses	Every Time	Most Frequently	Sometimes	Often	Never Don't
Analysis of own purchasing capacity	36	43	16	4	2
I feel satisfied when spend all my money	10	16	26	47	2
Pay of bills	91	7	2	1	0
Taking risks on saving and investment	49	24	16	8	4
Allocate a certain amount of received salary/wages to save	40	39	19	3	0 monthly

Source Field Survey, 2024

Table (2) depicts different horizons of respondent's knowledge of different financial activities and taking decisions. 36 respondents replied they did not buy anything randomly and considered every time if they needed the goods or not and if they could afford it. On the same 43 replied that considered most frequently before buying while 4 and 2 respondents replied often didn't and never analyzed and bought what they liked it.

In response to the statement regarding 'satisfaction' while spending money, out of 101, only 10 respondents said that they feel 'very satisfied' every time they spend and enjoy shopping. It means they didn't think about their future security, they get happiness in the short run. Sixteen respondents stated that they feel this way 'most frequently,' while 26 replied that they feel satisfied 'sometimes.' A majority, 47 respondents, did not get satisfaction while spending money, and 2 individuals indicated that they 'never liked to spend.' A key factor contributing to the majority's negative response toward spending is related to their age group and marital status, which likely increases their sense of responsibility toward their families.

On behalf of paying the bills (electricity, water, rent), 91 respondents paid their bills timely. On a statement about the ability to take risks of their investment and savings, nearly 50 percent (49) of respondents feel responsible for themselves every time, 24 respondents responded most frequently, and only 8 and 4 respondents replied often don't and never respectively. Saving is a source to minimize future economic risk.

Accordingly, 40 respondents regularly save some portion of their income; 39 respondents saved most frequently; 19 respondents saved sometimes, and the remaining 3 respondents have no power to save. It means that the women respondents have good tendency to save what they earn to minimize future economic risk and to be economically independent.

Financial Decision-Making Capacity

Decision-making power and capacity determine financial inclusion in households and community life. All sorts of decisions taken at the household level if properly, equally, and inclusively done in terms of expenditure, consumption, saving, risk-bearing issues, and buying properties then women's economic empowerment becomes strong. The women working in fair-trade practices in terms of different small-scale economic ventures are presented in Table (3).

Table 3

Decision-making power of women in different economic activities

Responses	**Frequency [N=101]**	
	Yes	No
Capacity to control over own income	99	2
Participate in financial decisions at the household level	94	7
Ownership of registered business and land property	32	69
Positive responsive made by family members	86	15

Economic empowerment	98	3

Source: Field Survey, 2024

Earning power is crucial for women's economic empowerment. It enables them to be financially capable and can contribute to their household's level decision-making process. Women's economic empowerment refers to the ability of women to have control over their financial resources and to participate fully in the household economy. It encompasses various aspects such as earning power, financial independence, and access to economic opportunities on equal terms with men. Regarding decision-making capabilities over their individual income and involvement in the financial decision-making process, out of 101 respondents, nearly 100 percent (99 respondents) have the power, and capacity to mobilize and manage their income. Similarly, 94 respondents have access to participate in the financial decisionmaking process in their respective households. Out of 101 respondents, only 32 responded to have property and business registered in their name and the majority 69 have registered with the other family members. Financial independence empowers women by reducing dependency on others, allowing them to make choices that align with their interests, and protecting them from financial vulnerability.

Discussion

This paper aims to assess the financial literacy of women working in fair-trade practices and its impact on their economic empowerment. Financial literacy, indeed, provides a better way to enhance women's capacity to mobilize finance for their betterment. Financial literacy and women's economic empowerment are highly associated to each other. This study reveals that women who are financially literate have a higher tendency to save and mobilize money more effectively. This study's findings are consistent with the other several studies (Hendriks & Hendriks, 2019; Postmus et al., 2013; Ranabhat, 2023; Schützeichel 2019) and conclude financial literacy has a positive and significant relation to accelerate the economic empowerment and social well-being of women. Hendriks & Hendriks (2019) conclude that digital financial services contribute to women's economic empowerment, and promote financial inclusion towards progress way to gender equality. Schützeichel (2019) conclude that higher levels of financial literacy will tend to have a higher likelihood of saving thereafter. Financial literacy, according to this study helps to improve women's bargaining power, awareness level to pay bills, and access to household decision-making capacity. In contrast, Lyons & Kass-Hanna (2021) opined that having many efforts there is no widely recognized methodological approach to measure financial literacy. However, the findings of this study are theoretically accepted. The proposed theoretical approaches argued human knowledge, attitude, behavior, skills, and capacity are highly influencing to promotion of women's economic empowerment.

Conclusion

The study reveals that women working in fair trade initiatives enhance their knowledge and awareness on behalf of paying bills, save some portion of income to reduce future risks, and build their capacity to make household-level decisions. The findings of this study demonstrate that financial literacy has a substantial positive impact on women's economic empowerment and daily lifestyle. Employed women who are financially aware have a higher tendency to save to reduce future risks and economic vulnerability. Similarly, women who engage in income-generating activities can acquire both monetary and non-monetary assets, consequently, they can effectively manage their personal lives. This leads to a higher sense of financial security, ownership, and the ability to deploy limited resources rationally for a better future.

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Comparative Analysis of Transformer and CodeBERT for Program Translation

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Abstract

Program translation refers to the technical process of automatically converting the source code of a computer program written in one programming language into an equivalent program in another. This study compares the transformer model and the CodeBERT-based encoder-decoder model on the program translation task. Specifically, it trains the 6 and 12-layer models for 50 and 100 epochs to translate programs written in Java to Python and Python to Java. The models were trained with 3133 sets of Java Python parallel programs. Among different layered models, the transformer model with 6 layers trained for 50 epochs to translate from Java to Python achieved the highest BLEU and CodeBLEU scores, with values of 0.28 and 0.28, respectively. Similarly, the transformer model with 6 layers trained for 100 epochs to translate from Python to Java received the highest BLEU and CodeBLEU scores of 0.39 and 0.40, respectively. These results show that the transformer models perform better than the CodeBERT models. Also, the BLEU and CodeBLEU scores of the Java to Python and Python to Java translation models are different.

Keywords: *Program Translation, Transformer, Code Bidirectional Encoder Representations from Transformers, Bilingual Evaluation Understudy (BLEU), Code Bilingual Evaluation Understudy (CodeBLEU)*

Comparative Analysis of Transformer and CodeBERT for Program Translation

Software applications are computer programs that may become obsolete over time due to a variety of factors, including hardware platform updates, skills shortages in the original programming language in which the application was written, and a lack of software support from the language compiler vendors. As a result, software developers are often required to review software applications implemented in one programming language to a more recent and efficient language. Such reimplementation of any software needs knowledge of both programming languages: one that was used to develop the software and the other that will be used to rewrite the software.

Also, reimplementation is an expensive and time-consuming procedure. A bank in Australia, for example, spent $750 million in 5 years to migrate its core COBOL platform to Java (Lachaux et al., 2020). To reduce the risk and cost associated with code migration, developers often apply the simplest form of software re-engineering approach called program translation. Program translation is the technical process of automatically translating the source code of a computer program written in one language into an equivalent program in another language (Ahmad et al., 2023). Unlike traditional compilers, which translate a program written in a high-level programming language to a lower-level machine code (Java → Bytecode), the program translation system, also called a transcompiler, focuses on translation between high-level programming languages (Zhu et al., 2022).

Traditionally, program translation is performed in a rule-based manner, which involves parsing the input source code, constructing an abstract syntax tree (AST), transforming the AST, and finally generating source code in the target programming language. Given the dataset, the program written in one language can be translated to a

different language without any programmatic intervention by employing a modern machine translation approach like neural machine translation (NMT). NMT is a machine learning approach to automate translation by utilizing neural networks.

As NMT was the recurrent neural network-based encoder-decoder model, this model has issues with long-range dependencies and non-parallelization within training examples. To deal with these issues, a novel transformer model was presented that achieved state-of-the-art on the WMT-14 English-to-German and English-to-French translation tasks and required significantly fewer calculations and less time to train (Vaswani et al., 2017). The transformer-based NMT model can be trained by initializing the model weights to random values. Alternatively, the weights can be initialized by copying them from a previously trained model. This approach is called warmstarting. In the case of the programming language, the encoder-only model, Code Bidirectional Encoder Representations from Transformers (CodeBERT), can be used to warm-start the encoder and decoder of the NMT model.

Problem Statement

As programming languages can be considered as natural languages (Aggarwal et al., 2015), program translation problems can also be viewed as natural language translation problems. Therefore, different natural language translation approaches, such as rulebased, statistical machine translation (SMT), or NMT methods, can be applied to program translation problems. The transformer-based NMT architecture and the pretrained models improve the translation quality. In the case of the pretrained models, the CodeBERT encoders can also be used on the decoder side of the encoder-decoder model to have better output representation. And to reduce the memory usage as well as to reduce the execution time, the weights of encoders can be shared with those of

decoders. The study attempts to provide answers of the following questions, How does encoder decoder model can be trained using parallel program data set?, How to compare different translation models?

Do the Java to Python and Python to Java translation models yield similar scores?

Objectives

- To train the transformer and CodeBERT models on the Java – Python parallel program dataset
- To translate the program written in Java to Python and vice versa using Transformer and CodeBERT
- To compare the performance of the transformer and CodeBERT using BLEU and CodeBLEU as evaluation metrics

Theoretical Background

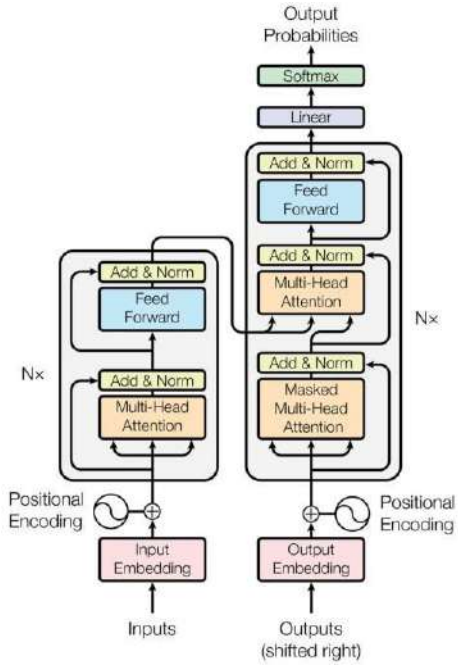
Transformer

A transformer is a deep learning model that utilizes the self-attention mechanism to solve sequence-to-sequence problems while resolving long-range dependencies. It is a type of artificial intelligence model that learns to understand and generate natural language text by analyzing patterns in large amount of text data. Transformers are a current state-of-the-art NLP model and are considered the evolution of the encoderdecoder architecture. This model avoids recurrence and trains the network in parallel to speed up the development of the model with a large number of parameters. Transformers are specially designed to comprehend context and meaning by analyzing

the relationship between different elements, and they rely almost entirely on a mathematical technique called attention. The transformer architecture is shown in

Figure 1.

Transformer Model Architecture (Vaswani et al., 2017)



The model consists of two components: an encoder and a decoder. The encoder reads a sequence of symbol representations $x = (x_1, \ldots, x_n)$ as input and generates a sequence of continuous representations $z = (z_1, \ldots, z_n)$. Given z, the decoder produces a sequence of symbols $(y_1, \ldots, y_m)$ one element at a time (Vaswani et al., 2017).

The encoder block consists of N identical layers stacked on top of each other. Each layer contains two basic sub-layers: a multi-head self-attention mechanism and a positionwise fully connected feed-forward network. The decoder also consists of N identical layers stacked on top of each other. Each layer contains three sub-layers: a

masked multihead attention mechanism, a multi-head attention mechanism, and a position-wise fully connected feed-forward network.

Given the input tokens or the output tokens, the embedding sub-layer generates the vectors of dimensions d_{model} using learned embeddings . The learned linear transformation sublayer projects the vector produced by the stack of decoders to a logits vector, and the softmax function converts the vector to predicted next-token probabilities. Positional encoding add information about the relative or absolute position to input embeddings, positional encoding of dimension d_{model} is computed using sine and cosine functions of different frequencies. An attention function uses a query and a set of keyvalue pairs to calculate an attention. The compatibility function of the query with the corresponding key determines the weight allocated to each value.

CodeBERT

Bidirectional Encoder Representations from Transformers (BERT) is a language representation model based on the transformer architecture. The two types of BERT models based on the model size are BERTBase and BERTLarge. BERTBase has 12 transformer layers, 768 hidden size, 12 attention heads, and 110M trainable parameters, whereas BERTLarge has 24 transformer layers, 1024 hidden size, 16 attention heads, and 340M trainable parameters

The BERT model is designed to pretrain deep bidirectional representation using two tasks:

masked language modeling (MLM) and next sentence prediction (NSP). During training the model, 15% of the tokens are masked, and the correct tokens in the masked positions are predicted using the final hidden state. NSP is used to learn the link between sentence pairs. For NSP, when choosing sentence pair A and B, 50% of the

time it is an arbitrary sentence in the corpus. To predict the correct label and compute loss, the output hidden state is used. The pretrained BERT model can be used to fine-tune the downstream natural language processing tasks (Devlin et al., 2019).

CodeBERT is a bimodal pretrained model based on the transformer architecture for programming languages (PL) and natural language (NL). It learns the semantics connection between Pl and NL and supports downstream NL-PL tasks like natural language code search, code documentation generation, and so on. CodeBERT uses the RoBERTa-base architecture with 125M model parameters (Feng et al., 2020). The CodeBERT is trained on both bimodal data (natural language–code) and unimodal data (code) across six programming languages (Python, Java, JavaScript, PHP, Ruby, and Go) with a hybrid objective function (Feng et al., 2020).

Methodology

Data Collection

A parallel dataset for Java-Python program translation was collected from AVATAR: A Parallel Corpus for Java-Python Program Translation (Ahmad et al., 2023). The dataset contains Java and Python solutions to the programming problems. These solutions were taken from programming contest sites such as Codeforces, Google Code Jam, and online platforms such as GeeksforGeeks, LeetCode, and Project Euler. Hence, 20,363 parallel programs were taken. However, due to resource limitations, the programs having lengths less than 5 and greater than 450 were discarded after cleaning and pretokenization, leading to size 3133. For this study, as mentioned earlier the programs having length less than 5 and greater than 450 were discarded, so after that 3133 parallel program tasks were used for training and testing the model. The details about data can be seen in Table 1.

Table 1

Dataset Description

Source	Java Python Program Counts
Codeforces	1726
GeeksforGeeks	1354
LeetCode	35
Project Euler	18
Total	3133

Out of 3133, 80% (2506) were used for training and the remaining 20% (627) were used as test samples. Sample of the dataset is presented in Figure 2 and Figure 3.

Figure 2

Program written in Java

```
import
java.io.*;
class GfG {
static int
sumOfTheSeries(int
n){ return (n * (n + 1)
/ 2) * (2 * n + 1) / 3;
}
```

```
public static void main (String[] args)
{  int n =
5;
System.
out.prin
tln("Su
m = "+
sumOfT
heSeries
(n));
}}
```

Figure 3

Program in Python of code of program written in Java in Figure 2

```
def
sumOfTheSeries( n ):
return int((n * (n + 1) / 2) *
(2 * n
+ 1) /
3) n =
5
print("Sum =", sumOfTheSeries(n))
```

Data Preprocessing

The dataset of Java and Python programs were processed through the preprocessing tasks to obtain data suitable to train the models. The tasks include data

cleaning, pretokenization and tokenization. Unlike other programming languages, indentation is a crucial concept that should be followed when writing Python code. Moreover, Python does not allow mixing tabs and spaces for indentation. However, Python programs in Project Euler have IndentationError, which was fixed using autopep8. Following this, pyminifier was used to remove the docstrings, comments, and extraneous whitespaces present in each Python program, as well as to minimize indentation spaces. The pyminifier uses a single space to substitute multiple whitespaces or tabs used as an indentation in the program.

In pretokenization phase, each program was split into meaningful code tokens. For the transformer model, each Java program was tokenized using javalang. The javalang tokenizer generates a stream of Java tokens, each having position (line, column)
and value information. It also removes code comments. Each Python program was tokenized using tokenize from the Python library. For CodeBERT, pretokenization of a Java program was done by splitting the program into tokens, detokenizing those tokens using javalang, and then binding tokens using a space character. Tokenization is the process of splitting a text into words, phrases, or other meaningful elements called tokens. In this step, each pretokenized program was split into smaller subunits using a subword tokenization approach called Byte Pair Encoding (BPE). A BPE has two parts: a token learner that generates a vocabulary from a raw training corpus and a token segmenter that tokenizes a raw program based on the vocabulary.

Neural Translation Model

Two neural translation models were built using an encoder and decoder model:

one with a transformer architecture and the other with both the encoder and the decoder initialized with the public CodeBERT checkpoint.

Inference

To generate translations from a probability model, the Greedy 1-best search criterion was used. In greedy search, the probability at every time step is calculated and the token that gives the highest probability is selected to use as the next token in the sequence.

Data Postprocessing

The programs translated using the transformer were postprocessed by first removing BPE tokens and "<unk>" tokens. In the case of Java program, the program tokens were detokenized by simply reformatting using javalang. For a Python program, any text in capital or small letters matching "newline" and "new line" was replaced with the text "NEWLINE", "indent" with "INDENT", and "dedent" with "DEDENT". Following that, the program was detokenized by splitting it on "NEWLINE", replacing "INDENT" appearing at the beginning of each line with four spaces, and removing the texts "INDENT", "DEDENT", "NL", and "ENDMARKER".
Finally, all the lines were joined with the "\n" character. In the resulting program, ". " and " ." were replaced with "." and minified using pyminifier.

Evaluation

The BLEU score and the CodeBLEU score were used to assess the transformer and CodeBERT models' performance. Both the BLEU and CodeBLEU scores ranges from 0 to 1, with 0 indicating a perfect mismatch and 1 indicating a perfect match. The models were evaluated under the hyper parameters described in Table 2.

Table 2

Hyperparameters Description

No. of layers	(6,6), (12,12)
No. of heads	12
Embedding size	768
FFN Hidden Dimension	3072
Activation	GELU
Dropout	0.1
Layer normalization epsilon	1e-12
Loss function	Cross Entropy Loss
Optimizer	Adam Optimizer
Batch size	16
Learning rate	2e-5
No. of epochs	50,100

Result Analysis

The experiment was conducted on different configurations of the transformer and the CodeBERT model, for varying numbers of epochs. The sample of output is shown in Figure 4 and Figure

Figure 4

Program written in Java 5

```
import java.io.*;

class GFG {

static long calculateSum(int n)

{

long sum = 0;

for (int row = 0; row < n;

row++) { sum = sum + (1 <<

row);

}

return sum;

}

public static void main(String[] args)

{

int n = 10;

System.out.println("Sum of all elements:"

+ calculateSum(n));

}}
```

Figure 5

Generated Python code of Figure 4

```
def

calculateSum(n

) : sum = 0  for
```

```
row in
range(n):
sum = sum +
(1 << row) return
sum n
= 10
print("Sum of all elements:",
calculateSum(n))
```

The BLEU and CodeBLEU scores of the transformer and CodeBERT models obtained for 627 testing samples are shown in Table 3 (Java to Python) and Table 4 (Python to Java).

Table 3

BLEU, CodeBLEU, scores for Java to Python translation

Epoch	Layers	Model	BLEU	Code BLEU
50	6	Transformer	0.28	0.28
		CodeBERT	0.13	0.21
	12	Transformer	0.26	0.27
		CodeBERT	0.10	0.19
100	6	Transformer	0.27	0.27
		CodeBERT	0.15	0.22
	12	Transformer	0.25	0.27
		CodeBERT	0.11	0.17

Table 4

BLEU, CodeBLEU, scores for Python to Java translation

Epoch	Layers	Model	BLEU	Code BLEU
50	6	Transformer	0.39	0.40
		CodeBERT	0.27	0.35
	12	Transformer	0.37	0.38
		CodeBERT	0.26	0.33
100	6	Transformer	0.39	0.40
		CodeBERT	0.29	0.37
	12	Transformer	0.37	0.38
		CodeBERT	0.29	0.37

In order to choose the appropriate model for program translation, the study evaluates the BLEU and CodeBLEU scores of the CodeBERT and the transformer models. The study uses trained models to translate programs from the test dataset and compute BLEU and CodeBLEU scores. It determines whether the Python to Java program translation models have equivalent BLEU and .CodeBLEU scores to the Java to Python program translation models. The results demonstrated that the transformer model with 6 encoder and 6 decoder layers, trained for 50 epochs to translate from Java to Python, received the highest BLEU and CodeBLEU scores, with values of 0.28 and 0.28, respectively. Similarly, the transformer model, trained for 100 epochs to translate from Python to Java, achieved the highest BLEU (0.39) and CodeBLEU (0.40) scores.

Additionally, the results demonstrate that Python to Java translation models have higher BLEU and CodeBLEU scores than Java to Python translation models. In this study, the transformer models have performed better than the CodeBERT models in terms of BLEU and CodeBLEU scores.

Conclusion

The purpose of this study was to compare the transformer and the CodeBERT model on program translation tasks. The study used a 3133 Java Python parallel program dataset to translate the programs written in the source language to the target language. 80% (2506) of the data was used to train and 20% (672) of the data was used to test the transformer and the CodeBERT models.

Based on the BLEU and CodeBLEU scores of the models trained for different epochs, it can be concluded that the transformer models performed better than the CodeBERT models on the test dataset used in the study. For the Java to Python program translation task, the transformer model with 6 encoder and 6 decoder layers trained for 50 epochs achieved the highest BLEU and Code BLEU scores, of 0.28 and 0.28, respectively.

Similarly, for the Python to Java program translation task, the transformer model with 6 encoder and 6 decoder layers trained for 100 epochs received the highest BLEU and CodeBLEU scores, with values of 0.39 and 0.40, respectively. Furthermore, the scores of Java-to-Python translation models differ from those of Python-to-Java translation models.

Future Enhancements

The study used the CodeBERT block on both the encoder and decoder side of the translation model with shared weights. It is possible to use an autoregressive model on the decoder side. Additionally, due to resource constraints, the experiment was run on a small set of data. It would have been good if all of the datasets were used to train the models.

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Information Extraction from a Large Knowledge Graph in the Nepali Language

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Abstract

Information is abundant on the web. The knowledge graph is used for organizing information in a structured format that can be retrieved using specialized queries. There are many Knowledge graphs but they differ in their ontologies and taxonomies as well as property types that bind the relation between the entities, which creates problems while extracting the knowledge from them. There is an issue in multilingual support. While most of them claim to be multilingual they are more suitable for querying in the English language. Most of the existing knowledge graphs in existence are based on Wikipedia Infobox. In this work, we have devised an information extraction pipeline for retrieving knowledge in Nepali Language from Wikidata using SPARQL endpoint. Queries based on Wikipedia infobox has more accurate responses than the Queries based on the paragraph content of Wikipedia articles. The main reason behind that is that the information inside the paragraph is not linked properly in the Wikipedia infobox.

Keywords: Question Answering, Semantic Network, Knowledge Graph, WikiData, SPARQL

Information Extraction from a Large Knowledge Graph in the Nepali Language

Knowledge graphs, a structured organization of knowledge, have garnered significant attention in recent times from both academic and industry research departments. An organised representation of facts made up of entities, relationships, and semantic descriptions is called a knowledge graph. Relationships show the link between things, and entities themselves can be both concrete objects and abstract ideas. Semantic representations of entities and their relationships include types and characteristics that have clear definitions. Often used graphs with nodes and relations having qualities or attributes are called property graphs or attributed graphs. Except for a little distinction, knowledge graph and knowledge base are interchangeable terms. Given its graph structure, a knowledge graph can be thought of as a graph. When it comes to formal semantics, it can be viewed as a foundation of knowledge enabling fact-based interpretation and deduction (Ji et al., 2022). Structured facts are used in knowledge graphs (KGs) to explain the real world. A fact can be defined as a SPO triple (Subject, Predicate, Object) made up of two things and the connection that connects them. An example of a fact would be (खोला, बस्छ, माछा).

Knowledge graphs are an effective way to show links between entities for organising data in structured format. Natural language processing, recommendation systems, semantic search, question answering and other fields have uses for them. But there are a number of obstacles that must be overcome in order for knowledge graphs to effectively represent information, which affects their usefulness and effectiveness. There are many Knowledge graphs but they differ in their in their ontologies and taxonomies as well as properties types that binds the relation between the entities, which creates problem while extracting the knowledge from them. There is issue in multilingual support. While most of them claim to be multilingual they are more

suitable for querying in English language. This research focuses on queries against WikiData for extracting information in Nepali Language.

Background

There are many structured knowledge graphs which are freely accessible in the web. The study of these graphs can provide an insight of knowledge representation in large knowledge graphs, which will be helpful in creating a structured knowledge graphs in Nepali Language.

Ontology and Taxonomy

A set of concepts inside a domain and the connections among them are formalized in an **Ontology**. To simulate the knowledge inside that field, it offers a common vocabulary. A domain's entity types, as well as the attributes and connections between them, are specified using ontologies. Property, constraint, and class information are included here. (McHugh, 2023)

Components of Ontology:

Classes: The main things in the domain (e.g., Person, Book) are called classe or concepts.

Qualities: Qualities or characteristics of the classes (e.g., population, age, title).

Relations: The connections between classes and properties (e.g., a city is situated in a country, an author writes a book). Examples of the classes in particular are called instances (for example, "John Doe" is an instance of the class Person).

A **taxonomy** is a hierarchical classification that arranges ideas according to parent-child relationships and frequently takes the form of a tree structure. Taxonomies are used to group and categorize items to make it easier to navigate, comprehend, and retrieve information. (McHugh, 2023)

Components of Taxonomy:

Nodes: The distinct components or groups that make up the taxonomy.

Edges: The nodes' connections with one another, which show hierarchical relationships (for example, a book is a type of book, while a mammal is an animal).

Hierarchy Levels: Various abstraction levels, with higher levels denoting broader categories and lower levels more narrowly defined ones.

Frameworks for Knowledge Representation

Web Ontology Language (OWL)

Ontologies is created and shared on the web using the formal language OWL. Its goal is to make it possible to define and exchange web-based knowledge in an organised, compatible way. It supports a wide range of operators to specify attributes, classes, and the connections between them, making it possible to express intricate relationships between concepts. It is developed on top of RDF and RDFS. In addition to that, OWL adds more vocabulary and semantic powers to these frameworks, enhancing their capacity to share data and work together across many systems and domains. OWL facilitates reasoning regarding the connections between concepts. Applications are thus able to deduce logical inferences from the data through automated inference of new knowledge based on the defined ontology (OWL 2 Web Ontology Language Document Overview (Second Edition), n.d.).

Resource Description Framework

Resource Description Framework (RDF) is a graph-based data model proposed for the realisation of the Semantic Web vision and key format of the Linked Data publication strategy. It makes use of triples, or sentences of the format subject – predicate – object, in which the subject is an entity (a product, a company, etc.), the predicate is a characteristic of the entity (a product's price, the location of a company, etc.), and the object is the predicate's value for the particular subject (a product, a

company, etc.). Triples are utilised to relate anonymous resources (blank nodes) or uniform resource identifiers (URIs) to other URIs, blank nodes, or constants (Literals) (Papadaki et al., 2023).

A collection of classes with specific characteristics that are based on the RDF extensible knowledge representation data model make up the RDF Schema, a unique vocabulary. Although RDF use URIs to uniquely identify resources, it is not semantically expressive, hence its goal is to arrange RDF resources. It makes use of properties to establish relationships between entities in a class and to represent constraints, and classes to show where a resource belongs (Papadaki et al., 2023).

Schema.org

Schema.org provides a common vocabulary for annotating data on web pages, which is essential to the creation of Knowledge Graphs. It creates a vocabulary that websites may use to define their content, such as Person, Event, and Location. In addition to helping websites embed rich information within their code, it enables search engines and other applications to comprehend the meaning and relationships between various pieces of information, identify entities, and enable the creation of connections between related entities across various websites, all of which contribute to the overall knowledge graph (Iliadis et al., 2023) .

Existing Knowledge Graphs

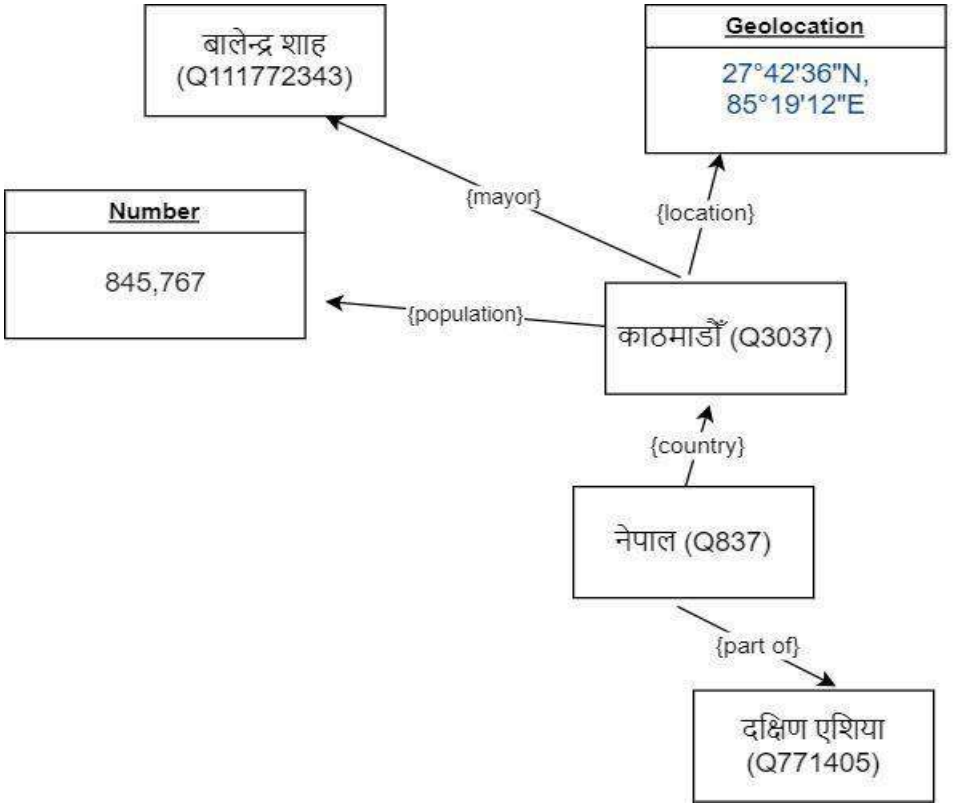
Wikidata

One of the largest general-purpose KBs nowadays is Wikidata. It offers a plethora of information on almost every topic spoken in everyday conversation, with over 100 million entities and 1.4 billion data about them. Since each entity has an abstract identifier (like Q83396), the identifiers are time- and language-invariant. The project has tens of thousands of contributors.

One of the largest general-purpose KBs nowadays is Wikidata. It offers a plethora of information on almost every topic spoken in everyday conversation, with over 100 million entities and 1.4 billion data about them. Since each entity has an abstract identifier (like Q83396), the identifiers are time- and language-invariant. The project has tens of thousands of contributors. (Suchanek, 2024)

Figure 1

Interconnected entities along with their properties and values in Wikidata



The primary components of the Wikidata repository are items, each of which has a label, a description, and an infinite number of aliases. A Q and a number serve as a unique identifier for an item; Douglas Adams is one example (Q42). Statements are made up of a property and a value that explain certain attributes of an item. In Wikidata, properties are denoted by a P and a number, for example, educated at (P69) (*Wikidata:Introduction - Wikidata*, 2024).

Babel Net

BabelNet is a multilingual semantic network Converging diverse resources including WordNet, Wikipedia, Wikidata, Wiktionary, and numerous others. Completing the image of the lexical and semantic knowledge gleaned from the integrated resources is achieved by integrating disparate pieces of information, much like in a jigsaw puzzle.

The concept of a synset, or the collection of synonymous words or senses that can be used to describe the same meaning in a particular language, is the foundation upon which BabelNet bases its representation of each meaning. For instance, in WordNet, the named entity NEW YORK is defined as the set {New York, New York City, Greater New York}, while the notion of DOG is represented by the set of terms {dog, domestic dog, Canis familiaris}. This idea is expanded by BabelNet to encompass equivalent lexicalizations across several languages (Navigli et al., 2021).

YAGO

YAGO is a comprehensive knowledge base that emphasises entities, facts, and their connections while presenting information in an organised manner. It combines a great deal of data from several sources, such as WordNet, Wikipedia, and GeoNames. Numerous subjects are covered, such as geography, history, biology, and culture. In order to provide a formal framework for expressing entities and their properties, YAGO organises knowledge into a hierarchical ontology. YAGO combines data from several languages, enabling the representation and reasoning of cross-lingual knowledge. YAGO uses automated techniques to extract information from unstructured text sources, which makes it possible for the knowledge base to grow and update automatically.

YAGO enhances our comprehension of the connections between distinct concepts by capturing a wide range of semantic links between entities, including is-a, part-of, located-in, and many more (Tanon et al., 2020).

DBpedia

DBpedia is a knowledge graph extracted from Wikipedia article's infoboxes. It enables users to connect the data to other online databases, run sophisticated queries on it, and use it for a variety of purposes. The infoboxes hold organised information regarding the topic of the article, including a person's birthdate, a city's population, or a product's characteristics. DBpedia is well known member of the Semantic Web and Linked Data initiatives, which seek to build an easily machine-processable web of interconnected data. The infobox templates are parsed throughout the extraction process, and the data is then transformed into RDF triples (About DBPedia - DBpedia Association, 2021).

ConceptNet

A labelled, weighted edge (an assertion) links words and phrases of natural language (terms) in ConceptNet. ConceptNet additionally depicts connections among information sources. In order to describe a relationship regardless of the language or source of the terms it connects, ConceptNet employs a closed class of chosen relations like IsA, UsedFor, and CapableOf.

` The most significant source of input for ConceptNet is Wiktionary, which contributes 18.1 million edges and is primarily responsible for its extensive multilingual vocabulary. ConceptNet comprises over 21 million edges and over 8 million nodes. Its English vocabulary comprises about 1,500,000 nodes, and it contains at least 10,000 nodes in 83 languages (Speer et al., 2017).

The CommonSense Knowledge Graph

CSKG is an extensive knowledge graph that includes common sense information. Information from multiple sources, including ConceptNet, ATOMIC, and others, is integrated to create the graph. With a focus on a broad range of subjects and situations, CSKG seeks to offer an organised representation of common-sense

knowledge akin to that of humans. The article addresses the development process, assessment techniques, and possible uses of CSKG in a number of fields, including artificial intelligence, machine learning, and natural language understanding. It includes a wide range of topics, such as ideas, methods, and even the relationships between words. It is set up in the form of a hyper-relational graph, which is a sophisticated method of displaying information linkages (Ilievski et al., 2021).

ATOMIC

Commonsense information about human interactions and behaviour is captured in the ATOMIC knowledge graph. It portrays an organised set of atomic-level occurrences, each with a subject, verb, and object as well as extra contextual details. The abbreviation ATOMIC is "The Atlas of Technologically Mediated Conversations." By offering a wealth of CommonsSense knowledge, it was designed to support research in artificial intelligence, machine learning, and natural language understanding. The graph includes more than 300,000 distinct textual descriptions of events that span a variety of situations and human behaviours. To facilitate more in-depth analysis and interpretation, each event is annotated with extra details like temporal information, intents, and effects (Sap et al., 2019b).

Related Works

The collaboratively editable repository QAWiki, which compiles questions in several natural languages along with the associated structured enquiries, serves as the foundation for Templet. Templet creates templates from question-query pairs on QAWiki. The user can generate a concrete question, query, and results by typing a question in natural language, choosing a template, and then using autocompletion to choose the entities they want to enter into the template's placeholders (Suárez & Hogan, 2023).

The issue of open domain factoid-based question responding, in which the response takes the form of a single word or brief phrase, is addressed in this paper. It offers a productive approach to question analysis and knowledge base-based suitable answer specification. Before anything else, a thorough linguistic study of a userspecified question is carried out. The question's primary triplets are developed, and its dependencies are indicated. To obtain the correct response to the inquiry, the system formulates a SPARQL query using the Wikidata inquiry Service API (Ploumis et al., n.d.).

Methodology

The structured information stored in the knowledge graph can be extracted in various ways. The most common approach is to use the SPARQL Queries against the knowledge base. The source of information of most of the large knowledge graphs is the Wikipedia infobox. The figure 2 below presents a simple pipeline to extract knowledge in Nepali Language.

SPARQL

Data stored in the Resource Description Framework (RDF) format can be queried and altered using the robust SPARQL query language and protocol. The acronym SPARQL represents SPARQL Protocol and RDF Query Language. **Triples** (subject-predicate-object statements) make up RDF data, which is specifically intended for querying. Triple pattern matching against RDF data is the fundamental operation of SPARQL queries (SPARQL 1.1 Query Language, n.d.).

Many kinds of queries are supported by SPARQL:

SELECT: Takes raw information out of the RDF database. Constructs new RDF graphs by using the query results as a basis.

ASK: Provides a Boolean answer indicating if the pattern of the question matches or not.

DESCRIBE: Provides an RDF graph that details the resources that were located.

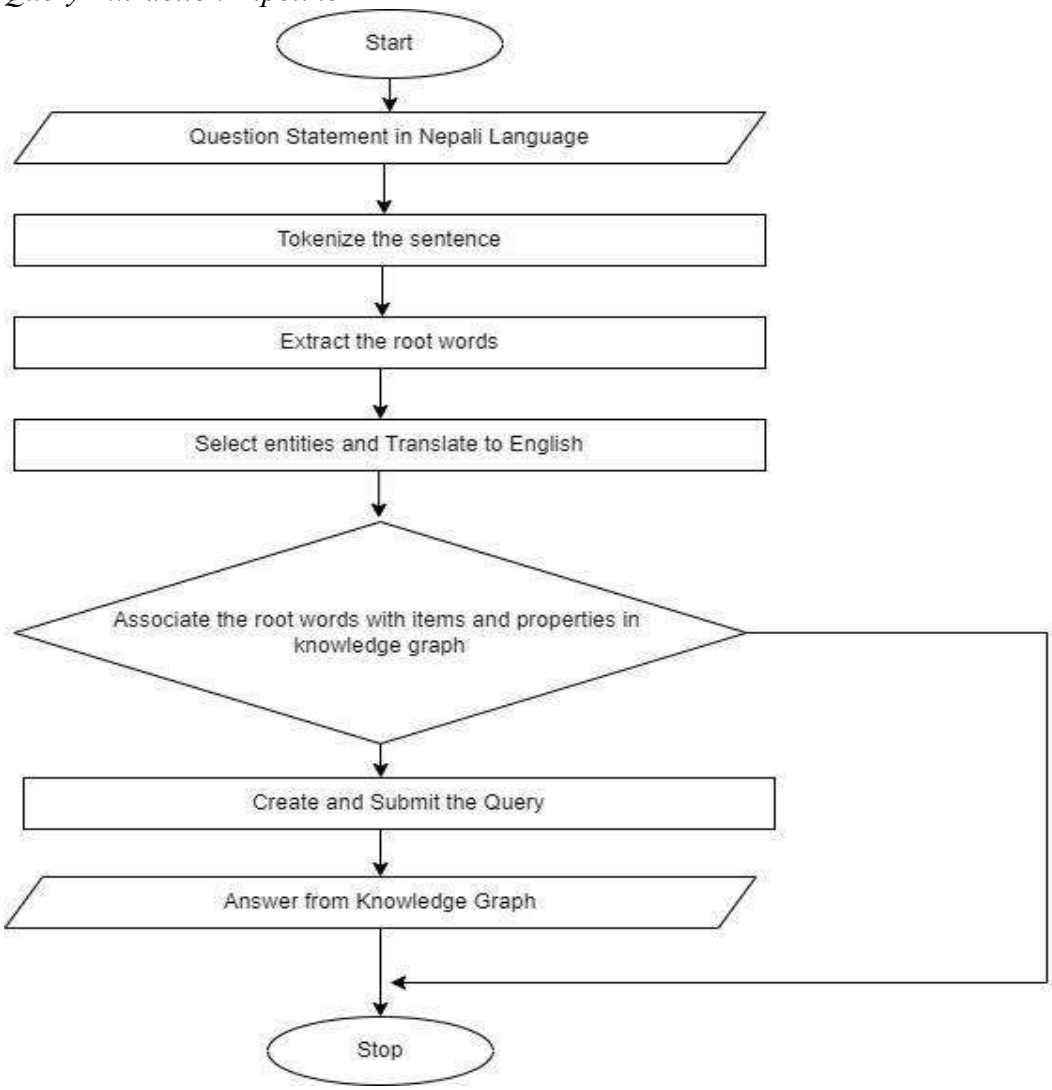
Example:

```
SELECT ?name WHERE
{
  ?person rdf:type foaf:Person .
  ?person foaf:name ?name .
}
```

This query searches for triples where the subject (**?person**) is of type **foaf:Person** and has a **foaf:name** property, returning the names.

Figure 2

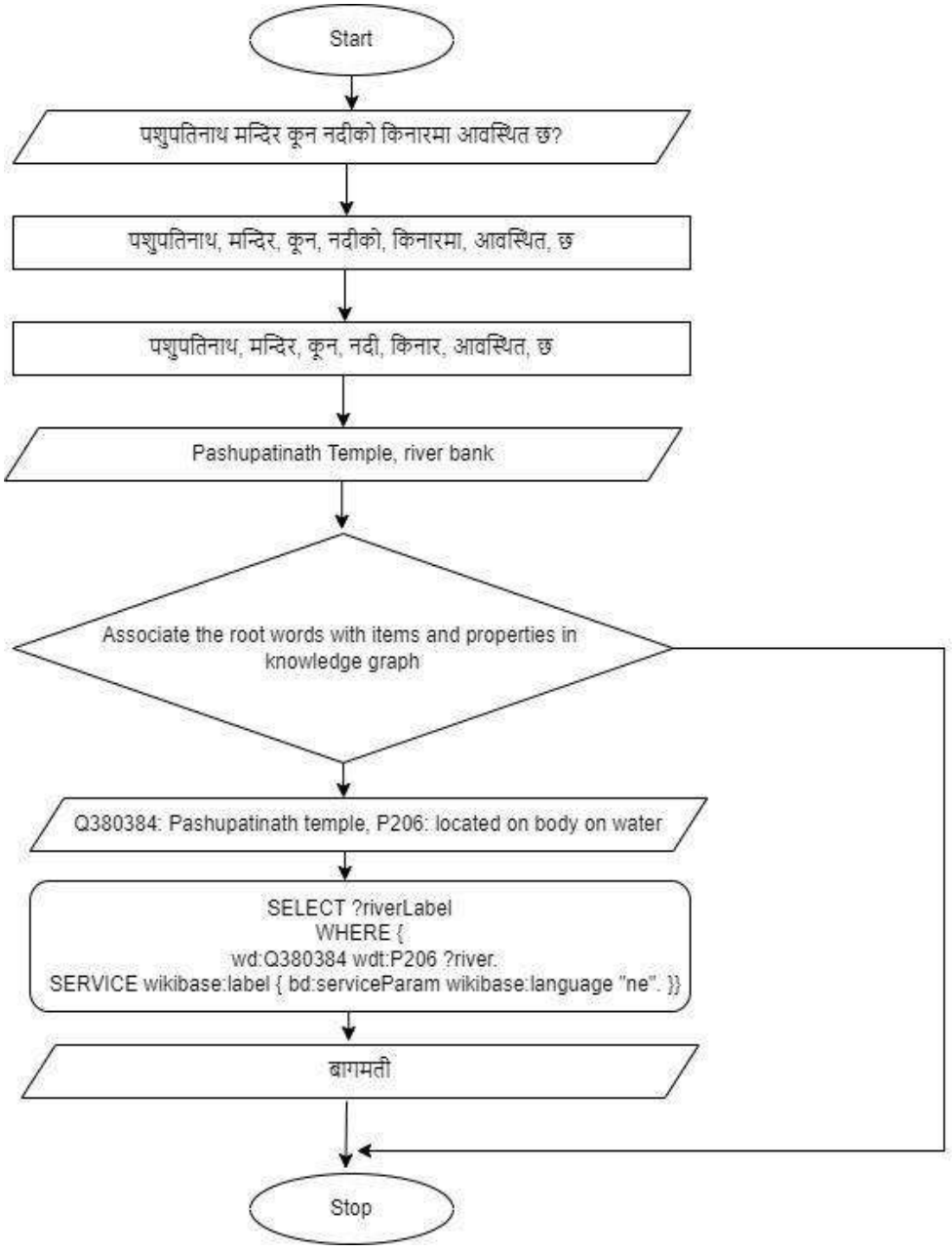
Query Extraction Pipeline



Knowledge Extraction from Wikidata against Query in Nepali Language is visualized in figure 3 using a working example.

Figure 3

Query Extraction Pipeline in Wikidata example



The question in Nepali language is tokenized first and the root words are extracted by removing inflections and postpositions. Then the subject and predicates are selected (manually done in this study) and these are matched against the Wikidata item ID and Wikidata properties then SPAQRL query is created and executed and results are noted down.

Implementation tools

Implementation is done using Python using the libraries such as SQLWrapper, Pandas etc in Google Colab. Wikidata SPARQL Queries were generated using RDF Framework.

Data Set

Two types of data set were prepared, 30 questions were generated manually by exploring infobox of different Wikipedia articles in Nepali Language Such as नेपाल (Q837), पशुपतिनाथ मन्दिर (Q380384), बागमिी नदी (Q4461769) etc.

पशुपतिनाथ मन्दिर कू न नदीको तकनार मा आवन्दस्थि छ ?

पृथ्वीनारायण शाहको जन्म कै ले भएको तथयो ?

Similarly, 30 Questions were generated manually by manually exploring paragraph content of Wikipedia Articles in Nepali Language.

आधुतनक नेपालको राष्ट्रतनमाा◌ाको रूपमा कसलाई तितनन्छ?

नेपालमा प्रजा◌िन्त्रको लातग क्रान्दि कतहले भएको तथयो?

Implementation Details **Tokenizing the input question sentence**

```
from nepalitokenizers import WordPiece text =
"पृथ्वीनारायण शाहको जन्म कै ले भएको तथयो?"
tokenizer_wp = WordPiece() tokens =
tokenizer_wp.encode(text)
print(tokens.ids) print(tokens.tokens)
print(tokenizer_wp.decode(tokens.ids))
```

'पृथ्वीनारायण', 'शाहको', 'जन्म', 'कै ले', 'भएको', 'तथयो'

Generating the root words

['पृथ्वीनारायण', 'शाह', 'जन्म', 'कै', 'भए', 'तथयो', '?']

Purging and Translating the words (Manual)

Prithvi Narayan Shah, Birth

Matching the item ID and Property in Wikipedia

wd:Q574450 wdt:P569 **Creating the SPARQL**

Query

```
SELECT ?dob WHERE
{ wd:Q574450
wdt:P569 ?dob.
}
```

Result

7 January 1723

Result Analysis

Table 1 shows the information regarding responses from Wikidata Knowledge graph in Nepali and English language.

Table 1

Response to queries

Questions Type	Total Questions	Answer in Nepali Language	Answer in English Language	No Answer
Questions from Wikipedia Infobox	30	23	3	4
Questions from Wikidata Paragraph Content	30	4	8	18

Similarly, table 2 shows the information regarding correct and incorrect answer to the questions presented to the Wikidata Knowledge Graph.

Table 2

Information on Correct and Incorrect Answer

Questions Type	Total Questions	Correct Answer	Incorrect Answer	No Answer
Questions from Wikipedia Infobox	30	25	3	2
Questions from Wikidata Paragraph Content	30	10	2	18

From above two table we can observe that, the responses to Queries based on Wikipedia infobox has more accurate responses than the Queries based on the paragraph content of Wikipedia articles. The correctness of answer was checked manually against the fact present in Wikidata infobox. The main reason behind that is that the information inside the paragraph is not linked properly in the Wikipedia infobox. For an instance while querying for the answer of "नेपालको रातष्ट्रय फु ल कु न हो"? , the entities ''नेपाल'' and ''फु ल'' have respective articles in Wikipedia however these are not linked properly through the infobox. In table 2 we can see that some of the responses of the query in

Nepali language is returned in English language as the number of articles in Wikipedia about different entities in Nepali Language is far below compared to articles in English Language.

Conclusion

This study gave valuable insight into the structure and source of knowledge of large KGs. Infobox of Wikipedia articles is the major source of knowledge graphs such as Wikidata, DBpedia, YAGO, Babel Net etc. Some KGs offer different ontologies and Taxonomies and link to other KGs. The SPARQL query based on the information listed in the Wikipedia infobox seems to be more effective than the question based on information in the paragraph content of Wikipedia articles. Similarly, the amount of knowledge in this knowledge graph in the Nepali Language is minimum compared to other language.

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Hotels, *Bhattis* and Porters: Dimensions and Dynamism of Power in Tourism of Khumbu

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Abstract

Tourism development in Khumbu region of Nepal created multiple opportunities to the local Sherpa and other in-migrants in one hand and at the same time it created different segments and layers among various tourism stakeholders. As the tourism began in Khumbu, some people operated hotels, bhattis, shops whereas others were employed as trekking staffs and porters. This article deals with the various dimensions and dynamism of power relationship among hotels, bhattis and porters. Based on the field work, I applied both participant and non-participant observation, unstructured interviews and kuragrphy as the major techniques for the primary data collection. The data reveals that hotels, bhattis and porters are indispensable parts of tourism in Khumbu. Each component is essential for the continuation of tourism in Khumbu. However, they exercise various forms of power over others. Judging through the laymen's eyes, their roles and relationships seem to be normal and natural but it is not the reality. The reality is that they are framed within a certain stamp of everyday power relationships. The hotels, bhattis and porters are intertwined in different power dimensions. They each exercise various forms of power to control the resources. Hotel owner Sherpas are powerful because of their economic prosperity and higher social status. Being local/insiders and their legacy in tourism and mountaineering are the additional indicators to rank them higher than other two components. They use different forms of power to influence and adjust each other. The power they exercise is not constant; it is a dynamic.

Keywords: Sherpa, non-Sherpa, status, relationships, migration

Hotels, *Bhattis* and Porters: Dimensions and Dynamism of Power in Tourism of Khumbu

Tourism development in the Khumbu region of Nepal has not only diversified the local people's occupation but also encouraged short-term and long-term in-migration and outmigration of Sherpa and non-Sherpa. Short-term migration towards Khumbu is employment in different tourism sectors such as trekking, domestic work, or work in hotels and lodges. The short-term migrants are job seekers. Whereas, the purpose of long-term migration toward Khumbu is entrepreneurship or business. The people who migrated for business operated hotels, lodge *bhatti*, shops, and so on in Khumbu. The hotels, *bhattis,* and shops are job givers to other people who are job seekers or short-term migrants in the area (Shrestha, 2018a).

Hotels, *bhatti,* and porters are the key elements of trekking tourism in the Khumbu region of Nepal. The tourism of the Khumbu region would be incomplete in the absence of any one of these. Hotels serve the tourists for the accommodation and other logistics. *Bhatti* welcomes Nepali guests, and trekking employees including the porters for food and accommodation whereas the porters carry the luggage of the tourists throughout the trekking in the Khumbu region. Simply, these elements have their own roles, relationships, duties and responsibilities but are indispensable for a successful trekking. The hotels, *bhatti* and porters have different roles, relationships and expectations in Khumbu. Each of them requires the others' existence for their survival. Interestingly, these elements survive in love-hate and conflictual relationships. In such a situation, this paper examines their roles, dynamic love-hate relationships and different expectations in the study area.

Research Objectives

The main aim of this paper is to examine the ways that the hotels, *bhattis* and the porters interact with each other. Keeping the concept of anthropology of power in centre, this article deals with the various dimensions and dynamism of power relationship among hotels, *bhattis* and porters in the study area. In addition to this, the paper explores the perceptions that they make for each other.

Research Methods

This is an ethnographic research. In-depth unstructured interviews and both participant and non-participant observation were the main techniques for collecting the information. I made several field visits in Khumbu in 2013, 2015, 2018 and 2020. I participated in trekking up to Gorakshep (near Everest base camp). I observed the behavior of hotel owners, *bhatti* owners and porters in the study area. In addition to this, I conducted unstructured interviews with hotel and *bhatti* owners and the trekking porters in Khumbu and in Kathmandu. Kuragraphy was another way of collecting the information. I had several informal talks with the informants. I updated the data in 2024.

Tourism in Khumbu

Khumbu is one of the major tourist destinations in Nepal. The region is popular for trekking, mountaineering and Sherpa culture. Thousands of tourists visit Khumbu every year for trekking and mountaineering. But, Khumbu region of Nepal was dominantly an agro-pastoral community before 1950 (Kunwar, 1989). The Sherpa as an indigenous people who produced only potatoes and buckwheat (Basnet, 2020) because of high altitude. In addition to this, there was a history of Sherpas' involvement in trans-

Himalayan trade with Tibet and working in tourism as porters in Sikkim and Darjeeling (Stevens, 1993 and Ortner, 1999).

Khumbu was developed as the major tourists' destination after 1950. Scaling Mt. Everest by Tenzing Norgay and Sir Edmund Hillary in 1953, construction of Tenzing Hillary Airport in Lukla in 1964, establishment of Sagarmatha National Park in 1976 were the main causes for fostering the growth of tourists in the region. These events opened the door of opportunities for many Sherpa families in the tourism sectors as porters, *sirdars* (guides), domestic workers and hotel and lodge owners (Shrestha, 2018a). The Sherpa became able to establish their own hotel and lodges on the trekking trails and they also operated trekking and mountaineering expedition companies in Kathmandu. Simultaneously, it pushed the Sherpas' out-migration from the Khumbu region along with the tragic death of Sherpa in the mountains during the high altitude trekking and mountaineering.

The construction of hotels, lodges and other tourism related businesses have increased with the growing numbers of tourists every year in the Khumbu region. The first data of tourists' arrivals at Khumbu from the government level was recorded in 1980. In that year, 5836 tourists visited Khumbu (Ministry of Culture, Tourism and Civil Aviation-MOCTCA, 2013). But the data from the informal section show that the number of tourists visited Khumbu was higher than the total population of Khumbu region in the year 1970. In 1970, the total population of Khumbu was 2761 and it was 3108 in the year 1982 (Pawson, Stanford, & Adams, 1984). However, their data excluded the number of tourists who visited Khumbu in those years.

In 1950, Nepal government allowed a small group of American and British mountaineers to visit Khumbu for survey of Mt. Everest (Rowell, 1980, c.f. Stevens,

1988). Hornbein (as cited in Stevens, 1988) stated that after 1950 expeditions became a fact of life in Khumbu during the pre-monsoon climbing season. The British came to Mt. Everest in 1951 and 1953, Cho Oyu in 1954, and Swiss came in 1952, 1955 and 1956. These mountaineers employed hundreds of high altitude porters and they were predominantly Sherpa who were paid Rs. 7.50 per day. The paid amount was seven times more than any agricultural labour in Khumbu (Fuerer-Haimendorf, 1975). Table 1 details about arrival of tourists in Khumbu in different years.

Table 1

Number of tourists visited Khumbu in different years

Year	Number of Tourists visited Khumbu
1980	5836
1985	8347
1990	11,314
1995	14,997
2000	26683
2005	19522
2010	32084
2015	34412
2020	32636
2023	52499

Source: Nepal Tourism Statistics, 2024

Bjonness (1980) stated that about 1400 trekkers per year were visiting Khumbu by 1970 and increased to 3200 in the year 1972-73 (Mishra, 1973). Hence, the increased number of tourists created various opportunities to the local people.

In 2011 the total population of three different VDCs of Khumbu (Chaurikharka, Namche and Khumjung now Khumbu Pasang Lhamu Rural Municipality) was 7161 and it was 8720 in 2021 (CBS, 2011; 2021). The number of tourists was almost six times more than the number of local residents in Khumbu including non-Sherpa. The number of tourists increased every year and reached to 34,645 in the year 2011 and 52499 in 2023 (MOCTCA, 2024). However, the arrivals of tourists were not constant. The numbers were fluctuating due to the various internal and external reasons such as the earthquake and Indian blockade in 2015 and world-wide effects of Covid 19 in 2019 onwards. The given data includes only foreign tourists and excludes their assistants such as guide, other staffs and porters along with domestic tourists. The governments of Nepal do not keep any records of domestic tourists and trekking employees such as the porters, guides and other staffs.

The evidences show that the people of Khumbu have interacted directly with many visitors from the different parts of the world. These interactions of the hosts and guests have multiple effects on the host communities like Khumbu. The number of hotels, lodges, *bhatti*, and other ordinary shops has increased year by year. Similarly, number of Sherpa and non-Sherpa people have migrated towards the Khumbu region searching for the better opportunities. Migration of these people for employment, business and domestic works segmented Khumbu into different clusters socially, culturally, economically and psychologically. The following section of this paper tries to analyze the dynamic roles, relations and reciprocity among the hotels, *bhattis* and porters in the study area.

The Hotels: Symbols of Status and Power of Sherpa

Tourism development encouraged the people to operate tourism business in the major trekking trails in Khumbu. As the number of tourists increased, people invested in hotel, lodges and *bhatti* to serve the tourists. The construction of hotel, lodges and *bhatti* not only fulfilled the tourists' requirements but also made Khumbu a platform to interact with various types of people migrated from different parts of the world.

The hotels are operated mostly by Sherpa. These hotels symbolize the owners' status in the community. The status is visible. The aim of decorating the hotels is not only to attract the trekkers to visit and stay at their hotel but also for their status which symbolizes their power in the community. A hotel owner stated:

> I am a local Sherpa and operated this hotel long ago. I worked as a trekking guide too. I was elected as the village leader several times. This hotel is not only for business but it supports to my local politics. (Personal communication with Mr. Sherpa, October, 2018).

Mr. Sherpa has a sound socio-economic and political status in the village. He collected donations from foreigners and distributed to the people during earthquake in 2015 to impress the people and maintain his social status.

The physical structures of the hotels show distinct 'Sherpaness'. The names of the hotels have incorporated the sense of place and Sherpaness. For example, some names are Hotel Everest, Khumbu Hotel and some names reflect the Tibet and Sherpa beginning from Potala- a Tibetan Palace and Sherpa such as Sherpa Lodge and Coffee shop.

The outer structures of hotels are quite beautiful. Although the hotels were made by stone and cement, the stones are cut in the same size which add extra-ordinary beauty to their hotels.

The interior of each hotel is attractive. The stone wall is covered by wood to protect from cold.

The wall is decorated by pictures and posters of mountains. The photos of Dalai Lama and Buddhism related posters were hanging on the walls which made the dining hall beautiful.

There is a huge competition among the hotel owners. The competition within Sherpa hotel owners is not very visible because they do not want to criticize each other. But there are rivalry relations between Sherpa and non-Sherpa hotel owners. "The non-Sherpa hotel owners cannot run the hotels for long-term due to heavy expenses. They cannot manage a flight ticket for the guests too because they do not have access with airlines," a Sherpa hotel owner stated.

The non-Sherpa hotel owners who have operated hotel in rent are compelled to provide much facilities to both tourists and Nepali guides for sustaining their business because they have to pay high rental amount and have to manage staff salaries and profit too. But this situation is not seen in case of the Sherpa hotel owners who have their own hotel, should not pay rent to others.

Such cases of conflict and competition for business are not new for tourists' destinations. The cases of battle over guiding rights and conflict for the hotel business were studied in Indonesia (Adams, 1997); there is competition for good jobs in Tibet (Hillman, 2017). All the hotel owners have a strategy to make their guests happy and satisfied. In addition to this, they keep good relations to trekking companies and guides who send the tourists to their hotel in each trekking season.

The hotels and lodges are the symbols of wealth and power. Power of the hotel owner in the community is embedded to the physical structure of hotel and the number of tourists visit to his/her hotel. It means that social and economic status of a hotel owner is determined by the business from tourism and structure and appearance of the hotels. Hence, Hotels in Khumbu, hence, not only exercised their economic power but they are the symbol of political power, acquired social and cultural significance and should be understood for their salience in status and power contestations (Lim, 2007).

The Bhattis: Symbol of non-Sherpa and marginalized people

The word *Bhatti* is popular in Nepal. The *bhatti* is presented in Nepali cinema as local liquor shop where mostly low category people gather in every evening for drinking alcohol. Nepali *Brihat Sabdakosh* (2067 B. S.) defines *bhatti* as a. liquor factory b. liquor shop and c. a place for liquor consumption (p. 962).

Similarly, the term *bhatti* indicates local liquor shop in Kathmandu in which people consume local liquor everyday mostly in the evening. But the *bhatti* in Khumbu region refers to small lodges and restaurants operated for serving the porters and other Nepali people on the trekking trails. The *bhatti* of Khumbu is not limited to selling and buying the alcohol as it is in Kathmandu but it has its own stories, meanings and activities embedded to the society and culture. The *bhatti* has incorporated the various forms of power and economy that the people enjoyed in Khumbu.

The *bhattis* are involved in small business but supportive to big hotels for serving the Nepali porters and staffs to whom the big hotels do not welcome. The structure of *bhatti* is different than those of the hotel and lodge. The *bhattis* are operated in small houses (sometimes calls *chappro*- a small hut) without any interior and exterior

design. The structure itself is enough to say about the socio-economic condition of its operators.

The *bhattis* in Khumbu symbolize three things. The first, the owners are mostly nonSherpa; the second, most of them are in-migrants and the third their business is related to the trekking porters.

The non-Sherpa *bhatti* owners are migrated from various parts of Nepal with their own stories and expectations. A *bhatti* owner migrated before 20 year tells "I migrated Khumbu after my second marriage. I was a porter at first lately I operated bhatti". Hence, second marriage is the cause of his migration and *Bhatti* operation. I found another case of migration and operation of *bhatti* in Lukla by Mr. Shrestha. Mr. Shrestha has also a story of inter-caste marriage. Mr.
Shrestha tells:

> I married without family consent and was not accepted by my family. We stayed outside the home, struggled for survival. I got a government job later. The government transferred me Khumbu. I came with my family and operated *Bhatti* along with my job (Personal communication with Mr. Shrestha, January, 2020).

These are some cases that tell why people migrate and operate *bhatti* in Khumbu. I got several such cases about the migration and operation of *bhatti* in Khumbu.

The Porters: Bottom of the layers

The porters are the key components of trekking in the Khumbu region. Porters carry luggage of the tourists that weighs about 30 KG. Carrying the load in their back and taking that into the destination each day is the work/duty of the porters. Generally,

porters receive the luggage in the morning and submit to the concerned tourists in the evening. The porters are unknown about the things inside the luggage but they handle it very carefully. Porters earn Nepali rupees 2000 to 2500 per day. The trekking company does not provide food and drinks.
The porters should manage their expenditure from the wages they get.

In Khumbu, porters are mostly non-Sherpa (Rai, Tamang, Kshetri, Magar, etc.) outsiders who have come from lower region of Solukhumbu and adjacent districts for seasonal work. There are few Sherpa porters but they are not from Khumbu region, they also come from outer parts of Khumbu. It means the Sherpa of Khumbu rarely do such a hard job. The Khumbu Sherpa are guides, mountaineers, trekking company owners, or doing big tourism businesses in Khumbu and other parts of Nepal.

The porters are at the bottom socially, psychologically and economically (Shrestha, 2018b; Frydendlund, 2017). Hence, the porters are almost powerless people in the structure of tourism in Khumbu. They are at the bottom because they work in low wage, cannot spend much and unable to stay at the hotels during the trekking. But the porters are the main guests of the *bhattis*. The porters enjoy staying at the *bhatti* rather than other places because of the similarities in their economic class and the freedom that the porters get at the *bhattis* and economic necessity for both compelled each other to stay together. Porters spend much in Lukla rather than other trekking trails because Lukla is the last destination for the tourists from where they fly back to Kathmandu.

The porters should not pay extra amount for lodging in bhatti. They spend their extra time by staying at *bhatti* because the porters have to wait some days for the next trekking. And sometimes they have to wait for months to get the trekking in Khumbu. The *bhatti* owners manage their food, drinks and other necessities of the porters in

credit even if they do not have money or job. When the porters get trekking and come back with their wages, they pay their dues to the *bhatti* owners. The *bhatti* owners not only serve them by providing food, drinks and sometimes lending money but also help them by searching clients. In the trekking season, the porters from their village make calls to the owners for managing jobs in the trekking as staffs or porters. The owner who has an access to trekking companies in Kathmandu is able to manage the jobs. As the *bhatti* owner become able to manage jobs for them and call the porters, the porters come with some gifts especially the local products of their village.

Dimensions and dynamism of Power among Hotels, Bhattis and Porters

Hotel, *bhatti* and porters have close, intimate and reciprocal relationships in Khumbu. These components are interdependent in everyday life. Generally, hotels and *bhattis* do not compete each other but their perception towards each other seems conflictual. The hotel lodge owners state *bhatti* owners as '*bichara'* (sympathy for poor and vulnerable). Mr. F. Sherpa, a hotel owner at Lukla stated that "the *bhattis* are '*bichara'* and they (the owner) also have to do something for their survival (struggling for their survival) and are not from the Sherpa community" (Personal communication with Mr. Sherpa, November, 2018).

This sympathy towards *bhatti* owners symbolizes their power and position in the community. I saw two things in this statement. The first, *bhatti* owners are poor and struggling for their survival. These people are unable to keep their voices strongly in the community. It is because they are not only poor but they are the migrants and not the local. The second shows the ethnic feeling or ethnocentrism. It also indicates how the hotel, lodge owners judge and perceive the non-Sherpa *bhatti* owners. Similarly, Mr. P. Sherpa, a hotel owner and local Sherpa in Khumbu states:

> There is the need of small things (*bhatti*) to run big one (hotel/lodge). The big cannot be run without smalls. *Bhattis* also have good business now because the porters cannot sleep at the expensive rooms of big hotels and they need a place to sleep. *Bhattis* welcome them to promote their business because the porters and other trekking staffs spend much amount of money on the last day of trekking (Personal communication with Mr. Sherpa, November, 2018).

Mr. Sherpa explains the necessity of the *bhatti* to run big hotels because *bhatti* give service to porters. The presence of *bhatti* has helped the hotels to manage porters in trekking because the hotels do not provide accommodation service for the porters.

The hotel owners blame the *bhatti* owners for not participating in local activities like tree plantation and festival celebration. So, there seems to be conflict between them. Mr. T. Sherpa stated, "a *bhatti* owner refused to take part in tree plantation and I took all fire wood from his kitchen. I also advised him to go to his own village to carry wood for fire" (Personal communication with Mr. Sherpa, November 2020). They are blamed for deforestation because they all are in-migrants. However, the *bhatti* owners refused it and stated that the local hotel/lodge owners were jealous to their deeds and criticized frequently in different matters like use of natural resources and attending at the social functions.

Bhatti owners have different eyes to see and judge the hotel/lodge owners in Lukla. The business of hotel/lodge owner is big. The guests for *bhatti* and hotel are also different. The hotel and lodges depend upon the tourists but *bhatti* depends upon the Nepali guests. Even though their clients are different, they are not made for each other; their relations are sometimes functional, dynamic and fluctuating. The *bhatti* owners

said that there was discrimination on natural resources distribution between *bhatti* owners and hotel/lodge owners. Mr. Shrestha, a *bhatti* owner states:

> Before some years, the hotel/lodge owners blamed us for doing nothing to the community welfare and nature conservation. They discriminated us for distributing the fire wood and other resources. But now the level of discrimination is decreasing due to the increased population of the outsiders (Personal communication with Mr. Shrestha, October, 2020).

The hotel/lodge owners are the Sherpa. They are Buddhist. The Buddhist believes on non- violence. Although they eat meat but there is the restriction of killing animals and birds in Khumbu. But the *bhatti* owners are non-Sherpa. These people have a culture of animal sacrifice. I found some ideological conflict in this regard too. The Sherpa has filed a case against non-Sherpa
Hindu for sacrificing the goats in Lukla. Besides these, the non-Sherpa informants stated that the Sherpa who own hotel and lodge in Khumbu feel superior and try to suppress them (*hamilai hepchhan*).

Interestingly, the non-Sherpa people made negative comments about Sherpas as being self-centric doing anything (wrong deeds) for money. The tourists have a good faith on Sherpa. This faith is not only because of the work of present Sherpa but it is also because of the Tenzing
Norgay Sherpa and the Sherpas before the rise of tourism in Khumbu. “The hotel/lodge owner Sherpas are selling the faith of their forefathers as being good Sherpa,” a Bhatti owner stated. Such a criticism is also a form of resistance; form of power often exercised by a weaker component in the society.

I found another reason for the conflict between Hotel owners and *bhattis* about noise made by the porters after drinking alcohol. The porters consume much alcohol at the last day of the trekking. On that day the porters even sing and dance producing noise. The noise disturbs the tourists who are staying at the hotel. It is why the hotel/lodge owners complain against *bhatti* owners.

As porters are also a major component of tourism in Khumbu, they have a love-hate relationship with hotels and *bhatti*. The hotel and lodge owners always look for the good payable tourists but porters cannot afford it, that's why the porters have almost no place to stay at the hotels. I observed that generally the porters would come twice in the hotels where their guests stay; evening with the luggage of the tourists and morning to take the same. I observed not much interaction between porters and hotel/lodge owners. It seems like they are not made for each other. The owners generally do not expect the porters to be at their dining hall.

> The porters blame the hotel owners for treating them as third class citizen of Khumbu.

When asked about their relatiohnships with the hotel owners a porter shared his grief:

> We were three people at Dingboche, one Sherpa and other two non Sherpa including me. The hotel / lodge owner discriminated us even in tea cup but I resisted and raised the question about difference in a tea cup. The Sherpa stated Rungba and Dungba (dominating words: rugnba- parbate people and dungba-dhakre, people who carry load) for non- Sherpa people at Khumbu (Personal communicatio with Mr. Kshetri, November, 2018).

The perceptions of the porters are rightly represented in the writings of Frydenlund (2017). The narratives of a Khaling Rai porter shows the 'death of humanity

in Khumbu'. It reflects the hotel owners' heavy commercialization due to the over flow of tourists in Khumbu.

Frydenlund presents:

> I am treated like an animal by the lodge owners and trekking companies. The money is good, but after paying for my own food and lodging in the expensive upper Khumbu, there isn't much left give my mother, I also feel humilated because I am not allowed in lodges and must sleep in porter's shelters (Frydenlund , 2017 p, 31).

The dining halls of hotels are warm due to its central heating system. The hall is found full of guests who pay more than any other ordinary Nepali customers. In Gorakshep, I observed the lodge owner not allowing the porters to be in the dining hall during the trekking. It shows the economic power of hotel owner and the way they exercise the power on the porters. In Nepal, it is our hospitality to respect the people who come to our home in the evening. But chasing out people from home and dinning has indicated the change in value system of the hotel owners in Khumbu. It is one of the best examples of commercialization of value; the tourism has brought in Khumbu.

But the hotel owners' statement is quite different about porters. When I asked him why the big hotel/lodge owners do not allow the porters to stay at their hotel, Mr. B. Sherpa states:

> The porters do not enjoy at the big hotels because they hesitate of entertaining in front of the guests that they have travelled together. They expect good relations with the tourists and do not expect bad complain in trekking office. If we give them room too they do not stay with us. They feel free in the *bhattis'* (Personal communication with Mr. Sherpa, November, 2018).

Now, we move to see how the porters and *Bhattis* behave with each other. The porters and the *bhattis* are made for each other. The porters are the main guests of the *bhattis*. The porters enjoy staying at the *bhatti* rather than other places because of the similarities in their social and economic class and the freedom that the porters get at the *bhattis;* and economic necessity for both compelled each other to stay together. The porters would not earn much money in trekking but they enjoy a lot in the last day of their trekking. The enjoyment is not because of getting extra amount of money as tips or some used or unused garments of the tourists but because of the end of their hard days of the trekking in Khumbu. Hence, the *bhattis* are guest house for the porters and The porters are the source of earnings to the *bhatti* owners.

The price of food and drinks in *bhatti* are lower than the other hotels and lodges in Khumbu. The *bhatti* owners respect the clients and serve them. They both survive in the reciprocity that the survival of one depends upon the presence of the other. Mr. A. Giri, who fled to Lukla after his second marriage from Khotang and operated *bhatti*, tells about such reciprocity.

Mr. Giri states, "I manage the porters to trekking company along with running my *Bhatti.* I pay
Rs. 100000 per annum as rent. I also manage logistics to the porters even in the off-seasons" (personal communication with Mr. Giri, November, 2018).

Mr. Giri has dual roles in Lukla a) managing the necessities for the porters to their day to day lives in his *bhatti* and b) managing the porters for trekking companies. Management of the porters to the trekking companies is related to the *bhatti* owner's social position. The *bhatti* owner who could manage the job for porters has higher social status in their community (porters' community) because the owner is the job provider to

the porters as the trekking companies and the *bhatti* keep reciprocal business relationship. The porters offer beer or wine after the trekking.

The porters also bring their local production such as rice, vegetable and sometimes chicken as *koseli* (gift) from their home while coming to seek a job. Such a gift is not just for maintaining social relationship between *bhatti* owner and porter. The gift compels *bhatti* owner to manage job to the porter. Hence, the gift has both social and economic values for tourism in Khumbu. A porter states, "we bring *koseli* (vegetable, fruits, chicken, etc.) to *bhatti* owner for securing the job in trekking because I stay at my village (lower Solu) during off season of trekking. He calls me when he fixes my job" (Personal communication with Mr. Kshetri, November, 2018).

On the other hand, management of the porter's job has helped Mr. Giri to ensure many guests at his *bhatti.* The *bhatti* owners at Khumbu have their own particular guests who always stay at their *bhatti*. The porters should not pay extra amount for lodging.

Conclusion

Power has social, political, economic, psychological and cultural dimensions, whereas, resistance is also a sort of power exercise. The hotels, *bhattis* and porters are intertwined in different power dimensions. They each exercise various forms of power to control the resources.

Hotels owner Sherpas are powerful because of their economic prosperity, higher social status. Being insiders and their legacy in tourism and mountaineering are the additional indicators to rank them higher than other two components in Khumbu.

Through the layman's eyes, one sees that these segments are well adjusted with harmonious relationships; which is a thin description. Each component has a particular job which are different in nature. There seems no business competition or contradictory relationships. But, while unfolding the layers of the tourism system (a thick description) in Khumbu, the scenes different than what seems in front of the stage.

Power is embedded in everyday lives. The hotels, *bhattis* and porters exercise different dimensions of power. Each segments are divided as insiders-outsiders, rich-poor, big-small and exercise their power accessing and controlling the social, cultural, natural and economic resources. Hence, they are not only "performing their functional roles" but also "constantly negotiating of power, authority and the control of definition of reality" (Cheong & Miller, 2000). The hotels and *bhattis* owners, and the porters are not only doing their functionally defined roles but they each are structured within the network of power. Their everyday decision making process and behavior pattern is influenced and determined by the power of each other.

The power is omnipresent in tourism. Power as an "ability of a person or social unit to influence the conduct and decision making of another…." (Adams, 1977:388) determines the behavior of another segment of tourism in Khumbu. However, the application of power is in both tangible and intangible forms in tourism. The hotels in Khumbu symbolize the power and authority of its owners. The owners' social and economic status is symbolized by the structure of hotels and visit of tourists in his/her hotels.

Social networks are also the sources of power production and reproduction. Cohen (1976:23) states that "power inheres in social relationships and relations of power are aspects of social relationships". The hotel owners produce and reproduce power through

the social and economic networks with trekking companies, guides and the tourists. The economic power is symbolized through their business but the business depends upon the owners' relationships with trekking companies and guides. Hence, there is intangible power application on hotel owners by trekking companies and the guides.

Carrier and Macleod (2010) have well argued that the power is useful to bear in mind when considering the interplay between individual people, groups and organizations where tourism is influencing particular sectors. So as the case in Khumbu, different individual, groups and organization are influencing the behavior of each other. The patterns of relationship between the porters and *bhatti* owners are influenced by social and economic power. They survive in reciprocity and enjoy symmetrical power relations. In contrast, there is an absolute power domination of hotel owners on the porters and *bhattis*. Blaming the *bhatti* owners as the main cause of deforestation, forcing them to take part in cultural practices and restriction for porters to be in a dining hall are some of the examples of absolute power domination of hotel owners. The exercise of power on porters is tangible whereas hotel owners exercise symbolic and intangible power on the *bhatti* owners. Resistance is another form of power exercise. The *bhatti* owners and the porters resist against hotel owners. They criticize the hotel owners and sometimes disobey them.

These forms of love and hate relationships are produced due to the structural inequality brought by tourism in Khumbu. The unequal social structure has configured a common interest group, i.e., a social class. However, the contradictory relationships cannot be analyzed only through the Marxist/materialist perspective. Moreover, the exercise of power should be analyzed in relation to people (caste/ethnicity), place (insider/outsider) and occupation in Khumbu.

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Modeling CO_2 Emissions in Nepal: The Role of Renewable Energy

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Abstract

Climate change and environmental degradation, largely driven by carbon dioxide (CO_2) emissions, have become significant global concerns. In Nepal, the challenge of balancing economic growth with environmental sustainability is pertinent due to the country's reliance on agriculture and hydropower. This study explores the relationship between CO_2 emissions, socio-economic factors, and renewable energy consumption in Nepal, utilizing advanced econometric techniques. Using a 30-year dataset from 1991 to 2020, this study employs the Dynamic Ordinary Least Square (DOLS) model to examine long-term relationships between CO_2 emissions and key independent variables such as renewable energy consumption, GDP, and human development. Unit root tests (ADF and PP) are conducted to ensure stationarity, followed by co-integration and causality tests. The findings indicate a positive and significant relationship between CO_2 emissions and economic growth, supporting the Environmental Kuznets Curve (EKC) hypothesis. Conversely, renewable energy consumption is found to significantly reduce CO_2 emissions, underscoring its role in mitigating environmental impacts. The coefficient for renewable energy consumption (LNREC) is -5.818686. This implies that for every 1% increase in renewable energy consumption, CO2 emissions decrease by approximately 5.82%.The results highlight the importance of renewable energy in balancing Nepal's economic and environmental goals.

Keywords: CO_2 emissions, renewable energy, economic growth, DOLS, environmental Kuznets curve.

JEL: Q56, O13, C32

Modeling CO_2 Emissions in Nepal: The Role of Renewable Energy

Climate change and global environmental degradation have emerged as major challenges for both developed and developing nations, with carbon dioxide (CO_2) emissions being a primary contributor to these issues. In Nepal, the challenge of balancing economic growth with environmental sustainability is particularly pertinent, given its reliance on agriculture and hydropower as primary economic drivers (Regmi& Rehman, 2021). While the country has made progress in leveraging its vast renewable energy resources, particularly hydropower, the relationship between renewable energy consumption, socio-economic factors, and CO_2 emissions remains underexplored (Regmi et al., 2024).

This study seeks to address this gap by modeling the impact of renewable energy and socio-economic indicators on Nepal's CO_2 emissions, utilizing the Autoregressive Distributed Lag (ARDL) approach to capture both short-term and long-term relationships. Nepal's reliance on both traditional agricultural practices and renewable energy, especially hydropower, offers a unique opportunity to explore how these factors influence CO_2 emissions (Shakya et al., 2023). As the country navigates its development path, balancing economic growth with the need to reduce emissions remains a critical challenge (Regmi & Rehman, 2021).

The environmental Kuznets curve (EKC) hypothesis has often been applied to explore the relationship between economic growth and environmental degradation, positing that emissions rise during early stages of development but eventually decrease as economies become more advanced (Abdulqadir, 2022; Regmi et al., 2024). However, empirical evidence regarding this theory in the context of Nepal remains limited. In

their study, Regmi et al. (2024) found that while economic growth has contributed to CO_2 emissions in Nepal, the country's renewable energy initiatives have helped mitigate some of these negative effects.

Globally, studies have shown that renewable energy consumption plays a crucial role in mitigating emissions while promoting sustainable development (Bekhet & Othman, 2018; Zhou, 2023). For instance, Adebayo et al. (2021) highlighted how agricultural practices and renewable energy contribute to CO_2 emissions in Indonesia, findings which resonate with
Nepal's reliance on agriculture as a major economic driver. Similarly, Aydoğan and Vardar (2020) emphasized the critical role of renewable energy in reducing emissions across emerging economies, suggesting that targeted energy policies could significantly reduce environmental damage.

This study builds on this growing body of literature by focusing on Nepal, a country with distinct socio-economic and energy dynamics. By utilizing a 30-year dataset from 1991 to 2020 and employing advanced econometric techniques such as Dynamic Ordinary Least Squares (DOLS), this research provides a deeper understanding of the relationship between renewable energy consumption, socio-economic factors, and CO2 emissions. The findings aim to inform Nepal's energy and environmental policies by offering insights into how renewable energy can contribute to a sustainable development pathway.

Literature Review

The relationship between economic growth and carbon dioxide (CO_2) emissions has been mostly studied, particularly within the framework of the environmental Kuznets curve (EKC). The EKC hypothesis posits that CO_2 emissions rise during the

early stages of economic growth but decrease as economies mature and adopt cleaner technologies (Farhani & Rejeb, 2012; Zhou, 2023). Studies such as those by Alam et al. (2016) and Adebola Solarin et al. (2017) have validated this hypothesis in large developing economies like India and China, where economic expansion initially contributed to higher emissions. However, the shift toward cleaner energy sources, including hydroelectricity, was shown to mitigate these emissions over time.

Energy consumption, particularly from non-renewable sources, remains a significant driver of environmental degradation and CO_2 emissions. Farhani and Rejeb (2012) emphasize that in the MENA region, energy consumption is directly correlated with higher emissions due to the reliance on fossil fuels. Similarly, studies by Bekhet and Othman (2018) and Aydoğan and Vardar (2020) highlight that energy consumption from non-renewable sources in emerging economies like Malaysia and the E7 countries leads to increased emissions, complicating efforts to achieve sustainable growth.

However, renewable energy has been increasingly recognized as a viable solution to curbing these emissions. In their study of OECD countries, Cheng et al. (2018) found that integrating renewable energy and technological innovations significantly reduced CO_2 emissions. This transition toward renewable energy is critical for countries like Nepal, where hydropower and other renewable sources are poised to play a key role in the country's future energy strategy (Shakya et al., 2023). The experience of EU countries, where renewable energy consumption has contributed to substantial reductions in CO_2 emissions, offers valuable lessons for Nepal (Alavijeh & Shadmehri, 2022).

The role of renewable energy in reducing CO_2 emissions has been well-documented in both developing and developed countries. Cheng et al. (2018) found that renewable energy consumption reduces CO_2 emissions, particularly when combined

with innovation and technological advancement. This view is supported by Dam and Işik (2022), who showed that renewable energy adoption, coupled with strong institutional frameworks, significantly lowers emissions in MENA countries.

Alavijeh and Shadmehri (2022) conducted a panel data analysis on EU countries and demonstrated that the expansion of renewable energy infrastructure plays a vital role in achieving emissions reduction targets. These findings are particularly relevant for Nepal, where investments in renewable energy, especially hydropower, are expected to drive longterm emissions reductions (Regmi, et al., 2024). The shift toward renewable energy in Nepal is also supported by research from Saleem and Khan (2022), who emphasize the role of green financing and technological innovation in promoting the adoption of clean energy sources and reducing carbon footprints.

The concept of green growth, which emphasizes economic growth alongside environmental sustainability, has gained prominence in both academic and policy discussions. Hao and Umar (2021) explored green growth strategies in the G7 countries, highlighting how low-carbon policies and investments in natural resources and human capital contribute to reduced emissions. Similarly, Do et al. (2021) demonstrated that green growth, supported by ecological innovation and ICT integration, can lead to both economic development and environmental preservation in emerging economies.

These green growth strategies are particularly relevant to Nepal, where the government has prioritized low-carbon development as part of its long-term energy and environmental policies. Green financing mechanisms, as highlighted by Saleem and Khan (2022), can provide the necessary support to ensure that renewable energy projects are both economically viable and environmentally beneficial. Such

mechanisms can help Nepal achieve its sustainability goals while fostering economic growth.

The studies reviewed highlight the critical role that renewable energy and policy frameworks play in achieving sustainable development. As seen in EU countries (Alavijeh & Shadmehri, 2022) and OECD nations (Cheng et al., 2018), strong institutional support and green financing are essential for promoting the widespread adoption of renewable energy technologies. For Nepal, lessons from these regions, as well as the Middle East and North
Africa (MENA) countries (Dam & Işik, 2022), suggest that robust policies promoting renewable energy and green growth can significantly reduce CO_2 emissions without hindering economic progress.

Regmi and Rehman (2021) emphasize that both long-term and short-term strategies are needed to balance economic growth with environmental sustainability in Nepal. Investments in renewable energy infrastructure, green financing, and ecological innovation will be critical for the country's future development path. With targeted policy interventions and continued emphasis on renewable energy, Nepal can effectively navigate the challenges of economic growth and emissions reduction.

While prior studies, such as Regmi et al. (2024) and Shakya et al. (2023), have examined the relationship between renewable energy, economic growth, and CO2 emissions in Nepal, critical gaps remain unaddressed. This study advances the field by evaluating the effectiveness of Nepal-specific policies, such as the National Renewable Energy Policy (2016), which prioritizes hydropower expansion, the Rural Energy Policy (2006), which aims to increase rural electrification, and the Energy White Paper

(2018), which emphasizes renewable energy investment to meet Nepal's target of 15% renewable energy in its total energy mix by 2030.

Additionally, it incorporates socio-economic variables like renewable installed capacity
(LNRIC), agriculture, forestry, and fishing value-added (LNAV), and the Human Development Index (LNHDI), which are uniquely tied to Nepal's economic and environmental dynamics. By utilizing a comprehensive 30-year dataset (1991–2020) and employing advanced econometric techniques, such as Dynamic Ordinary Least Squares (DOLS), this study provides robust insights into both short-term and long-term relationships between variables. These contributions offer a deeper understanding of Nepal's distinctive context, supporting the development of tailored policies for sustainable growth and emissions reduction.

Methodology

This quantitative study employed analytical and descriptive research designs (Poudel & Sapkota, 2022). Secondary data were used to evaluate the impact of independent variables on the dependent variable. The data were analyzed and interpreted using EViews version 10. The investigation relies on secondary and time series data. The study utilized 30 sets of time series data spanning from 1991 to 2020 to analyze the relationship between the dependent and independent variables.

Nature and Sources of Data

The information utilized in this analysis is derived from secondary and time series data.
Data sources include World Development Indicators database, World Bank (Online) only.

Table 1.

Variable, their description and measurement

Variables	Definition	Measurement
$LNCO_2$	Natural Log of CO_2 Emissions	metric tons per capita
LNREC	Natural Log of Renewable Energy Consumption	% of Total Final Energy Consumption
LNGDP	Natural Log of Gross Domestic Product Per Capita.	constant 2015 US$
LNRIC	Natural Log of Renewable Installed Capacity	Mega Watt
LNAV	Natural Log of Agriculture, Forestry, Fishing Value Added	% of GDP
LNHDI	Natural Log of Human Development Index	Value between 0-1

Specification of the Model

The suggested model structure is presented as: $CO_{2t}=f(REC_t, GDP_t, RIC_t, AV_t, HDI_t)$

This model can be further elaborated based on specific assumptions and available data. For a basic linear model, the representation is as follows:

$$CO_{2t} =\beta_0 +\beta_1 REC_t+\beta_2 GDP_t +\beta_3 RIC_t+ \beta_4 AV_t+ \beta_5 HDI_t+\varepsilon_t$$

Where:

CO_2 =Carbondioxide (CO_2) Emission (metric tons per capita)

REC = Renewable Energy Consumption (% of Total Final Energy Consumption)

GDP = Gross Domestic Product Per Capita (constant 2015 US$)

RIC= Renewable Installed Capacity (MW)

EIC = Electricity Installed Capacity (MW)

AV = Agriculture, Forestry, Fishing Value Added (% of GDP)

HDI= Human Development Index

β_0 ,β_1 ,β_2 , β_3, β_4, β_5 are coefficients to be estimated.

ε_t represents the error term.

We estimate an alternative specification of our model, with all variables expressed in their natural logarithmic form, as follows:

$$\ln CO_{2t} = \beta_0 + \beta_1 \ln REC_t + \beta_2 \ln GDP_t + \beta_3 \ln RIC_t + \beta_4 \ln AVt + \beta_5 \ln HDI_t + \varepsilon_t$$

Econometric Method

Econometrics is a field within economics that utilizes statistical techniques to analyze economic data. This tool is utilized for testing economic theories, estimating economic relationships, and predicting future economic outcomes (Poudel,2022; Poudel, 2023). Econometrics is a versatile tool that can be utilized to address a broad spectrum of inquiries regarding the economy.

The unit root testing

The unit root test allowed us to determine the order of integration for each time series. To proceed with the DOLS, the time series needed to be integrated at either I(0) or I(1). Therefore, the ADF and P-P tests were used in this study to identify the order of integration.

DOLS

Due to the accumulation of leads and lags among the explanatory variables, this estimator consequently gives solutions to the problems of endogeneity, small sample

bias, and autocorrelation (Stock & Watson, 1993). The DOLS method was used to find the different level of integrations of dependent and independent variables as well as it is also used when endogeneity in independent variables.

Data Analysis and Results

Descriptive Statistics

The descriptive statistics for Nepal's economic indicators show significant variability and deviations.

Table 2.

Descriptive Statistics

	$LNCO_2$	**LNGDP**	**LNAV**	**LNHDI**	**LNRIC**	**LNREC**
Mean	-1.895456	6.468779	3.478456	-0.685547	6.247251	4.467471
Median	-2.077202	6.415276	3.511563	-0.693197	6.362136	4.490709
Maximum	-0.632839	6.967425	3.800497	-0.492658	7.224025	4.545314
Minimum	-2.834831	6.077881	3.071923	-0.896488	5.451038	4.307976
Std. Dev.	0.649349	0.272470	0.202139	0.126202	0.547915	0.067608
Skewness	0.636844	0.311358	-0.530462	-0.008880	-0.117803	-1.205743
Kurtosis	2.367283	1.888500	2.334830	1.712778	1.829949	3.387911
Observations	30	30	30	30	30	30

Source: *Results from data analysis.*

The descriptive statistics for Nepal's economic indicators reveal notable patterns and variability, providing insight into the country's development and sustainability challenges. The mean value of $LNCO_2$ (-1.895) indicates low per capita carbon emissions, likely due to

Nepal's reliance on renewable energy sources, as reflected by a high mean for LNREC (4.467). However, the wide range in CO_2 emissions, from -2.835 to -0.633, suggests considerable variability, which could be driven by fluctuations in industrial activity and energy consumption patterns.

The moderate standard deviation in LNGDP (0.272) highlights stable economic output per capita, yet skewness (0.311) and kurtosis (1.889) suggest a mildly right-skewed distribution with a flatter than normal peak, implying that while GDP growth has been steady, periods of rapid growth or downturns exist. LNHDI's low mean (-0.685) underscores the country's developmental challenges, reflected in its Human Development Index. The relatively higher variability in renewable installed capacity (LNRIC) shows Nepal's ongoing efforts to expand clean energy infrastructure. Overall, these indicators reflect the complex interplay between environmental sustainability, energy consumption, and economic growth, with policy implications for balancing development goals with ecological preservation.

Table 3.

Covariance Analysis: Ordinary

Correlation (Prob.)	$LNCO_2$	LNGDP	LNAV	LNHDI	LNRIC	LNREC
$LNCO_2$	1.0000					
LNGDP	0.9571	1.0000				
	0.0000					
LNAV	-0.9453	-0.9800	1.0000			
	0.0000	0.0000				
LNHDI	0.9287	0.9904	-0.9587	1.0000		
	0.0000	0.0000	0.0000			

LNRIC	0.8798	0.9549	-0.9397	0.9624	1.0000	
	0.0000	0.0000	0.0000	0.0000		
LNREC	-0.9750	-0.8952	0.9094	-0.8458	-0.8141	1.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	

Source: *Results from data analysis.*

The covariance analysis in Table 3 highlights strong correlations among Nepal's economic and environmental indicators. $LNCO_2$ and LNGDP exhibit a highly positive correlation (0.957), suggesting that as economic output grows, carbon emissions rise significantly, reflecting a potential trade-off between growth and sustainability. Conversely, LNREC has a strong negative correlation with $LNCO_2$ (-0.975), indicating that higher REC is associated with lower emissions, supporting the case for cleaner energy transitions. The inverse relationship between LNAV and both LNGDP (-0.980) and $LNCO_2$ (-0.945) underscores the declining role of agriculture in driving emissions and economic development. Overall, these correlations suggest critical links between economic growth, energy policy, and environmental outcomes in Nepal.

Trend lines of concerned variables

The trend lines of the concerned variables reveal distinct trajectories over time, reflecting Nepal's economic and environmental shifts.

Figure 1.

Time series plots

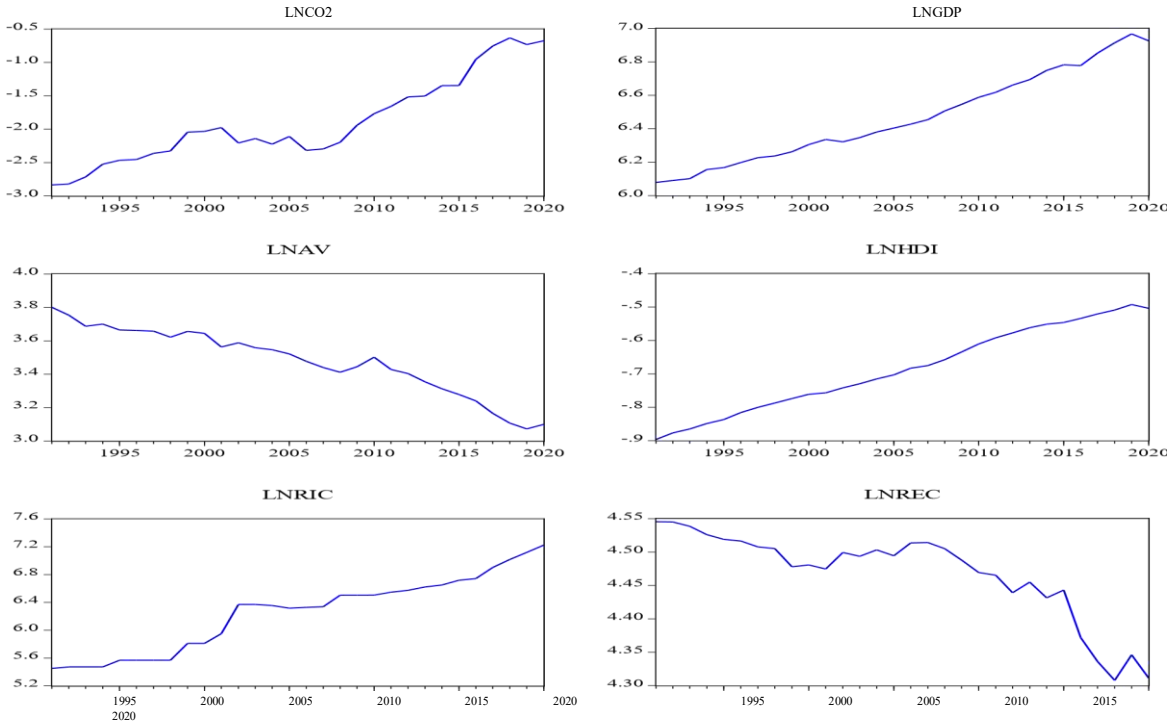


Figure 1 illustrates the time-series trends of Nepal's key economic and environmental indicators from 1991 to 2020, including CO2 emissions (LNCO2), GDP per capita (LNGDP), renewable energy consumption (LNREC), renewable installed capacity (LNRIC), agriculture's contribution to GDP (LNAV), and the Human Development Index (LNHDI). The steady increase in LNCO2 indicates rising carbon emissions, driven by economic growth and industrial activities, as reflected in the upward trend of LNGDP. However, while GDP growth signifies improved living standards and economic development, it also highlights the trade-offs between economic expansion

and environmental sustainability. LNREC and LNRIC, though showing positive trends, lag behind GDP growth, suggesting that Nepal's energy demand remains heavily reliant on traditional or non-renewable sources despite progress in renewable energy infrastructure.

A closer examination of LNAV reveals a gradual decline in agriculture's share of GDP, indicating a shift toward industrialization and urbanization, which increases energy demand and emissions. At the same time, the steady rise in LNHDI reflects improvements in socioeconomic conditions, such as education and healthcare, which influence energy consumption and environmental practices. These trends underscore the need for targeted policies to accelerate renewable energy adoption, decouple economic growth from carbon emissions, and ensure a sustainable transition for agriculture-dependent populations. The interplay between these indicators highlights Nepal's ongoing challenge of balancing development with environmental preservation.

Unit Root Testing

Unit root testing determines whether a time series is non-stationary and possesses a unit root, indicating that shocks to the series have a permanent effect. Common tests, like the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP), help identify whether differencing is required to achieve stationarity.

Table 4.

Unit root test results (ADF and PP).

PP

At Level		$LNCO_2$	LNGDP	LNAV	LNHDI	LNRIC	LNREC
With Const.	t-Statistic	0.1232	2.2515	0.1577	-1.5351	0.1249	1.6373
	Prob.	***0.9621***	***0.9999***	***0.9648***	***0.5020***	***0.9622***	***0.9993***
		no	no	no	no	no	no

With Const. & Trend	t-Statistic	-1.4262	-2.0148	-1.7592	-1.0622	-2.2319	-1.0659
	Prob.	***0.8313***	***0.5692***	***0.6981***	***0.9184***	***0.4554***	***0.9178***
		no	no	no	no	no	no
At First Difference		d($LNCO_2$)	d(LNGDP)	d(LNAV)	d(LNHDI)	d(LNRIC)	d(LNREC)
With Const.	t-Statistic	-4.9751	-4.4750	-5.1048	-3.2302	-4.9241	-5.9063
	Prob.	***0.0004***	***0.0015***	***0.0003***	***0.0287***	***0.0005***	***0.0000***
		***	***	***	**	***	***
With Const.& Trend	t-Statistic	-4.9171	-4.5177	-5.2507	-3.3620	-4.8758	-6.3629
	Prob.	***0.0025***	***0.0064***	***0.0011***	***0.0772***	***0.0028***	***0.0001***
		***	***	***	*	***	***

ADF

At Level		$LNCO_2$	LNGDP	LNAV	LNHDI	LNRIC	LNREC
With Constant	t-Statistic	0.9375	2.7819	0.0859	-1.5612	0.1411	2.0163
	Prob.	***0.9944***	***1.0000***	***0.9590***	***0.4891***	***0.9635***	***0.9997***
		no	no	no	no	no	no
With Const. & Trend	t-Statistic	-1.9509	-2.0938	-1.6895	-0.7364	-2.0836	0.5606
	Prob.	***0.5973***	***0.5275***	***0.7301***	***0.9603***	***0.5329***	***0.9989***
		no	no	no	no	no	no
At First Difference		d($LNCO_2$)	d(LNGDP)	d(LNAV)	d(LNHDI)	d(LNRIC)	d(LNREC)
With Constant	t-Statistic	-3.6337	-1.7717	-5.1159	-3.2381	-4.9253	-1.3990
	Prob.	***0.0120***	***0.3850***	***0.0003***	***0.0282***	***0.0005***	***0.5664***
		**	no	***	**	***	no
With Const.& Trend	t-Statistic	-3.9578	-5.0972	-5.1404	-3.3544	-4.8762	-4.4820
	Prob.	***0.0237***	***0.0019***	***0.0015***	***0.0783***	***0.0028***	***0.0076***
		**	***	***	*	***	***

*Significant at the 10%; **Significant at the 5%;

*** Significant at the 1%. and no Not Significant.

Source: *Results from data analysis*

The unit root test results (ADF and PP) reveal the stationarity properties of the variables, crucial for econometric modeling. At the level, both the ADF and PP tests fail to reject the null hypothesis for all variables, indicating non-stationarity. This suggests that variables like carbon emissions ($LNCO_2$), GDP per capita (LNGDP), and renewable energy consumption (LNREC) follow a stochastic trend, which can lead to spurious regressions if not addressed. However, after first differencing, most variables become stationary, as indicated by significant t-statistics and probabilities below the 5% level, except for LNGDP and LNREC in some cases.

This transformation is critical for ensuring valid long-run relationships in DOLS model , where variables need to be integrated at either I(0) or I(1). The stationarity of key economic indicators, such as GDP and renewable energy, highlights the dynamic nature of Nepal's economic and environmental growth, enabling the application of further econometric techniques like co-integration and causality tests.

Co-Integration

Co-integration is a statistical property of a collection of time series variables that indicates a long-term equilibrium relationship among them, even if the individual series themselves are non-stationary. When variables are co-integrated, they tend to move together over time, suggesting that deviations from this equilibrium are temporary (Acharya et al., 2024a; Kharel et al., 2024). This concept is crucial for economic modeling, as it allows researchers to identify and model relationships that persist despite short-term fluctuations.

Table 5.

Johansen's Cointegration test

	Trace Test		**Maximum Eigenvalue Test**	
No. of Cointegration vectors	**Statistic**	**5% Critical Values**	**Statistic**	**5% Critical Values**
None *	116.0700	95.75366	57.77580	40.07757
At most 1	58.29424	69.81889	23.60676	33.87687
At most 2	34.68749	47.85613	15.81428	27.58434
At most 3	18.87321	29.79707	12.69067	21.13162
At most 4	6.182539	15.49471	5.656210	14.26460
At most 5	0.526329	3.841466	0.526329	3.841466

Source: *Results from data analysis.*

The Johansen cointegration test results in Table 5 suggest the presence of a long-term equilibrium relationship among the variables. The trace test indicates one cointegrating vector, as the test statistic (116.07) exceeds the 5% critical value (95.75) at the "None" hypothesis, confirming the presence of a long-run relationship between $LNCO_2$, LNGDP, and other variables like renewable energy consumption (LNREC) and human development (LNHDI). This is crucial for economic applications, as cointegration implies that although individual variables may be non-stationary, their combined movement reflects a stable, longterm equilibrium.

The Maximum Eigenvalue test corroborates this, with one cointegrating vector (57.77 > 40.08). These results support using models like Vector Error Correction (VECM), which account for both short-run dynamics and long-run equilibrium. For Nepal, this indicates that while short-term fluctuations in GDP and emissions are

expected, policies fostering renewable energy and human development could contribute to long-term environmental sustainability and economic growth.

Table 6.

Results of DOLS Cointegration

Dependent Variable: $LNCO_2$

Variable	Coeff.	Standard Error	t-Stat.	Probability
LNGDP	3.377694	0.964358	3.502532	0.0128
LNAV	2.001036	0.359805	5.561446	0.0014
LNHDI	-1.697294	1.474638	-1.150991	0.2935
LNRIC	-0.071547	0.076876	-0.930675	0.3879
LNREC	-5.818686	0.931246	-6.248280	0.0008
C	-5.124913	10.54018	-0.486226	0.6441
R-squared	0.998749	Mean dependent var		-1.871645
Adjusted R-squared	0.994578	S.D. dependent var		0.587865
S.E. of regression	0.043288	Sum squared resid		0.011243
Long-run variance	0.000710			

Source: *Results from data analysis.*

The results from the DOLS cointegration model indicate that a 1% increase in GDP per capita (LNGDP) leads to a 3.38% rise in carbon dioxide emissions ($LNCO_2$), highlighting the strong positive relationship between economic growth and environmental degradation in Nepal. This significant and large coefficient suggests that economic activities, likely driven by industrial expansion, energy consumption, and urbanization, are heavily reliant on carbonintensive processes. As the economy grows,

the demand for energy increases, much of which may still be sourced from non-renewable resources. This creates a clear trade-off: while GDP growth fosters economic development, it simultaneously accelerates environmental damage by increasing carbon emissions.

Conversely, the negative coefficient for renewable energy consumption (LNREC) shows that a 1% rise in renewable energy use cuts CO_2 emissions by 5.82%. This underscores the potential for renewable energy to mitigate the negative environmental impacts of economic development. If Nepal can shift its energy consumption towards renewables like hydropower or solar energy, it can effectively decouple economic growth from carbon emissions. In policy terms, these findings highlight the importance of promoting sustainable energy initiatives and improving energy efficiency to balance growth with environmental preservation. The results suggest that without significant investment in renewable energy, Nepal's development trajectory may come at a high environmental cost.

Table 7.

Correlation matrix of explanatory variables in levels

	LNGDP	**LNAV**	**LNHDI**	**LNRIC**	**LNREC**
LNGDP	1	-	-	-	-
LNAV	-0.9800	1	-	-	-
LNHDI	0.9904	-0.9587	1	-	-
LNRIC	0.9549	-0.9397	0.9624	1	-
LNREC	-0.8952	0.9094	-0.8458	-0.8141	1

Source: *Results from data analysis.*

The correlation matrix shows strong relationships among the explanatory variables. LNGDP and LNHDI have a highly positive correlation (0.9904), indicating that economic growth and human development progress together. However, LNREC negatively correlates with both LNGDP (-0.8952) and LNHDI (-0.8458), suggesting that increased renewable energy consumption is associated with lower economic growth and human development, potentially due to the transition costs of shifting to greener energy sources.

Table 8.

Correlation matrix of explanatory variables in first differences

	D(LNGDP)	**D(LNAV)**	**D(LNHDI)**	**D(LNRIC)**	**D(LNREC)**
D(LNGDP)	1	-	-	-	-
D(LNAV)	-0.2298	1	-	-	-
D(LNHDI)	0.4642	0.1209	1	-	-
D(LNRIC)	-0.1627	0.1272	-0.1730	1	-
D(LNREC)	0.0593	-0.0638	0.2309	0.0861	1

Source: *Results from data analysis.*

The correlation matrix of the first differences reveals varying relationships among the changes in the explanatory variables. D(LNGDP) shows a weak negative correlation with D(LNAV) (-0.2298), suggesting that increases in agricultural value added may not directly coincide with GDP growth. Additionally, the positive correlation between D(LNHDI) and D(LNREC) (0.2309) indicates that improvements in human development may be associated with changes in renewable energy consumption, highlighting a potential link between sustainable practices and social progress.

The correlation matrices presented in Tables 7 and 8 illustrate the relationships in both levels and first differences. These tables indicate that the levels exhibit very high correlations, potentially resulting from spurious correlations. To address this, we examine the data in first differences, which may estimate the residual series used in the experiment design to induce correlation; even in this form, the correlations among the variables remain notably low, ranging from 0.05 to 0.46.

Granger Causality Test

The Granger Causality Test in a DOLS framework evaluates whether one time series can predict another, taking into account both short- and long-run dynamics. It is used to assess the causal relationships between integrated variables within cointegration models (Poudel et al., 2023).

Table 9.

Pairwise Granger Causality Tests

Direction of Causality		**Observations**	**F-Stat.**	**Prob.**
LNGDP →	$LNCO_2$	29	3.33077	0.0795
$LNCO_2$ →	LNGDP		0.05757	0.8123
LNAV →	$LNCO_2$	29	2.02851	0.1663
$LNCO_2$ →	LNAV		4.33840	0.0472
LNHDI →	$LNCO_2$	29	2.95494	0.0975
$LNCO_2$ →	LNHDI		3.29380	0.0811
LNRIC →	$LNCO_2$	29	0.14745	0.7041
$LNCO_2$ →	LNRIC		6.25501	0.0190
LNREC →	$LNCO_2$	29	3.29556	0.0810
$LNCO_2$ →	LNREC		5.32866	0.0292

LNAV → LNGDP		29	0.03313	0.8570
LNGDP → LNAV			6.00680	0.0213
LNHDI → LNGDP		29	6.58210	0.0164
LNGDP → LNHDI			4.53151	0.0429
LNRIC → LNAV		29	0.73906	0.3978
Direction of Causality		**Observations**	**F-Stat.**	**Prob.**
LNAV → LNRIC			5.42075	0.0279
LNREC → LNRIC		29	5.32627	0.0292
LNRIC → LNREC			0.73404	0.3994

Source: *Results from data analysis.*

The pairwise Granger causality tests offer valuable understandings into the dynamic associations among the economic and environmental variables in Nepal. The null hypothesis tests reveal that LNGDP (economic growth) significantly Granger-causes $LNCO_2$ (carbon emissions) with a p-value of 0.0795, suggesting that increases in GDP precede rises in CO_2 emissions, albeit at a marginal significance level. This relationship underscores the challenge of balancing economic growth with environmental sustainability, indicating that as the economy expands, it may lead to increased carbon emissions unless there are proactive measures to promote clean energy and sustainable practices.

Conversely, $LNCO_2$ significantly Granger-causes LNREC (renewable energy consumption) with a p-value of 0.0292, suggesting that higher emissions may spur the demand for renewable energy solutions, emphasizing a reactive policy approach rather than a proactive one. Moreover, the strong causality from LNHDI (Human

Development Index) to LNGDP (p = 0.0164) suggests that improvements in human development drive economic growth, which aligns with the theory that better health and education contribute to a more productive workforce. Overall, these findings highlight the intricate interplay between environmental impacts and economic growth, highlighting the need for integrated policies that foster sustainable growth while enhancing human development outcomes.

Wald Test

The Wald test, named after statistician Abraham Wald, is a hypothesis test used to assess the significance of coefficients in regression analysis or the parameters of a statistical model. It evaluates whether a particular parameter estimated from the data significantly differs from a hypothesized value, often zero. By comparing the estimated parameter to its standard error and assuming a normal distribution, the Wald test generates a test statistic. This statistic follows a chi-squared distribution under the H_0, allowing researchers to determine whether the observed deviation is statistically significant. Thus, the Wald test provides a crucial tool for understanding the relevance and reliability of specific variables or parameters within complex statistical models.

Table 10.

Wald Test Results

Test Stat.	***Value***	***Degree of freedom***	***Prob.***
F-stat.	321.4927	(5, 6)	0.0000
Chi −square	1607.463	5	0.0000
Normalized Restriction (= 0)		***Value***	***Std. Err.***
C(1)		3.377694	0.964358

C(2)	2.001036	0.359805
C(3)	-1.697294	1.474638
C(4)	-0.071547	0.076876
C(5)	-5.818686	0.931246

Source: *Results from data analysis.*

The Wald test results presented in Table 10 indicate significant relationships among the model's coefficients, suggesting that a minimum of one of the explanatory variables has a substantial effect on carbon emissions ($LNCO_2$). The F-statistic (321.49) and Chi-square statistic (1607.46), both yielding probabilities of 0.0000, strongly reject the H_0 that all coefficients are zero. This statistical significance implies that changes in variables such as GDP (C(1)), agricultural value added (C(2)), human development index (C(3)), renewable installed capacity (C(4)), and renewable energy consumption (C(5)) collectively contribute to explaining variations in carbon emissions.

The relationship between economic growth and carbon emissions, as reflected by the positive GDP coefficient (C(1) = 3.3777), and the mitigating role of renewable energy consumption, indicated by the negative coefficient (C(5) = -5.8187), highlights a complex dynamic rather than a contradiction. Economic growth in Nepal, driven by industrialization and urbanization, increases energy demand, much of which is still met by carbon-intensive sources. Meanwhile, renewable energy consumption significantly reduces emissions in regions or sectors where it is integrated, demonstrating its potential to offset environmental degradation.

However, the slower adoption of renewable energy compared to the pace of economic expansion results in continued emissions growth overall. This dual effect underscores the need for accelerated renewable energy adoption, particularly in

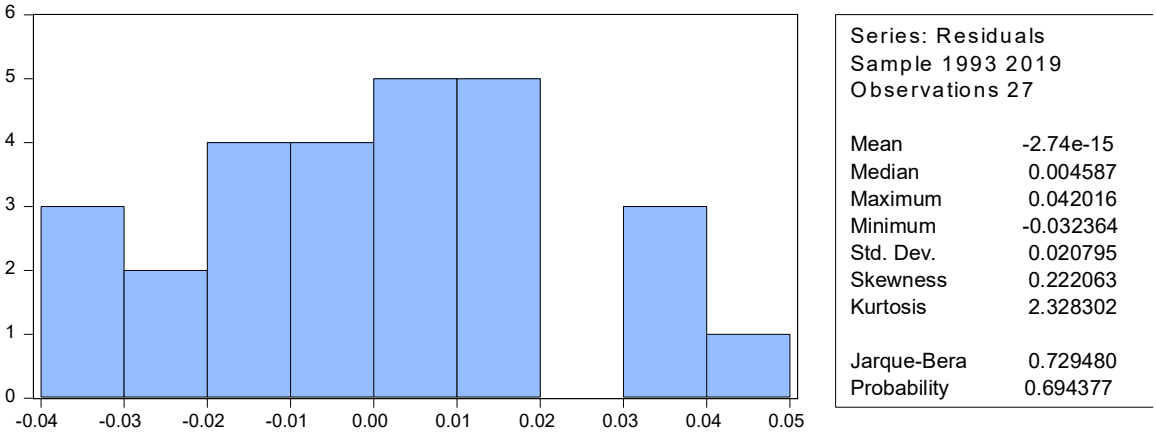
industrial and urban sectors, alongside integrated policies that align economic development with sustainability goals. By investing in renewable energy infrastructure and promoting sustainable practices, Nepal can effectively balance economic growth with environmental preservation.

Normality Test

A normality test determines whether a dataset follows a normal (Gaussian) distribution, which is a key assumption in many statistical models. Common tests, such as the Jarque-Bera assess this by analyzing the kurtosis and skewness of the data.

Figure 2.

Jarque-Bera Normality Test



Source: *Results from data analysis*.

The Jarque-Bera test's probability value (0.694377) exceeds the 5% significance level, suggesting that the residuals of the model follow a Gaussian distribution. This indicates that the assumption of normality for the model's variables is likely met.

Discussions

This study's findings align with the results of previous research while offering insights into Nepal's unique socio-economic and energy dynamics. Similar to Adebayo et al. (2021) and
Aydoğan and Vardar (2020), the results confirm that economic growth significantly contributes to CO2 emissions, as seen in Nepal's reliance on industrialization and urbanization to drive GDP. The negative correlation between renewable energy consumption and emissions supports the pivotal role of renewables in mitigating environmental degradation, resonating with findings from Indonesia and E7 countries. Institutional quality, as emphasized by Dam and Işik (2022) in the MENA region, is also relevant to Nepal, where policy implementation often faces challenges due to weak institutional frameworks.

Technological innovation and strong policy support, highlighted by Cheng et al. (2018) and Alavijeh and Shadmehri (2022) in OECD and EU contexts, emerge as critical drivers for emissions reduction. In Nepal, however, the lack of green financing mechanisms, inconsistent policy implementation, and limited access to technological advancements hinder the widespread adoption of renewable energy solutions. Although Regmi et al. (2024) emphasized the potential of hydropower to balance economic growth and sustainability, this study underscores the need to accelerate investment in other renewable sources, such as solar and wind energy, to diversify Nepal's energy mix.

Fundamental issues in Nepal include inadequate infrastructure for renewable energy, reliance on traditional agricultural practices, and limited awareness of energy efficiency measures. Policy shortcomings involve the lack of targeted subsidies for renewable

energy projects, fragmented energy governance, and insufficient integration of renewable energy in industrial sectors. To address these challenges, Nepal must enhance institutional capacity, streamline renewable energy policies, and establish green financing initiatives to support infrastructure development and innovation. These measures are essential for achieving longterm sustainability while fostering economic growth.

Conclusions

This study examined the relationships between carbon emissions, economic growth, renewable energy consumption, and socio-economic factors in Nepal, revealing important insights. The results show that a 1% increase in GDP per capita contributes to a 3.38% rise in CO2 emissions, highlighting the significant environmental impact of economic growth driven by industrialization and urbanization. In contrast, a 1% increase in renewable energy consumption reduces CO2 emissions by 5.82%, underscoring the crucial role of renewable energy in mitigating environmental degradation.

These quantified findings emphasize the dual challenge Nepal faces in balancing economic growth with environmental sustainability. While economic expansion increases emissions, renewable energy offers a pathway to decouple growth from environmental harm. The study also highlights the influence of socio-economic factors. For instance, human development (LNHDI) has a nuanced role: its positive impact on quality of life indirectly increases emissions due to higher energy demand, while its negative coefficient in the model suggests that advancements in human capital can also foster sustainable practices.

Agriculture's share of GDP (LNAV) shows a diminishing contribution to emissions, reflecting Nepal's economic shift from agriculture to industrial and service sectors. Policymakers must consider these socio-economic dynamics to develop targeted strategies that address emissions holistically. The use of advanced econometric models, including ARDL and DOLS, ensures robust analysis of short- and long-term relationships among these variables, providing reliable evidence for policy formulation.

Promoting investments in renewable energy infrastructure, particularly in hydropower,
solar, and wind energy, could further reduce Nepal's carbon footprint. Future research could explore the long-term impacts of diversifying renewable energy sources and conduct comparative studies with other developing countries to draw broader insights. Addressing socio-economic factors such as education, healthcare, and sustainable agricultural practices should also be integral to designing effective energy policies for sustainable growth.

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Determinants Shaping Coffee Consumption Culture among Banking Professionals in Kathmandu Valley

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Abstract

The lifestyle of Nepali consumers, particularly in Kathmandu, is shifting due to the influence of globalization and Western culture. This study explores the emerging coffee culture, primarily among bankers in Kathmandu Valley, where coffee consumption is rising despite Nepal's traditional preference for tea. The research aims to identify the factors driving this trend, such as Western influence and changing consumer behavior and examines the attitudes of bank employees toward coffee. The study provides insights that will help marketers and the coffee industry strategize for future growth and offers a foundation for further research on coffee consumption in among various emerging cultures, Coffee drinking is one of the emerging cultures among Nepali consumers. These days, White Mochas, Cappuccinos, Lattes, Cafe Mocha, Americano, and Espressos are on everybody lips, literally and figuratively. Traditionally, Nepalese are more tea-people than coffee-people. There are tea stalls in virtually every nook and corner of the country and it is still the favorite national drink for the rich as well as the poor. But over the last couple of years, the habit of coffee consumption has shot up dramatically, particularly in Kathmandu and other urban centers, with youngsters of the MTV generation and foreign-returned professionals as the primary consumers.

Keywords: Coffee consumption habit, banking professionals, coffee culture, Kathmandu Valley

Determinants Shaping Coffee Consumption Culture among Banking Professionals in Kathmandu Valley

The lifestyle of Nepali consumers is undergoing significant transformation, particularly in urban areas like Kathmandu, as a result of globalization and the growing influence of Western culture. This shift is evident not only in entertainment and leisure preferences but also in eating and drinking habits. Coffee culture, once foreign to Nepal, is becoming increasingly popular, especially among younger generations and professionals. As stated by sociologist T.B. Subba, "Globalization is altering the fabric of traditional societies, blending local and global habits into a new cultural synthesis" (Subba, 2019). This shift is especially noticeable in the rising coffee consumption, an emerging trend in a nation that has long favored tea.

Traditionally, tea has been the beverage of choice in Nepal, ubiquitous in every corner of the country. However, the last few years have witnessed a surge in coffee consumption, particularly in Kathmandu, with young people and returning expatriates being the primary drivers of this shift. As noted by G. Sharma (2021), "The urban centers of Nepal are rapidly embracing coffee culture, with cafes mushrooming around educational institutions and office spaces." This trend, initially seen among tourists and foreigners, is now becoming mainstream, with local cafes and coffee chains meeting the growing demand.

Despite the increasing popularity of coffee, this habit has not yet reached the levels seen in Western countries where coffee is a daily staple. Nonetheless, the growing fascination with coffee in Kathmandu presents vast potential for market expansion. This study aims to analyze the factors driving the rise of coffee consumption among bankers in the Kathmandu Valley, examining the role of Western influence and changing consumer behavior.

Literature Review

Huang et al. (2013) studied how price promotions influence customer product evaluations in coffee chain stores. Using a questionnaire survey of Starbucks consumers in Taiwan, the study found that price promotions had positive effects on customer quality evaluations and repeatpurchase intentions. It highlighted the need for coffee chain managers to strategically manage price promotions, taking into account customer characteristics to enhance long-term sales.

McGuire (1976) explored the internal psychological factors influencing consumer choices. The research identified three key factors: external influences (product exposure), internal directive factors (personality traits guiding decision-making), and internal dynamic factors (motivational forces driving consumption behavior). The study underscored the importance of understanding how these psychological factors shape consumer decisions. Brown et al. (1993) investigated the relationship between coffee and tea consumption and coronary heart disease in Scotland. Using data from the Scottish Heart Health Study, the research found that non-coffee drinkers had a higher prevalence of coronary heart disease compared to coffee drinkers. However, after adjusting for risk factors, no positive relationship between coffee or tea consumption and coronary heart disease was supported. Coffee is one of the most widely consumed beverages and most internationally traded commodities in the world in good part because caffeine is the world's most popular drug, a legal drug. Coffee was also a sort of early sports medicine, a pep pill that had the dual advantages of accessing energy through its caffeine and quelling hunger pangs. Coffee's purpose was to stimulate individual fortitude, not sociability. Coffee, which mainly grew wild, only slowly became a traded commodity.

Research Objectives

The research study is aimed at analyzing the factors influencing Coffee consumption culture among bankers of Kathmandu valley. The major objectives of the study are as follows:

To study the factors influencing Coffee consumption culture among Nepalese consumers, working at selected banks of Kathmandu Valley.

To find out the most important factor responsible for influencing Coffee consumption culture among Nepalese consumers, working at selected banks of Kathmandu Valley.

Research Methodology

The study has focused on an analysis of factors influencing coffee consumption culture among employees of selected banks of Kathmandu Valley. The research is descriptive and applied research. The research is based on quantitative data as the research involves collecting and converting data into numerical form so that statistical calculations can be made and conclusions are drawn. A total of 150 respondents were randomly selected from diverse positions working at various commercial banks in Kathmandu Valley. Questionnaires, telephone calls and at times emails were sent to collect the data.

The sources of secondary data include books, journals, magazines, newspapers, internet and related research papers. The data was collected by visiting different locations in the valley and in a specific time period of four to six weeks. The data was collected from primary as well as secondary sources. Descriptive analysis as well as inferential analysis was used for analyzing the data. The central tendency, frequency table was used for descriptive analysis whereas the ANOVA test was done for inferential analysis.

General Information of Respondents

Table 1

Frequency distribution of Gender

Gender	Frequency	Percent
Male	91	60.7
Female	59	39.3
Total	150	100

Among the respondents, males were found to prefer coffee over other drinks than their female counterparts, so their number is slightly found to be higher than females.

Table 2

Frequency distribution of Age group

Age Group	Frequency	Percent
18-30	54	36
30-35	61	40.7
35 and above	35	23.3
Total	150	100

During the research, respondents aged between 30-35 were found be consuming coffee frequently then the other age categories. The reason behind was the peer pressure and wanted to try various types of coffee as their adrenaline is slightly higher than the others.

Table 3

Frequency distribution of Educational Background

Educational Background	**Frequency**	**Percent**
Intermediate or below	12	8
Bachelors	60	40
Masters and above	78	52
Total	150	100

As the aforementioned data indicates bankers with maters and above degrees were found to be more frequently consuming coffee than the other levels of education. This is due to their developed habit of consuming coffee over period.

Table 4

Frequency distribution of Monthly Income

Monthly Income	**Frequency**	**Percent**
Less than 25,000	35	23.3
25,000 - 50,000	46	30.7
50,000 - 75,000	41	27.3
75,000 and above	28	18.7
Total	150	100

According to this distribution of monthly income, employees with an average salary below 50,000 were found to be consuming frequent coffee because of their low workload, being sociable, and habit.

Table 5

Frequency distribution of Job Position

Job Position	**Frequency**	**Percent**
Assistant Level	44	29.3
Officer Level	60	40
Manager Level	46	30.7
Total	150	100

In the above table, officers level staff were found be to frequently drinking coffee to keep them active with their work, sociable and at times offering to their clients as well.

Table 6

Cross-tabulation between gender and number of cups of coffee per day.

Number of cups of coffee per day							
Gender	1	2	3	4	5	6	Total
Male	15.4%	39.6%	11.0%	16.5%	11.0%	6.6%	100.0%
Female	33.9%	8.5%	32.2%	6.8%	10.2%	8.5%	100.0%
Total	22.7%	27.3%	19.3%	12.7%	10.7%	7.3%	100.0%

Pearson chi square value= 29.255, p=0.000

In the above table, the highest i.e. 39.6% of the male respondents drink 2 cups of coffee per day, and likewise for the female highest i.e. 33.9% of female respondents drink one

cup of coffee per day. We can conclude that in the case of male respondents, most of them drink 2 cups of coffee per day and in the case of female respondents most of them drink one cup of coffee.

Table 7

Cross Tabulation between Age Groups and consumer's most preferred place for Coffee consumption

Most preferred place for coffee consumption					
Gender	Café	Meeting Room	Working Desk	Open Environment	Total
18-30	24.1%	18.5%	37.0%	20.4%	100.0%
30-35	34.4%	11.5%	21.3%	32.8%	100.0%
35 and above	14.3%	0.0%	42.9%	42.9%	100.0%
Total	26.0%	11.3%	32.0%	30.7%	100.0%

Pearson chi square value= 17.565, p=0.007

In the above table, 24.1% of the age group 18-30 respondents prefer coffee at a café, 18.5% prefer a meeting room, 37% prefer at working desk and 20.4% an open environment. Likewise, 34.4% of the age group 30-35 prefer coffee at a café, 11.5% at a meeting room, 21.3% at the working desk, and 32.8% at an open environment. Meanwhile, in the case of the age group above

35, 14.3% prefer at café, no one prefers in meeting room, 42.9% prefer at working desk and

42.9% prefer in open environment.

We can conclude that in the case of the age group, 18-30 highest respondents preferred a working desk, in the case of 30-35, the highest respondents preferred a café and in the case of age group of above 35 most of the respondents prefer in working desk and open environment.

Table 8

Cross Tabulation between Income level and cup of coffee consumption per day

Number of cups of coffee							
Monthly Income	1	2	3	4	5	6	Total
Less than 25000	54.3%	31.4%	0.0%	14.3%	0.0%	0.0%	100.0%
25000-50000	32.6%	21.7%	10.9%	10.9%	13.0%	10.9%	100.0%
50000-75000	0.0%	24.4%	58.5%	14.6%	0.0%	2.4%	100.0%
75000 and above	0.0%	35.7%	0.0%	10.7%	35.7%	17.9%	100.0%
Total	22.7%	27.3%	19.3%	12.7%	10.7%	7.3%	100.0%

Pearson chi square value= 115.289, p=0.000

In the above table, 54.3% of respondents with a monthly income of less than 25000 drink one cup of coffee per day, 31.4% respondent two cups per day, and 14.3% respondent drink four cups of coffee per day. Likewise, 32.6% of respondents with income level between 25000 to 50000 drink one cup of coffee per day, 21.7% two cups per day, 10.9% three cups, 10.9% four cups per day, 13% five cups per day and 10.9% drink six cups of coffee per day. Among the respondents of income level 50000-75000, 0% drink one cup, 24.4% drink two cups of coffee, 58.5% drink three cups of coffee per

day, 14.6% drink four cups, and 2.4% drink six cups of coffee per day. Similarly, o% of respondents with income of 75000 and above drink one cup of coffee per day, 35.7% drink two cups of coffee, 10.7% drink four cups of coffee per day, 35.7% drink five cups of coffee per day, and 17.9% respondents drink six cups of coffee per day. We can conclude that, among the respondents with an income level less than 25000 highest of them drink one cup of coffee per day, among 25000-50000 highest of them drink one cup of coffee, among 50000-75000 highest prefer three cups of coffee per day and among the respondent with income level 75000 and above highest number prefer two and five cups of coffee per day.

Table 9

Cross Tabulation between job position and craving for coffee the most

When do you crave coffee the most						
Job Position	High work pressure	During meetings	Break time	Cold weather	All weather	Total
Assistant Level	20.5%	0.0%	34.1%	34.1%	11.4%	100.0%
Officer Level	31.7%	8.3%	33.3%	10.0%	16.7%	100.0%
Manager Level	21.7%	21.7%	32.6%	13.0%	10.9%	100.0%
Total	25.3%	10.0%	33.3%	18.0%	13.3%	100.0%

Pearson chi square value= 22.446, p=0.004

In the above table, 20.5% of assistant-level respondents crave coffee during high work pressure, 0% during meetings, 34.1% during break time, 34.1% during cold weather,

and 11.4% during all weather. Likewise, 31.7% of officer-level respondents crave coffee during high work pressure, 8.3% during meetings, 33.3% during break time 10% during cold weather, and 16.7% during all weather. Among the manager-level respondents, 21.7% crave coffee because of high work pressure, and other 21.7% during meetings, 32.6% crave it during break time, 13% in cold weather, and 10.9% in all-weather including rainy and summer seasons.

Table 10

Correlation Analysis by Consumption Decision

	Coffee is a refreshing drink	Coffee is an aromatic and tasty drink	Coffee is a social drink	Coffee is a healthy drink	Coffee is a Western drink	Coffee is an addictive drink	Coffee is a superior drink	Coffee is an allseason drink
Coffee is a refreshing drink		.359**	-.280**	-.276**	-.008	.457**	.085	.213**
Coffee is an aromatic and tasty drink			.597**	.201*	.563**	.498**	.562**	.713**
Coffee is a social drink				.511**	.763**	.074	.668**	.658**
Coffee is a healthy drink					.310**	.094	.379**	.104
Coffee is a Western drink						.270**	.567**	.449**
Coffee is an addictive drink							.386**	.316**

Coffee is a superior drink compared to other available beverages								.672**
Coffee is an all-season drink								

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

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

Finding

From the above correlation Table 1, the following inferences, and conclusions can be made:

Coffee is a refreshing drink and has a positive correlation with coffee being an addictive drink and coffee is an aromatic and tasty drink i.e., 0.457 and 0.359 respectively. Therefore, as the perception of people perceiving coffee as a refreshing drink increases, similarly their perception of coffee as an aromatic tasty drink, and addictive drink increases, and vice versa.

Coffee is an aromatic and tasty drink that has a strong correlation with coffee as a social drink, coffee is a Western drink and coffee is a superior drink compared to other available beverages
i.e. 0.597, 0.563, and 0.562 respectively. Therefore, as the perception of people perceiving coffee as an aromatic and tasty drink increases, similarly, their perception of

coffee as a social drink, coffee is a Western drink, and as a superior drink increases, and vice versa.

Coffee is a social drink and has a strong correlation with coffee being a Western drink and coffee is a superior drink compared to other available beverages i,e. 0.763 and 0.668 respectively. Therefore, as the perception of people perceiving coffee as a social drink increases, similarly their perception of perceiving coffee is a Western drink and coffee is a superior drink compared to other available beverages increases, and vice versa.

Coffee is a healthy drink and has a strong correlation with coffee is a superior drink compared to other available beverages i.e. 0.379. Therefore, as the perception of people perceiving coffee is a healthy drink increase, similarly perception of people perceiving coffee is a superior drink compared to other available beverages increases, and vice versa.

Coffee is a Western culture drink that has a strong correlation with coffee being a superior drink compared to other available beverages i.e. 0.567. Therefore, as the perception of people perceiving coffee as a Western culture drink increases, similarly, the perception of people perceiving coffee as a superior drink compared to other available beverages increases, and vice versa.

Conclusion

The research reveals a significant rise in coffee consumption among bankers in Kathmandu Valley, primarily driven by coffee's role as a stimulant and refreshing drink. The coffee culture is poised for growth, especially in workplaces, offering substantial market opportunities.

Refreshments, followed by taste and aroma, are the key factors influencing coffee consumption, while the impact of Western culture appears minimal. Older respondents, facing higher work pressure, crave coffee more during breaks, often consuming it at their desks due to time constraints. Younger bankers, with lighter workloads, prefer cafés. Higher education correlates with a preference for black coffee, reflecting health-consciousness, while increased income is linked to greater coffee consumption with milk.

Overall, coffee is steadily gaining traction in Nepal, particularly in the banking sector. Given Nepal's comparative advantage in coffee cultivation and growing demand for Nepali specialty coffee, this sector holds significant potential for commercialization. Government and industry stakeholders should capitalize on this opportunity for future growth.

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Assessing the Interconnected Challenges of Housing, Health, Education, and Employment in Balaju Slum Settlement

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Abstract

The deprivation of slums compels dwellers to encounter employment opportunities, income constraints, access to health and sanitation, poor housing arrangements, social displacement, and public participation. In addition, they are trapped with a lack of waste management and drainage systems, a high risk of natural catastrophe, unsystematic housing, a lack of social provision and many more. This research explores the way slum dwellers are deprived of housing security, educational opportunities, employment choices and health facilities and sanitation. In-depth interviews have been utilized to collect the data through random sampling based on Balaju slum and squatter settlement. The author of this research explored that slum dwellers have poor housing condition with lacking proper ventilation, prone to natural calamity and unavailability of enough space. In addition, the higher drop out of the students from the government schools indicate the low educational condition. Moreover, Admission in private schools is just a nightmare. Similarly, Slum dwellers are dragged into the informal labor market with less wage and children of slum area are the victims of the malnutrition.

Key Words: Deprivation, Slum Settlement, Housing Insecurity, Health Condition Employment Constraints

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According to the European Union's agreed set of indicators (Eurostat, 2016), housing deprivation is determined based on specific criteria using data from the EU-SILC survey. A household is considered to be experiencing housing deprivation if its dwelling meets at least one of the following conditions: the presence of a leaking roof, dampness, or rot; absence of a bath or shower; lack of a flushing toilet; insufficient natural light; or the combined lack of a bath, shower, and toilet. Severe housing deprivation is identified when these conditions are present alongside overcrowding in the dwelling.

However, other multiple deprivations are evident among the slum settlements, particularly in the developing world. Slum dwellers are facing extreme levels of social and economic deprivation worldwide. The deprivation forced on them ranges from employment opportunities, income constraints, access to health and sanitation, poor housing arrangements, social displacement, and public participation etc. In addition, they are compelled to encounter with lack of waste management and drainage systems, a high risk of natural catastrophe, unsystematic housing, a lack of social provision, and many more.

Scholars define deprivation differently, for example, capability failure (Sen, 2000), deprivation in social participation Townsend (1986), and deprivation in well-

being, capabilities, human flourishing, and quality of life (Ruth, 2004). In a similar vein, De Haan (2000) exhibits the need to focus on multidimensional aspects of deprivation. He further illustrates that crop failure of a certain household depends on its access to support from the state, relatives, or market. What I implicate from Haan is that the slum and squatter settlements are deprived of state provision, no or little access to property, fear of eviction, pathetic living standards, and vulnerability to natural calamity and violence. The most vulnerable groups like women and children are more prone to insecurity among the slums and squatters. For example- women suffer from high rates of teen pregnancy, children from early drop out from schools, populations with disabilities due to weak infrastructural facilities and refuses from displacement (UN-Habitat, 2015/16).

881 million people are estimated to be living in slums in the world. It means one lives in slums out of 8 people. And, the bitter reality today is that populations of slums are swelling worldwide, especially in developing world in spite of the fact that upgrading settlement has been initiated with an emphasis on improving and slums settlements and preventing their formation (UN-Habitat,2016). In Nepal, 10 percent of total urban population is estimated to be living in informal settlements, not clearly identifying the population of slums. (MoUD, 2016). The total number of slum settlements inside the valley was found to be 65 with a total number of households 4,696 having total population of 28,412(Khanal and Khanal, 2022) which was 2134 in

1985. This was 4295 in 1990, 11862 in 2000, and 15000 in 2005 (Toffin, 2010). It showed that the slum population in Nepal is growing steadily. The causes of population growth in slums are skyrocketing housing affordability access, land shortage due to invertor-led land-buying activities, and a rise in poverty in urban spaces in Kathmandu (Sengupta, 2013). The swelling population incessantly in Nepal as an emerging social problem in urban spaces attracted me to conduct the research. The rise in population adds more impoverishment to the lives of slums on one side and local government's attempt for eviction intensified after the last election with new leadership elected in Kathmandu.

Objectives of the study

The general objective of this study is to map out the overall social and economic deprivation of the slum dwellers. Likewise, the specific objectives are as follows:

1. To study the deprivation in terms of education, housing, and health of the slum settlements.
2. To explore the challenges of slum settlements in terms of employment.

Literature Review

Slums, squatters, and informal settlements are often used to denote similar meanings. However, they imply different meanings. Informal settlements entail areas in

which inhabitants are deprived of security of tenure, and the housing arrangement recognizes no planning regulations. In this light, slums cannot be explained as informal settlements since informal settlements incorporate middle—and high-income people. These settlements are unauthorized but include all income populations (Buddiman, 2022).

In contrast, Slums are related to the poor households deprived of multiple possibilities. Slum Almanac (2015/16) maintains," Slums are marginalized, large agglomerations of dilapidated housing often located in the most hazardous urban land – e.g. riverbanks; sandy and degraded soils, near industries and dump sites, in swamps, flood-prone zones and steep slopes – disengaged from broader urban systems and the formal supply of basic infrastructure and services, including public space and green areas." (UN Habitat, 2015/16). Squatters squat on vacant private or public life due to the lack of tenured land without the permission of the concerned governmental body. Willis (2009) states that squatter settlement is characterized by land tenure where inhabitants occupy the land illegally. In the present study, I will exclude the informal settlements and use slum and squatter settlements because I argue that these settlements (popularly known as Sukumbasi in Nepali) are inhabited by the settlers who are thrown to the status of impoverishment due to the overcrowded city and occupied these areas illegally in the hope of housing. Therefore, this study uses slum and squatter settlements throughout, considering that slum dwellers are poor and deprived in multiple forms together.

Growth of Slums in Nepal

Scholars view that there were two historical phases of an influx of slum settlements in Nepal. (Sengupta, 2013). The first phase was 1950s which was created by the government to settle displaced rural populations due to floods, earthquakes, and landslides. The resettlement programs initiated by the government with the implementation of the Rapti Multiple Project in 1959 shifted the displaced populations in the hills. Another turning point of slum settlement growth was caused because of the Land Reform Act, of 1964 which theoretically acclaimed the tenancy rights to the peasants. The attraction of poor people to the public land for housing intensifies with the arrangement of land reform. This turning point marked the different rationale that instigated people to capture the public land without the legal and constitutional framework. The second phase of slum settlements triggered a massive exodus of rural populations to urban centers due to Maoist upheavals and the violence initiated by both the government and Maoists which was supported by the evidence that the slum population massively increased between 1985 to 2000. The rising unemployment with the massive flow of people from the origin to the urban centers played a catalyst role in enumerating the rise in slum populations in Kathmandu. The unsystematic and haphazard urbanization in Kathmandu resulting from government failure accelerated the population of slums and squatters in Kathmandu (Toffin, 2010).

Multiple Deprivation of Slum and squatter population

Housing insecurity

Gardiol (2006) highlights that residents of slums and squatter settlements are faced with illegal and substandard housing, overcrowding, unhealthy living conditions, physical vulnerability, and insecurity of land tenure, poverty, and social exclusion. He further distinguishes between types of deprivation, noting that some are related to physical and spatial factors, while others are linked to social aspects. Slums are often perceived as separate from the city, with their inhabitants marginalized from mainstream society. Foley (1980) argues that any study of housing must consider the influence of social values and an individual's social position, which both enable and limit personal choices. He emphasizes that factors such as lifestyle preferences, social relationships, personal growth, and satisfaction are all shaped by these elements.

Ayala and Navarro (2007), based on discussions with Norwegian Somalis, identify two main reasons for housing deprivation among low-income immigrant groups. On one hand, limited financial resources restrict their access to better housing. On the other hand, cultural beliefs against taking out loans further complicate the situation for Muslim families. Due to these financial and cultural barriers, many end up in social housing, which often offers poorquality accommodations characterized by small, damp, and humid rooms unsuitable for larger families. This move to public

housing also disrupts children's stability, as it often necessitates transferring to new schools.

Martin (2017) critiques traditional approaches in housing sociology, suggesting that the impact of neighborhoods on individual life outcomes is relatively minor and short-lived. He argues that the relationships with mortgage lenders and landlords have a more profound effect on people's lives than their neighbors. This perspective, which highlights the importance of housing arrangements over neighborhood dynamics, presents a new approach in the field. Martin posits that for low-income urban households, the social relations surrounding housing are more significant than the physical living space itself.

Desmond (2012) views housing deprivation as a key factor perpetuating urban poverty. He notes that poor housing conditions lead to health problems, mental distress, and overall diminished living standards, which negatively affect children and erode community cohesion. Desmond focuses on the cycle of eviction, where families, facing limited options, often resort to substandard housing in impoverished neighborhoods. He points out that strong social networks can backfire, as landlords may view these households as overcrowded due to frequent visits from friends and relatives, making them more vulnerable to eviction.

Deprivation from education, health, and employment

Similarly, Singh (2016), analyzing literature on Indian slums, identifies major issues including poor educational opportunities, inadequate healthcare, lack of participation in policymaking, substandard housing with deteriorating structures, insufficient ventilation and lighting, high unemployment rates, violence against women, water scarcity, and the absence of essential services. The lack of public involvement further deepens the deprivation of cultural capital, citizenship, social cohesion, dignity, and mutual understanding (Silver, 1995). Silver's viewpoint is particularly relevant given the ongoing challenges faced by slum settlements.

Drawing on Adam Smith's (1776) emphasis on the shame associated with exclusion from public life, Amartya Sen (2000) argues that deprivation manifests a broader failure in people's capability. In their study of Nairobi, Kenya, which has one of the largest slum populations in Africa (estimated between 235,000 and 270,000 residents), Mitra et al. (2017) describe slum areas as being plagued by unemployment, poverty, rising crime rates, inadequate sanitation infrastructure, poor housing conditions, and insecurity. Their research, conducted in the aftermath of the post-election violence of 2007-2008, indicates that the conflict exacerbated these issues. Additionally, the slum areas suffer from frequent local flooding due to poor drainage and inadequate waste management systems.

Slums have some characteristics in common; they are areas where there may be proximity effects facilitating the impact of factors such as environmental pollution, massive waste, overcrowding, non-standard houses, and physical hazards (such as accidental burns and fires), on residents' health (Lilford et al., 2017). The accumulation of problems in these areas endangers the physical, mental, and social health of these areas' residents. Studies have shown that the health status of people living in slums is much worse than that of those living in adjacent urban areas (Ompad et al., 2007).

As far as educational deprivation is concerned, it is assumed that squatter settlement admit the children in few number and the children face educational retardation. They experience dropouts from schools in early age, frequent repletion in the same classes, series of failures and difficulty in upgrading to the higher classes. Students from the slum settlements generally represent lower classes, so called lower caste, suffering from malnutrition and poor housing condition who lack basic educational amenities (Upadhyay, 2017).

Slum people are mostly involved in informal jobs which is very insecure. Informal employment deprives the people from different dimensions like the nature of employment conditions, the presence or absence of a written job contract, the method and regularity of wage payments, access to paid leave, eligibility for social security benefits, and the number of hours worked (Rustagi 2015).

In a nutshell, the multifaceted deprivation experienced by slum and squatter populations is a reflection of severe inequalities and structural challenges that span across housing, health, education, and social inclusion. Residents face substandard and insecure housing, exacerbated by financial constraints, cultural barriers, and exclusion from mainstream urban planning and decision-making processes. Socially, they suffer from marginalization, limited opportunities for upward mobility, and inadequate access to basic services, which perpetuate cycles of poverty. This deprivation extends beyond physical spaces, affecting social cohesion, mental health, and overall well-being. Educational barriers, compounded by poor living conditions, result in lower enrollment rates, frequent dropouts, and poor academic performance, further limiting future opportunities for the younger generation. The cumulative effects of these interconnected issues underscore a broader systemic failure to address the needs of marginalized urban communities, highlighting the urgent need for inclusive policy interventions and targeted support to break the cycle of deprivation and promote sustainable development.

Research Methods

This study has followed an exploratory research design. Singleton and Straightview" Exploratory research design is undertaken to explore the phenomenon to gain insight and deep understanding about it, frequently to formulate a precise research problem for further study" (2005). This study will explore the multifaceted aspects of deprivation of slum settlements as the objectives require. The data collected and

analyzed incorporates a fundamentally qualitative nature. Primary sources of data are collected from the field, and slum areas of Balaju, Kathmandu. In addition, secondary data are collected from different texts relevant to the multiple deprivation of slums. This study applies in-depth interviews to examine the way slum dwellers face multiple deprivation in their lives. In an in-depth interview, the researcher needs to actively listen to understand what is being said and connect it with the research. At the time of analysis of the data, the context in which the interview occurred should be taken into consideration (Walsh, 1998).

Out of 138 households. In-depth interviews were taken with 15 household heads selected from the random sampling method. While selecting the sample, the researched applied lottery method. First of all, unique numbers from 1 to 138 were written on every slip of paper in addition to the household numbers given by the ward office. Then, those papers were randomly mixed in a basket. Finally, the researcher picked up 15 papers one by one. The picked papers with the household numbers became the sample participants for this research. In terms of conducting the interview procedure, a researcher approached the selected participants at their houses with semi-structured questions after the sample selection process was accomplished. Few days, the interview could not be capitalized since rapport building was necessary. After a series of informal conversations with clarity of the purpose and contents of the research, the interview procedure proceeded. It took 15 days to gather information for 3 hours were allocated

for interviews mostly in the morning considering the availability of the participants at home. The conversation during the interview highlighted housing insecurity, educational deprivation, health vulnerability, employment constraints, and obstacles to social participation in slum settlement.

Result and Discussion

Housing Insecurity

The housing condition of slum settlements in the Balaju area is very poor. The houses are built at the bank of the Bishnumati River which is vulnerable to flood on the one hand and lack of sufficient space, poor drainage system and dirty water flowing from the river, lack of ventilation, etc., on the other hand, constitute the poor housing arrangement in slum settlement. Sajjad (2014) states that all slum houses are overcrowded in Mumbai slum. They lack wellventilated houses and their structure and materials are so poor. Therefore, they are more vulnerable to different diseases. Souza's (1978) study on the slum settlement of Kolkata also emphasizes that the housing condition of slum dwellers is not safe. 60 percent of the households in Balaju are constructed with roofs of tile or tin in Balaju slum. They have very poor windows and poorly ventilated and dark rules even on a sunny day. Owing to the narrow street inside the slum settlement, houses may be prone to natural calamities including fire. Once 3 years back, the settlements caught fire, lots of properties were damaged and many

houses were burnt. That led the slum people to further impoverishment. Most of the houses during the past earthquake were destroyed.

The Balaju area was one of the sensitive areas in terms of the destruction of houses. Some of the slum dwellers were found comparatively well off. However, they were reluctant to build the pillared houses due to the fear of eviction. The fear of eviction possibly leading them to homelessness is the terrorizing everyday experience for the slum dwellers.

Slum settlement is always in fear of eviction. There is a paradoxical role of government and political parties. Once in government, they wish for eviction of the settlement. The eviction in action and only the threat of eviction may lead the people to the condition of housing insecurity. In opposition, their voices change and pretend to safeguard the slums. However, people are frightened there with the potential eviction attempts of the government. Sun Maya Pun expressed the fear of people during the Baburam Bhhatari government planned to evict the slums in 2012:

> The police intervention came at midnight on a day of Mansir was full of arms. The people around gathered having no systematic plan to resist the attack. Their priority was to safely relocate the belongings from the intervention. They cried out of an uncertain future. However, after many houses were destroyed, slum

people became able to resist the police in the support of civil society and the solidarity of many NGOs.

However, the loss was not compensated. We had to build the house again.

The flood that frequently terrifies Kathmandu has a more devastating effect on slum settlement. Every year the settlement is drowned and they are compelled to bear the loss of wealth collected from the hard-earned money.

Educational Deprivation

Educational opportunities always contribute to the advancement of society. Generally, the literacy condition of the slum dwellers is poor. Lack of abundance of income leads them to fail to send their children to school. Lack of competence due low level of education always creates obstacles for them to find a job in the market. Therefore, they are dragged into the array of the informal market which is insecure and yields low-income levels. Poverty in the slums results in the attainment of quality education (Sinha et al., 2016). The interviewed households state that they have admitted their kids to school. However, the rate of dropouts (30%) from the school is relatively high. The reasons for dropouts are multifaceted. But, the significant reason was found to be poverty. Almost all children go to government schools. The government had declared free education up to secondary level. However, government schools levy fees to the students owing to the reason that sufficient teachers are not recruited by the

government. Therefore, they should be given a salary from the internal sources. As a consequence, slum dwellers fail to pay the fees leading to high dropouts from the schools. Participants responded that very few slum students join higher education due to the lack of good-paying jobs of parents. It is found from the study area that they are not provided with a reading environment at home since they happen to encounter noise from the crowd of people because the Bus Park is a short distance. The noise from the vehicles hampers the reading atmosphere.

Health condition of the slum settlement

The living arrangement of a slim area impacts the health condition of the people. Low income levels, low literacy, and high rates of mortality and fertility remind us that awareness of public health should be taken into account. The increasing slum areas in the world also have contributed to the rise in environmental degradation in the world (Goswami and Manna, 2013). The health condition of slum dwellers is pathetic. Many street fruit shops, tea shops, motorcycle garages, and factories are established near slum settlements. People haphazardly throw garbage into the Bishnumati River at midnight which has caused negative consequences to the lives of the dwellers. Passengers in and out throw garbage into the river which further deteriorates the health condition of the people.

Due to environmental pollution and unsafe living conditions, slum children are prone to diarrhea, typhoid, malaria, and malnutrition (Nijama et al, 2003). It is found in the Balaju slum that Common diseases frequently observed include viral fevers such as malaria, dengue, typhoid, and other epidemic illnesses. Diarrhea is notably prevalent among children residing in these communities. The primary causes of various health issues in slum areas are high population density, substandard living conditions, low immunization coverage, lack of proper healthcare, and inadequate health services. Women in slum regions commonly experience seasonal viral fevers, respiratory issues like cough and cold, asthma, infectious diseases, as well as some hereditary health conditions. Malnutrition is another factor to worsens health conditions. Likewise, there were some public toilets in settlements which have outlets to the river. Both public and private toilets are dirty. Constant unpleasant smells from the river and the toilets have made the health condition of people further worse. There are no problems with the minor checkup. However, serious diseases cannot be cured due to lack of money.

Constraints in employment opportunities

The employment opportunities for the slum dwellers are very limited. As Amartya Sen (2000) makes clear the poor are trapped in multiple deprivation, and the slum dwellers are no exception. Since they are deprived of educational opportunities, they do not have access to high-paying professional jobs in the market. Sajjad (2014)

found that the rate of unemployment among slum dwellers is relatively high. The male slum dwellers are engaged in the informal market as wage laborers daily. They are involved as rickshaw pullers, factory workers, and construction workers. If some are engaged in self-employment, they are found running small businesses like street vending, handicrafts, and small shops Women are mostly involved in household work in nearby localities. They are forced to suffer verbal abuse and termination from work because of illness. Dhan Maya Khatri who works in one of the famous Marwari families in town told her story this way:

> I was working well and earning 10000 per month from washing clothes and dishes and cleaning the big house I almost spent 5 hours a day. The salary was on time. However, t sometimes the owners used to shout at me if delayed. Since my husband had left me and two daughters for another lady, I got late to reach the workplace sometimes not out of intention but of my compulsion to take care of my kids. Once I got a fever. So I could not join the work few days. Despite my information to him, he fired me and hired new women which pushed me to sadness and extreme deprivation. I am seeking the work again but in vain.

The pertinent problem regarding their employment opportunities is the lack of availability of works regularly which force the dwellers to face the financial crisis. They are mostly engaged in an informal job market like construction. The slum dwellers

in the Balaju area responded that they are awarded 500 Rupees per day as they are manual workers which is not enough to sustain their livelihood. Ram Bahadur Tamang, a construction worker simply put it this way:

> I used to work as the cheap labor force in the construction sector in an occasional call of contractors. To the minimum, I was affording my family expenses anyway. After I bore excessive back pain, I had to quit the work. After that, we started to depend on the amount of money my wife earned from the household work that paid us only 8000 per
>
> month. To the worst, I gradually began to feel desperate due to my failure to feed my family.

They do not get opportunities to work daily as Sen (2000) states that the poor lack freedom of choice. They have very limited choices due to capability deprivation. Thus, they are forced to work as daily wage workers. The average monthly income of the participant is

Rs.1200 which is not sufficient for the household's expenses, children's education, purchasing medicine, etc. Therefore, the Economic exclusion of the slum dwellers is what follows from

Amartya Sen's intrinsic deprivation. This implies that slum dwellers being deprived of the freedom of choices in employment leads them to incapability to livelihood

sustenance. The economic condition of the migrant workers, few only, from this settlement is relatively better. However, they responded that saving remains their dream unachievable. Much of the remittances received are spent on household expenses and others. The unemployed youths are vulnerable to drug addiction and criminal activities which has become the painstaking problem among the slum settlements. Alcoholism has further troubled the people, especially women which also led the dwellers to family conflict. This, sometimes, culminates in violence among the household members.

Conclusion

The slum settlement in Balaju faces severe socio-economic and health challenges exacerbated by poor housing, educational deprivation, inadequate healthcare, and limited employment opportunities. Insecure living conditions, fear of eviction, and environmental hazards make the dwellers vulnerable to natural disasters and health issues, including malnutrition and infectious diseases. Educational access is hindered by poverty, leading to high dropout rates, while employment is restricted to low-paying, informal sectors, trapping the residents in a cycle of economic hardship. The combined effects of poor living conditions, insufficient income, and lack of support mechanisms perpetuate the slum dwellers' struggle for survival and highlight their systemic exclusion from economic and social progress.

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Application of Mathematics in Economics

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Abstract

Mathematics is adopted in economics to provide a precise, logical, and systematic framework for analyzing and solving problems related to resource allocation, production, consumption, and distribution. This article demonstrates how some economic principles are translated into mathematical form and solves various economic issues using basic mathematical methods. Mathematics is used to create economic models. The Cobb-Douglas production model, IS-LM model, supply and demand model, game theory, Solow growth model, and others are examples of concrete economic models. Mathematics serves as the backbone of modern economics, providing rigor and a structured approach to understanding complex systems. By leveraging mathematical tools and models, economists can analyze data, predict outcomes, and design policies to address real-world challenges.

Keywords: Mathematics model Econometrics, Business and Commerce, Business Mathematics

Application of Mathematics in Economics

Mathematics has significantly influenced social science, particularly economics. It broadened economics' scope and provided a scientific methodology for its breakthrough development. This paper explores the importance of applying mathematics to economics, rationalizing research, and its role in economics.

Historical Background

Mathematics played a crucial role in economics during the "Marginalist Revolution," replacing classical production, growth, and distribution. The focus lifted from economy and social classes to leading to Augustin Cournot's systematic application of mathematics in economics. This shift has led to macroeconomics emerging as a separate mathematical system from microeconomics, heavily reliant on mathematics (Muto, 2023). Standard economic theory assumes decision makers, including consumers, firms, and governments, are rational, ordering outcomes based on preference actions and choosing the preferred one (Muto, 2023).

Literature Review

The application of mathematical methods to economic problems—often known as mathematical economics—is what Salunkhe called methodological potential. Through the application of mathematical techniques to intricate financial and economic ideas and issues, economists are able to develop sound hypotheses on difficult subjects (Salunkhe, 2020). Calculus and matrix algebra are two analytical tools used in mathematical economics that are essential to contemporary economic theory. Problems are solved using differential equations, real analysis, matrix algebra, and mathematical modeling (Ebele, 1996). In economics, the application of mathematics is becoming increasingly important for communicating and representing concepts. This is relevant on

several levels, such as when educators choose their courses and when lawmakers understand the policy recommendations they make. Because of its many variables, mathematics is the main tool used to solve economic problems. A change in the discipline's content results from economics' growing reliance on sophisticated statistical techniques and mathematical tools (Dowlin, 2001).

Objectives

(i) To explore the application of Mathematics in Economic theory and analysis.

Material and Method

Role of Mathematics in Economics

Mathematics in economics involves translating economic theory into mathematical language using tools like ratios, equations, derivatives, anti-derivatives, logarithms, and determinants. This helps express models and theories in concrete form, making them more precise and practical.

The uses of mathematical tools in economic analysis are presented below:

(i) Economics is a positive science that demonstrates cause-and-effect relationships between variables, such as quantity supplied and price. Mathematical terms like Q and f(P) help express functional relationships between economic variables like demand, price, saving, and investment.

(ii) Graphs can display relationship between variables, but for problems with multiple variables, mathematical tools like simultaneous equation solutions and matrixes can be used for analysis.

(iii) Mathematical symbols can be used to express concepts like average values, marginal values, and elasticity, making conclusions easier to interpret and reach faster than graphical and verbal methods.

(iv) Input output analysis is a recent development in economics. It is a technique for analyzing inter-industry relations and it can also be used in economic planning.

Matrix algebra forms the basis of input output analysis.

Mathematics in Economics

Stock Market: Mathematical methods are utilized by investors and financial companies to create profitable portfolios and automate trading, reducing risk and saving time during busy market hours.

Modeling: Most companies check for earnings using intricate mathematical models. These models are highly precise and may be used to determine the actual amount of profits earned by the firm after deducting all potential costs since they incorporate data on inflation and interest rates.

Machine Learning: Financial data is used by many companies to train the system, monitor potential earnings, identify problems, and make any necessary adjustments to the business plan. A corporation may train a computer to be quite accurate at predicting the preferences, dislikes, and potential commercial opportunities of its consumers because to the vast quantity of user data it possesses.

Blockchain: Blockchain, a distributed ledger system that employs sophisticated arithmetic for extremely secure encryption, is the way of the future for transactions. Math is also employed in bitcoin transactions, such as determining if the sender has enough cryptocurrency to deliver to the recipient.

Tax Calculation: Basic math may be used by both individuals and businesses to determine their taxes and potential deductions. Additionally, it aids in their assessment of potential tax breaks before they fill out the tax form. The optimal tax and investment

choices to minimize taxes or optimize tax returns are then calculated with the use of a few mathematical formulae.

Econometrics: The use of statistical and mathematical techniques to examine economic data and evaluate economic ideas is known as econometrics. In order to comprehend and quantify the links between economic variables, estimate parameters, and make forecasts or policy recommendations based on empirical evidence, it entails employing mathematical models. In econometrics various type of econometrics models are used:

Simple Linear Economic Model

An equilibrium in economics is a state where demand and supply are equal, and the equilibrium price is the price when the demand and supply are equal, without any tendency to change.

Partial Equilibrium Market Model

In partial equilibrium analysis, the price of a commodity and the total sales are determined in a market which is supposed to be perfectly competitive. It is also assumed that the prices of other commodities and the demand for them do not change. We consider three micro economic variables the quantity demanded Q_d the quantity supplied Q_s and the unit price P in the model and we make the following assumptions to construct it:

(i) At the equilibrium price, the quantity offered for sale must be equal to the amount demanded. In other words, the market is cleared at that point.

(ii) Demand for the commodity increases as the price decreases and supply increases as the price increases.

Then the model can be written in the form of the following equations:

Equilibrium Condition: $Q_d = Q_s$ (i)

Demand function: Q_d = a - bp (ii)

Supply function: Q_s

= $-\alpha + \beta p$ On solving, a-bp

= $-\alpha + \beta p$ or, a + α = (b+

$\beta)p$

So, p = $\frac{a}{b+\beta} + \alpha$

Now, putting the value of p in equation (ii), then, Q = a $- \frac{b(a+\alpha)}{b+\beta}$

Static Macroeconomic Model

In Keynesian model for the equilibrium of national income, the total expenditure is the sum of consumption expenditure (C) and investment expenditure (I). The consumption expenditure (C) itself is presumed to have two components.

(i) expenditure on the minimum requirements irrespective of income i.e. autonomous consumption (i.e. a) and

(ii) A fraction of every unit of income (Y) allocated to consumption. Also, for equilibrium, total expenditure or the aggregate demand (E) and national income Y are equal. Thus, the equations of the model are

E = C+ I (i)

C = a+ b Y (ii)

E = Y (iii)

Substituting Y = E in equation (i), Y = C +I or, C = Y -I

Substituting, C = Y – I in (ii), Y – I = a +bY
Or, Y-by = a +I

Or, $Y = \frac{1+a}{1-b}$ and $C = Y\text{-}1 = \frac{a}{1-b} + 1 - 1 = \frac{1+bI}{1-b}$

So, Y and C can be found out when I is given and b is marginal propensity to consume.

Application of Derivatives in Economics

Let C, P, Q, R and a represent the total cost, price, quantity produced, total revenue and profit respectively. Let AC, AQ and AR represent the respective small changes in C, Q and R respectively.

Marginal cost function

Let C = C(Q) be the cost function. Let C (Q_1) and C(Q_2) be the total cost when the volume of productions is Q_1 and Q_2 respectively. Then, Change in total costs = ΔC = C(Q_2)-C(Q_1) and Change in productions $\Delta Q = Q_2 - Q_1$

$$\frac{\Delta C}{\Delta Q} = \frac{C(Q_2) - C(Q1)}{Q2 - Q1}$$

When $\lim_{\Delta Q \to 0} \frac{\Delta C}{\Delta Q} = \frac{dC}{dQ}$

gives the rate of change of cost concerning Q and is known as the marginal cost function.

Marginal Revenue functions

Let P be the price per unit output and Q, the output, then R = Revenue function = PQ. If

ΔR and ΔQ represent the small changes in revenue and the output,

then $\frac{\Delta R}{\Delta Q} = \frac{R(Q_2)-R(Q^1)}{Q_2-Q_1}$

gives the average rate of change of revenue with respect to the output. This ratio is known as the average marginal revenue function.

When $\lim_{\Delta Q \to 0} \frac{\Delta R}{\Delta Q} = \frac{dR}{dQ}$ gives the rate of change of revenue with respect to Q and is known as the marginal revenue function. **Marginal profit function**

Profit = Revenue - Cost
π= R-C

Or, $\frac{d\pi}{dQ} = \frac{dR}{dQ} - \frac{dC}{dQ}$

i.e. Marginal profit function = Marginal revenue function – Marginal cost function.

Marginal product

A production function Q = f(z) denotes the required quantity of labour or capital or some raw material for a production Q and we defined marginal product as

Marginal product = $\frac{dQ}{dZ} = \frac{dQ}{dL}$

Marginal propensity to Consume

P be the consumption expenditure of a person when his disposable income is x. Then P is a function of x

i.e. P = f(x)

Average propensity to consume (A.P.C) = $\frac{P}{X}$ and the marginal propensity to consume (M.P.C) = $\frac{dP}{dx}$.

Elasticity of demand

The elasticity of demand is the value of the ratio of the proportionate change in demand to the proportionate change in price. Let Q be the quantity of a commodity demanded when it's price is p. Let ΔQ be the change in Q when the change in p is Δp, then proportionate change in price f($\Delta p, p$) and corresponding proportionate change in demand is $\frac{\Delta Q}{Q}$.

The average elasticity of demand over the price range from p to (p+ Δp) = $\frac{\frac{\Delta Q}{Q}}{\frac{\Delta P}{P}} = \frac{P\Delta Q}{Q\Delta P}$.

The elasticity of demand at price

p is $\lim_{\Delta p \to 0} \frac{P\Delta Q}{Q\Delta P} = \frac{P}{Q} \cdot \frac{dQ}{dP}$

Generally, the demand falls when the price rises so that $\frac{dQ}{dP}$ is negative, in order to avoid the negative sign, we put a minus sign before it and define elasticity of demand as - $\frac{P}{Q} \cdot \frac{dQ}{dP}$. It is also denoted by E_d.

i.e. $E_d = -\frac{P}{Q}.\frac{dQ}{dP}$

It should be understood that the negative sign is inserted for the sake of convenience.

Note: (i) If $E_d = 0$ then demand is perfectly inelastic.

(i) If $0 < E_d < 1$ then demand is inelastic

(ii) If $E_d = 1$ then demand is inversely proportional to price.

(iii) If $E_d < 1$then demand is elastic.

Marginal Revenue and elasticity of demand

The elasticity of demand $E_d = -\frac{P}{Q}.\frac{dQ}{dP}$ (i)

The total revenue R = PQ

(ii) And the marginal revenue $R' = \frac{dR}{} = p + Q\frac{dp}{}$

(iii)

From (i), $Q\frac{dp}{dQ} = -\frac{P}{Q}$

$\therefore$ From (iii), $R' = p - \frac{P}{E} = P\left(1 - \frac{1}{E}\right)$

Also, $\frac{1}{E} = 1 - \frac{R'}{P} = \frac{P-R'}{P}$

$\therefore E = \frac{p}{p-R'}$

Thus, elasticity of demand can be obtained if we know the price and the margin revenue.

Increasing and Decreasing Functions

A function f(x) is called increasing on an interval if, for any two points x_1 and x_2 in that interval where $x_1 < x_2$,the inequality $f(x_1) \leq f(x_2)$ holds. If $f(x_1) < f(x_2)$ for all $x_1 < x_2$ then f(x) is said to be strictly increasing.

A function f(x) is called decreasing on an interval if, for any two points x_1 and x_2 in that interval where $x_1 < x_2$,the inequality $f(x_1) \geq f(x_2)$ holds. If $f(x_1) > f(x_2)$ for all $x_1 > x_2$ then f(x) is said to be strictly increasing.

How to Determine Increasing or Decreasing

Derivative Test: If a function if is differentiable on an interval, you can use its derivative f′(x) to determine if the function is increasing or decreasing:

Increasing: If f′(x) > 0 for all x in the interval, then if is increasing on that interval.

Decreasing: If f′(x) < 0 for all x in the interval, then if is decreasing on that interval.

Critical Points: To find intervals where a function changes from increasing to decreasing or vice versa, you can:

Find the critical points of the function where f′(x) = 0 or f′(x) does not exist.Use the first derivative test by checking the sign of f′(x) around these critical points to determine if the function is increasing or decreasing on the intervals.

Maxima and Minima

Business and manufacturing aim for maximum profit and revenue, requiring economic analysis students to tackle problems such as maximization of profit, revenue,

and minimization of production costs. This involves finding maximum or minimum values of functions using first and second order derivatives.

Maxima

A function y = f(x) is said to have a maximum value at a point x = a if its value at x = a

i.e. the ordinate f(a) is the greatest of all the ordinates at the points other than x = a in a small neighborhood of this point. The corresponding maximum point on the curve represented by y = f(x) is A (a, f(a)) at which the tangent to the curve is parallel to the x-axis. The quantity f(a) is said to be maximum value of f(x).

Minima

A function y = f(x) is said to have a minimum value at the point x = b if its value at x=b

i.e. the ordinate f(b) is the smallest of all the ordinates at the points other than x = b in a small neighborhood of this point.

The corresponding minimum point on the curve represented by y = f(x) is (b, f(b)) at which also the tangent to the curve is parallel to the x-axis. The quantity f(b) is said to be the minimum value of f(x).

Procedure of Finding Maxima and Minima

To find the maximum or the minimum values of a function, we follow the following steps: (a) We at first find $\frac{dy}{dx}$ (or f'(x) of (the function y = f(x) and then find those values of x for

which $\frac{dy}{dx}$ = f'(x)= 0. Let these values be a, b,----

(b) At the point of maximum, the function changes its nature from increasing to decreasing so that $\frac{dy}{dx}$ or f''(x) changes its sign from positive to negative. So, we calculate fla-h) and fla + h)

where h is an arbitrarily small positive number. If we find that f'(a-h) > 0 and f(a-h) <0, then f(x) has a maximum at x=a and its maximum value is f(a) which is obtained by putting a in f(x).

(c) At the point of minimum, the function changes its nature from decreasing to increasing so that f'(x) changes its sign from negative to positive. So, if f'(a-h) <0 and f'(a + h)>0, then f(x) has a minimum at x= a and its minimum value is f(a) which is obtained by putting x=a in f(x). (d) Although $\frac{dy}{dx}$ or f'(x)=0 at x = a, if f''(x) does not change the sign, when x is changed from a-h to a +h i.e. if f'(a-h) and f'(a + h) are of the same sign, then the function f(x) has neither maximum nor minimum at x =a. (e) The same steps are repeated with the other points x=b etc. at which $\frac{dy}{dx}$=0.

Order Condition for Maxima and Minima (Extremum)

These conditions are known as order conditions.

Table 1

Condition for Maxima and Minima

Conditions	Maximum	Minimum	Neither Max. Nor. Min.

1st order	$\frac{dy}{dx} = 0$	$\frac{dy}{dx} = 0$	$\frac{dy}{dx} = 0$
2nd order	$\frac{d^2y}{dx^2} < 0$	$\frac{d^2y}{dx^2} > 0$	$\frac{d^2y}{dx^2} = 0$
3rd order	--	--	$\frac{d^3y}{dx^3} \neq 0$

Economic Application of maxima and minima

The economists frequently called upon to help a firm maximize profits and levels of physical output and productivity, as well as to minimize costs, levels of pollution and the use of scarce nature resources. This is done with the help of the following techniques.

Condition for cost minimization and minimum average cost:

Let a firm's costs function be C = C (Q)

(i)

where Q denotes the quantity. Then average cost represents the cost per unit of production. Then,

average cost (AC = $\frac{C}{Q} = \frac{C}{Q}(Q)$.

To find minimum cost we must apply first and second order conditions.

(i) MC = $\frac{dC}{DQ}$ =0; and

(ii) (ii) $\frac{d^2C_2}{dQ} > 0$.

For average cost (AC) to be minimum, the

conditions are: (i) $\frac{d}{dQ}(AC) = 0$; and (ii) $\frac{d^2}{dQ}$

(AC) > 0.

Condition for maximum revenue

For any demand function p = f(Q), and revenue function R= R(Q), the total revenue (TR) is the product of demanded (Q) and the price per unit of output.

TR = P× Q= f(Q)× Q

Total revenue TR to be maximum, the conditions are

MR = $\frac{dR}{dQ} = 0$; and $\frac{d^2R}{dQ^2} <0$.

Conditions of profit maximization

Let a firm's total revenue and total cost function are given as R(Q)and C(Q) respectively, where Q denotes the quantity or output. Then R= R(Q) and C= C(Q)

Let P be the price at which a quantity Q is sold Then total receipt or revenue (R)=

P ×Q. If π be the total profit, then

n=R-C = R(Q)-C(Q) = PQ-C

For π to be maximum, the following conditions are holds:

First order condition

$$\frac{d\pi}{dQ} = \frac{dR}{dQ} - \frac{dC}{dQ} = 0$$

$$\frac{dR}{dQ} = \frac{dC}{dQ}$$

MR=MC

For maximum π, marginal revenue should be equal to marginal cost for maximum profit.

Second order condition

$$\frac{d^2\pi}{dQ^2} = \frac{d^2R}{dQ^2} - \frac{d^2C}{dQ^2} < 0$$

For π to be maximum, the conditions are

$$\frac{d\pi}{dQ} = 0 \text{ and } \frac{d^2\pi}{dQ^2} < 0.$$

Economic Application of Partial Derivative

Partial derivatives are a crucial economic tool for analyzing the impact of small changes in one variable on another, thereby aiding in problem-solving. As an application of partial derivative, we deal with the production function, utility function and elasticity of demand etc.

Production function

For firms, partial derivatives are used to analyze production functions, which describe how inputs (like labor L and capital K) are converted into output Q. Various factors such as raw materials, land, labour, capital etc. are essential in order to produce the goods. Thus, in producing the goods, we need labour (L), and the capital (K). Hence output is the function of the labour (L) and the capital (K) i.e.

$Q = f(L, K)$

A production function, mostly used in economic analysis is the Cobb-Douglas production function which is expressed as

$Q = A\,L^{\alpha}\,K^{\beta}$ where A is constant and

$0<\alpha<1$, $0<\beta<1$, $L>0$, $K>0$.

Returns to scale

As of the Cobb-Douglas production function $Q = AL^{\alpha}K^{\beta}$ if proportionate changes occur in the inputs L and K; proportionate change in the output Q can be obtained.

Utility function

Let X and Y be the two goods that a consumer wants to purchase. If the consumer has a satisfaction when he purchases x quantity of X and y quantity of Y, then the total utility function denoted by U is defined by

$U= f(x, y)$

A most commonly used utility function in economic analysis is Cobb-Douglas utility function which is expressed in the form

$U = Ax^{\alpha}y^{\beta}$

where A is constant and $0<\alpha<1$, $0<\beta<1$, $x>0$, $y>0$. and x, y being the respective quantities of goods X and Y consumed. **Price elasticity of demand**

If Q = f(P, Y, P_A) denoted by E_d is the price elasticity of demand is the percentage change in quantity demanded Q by the percentage change in the respective price P of the goods A, keeping

Y and P_A constant. E_d is given by

$$E_d = \frac{dQ}{dP} \cdot \frac{P}{Q}$$

Application of Integration in Business and Economics

If C) x) R(x) and π(x) be the cost function, revenue function and profit function respectively.

Marginal Cost Function = (MC) = $\frac{dC}{dx}$ = C'(x)

Marginal Revenue Function (MR)= $\frac{dR}{dx}$ = R'(x)

Marginal Profit Function (MR)= $\frac{d\pi}{dx}$ = π'(x)

Since integration is the reverse is the reverse process of differentiation, so find C(x), R(x) and

π(x) by integration C'(x), R'(x) and π'(x)

respectively. cost function = $\int \frac{dC}{dx} \cdot dx = \int C'(x)dx$

$= C(x) + k$

dx

Revenue function = $\int \frac{dR}{dx}$. Dx = $\int R'(x)dx = R(x) + k$

And profit function = $\int \frac{d\pi}{d\pi}$. dx = $\int \pi'(x)dx = \pi(x) + k$

Where k is the constant of integration and its value will be obtained by the use of given condition. **Economic application of differential equation**

Differential equations are utilized in various economic branches to identify functions, determine dynamic stability conditions, and track growth paths. They estimate demand functions based on point elasticity and growth rate.

Dynamic analysis

For a one commodity market model, the demand and supply functions are given by

$$Q_d = a - bP \qquad (a, b > 0)$$
$$Q_s = -c + dP \qquad (c, d > 0) \tag{i}$$

where Q_d = quantity demanded, Q_S = quantity supplied, P = price.

Here, each of Q_d, Q_s and P are the functions of time t.

Let us assume that rate of price change with respect to time (t) at any moment is always directly proportional to the excess of demand over supply $(Q_d - Q_s)$, prevailing at that moment. Such a pattern of change can be expressed symbolically as

$$\frac{dP}{dt} = k(Q_d - Q_s) \ (k > 0) \tag{ii}$$

where k = positive constant called adjustment

coefficient. From (i), and (ii), we get

$$\frac{dP}{dt} = k[(a - bP) - (-c + dP)]$$

$$= k[(a + c) - (b + d)P]$$

$$= k(a + c) - k(b + d)P$$

$$\frac{dP}{dt} + k(b + d)P = k(a + c)$$

This is the first-order linear differential equation with constant coefficient and constant.

$P(t) = P_c + P_p$ (iii)

To find P_c

Let homogeneous differential equation of (iii) be

$$\frac{dP}{dt} + k(b + d)P = 0$$

or $\frac{dP}{dt} = -k(b + d)P$

or $\frac{dP}{P} = -k(b + d)dt$

Integrating both sides, we get

$$\int \frac{dP}{P} = -k(b + d) \int dt$$

or $\ln P = -k(b+d)t + \ln C$ or $\ln P = \ln e^{-K(b+d)r} + \ln \ln \because \ln e^{x} = x$ or $\ln P = \ln [Ce^{-K(b+d)t}]$ or $P = Ce^{-K(b+d)t}$

This is the required complementary function (P_c) of the homogeneous differential equation. For equilibrium price P,

$$Q_d = Q_s$$

or $a - bP = -c + dP$ or $P = \frac{a+c}{b+d}$.

This is the required equilibrium price.

To find P_p Let $P = P^-$ be the particular integral of (iv). Then, $\frac{dP}{dt} = 0$.

Substituting these values in (iv),

we get

$$0 + k(b+d)P^- = k(a+c)$$

or $P^- = \frac{a+c}{b+d}$, which is the required particular integral.

Hence, the general solution of (iii) is given by

$$P(t) = P_c + P_p = Ce^{-k(b+d)t} + \frac{a+c}{b+d} \quad \text{(iv)}$$

where $P_p =$ the particular integral which gives the equilibrium price. $P_c =$ the complementary function which gives the deviations from the equilibrium. When $t = 0$, then $P(0) = Ce^{\circ} + \frac{a+c}{b+d}$

or $P(0) = C + \frac{a}{+\frac{c}{b}} + d$

or $C = P(0) - \frac{a+c}{b+d}$

Putting the value of C in (iv), we get the definite solution as

$$P(t) = (P(0) - \frac{a+c}{b+d})\, e^{-t(b+d)} + \frac{a+c}{b+d}$$

$$\Rightarrow P(t) = (P(0) - P)e^{-2(b+dt} + P, \ P = \text{equilibrium price} = \frac{a+c}{b} + d \Rightarrow P(t) = [P(0) - P]e^{-\beta t} + P \ \text{... (v) where } \beta = k(b+d)$$

This is the required time path of the price.

In equation (v), as t

$\rightarrow$

∞, $e^{-\sin'} = \frac{1}{\pi} \rightarrow 0$

r

e

Hence, $\lim_{t\to\infty} P(t) = 0 + \bar{P} = \bar{P}$ = equilibrium price.

In other words, in the long-run, price will converge to the equilibrium price (P) and in this way the equilibrium is said to be dynamically stable and P(t) is called inter-temporal price.

When $\beta = k(b + d) < 0$, then $e^{-\beta t} \to \infty$ as $t \to \infty$. In such case, P(t) diverges and price will not be stable.

Economic Application of Difference Equation The Cobweb Model

The basic Cobweb model assumes that today's demand for any commodity is a function of the present price (P_t), it means Q_d is an unlagged function of price, while today's supply depends upon yesterday's decision about the output, it means Q_s is a lagged function of price.

Hence output is naturally influenced by yesterday's price (P_{t-1}).

$$\therefore Q_{st} = S(P_{t-1})$$

$$Q_{dt} = D(P_t)$$

Since both demand and supply functions are assumed to be linear, then,

Demand function: $Q_{dt} = a - bP_t$, $(a > 0, b > 0)$ (i)

Supply function: $Q_{st} = c + dP_{t-1}$, $(c > 0, d > 0)$ (ii)

For market to be in equilibrium,

$$Q_{dt} = Q_{st}$$

$$\therefore \quad a - bP_t = c + dP_{t-1}$$

or, $$-bP_t - dP_{t-1} = c - a$$

or, $$bP_t + dP_{t-1} = a - c$$

or, $P_t = \left(\frac{d}{b}\right)P_{t-1} = \frac{a - c}{-b}$

Application of Linear Algebra

Sarus rule

In determinant, Sarus rule is the mathematical rule which is used to find out the values of three order determinant only.

Let $|A| = \begin{vmatrix} x_1 & y_1 & z_1 \\ x_2 & y_2 & z_2 \\ x_3 & y_3 & z_3 \end{vmatrix} = x_1y_2z_3 + y_1z_2x_3 + z_1x_2y_3 - x_3y_2z_1 - y_3z_2x_1 - z_3x_2y_1$

Sarus rule consists of the following steps:

(i) List the elements of the first three columns of the given determinants.

(ii) Repeat the first two columns.

(ii) Find the products of the elements lying on the diagonals from top to bottom containing three elements $x_1y_2z_3$, $x_3y_1z_2$, $x_2y_3z_1$.

(iii) Similarly, find the products of the elements lying on the off diagonals from bottom to top containing three elements: $x_3y_2z_1$, $x_1y_3z_2$, $x_2y_1z_3$.

(iv) The three products obtained in step (iii) is taken with positive signs and the three products obtained in step (iv) is taken with negative signs then the sum of six terms is the value of the determinant. Thus,

$$\mathrm{D} = x_1y_2z_3 + x_3y_1z_2 + x_2y_3z_1 - x_3y_2z_1 - x_1y_3z_2 - x_2y_1z_3$$

Cramer's Rule

It is a method of solving simultaneous equations with the help of determinants.

Let $a_1x + b_1y = c_1$ (i)

$a_2x + b_2y = c_2$ (ii) be two simultaneous equations of two variables x and y.

Multiplying equation (i) by a_2 and equation (ii) by a_1 and subtracting (i) from (ii), we get

$$a_1a_2x + b_2a_1y = c_2a_1$$
$$a_1a_2x + b_1a_2y = c_1a_2$$
$$- \quad -$$
$$(b_2a_1 - b_1a_2)y = c_2a_1 - c_1a_2$$

$$y \begin{vmatrix} a_1 & c_1 \\ a_2 & c_2 \end{vmatrix} = D_2 = c_2a_1 - c_1a_2 = \begin{vmatrix} a_1 & b_1 \\ a_2 & b_2 \end{vmatrix} = D = b_2a_1 - b_1a_2$$

Similarly, we can obtain, $x = \frac{\begin{vmatrix} c_1 & b_1 \\ c_2 & b_2 \end{vmatrix}}{\begin{vmatrix} a_1 & b_1 \\ a_2 & b_2 \end{vmatrix}} = \frac{D_1}{D}$

$b_1|$

$D\ a_2$

b_2

where, $D = |a^1 \quad b_1|$ is coefficient matrix
$\quad\quad a_2 \quad b_2$

$D_1 = |c c^1{}_2 \, b b^1{}_2|$ and $D_2 = |a a^1{}_2 \, c c^1{}_2|$. Provided that $D \neq 0$.

Similarly, for 3 variables x, y and z

$$x = \frac{D_1}{D}, y = \frac{D_2}{D}, z = \frac{D_3}{D}, \text{ provided } D \neq 0$$

Inverse Matrix Method

Consider the following system of simultaneous equations

$$a_1x + b_1y + c_1z = d_1$$
$$a_2x + b_2y + c_2z = d_2$$
$$a_3x + b_3y + c_3z = d_3$$

It can be expressed in augmented matrix form as:

$$\begin{matrix} a_1 & b_1 & c_1 \\ [a_2 & b_2 & c_2] \end{matrix} \begin{matrix} x \\ [y] \end{matrix} = \begin{matrix} d_1 \\ [d_2] \end{matrix}$$

$$a_3 \quad b_3 \quad c_3 \quad z \qquad d_3$$

which is in the form of $A\,X = D$

$$\text{where } A = \begin{bmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{bmatrix}, X = \begin{Bmatrix} x \\ y \\ z \end{Bmatrix} \text{ and } D = \begin{bmatrix} d_1 \\ d_2 \\ d_3 \end{bmatrix}$$

Pre-multiplying equation (i) by A^{-1} then

$A^{-1} \cdot AX = A^{-1}D$

$$IX = A^{--11}DD$$

$$X = A$$

Thus, the solution is obtained by finding A^{-1} and multiplying it to D.

Conclusion

Many assumptions are made in the fields of econometrics, game theory, and mathematical economics. For instance, all Boolean topics are assumed to be homogenous and fully rational in game theory. Mathematics has been widely employed in the study of economics as a technique and as a tool.

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Happily Old! A Qualitative Inquiry into Sources of Happiness Among Older Adults of Nepal

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Abstract

Old age is characterized by a decline in physical ability, less social life, and a lowering of cognitive functioning, but older adults have distinct ways to enjoy life. This study aimed to explore and understand the sources of happiness among the older adults of Nepal in a phenomenological qualitative design. A convenient sample of 39 was made with the help of research assistants. The data collected by interviews were transcribed, coded, and categorized in the framework of thematic analysis. The interpretation of data was summarized in four themes: physical agility, social harmony, correct thought, and retirement management. The understanding of the causes of happiness for older adults can be useful for the design of interventions to enhance the quality of life among them. The limitations and future studies have also been discussed.

Keywords: Old age, senior citizens, older adults, *ashram*, prachya philosophy, happiness

Happily Old! A Qualitative Inquiry into Sources of Happiness Among Older Adults of Nepal

Developmental psychologists study old age as late adulthood and believe it starts from a person's sixties or seventies (Santrock, 2019, p. 15). "Older adults" is the phrase used to define people of 60 or 65 years and above (R. Gautam et al., 2007; Tausig & Subedi, 2022). However, the authentic dictionary of Nepal Academy mentions 50 years as a cut-off of old age (Nepal Academy, 2076BS [2019]). Nepal Government gives "*vriddha bhattaa*" or old people's allowance from the age of 70 (Dhungana et al., 2020). This age was reduced to 68 but is about to be reverted to 70. In Nepal, "*jestha nagarik*" or "senior citizen" is an accepted vernacular to mean old persons or older adults. In Nepal, government documents use this term and it refers to persons of 60 years or above (Government of Nepal, 2021).

Biologically speaking, growing old age comes with real physical decline (Boyd & Bee, 2015, p. 440) seen in processes like shrinkage in frontal lobes (Berk, 2018, p. 605) hearing impairment, and vision problems. Cognitive declines like memory failures, slower language processing, and impaired problem-solving are apparent (Berk, 2018, p. 607). Socially, old persons interact selectively; their social network diminishes. Physical health is the predictor of late-life psychological well-being. Older adults may have to face widowhood. They may feel alone and depressed. Spouses of depressed older adults

may have to suffer because of the added caregiver burden (Gurung et al., 2003). The socioemotional selectivity theory posits that elderly people lessen relationships but retain quality ones as they grow (Giddens et al., 2018). Another functionalist theory called activity theory contends that busy and engaged older adults are likelier to lead happy lives. Continuity theory says that if older adults do activities that match their personality and preferences, they can be healthier (p.300). In Nepal, 33 to 44 percent older adults showed depressive symptoms (Adhikari, 2023; Adhikari & McLaren, 2021). Six percent of rural older adults were functionally impaired (Adhikari & McLaren, 2021). Most of the persons in Nepal enter old age after deprivation such as inadequate quality and quantity of food (Geriatric Center Nepal, 2010). In city, almost all older adults belonged to middle-class families, more than half of older adults were literate, threefourths of older adults got old age allowance, and nearly three-fourths of older adults had a social connection of some sort (Adhikari, 2023).

Old Age in *Prachya* Philosophy

Life should proceed in four *ashrama* (or stages): *brahmacharya* (student), *grihastha* (householder) , *vanaprastha* (forest-dweller), and *sanyas* (renouncer) and aim for four *purushartha* (purposes): *dharma* (appropriate conduct), *artha* (material wellbeing), *kama* (physical satisfaction) and *moksha* (liberation) according to *Prachya*

Darshan (also called Indian philosophy). Somebody can be a true renouncer in old age if they lived a rich life in their younger days (Chakravarthi, 1995). *Vanaprastha* and *sanyasa* are related to old age (Dwivedi, 2018). Literary works like *Vairagya Shatakam* or 100 Verses of Detachment (Bhartrihari, n.d./2018) portray old age as fearsome as a tigress (*vyaghriva tishtati jara*) rather than an obvious and inevitable phase of life. It mentions that old age comes with symptoms like feeble limbs, unsteady walking, drooling, falling of teeth, and poor eyesight. The relatives disregard the old person's ideas. The spouse cannot help and the children get hostile (verse 73). Tausig and Subedi (2022) suggest considering social factors while considering the health, and well-being of older adults in Nepal. So, biological and psychological considerations would not be enough.

Problems of Old People in Nepal

The trend of young children's migration for employment has left old couples alone in villages or cities of Nepal. They are suffering from psychological distress. Almost half of older adults were found to have depression in rural mid-hills (Adhikari & McLaren, 2023). In city, one in every three older adults were depressed (Adhikari,

2024). Older adults are lonely and have to bear the cultural and social burdens (T. R. Gautam, 2008). The urban old people have similar problems. Almost half of older people have been abused (Chalise & Basnet, 2017) emotionally, economically, physically, or otherwise. Neglect, disrespect, and verbal slurs are the most common forms of abuse. Almost three-fourths of older people have problems with sleep (Dangol et al., 2020). Half of urban older people have depression (Simkhada et al., 2018) and frailty (Devkota et al., 2017). Lower literacy, smoking, the prevalence of diseases, and exclusion during family decision-making are at the roots of the problems. Family conflict and economic hardship (Adhikari et al., 2017) are some causes of psychosocial and mental problems in older adults in Nepal. The old age homes in Nepal are growing in demand. Existing ones have basic facilities. Still, abandoned old persons find relief in those homes (Speck & Muller-Boker, 2021).

Sources of Happiness in Older Adults

Happiness in old age is related to challenges of old age, strategies to lead meaningful life, and available resources (see Jitdorn et al., 2021 for review). Independence, freedom, and ability to do daily activities are needed for happiness. Setting life goals, doing daily/religious activities, and engaging in enjoyable activities are also necessary. Older adults who get support are happier. Pandemic showed that sources of happiness for older adults were family and social relationships, social contact

through digital media, and hobbies (Whitehead & Torossian, 2021). Physical activities, and time in nature were also helpful to increase psychosocial well-being.

Psychosocial Strengths Among Older Adults in Nepal

Culturally, old age is a respected stage of life in Nepal (Chalise, 2021). There are some rites like Chaurasi Pooja specially dedicated for older adults (Adhikari, 2023). Older adults especially widowed women can resile if they have higher education and financial independence (Pant, 2022). Two-third older adults are found satisfied in life (Subedi, 2022). Active learners, rich and married people, and those with high nutritional scores are more satisfied in life (Ghimire et al., 2018). The quality of life is better in the earlier part of old age than in the later part (Samadarshi et al., 2021; Subedi, 2022). It is better for those with higher income, low depression, and those who receive social support and can afford health services (Samadarshi et al., 2021). Happiness varies based on the gender, caste, and geography of older adults. Hope and agency can even weaken the relationship between the feeling of being burdened and suicidal thoughts, and pathways can weaken the relationship between the feeling of belonging with none and thoughts of suicide (McLaren & Adhikari, 2023). Social capital like social support and culture can be additional resources for older adults (Adhikari, 2023; Adhikari & McLaren, 2023).

Culture and values in Nepalese society are friendly to older adults. Older adults have the strengths such as life experiences, wisdom, emotional intelligence, positive outlook, social support, resilience, being satisfied with what they already have, and spirituality/faith in higher power.

Relevant Theories

Vanaprashtha and *Sanyas* ashrams are the last two stages of old life. The developmental tasks of *vanaprastha* are to pass on duties to progenies, shift to the forest, read books, have peace of mind, and abandon indulgence and those of *sanyas* are to meditate, give up desires and attain 'moksha' or make supreme God one's pal (Dwivedi, 2018). These two concepts have been taken as a framework of this study and findings have been weighed on the reference of these developmental milestones.

Significance of the Study

Need to find ways to enhance well-being among older adults has been suggested (Jitdorn et al., 2021). In Nepal, the study of problems of older adults has gained good attention but strength-based inquiries are very few. Some existing inquiries are about resilience, quality of life, and life satisfaction. This study aimed to find the sources of happiness, a positive emotion among older adults in Nepal by qualitative exploration. It

also aimed to understand if the older adults in Nepal today achieve the developmental milestones imagined by the last two *ashrams* in prachya philosophy. This inquiry is expected to contribute to the theory and practice of positive psychology and social psychology of older adults that the quantitative studies have not addressed yet.

Objectives and Research Questions

This study aimed to explore the experiences of happiness in older adults and understand the things, moments, or activities that make older adults happy, glad, or joyous. It also weighed the developmental tasks of older adults against those guided by the last two *ashrams* in prachya philosophy. The related research questions are given below:

- What are the things, moments, and activities that make older adults happy?
- What are the sources of older adults' happiness?

Method

A convenient sample of 39 older adults was made with the help of research assistants. Data was collected by interview method. Some participants were interviewed more than once. The participants hailed from various parts of the country: four from Bara, one from Hetauda, one from Terhathum, three from

Panauti, ten from Kathmandu, three from Biratnagar, three from Tanahu, nine from Bhaktapur, and the remaining five from Pokhara. There were 22 males and 17 females. The participants were asked open-ended questions like “Can you recall the moments when you were very happy?” or “How can an older adult be happy?” Research assistants also did the transcription. After the interviews were transcribed, they were coded. The codes were categorized and developed into themes. Thematic analysis was used as a data analysis approach. It has been informed by the philosophical framework of phenomenology because thematic analysis cannot occur in a vacuum or be atheoretical (Clarke & Braun, 2018). On every positive side, there is a negative one. The research was about sources of happiness; the participants broached sad aspects of life when they talked about happiness. Hence, the analysis of interviews has generated several ideas about miseries or problems also (refer to Table 1). As part of the reflexivity that is necessary for qualitative research (Adhikari, 2021), I need to state that I am the son of two parents in old age and several other relatives in the same phase of life. I know their stories and have witnessed their times of joy and misery. The interpretation has been affected by my experiences with older adults. In the process of research, I have got the wise words of older adults to get prepared for

Sources of happiness	Sources of misery

old age timely. I have a clearer understanding (*verstehen*) about this phase of life and my attitude has broadened.

Findings Table 1

Codes Derived from the Interview Transcripts

Good health; ability to do activities of daily living	Bad health; weak body; functional impairment; frailty; waning self-efficacy
Settled children; occasional gifts from children's them; regular interaction with them	Unemployed children; poverty; emigration
Family support; care; occasional visit to relatives/temple; celebration of festivals with family and relatives	Worry about children; neglect; disobedience; family conflict; physical abuse
Old age allowance; health insurance; governmental regulation (of vegetables for chemicals)	Indifferent government (during disasters); legal apathy; air pollution; traffic congestion
Basic needs fulfilled	Lack of good house; loss of financial control
Pet; somebody to talk/chit chat; minor agricultural tasks on farm to do	Loneliness; children spending time on social media rather than with old persons
Self-reliance; engagement in suitable occupation	Dependence; burdensomeness
Good past recollection	Bad memories

Respect/Acceptance/approval from others; praise	
	Disrespect; discrimination; slight; family's un-cooperation; exclusion from family affairs; wealth-minded sons
Sources of happiness	Sources of misery
Creative deeds; pastime activities; success in life	Boredom
	Political affairs in the country
Hangout; religious activities; faith; physical exercise (walking, yoga)	
Small dreams; helping others	Unfulfilled dreams (like education)
Flexibility; accept changes in life	Rigidity; want to dominate family affairs
Anger management; calmness; social harmony	Anger
Understanding partner	Spouses' conflicting values; children's ruined life (like by alcoholism)
Polite interaction from the family	Bland meal
Acceptance of old age problems	Being the odd one out; disregarding of old person's intellect
Handing responsibilities to family members	Fear of bad perception of frailty
Positive thinking	Relatives sowing conflict in family

The following themes have been generated after analyzing the data. The codes given in

Table 1 have been categorized even though the categorization was an arduous task.

Physical Agility

Being healthy is an important thing in old age to be happy. Many older adults reported having problems with body parts aching and getting ill. Some had chronic conditions like arthritis and gastritis. Abilities to do activities of daily living are valuable because every old person may not be able to do those. Bad health, weak body, functional impairment, and frailty all decreased the degree of joy in life.

I walk and roam around, visit friends, and chat with them. I go to Bihar and attend bhajan kirtan. I am illiterate and innocent. I spend days likewise. I feel I am still young but others remind me that I have grown old. I am happy because I do not have a disease or loans. Above all, I am free from disease. I walk a lot and my body gets tired. So, I sleep well too [p32, male, Kathmandu]. Maybe people above 80 can be called old. People are fitter now. In my parents' generation, people got older earlier. I have friends of 40, 45. I walk with them daily and do not feel old. However, my ability to work has declined [p31, male, Kathmandu] Can't stand from the place I sit. I feel embarrassed about what others will think [p21, female, Biratnagar]

I am mostly fit. I have a cow to look after. I do kitchen work when my youngest son is absent. Otherwise, he does it. Then I go to cut grass. Then I manage cow dung. Looking after the cow helps me spend my time. My husband also goes out to work during the day. How lonely would it be if there was no cow! There is hard work but I am happy. Lately, continuous pinching pain has started in my knee and I have begun to think I may no longer be able to rear a cow in the near future [p29, female, Kavre].

Social Harmony

The need for affiliation continues in senescence also. However, old adults are less able to give. They can offer consultation and best wishes. Not just the matters of receiving, old people are happy to observe family members being settled and everybody else doing good. They are disturbed by country affairs going wrong. The older adults reported being happy when progress and developments were witnessed in the surroundings. Development issues like pollution and congested traffic were bothersome to old adults in urban areas.

Observed Social Wellness

The old adults were happy to see that their progeny settled (as in marriage, employment, or educational achievement). They were disturbed, annoyed, and unhappy if the children were unemployed, unmarried, and deviant (as in

alcoholism). Children's leaving education got on their nerves. It was soothing for them to recollect pleasant experiences from the past. Happiness surged when they could remember the past selves that were strong, cordial, and responsible but plunged when feeble past selves were visualized. The older adults were happy when they saw their children flourish.

I got both my son and daughter married. My family provides help. They do not slight me; everything is just fine [p9, female, Tanahun] *I am glad to see my children settled. Everybody treats me well. Son's life is good. He also married. His wife left her home for us and is living here as a daughter. We have built our house. My daughter is settled in the US; she has her children there [p34, male, Bhaktapur].*

Received Social Benefit

Old adults deserve respect and they are happy to get it. They are happy to be honored. They do not want to be lonely and depressed. The old people need somebody to talk to. They want relatives to visit occasionally. Some older adults suggested that they needed to get creative with things around them to increase happiness. They wanted their children to take them for visits to relatives sometimes and houses of worship (like temples) sometimes. Some older adults reported that *bhajan kirtan* (singing God's praise) and *jap* (repeatedly verbalizing God's names mentally) had become their

favorite pastimes. If there was nobody to talk to, no work to do, and no activity to be involved in, a day stretched to a week. Receiving praise and approval from others is not unwelcome. They boost morale. The government's giving of an old age allowance is a good thing but it benefits older adults of 70 and above. Older adults in this study expected sweet interaction from the family on a regular basis. They did not expect but got surprised by the occasional gifts from children.

My family is good. They take care. Daughters have given shelter. Son is rotten. He drinks. We had tried to provide education but he did not study. All other desires have been fulfilled. I am happy [p7, female, Tanahun] I feel emptiness because of illness. My body aches, limbs feel like breaking. I consume medicines daily. That is what I dislike. My daughter-in-law massaged me; I was relieved and could sleep that night [p9, female, Bara] We are good and fit today. Everybody is doing good. Our needs are also met. I hope the family will take care when we grow even older and maybe weaker [p35, female, Bhaktapur].

Correct Thought

Old age is the age of renunciation. If old persons deny or resist the frailty that is obvious to happen sooner or later, they may be unhappy. Accepting the changes in the body, in the family, and in society is a key to joy in life. Trying to have dominance in

the family was not suggested by the participants of this study. They suggested having high self-esteem, accepting the changes easily, and remembering God rather than worrying unnecessarily. Older persons should be able to control their anger. If the basic needs were met, they should console themselves, the participants suggested.

During old age, positive thinking should be a habit. If bad thoughts come, we should distract [p8, male, Bara]. Life can be more relaxing in old age. There is the son and his wife. They treat well or at least I think they treat well. We should be satisfied whatsoever [p20, male, Biratnagar].

Retirement Management

Correct thought should be executed by proper management like creating an environment to get basic needs fulfilled and arranging pastime activities like yoga or religious involvement (like *bhajan kirtan*). They should have suitable pets like dogs or cows. Above all, the family responsibilities should be handed over to the successors. Still, for the security of older adults, the property should be retained with them till the end of life.

I would feel lonely all day if I did not have this dog. There is none to talk to. I play with this dog. I feed and bathe it. It is my closest companion since my body became nearly crippled and I could not go out [p28, female, Kavre]

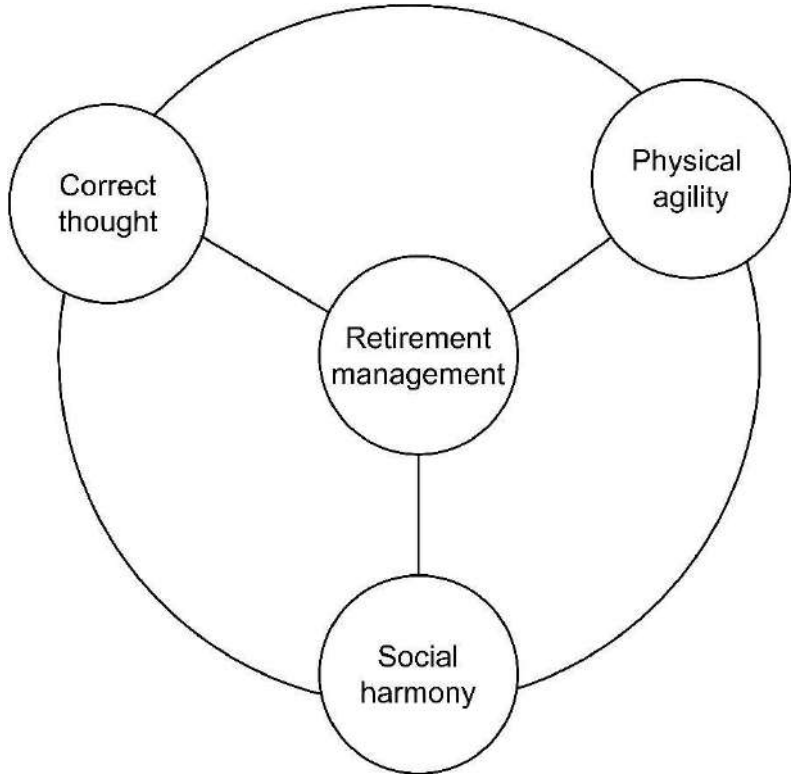
I meditate on God and my problems are forgotten. Doctors cannot heal me. I want to be guided by God's sermon. Truth be on my mind, om shanti (pray for peace)! (p11, male, Bara). I feel lonely and wish there were a park so that older adults could gather. I am in the city; my heart goes back to the village. There would be open space to roam if I lived in the village (p13, female, Bhaktapur).

There is a relative of mine who wants to stick to her ways even when she is old and her children are ready to take the helm. She would be way happier if she renounced. Look at me, I am deserting everything gradually. Her mistake was to pass on all the property too soon and hence the family started to slight (p27, male, Kavre).

I have kept myself active in science, literature, social work, and vipassana. These activities keep me happy and alive. I have crossed 60 but am still as energetic [p33, male, Kathmandu].

Figure 1

Sources of happiness in old age: Four themes of this study



Discussion

The findings are summarized in Figure 1. Some findings are in support of the activity theory. The older adults' want of pets to cater to and play with indicates their need for involvement. They also reported the need for some tasks that they are capable of doing. This sentiment resonated with the saying "*sakunjel garnuparchha; kaam*

nagare pani jiu kunjo hola" or "We need to do some tasks that we can do, lest the body parts jam". So, remaining busy not only leads to a fulfilling life but also is helpful for physical agility. The activity theory may be refined in the newer dimension of physical fitness also. Activity theory suggests maintaining activities and finding status and roles as things change (Conerly et al., 2021, p. 397).

The findings indicate some extent of Nepalese older adults' compliance with *vanaprastha* and *sanyasa*. They reported passing on family and civil responsibilities to successors. Obviously, living in forests would not be feasible but leaving desires and meditating on God would be. In this study, some older adults were satisfied with what they had but other older adults clung to desires like that of a better house, settlement of their grown-up children, and more old age allowance. In a true sense, the older adults had not renounced even though most of them were aware that they had to. The practical implication is that older adults can be trained for a better and more fulfilling old age. Some organizations including the government can bear the responsibility and design interventions that facilitate teaching skills for physical agility, correct thought, social harmony, and retirement management. Some uncontrollable aspects like observed social wellness cannot be managed by older adults but they can do cognitive restructuring to be satisfied with what they have, accept changes around and meditate on objects of faith (like God).

This study found that older people perceived to have been both physically and mentally weak as they aged but Thapa (2018) found them to be mentally agile. However, his findings like experiences of neglect, discrimination, loneliness, insecurity, and involvement in spiritual practices and thoughts are verified in this study also. They seek respect and expect family care, also as he pointed out. An older adult said an adage *budho bhayo saba ranga gayo, aagan bhayo pardesh* (With the coming of old age, the colorfulness has gone away; own courtyard has been converted to a foreign land, hey!) as reported in Sharma (2019). Old age allowance is perceived as guardianship of the government. It provides economic freedom (Sendhai, 2021) and older adults are satisfied with this social security. A Chinese study (Chyi & Mao, 2012) showed that older adults living with grandchildren were far happier than those without grandchildren. In Nepal, children's settlement not only means economic stability but also it means happy marriage and procreation. This study is in agreement with Adhikari and McLaren's (2023) and Adhikari's (2023) conclusion that social support is useful for alleviating mental distress, or conversely, increasing happiness.

Limitations and Future Research

This study was limited by a psychological perspective. The sociological perspective can unveil more sources of happiness and the roles of social institutions in facilitating the well-being and joy of older adults in the last phase of their lives. Some

participants in this study have called out the government to solve their miseries. Future studies can be done with a sociological perspective. Observed social wellness depends on some psychological factors but most on sociological and economic factors like employment. Inductive probing, which is lacking in this study, would have generated finer details about how older people got happier.

Ethnomethodology would be a more suitable framework to study the process of older adults' happiness. Future studies can take its care. This study took all older adults as participants. Future inquiries can cross-sectionally study older adults from different socio-demographic segments. For example, participants can be compared based on age groups (below 75 vs. above 75).

Conclusion

The indication of a well-functioning society is seen on the faces of older adults. If they are brilliant and smiling, society is doing well and going on rightly but the gloomy old age indicates that society is degrading. So, cheerful older adults are what we want to have in our society. This study showed some sources of happiness for them. They are physical fitness, the right way of cognition, social wellness, and retirement management techniques. Older adults enjoy interaction with children and others, *bhajan kirtan* and other religious activities, playing with, and taking care of pets. They are happy to know about children's progress and society's development. Older adults are

glad when government takes care of them as in allowance or health insurance, or when children bring gifts surprisingly. The older adults are aware that they should forsake desires but have not been able to do the renunciation completely. They are too attached to the family's future and too worried about their future status sometimes. They are very insecure and have not surrendered to God as the last two ashrams of prachya philosophy would require them to. Happiness comes from the familial and social support received by older adults. The observed familial and social harmony also gives joy to older adults.

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Breast Cancer Prediction: A Comparative Study of Support Vector Machine and Logistic Regression

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Abstract

One of the most common malignancies among women worldwide is breast cancer and a key factor in raising survival rates is early identification. So, it is important to differentiate between malignant (cancerous) or benign (non-cancerous) tumors. Support Vector Machine (SVM) and Logistic Regression are popular machine learning models that has been widely used for binary classification problems including breast cancer prediction. This study explores the effectiveness of SVM and Logistic Regression in predicting breast cancer and compare their performances. This study uses Python programming to implement SVM and Logistic Regression to classify the Breast Cancer Wisconsin dataset from the UCI machine learning repository. Performance metrices such as recall, F1 score, accuracy, precision, and AUC-ROC have all been used to gauge how well these two algorithms work. Upon comparison, the result showed that SVM model outperformed Logistic Regression model on all the performance metrices.

Keywords: Breast Cancer, Logistic Regression, Support Vector Machine, Performance Metrics

Breast Cancer Prediction: A Comparative Study of Support Vector Machine and Logistic Regression

One of the most common diseases affecting women globally is breast cancer. It is the second largest disease that is responsible for women's death in the world. A precise and timely diagnosis is a crucial first step in recovery and care. This disease is caused by abnormal breast cells that proliferate and develop into tumors. If left untreated, tumors can spread throughout the body and become fatal. Breast cancer is still a complicated and common health issue that affects millions of people globally. Breast cancer is one of the many common malignant tumors that harm women. Breast cancer can grow and arise as a result of many internal and environmental factors. Poor lifestyle decisions, environmental circumstances, and social and psychological issues are linked to its prevalence. According to research, genetic abnormalities and family history account for 5% to 10% of breast cancer instances, whereas potentially modifiable variables account for 20% to 30% of cases. The cells of the breast are where breast cancer starts. A collection of cancer cells that has the potential to spread and destroy nearby tissue is called a malignant tumor (Obeagu & Obeagu, 2024).

Breast cancer diagnosis often relies on mammograms and biopsies. However, machine learning models can provide an additional layer of prediction to help clinicians make more informed decisions. For binary classification, two effective machine learning algorithms used are Support Vector Machine and Logistic Regression. Due to their adaptability and efficiency in a variety of applications with high-dimensional data and nonlinear relationships, these algorithms have been extensively used for binary classification tasks like distinguishing between malignant and benign tumors (Géron, 2017).

Based on a breast cancer dataset (Wolberg et al., 1993), this study focuses on applying SVM and Logistic Regression to classify malignant or benign tumors. Five metrics (Han et al., 2011), including accuracy, precision, recall, F1 score, and AUC-ROC, were used to compare these two algorithms. To determine which of these two algorithms is superior for predicting breast cancer, a comparison between them has finally been conducted.

Literature Review

Many researchers have recently been interested in applying machine learning algorithms for cancer prediction. This section summarizes some of the recent methods that have been widely used in cancer prediction. The authors of (Huang et al., 2017) evaluated the prediction performance of SVM and SVM ensembles using both small- and large-scale breast cancer datasets. For small-scale datasets, where feature selection should be done in the data preprocessing stage, linear kernel-based SVM ensembles based on the bagging method and RBF kernel-based SVM ensembles with the boosting method may be the better options, according to the experimental results based on accuracy, ROC, F-measure, and computational times of training. SVM ensembles based on boosting and RBF kernels outperformed the other classifiers on a big dataset. Authors (Jiang et al., 2023) compared SVM and Bayesian classification algorithms for breast cancer risk prediction. The test result showed that SVM outperformed the Bayesian classification algorithm in the actual target-tracking problem. For predicting the risk of breast cancer, the authors of (Jiang et al., 2023) contrasted SVM with the Bayesian classifier. According to the test results, SVM performed better in the real target tracking problem than the Bayesian

classifier. A comparative analysis of data mining, deep learning, and machine learning algorithms for breast cancer prediction was reported by the authors in (Fatima et al., 2020). The main objective of this research was to assess and contrast several machine learning and data mining techniques that are currently in use to identify the most effective technique for managing large datasets with high prediction accuracy. Compiling the results of previous research on machine learning algorithms for breast cancer prediction was the main objective. The authors in (Islam et al., 2024) assessed and contrasted the classification accuracy, precision, recall, and F1 scores of five distinct machine learning techniques: XGBoost, Logistic Regression, Random Forest, Decision Tree, and Naive Bayes. They did this using a primary dataset of 500 patients from Dhaka Medical College Hospital. In this study, XGBoost outperformed other algorithms with an accuracy of 97%.

To improve breast cancer prediction using machine learning techniques, the authors of (Das et al., 2024) suggested an expert system called the "Machine Learning Based Intelligent System for Breast Cancer Prediction (MLISBCP)". The proposed approach makes use of the "Boruta" feature selection strategy to identify the most pertinent characteristics from the breast cancer dataset and the "K-Means SMOTE" oversampling method to address the class imbalance issue. Accuracy, precision, recall, F1-score, and AUC-ROC score were used to assess MLISBCP's efficiency in comparison to a range of single classifier-based models, ensemble models, and models from the literature. This study concluded that the proposed model achieved the best accuracy of 97.53% when compared with other models. The Wisconsin Breast Cancer Diagnostic dataset was utilized by the authors of (Khan et al., 2022) to identify breast cancer using a variety of machine learning algorithms. Various performance indicators were used to

assess and compare the K-nearest neighbor, logistic regression, random forest, and decision tree algorithms. When the results are compared, it is shown that the logistic regression model yields the best results. Logistic regression has an accuracy of 98%, which is superior to the previously described method. The authors of (Zuo et al., 2023) evaluated several machine algorithms to determine which model was most effective at forecasting the recurrence of breast cancer. This research took eleven distinct machine learning (ML) algorithms to construct the prediction model. The area under the curve (AUC), accuracy, sensitivity, specificity, negative predictive value (NPV), positive predictive value (PPV), and F1 score were used to evaluate the prognostic model's performance. Shapley Additive Explanation (SHAP) values were used to rank the feature importance and determine which machine learning model performed best. The AdaBoost algorithm was used to create the prediction model since it demonstrated the greatest prediction performance among the 11 algorithms when it came to accurately predicting the recurrence of breast cancer. Furthermore, it was discovered that the most crucial variables in the dataset for predicting the recurrence of breast cancer were CA125, CEA, Fbg, and tumor diameter.

A novel prediction model that utilizes machine learning techniques to accurately classify cases of breast cancer has been proposed by experimenting by the model using the WDBC breast cancer dataset. Based on accuracy, precision, recall, and f-measure, it was found that the proposed model performed better than other state-of-the-art machine-learning techniques (Wadhwa et al., 2023). To predict breast cancer, the authors in (Zhu, 2024) used the Light Gradient Boosting Machine (LightGBM) algorithm. The accuracy and speed of the LightGBM were both good. The bootstrap aggregating (Bagging) approach

was used in this work to address the over-fitting issue. The study demonstrated how LightGBM can be used to create medical detection devices that are precise, quick, and affordable.

By evaluating the benefits and drawbacks of popular machine learning algorithms, authors (Shengjie, 2024) developed and deployed a breast cancer prediction system that would increase the early detection rate of the disease and lower healthcare expenses. Furthermore, using the real development environment, the authors developed a machine learning model appropriate for predicting breast cancer and conducted methodical testing and deployment. The findings of this study offered a novel technical method for the early detection of breast cancer in addition to significant experience in the use of machine learning in the medical field.

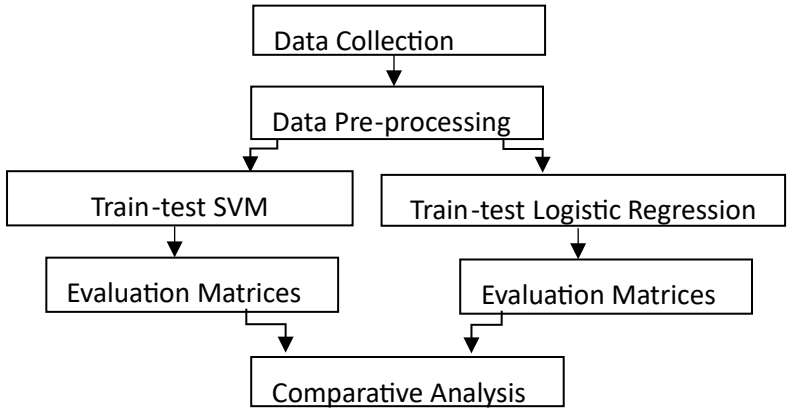
With recall serving as the primary evaluation index, authors in (Chen et al., 2023) established various models to classify and predict breast cancer. The authors considered a random forest, XGBoost, KNN, and logistic regression for classification. The goal was to serve as a reference for the early diagnosis of breast cancer. To assess and contrast the predictive impact of each model, this article also takes precision, accuracy, and F1-score evaluation markers into account. The Pearson correlation test was used to eliminate 15 features from the model's input to identify the ideal subset and raise the model's accuracy.
Using the Wisconsin breast cancer diagnostic dataset, authors in (Wei et al., 2023) provided a comparative examination of three machine learning models for breast cancer prediction: logistic regression, decision trees, and random forests. The results of the study demonstrated that, for the test dataset, the Random Forest model obtains the highest predicted accuracy of almost 95% and a cross-validation score of roughly 93%.

Methodology

Two machine learning models, SVM and Logistic Regression, were trained using a breast cancer Wisconsin data set and evaluated based on accuracy, precision, recall, f1-score, and AUC-ROC scores as shown in the figure below.

Figure 1:

Research Methodology



These two algorithms were implemented using Python programming language and its libraries such as numpy, pandas, matplotlib, seaborn, and sklearn. Python is a popular objectoriented, interpreted, high-level, dynamically-semantic programming language used for generalpurpose work. Programmers may communicate their ideas in less lines of code because to its syntax, which was developed with the readability of code as a primary focus. Python is a programming language that facilitates faster work and more effective system integration. In recent years, Python has grown to be one of the most widely used programming languages worldwide. It has been applied to a wide range of tasks,

including software testing, website development, and machine learning. Both developers and non-developers can use it.

Data Collection and Preprocessing

The Wisconsin Breast Cancer Dataset (Wolberg et al., 1993) is used in the study. It contains features that were taken from digital images of breast mass fine needle aspiration (FNA) procedures. The dataset contains thirty features including radius, texture, area, perimeter, smoothness, and compactness. To eliminate any omitted or unnecessary entries, the data is cleansed. The dataset is also normalized by applying feature scaling.

Model Development

Support vector machine and Logistic regression are employed as the primary predictive models in this research. Finding the optimal hyperplane in an N-dimensional space to partition data points into different feature space classes is the main objective of the SVM method. The hyperplane aims to keep as big a buffer as possible between the closest points of different classes. The dimension of the hyperplane is determined by the number of features. The equation of hyperplane is given as:

$W^T X + b = 0$

Here, **W** is a weight vector, **X** is the input vector, and **b** is biased. The goal is to maximize the margin. For the linear SVM classifier, the output will be 1 if $W^T X + b \geq 0$ and 0 if $W^T X + b < 0$. Predictions and their probability are mapped using logistic regression using a logistic function known as the sigmoid

function. An S-shaped curve that transforms any real value into a range between 0 and 1 is known as the sigmoid function. Moreover, the model predicts that the instance belongs to that class if the estimated probability produced by the sigmoid function exceeds a predetermined threshold on the graph. The model anticipates that the instance does not belong in the class if the calculated probability is less than the predetermined threshold. $Logit(pi) = \frac{1}{1+\exp(-pi))}$ ---------- Equation 1

$$\ln\left(\frac{pi}{1-pi}\right) = \beta_0 + \beta_1 X_1 + \cdots + \square_n X_n$$ ----------

------Equation 2

Here Logit(pi) is the dependent variable and X is the independent variable and □i are coefficients.

A training set and a testing set were created from the dataset in order to evaluate each model's performance.

In this case, the training set contained 70% of the data, whereas the testing set contained 30% of the data.

Performance Evaluation

Selecting an appropriate metric is essential when assessing machine learning (ML) models. After a machine learning algorithm has been put into practice, the next stage is to determine the model's effectiveness using metrics and datasets. Various machine learning algorithms are assessed using different performance indicators. The most common metrics are accuracy, precision, recall, F1-score, and AUC-ROC. The performance of both machine learning models has been assessed using these matrices. To calculate the value of

different performance indicators, a confusion matrix is used. Confusion matrices, which are frequently used to assess the effectiveness of classification models, which seek to predict a categorical label for each input instance, are matrices that summaries the performance of a machine learning model on a set of test data. According to the model's predictions, they indicate the proportion of accurate and inaccurate instances. The number of instances that the model generated on the test data is shown in the matrix.

- True Positive (TP): When a positive outcome is accurately predicted by the model, the actual result is also positive.
- True Negative (TN): When a negative result is accurately predicted by the model, the real result is also negative.
- False Positive (FP): When a positive result is predicted by the model but the actual result is negative. Likewise referred to as a Type I mistake.
- False Negative (FN): When a positive result occurs instead of the expected negative one, the model predicted the wrong thing. Likewise referred to as a Type II mistake. How often a machine learning model predicts the outcome accurately is measured by its accuracy. It is calculated by dividing the number of correct predictions by the total number of predictions.

$$\text{Accuracy} = \frac{TP+TN}{TP+FN+FP+TN}$$

The quality of a positive prediction produced by the model is referred to as precision. In other words, the proportion of observations that fall under the category of good emotion that are truly in that category.

$$\text{Precision} = \frac{TP}{TP+FP}$$

The frequency with which a machine learning model properly selects positive examples from among all of the real positive samples in the dataset is measured by a statistic called recall.

$$\text{Recall} = \frac{TP}{TP+FN}$$

The F-measure, which is the harmonic mean, combines the measurements of recall and precision.

$$\text{F-measure} = 2\frac{}{pression+recall} \times precision \times recall$$

The area under the ROC curve is called the AUC-ROC score.

Figure 2.

Confusion Matrix of Support Vector Machine

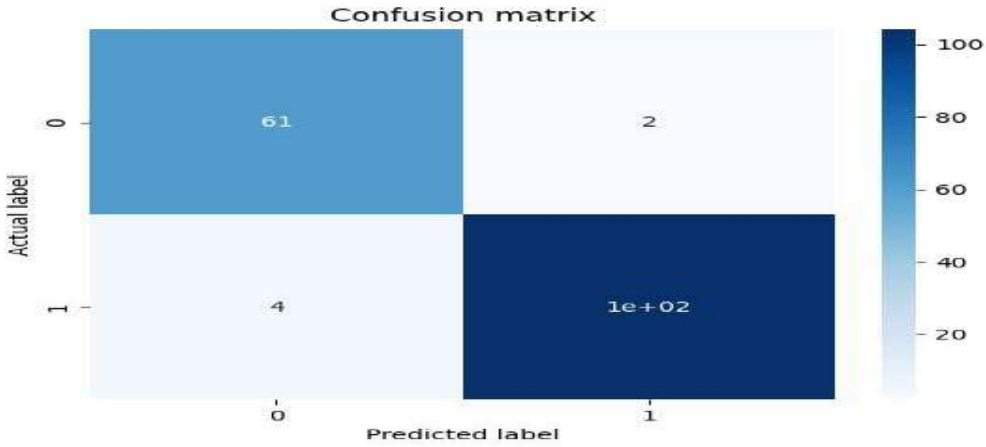
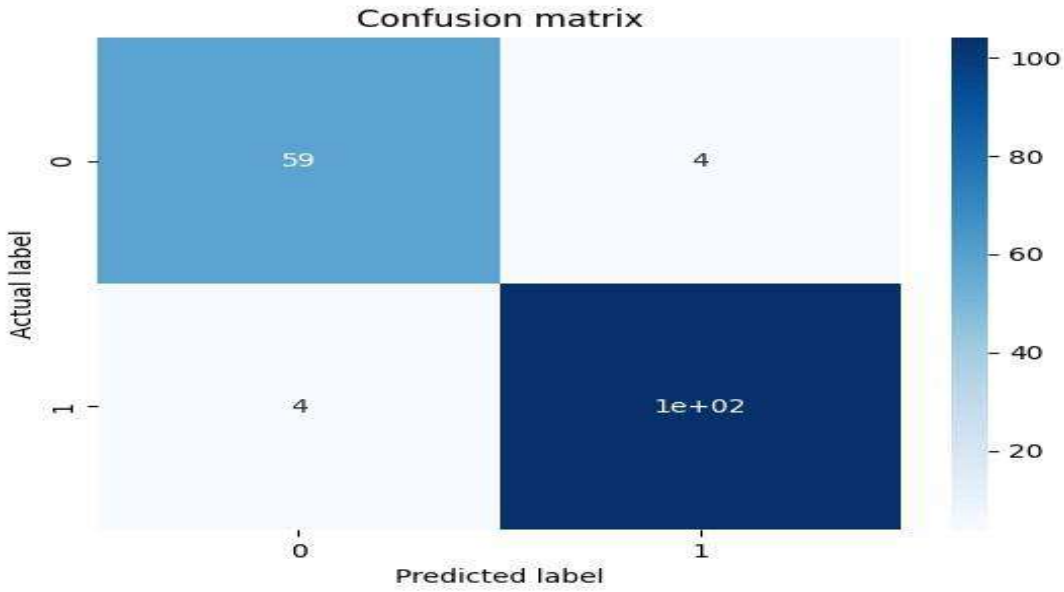


Figure 3.
Confusion Matrix of Logistic Regression



It summarizes the model's ability to provide relative scores that distinguish between positive and negative examples across all categorization levels. The AUC-ROC score has a range of 0 to 1, with 1 denoting ideal performance and 0.5 representing random guessing.

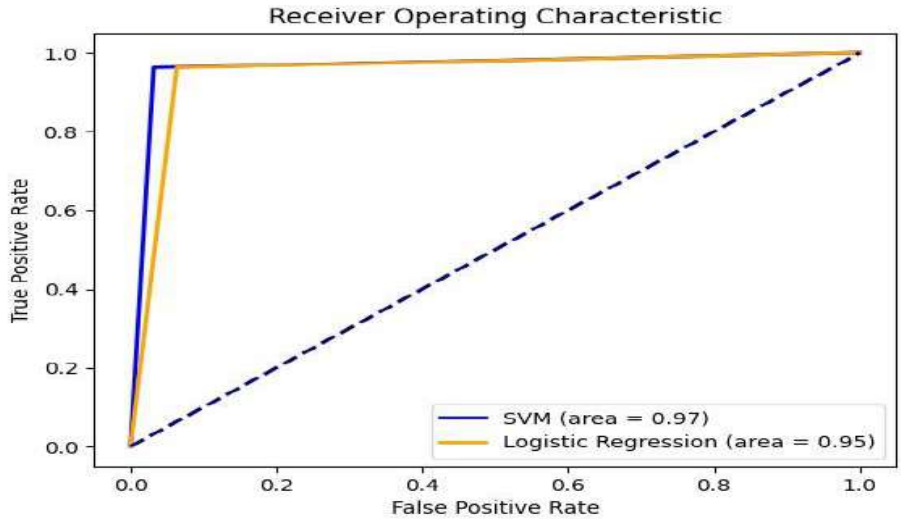
Figure 2 and Figure 3 above show the confusion matrix of the classification report that has been obtained after testing SVM and Logistic Regression respectively on the test dataset. Table 1 below shows the accuracy, precision, recall, F1-score, and AUC-ROC scores of both SVM and Logistic regression.

Table 1.
Accuracy, Precision, Recall, F1-score, AUC-ROC score of both models

Model	Accuracy	Precision	Recall	F1-score	AUC-ROC
SVM	0.965	0.981	0.963	0.972	0.966
Logistic Regression	0.953	0.963	0.963	0.963	0.950

The AUC-ROC curve for the models is displayed in Figure 4 below. This curve demonstrates that SVM is a more accurate predictor of breast cancer than logistic regression. The area under the ROC curve is known as the AUC-ROC score. It combines the relative scores that a model can generate to determine whether an occurrence is good or negative across all classification criteria. The AUC-ROC score has a range of 0 to 1, with 1 denoting ideal performance and 0.5 representing random guessing.

Figure 4.
AUC-ROC curve of SVM and Logistic Regression



Results And Discussion

The study highlights the importance of using SVM and logistic regression in clinical settings due to its simplicity and the ability to interpret the results easily. While other complex models may provide slightly better accuracy, SVM and logistic regression remain strong contenders for breast cancer prediction due to its transparency and ease of use.

- SVM achieved an accuracy of approximately 97% on the test dataset.
- The ROC-AUC score for SVM was found to be 0.966, indicating a strong predictive performance.
- Compared to logistic regression, SVM showed competitive results, especially in terms of interpretability and simplicity.

Conclusion

This study examined both SVM and logistic regression models for predicting breast cancer using the Breast Cancer Wisconsin (Original) dataset from the UCI machine learning repository. Performance of both of these algorithms were evaluated using F1 score, AUC-ROC, recall, accuracy, and precision. The accuracy, precision, recall, f1-score, and AUC-ROC scores of SVM were 0.965, 0.981, 0.963, 0.972, and 0.966 respectively. These scores of Logistic Regression were 0.953, 0.966, 0.963, 0.963, and 0.95 respectively. The final result of this study demonstrates that the SVM model slightly improves classification accuracy compared to Logistic Regression model in predicting breast cancer.

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Thank you.

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