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EDITORIAL NOTE

We are delighted to announce the publication of the first issue of Volume 4 of the Sri Lanka Journal of Social Sciences and Humanities (SLJSSH). As a biannual, interdisciplinary journal, SLJSSH is dedicated to fostering research in the social sciences and humanities. We invite scholars to submit theoretical, empirical, policy, and practitioner-focused research that contribute to global academic discourse. Our mission is to create a platform for diverse research, facilitating collaboration among experts across the social science community.

All submissions to SLJSSH undergo a rigorous double-blind peer-review process, ensuring the highest quality standards. The Editorial Board carefully reviews each submission to maintain the journal's integrity. As a cited journal in the Sri Lanka Journals Online (SLJOL) database, SLJSSH has experienced a steady increase in readership, submissions, and citations. Our growing reputation reflects our commitment to impactful research.

The success of SLJSSH is a result of the collective efforts of our editorial team, reviewers, authors, and the continued support of the Dean of the Faculty of Social Sciences and Languages at Sabaragamuwa University of Sri Lanka. We are grateful for their guidance, hard work, and commitment.

This issue features research studies relevant to Sri Lanka's socio-economic development. The study on ChatGPT's impact on education, using topic modeling on Twitter data, provides insights into AI's role in reshaping educational methodologies. The research on emotional labor, job satisfaction, and organizational commitment among Ayurveda physicians highlights the importance of healthcare professionals' well-being. The application of geo-spatial technology to identify optimal well locations in Kolugala Pahalagama GND addresses groundwater management challenges. A comparative analysis of job expectations among unemployed men and women offers insights into gender-specific dynamics in the labor market, informing equitable employment policies. Finally, the study on land-use changes in the Greater Kandy Development Area provides critical data for sustainable urban planning.

As the new Editor-in-Chief of SLJSSH from September 1, 2024, I would like to express my gratitude to the Coordinating Editor, Editors, reviewers, Text Editor, and Editorial Assistant for their dedication and expertise. We appreciate the valuable contributions of our authors and look forward to your continued support as we strive to advance the journal's success. Thank you for your commitment to SLJSSH, and best wishes for your future contributions.

Prof. G.R.S.R.C. Samaraweera
Editor in Chief
Sri Lanka Journal of Social Sciences and Humanities

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CONTENTS

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The multi-disciplinary bi-annual double-blind peer-reviewed international journal published by the Faculty of Social Sciences and Languages, Sabaragamuwa University of Sri Lanka.

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Faculty of Social Sciences and Languages, Sabaragamuwa University of Sri Lanka is pleased to present volume 4 issue 1 of the Sri Lanka Journal of Social Sciences and Humanities (SLJSSH) to provide the national and international scholars with an intellectual platform for the publication of a quality journal. This multi-disciplinary bi-annual international journal in English aims to promote studies in Social Sciences and Humanities and thereby cater to the needs of all researchers and academics looking forward to contributing their knowledge, skills, and abilities to the field of Social Sciences and Humanities. All articles in this journal are subject to a rigorous double-blind peer-review process followed by thorough scrutiny by the Editorial Board to ensure high academic and research standards before final publication.

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Exploring the Educational Landscape of ChatGPT: A Topic Modeling Approach on Twitter Data

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Banujan Kuhaneswaran[1*], Abishethvarman Vadivel[2], Ashansa Wijeratne[3], Nirubikaa Ravikumar[4], Samantha Kumara[5], Achchuthan Sivapalan[6], and Thanosan Vijayanandan[7]

[1]Faculty of Science and Engineering, Southern Cross University, Gold Coast, Australia

[1,2,5]Department of Computing and Information Systems, Faculty of Computing, Sabaragamuwa University of Sri Lanka, Belihuloya, Sri Lanka

[3,4]Department of Software Engineering, Faculty of Computing, Sabaragamuwa University of Sri Lanka, Belihuloya, Sri Lanka

[6]Department of Commerce, Faculty of Management Studies & Commerce, University of Jaffna, Jaffna, Sri Lanka

[7]99x, Colombo, Sri Lanka

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Abstract

In the rapidly evolving landscape of Artificial Intelligence (AI), platforms like ChatGPT are reshaping the educational domain, prompting deeper explorations into the nature and depth of this intersection. This study aimed to systematically uncover the prevailing sentiments, concerns and discussions on Twitter surrounding ChatGPT's role in education. Through an extensive data collection process, over 3.8 million tweets were initially gathered, followed by rigorous refining processes that included expert-driven tweet labelling and subsequent classification using Machine Learning (ML) and deep learning models. The cleaned dataset underwent a series of preprocessing steps and feature extraction and was ultimately subjected to Latent Dirichlet Allocation (LDA) for topic modelling. Our findings unveiled 15 distinct topics that broadly spanned common discussions, AI implementation, and its potential impacts. The data's visualisation using t-distributed stochastic neighbour embedding (t-SNE) showcased a dense central clustering of these topics. In conclusion, our research underscores the multi-faceted dialogues on AI, particularly ChatGPT, in education, emphasising the pressing need for continued discourse and research as AI tools further integrate into our educational paradigms.

Keywords: ChatGPT, Education, Tweets, Topic Modelling, Latent Dirichlet Allocation (LDA)

INTRODUCTION

In the rapidly evolving landscape of the 21st century, education is a testament to the enduring quest for knowledge and human advancement. Historically, every transformative epoch, from the invention of the printing press to the rise of the internet, has left an indelible mark on how we learn, teach and disseminate knowledge (Briggs & Burke, 2009). Today, as we traverse the digital age, Artificial Intelligence (AI) tools are emerging as the latest torchbearers, reshaping the contours of educational paradigms (Montenegro-Rueda et al., 2023).

The digital revolution, driven by advancements in AI and Machine Learning (ML), continues to impact myriad sectors, with education being a prime beneficiary and sometimes a subject of contention. Central to this transformation is the rising influence of AI chatbots, which have emerged as versatile tools in various domains, from customer service to health diagnostics and, notably, educational assistance (Bahroun et al., 2023). One of the most discussed chatbots recently has been ChatGPT by OpenAI (Hariri, 2023).

ChatGPT, powered by the ML models known as Generative Pre-trained Transformers (GPT), represents a powerful combination of cutting-edge technology and extensive training data. This innovative system has opened up educational possibilities. Its ability to offer learning experiences that support the creation of educational materials and overcome language barriers can significantly enhance teaching and learning outcomes (Kasneci et al., 2023). For instance, ChatGPT can aid teachers in developing tailored questions, quizzes, assignments and interactive educational content like games and simulations that cater to individual student learning styles. Additionally, ChatGPT can assist students in customising their learning journey and provide feedback (Li et al., 2023).

ChatGPT has attracted much interest from people in the tech community, educators, students, and researchers since its creation. This has made it a popular subject on media platforms like Twitter (Mujahid, Rustam, et al., 2023). These platforms offer a range of public opinions, conversations

Corresponding author: Tel.: +94 (77) 519 3372; Email: bhakuha@gmail.com
https://orcid.org/0000-0002-0265-2198

and debates that give us valuable insights into such impressive technologies' societal and educational impact. Recent studies have emphasised the value of Twitter data for sentiment analysis and topical exploration. Given its real-time nature, Twitter is a vibrant hub for tech discussions, reactions and forecasts. For instance, a study by (Montenegro-Rueda et al., 2023) utilised tweets to gauge the public's reception towards virtual reality in education, while another (Arambepola, 2020) elucidated the perceptions surrounding online learning platforms during the pandemic.

In this study, we analyse data collected from Twitter, which was renamed to X as part of a rebranding in July 2023. However, for clarity and consistency, we continue to use the name 'Twitter' throughout this paper. The research and data collection was conducted during the early part of 2023, prior to the rebranding, specifically up until June 2023.

Harnessing these vast, unstructured data troves necessitates advanced techniques that can navigate the intricacies of human language and sentiment. ML and Natural Language Processing (NLP) can be used for that. These computational methodologies evolved over decades of research and now equip us with tools to analyse, classify and derive insights from text data at unprecedented scales (Heumann et al., 2023). Deep learning, a subset of ML with architectures like Long Short-Term Memory (LSTM), has shown remarkable efficacy in handling sequential data, such as tweets (Ain et al., 2017). Furthermore, topic modelling algorithms breathe life into raw data, illuminating underlying themes and trends that might remain obscured (Taecharungroj, 2023).

In this study, we researched ChatGPT and education-related tweets gathered from various sources. The main objective of this research was to analyse tweets related to ChatGPT and education. The aim was to identify topics using topic modelling techniques. Additionally, the study aimed to categorise these topics into three domains: topics, implementation topics and impactful topics. The research also looked into aspects of ChatGPT, such as its performance in subject areas, potential uses in education, challenges, and possible solutions. Additionally, the study delved into the difficulties and risks that ChatGPT may pose in education and proposed immediate steps to lessen their impact.

The findings of this research have implications for education and how ChatGPT can be utilised in teaching and learning settings. It provides insights into how ChatGPT can serve as a technology in education while emphasising the need to address specific challenges to enhance learning rather than hinder it. Moreover, the study highlights the significance of research in exploring ChatGPT's potential in education and developing strategies for integrating it into teaching and learning practices.

LITERATURE REVIEW

AI's potential in education has been highly anticipated for a while now. The stages of AI in education mainly focused on Intelligent Tutoring Systems (ITS) (McCalla, 1992), which aimed to customise learning experiences based on each student's unique data. More recent advances have been significantly more comprehensive, employing AI for everything from curriculum design to administrative tasks (Kannan & Munday, 2018). Educators and researchers alike have emphasised the potential of AI-driven tools in enhancing the teaching and learning experience. ML algorithms, for example, can predict student performance and offer interventions in real-time (Khan et al., 2021). These predictions can help educators tailor curriculum and resources to individual student needs.

Arguably, one of the most groundbreaking advancements in AI in recent times is the development and refinement of GPT models. GPT models are computer programs that can create human-like text without being explicitly programmed to do so. As a result, they can be fine-tuned for a range of NLP tasks, including question-answering, language translation and text summarising. (Lund et al., 2023) showcased the versatility of GPT-3 across a range of tasks without domain-specific training, marking a paradigm shift in ML from task-specific models to more generalised, adaptable systems. The potential of GPT models in education is vast. From aiding in content creation to acting as learning assistants, GPT models offer students and educators tools to revolutionise traditional pedagogies (Rudolph et al., 2023).

Social media platforms, particularly Twitter, have evolved into rich data sources reflecting societal trends, sentiments and discourses. Twitter is one of the most popular social media platforms, and it is a rich source of data that can be analysed to gain insights into various topics, including education-related discussions. Educators, schools and students have been actively using Twitter as a tool for a range of purposes within the educational community. The platform has become an essential resource for development opportunities to enhance classroom engagement (Davis III et al., 2015). Hence, analysing tweets offers a window into the collective consciousness of the education sector and its stakeholders.

Over the years, some fascinating advancements in NLP and ML have provided us with fresh opportunities to analyse and understand social media data. Social media has become a part of our lives, serving as a platform where people can openly share their thoughts, viewpoints and personal encounters. ML and NLP have long been tools for effectively understanding and utilising textual information. Traditional ML models like Support Vector Machines and Decision Trees have proven helpful in sentiment analysis and topic classification (Sharma & Dey, 2012). A new era for NLP has emerged with the rise of deep learning, especially with architectures like LSTM. LSTM's ability to remember patterns over long sequences makes them particularly adept for tasks involving sequential data like tweets or textual conversations (Graves et al., 2016). This has been complemented by word embeddings, such as GloVe and BERT, that provide dense vector representations of words, capturing semantic meanings in previously infeasible ways (Van Loon & Freese, 2023).

Topic modelling is a technique that can be used to identify topics in a collection of documents, such as education-related tweets (Devi et al., 2022). Topic modelling, most popularly associated with algorithms like Latent Dirichlet Allocation (LDA), provides a method to discover abstract "topics" within a body of text (Jelodar et al., 2019). For platforms like Twitter, where discourse is vast and varied, topic modelling helps condense information into coherent themes, revealing

underlying structures and patterns. Recent research endeavours have deployed topic modelling on tweets to understand various phenomena. For instance, (Mee et al., 2021) analysed tweets to discern public sentiments towards climate change, revealing a spectrum of opinions and concerns.

Over the years, Twitter has evolved as a rich data source for academic and applied research across many contexts. Twitter data has been widely used in fields like disaster response (Kankanamge et al., 2020; Kuhaneswaran et al., 2020), political sentiments (Hitesh et al., 2019; Xia et al., 2021), crime reporting (Adeeba et al., 2023; Sandagiri et al., 2021), customer satisfaction (Kumar & Zymbler, 2019), pandemic outbreaks (Kankanamge et al., 2020; Kariyapperuma et al., 2022; Long et al., 2020) and stock market movements (Guo & Li, 2019; Padmanayana & Bhavya, 2021). This platform's many users and real-time data make it a valuable resource for understanding opinions, tracking emerging trends and monitoring events. Researchers have used methods like prediction models (Guo & Li, 2019; Padmanayana & Bhavya, 2021; Sandagiri et al., 2021), classification algorithms (Kariyapperuma et al., 2022; Mujahid, Kanwal, et al., 2023) and sentiment analysis (Devi et al., 2022; Hitesh et al., 2019; Mee et al., 2021; Mujahid, Rustam, et al., 2023; Tubishat et al., 2023; Xia et al., 2021) to extract patterns and valuable insights from the vast amount of tweets. This combination of Twitter data and research shows how versatile the platform is as a study tool. It also highlights the significance of social media analytics in research approaches. However, it is important to recognise that Twitter data usage in research falls between primary and secondary data analysis, and researchers need to consider ethical, legal and privacy issues when conducting research using Twitter data.

Tubishat et al. (2023) conducted a sentiment analysis of tweets related to ChatGPT in education. The study found that the majority of tweets related to ChatGPT are positive. A paper by Feng et al. (2023), who discussed the impact of ChatGPT on streaming media platforms like Twitter and Reddit, analysed the impact of ChatGPT on streaming media using Twitter and Reddit data. The study found that ChatGPT-generated text is acceptable for news articles but detrimental for school essays.

Another research paper by Heumann et al. (2023) analysed social media conversations and scholarly articles. Their goal was to explore perspectives on ChatGPT, its potential misuse for plagiarism, and the comparatively lower interest in GPTZero, which is designed to combat AI-driven plagiarism. The study utilised techniques like sentiment analysis and topic modelling through NLP to uncover challenges and opportunities associated with ChatGPT and GPTZero. According to the survey, ChatGPT shows promise in offering personalised learning experiences, enhancing student engagement and reducing teachers' workload. However, there are concerns that it may inadvertently perpetuate biases and discrimination within education while also making teaching more formulaic. Additionally, there is apprehension about students using ChatGPT to cheat on assignments.

Overall, this research provides insights into how ChatGPT can be effectively integrated into educational settings as an assistive technology. It highlights the importance of addressing challenges to ensure that ChatGPT facilitates learning rather than hinders it. These findings have implications for education and the responsible use of ChatGPT in teaching and learning contexts. The research emphasises the importance of investigating how ChatGPT can be utilised in education and devising successful approaches for integrating ChatGPT into the teaching and learning process.

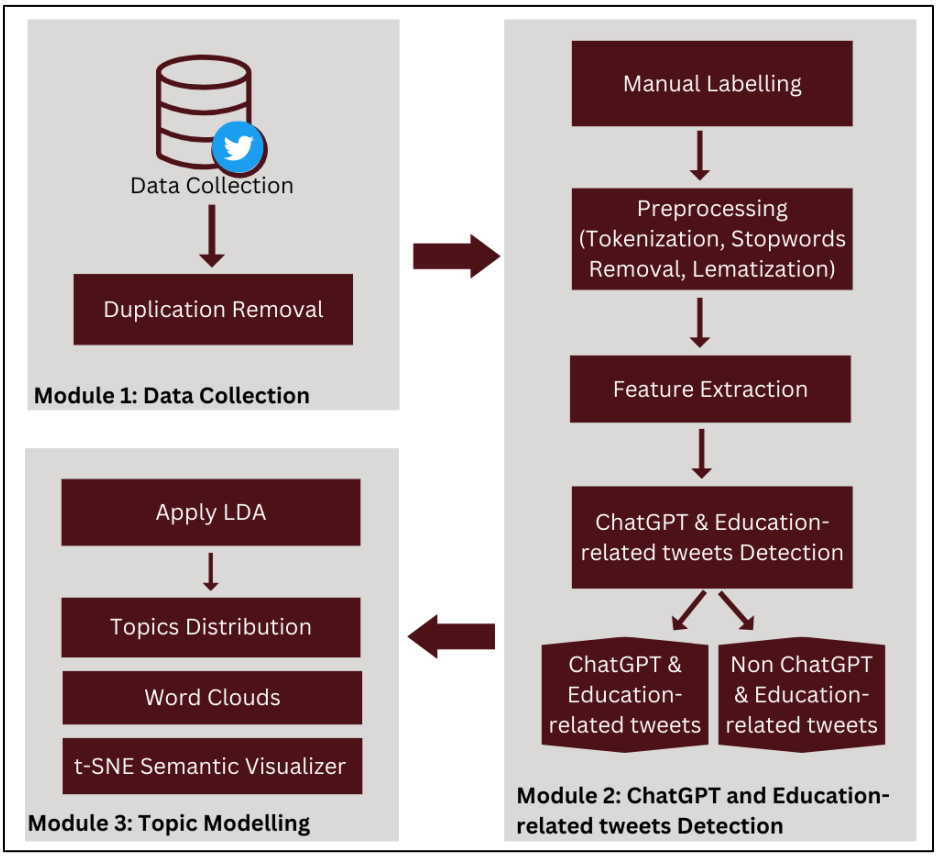
In a study conducted by Mujahid, Rustam, et al. (2023), they investigated how people perceive the popular trend of ChatGPT on a global scale. The study is significant as it gathers data and examines individuals' sentiments towards this important advancement. The researchers employed the LDA method to extract topics discussed in the ChatGPT tweets dataset. This analysis offers insights into the common themes and subjects frequently discussed. Sharma et al. (2023) conducted a semi-automated analysis of over 1,006,000 tweets to assess the sentiment of tweets regarding ChatGPT. The study found that users have mixed feelings about ChatGPT, with some expressing positive opinions and others expressing negative views. "Tracking Public Attitudes toward ChatGPT on Twitter using sentiment analysis and topic modelling" by Koonchanok et al. (2023) investigated public attitudes toward ChatGPT using sentiment analysis and topic modelling techniques. The study found that the overall sentiment is largely neutral to positive, which also holds across different occupation groups.

Most studies on ChatGPT and education have used traditional methods like surveys and controlled experiments. However, few have explored how the public talks about these technologies on social media. In particular, no research has applied topic modeling to Twitter data to examine how people perceive ChatGPT in education. This study aims to fill that gap by using topic modelling to identify common themes and patterns in public conversations. By analysing real-time, unfiltered Twitter data, this research provides a fresh and detailed view of how people perceive ChatGPT, offering insights that traditional methods might miss. So, this research on identifying the topics and interpreting the perception would be a significant contribution to understanding public sentiment around ChatGPT in education, providing a fresh perspective

METHODOLOGY

Our research methodology, which focuses on thoroughness and careful management of data, aimed to explore the range of conversations about ChatGPT and its impact on education on Twitter. We employed a series of steps to prepare the data extract features and use topic modelling with LDA to gain insights into the predominant emotions, concerns and discussions surrounding AI-based educational tools. The overall process we followed is illustrated in Figure 1.

Figure 1: Methodology



Source: Developed by author, 2023

Data collection and initial screening

Our research involved gathering a dataset of education-related tweets focusing specifically on the keyword "ChatGPT." We chose Twitter as a platform due to its user base and abundant conversations on various topics, including the intersection of AI and education. We collected 3,821,843 tweets showcasing the significant interest and discussions surrounding ChatGPT in education. While a testament to the topic's importance, such a vast dataset also posed challenges in processing and extracting meaningful insights.

Data enrichment and tweet relevance classification

Even though ChatGPT and education-related keywords were used to fetch the Tweets, not all these tweets were guaranteed to be relevant to the educational context. We undertook a meticulous tweet-labelling process involving three academic experts to refine our dataset. Their expertise allowed us to categorise tweets with higher precision. Following this, a battery of models, both deep learning (like LSTM) and traditional ML (SVM, LR, DT), were employed to ascertain the relevance of each tweet to ChatGPT and education. We employed both GloVe and BERT as word embedding techniques to enhance the performance of our models during this phase. The complementary use of these methods improves the analysis by balancing efficiency and deeper contextual understanding. GloVe (Global Vectors for Word Representation) is a pre-trained, efficient, and lightweight method that captures word co-occurrences in a global context, making it ideal for general words. On the other hand, BERT (Bidirectional Encoder Representations from Transformers) is a transformer-based model that captures more complex, context-dependent relationships between words by considering both the left and right contexts in a sentence, providing a deeper understanding of semantic nuances. Using these methods together allows for a more comprehensive analysis, as GloVe provides robust embeddings for large-scale tasks. At the same time, BERT offers a fine-grained, context-aware approach to understanding public discourse on ChatGPT and education.

Preprocessing and data cleaning

Textual data, especially from social media platforms like Twitter, is often noisy and requires rigorous preprocessing to be fit for modelling.

Tokenisation: The initial step in our preprocessing journey was tokenisation. Tokenisation is the process of splitting textual data into individual words or tokens. This step is vital as it breaks down complex textual data into manageable units to be processed and analysed.

Stop word removal: Stop words, the frequently occurring words in any language that don't add significant meaning to the text, were removed. Common examples include words like "and", "the" and "is". However, given the specific nature of our dataset, we extended the list to include terms such as "more", "good", "one" and even context-specific words like "gpt", "chatgpt", "ai", "bot" and so forth. Removing these terms ensured that our models focused on words that genuinely carried the essence of the discussions around ChatGPT and education.

Lemmatisation: Finally, we performed lemmatisation. Unlike stemming, which crudely chops off inflexions, lemmatisation involves reducing a word to its base or root form. For

instance, “running”, “runs” and “ran” would all be converted to “run”. This process ensured uniformity in our dataset and removed variations of the same word, making our subsequent analyses more robust and meaningful.

Table 1: Raw tweets and processed tweets

Before preprocessing	After preprocessing
[GPT-3] This post discusses the need for an audit system for Artificial Intelligence (AI) to ensure safety and cooperation. It suggests that the development of AI should focus on creating a system of logic and cooperation https://t.co/iRNQQH8UjX	post discus need audit system artificial intelligence ensure safety cooperation suggests development focus creating system logic cooperation
@soniajoseph_ Gpt = black box = fancy statistics	black box fancy statistics
Today, I’m working on building my own AI writing assistant w/ GPT-3 <U+2728> Here’s the plan: - Explore OpenAI + Playground - Connect to GPT-3s API - Ship a web app + Chrome extension If this seems cool and you also wanna build it, check out @_buildspace: https://t.co/RrHDq23BRp	today working building writing assistant plan explore playground connect ship web app chrome extension seems cool also wanna build check
Ars Technica: OpenAI upgrades GPT-3, stunning with rhyming poetry and lyrics. https://t.co/RKFTixDexK	ars technica upgrade stunning rhyming poetry lyric
via @GoogleNews @RandomSprint @goth600 @jeremymstamper @heyorson Type of guy who talks like GPT-3 and can’t stop. Nobody believes he’s real	type guy talk stop nobody belief real

Source: Generated by author, 2023

Feature extraction

Post-preprocessing, the next pivotal step was converting the cleaned textual data into a format our models could ingest. For this, we employed the CountVectorizer from the Scikit-learn library. This tool transforms textual data into numerical data by counting the occurrences of each word. The result is a matrix where each row represents a tweet and each column represents a word from our dataset. The value in each cell of this matrix corresponds to the number of times a particular word (column) appears in a particular tweet (row).

LDA for topic modeling

With our data pre-processed and transformed, we were ready for the main event: topic modelling using LDA. LDA is a probabilistic model that assumes each document (in our case, a tweet) is a mix of topics and a topic is a mix of words. By applying LDA, we aimed to uncover the latent topics driving the discussions around ChatGPT in the educational sector. Given the richness of our dataset and preliminary insights, we settled on extracting 15 topics. The number was determined considering both the computational feasibility and ensuring comprehensive coverage of the diverse discussions. Once the LDA process was executed, we mined the outputs to discern the dominant topics and associated keywords, providing a structured view of the sprawling Twitter discussions.

We also performed multiple runs of the LDA algorithm with different random seeds to test the stability of the topics across different iterations. This process helped verify that our topics were consistent and not artefacts of specific initial conditions. Additionally, we experimented with different numbers of topics to identify the optimal number that best balanced computational efficiency with comprehensive coverage of the discussions. Finally, we conducted a qualitative assessment where domain experts reviewed the topics and associated keywords to confirm their relevance to the discussions on ChatGPT in the educational sector. These steps ensured that our topic modeling results were both robust and reflective of the underlying public discourse.

RESULTS

Education and ChatGPT-related tweets detection

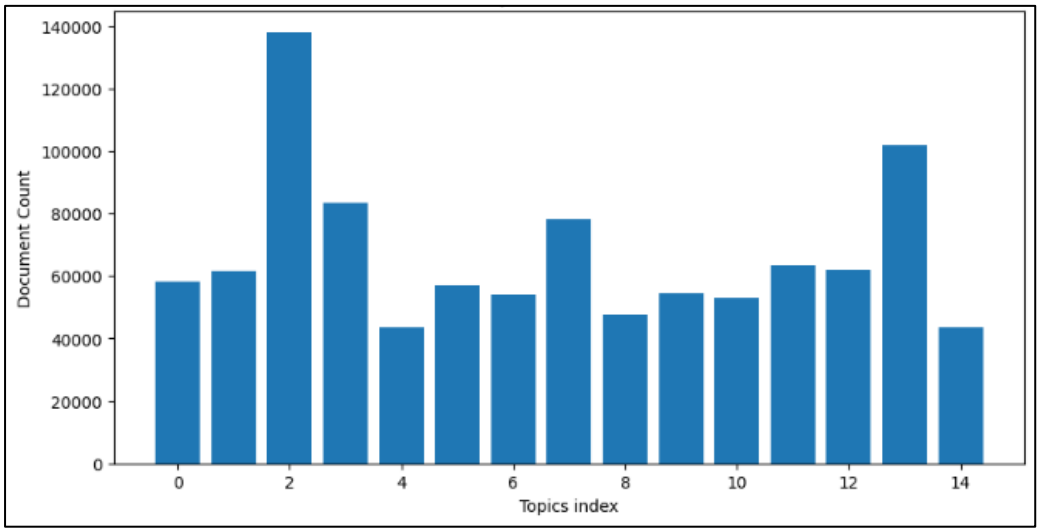
This phase's results emphasise the imperative of a comprehensive and multilayered approach to data classification and relevance assurance in social media analytics research, especially concerning extensive and varied platforms like Twitter. The nuanced and context-aware labelling by academic experts and the advanced model applications and word embeddings synergistically converged to elevate the data quality and research reliability. The standout performance of the LSTM model, especially when enhanced with GloVe embedding, highlights the continued advancement and applicability of deep learning techniques in social media data analysis.

Topic modeling

In this research, the team employed the LDA method to scrutinise tweets pertaining to education and their references to ChatGPT. Through this rigorous analysis, we identified 15 unique topics. These topics encompass a broad spectrum of discussions, spanning the influence of technology on business landscapes, the technical community's perspectives on AI and ML, and dialogues centred explicitly around education. Furthermore, conversations that delved into areas like code generation and the transformative potential of AI in supplanting human-driven tasks were also distinctly identified.

The collected tweets were evenly categorised across these 15 topics, as illustrated in Figure 2. This distribution affirmed that our chosen topics effectively captured the primary areas of discussion present within the dataset.

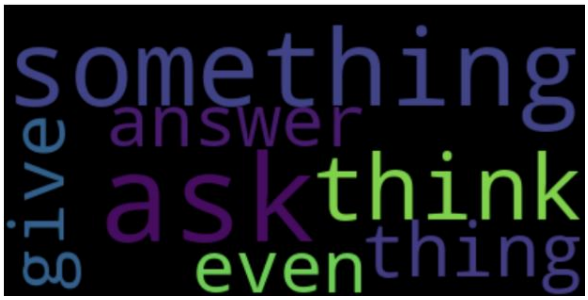
Figure 2: Distribution of documents in 15 topics in numeric scale



Source: Generated by author, 2023

Topic 2: Sharing and Generosity displayed here in Figure 3 has significant keywords like "something," "ask," "think," and "thing", which are generous words that make a conversation or phrase generous.

Figure 3: Topic 2; Sharing and generosity



Source: Generated by author, 2023

The topic Time and Fun are displayed in Figure 4 and have keywords related to time directly and keywords such as "game," "going," and "everyone" give the hint to name the topic as fun along with time.

Figure 4: Topic 13; Time and fun

Source: Generated by author, 2023

The outcomes of the LDA analysis are presented in Table 2. Following the standard procedures, we set for analysing the perception, the identified topics were categorised into three primary domains: Common, Implementation and Impactful. Leveraging the prominent keywords associated with each topic, the authors, in collaboration with linguistics and academic experts, assigned meaningful and descriptive labels to each topic to ensure clarity and relevance.

This classification was strategically designed to capture the multi-faceted nature of discussions surrounding ChatGPT in

education. The Implementation domain focuses on practical aspects and strategies for integrating ChatGPT into educational environments, addressing the specific challenges and methodologies associated with its use. The Impactful domain examines the significant effects and outcomes of ChatGPT on educational practices, highlighting both positive and negative consequences. Topics not fitting into these two distinct categories were grouped under the Common domain, which considered general and frequently discussed themes that reflect broad public perceptions. This approach allows us to provide a structured analysis while maintaining clarity and relevance.

Each domain offers a unique lens through which the relationship between humans and technology, especially in the context of ChatGPT, is perceived and discussed.

Common topics

These topics diverge from specialised discussions on the technology's application or anticipated impacts. Instead, they reflect more general themes frequently observed in writings like blogs.

- Search and SEO: This topic delves into online search engines and optimisation (SEO). Keywords such as "Google," "search," "engine," and "SEO" indicate an emphasis on web search technologies. It spans discussions on search engine algorithms, website ranking and strategies to enhance online visibility.
- Jobs and Articles: Here, discussions pivot around career opportunities, job postings and various articles. Keywords like "job," "article," "well," and "coming" signal a concentration on employment-related content.
- Sharing and Generosity: This topic centres on professional growth and development. Discussions encompass job searching, career planning, networking, skill development and workplace dynamics. Owing to its wide-ranging nature, it finds a significant presence on platforms like Twitter.
- People and Thoughts: Anchored around human behaviour, thoughts and perceptions, keywords such as "think," "people," "know," and "human" manifest. Conversations often involve cognitive processes, decision-making, social dynamics and self-reflection.

Implementation topics

These subjects shed light on the tangible applications of AI and advanced technologies.

- Writing and Tweeting: Focusing on content creation and sharing on social media platforms, keywords like "project," "like," "ask," and "write" suggest an emphasis on content creation and public engagement.
- Content Writing and Tools: This topic revolves around content creation, the tools used and content marketing strategies. Keywords include "use," "content," "tool," and "marketing."
- Language Models and ML: A Deeper Dive into Advanced AI Technologies, especially Language Models and ML. Conversations touch upon NLP, data analysis and AI-driven solutions.
- Questioning and Responding: This topic addresses the interactive aspect of AI technology, focusing on querying and responding.
- Code and Problem-Solving: Participants discuss coding, programming and employing AI for technical solutions.
- Prompts and Creativity: Conversations revolve around creative content generation, storytelling, poetry and AI-generated prompts for artistic pursuits.

Impactful topics

These topics contemplate the transformative potential of technological advancements.

- Business and Technology: Exploring the confluence of business strategies with technological innovation, discussions vary from the role of tech in businesses to the legal dimensions of emerging technologies.
- Microsoft and AI: An in-depth look into Microsoft's pursuits in AI and its implications for the tech world.
- School and Education: Delving into how technology is revolutionising the education sector, discussions encompass chatbots, online learning platforms and the changing landscape of education.
- Time and Fun: Focusing on leisure in the digital age, this topic delves into how tech has redefined entertainment, including gaming and streaming.
- Use and Technology Replacement: Examining the evolving human-tech dynamic, discussions ponder instances where technology streamlines or replaces traditional human tasks.

Table 3 shows examples of Tweets for each of the three overarching domains: Common, Implementation and Impactful.

Table 2: Outcomes of the LDA analysis

Domains	Topics	Keywords	Definition
Common topics	Search and SEO	google, search, engine, thread, SEO, summary, extension, bing, result, mind	These topics encompass broad discussions and broad themes and cover a wide range of general subjects. They often involve common topics and questions that people discuss in various contexts.
	Jobs and Articles	job, article, well, na, people, may, take, coming, soon, gone	
	Sharing and Generosity	get, ask, something, think, could, thing, give, even, answer	
	People and Thoughts	think, people, know, work, like, even, still, time, human, need	
Implementation topics	Writing and Tweeting	project, like, ask, give, really, great, right, something, would, HTTP	Functional topics revolve around the practical applications and functions of technology and AI. It mainly focuses on how these technologies can perform specific tasks or solve problems.
	Content Writing and Tools	use, content, HTTP, tool, ai, help, way, life, writing, marketing	
	Language Models and ML	model, language, amp, learning, data, machine, generate, large, used, customer	
	Questioning and responding	asked, question, answer, write, ask, response, say, said, asking, gave	
	Code and Problem-Solving	use, HTTP, code, write, using, know, would, writing, help	
	Prompts and Creativity	chat, HTTP, write, asked, written, wrote, poem, using, story, style	
Impactful topics	Business and Technology	business, exam, power, potential, technology, future, marketing, YouTube, law, startup	These topics focus on the potential consequences, effects and implications of technology and AI on various aspects of society, business and education. This topic explores how these advancements might shape the future and have lasting impacts.
	Microsoft and AI	Microsoft, intelligence, artificial, company, billion, join, creator, technology, tech, investment	
	School and Education	school, month, user, education, year, version, chatbot, million, technology, chatbots	
	Time and Fun	time, day, going, thing, game, fun, everyone, around, go, first	
	Use and Technology Replacement	use, know, human, open, need, case, chatbot, replace, technology	

Source: Developed by author, 2023

Table 3: Examples of tweets for common, implementation and impactful domains

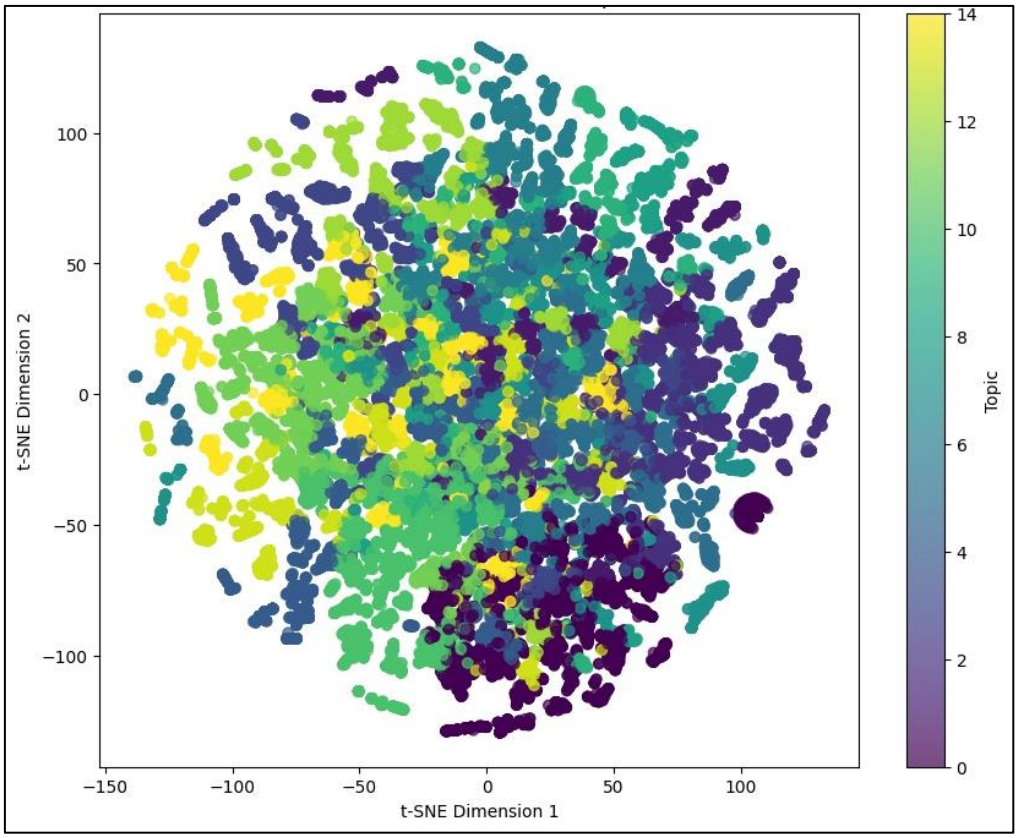
Common topics
ChatGPT is the latest version of â€œI am feeling luckyâ€ feature of Google search! Same construct, yet so advanced.
After having played with OpenAI's ChatGPT for 2 days. I can safely say that the game has changed.
Computers have led to the loss of writing skills
Yeah GPT 7.75 Final Chapter Prologue will probably be able to do a decent translation because google isn't too far off that now but /localisation/ is a different thing entirely and if you can't make your translation contextually & culturally relevant it isn't good.
ChatGPT doesn't understand homophones, it confuses them with rhyming words.
Implementation topics
ChatGPT is awesome. Not close to an AGI like Skynet or JARVIS, but more advanced than any chatbot I've seen. This project is so massive that I wonder what it will take to build an AI that can perform any intellectual task that a human can. Maybe when we crack Moravec's paradox?
It might be the end of corporate CEO/Marketing mumbling speeches, which is good but AI will also improve their output...
Which application are you addicted to and has become part of your life?
The "hook" would be that it would be as automated as possible. Even using AI to write chunks of dialogue via ChatGPT
[Post written by OpenAI GPT with the prompt "Make a prediction of when AI will generate most text, images and videos online, in very ganster style with one concrete example of best and worst scenarios, that maximises thoughtful comments when posted."]
@WilliamLamkin I did this with the previously available GPT interface, but learning Spanish was up there.
Impactful topics
â€œWrite an elevator pitch for a new startup CouchPoint an Independant travel brand between Airbnb and CouchSurfingâ€ https://t.co/Am9vSD6jZ6
Asked ChatGPT to write a simple Kotlin function and it did so surprisingly correctly along with an example input, I then told it to rewrite it without using var or other mutable types and it knew the functional equivalent. Like wow.
I have fun with it, but itâ€™s a cool technologyâ€¦arge
My guess is, Bing is going to get a heavy boost as a search engine with this https://t.co/oEeuysquc0 as Microsoft has exclusive license to all OpenAI properties.
#GPT #OpenAIChat #ArtificialIntelligence #Google #Microsoft #technology @sama @elonmusk #ELONMUSK @paulg #innovation
As Iâ€™ve noticed in this â€¦ conversation it has difficulty comprehending time. https://t.co/toMaLTJgfk
@cogentgene Working on launching a Shopify app soon with the core functionality completely built out by ChatGPT.

Source: Generated by author, 2023

In summary, this study maps out how humans engage with technology, from shared curiosities to pragmatic applications and visionary outlooks on future implications. The Common domain captures the broad, frequently discussed themes that reflect general public attitudes and interests. The Implementation domain highlights specific strategies and challenges associated with integrating ChatGPT into educational practices, providing evidence of the practical considerations involved. The Impactful domain reveals the significant effects and outcomes of ChatGPT's use, offering insights into its broader implications for education. Together, these domains offer a comprehensive view of the multi-faceted relationship between humans and this technology. The evidence from our analysis underscores the complexity of these interactions and highlights the need for ongoing research and dialogue to fully understand and address the evolving role of such tools in our lives.

Figure 5 visualises the LDA results using t-distributed stochastic neighbour embedding (t-SNE). t-SNE is a dimensionality reduction technique designed to represent high-dimensional data in two dimensions, ensuring that the most crucial structures within the data are retained. The visualisation reveals that the 15 topics are primarily clustered in the centre, with a few outliers appearing at the extreme maximum and minimum values.

Figure 5: SNE of LDA distribution



Source: Generated by author, 2023

While formal validation techniques such as k-fold cross-validation, test-retest reliability, and inter-annotator agreement metrics were not applied in this study, we implemented a thorough manual validation process to ensure the reliability and validity of our model. This involved a qualitative review where domain experts examined the topics and keywords produced by the LDA model to assess their coherence and relevance to the public discourse on ChatGPT in education. The manual validation provided a robust check on the model's outputs, ensuring that the identified topics accurately reflected the discussions in our dataset. Furthermore, we compared the results with established baselines from prior research to contextualise and validate the effectiveness of our model. Although formal metrics were not used, these steps contributed to a reliable and credible analysis of the data.

Our findings align with previous studies that identify key themes such as implementation challenges and benefits of ChatGPT in education. However, we also observed distinct perspectives on future applications that were not highlighted in earlier research. This divergence suggests an evolution in public discourse and underscores the value of recent data in capturing emerging trends. By comparing our results with existing studies, we provide a clearer understanding of how perceptions of ChatGPT are shifting, thereby contributing new insights to the field.

CONCLUSION

The rapid advancement of AI, epitomised by platforms like ChatGPT, is forging novel intersections in various realms, education being a notable one. This research embarked on a meticulous journey, systematically weaving through the vast tapestry of Twitter discussions to unravel these intersections. By traversing a methodologically rigorous pathway from data collection to topic modelling, this study spotlighted the multi-dimensional dialogues encircling ChatGPT in the educational domain.

This research advances knowledge by theoretically exploring public perceptions of ChatGPT in education, empirically presenting new insights from recent social media data, and methodologically introducing the use of topic modeling on Twitter. These contributions enhance our understanding of AI in education and demonstrate the value of innovative data analysis techniques.

The sheer volume of tweets underscores the immense interest surrounding AI, specifically ChatGPT, in the education sector. Such volume highlights the relevance and importance of AI tools in contemporary discourse. The involvement of academic experts in tweet classification, combined with sophisticated ML and deep learning models, ensured a dataset of high relevance and contextual accuracy. The LDA-driven extraction of 15 distinct topics illustrates the varied dimensions of AI-related conversations. The exchanges span a broad spectrum, from general discussions of application-centric dialogues to the potential ramifications of AI integration.

The highlighted topics reflect the multi-faceted relationship between humans and AI. Whether it's the curiosity-driven discussions, practical applications of the tool, or future-gazing into the implications, it is clear that AI platforms like ChatGPT are more than mere tools; they're reshaping the ways we think, interact and envision our future. The t-SNE

visualisation further reinforced our topic modelling outcomes, showcasing dense central clustering and highlighting unique, outlier discussions.

While this research provides a comprehensive glimpse into the ongoing discourse, several avenues beckon deeper exploration. Future studies can assess the temporal evolution of these discussions. How have perceptions and dialogues shifted over time, especially with the rapid evolution of AI capabilities? Beyond the topics of discussion, it would be valuable to gauge the sentiment of these tweets. Are they generally optimistic, sceptical, or neutral concerning AI's role in education?

Further studies might delve deeper into linguistic nuances, understanding the tweets' tone, style and other subtleties. How do discussions on ChatGPT in education compare with other AI tools or platforms? A comparative analysis can offer broader insights into the AI education landscape. Directly linking ChatGPT to educational outcomes could provide empirical evidence of its effectiveness as a pedagogical tool.

This research is a single thread in the grand tapestry of AI and education. As AI continues to evolve and permeate diverse domains, sustained research endeavours will remain paramount in understanding, navigating and optimising this symbiotic relationship between humans and machines.

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The Effect of Emotional Labour on Job Satisfaction and Organizational Commitment among Ayurveda Physicians in Sri Lanka

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Dharmasena, M. T. S. S.[1*] and Priyanath, H.M.S.[2]

[1*]Faculty of Graduate Studies, Sabaragamuwa University of Sri Lanka, Belihuloya, 70140, Sri Lanka

[2]Department of Economics and Statistics, Sabaragamuwa University of Sri Lanka, Belihuloya, 70140, Sri Lanka

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Abstract

Similar to other medical specialities, Ayurvedic physicians have a distinct set of duties and responsibilities, with patient interaction playing a big role. In interpersonal interactions with patients, Ayurvedic physicians need to control their emotions. Emotional labour (EL) is the term used to describe the extreme patience and emotional control required to provide effective patient care. Previous researchers have not given adequate attention to studying the effect of EL on-job satisfaction (JS) and organizational commitment (OC), of Ayurvedic physicians. This research attempts to explore the effect of EL on JS and thereby OC, particularly among Ayurveda physicians in Sri Lanka. Primary data was gathered using multistage sampling from 331 Ayurvedic physicians in Sri Lanka for a structured questionnaire. The Partial Least Squires Structural Equation Model (PLS-SEM) was utilized to analyse the data, with the support of SmartPLS software. The results revealed that EL has a positive influence on OC while EL positively affects JS. The results further confirmed that JS has a positive effect on OC. Finally, the findings demonstrated that JS plays a partially mediating function in the connection between EL and OC. These findings help the advancement of existing knowledge by providing empirical evidence in the context of Ayurvedic physicians in Sri Lanka. Healthcare administrators and policymakers should pay attention to improving emotional labour, job happiness, and organizational commitment of Ayurvedic physicians to enhance patient care efficiency.

Keywords: Ayurveda Physicians, Emotional Labour, Job Satisfaction, Organizational Commitment

INTRODUCTION

According to the World Health Organization (WHO) (2019), 88% of the world's population uses conventional medicines, primarily from herbal sources, for health care. Workers in the healthcare industry are a special group since they must expend a lot of emotional energy when interacting with patients, which has a significant impact on both their work and personal well-being (Smith & Jones, 2021). Healthcare professionals are obligated to engage in emotional labour due to their work environment (Yeh et al., 2020). Good emotional expression is necessary while treating patients, and individuals who can successfully express their emotions in client-facing roles must be able to do it in a way that conforms to social, professional, and organizational norms (Hochschild, 1983). A situation where a person feels forced to repress their feelings is called EL (Wilkinson, 2018). Emotional labour involves suppressing one's emotions, and healthcare workers use it to build and maintain relationships with patients or customers. Ideal healthcare workers possess high professionalism, solid theoretical knowledge, practical experience, and purity in thoughts, actions, and words (Vagbata, 2012). Tsai (2009) found that emotional management is strongly correlated with customer relations behaviour.

Unlike other medical methods, people expect a lot of friendliness and a strong doctor-patient relationship from an Ayurveda physician. In the Ayurvedic medical system, time is taken to talk to a patient and maintain a close relationship with the patient until the disease is cured. In Ayurveda, mental health is given the same consideration as physical health when treating patients. The medical field is an emotionally exhausting profession, which helps to promote the image of the emotionally detached doctor (Kerasidou & Horn, 2016). Kerasidou and Horn (2016) mentioned that physicians must be clinically competent as well as sympathetic toward their patients to practice medicine. In practice, physicians may find it challenging to meet both needs. The profession is dominated by the idea of the technically proficient, analytical, and emotionally cold doctor, which keeps doctors from feeling the same emotions as their patients (Kerasidou & Horn, 2016). However, to improve organizational efficiency, individuals are supposed to have positive emotional labours that allow them to influence others (Deliveli & Kiral, 2020). Kinman, Wray, and Strange (2011) revealed a substantial impact between EL and JS in their study among UK teachers. JS means how much people enjoy or love their jobs (Ali & Anwar, 2021). Munir and Rahman (2016) mentioned that it is essential to develop and maintain employee satisfaction for the benefit of both the individual and the company.

* **Corresponding author:** Tel.: +94 77 420 1545, Email: thepuliess@gmail.com
https://orcid.org/0009-0002-9146-2851

Apasara and Arachchige (2016) found a connection between job happiness and surface acting. According to Pandey and Singh (2015), JS is negatively impacted by the deep acting level. In their 2019 study, Gulsen and Ozmen examined nurses and discovered a robust positive correlation between EL and JS. Researchers have therefore verified that EL has a significant impact on JS.

Employees' voluntary displays of EL behaviours to attain organizational goals might provide information about their commitment to the organization (Deliveli & Kiral, 2020). The force of a worker's commitment to the organization in which he or she works is demonstrated through OC (Demiray & Curabay, 2008). Suharto, Suyanto, and Hendri (2019) revealed that OC has a direct positive influence on job performance. Considering how JS affects OC, Alnajjar (1996) found that employees who were satisfied with their jobs were more committed and dedicated. Bangwal, Tiwari, and Chamola (2017); Hedayat (2018); Isfahani and Heydari (2019); Kaplan, et al. (2012); and Salem et al., (2016) revealed a positive and significant correlation between JS and OC. In the Sri Lankan context, empirical evidence related to EL, JS, and OC, particularly among Ayurvedic physicians in Sri Lanka, is still in the minority. Therefore, this study aims to explore the impact of EL on JS and OC among Ayurvedic physicians in Sri Lanka. The findings could improve healthcare organizations' workforce efficiency and service delivery. The paper presents the available body of both theoretical and empirical knowledge in the next section, then the research model and hypotheses, methodology, results, and discussion, and finally concludes with a discussion on the effectiveness of healthcare organizations.

LITERATURE REVIEW

Emotional labour

Wilkinson (2018) has defined emotional labour as a situation where an individual feels the need to suppress his or her emotions. Hochschild (1983) defines EL as "the management of feeling to create a publicly observable facial and bodily display". Additionally, he listed three traits of employment requiring emotional labour: a). Direct communication with the public, either in person or through voice (voice-to-voice), b). To elicit the same emotional experiences in another person, they must exert effort, and c). They provide the employer with some influence over the employee's emotional behaviour through supervision and training. According to Grandey (2000), EL is the process of controlling one's emotions or sentiments to avoid emotional outbursts within an organization. When an employee exhibits rule-abiding behaviour, such as smiling at clients even when they don't feel like it, they are exhibiting EL, which Robbins and Judge (2017) have called the act of an employee expressing emotions that the organization wants them to express during interpersonal transactions at work. The goal of emotional work is to actively influence, generate, or change the way that emotions are expressed throughout continuous encounters and relationships. Reinterpreting an incident or scenario (cognitive), restraining emotional outbursts (behavioural), or lowering arousal by abusing psychoactive drugs (physical) approaches to emotion regulation are all possible (Pugliesi, 1999).

Authentic acting, deep acting, and surface acting are the three stages of emotional acting (Ashforth & Humphrey, 1993; Hochschild, 1983). EL has been defined by Gabriel and Diefendorff (2015) as a dynamic self-regulation process that happens throughout interactions with clients, when employees continuously assess, modify, and communicate their emotions. There are two kinds of acting, according to Robbins and Judge (2017): surface acting and deep acting. Deep acting, surface acting, and emotional dissonance (also known as emotional deviance) are the three categories of EL. Morris and Feldman (1996) claim that the four aspects of emotional labour; frequency of acceptable emotional display, attention to needed display norms, diversity of acceptable emotions, and emotional dissonance, are the most useful for characterizing EL. In relation to this, Yang and Chang (2008) have identified the following: the emotional display rule, surface acting, deep acting, range of emotions needed, frequency and duration of interactions. Furthermore, their findings demonstrated that EL had two dimensions that are similar to Hochschild's active deep acting: emotive dissonance and emotional effort. It is significant that Diefendorff et al. (2005) discovered that when offering customer service, staff members from a variety of companies displayed real emotions. Of the three tactics for EL, expressing one's naturally occurring sentiments is the one that is used the most frequently. Ashforth and Humphrey (1993) contend that because people still need to consciously check that their displays conform to the expectations of the organization, EL has a role in spontaneous emotional expression.

Job satisfaction

According to Munir and Rahman (2016), Hoppock was the first to bring the word "job satisfaction" to public attention in 1935. According to Hoppock (1935), a person's expression of joy with their employment is the result of a combination of psychological, physiological, and environmental elements. Amin et al., (2021) mentioned that positive attitudes towards the tasks completed are reflected in job satisfaction. It will make a person feel confident and enthusiastic about every job. Ali and Anwar (2021) mentioned that satisfaction shows us how much people love or enjoy their work. Aslaniyan and Moghaddam (2013) described JS as an employee's emotional focus on work, and they also mentioned that it is an effective response to a job as a result of comparing the perceived results with those desired. In human resources, a person's sense of contentment at work that motivates them to work is known as JS. Munir and Rahman (2016) assert that JS is more significant than feelings of pleasure, happiness, or self-satisfaction. Robbins and Coulter (2016) said that "JS refers to an employee's general attitude toward his or her job" and they noticed that many managers are concerned with JS because happy workers are more inclined to come to work and perform well, and remain with the organization.

Universal and facet measures of JS have been used to measure JS. Global measurements are utilized to forecast behaviour such as resigning by focusing on general attitudes about the work (Fritzsche & Parrish, 2005). Facet measurements concentrate on JS with specific components of the job and are used to identify organizational or workforce weaknesses as well as strengths (Ironson et al., 1989). Facets may include colleague contentment, fringe benefits, workplace circumstances, salary oversight, or the amount of personal growth available at work (Spector, 1997). Employees are asked to describe how satisfied or unhappy they are with various aspects of their job activities in interviews or through questionnaires, which are used to evaluate work ethic, attitude

toward work, and JS (Taber & Alliger, 1995). Another popular metric used in JS research is the Minnesota Satisfaction Questionnaire (MSQ).

Organizational commitment

OC is measured by absenteeism and staff turnover rates, which indicate how much workers believe in and support organizational goals as well as their readiness to stay or leave the company (Dewi et al., 2021). Highly engaged employees (high commitment) tend to feel happy on the job because they need to achieve what they believe in the organization (Dewi et al., 2021). OC is an attitude that displays how well an individual appreciates and is connected to his organization and a person who is deeply dedicated will most likely regard himself or herself as a true member of the organization. Further, Devi et al. (2021) mentioned that OC is the amount of trust and acceptance of workers into company goals and interest to stay in the organization. Also, OG is described as a strong desire to stay an active member of a specific organization, a desire to perform according to the intentions of the organization and particular beliefs, and approval of organizational goals and values (Curtis & Wright, 2001). The extent to which a worker connects with a certain company and its objectives, and their desire to remain there is referred to as organizational commitment (Robbins & Coulter, 2016; Robbins & Judge, 2017). Employees who are not happy in their current positions, if they are engaged or devoted enough, are willing to make sacrifices for the company. OC demonstrates the power of a worker's commitment to the organization in which he or she works and several studies have also revealed that numerous characteristics influence OC (Demiray & Curabay, 2008). Mowday, Porter, and Steers developed a taxonomy of these characteristics and labelled them as personality traits, role and job qualities, work experience, and working environment. It also consists of at least three distinct parts that each reflect commitments needed for an organization to remain operational: (1) an obligation (Normative commitment), (2) a need (Continuance commitment), and (3) a desire (Affective commitment).

HYPOTHESES

Emotional labour and organizational commitment

Fernando and De Alwis (2022) exposed a positive relationship between EL and OC. According to the findings of Deliveli and Kiral (2020) on teachers at the University of Turkey and, Yagci and Avcikurt (2020) on the instructors, discovered that emotional labour had a positive and significant influence on OC. Cho et al. (2013) discovered that EL is positively connected with affective commitment among retail sales personnel in South Korea. The research done by Oranika et al., (2020) on secondary school teachers in Nigeria and Kim and Yang (2018) on workers of IT companies in Seoul and Gyeonggi-do, South Korea found deep acting positively predicted continuance commitment. Giderler et al. (2016) found that surface behaviour and normative and continuation commitment are positively correlated, and that deep behaviour has a significant correlation with normative commitment. Overall, the evidence suggests that the two factors have a favourable positive association. Then, the study predicts emotional labour has a positive influence on the OC of Ayurveda physicians in Sri Lanka.

H1: The emotional labour of Ayurveda physicians in Sri Lanka has a positive influence on organizational commitment

Emotional Labor and Job Satisfaction: research done by Cho et al. (2013) on retail sales staff in South Korea, (Yang & Guy, 2015), Fernando and De Alwis (2022) on physiotherapists, Lee (2018) on South Korean public service employees, Hsieh et al. (2012) on public service workers discovered that emotional labour is positively connected with JS. A positive connection has been found between EL and JS in many research (Jin & Guy, 2009). According to a study conducted on public officials in South Korea, individuals who engage in emotional labour report higher levels of job satisfaction when their emotional intelligence is higher (Lee, 2020). Some researchers have considered emotional labour as a one-dimensional concept and discovered that it is favourably linked with job satisfaction in the case of hotel employees (Chu et al., 2012), while Cho et al., (2013) also discovered a favourable association with retail personnel. The majority of the research points to a favourable correlation between the two factors. Therefore, the study assumes that EL positively affects Ayurvedic doctors' JS.

H2: Emotional labour has a positive influence on the job satisfaction of Ayurveda physicians in Sri Lanka

Job Satisfaction and Organizational Commitment: Research conducted by Tsai et al. (2010) with employees in the hospitality industry in Taipei City, Taiwan; Top and Gider (2013) with nurses and medical secretaries in three hospitals in Turkey; Isfahani and Heydari (2019) in hospitals in Iran; and Mehdi et al. (2013) among nurses, found JS and OC to be positively influenced. The study conducted by Kaplan et al. (2012) on hospital personnel in Turkey found a favourable correlation between JS and both affective commitment and OC. A study conducted on hospital management and staff at Isfahan University Hospitals found that JS and OC were positively correlated and that personnel who were content with their jobs also had greater levels of OC (Mosadeghrad & Ferdosi, 2013). Additionally, a number of studies conducted by Iranian employees and visiting lecturers (Hedayat et al., 2018) discovered a strong correlation between JS and OC (Eslami & Gharakhani, 2012). As a whole, the above evidence implied that the two elements have a positive relationship. Therefore, the study hypothesizes that JS positively influences the OC of Ayurveda physicians.

H3: Job satisfaction positively affect the organizational commitment of Ayurveda physicians in Sri Lanka

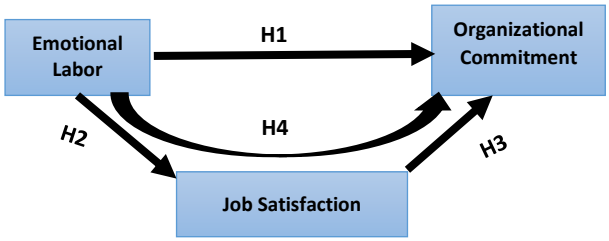
The Mediating Role of Job Satisfaction: In a nationwide survey of teachers, JS acted as a mediator in the association between EL and affective commitment (Mahoney et al., 2011). Fernando and De Alwis (2022) discovered that among physiotherapists, work satisfaction acted as a moderator between EL and OC. Hofmann and Stokburger-Sauer (2017) discovered that employee JS acts as a mediator in the link between emotional dissonance and OC. Chen et al. (2011) found that JS acts as a mediator in the link between deep acting and surface acting and work performance. Nursing staff at Taiwan's teaching hospitals can effectively use JS to mediate deep acting and OC (Yang & Chang, 2008). Consequently, the data points to a mediation role for JS between OC and emotional labour. Therefore, the study hypothesizes

that the relationship between EL and the OC of Ayurvedic physicians is mediated by job satisfaction.

H4: Job satisfaction plays a mediating role in the relationship between emotional labor and organizational commitment of Ayurveda physicians in Sri Lanka

The conceptual framework of the study is shown in Figure 1. The inspiration for the project came from a desire to find out more about how EL affects OC and JS. Moreover, it was proposed that the relationship between EL and OC would be mediated by JS. According to the figure, OC is the dependent variable, and EL is the independent variable. JS is thought to be the mediating variable.

Figure 1:Conceptual framework



Source: Developed by author; field survey, 2023

METHODOLOGY

The research paradigm of this study is positivism because three well-developed theoretical concepts have been used to conduct this empirical study. The study attempts to test the efficacy of the practical implementation of theoretical concepts by Ayurveda physicians in Sri Lanka, therefore, the research approach is deductive. In the purest version of positivism, the principal purpose of the research is to examine the explanatory or causal links between variables (Park et al., 2020). Therefore, this study is a cause-and-effect study. Based on all these, the study employs a quantitative approach to test hypothetical relationships. The unit of analysis of this study is Ayurveda physicians in Sri Lanka. Approximately, Sri Lanka has 2413 Ayurveda physicians. Out of this, 331 Ayurveda physicians were selected using the sample size determination formula highlighted by Krejcie & Morgan (1970). In this research, the sampling technique was the multi-stage. First, the sample was calculated as a percentage of the total and the number of physicians representing each province was decided. Then, physicians from respective provinces were randomly selected from the existing hospitals in that province as shown in Table 1. Finally, a random sampling method was used to choose the sample. A structured questionnaire was used to gather data.

Table 1: The sample

Province	Population (total number of physicians)	The sample
Central	338	46
Eastern	205	28
North Central	136	19
Northern	232	32
North Western	260	36
Western	644	88
Sabaragamuwa	185	25
Southern	262	36
Uva	151	21
Total	**2413**	**331**

Source: Developed by author, 2023

A slightly modified version of Yang et al.'s scale (2019) was used to measure EL. Emotion termination, expression of inherently felt emotions, deep acting, and surface acting are its four dimensions. 16 items that were used by Diefendorff et al. (2005), Brotheridge & Lee (2003), Cukur (2009), and Naring et al. (2007) were used to quantify surface acing. Deep acting was measured using nine questions, as used by Cukur (2009), Diefendorff et al. (2005), Naring et al. (2007), and Yin et al. (2019). Expression of naturally felt emotions allows employees to experience what is intended to be communicated without having to create feelings (Grandey, 2000). This dimension was measured by 3 items and emotional termination also was measured by 3 items (Yang et al., 2019). Emotional termination is when the employee actively alters their opinions without emotional expression or inner sensations, notably while dealing with customer issues (Yang et al., 2019). The Spector (1985) job satisfaction questionnaire was used to gauge employee satisfaction. 36 items on a scale were used to measure it. The notion of organizational commitment was derived from the organizational commitment questionnaire developed by Allen and Meyer (1990). The questionnaire had 24 items that were divided into three categories: normative commitment, affective commitment, and continuity commitment. For each of the three variables in this study, a seven-point Likert scale with anchors ranging from 1 (strongly disagree) to 7 (strongly agree) was employed. One score was assigned to strongly disagree, two to moderately disagree, three to slightly disagree, four to neither agree nor disagree, five to slightly agree, six to moderately agree, and seven to strongly agree.

Partial Least Square Structural Equation Modelling (PLS-SEM) was used to test the hypotheses. The first, and second-order analyses were assessed to measure independent variables. Reliability was measured using indicator reliability and internal consistency reliability. Convergent and discriminant validity were used to assess the validity. Fitting the second-order analysis, or final model, is considered appropriate if there is satisfactory validity and reliability. It is also examined utilizing the validity and reliability of the latent variables and indicators. Additionally, multicollinearity, path coefficient importance, coefficients of determination, R square, effect size, and predictive relevance were assessed by the hypothesis testing, in the inner model.

RESULTS

The majority (181) of the sample of 331 respondents were medical officers, making up 51% of the total. They were followed by 135 community medical officers (38%), 37 medical officers (10.4%), one medical superintendent (0.3%), and one consultant (0.3%). A total of 355 people made up the sample, and 59.2% of them were under the age of 30. The following group, comprising 33% of the sample, was aged 40 to 49. Whereas 0.6% of the population was over 60 years old, and 7.3% were between 50 and 59.

Table 2 demonstrates that the outer loading values that are obtained exceed the minimum value of 0.7 required by the threshold requirement. On the other hand, as the outer

loadings are over 1.96 at a 95% confidence level, indicating that all indicator reliability was satisfied by the constructs under first-order analysis, the T-test claims that the factor loadings were statistically significant. Table 2 additionally demonstrates that the ratings for internal consistency and dependability for both Composite dependability (CR) and Cronbach's alpha (Cro. α) is greater than 0.7. Table 2 also revealed that the dependent variable's first-order constructs had convergent validity because all values were more than 0.5 Average Variant Extracted (AVE) needs to be equal to or greater than 0.5).

Table 2: Analysis of the first-order constructs

	T Stat	Load -ings	Cro. α	CR	AVE
1. Emotional Labour					
LV 1.1 Surface Acting			**0.840**	**0.882**	**0.555**
I show feelings to customers that are different from what I feel inside	28.858	0.757			
I fake the emotions I show when dealing with patients	23.849	0.738			
Pretend to have emotions that I don't really have	32.760	0.757			
Hide my true feelings about a situation	25.688	0.731			
I try to control my feelings to have emotions I need to display from my job" When one of your co-workers making rude jokes about you	24.452	0.744			
I try to control my feelings to have emotions I need to display from my job" When figuring out your patients did not follow the treatment protocol that you think very important	27.684	0.742			
LV 1.2 Deep Acting			**0.891**	**0.913**	**0.567**
Make an effort to actually feel the emotions I need to display toward others	24.384	0.727			
Work at conjuring up the feelings I need to show to patients	28.655	0.749			
Work at developing the feelings inside of me that I need to show to patients	34.012	0.770			
I try to put an effort to actually feel the emotion I need to display" When getting very bad news from your family before the duty time	30.252	0.750			
I try to put an effort to actually feel the emotion I need to display" When You did not find very funny most of the jokes that your co-workers do	27.585	0.752			
I try to put an effort to feel the emotion I need to display" When You need to do a lecture that you don't like very much about a not very interesting subject	30.571	0.767			
I try to put an effort to feel the emotion I need to display" When Your supervisor generally makes negative and hurting comments	27.218	0.743			
I try to put an effort to feel the emotion I need to display" When discussing frequently with patients about their diseases	26.708	0.763			
LV 1.3 Expression of naturally felt emotions			**0.845**	**0.906**	**0.763**
The emotions I express to customers are genuine	30.758	0.827			
The emotions I show customers come naturally	82.298	0.902			
The emotions I show customers match what I spontaneously feel	53.904	0.891			
LV 1.4 Emotion termination			**0.789**	**0.877**	**0.703**
When there is disagreement with the customer, I will serve according to the customer's requirements without any emotional change	34.859	0.816			
When customers disapprove of my service, I will choose silence	55.446	0.854			
Feel helpless when customers ask too much or are unable to meet them temporarily	48.551	0.845			
2. Job Satisfaction					
LV 2.1 Pay			**0.859**	**0.905**	**0.704**
I feel I am being paid a fair amount for the work I do	37.705	0.817			
Raises are too many	30.167	0.792			
I feel appreciated by the organization when I think about what they pay me.	56.958	0.880			
I feel satisfied with my chances for salary increases	52.670	0.865			

LV 2.2 Promotion			**0.878**	**0.916**	**0.733**
There are really many chances for promotion in my job	37.247	0.827			
Those who do well on the job stand a fair chance of being promoted	46.272	0.879			
People get ahead as fast here as they do in other places	41.140	0.839			
I am satisfied with my chances for promotion	56.249	0.878			
LV 2.3 Supervision			**0.914**	**0.940**	**0.795**
My supervisor is quite competent in doing his/her job	47.059	0.869			
My supervisor is fair to me	67.291	0.904			
My supervisor shows more interest in the feelings of subordinates	56.537	0.885			
3.3.d I like my supervisor	85.686	0.909			
LV 2.4 Benefits			**0.773**	**0.856**	**0.601**
I am satisfied with the benefits I receive	43.854	0.829			
The benefits we receive are as good as most other organizations offer	44.179	0.836			
The benefits package we have is equitable	35.320	0.796			
There are benefits that we should have	15.093	0.619			
LV 2.5 Contingent rewards			**0.813**	**0.877**	**0.641**
When I do a good job, I receive the recognition for it that I should receive	43.622	0.821			
I feel that the work I do is appreciated	41.777	0.836			
There are many rewards for those who work here	28.443	0.779			
I feel my efforts are rewarded the way they should be	26.346	0.764			
LV 2.6 Operational procedures			**0.804**	**0.872**	**0.630**
Many of our rules and procedures make doing a good job easy	43.142	0.809			
My efforts to do a good job are seldom blocked by red tape	39.262	0.813			
I have less work to do at work	26.515	0.745			
I have less paperwork	37.577	0.806			
LV 2.7 Co-workers			**0.796**	**0.866**	**0.618**
I like the people I work with	46.413	0.815			
I find I have to work easy at my job than I should because of the competence of the people I work with	37.983	0.807			
I enjoy my co-workers	24.202	0.767			
There is no bickering and fighting at work	24.081	0.754			
LV 2.8 Nature of work			**0.861**	**0.915**	**0.782**
I feel my job is meaningful	59.843	0.883			
I feel a sense of pride in doing my job	64.313	0.897			
My job is enjoyable	53.467	0.873			
LV 2.9 Communication			**0.898**	**0.929**	**0.766**
Communications seem good within this organization	43.009	0.844			
The goals of this organization are clear to me	60.676	0.886			
I feel that I know what is going on with the organization	78.685	0.899			
Work assignments are often fully explained	54.267	0.872			
3. Organization Commitment					
LV 3.1 Affective Commitment			**0.868**	**0.905**	**0.657**
To work for this company for the remainder of my career would make me very happy.	42.922	0.822			
I think I could easily become as devoted to another organization as I am to this one since it holds a lot of personal significance for me.	39.115	0.831			
I enjoy talking about my organization with individuals outside of it.	53.732	0.870			
I truly feel that the challenges facing this organization are my own.	28.983	0.786			
LV 3.2 Continuance Commitment			**0.736**	**0.834**	**0.558**
At this point, I feel that sticking with my organization is more necessary than desirable because I don't feel like I have many other options.	22.547	0.722			
The lack of viable options would be one of the few significant effects of quitting this organization.	24.705	0.766			

The lack of viable options would be one of the few significant effects of quitting this organization.	25.443	0.777			
One of the main reasons I stay on staff is that I would have to make a lot of personal sacrifices to leave; the perks I receive from this company may not be comparable to those of another.	20.547	0.721			
LV 3.3 Normative Commitment			**0.772**	**0.854**	**0.595**
I believe that too many people these days switch jobs too frequently.	23.215	0.728			
I was raised to believe in the importance of sticking with one organization, which is one of the main reasons I still work there.	28.809	0.781			
I also feel obligated to the organization since I think loyalty is crucial.	39.474	0.821			
Things used to be better when individuals spent the majority of their careers with a single company.	25.286	0.752			

Source: Field survey, 2023

As seen in Table 3, the absence of inter-construct correlation values greater than the square root of the AVE satisfied a prerequisite for the discriminant validity of the first-order constructs.

Table 3: Discriminant validity of first-order constructs

	LV1.1	**LV1.2**	**LV1.3**	**LV1.4**	**LV2.1**	**LV2.2**	**LV2.3**	**LV2.4**	**LV2.5**	**LV2.6**	**LV2.7**	**LV2.8**	**LV2.9**	**LV3.1**	**LV3.2**	**LV3.3**
LV1.1	**.744**															
LV1.2	.614	**.753**														
LV1.3	.536	.674	**.873**													
LV1.4	.602	.702	.672	**.838**												
LV2.1	.434	.428	.407	.438	**.839**											
LV2.2	.478	.423	.405	.449	.658	**.856**										
LV2.3	.543	.564	.534	.556	.441	.510	**.892**									
LV2.4	.602	.569	.528	.558	.552	.539	.534	**.775**								
LV2.5	.555	.555	.502	.580	.545	.561	.544	.729	**.801**							
LV2.6	.554	.576	.548	.523	.557	.531	.567	.797	.687	**.794**						
LV2.7	.482	.557	.556	.559	.401	.363	.558	.471	.464	.489	**.786**					
LV2.8	.386	.492	.466	.480	.326	.321	.426	.433	.398	.437	.692	**.884**				
LV3.9	.496	.516	.497	.485	.391	.415	.529	.487	.499	.509	.641	.494	**.875**			
LV3.1	.608	.686	.638	.639	.491	.538	.648	.628	.626	.625	.621	.502	.633	**.811**		
LV3.2	.587	.667	.577	.596	.407	.403	.573	.520	.497	.507	.544	.452	.495	.599	**.747**	
LV3.3	.619	.624	.626	.615	.494	.495	.590	.688	.631	.651	.571	.450	.531	.718	.573	**.771**

Source: Field survey, 2023

Table 4 shows how the scores of the latent variables of the first-order constructs were used to produce the second-order level constructs. The second-order level was subjected to the same validity and reliability tests as the first-order level. Thus, the fifteen latent variables—four second-order independent variables (EL), eight under the mediating variable (JS), and three under the dependent variable (OC)—were assessed collectively for indicator reliability. Table 4 illustrates that all of the path coefficients of the standardized factor loadings were greater than the 0.7 threshold. However, it was evident that all of the t-statistics were significant at a 95% confidence level because they were all over 1.96. Additionally, Table 4 demonstrated that Cronbach's alpha was greater than the required value of 0.7 and that the composite reliability exceeded the recommended threshold of 0.7. Furthermore, the computed results showed that the AVE for the second-order construct's convergent validity was more than 0.5.

Table 4: Analysis of the second-order constructs

	T Stat	Loadings	Cro.α	CR	AVE
2. Emotional Labour			**0.874**	**0.914**	**0.826**
2.1 Surface Acting	28.937	0.807			
2.2 Deep Acting	62.983	0.881			
2.3 Expression of naturally felt emotions	47.166	0.844			
2.4 Emotion termination	57.061	0.874			
3. Job Satisfaction			**0.902**	**0.921**	**0.795**
3.1 Pay	25.514	0.719			
3.2 Promotion	24.508	0.725			
3.3 Supervision	28.956	0.766			
3.4 Benefits	48.773	0.837			
3.5 Contingent rewards	46.078	0.821			
3.6 Operational procedures	52.079	0.841			
3.7 Co-workers	23.531	0.718			
3.9 Communication	25.941	0.728			
4. Organization Commitment			**0.836**	**0.902**	**0.754**
4.1 Affective Commitment	74.558	0.897			
4.2 Continuance Commitment	37.284	0.821			
4.3 Normative Commitment	68.753	0.884			

Source: Field survey, 2023.

After calculating the discriminant validity of the second-order constructs, Table 5 revealed that all inter-construct correlation values were less than the square root of AVE, indicating that the second-order constructs satisfied the discriminant validity criteria.

Table 5: Discriminant validity of the second-order constructs

	Emotional Labour	Job Satisfaction	Organization Commitment
Emotional Labor	**0.909**		
Job Satisfaction	0.789	**0.891**	
Organization Commitment	0.843	0.843	**0.868**

Source: Field survey, 2023

When the independent variables have a high degree of correlation, multicollinearity occurs. With the help of the VIF value, this study evaluated the structural model's multicollinearity. The results suggest that no problems with multicollinearity were found among the variables when the VIF value was under the suggested threshold value of 5, indicating that there was no issue with the variables' multicollinearity.

The importance of the hypothesized correlations was evaluated in the second stage of the structural model evaluation. The PLS technique was used as a first stage in the evaluation of the path coefficients. Each path coefficient's statistical significance was calculated using the t-values. The essential t-value for a two-tailed test was established to be 1.96 at a significance level of 0.05 (Hair Jr., et al., 2014). Therefore, all the hypotheses that are accepted based on the t value are shown in Table 6.

Table 6: Hypotheses testing

Hypothesis	Path coefficients	T statistics	P values	Decision
H1: Emotional Labour -> Job Satisfaction	0.78	32.89	0.00	Accepted
H2: Emotional Labour -> Organization Commitment	0.47	11.39	0.00	Accepted
H3: Job Satisfaction -> Organization Commitment	0.47	11.81	0.00	Accepted

Source: Field survey, 2023

The study evaluated the mediating role of JS. Table 7 demonstrates that JS has a substantial mediating influence on the link between the two variables. The calculations revealed that JS has a partial mediation influence between EL and OC. The JS R2 was 0.622. The R2 for OC was 0.795, and EL explains 62.2% of the variance in JS. The model demonstrates that the impact of the predictive variables is significant.

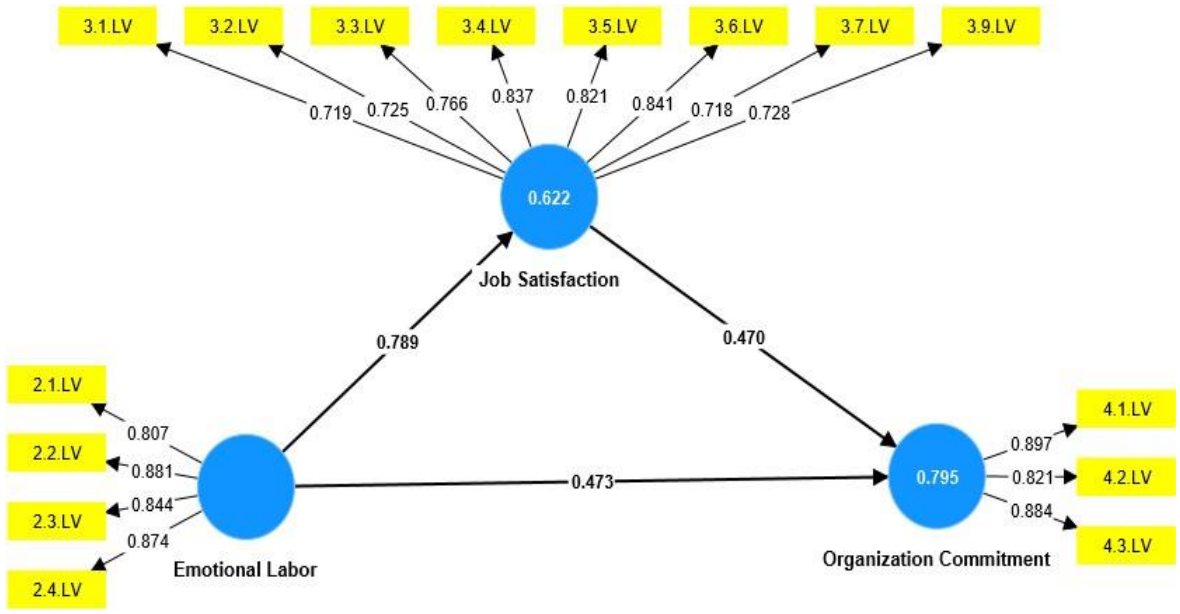
In summary, all of the hypotheses are accepted regarding the study findings displayed in Figure 2.

Table 7: The mediating role of job satisfaction

Hypothesis	Path coefficients	T statistics	P values	Decision
H4: Emotional Labour -> Job Satisfaction -> Organization Commitment	0.371	10.820	0.000	Partial Mediating

Source: field survey, 2023.

Figure 2: The path coefficients



Source: Field survey, 2023

DISCUSSION

The current study looked specifically at how EL affected OC and JS among Ayurvedic practitioners in Sri Lanka. The findings showed that among Ayurvedic doctors, EL positively impacts OC. Thus, Hypothesis I is statistically significant at a 99% confidential level (path coefficient = 0.473 and t-value = 11.395). Surface acting, deep acting, expressing naturally felt emotions, and emotional termination were all assessed separately for a deeper comprehension of how emotional labour affects OC. These results are consistent with the results of Sezen-Gultekin, et al., (2021) done on teachers working in the Sakarya province of Turkey, Akin (2021) done on teachers from a province in Turkey's central Black Sea area who teach in elementary, middle, and high schools and research done on physiotherapists in Sri Lanka (Fernando & De Alwis, 2022). Their research revealed a strong and favourable link between organizational commitment and emotional labour. Research on Animators (Yagci & Avcikurt, 2020) revealed a positive relationship. As more and more Ayurveda doctors learn how to control their emotions or express the emotions that are required to draw customers and are based on the expectations of the organization, it will become clear why there is such a favourable association between emotional labour and organizational commitment.

The second specific objective of the study was to identify the influence of EL on JS among Ayurveda physicians. To do this, Hypothesis 2 was created. The results show that an increase of 1 unit in EL will increase JS by 0.789 (path coefficient = 0.789 and t-value = 32.893). The statistical analysis presented in Table 5 above shows that EL positively and significantly affects JS. Consequently, the second goal was achieved. Similar findings have been made by several researchers. Research on a sample group of foreign capital bank managers at all levels in Turkey indicates that EL has a positive effect on the phenomenon of JS (Camli et al., 2022). According to Dar (2023), the JS of personnel of a top-tier Balochistani telecommunications business is promoted by EL. According to Hochschild (1983), doctors are often taught to express caring, trustworthy care for their patients. It should be highlighted that doctors interact with patients directly, attempt to influence their emotional states, and do not always have an emotional supervisor on hand. Instead, they manage their EL by taking customer expectations and informal professional norms into account. The findings of all the aforementioned prior studies provide additional justification for the favourable association between EL and JS discovered in this study.

To achieve the third specific objective, to ascertain how OC is impacted by JS among Ayurveda physicians, hypothesis 3 was formed. There was enough statistical support to demonstrate that JS had a positive and significant effect on OC. An increase of 1 unit in JS will increase OC by 0.47 (path coefficient = 0.47 and t-value = 11.819). Hence the third hypothesis was also accepted. There is much research done on nurses to find a link between OC and JS similar to the result. The research done on the nurses from several public hospitals in Riyadh city (Al-Aameri, 2000), on the nursing students in a medical university in China (Wu & Norman, 2006), in

three hospitals in Turkey, on the nurses and medical secretaries (Top & Gider, 2013) and on the nursing staff of a teaching hospital in Taiwan (Yang & Chang, 2008), found that JS positively affects OC. Mosadeghrad and Ferdosi (2013) did a study among hospital employees and managers in Iran's public hospitals and revealed a positive link between Job Satisfaction and Organizational Commitment. Bangwal et al., (2017) in research done with three Indian companies, Isfahani and Heydari (2019) in Hospitals in Iran, and Hedayat et al., (2018) with visiting lecturers of Payam Nour University of Iran also found a positive significant relationship between OC and JS.

The fourth hypothesis was created to accomplish the fourth specific objective of the study. The mediating effect of job satisfaction was tested (path coefficient = 0.371 and t-value = 10.82). The results show that there was a partial mediating effect. Hence the hypothesis was accepted. This result is similar to the research done by Abraham (1999) on customer service representatives in the South-eastern United States' telecommunications, entertainment, food service, and clothes retail sectors and also to the research done on physiotherapists in Sri Lanka (Fernando & De Alwis, 2022). Hofmann and Stokburger-Sauer (2017) found that JS plays a mediating role in the associations between EL and OC among employees in the hospitality sector, as well as between positive emotion expression and OC. Among the nursing staff at Teaching hospitals in Taiwan, work satisfaction can successfully act as a mediator between deep acting and OC (Yang & Chang, 2008).

CONCLUSION

The study attempted to examine the effects of EL on JS and OC among Ayurveda physicians. In this research, JS was hypothesized to mediate the association between EL and OC. Four hypotheses were developed and investigated in this study. The findings provide empirical evidence that EL among Ayurvedic physicians positively impacts OC, with all hypotheses being statistically accepted. Moreover, JS positively impacts EL, and OC positively influences JS. Ultimately, the findings supported the notion that JS acts as a moderator in the association between EL and the OC of Sri Lankan Ayurvedic physicians.

This study significantly advances the existing knowledge of healthcare management by filling in theoretical, methodological, and empirical gaps in the literature regarding emotional labour, job satisfaction, and organizational commitment. There was no cohesive single theory to explain the interaction of these variables in the prior research in this field. This study fills this theoretical vacuum by creating an integrative framework that incorporates these three factors and empirically examines their interactions. A notable contextual gap in the literature was the limited empirical investigation of all four dimensions of emotional labour within a single study. Furthermore, few prior studies have examined the role that JS plays as a mediating effect between EL and OC. This study closes these gaps by assessing the mediating effect of job satisfaction in addition to measuring all four aspects of EL. This study fills a contextual gap by focusing on the influence of JS on the connection between EL and OC of Ayurvedic physicians in Sri Lanka, Moreover, the bulk of research that has been done on EL, JS, and OC has been concentrated on occupations like teaching and nursing. Research in the medical area was conspicuously lacking, particularly about Ayurvedic physicians in Sri Lanka. With its fresh perspectives and factual data on Ayurvedic doctors in Sri Lanka, this study closes this empirical gap. The study's methods and conclusions provide a fresh perspective on the dynamics of EL, JS, and OC in the healthcare industry, enhancing scholarly discussion and possibly influencing practice.

The following proposals are given to enhance the noble profession and raise the current standard to a level consistent with that of the world. In areas like pay, promotion, and rewards, management should implement methods and policies to raise the degree of JS. Ayurvedic physicians' financial and non-financial benefits should be updated and adjusted in line with the inflationary trends that are outpacing them. Ayurvedic physicians should be motivated to learn how to connect emotionally with patients. In training programs, Ayurveda medical teaching institutes should provide a deeper grasp of these emotional needs and various EL techniques. Training would guide how to use EL tactics in a balanced manner. The improvement of EL will has two benefits, one for OC and the other for JS, given that EL is proven to have a favourable impact on both JS and OC. As a result, the healthcare administration may elect to frequently check the EL process to ensure that staff members are not being exhausted by frustrated patients. Perhaps most importantly, top leaders and managers should regularly assess the organization, JS, and the nature of employees' EL, and they should take the necessary action to make improvements or develop an existing work.

Future research should have a comprehensive view of doing a thorough investigation into this topic in Sri Lanka with the participation of all medical workers, including nurses, attendants, Ayurveda therapists, etc. which might lead to important suggestions for managing health care effectively. Furthermore, given the cultural impact, further research may replicate this study, in particular, looking at samples from diverse nations and professions might broaden the conclusions. Future research might concentrate on determining if a variety of personal traits have an impact on employees' EL. A better knowledge and description of OC and JS is also required. To delve deeply into the issue of JS and OC, a replication of this study in other contexts with factors like empowerment and leadership style, turnover, and retention, could be taken into consideration in future findings. The customer's perspective of emotional work may also be the subject of future research.

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Geo-Spatial Technology for Identifying Optimal Well Locations in Kolugala Pahalagama Grama Niladhari Division for Effective Groundwater Management

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Ranasinghe, L.A.[1*] and Nishantha Patabandi, K.P.L.[2]

[1, 2] Department of Geography and Environmental Management, Faculty of Social Sciences and Languages, Sabaragamuwa University of Sri Lanka

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Abstract

This study utilized Geographic Information System (GIS) technology to pinpoint optimal locations for establishing wells, addressing the issue of declining water yields in the Kolugala Pahalagama Grama Niladhari Division (GND); a geographically diverse region. The research integrated geospatial data, including geolocations of sample wells, garbage pits and quarterly water level measurements collected through field surveys. Several thematic layers, namely, geology, elevation, slope, drainage density, soil type, and land use types were analysed to delineate groundwater potential zones within the GND. Satti's analysis hierarchy was employed to assign appropriate weights to these factors, reflecting their influence on groundwater recharge and well productivity. Spatial analysis revealed that 9.64% of the area displayed very good groundwater potential, 42.17% had good potential, 39.76% showed moderate potential, and 7.23% exhibited poor potential. The distribution of existing wells was also evaluated, showing that 6% were located in very good groundwater potential zones, 56% in good groundwater potential zones and 38% in moderate groundwater potential zones. Despite this, only 34% of the wells were placed in regions suitable for the establishment of wells, while the majority, 66%, were located in unsuitable areas. Notably, 18 wells displayed lower water levels, likely due to their excessive distance from neighbouring wells. Further spatial analysis identified 29 hectares as unsuitable and 54 hectares as suitable for the future establishment of wells. These findings underscore the significance of geographic factors in the placement of wells, emphasising the need for strategic planning to ensure that wells are sited in areas with high groundwater potential, thus improving long-term water yield sustainability in the region.

Keywords: Garbage Pits, Groundwater, Geo–Spatial Technologies, Kolugala Pahalagama GND, Wells

INTRODUCTION

It's evident that Sri Lanka heavily relies on groundwater for various purposes, with a notable emphasis on addressing the critical issue of clean drinking water scarcity. The historical shift from lakes and ponds to groundwater as the primary source of drinking water can be traced back to the influence of Western colonization, with the trend becoming particularly pronounced around 1984.

As of 2022, approximately 39.6% of Sri Lankans meet their daily water needs through groundwater sources. According to Dhanapalayan's 2021 findings, the estimated groundwater potential in Sri Lanka is 780,000-hectare meters per year. Rainfall contributes to groundwater recharge, accounting for 3% - 7%, with a range of 200-600 million litres.

Sri Lanka's geological composition significantly influences the distribution of groundwater, which can be divided into three main zones. The Miocene Limestone Belt, spanning from Puttalam to Jaffna and Mullaitivu, is a critical region where water is primarily sourced through Aadiya wells. Cities like Puttalam, Jaffna, and Mullaitivu rely on these wells for their water supply. The East, West, and South-East Coasts, including cities such as Trincomalee, Batticaloa, Hambantota and Galle depend on shallow wells, typically 3-5 meters deep, as their main water source. The remaining land area, which covers approximately 80% of the country, includes major regions like Colombo, Kandy, Anuradhapura and Kurunegala, where different groundwater extraction methods are used. Adia irrigation wells are widespread in the Northwest and the North, particularly in Jaffna with over 100,000 wells, 25% of which are dedicated to irrigation purposes. Tube wells introduced in the 1980s, have expanded significantly, with over 30,000 wells established across the country. Major cities like Anuradhapura, Kurunegala and Puttalam saw the most growth, with 5,022, 3,684, and 3,268 tube wells respectively. In dry regions such as Hambantota and Polonnaruwa, cultivation wells have historically been used for agricultural purposes, with around 12,000 wells present. Finally, shallow wells and springs are prevalent in the wet zone, including areas like Colombo and Kandy where abundant groundwater is more accessible compared to the dry zone (Dhanapala,2021).

* **Corresponding author:** Tel.: +94 (76) 457 9191; Email: amandaranasinghe6@gmail.com
https://orcid.org/0009-0007-8956-9031

Despite the diverse approaches to accessing groundwater for various activities, there is a notable trend in Sri Lanka where proper well-setting practices, especially for drinking water purposes, are not consistently followed. In contrast to cities like Mexico, Texas, Kansas, and Missouri, where setting up a private well requires a mandatory permit, Sri Lanka doesn't have a similar regulatory framework. In these cities, a thorough process involving informing relevant institutions, selecting suitable locations based on groundwater potential, and obtaining permits are in place to establish private wells.

In Sri Lanka, the absence of such structured programs and regulations can lead to challenges. As a developing country, the lack of mandatory permits and preliminary groundwater tests may result in the haphazard digging of wells, leading to abandonment when water dries up in a short period. This situation is often financially burdensome for the population, highlighting the need for more organized and regulated approaches to groundwater extraction to ensure sustainability and proper resource management.

The selection of a suitable location is a critical factor when establishing a private well for drinking water needs. Guidelines from the Mississippi State Department of Health (MSDH) emphasize specific distances that should be maintained to ensure the safety and quality of the groundwater. These guidelines are essential to prevent contamination and ensure the uniform extraction of fertile groundwater. The recommended distances, outlined in Table 1, are based on foot size and the proximity to potential pollution sources:

Table 1: Distances to be followed while drilling a well

Feet	Pollution sources
50 feet	-From a garbage pit
100 feet	-From underground waste disposal fields -From a grave or cemetery -From an abandoned well
300 feet	-From lagoon areas -From underground storage designed for petroleum products or chemical substances -From fertilizer storage areas

Source: Division of geology and land surveying, 1996

In light of the practices observed in some developed countries, where stringent regulations are in place, it's important for regions like Sri Lanka to consider implementing similar guidelines and standards. This approach would contribute to the sustainable development of groundwater resources and help address the challenges associated with haphazard well digging and potential water shortages.

Statement of the problem

Hatraliyadda DSD has 57 GNDs. Although there is more or less a water problem in the division, there is a different kind of problem related to groundwater in Kolugala Pahalagama GND.

According to the well census report of 2021, there are 95 wells to meet the drinking water requirement of the division. Presently, all 95 wells remain active and in use. However, approximately 20 wells have been abandoned from the past until now due to diminished water and other factors. Studies reveal that the abandonment of a single well can contaminate groundwater across about 100 miles (161 km) (Kerr,1997), posing a significant risk to aquifer quality. This issue of aquifer degradation is particularly alarming in the context of the world's escalating water scarcity crisis. Geographically, the implications of abandoned wells extend far beyond their immediate surroundings, affecting groundwater resources across a wide area.

Villagers in the division received a public tube well, courtesy of government support, but it dried up within just one and a half years. The tube well wasn't established following a groundwater assessment. Given the present economic conditions, conducting thorough inspections and establishment of wells poses a financial burden that exceeds the capabilities of both the government and the local populace. Therefore, a practical and cost-effective solution is urgently needed to address this issue.

During field observations within the division, it became evident that the community lacked adequate knowledge about proper well-establishment practices. Consequently, wells in the area experience rapid declines in water levels, particularly during the dry season. One contributing factor is the failure to maintain sufficient distances between wells. Additionally, the negligent establishment of drinking water wells in paddy lands poses health risks. Addressing these knowledge gaps and implementing appropriate well-placement strategies are crucial for ensuring sustainable access to water and mitigating health and environmental concerns.

Kolugala Pahalagama division is mainly facing problems related to the location of wells, so it is necessary to identify the groundwater potential zones for the location of wells in a place with continuous water yield, minimum distances between wells and the minimum distance from the sources of pollution. The answer to this problem can be found by identifying the most suitable zones.

Objectives

The primary objective of this research is to investigate the factors influencing the decline in well-water yield within the Kolugala Pahalagama Grama Niladhari area, employing Geospatial technology. Additionally, this study assesses the suitability of current well locations and aims to identify optimal sites for future well establishment.

LITERATURE REVIEW

The research conducted in Puthuhapuwa GND aimed to assess groundwater potential zones utilizing GIS technology, incorporating seven key thematic factors: geology, elevation, drainage density, soil, line density, and land use. The GIS analysis resulted in the development of a final groundwater potential zone map for the GND, categorized into three classes – high, moderate, and low. According to the findings, an area spanning 112,095 square meters in Puthuhapuwa GND was identified as having good groundwater potential, while 683,700 square meters exhibited moderate potential. Conversely, a significant portion, totalling 229,066 square meters, was determined to have very low groundwater levels (Kulasekara and Wijeratne, 2023).

The investigation into potential underground zones in the Kilinochchi district entailed the amalgamation of eight crucial concepts, leveraging a combination of Remote Sensing (RS), GIS, and the Analytical Hierarchy Process (AHP).

Through this comprehensive methodology, a substantially high groundwater potential zone covering 111.26 km² was successfully identified in the Kilinochchi district, specifically in Pacchileipalli DSD. Additionally, Punakari DSD exhibited a high groundwater potential, with the western part recognized as an extreme area of groundwater potential. The study underscored the significant influence of rainfall, geology, and soil factors on groundwater potential in Kilinochchi district. By integrating diverse datasets and methodologies, it aimed to provide a holistic understanding of groundwater potential in the region (Padmanandakumar, 2021).

The Kilinochchi area's groundwater potential was assessed by examining key factors such as geomorphology, geology, soil type, slope, and land use through RS and GIS technologies. These factors were assigned using the weighted overlay method, culminating in the development of a groundwater potential zone map. The results indicate that 5.32% of the groundwater is at a good level, 61.90% at a moderate level, 26.61% at a poor level, and 6.17% at a very poor level. The study identifies water geomorphological features, including alluvial plains, gently sloping areas, and forest lands, as prominent groundwater potential zones in the Kilinochchi area. This comprehensive analysis provides valuable insights for effective water resource management and planning in the region (Kumar et al., 2016).

Castillo et al., (2022) conducted a study to investigate groundwater potential zones within the semi-arid basin of San Luis Potosi, Mexico, through the integration of GIS, RS, and AHP methods. Various thematic factors, including geology, linear density, land use, wetness index, precipitation, drainage density, and slope, were transformed into a raster model. Using the AHP methodology to assign weights, the final groundwater potential zone map was generated. The findings indicate that 68.21% of the study area exhibits a low groundwater potential, while 26.30% demonstrates a moderate groundwater potential. Validation was conducted using time data from 15 regular wells, confirming the reliability of the results. Additionally, the Operating Characteristic Cycle (ROC) analysis yielded an accuracy of 0.677, emphasizing the robustness of the methodology employed in this study.

Moodley et al., (2022) aimed to assess groundwater potential zones in the Kwazulu-Natal area through a multi-criteria analysis hierarchy using GIS and RS. Thematic layers, including geology, linear density, slope, drainage density, precipitation, land use, and evaporation, were incorporated into the analysis. Weights for these layers were determined using the AHP method. To validate the generated map, a comparison was made with 113 wells using the AUC and ROC methods. The results indicate that 47.3 km² of the total study area exhibits excellent groundwater potential, while 24,405.4 km² has good groundwater potential. Moreover, 13,380.8 km² of land is identified with poor potential, and 135.6 km² of land has very poor groundwater potential, showcasing a substantial 72.6% correlation between the map and well data.

Another research, undertaken to investigate groundwater potential zones in the eastern Chad basin, primarily employing a mechanical method. The study leveraged 20 machine-learning algorithms, utilizing 488 wells within the study area as benchmarks for correlation and cross-validation parameters. Thematic layers, including wetness index, subsoil depth, distance between channels, and slope, were incorporated, and the random forest classification method was employed. The study's main findings revealed that seasonal changes derived from satellite images proved to be most effective in studying groundwater potential zones through extensive supervised classification (Victor et al., 2021).

The research conducted in Megech, within the sub-basin of Lake Tana, Blue Nile, Ethiopia, aimed to delineate groundwater potential zones and pinpoint locations crucial for sustainable water resources management. Employing GIS and RS technology, the study generated thematic maps encompassing factors such as lithology, linear density, slope, topography, soil, land cover, rainfall, and drainage density. Altitude served as proxy data to delineate the groundwater potential zones within the catchment area. The integration of an AHP and PriEST facilitated the creation of a comprehensive final map. The research findings underscored the significance of geology, linear density, slope, and geomorphology as sensitive factors influencing groundwater dynamics in the Megech region (Berhanu and Hatiye, 2020).

In 2020, Benjmel et al. conducted a study to identify optimal water catchment areas and drilling sites in the Argon Basin, situated in the Western Atlas of Morocco, to address the local water demands effectively. Leveraging RS and GIS technologies, the study incorporated 11 factors, including geology and hydrology, to generate detailed maps. The final map was constructed using an AHP hierarchy. The results revealed that 17% of the entire land exhibited favourable geopotential, while 64% was identified as a region with moderate water potential. Additionally, the study concluded that 18% of the area constituted a zone with weak potential for groundwater. The accuracy of these findings was corroborated by comparing the water potential map with data from 159 wells strategically distributed throughout the Argon Basin, validating the reliability of the research outcomes.

A comprehensive study of the groundwater potential zones in the Itwad-Khamis watershed in Saudi Arabia was conducted by a team of eight international experts. Primary data for the study was gathered through field questionnaires and interviews, drawing upon the practical knowledge and expertise of the research team. Utilizing RS technology, thematic maps were generated for geology, slope, elevation, precipitation, drainage density, linear density, terrain, climatic conditions, vegetation cover, land cover, soil texture, hydraulic conductivity, and the topographic wetness index (TWI). These datasets were geometrically mapped using ArcGIS 10.3 and ERDAS 9.2 IMAGINE, with a general projection applied. The study employed Fuzzy Analytical Hierarchy Process (FAHP) and Multi-Criteria Decision Making (MCDM) techniques in the field, analysing the distribution of wells to create a groundwater potential zone map. The results indicated that 82% of the wells were situated in areas categorized as very good and good groundwater potential zones. The overall study identified 14.6% of the area as a very good groundwater zone, 27.3% as moderate, and 20.2% as a poor groundwater zone, providing valuable insights for water resource management in the Itwad-Khamis watershed (Mallick et al., 2019).

In 2019, Etikala et al. tried to decipher the groundwater potential zones in the Tirupati area. To assess these zones, various factors such as lithology, linear density, topography,

land use, drainage density, soil, rainfall, and slope were considered. Weights were assigned to these factors based on their water retention potential using the MIF hierarchy. The water potential zone map was subsequently generated utilizing the Weighted Sum overlay tool in ArcGIS. The findings of the study revealed the presence of a weak groundwater potential zone covering an area of 89.99 km2, while a moderate water potential zone extended over 181.10 km2. Additionally, the research identified 101.75 km2 as a good groundwater zone and 15.64 km2 as a very good groundwater potential zone. This mapping and zoning approach provides valuable insights for sustainable groundwater resource management in the Tirupati area.

Njeban, (2018) focused on the groundwater level in Al-Salman area, and aimed to compare spatial prediction methods for accurate groundwater level estimations. The study, conducted in 2016, involved analysing groundwater levels from 764 wells. Spatial interpolation methods, including Radial Basis Function (RBF), Inverse Distance Weighting (IDW), Ordinary Kriging (OK), Universal Kriging (UK), and Spline Kriging (SK), were employed to identify groundwater areas. Through cross-validation, the study determined the Cors-Validation method as the most suitable, considering its lowest Root Mean Square Error (RMSE), Mean Error (ME), and the highest Coefficient of Correlation (R2). GIS technology facilitated the calculation of groundwater levels, revealing that spatial interpolation methods were most effective in representing groundwater levels. Cross-validation further validated the accuracy of the predictions, with an RMSE of 10.64, ME of 5.36, and an impressive R2 value of 0.98 for the study area. Consequently, cross-validation emerged as the preferred method for testing and validating groundwater level estimations in the Al-Salman region.

In 2017, Abdul et al., conducted a study to delineate potential underground zones within the Gerardo River watershed in the Wollo region of northern Ethiopia, employing GIS software, alongside the MCDA tool and IDRSI software. The research focused on eight critical biological and environmental factors, including geomorphology, rock structure, slope, rainfall, land use, linear density, soil, and drainage density. These factors were derived from satellite images, digital data, and meteorological sources. A comprehensive land-use map was created using satellite imagery, supplemented by field visits for topography, soil, and rock data, all integrated through GIS technology. Additionally, a Digital Elevation Model (DEM) was generated using spatial analysis tools to study slope, linear density, and drainage density. Thissen polygonal intersection facilitated the creation of a rainfall surface map. Weights were assigned to thematic maps using IDRSI software, culminating in the development of a potential groundwater map. The MCDA tool was instrumental in monitoring and evaluating the map. The study's key findings identified the central and eastern areas of the study region as high groundwater zones, while the northern and western parts of the watershed were identified as weak groundwater areas. This GIS-based approach, augmented by MCDA tools, proved effective in assessing and categorizing groundwater potential in the Gerardo River watershed.

Panahi et al. (2017) conducted a study to evaluate the groundwater resources potential in Tehran, the capital of Iran, and the largest city, Karaj, by integrating GIS and AHP. Shuttle Radar Topography Mission data were utilized to generate slope and drainage density maps, while Landsat-8 satellite images provided information for line density and land use. Geological data, soil data, and average annual rainfall data were also incorporated. The AHP hierarchy was employed to assign weights to these layers and create a map highlighting potential groundwater zones in the area. The results were validated using discharge values from 102 pumping wells installed between 2002 and 2014. The research revealed that 10.20% of the study area exhibited poor groundwater potential, with 28.25% of the discharge well data demonstrating good agreement with the modelled potential groundwater zones. This integrated GIS and AHP approach offers valuable insights for effective groundwater resource management in the Tehran and Karaj regions.

In 2012, Mukherjee et al. aimed to comprehensively analyse the hydrology of an Arid region, exploring the interconnected relationships among various factors to identify groundwater potential zones. The study incorporated essential thematic layers, including drainage density, lithology, topography, slope, soil, digital elevation, rainfall, land cover, and data from 90 wells. Thematic layers of water level were integrated, and weights were assigned using spatial analysis tools in ArcGIS 9.2 to construct a potential water map. The resulting map delineated 13.7% of the study area as a very poor water catchment area, contrasting with 5.4% identified as a very good water catchment area. Conclusively, the research findings, supplemented by well-yield data ranging from 23-40.31/s and 8.1-10.61/s, provide a holistic understanding of groundwater potential within the Arid region, offering valuable insights for informed water resource management strategies.

Rao and Jugran, (2010) conducted a study to delineate groundwater potential zones and assess groundwater quality for domestic needs in Chittoor, Andhra Pradesh, India, a region highly susceptible to drought. Utilizing remote sensing and GIS technology along with on-site field visits, the study incorporated data from various sources, including geology, linear density and geology, well locations, well yield, water table levels, and groundwater samples. Spatial analysis techniques, incorporating factors such as magnesium concentration, groundwater condition, hardness, and distance between wells, were employed to classify and analyse the geological and hydrological data. Weights were assigned to these parameters to create a purpose-specific map for the study area. The findings indicated that Chittoor city exhibited a high groundwater potential of 1.64%, but it was determined to be only moderately suitable for domestic purposes. Additionally, areas with good groundwater potential constituted 31.68% of the city. The research concluded that 62.05% of Chittoor city possesses a moderate groundwater potential, rendering it either suitable or moderately suitable for domestic use. This comprehensive assessment, integrating remote sensing, GIS technology, and field data, provides crucial insights for effective water resource management in the face of the region's pronounced susceptibility to drought.

The study of groundwater in the central highlands of Eritrea has benefitted significantly from the integration of remote sensing, digital elevation models, and GIS techniques. Through the analysis of thematic layers such as rocks, linear

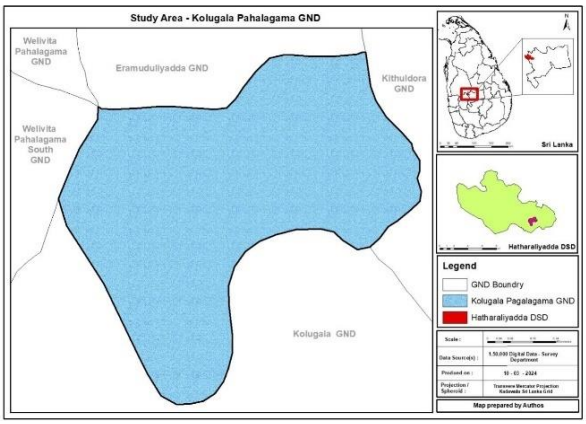
density, topography, and slope, a comprehensive understanding of the groundwater dynamics in the region has been achieved. The research underscores the pivotal role of rock structures and landforms in influencing the yield of high groundwater. Notably, primary and secondary basaltic rocks emerge as key contributors to groundwater availability. The study highlights that areas characterized by fertile springs and wells near boreholes are particularly suitable for reliable water sources. Furthermore, the research identifies drainage channels with intrusive rocks, valley-fill deposits featuring rough landforms in metamorphosis, and biota-rich regions as having exceptional groundwater potential. In conclusion, the application of GIS technology in conjunction with remote sensing and digital elevation models has proven instrumental in unravelling the intricate interplay between geological features and groundwater resources, providing valuable insights for sustainable water management in the central highlands of Eritrea (Solomon and Quiel, 2006).

MATERIALS AND METHODS

Study area

Kolugala Pahalagama GND, designated as Division 355, covers an area of 83.2 hectares within the Hatharaliyadda divisional secretariat under the Tumpane jurisdiction of Kandy district, Sri Lanka.

Figure 1: Study area



Source: Developed by author based on 1.50000 digital data, survey department, 2017

It is geographically bordered by the Eramuduliyadda Division to the north, Kithuldora Division to the east, Kolugala Upper Division to the south, and the Pahalagama Division in Welivita to the west. The division encompasses the villages of Pulleniwatta and Kolugala Pahalagama, with its absolute location identified by coordinates 7°18'47" N latitude and 80°31'6" E longitude, according to the 2021 Resource Profile.

Creating thematic layers

ArcGIS 10.4 software played a pivotal role in the creation of thematic layers for an in-depth geospatial analysis. The process began with the utilization of a georeferenced geology map to generate a detailed geology map. The map was then digitized and converted into a raster layer, laying the foundation for the subsequent creation of a geology thematic layer that identified five distinct rock types in the study area. Contour data were harnessed to construct elevation, slope, and drainage density thematic layers. The integration of the Global Positioning System (GPS) visualizer/elevation web and Google Earth Pro software facilitated the extraction of essential data. The Inverse Distance Weighted (IDW) tool was employed to develop a surface based on GPX format datasets, subsequently converted into Triangular Irregular Networks (TIN) data using a 3D analyst tool. This TIN data was further transformed into raster data, culminating in the creation of a Digital Elevation Model (DEM).

The DEM model was then instrumental in generating the slope thematic layer through the application of the slope tool. The creation of a drainage density thematic layer involved several sequential steps, including the utilization of the "Fill tool" to address sink issues, the "direction tool" for flow direction, and flow accumulation computation. Data were organized according to Strahler's stream order, converted into vector data, and subjected to the "line density tool" to derive the drainage density.

In parallel, the land use thematic layer was developed by incorporating data from the Land Use Policy Planning Department of Sri Lanka onto the study area map. Similarly, the soil thematic layer was constructed by processing digital soil data on the study area map. The "merge tool" facilitated the isolation of the relevant area, which was then converted into raster data to finalize the soil thematic layer.

This comprehensive approach, facilitated by ArcGIS 10.4, allowed for the creation of cohesive thematic layers encompassing geology, elevation, drainage, land use, and soil characteristics. The integration of diverse data sources and advanced geospatial tools ensures a robust foundation for subsequent analyses and decision–making processes.

Creating reclassified thematic layers

Following an extensive review of relevant literature to determine the appropriate classification procedure, the subsequent step involved utilizing the "reclassify tool" within the ArcGIS software. This tool was employed to systematically reclassify the map based on the identified classification criteria derived from the literature study. The use of the "reclassify tool" ensured a precise and standardized approach to categorising the geographic data, aligning with the established classification methodology gleaned from the literature review. This step is crucial for refining and organizing spatial information according to specific criteria, laying the groundwork for more nuanced analyses and decision-making processes within the geospatial context.

Building weights and map combining

In the development of the groundwater potential zones map, a crucial step involved constructing weights through the application of Satti's Analysing Hierarchy. These weights were assigned as percentages, reflecting the influence of reclassified thematic layers on the overall determination of water potentials. The allocation of percentages followed a meticulous process, with considerations for the impact of each thematic layer on groundwater potential. The specific percentages were determined using the following equation 1 (Ranasinghe and Patabandi, 2024).

$$Impact = \left(\frac{satti's\ scale}{sum}\right) * 100 \quad (1)$$

This equation was employed to calculate the weights assigned to the relevant factors, ensuring a proportional and systematic representation of their contributions to the groundwater potential zones map.

Table 2: Percentage weights of factors affecting groundwater potential zones in the study area

Factor	Contribution to the creation of groundwater	Satti's scale (Fractions)	Satti's scale (Fractions)	Impact (%)
Geology	High	1	1	40
Soil	↓	1/2	0.5	21
Slope (Degrees)		1/3	0.33	14
Elevation (Meters)		1/4	0.25	10
Land Use		1/5	0.2	8
Drainage density (Meters/ Sq Meters)	Low	1/6	0.16	7
Total			2.44	100

Source: Ranasinghe and Patabandi, 2024

Validation

The groundwater potential zone map's validity was assessed through two distinct methods. Firstly, a comprehensive evaluation was conducted using 500 samples, employing a "segmentation and classification tool." This approach involved analysing and categorising the groundwater potential zones based on the collected data.

As a second validation method, GPS values from 50 sample wells were selected using random sampling method from a pool of 95 wells within the study area, essential for the community's daily water needs. The GPS coordinates were acquired using the "GPS waypoint" mobile app and subsequently mapped onto the study area using the "GPX tool" in ArcGIS 10.4. Quarterly water levels for these wells were calculated, and their annual average water level was determined using Excel software. This rigorous process was undertaken to further confirm the accuracy and reliability of the groundwater potential zones depicted on the map, ensuring the robustness of the findings.

Getting garbage pits' GPS points

The identification of suitable locations for well-establishment within areas with groundwater potential involved a meticulous process. Using the "GPS waypoint" mobile app, the locations of 55 garbage pits were selected through the random sampling method. Subsequently, the gathered GPS coordinates were meticulously mapped onto the study area using the "GPX tool" in ArcGIS 10.4.

Data analysis

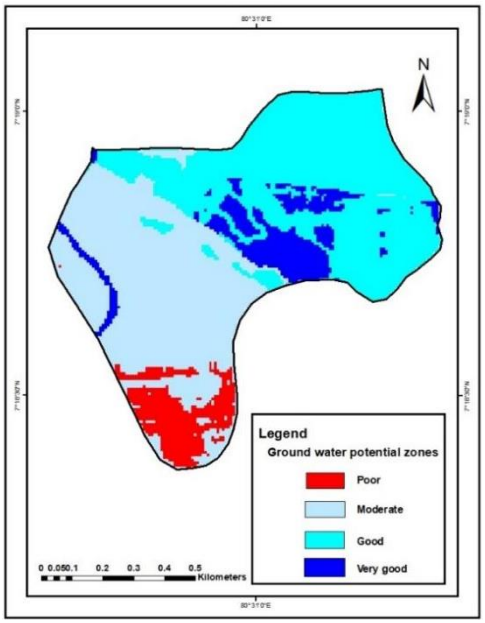
The primary tools employed for the analysis of all collected data in this study were ArcGIS 10.4 software and Excel software. These software applications played a central role in processing, interpreting, and presenting the information gathered. ArcGIS 10.4 was instrumental in creating detailed maps to visualize the spatial distribution within the datasets, providing a comprehensive understanding of geographical patterns, particularly in relation to groundwater potential zones. Simultaneously, Excel software was utilized for analytical purposes, aiding in the construction of graphs that succinctly presented key quantitative information. This combined use of ArcGIS 10.4 and Excel ensured a thorough and effective analysis of the collected data, enhancing the study's overall depth and interpretability.

RESULTS AND DISCUSSION

Groundwater potential zone

The content of Figure 2 illustrates the delineation of groundwater potential zones within the Kolugala Pahalagama GND.

Figure 2: Groundwater potential zones in Kolugala Pahalagama GND



Source: Developed by author based on 1.50000 digital data, survey department, 2017

In the study area, the assessment of groundwater potential has led to the classification of four main zones, poor, moderate, good, and very good. Each zone signifies varying levels of groundwater availability and suitability for extraction. The delineation of these zones allows for a comprehensive understanding of the spatial distribution of groundwater potential across the study area. Consequently, the identified poor zones indicate areas where groundwater resources may be limited or less reliable, while moderate zones suggest a moderate level of potential. Additionally, good and very good zones represent areas with substantial and highly favourable groundwater potential, respectively.

Correlation of well water levels with groundwater potential zones in measuring map validity

In the 2021 well census report for Kolugala Pahalgama GND, it was discovered that there are a total of 95 active wells within the administrative boundaries of the GND. Out of this pool, 50 wells were specifically chosen for in-depth analysis and study. Among these selected wells, 3 were situated within zones exhibiting high water potential, 28 were pinpointed within areas showcasing good groundwater potential, and 19 were found in regions with moderate groundwater potential.

Table 3: Relationship between groundwater potential zones and water levels in wells.

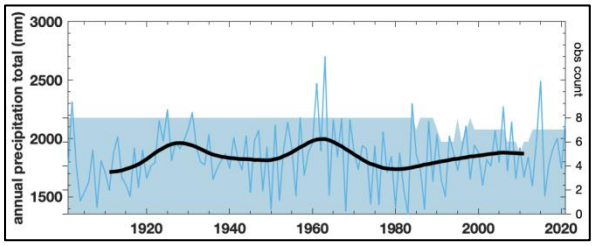
Groundwater potential zones	Mean annual water levels in sample wells
Very good groundwater potential zone	12 feet 6 inches
Good groundwater potential zone	8 feet 5 inches
Moderate groundwater potential zone	7 feet 4 inches

Source: Feld data, 2023

Status of groundwater recharge in Kolugala Pahalagama GND

Rainfall is the sole method of groundwater recharge in any area (Dhanapala,2021). The following chart illustrates rainfall levels over 120 years, from 1900 to 2020, in Kolugala Pahalagama GND.

Figure 3: Precipitation levels from 1900 to 2020 in Kologala Pahalagama GND



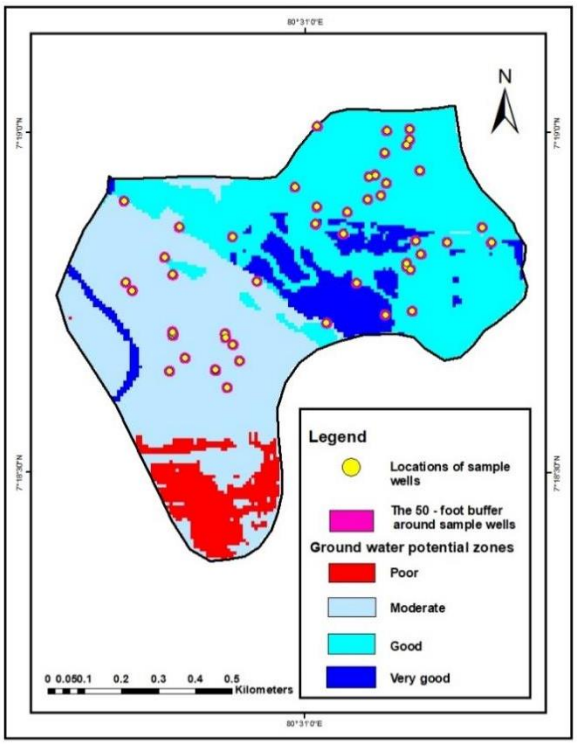
Source: University of East Anglia, 2023

Studying the graph reveals that despite a decline in rainfall from 1975 to 1983, the region still experienced substantial precipitation. Analysing the rainfall data over a 120-year period in the study area demonstrates that the aquifers have consistently received adequate water for replenishment.

Evaluating the suitability and unsuitability of wells established in the Kolugala Pahalagama GND

Based on the 2021 well census report for the Kolugala Pahalagama GND, there are a total of 95 wells catering to daily needs. From this population, 50 wells were specifically selected for a thorough study. Among these, 3 wells fall within a zone with very good groundwater potential, while 28 wells are situated in areas with good groundwater potential. Out of the 50 sample wells, 19 have been established in zones with moderate water potential. Minimum distances between wells must be maintained during the setup process, with the standard requirement being a minimum distance of 50 feet (Missouri Well Construction Rules, June 1996).

Figure 4: Sample wells and 50-foot buffer around sample wells in Kolugala Pahalagama GND



Source: Developed by author; groundwater potential zones map and field data, 2023

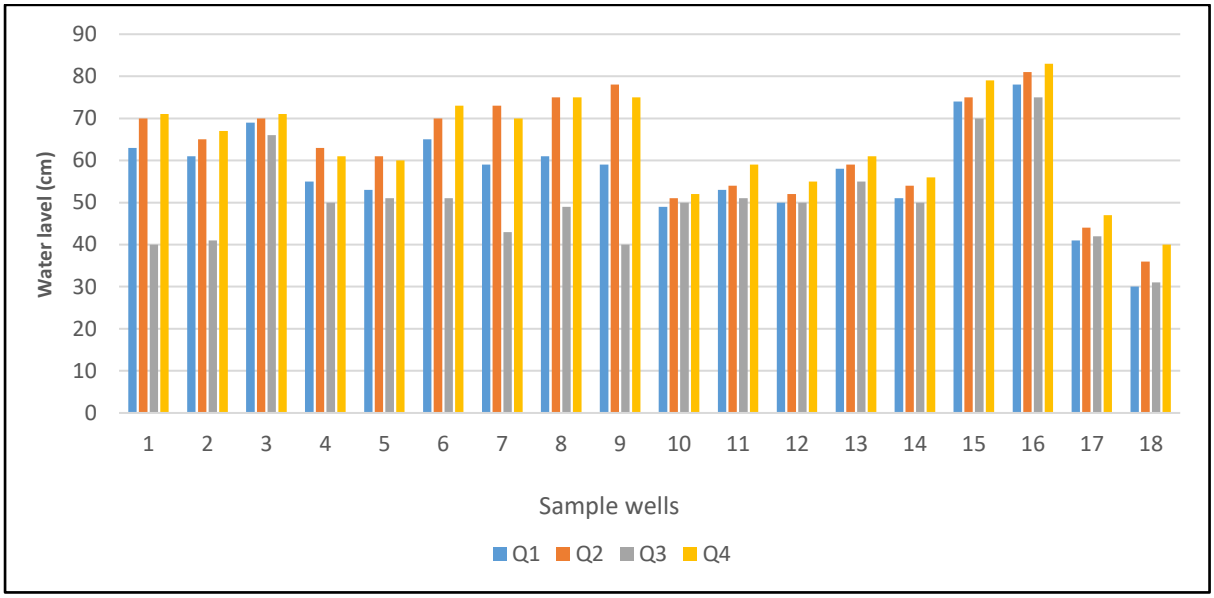
There are two main reasons for maintaining the minimum distance between two wells (Loganathan, 2019).

i. Maintaining a minimum distance of 50 feet between wells ensures that water is not drawn from the same aquifer for both wells.

ii. In some cases, even if water is drawn from the same aquifer, faster filling occurs when the wells are spaced apart, allowing for the effective replenishment of water from all directions.

According to the map, 18 out of 50 wells have failed to maintain the minimum distance requirement. The water levels of these 18 wells are categorized by quarters as follows:

Figure 5: Water level by quarters in wells without 50 feet distance between two wells 2022/2023 in Kolugala Pahalagama GND



Source: Field data, 2023

The Missouri Department of Natural Resources specifies a minimum distance of 50 feet to be upheld between a well and a garbage pit. Likewise, recommendations from the United States Environmental Protection Agency and the Department of Housing and Urban Development also advocate for maintaining a minimum distance of 50 feet between a garbage pit and a well. There are several key reasons for adhering to this 50-foot separation from the garbage pit:

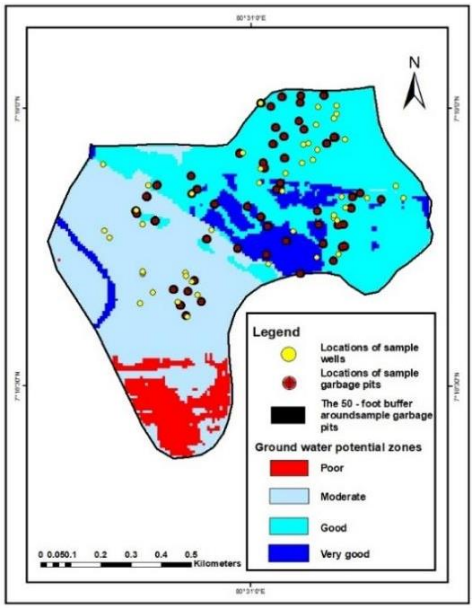
i. Prevention of mixing of E - Coli bacteria contained in sewage with water.

ii. Prevent phosphates produced from soaps and detergents from mixing with water.

iii. Preventing heavy metals from mixing with water.

can be pointed out.

Figure 6: Wells located within 50 feet of the garbage pits in Kolugala Pahalagama GND

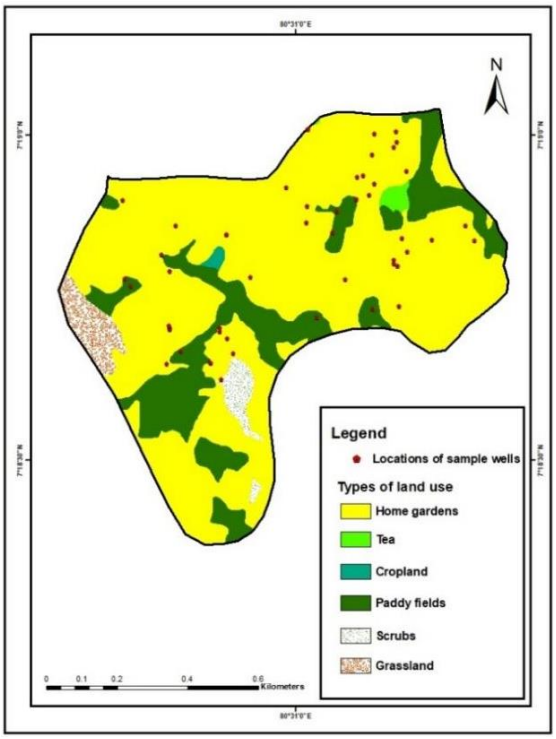


Source: Groundwater potential zones map, 2023 & field data, 2023

According to the map, it can be identified that 7 wells in the GND are within 50 feet of a garbage pit.

Also, considering how the wells are established along with land use in Kolugala Pahalagama GND, 8 out of 50 regular wells can be seen as related to paddy land use. Paddy fields belong to the category of swampy land, although a high ground water source can be obtained, it is not suitable for drinking water (Shipley et al., 2022). It can be recognized that the groundwater, when mixed with the chemicals used, is not suitable for drinking.

Figure 7: Land use and location of sample wells in Kolugala Pahalagama GND



Source: Land use & policy planning department data, 2019 & field data, 2023

Considering all factors, the suitability and unsuitability of establishing wells within the Kolugala Pahalagama GND can be summarized as follows:

Table 4: Unsuitable wells in Kolugala Pahalagama GND

Reason for unsuitable location of wells	Number of wells	Percentage
Unsuitable for drinking	15	30%
Lack of high-water yield	18	34%

Source: Field data, 2023

Based on this assessment, 17 wells, constituting 34% of the total, are situated in suitable zones, while the remaining 33 wells, accounting for 66%, are positioned in unsuitable areas.

CONCLUSION

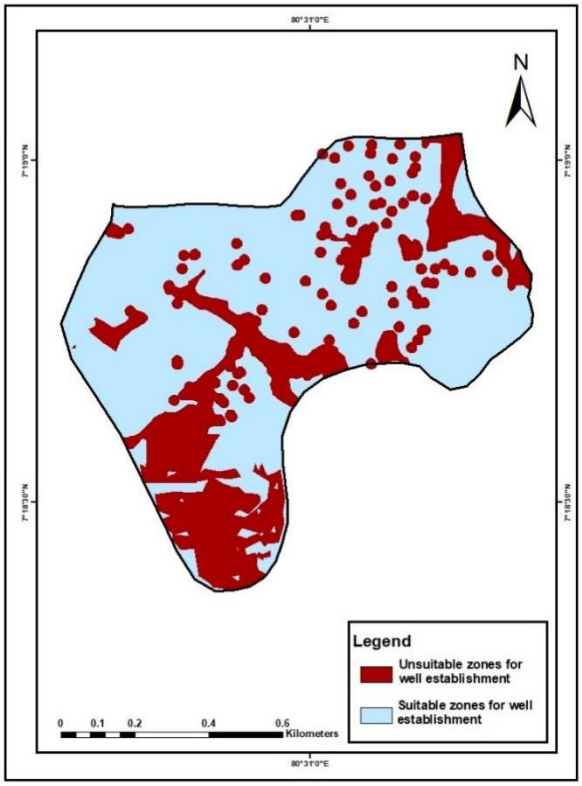
This study is focused on exploring critical factors pertinent to groundwater management, specifically examining the requisite minimum distance between two wells, the optimal spatial separation between wells and garbage pits, and the placement of wells within paddy lands. Through this investigation, the objective was to develop insights into how these factors influence groundwater conservation and sustainability in the study area.

In the surveyed area, analysis revealed the location of 18 wells that fail to adhere to the prescribed minimum distance of 50 feet between wells. Among these identified wells, a noticeable observation was the substantially lower water levels in comparison to other wells. This finding underscores the hydrogeographic significance of maintaining adequate spatial separation between wells, emphasizing the implications for groundwater availability and sustainability in the area.

The geographically focused analysis pinpointed the location of 7 wells failing to uphold the mandated 50-foot distance between garbage pits and wells. Notably, the water quality in these identified wells posed significant concerns for potability. Elevated levels of E-coli bacteria, phosphates, and heavy metals were detected, likely stemming from the infiltration of decomposed waste into the groundwater. Consequently, the proximity of garbage pits to wells exacerbates contamination risks, rendering the water unsuitable for drinking purposes. This underscores the critical need for stringent spatial planning measures to safeguard groundwater quality and public health within the studied area.

In examining fields categorized as swamps, 8 wells were observed within this terrain. Notably, findings indicate a concerning trend regarding the potential health hazards posed by chemicals utilized in paddy fields, as evident from their leaching into groundwater. During field study, a noteworthy observation emerged: the well exhibiting the highest water level was situated within a paddy field.

Figure 8: Suitable and unsuitable zones for the establishment of wells in Kolugala Pahalagama GND



Source: Groundwater potential zones map, 2023 and field data, 2023

As a whole, according to the locations and regions of the wells in the GND, it is concluded that 34% are located in suitable locations and 66% of the wells are established in unsuitable regions and locations. The study concludes that within the 83-hectare area, certain parts of the 29-hectare GND are not suitable for setting up wells. Specifically, the unsuitable areas include locations within 50 feet of garbage pits, areas within 50 feet of existing wells, land used for paddy cultivation, and regions with poor groundwater potential. These areas should be avoided for the construction of wells. Accordingly, it can be determined that only a land area of 54 hectares in the study area is suitable for setting up wells.

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A Comparative Analysis of the Factors Influencing Job Expectations among Unemployed Men and Women in Sri Lanka

A.P.Y.G.V. Gunawardena [1*] and G.R.S.R.C. Samaraweera[1]

[1] Department of Economics and Statistics, Sabaragamuwa University of Sri Lanka

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Abstract

In Sri Lanka, persistent gender differences in unemployment rates exist, with women enduring greater rates of unemployment despite having a higher average educational attainment than men. Gender differences in job search intensity vary with attitudes toward employment or unemployment as attitudes play a significant role in employment decision-making. These differences are intimately linked to people's expectations and mindsets regarding their work, which are strongly influenced by societal and cultural gender roles. This study looks at how job expectations differ between unemployed men and women in Sri Lanka. This study relies on data from the Department of Census and Statistics Sri Lanka Labour Force Survey (2021) and a multinomial logistic model to analyse the total unemployed, male unemployed, and female unemployed separately while taking two dependent variables; job sector expectations and occupational expectations. The study's findings emphasise the pivotal role of gender in sharpening job expectations among the unemployed. Regarding job sector expectations, unemployed women are more inclined towards jobs in the public sector than those in the private sector because of the government's reputation for offering standardized working hours and a work-life balance conducive environment. Furthermore, there are noteworthy differences in occupational expectations as unemployed women are more likely to expect professional and managerial level jobs with the increase in higher education enrolment. This study offers a groundbreaking contribution to the literature by unveiling unique, gender-specific determinants of job expectations among Sri Lanka's unemployed, highlighting the influence of unemployment duration, and employing distinct analytical models to bridge significant theoretical, empirical and methodological gaps. Finally, this study puts forth the broader discourse on gender, unemployment, and labour market dynamics in Sri Lanka, offering gender-specific policy recommendations aimed at bridging the expectation gap between unemployed men and women in Sri Lanka.

Keywords: Gender Differences, Job Expectations, Occupational Expectations, Unemployment, Unemployment Duration

INTRODUCTION

Unemployment has historically been a significant and sensitive macroeconomic issue in Sri Lanka and the problem has received considerable attention. It has been revealed by the latest official data released by the Labor Force Survey (2021) that Sri Lanka's unemployment rate has risen substantially compared to previous years. This is due primarily to the COVID-19 pandemic and the current economic downturn, where the country has experienced unprecedented economic and labour market crises, which have exacerbated the worst economic crisis ever experienced.

In comparing the unemployment rate by gender, there is also a consistent gender gap, as female unemployment remains higher than male unemployment. In line with the Global Gender Gap Report (2021), Sri Lanka has the 17th largest labour force participation gap globally. Furthermore, the National Labour Statistics indicate that two-thirds of working-age women do not participate in the labour force annually, primarily because they choose to stay at home or cannot work due to age, disability, or illness. Despite higher levels of female education and low fertility rates contributing to other human development outcomes, Sri Lanka still ranks low in female labour force participation compared to other South Asian countries (Solotaroff, Joseph, Kuriakose, & Sethi, 2020).

Female labour force participation is crucial for economic development and household well-being, necessitating an analysis of why many women remain outside the labour force. So, from that point of view also, the gender gap in unemployment in Sri Lanka could exist. In Sri Lanka, widespread beliefs concerning the sociological and cultural factors significantly influence employment and unemployment outcomes among men and women.

* **Corresponding author:** Tel.: +94 (76) 3491703; Email: yashoragayashi@gmail.com
https://orcid.org/0009-0009-4951-8621

A prevalent belief is that women should primarily engage in household activities, contributing to the gender gap in labour force participation. To explore the behaviour of young Sri Lankan women in developing societies at the household level, Malhotra and DeGraff (1997) conducted a study on 'Entry versus success in the labour force,' focusing on job opportunities for young women in Sri Lanka. Their findings revealed that higher education levels lead to greater labour force participation, but women with higher levels of education are more prone to unemployment than employment. Women's outcomes in Sri Lanka's labour market are hindered by household responsibilities, a mismatch between their skills and labour market demands, and gender bias in job searches, recruitment, and promotions (Vithanagama, 2020).

The high percentage of unemployment in Sri Lanka is ascribed to unrealistic expectations, skill mismatches, long waits for public sector employment, and stringent job security regulations. Over the years, numerous explanations for Sri Lanka's high unemployment rate have been put forth. International Labour Organization (ILO) defines the "skills mismatch" hypothesis as a key factor, highlighting that the education system produces skills not valued by employers, leading to high unemployment among educated youth (Seers, 1971). This hypothesis remains relevant in Sri Lanka as the education system continues to produce skills not valued by employers, thus boosting employee expectations and unemployment among educated youth. This mismatch creates a situation where unemployed individuals are not interested in the available jobs, and employers are unwilling to hire them due to the lack of requisite skills. Recent studies indicate that the skills mismatch remains a persistent issue. According to the World Bank (2019), a considerable gap remains between the skills generated by the education system and those required by employers in Sri Lanka.

The COVID-19 pandemic has also accelerated the need for digital skills, which are still underrepresented in the current education curriculum. The second explanation, put forth by Dickens and Lang (1996), focuses on employment and pay policies in the public sector in more detail. In Sri Lanka, public sector jobs are typically better paid, more stable, offer greater benefits, are less labour-intensive, and carry more prestige than private sector roles. Consequently, new labour market entrants often wait for public sector openings. According to Dickens and Lang (1996), Sri Lanka's government deliberately creates jobs in the public sector to address the country's unemployment issue. In compliance with this second explanation, implementing credible reforms in public sector recruitment and wage policies could be the most effective approach to reducing unemployment, as it would deter the tendency to "queue" for public sector jobs (Rama, 1996). Aligning with past studies, a more recent analysis by Gunatilaka (2021) shows that the preference for public sector employment persists, largely due to the job security and benefits it offers, but there is also increasing recognition of the need to diversify employment opportunities and reform public sector policies to make the private sector more attractive. Policy initiatives such as vocational training programs and public-private educational partnerships have been introduced to address these issues, but their effectiveness is still under review.

Meanwhile, the Sri Lankan economy has undergone significant changes in the past couple of decades, requiring updated explanations for persistent unemployment. Issues such as labour laws, particularly regarding maternity leave and child-care support, also negatively impact women's employment opportunities. The absence of sufficient childcare services and supportive maternity leave policies limits women's ability to participate in the labour force fully. It is generally true that women are responsible for more childcare responsibilities than men, so the lack of employer-sponsored childcare can make it difficult for them to participate in paid employment. The benefits of investing in childcare are widely recognized by global research. Providing childcare support can improve labour force quality by improving women's employability (IFC, 2018).

According to the World Bank (2020), improvements in these areas could lead to increased female labour force participation and economic growth. The emotional toll is heightened by a lack of trust in childcare centres and the scarcity of high-quality, affordable options. These pressures are often compounded by spousal expectations and deeply ingrained cultural beliefs about 'good motherhood,' which elevate the socio-psychological importance of personally caring for one's child. Consequently, this burden frequently pushes women out of the workforce or prevents them from entering it altogether. (Verite Research, 2022). So, these factors need to be addressed in contemporary discussions on unemployment to provide a comprehensive understanding of the current labour market dynamics in Sri Lanka.

In view of the current economic condition in Sri Lanka, economic stability profoundly influences job expectations by providing a foundation for secure and predictable employment. Moreover, it allows individuals to confidently pursue their career goals, while businesses can create stable, long-term employment opportunities (Jayathilake, Hewage, & Nanayakkara, 2018; Gunawardana & Liyanage, 2020). On the other hand, assortative mating affects female employment by reinforcing traditional gender roles within households. Couples with similar socioeconomic backgrounds may have traditional expectations, which can limit women's employment opportunities. Conversely, in households where both partners are highly educated and have high incomes, women are more likely to pursue careers (IPS, 2021).

Gender differences in job search intensity vary with the attitudes toward employment or unemployment, as attitudes play a significant role in employment decision-making. These views are a result of the disparities in the perceptions of male and female unemployment. On the other hand, expectations are reflected in attitudes. Female attitudes affect unemployment. For instance, attitudes toward work-life balance conflicts and a lack of job benefits make women more inclined to reject jobs. Female unemployment and labour force inactivity are significantly affected by household chores and caregiving responsibilities, which fall disproportionately on women. This limits the time they can dedicate to employment and thus contributes to female employment. Despite having higher education levels, women still queue for limited jobs in the public sector, which raises their unemployment rate as they expect that government jobs are considered to offer more flexible hours, job security (Elizur, 2001), an implicit reputation, and status attached to

government jobs by society and financial security than private sector jobs.

Most people place greater value on a civil service position than on a formal private sector job that offers EPF/ETF coverage, a two-year contract, bonuses, and opportunities for advancement. As a result of the non-wage benefits and social status that come with government work, youth are likely to be attracted to government work. Despite the quasi-formal private sector offering 50% higher pay than civil service roles, young women are more likely to prefer government jobs (Dissanayake, 2020). This scenario was also explained by the International Labour Organization (2016) in such a way that the preference and the queuing hypothesis for public sector employment leads to a situation where women in well-paid, prestigious private sector roles voluntarily leave or hold out for public sector jobs. When jobs seem unattainable, job seekers become discouraged and may continue to be unemployed as they look for work that fits their ideal position expectations.

Men and women usually have different expectations and preferences for their jobs, as well as different approaches to problem-solving. For example, women tend to expect and prefer jobs that are simpler and easier to access than those held by men because of low self-esteem (Elizur, 2001). Low self-esteem in women is believed to be a result of cultural, traditional, and social values that have shaped female thinking. From various perspectives, both men and women prefer and anticipate working for a living. Nonetheless, they typically view it as a subordinate responsibility to their household duties. Furthermore, the high unemployment rate among women is a result of cultural misconceptions about women, which lead society and businesses to believe that men do better than women in the workplace. As a society, women are still viewed as having low self-esteem, being less confident, and being less productive than men. Some female bosses prefer to hire male employees over female employees. This proves that women themselves underrate other women's performance potential. Such societal and organizational beliefs and expectations lead to men's expectations and preference for better, more challenging professions that pay more. This inversely affects women's expectations and preferences.

So, these expectations caused unemployment to rise which led to a continuous unemployment rate with gender differences for a long period in Sri Lanka. Therefore, paying attention to job expectations among unemployed men and women in a recessionary period in Sri Lanka is crucial.

The main objective of this study is to compare the demographic, socio-economic, and geographical factors influencing job expectations among unemployed men and women in Sri Lanka. This research paper begins by providing background information, using the economics of gender and the labour market to define the gender market, particularly concerning employment expectations. Then, after reviewing the relevant empirical literature, the methodology is presented, followed by an analysis of the results and policy implications.

LITERATURE REVIEW

Theoretical background

Unemployed is defined as an individual who has been without a job for more than four weeks and is actively seeking employment, available to work, and willing to accept a job offer within two weeks if one becomes available (Sri Lanka Labour Force Survey: 2021). In general terms, "expectation" refers to a temporary belief in what is likely to occur in the future or what is expected to occur in a given situation (Vroom, 1964). In the view of Woods (1993), pre-entry job expectations arise from the perspective of the employee when they begin working based on their achievements and personal characteristics.

The theoretical, empirical, and methodological literature that relates to the present research are derived from the following aspects: There is a growing importance given to the Job Search Theory in the current stage of economic analysis. As a substitute for the "standard" neoclassical labour supply theory, the Job Search Theory has gained popularity since the 1970s. As a result of the assumptions behind the neoclassical framework, which was based on the assumption that perfect information existed, the neoclassical framework does not account for those actively seeking employment but not being able to find it. Nevertheless, it has been demonstrated that unemployment and unemployment duration cannot be ignored. A group of scholars developed the "Job Search Theory" as an alternate theory of unemployment as a result of this (Faggian, 2014). Theoretical arguments based on search theory suggest that unemployed individuals must make significant concessions to acquire new jobs. Furthermore, expectations of either employment or unemployment are related to the duration of the job search.

The Social Cognitive Career Theory highlights the role of self-efficacy beliefs that possess a significant impact on determining career-related behaviours and outcomes. Unemployed individuals with high self-efficacy are more likely to set ambitious job expectations and engage in proactive job search behaviours. The Social Cognitive Career Theory can shed light on how self-beliefs, social support and contextual factors influence job expectations and subsequent job search efforts. Heineck (2011) examined how cognitive abilities affect unemployment entry and exit rates in a dynamic setting. It was found by Heineck that cognitive skills have a rather small impact on unemployment propensity and contribute very little to individual heterogeneity. Despite this, they can provide the males with the tools to stay out of unemployment (Bandara, 2019).

According to the social cognitive model of career self-management proposed by Lend & Brown (2013) and supported by prior empirical evidence from Empson, Warner, and Krahn (1992), young adults tend to adjust their career aspirations and expectations in response to negative job search experiences. As a consequence, Monika Mühlböck, Kalleitner, Steiber & and Kittel (2022) emphasized that individuals who have been unemployed for a longer period will experience a more significant reduction in aspirations and expectations than those who have been unemployed for a shorter period.

Empirical background

Job expectations among males and females

Unemployment gender differences are relevant for our objective because previous literature explains these gender differences in terms of expectations about jobs. Many researchers have supported that gender impacts intentions and actions regarding employment choices. Previous studies have shown that job expectations among males and females are different (Mellado & Scherman, 2017; Tulu, 2017; Tomkiewicz, Frankel, Sagan, & Wang, 2011; Chullen & Bello, 2015).

In the Sri Lankan context, gender differences in job expectations have also been explored. De Silva (2016) identified that female employees often prioritize work-life balance and job stability more than their male counterparts, who tend to focus more on salary and career progression. Therefore, factors related to job expectations are categorized into two main sub-sectors, with corresponding hypotheses developed for each.

Demographic determinants on job expectations

Gender is one of the most important determinants of job expectations. Tulu (2017); Bandara (2019); Mellado and Scherman (2017); Tomkiewicz, Frankel, Sagan, and Wang (2011); Simões, Tosun, & Rocca, 2022 have expressed that gender is positively associated with job expectations. According to Tulu (2017), there is a gender disparity in job expectations and preferences among psychology graduates. While newly graduated men often seek challenging roles with high salaries and prefer jobs related to their field of specialization, newly graduated women generally expect fewer demanding jobs with moderate to low salaries and are more inclined to accept simpler positions regardless of the salary.

The reason males desire the most difficult and highest-paying jobs is to gain social respect and value, while females want jobs that offer social acceptance. Social values, culture and tradition affect female job expectations and preferences. In comparison to women, men placed higher job expectations for pay, responsibility, independence and influence at work and inside the organization. In comparison to males, women placed a higher value on meaningful work, respect, supervision, co-workers, social interaction, convenient work hours, job security and benefits (Elizur, 2001). Similar findings were indicated by Mellado and Scherman (2017) who stated that there are different job expectations among male and female students. Furthermore, they have explained that the job expectations of students are linked to their gender, with a clear relationship between gender and job expectations. Female students are more likely to be drawn to communication fields other than journalism, such as public relations, teaching, and research. This finding aligns with previous research on Chilean students. Gender has a significant impact primarily on the field of public relations, which falls under advertising, while it does not significantly affect other areas like teaching, research, and other non-communication fields. However, opposite findings were revealed by Tomkiewicz, Frankel, Sagan, and Wang (2011).

According to their findings, job characteristics valued by both male and female students are similar, with no significant differences between the genders regarding either intrinsic or extrinsic job variables. Most of the scholars found that, as an explanatory variable, age is a significant determinant of job expectations. A study conducted by Kowske, Rasch, and Wiley (2010) revealed that age is an important factor in predicting the degree of satisfaction with pay and benefits. A comparison of sales managers' job expectations at different career stages and at various ages does not reveal any significant differences (Malik & Subramanian, 2015). However, the literature on psychological contract breaches suggests that older employees tend to view breaches less negatively than younger employees, who typically have higher job expectations (Vantilborgh, Dries, De Vos, & Bal, 2015). The positive impact of age and marriage often occurring later in life on job expectations and satisfaction can be attributed to the more advanced positions held by individuals in fields such as science and higher education. Studies by Saner and Eyüpoglu (2013) and Sharma and Jyoti (2009) have shown that married life positively influences job satisfaction and expectations.

Considering ethnicity as an explanatory variable, according to Brenner and Tomkiewicz (1982), black and white graduates with business college degrees have different job expectations. Compared with White respondents, Black respondents valued the job characteristics that are strongly related to long-term career objectives and structure. There was a significant difference by gender for white females, who placed a greater emphasis on encouraging continued knowledge and skills development when compared to black females, and for black males, who placed a greater emphasis on this same characteristic. Additionally, Black males rated "rewarding good performance with recognition" as more important than White males, whereas White females valued this characteristic more than Black females. Tomkiewicz, Johnson, and Brenner (1997) revisited the job expectations of White and Black business students and identified five differences in job expectations between Black and White males and females compared to the 1982 study.

In line with this strand of literature, the study can hypothesize that*: H1: Demographic factors affecting job expectations differ for unemployed men and women in Sri Lanka.*

Socio-economic determinants on job expectations

Education is another important determinant of job expectations. Bandara (2019); Simões, Tosun, & Rocca (2022); Mellado & Scherman (2017); Calvès, Kobiané & N'Bouké (2013); Minchna, Kmieciak & Burzyn'ska-Ptaszek (2017) and Muller et al. (2020) have expressed that education is an influential factor in job expectations. Bandara (2019) found that educated youth are more likely to expect and secure better jobs, particularly in technical and professional fields, whereas those with lower educational levels, such as primary education or less, are more inclined to expect employment in less complex occupations. When using education as the sole criterion, fewer than 10% of job expectations align with the required skills, while 55% and 34% of individuals are either under or over-educated for the jobs they expect, respectively.

Conversely, having a low level of education, such as below secondary or no formal education, significantly lowers job expectations. In contrast, secondary education generally has a stronger positive effect on job expectations across most sectors, except in administrative and technical roles. Post-secondary education positively influences job expectations

in high-complexity occupations but negatively impacts expectations in low-complexity jobs, although these differences are not statistically significant. Based on the findings of Bandara (2019), there is sufficient evidence to conclude that youth education significantly impacts both employment expectations and outcomes, with higher levels of education exerting a stronger influence on job expectations. Similarly, Mellado and Scherman (2017) also revealed that the job expectations of the students are linked to their levels of education. The length of unemployment varies depending on its type, and as it lasts longer, it could put more bias into people's expectations about their future employment. The study conducted by Kamyar (2019) mainly focused on discussing how the duration of unemployment affects one's expectations of the short-term possibility of employment. Extended periods of unemployment typically lower an individual's expectations of finding and accepting a job within the next three months. According to Marcel Garz's article "Unemployment Expectations, Excessive Pessimism, and News Coverage," it is anticipated that the longer someone remains unemployed, the more their expectations about job prospects will diminish on average.

According to the above existing literature, the study can postulate that; *H2: Socio-economic factors affecting job expectations differ for unemployed men and women in Sri Lanka.*

Residential determinants of job expectations

Generally, urban males and females find employment shortly after completing their education, whereas rural females tend to experience longer periods of unemployment, mainly due to limited access to job opportunities and insufficient information about available positions and how to locate them. Additionally, parental expectations and cultural norms about what constitutes "acceptable" work in rural areas further contribute to this extended unemployment. As a result of parental pressure and cultural influences regarding what is considered "acceptable" work in rural areas, rural females experience relatively longer periods of unemployment (Dissanayake, 2020). Bandara (2019), Tulu (2017), and Muller et al. (2020) have all discussed the connection between the residual sector and job expectations in their research. Bandara (2019) highlighted that urban residency has a significant positive impact on job match quality in technical, clerical, and operational sectors, but a negative effect in agriculture. For example, job match quality improves by 0.003–0.023% with a 01% increase in the likelihood of residing in urban areas. This suggests that individuals living in urban areas are better positioned to meet the skill requirements of higher-complexity jobs due to their greater access to quality education, economic knowledge, and employment opportunities.

According to Tulu (2017), the job expectations and preferences of fresh psychology graduates are also impacted by their residence. Therefore, it can be concluded that the residence of recent graduates is another factor influencing their job expectations and preferences. The findings of Tulu (2017) indicated that, regardless of the educational achievements of men and women, the majority of graduates in rural areas expect that those people will face difficulties in obtaining employment. They prefer to begin with local jobs offering a moderate salary before eventually leaving their family to seek work elsewhere. However, one highly educated female graduate from a rural area feels that while her location may influence her job prospects, it won't stop her from finding employment. According to Theodori & Theodori (2015), young women from multicultural or economically challenged backgrounds who reside in rural or peri-urban areas are less likely to think about moving abroad to improve their career and employment chances (Weiss, Ferrante, & Soler-Porta, 2021).

Thus, this study can assume that; *H3: Residential factors affecting job expectations differ for unemployed men and women in Sri Lanka.*

Some researchers have studied gender differences in job expectations (Chullen & Bello, 2015; Bandara, 2019; Mellado & Scherman, 2017; Muller, et al., 2020). Nevertheless, there are surprisingly few studies that compare the unemployment rates of men and women and demonstrate the influence of demographic, socioeconomic, and geographical factors on job expectancies. Up to now, the literature includes only one study (Wickramasinghe & Wickramanayake, 2013) that has previously explored job expectations in Sri Lanka. Furthermore, no studies focus on job expectations among unemployed men and women in Sri Lanka. As noted in the introduction, given the significant increase in the gender gap in unemployment in Sri Lanka, which is considered an increasingly problematic labour market, a study examining gender differences in job expectations is quite relevant at this moment.

Thereupon, this study is expected to satisfy these gaps by contributing new knowledge to the field.

MATERIALS AND METHODS

The study attempts to identify the demographic, socio-economic and geographical factors of job expectations and to compare the job expectations among unemployed men and women in Sri Lanka by testing the hypothesized relationship given in the literature review. To accomplish this objective, hypotheses were developed with sufficient justification based on the literature review. An explanatory type of research was conducted by the researcher to test the hypotheses.

This study is classified as applied research because it tackles the practical issue of the substantial gender unemployment gap in Sri Lanka. It seeks to explore how job expectations impact this gender disparity in unemployment. Following the viewpoint of the mode of thinking, this research uses a deductive approach as this study seeks to examine existing theories, such as Job Search Theory, rather than developing new ones. This research study was conducted under a positivist view, assuming that the determinants that affect job expectations among unemployed men and women were measured using quantitative techniques. This study utilizes secondary sources to collect the necessary data from the Sri Lanka Labour Force Survey 2021, which is widely accepted as a reliable source of secondary data and covers the whole country, including all nine provinces in Sri Lanka, from 2013 onward.

The study targets a population of 439,784 unemployed individuals in Sri Lanka, comprising 206,943 males and 232,840 females. A two-stage stratified sampling method was used

to select a sample from 25,750 housing units, focusing exclusively on residents of these units and excluding institutional populations. The sample frame was derived from the 2021 Census of Population and Housing. The final sample for the Labor Force Survey (LFS) in 2021 included 1,567 unemployed individuals aged 15 and over, covering all provinces in Sri Lanka.

According to questions 54 and 56 in the SLLFS schedule for 2021, job sector expectations and occupational expectations were identified as the job expectations for three separate dependent variables, respectively. Furthermore, 1,000 unemployed people, including 465 male unemployed people and 535 female unemployed people, were selected as the sample for job sector expectations, while 1,092 unemployed people, including 464 male unemployed workers and 628 female unemployed workers were chosen as the sample for occupational expectations. As the total sample size of the unemployed is 1,567, the job sector expectations and occupational expectation variables consist of only 1,000 and 1,092 observations, respectively, because the model dropped 567 and 475 cases as missing values generated by non-responders in those cases.

Six models were prepared for job sector expectations and occupational expectations separately. As all the selected dependent variables were qualitative and categorical, all the models were analysed using a multinomial logistic regression method. Here, the categorical variable of job sector expectation consists of the public sector, which consists of both government and semi-government sector expectations, the private sector and the unemployed, who are expecting employment in any sector. Occupation expectations are categorized based on the Sri Lanka Standard Classification of Occupation (2008) (SLCO 2008), which is based on the International Standard Classification of Occupation (2008) (ISCO 2008), and three types of expectations are generated: professional and managerial level jobs (professional and managerial), skilled jobs (technicians, clerks, service, agricultural and production), and non-skilled jobs (elementary).

Based on the literature review, the explanatory variables for all models were selected to include demographic factors such as gender, age, marital status, and ethnicity; socio-economic factors like years of schooling and duration of unemployment; as well as geographical factors, including the residential sector as outlined in the SLLFS 2021. Tables and text were used to present the results of the study in such a way that the reader could understand them clearly and easily.

Table 1: Operationalization of the variables: job expectations

Variable	Operationalisation of variable	Source
Dependent variable	Job Sector Expectations (Y_1) • Private Sector=1 • Public Sector=2 • Any Sector=3	
Job Expectations	Occupational Expectations (Y_2) • Professional and Managerial=1 • Skilled=2 • Non-Skilled=3	
Independent variables		
Gender	• Male =0 • Female=1	
Age	Age as at the last birthday (Continuous Variable) • age15_24=1 • age25_34=2 • age35_44=3 • age45_55=4 • age55plus=5	LFS (2021), Data
Marital Status	• Married=0 • Never Married=1	
Ethnicity	• Sinhalese=0 • Non-Sinhalese=1	
Years of Schooling	Continuous Variable • No Schooling=16 • Studying/Studied Grade 1=0 • Passed Grade 2=1 • Grade 3=2 • Grade 4 =3 • Grade 5=4 • Grade 6=5 • Grade 7=6 • Grade 8 =7	

	• Grade 9=8 • Grade 10=9 • Passed G.C.E O/L / N.C.G. E=10 • Passed Grade 12=11 • Passed G.C.E.(A/L) / H.N.C. E=12 • Passed G.A.Q./G.S. Q=13 • Degree=14 • Post Graduate Degree / Diploma=15
Unemployment Duration	• Less than one year=0 • More than 1 year=1
Residential Sector	• Urban=0 • Non-urban=1

Source: Developed by the researcher, 2023

The general equation for the multinomial logistic regression applied to six models of job sector expectations and occupational expectations is formulated as follows:

$$MLogit(Y_i) = \alpha + \beta_i D_i + \gamma_i X_i + U_i \quad (1)$$

For Occupational Expectations:

$$\text{MLogit (Y2)} = \alpha + \beta_i D_i + \gamma_i X_i + U_i \quad (2)$$

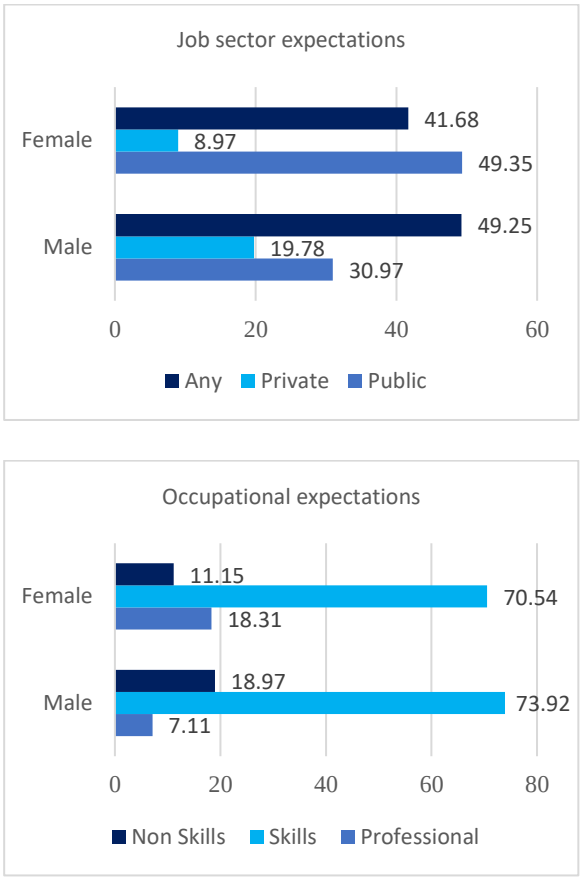
In equations 1 and 2, Y1 and Y2 indicate job expectations for the job sector and occupational expectations respectively, for total unemployed men and women separately. α signifies the constant. β_i signifies the coefficients of dummy variables and γ_i denotes the coefficients of continuous variables while ui denotes the error term. The same independent variables are used in both equations. Demographic, socioeconomic and geographical factors are represented by Dummy variables (D_i- gender, marital status, ethnicity, unemployment duration and residential sector) and continuous variables (X_i - age and years of schooling). Details of those variables are given in Table 2.

RESULTS AND DISCUSSION

In Sri Lanka, there is a notable disparity between genders in terms of job sector and occupational expectations. (Figure 1). Accordingly, unemployed women's job expectations in the public sector are higher than those of unemployed men, while unemployed women's job expectations in the private sector are lower than those of unemployed men in Sri Lanka.

On the other hand, occupational expectations for professional and managerial levels are higher for women than for men. This is mainly because of the increase in higher education among women, as their higher education enrolment is higher than that of men. For instance, according to the GPI for gross tertiary education enrolment in Sri Lanka in 2020, there were 1.38 women for every man enrolled at the tertiary level, whether in a public or private institution. This surge in female higher education has significantly narrowed the gender gap in occupational expectations, as more women attain the qualifications needed for professional and managerial roles. The higher educational attainment among women justifies their elevated occupational expectations, aligning them with or even exceeding those of their male counterparts.

Figure 1: Job expectations by gender



Source: Developed by the researcher using LFS data, 2021

Descriptive statistics, including the mean or proportion and standard deviation, were calculated for each selected dependent and explanatory variable to compare job expectations between unemployed men and women in Sri Lanka. Table 2 presents these descriptive results for three models: the overall model, the male model, and the female model. It includes several observations (No. of Obs.), the mean or proportion (Mean/Prop.), and the standard deviation (Std. Dev.). It is crucial to keep in mind that before discussing the results of the multinominal regression analysis, out of the total sample size of 1,567 unemployed, the two variables of job sector and occupational expectation had only 1,000 and 1,092 observations respectively, because the model dropped 567 and 475 cases as missing values generated by non-responders in those cases.

Table 2: Descriptive statistics for job expectations of total, male and female models

Name of the model	Total		Male		Female	
Number of Observations						
Job Sector Expectations(Y1)	1,000		465		535	
Occupational Expect: (Y2)	1,092		464		628	
Variable	**Mean**	**Std.Dev.**	**Mean**	**Std.Dev.**	**Mean**	**Std.Dev.**
Dependent Variable						
Job Sector Expectations(Y1)	2.044	0.927	2.183	0.878	1.923	0.952
Occupational Expect: (Y2)	2.009	0.530	2.119	0.497	1.928	0.538
Explanatory Variables						
Demographic Factors						
Gender						
Female (D1)	0.528	0.499	_	_	_	_
Age (X1)	27.322	9.291	26.666	9.728	27.908	8.848
Ethnicity						
Non-Sinhalese (D2)	0.244	0.429	0.240	0.427	0.248	0.432
Marital Status						
Unmarried (D3)	0.728	0.445	0.812	0.391	0.653	00.476
Socio-economic Factors						
Educational Attainment(X2)	11.754	2.193	11.340	2.043	12.123	2.257
Unemployment Duration						
More than 1 year (D4)	0.411	0.492	0.356	0.479	0.460	0.499
Geographic Factors						
Residual Sector						
Non-Urban (D5)	0 .854	0.353	0.853	0.355	0.855	0.352

Source: Author's calculations using LFS microdata, 2021

Notes:

- All numbers are rounded to three decimals.
- (D) and (X) indicate the dummy and continuous variables respectively.
- For the dummy variables, proportions are presented only for the categories that are equal to one.
- Out of the overall sample size of 1,567 unemployed, the models for the two variables of employment sector and occupational expectation only contained 1,000 and 1,092 observations respectively, because the model excluded 567 and 475 cases due to missing values produced by non-responders.

Additionally, multinomial logistic regression models were used to analyse the factors influencing job sector and occupational expectations among unemployed men and women. The results of these analyses are presented in Tables 3 and 4. Tables 5 (Annex A) and 6 (Annex B) provide the multinomial logit coefficients (Coe.), probability values (Prob. Value), and marginal effect coefficients (Marg. Effect).

I. Job sector expectations among unemployed men and women in Sri Lanka.

• *Demographic factors on job sector expectations between unemployed men and women*

As presented in Table 3, in the demographic aspect, firstly this study marked that gender affects job sector expectations. Tulu (2017); Bandara (2019); Mellado and Scherman (2017) have expressed that gender is a determinant of job expectations. Gender is significant in government and private job expectations. Regarding job expectations for any sector, government sector job expectations are higher and private job expectations are lower for unemployed women (Dickens & Lang, 1986).

This is mainly because government sector jobs often come with standardized working hours (Elizur, 2001), social acceptance (Tulu, 2017) and a better work-life balance compared to the private sector. This can be attractive to women who prioritize family responsibilities and desire more flexibility to manage their personal and professional lives as government sector jobs are often seen as providing more stability and job security (Elizur, 2001) compared to private sector

jobs. Age has a significant negative impact on public sector job expectations and a significant positive impact on private sector expectations of unemployed persons concerning the base categories. When assessing the influence of age on government job expectations of unemployed men and women, the age of both has a negative impact and is significant for only unemployed men on government job expectations. However, the age of both unemployed men and women positively and significantly impacts private-sector job expectations. Being an unemployed non-Sinhalese has no impact on government and private job expectations concerning any sector. When comparing unemployed men and women individually, it was observed that being a non-Sinhalese unemployed woman hurts government job expectations. This is mainly because government jobs often require proficiency in the official language of the country, which may be the majority language (for example, Sinhala in Sri Lanka). In the absence of fluency in the majority language, non-Sinhalese men may have difficulty getting government jobs, which may negatively impact their expectations. However, being a non-Sinhalese unemployed woman has a positive impact on government job expectations while being insignificant on private job expectations for both men and women. Further, findings indicated that being an unemployed unmarried person is positive and insignificant on government job expectations while insignificantly negative on private job expectations, and the same results are also revealed both for unmarried unemployed men and women.

- ***Socio-economic factors on job sector expectations between unemployed men and women***

In this study, the second hypothesis is to examine the impact of socioeconomic factors on job expectations. Bandara (2019); Mellado and Scherman (2017); Minchna et al., (2017); and Muller et al., (2020) have expressed that the level of education is an influential factor in job expectations. Out of them, years of schooling significantly positively impact job sector expectations for both unemployed men and women, which is aligned with results obtained by Minchna et al., (2017) and Muller et al., (2020). It is not a significant factor in private job expectations of the common sample and men separately, while it is significant for unemployed women concerning any sector. It is common for government jobs to have specific educational and eligibility requirements.

As a result, acquiring higher levels of education can enhance an individual's qualifications and increase their eligibility for a wide range of government positions. So, unemployed individuals with higher education tend to have greater expectations of securing government jobs due to their enhanced educational background. The level of education and the field of study have been found to affect job expectations. Jayasinghe and Gunawardena (2019) emphasized that graduates from prestigious universities have higher job expectations in terms of salary and career advancement compared to those from lesser-known institutions. The study disclosed that more than one year of unemployment duration has a significant positive impact on government job sector expectations while having a significant negative impact on private job sector expectations of the common sample. The results show that an unemployed person with more than one year of unemployment duration is less likely to expect private jobs. As the private sector expands throughout Sri Lanka, there are more employment opportunities in the country.

Therefore, when an unemployed person has more than one year of unemployment duration, the probability of having private job expectations will decrease by 11.9%. On the other hand, an unemployed person with more than one year of unemployment duration is more likely to expect government jobs. As there are fewer government job opportunities in the country, people have to wait a long period for a job opportunity.

When explaining how unemployment duration influences private job expectations, the study confirmed that being unemployed for men and women with more than one year of unemployment duration has a negative and significant impact. Kamyar (2019) and Monika Mühlböck, Kalleitner, Steiber and Kittel (2022) also reached similar conclusions that job expectations will be significantly lower for those who have been unemployed for a more extended period. Regarding the impact of unemployment duration on government job expectations with reference to the base category, it is only significant for unemployed women.

- ***Geographical factors on job sector expectations between unemployed men and women***

When it comes to the geographical factors that make up the model, there is a positive relationship between all sector expectations for all three models in the study. Only being an unemployed person and being an unemployed female living in the non-urban sector has a significant impact on government job expectations.

This is because government-funded infrastructure and public services are often crucial to non-urban areas. As a result of this reliance on government initiatives, there is an expectation that job opportunities will be available in fields such as construction, transportation, healthcare, education and public administration in the non-urban sector. Non-urban unemployed individuals naturally gravitate toward government jobs, because they expect to find work in fields directly related to social welfare and public services. The empirical literature provides opposite evidence as a negative relationship between job expectations and the non-urban sector which has been investigated by Bandara (2019); Tulu (2017); Muller et al., (2020).

Table 3: Multinominal-logistic regression models for job sector expectations of unemployed by gender

Model	**Multinominal logistic model 1**				**Multinominal logistic model 2**				**Multinominal logistic model 3**			
Name of the model	**Total**				**Male**				**Female**			
	Public		**Private**		**Public**		**Private**		**Public**		**Private**	
	Coe:	**P**	**Coe:**	**P**	**Coe:**	**P**	**Coe:**	**P**	**Coe:**	**P**	**Coe:**	**P**
Independent Variable												
Demographic Factors												
Gender												
Female (D1)	0.397	0.009 ***	-0. 575	0.007 ***	-	-	-	-	-	-	-	
Age (X1)	-0.039	0.004 ***	0.032	0.013 *	-0.048	0.034 **	0.029	0.088 *	-0.029	0.109	0.036	0.091 *
Ethnicity												
Non-Sinhalese (D2)	-0.031	0.872	0.353	0.153	-0.793	0.026 **	0.316	0.194	0.449	0.062 *	0.155	0.701
Marital Status												
Unmarried (D3)	0.014	0.950	-0.270	0.363	0.194	0.691	-0.310	0.482	0.026	0.119	-0.040	0.923
Socio-Economic Factors												
Years of Schooling (X2)	0.283	0.000 ***	-0.043	0.382	0.299	0.000 ***	0.063	0.131	0. 287	0.000 ***	-0.257	0.001 ***
Unemployment Duration												
More than 1 year	0.470	0.002 ***	-0.927	0.000 ***	0.126	0.587	0.305	0.001 ***	0.688	0.001 ***	-1.021	0.009 **
Residential Sector												
Non-Urban (D4)	0.557	0.006 ***	0.428	0.127	0.332	0.288	0.567	0.127	0.671	0.014 **	0.146	0.741
Constant	-3.519	0.000 ***	-1.264	0.132	-3.181	0.007 ***	-2.867	0.014 **	-3.730	0.000 ***	0.689	0.595
Sample Size		1,000					465				535	
LR chi2(12)		185.46					75.56				94.40	
Prob > chi2		0.0000					0.0000				0.0000	
Pseudo R2		0.0927					0.0787				0.0949	

Source: Author's calculations using LFS microdata, 2021

Notes:

- (D) and (X) indicate the dummy and continuous variables respectively.
- (Coe:) and (P) indicate the coefficient and probability value.
- ***, **, and * designate statistical significance at 1%, 5% and 10% levels respectively.
- Reference Category for Y: Expecting a job from any sector, either the public sector or the private sector.
- Reference category for Total: Being an unemployed person who is married, Sinhalese male living in the urban sector with less than 1-year unemployment duration.
- Reference category for Male: Being a male unemployed person who is married, Sinhalese, living in the urban sector with less than 1 year unemployment duration.
- Reference category for Female: Being a female unemployed person who is married, Sinhalese, living in the urban sector with less than 1-year unemployment duration.

II. Occupational expectations among unemployed men and women in Sri Lanka.

• *Demographic factors on occupational expectations between unemployed men and women*

Job expectations under occupational expectations comprise professional and managerial, skilled and non-skilled jobs. The base category for the total model is an unemployed person who is married, a Sinhalese male living in the urban sector with less than one year of unemployment duration, and non-skilled for the dependent variable. In line with this, as presented in Table 4, gender has a highly significant impact on professional and managerial expectations.

Concerning the base categories, unemployed women are more likely to expect professional and managerial jobs than men. As, being an unemployed person who is female, the probability of having professional and managerial expectations will increase by 8.6%. Increased participation of women in higher education has resulted in more women attaining advanced degrees and qualifications, which has caused them to have higher expectations for professional and managerial roles that require specific skills and knowledge gained through education and training. Women tend to anticipate securing professional and managerial positions, as higher levels of education significantly influence their job expectations and ability to obtain better employment, particularly in technical and professional sectors. This aligns with previous research by Bandara (2019). Additionally, female students are often more drawn to fields like public relations, teaching, and research, rather than journalism, as noted by Mellado and Scherman (2017).

Consequently, unemployed women tend to have higher expectations of securing skilled positions compared to men. Regarding the influence of age, older unemployed men and women are more likely to expect both professional-level and skilled jobs, excluding unemployed females' expectations for professional and managerial jobs. Only the age of unemployed men is positive and significant for professional and managerial job expectations. Malik and Subramanian (2015) discovered contrasting findings: job expectations of sales managers are not significantly influenced by career stage or age. Ethnicity can also be identified as one of the influential factors in occupational expectations.

Concerning the base category, being a non-Sinhalese unemployed person has a positive and significant impact on both professional and managerial level and skilled level job expectations. When compared gender-wise, being a non-Sinhalese unemployed male and being a non-Sinhalese unemployed female have a positive and significant impact on professional and managerial level expectations, while being a non-Sinhalese unemployed female has a significant impact on skilled job expectations, except for being a non-Sinhalese unemployed male, which is aligned with results obtained by Tomkiewicz (1982) and Tomkiewicz et al. (1997), as black and white graduates have different job expectations.

The results for marital status revealed that the influence of being an unmarried person, concerning base categories, has a notably positive effect exclusively on expectations for skilled jobs. That implies that unmarried unemployed men and women are more likely to expect skilled jobs. This is because if a person is expected to work in skilled jobs, they always try to gain the necessary qualifications relevant to their career path, as they do not have the same family responsibilities and commitments as married individuals. So, they are more inclined to invest time and effort into acquiring the necessary skills and qualifications for skilled jobs.

Socioeconomic factors on occupational expectations between unemployed men and women

Years of schooling can be identified as a significant factor in occupational expectations in the common sample and for men and women separately. When being an unemployed person with higher education, the probability of having professional and managerial-level jobs and skilled job expectations will increase by 3.9% and 1.02%, respectively (Table 6).

However, the findings of Bandara (2019), contrary to the results of this study, exhibit a negative impact on high-complexity roles, such as those in administrative, professional, and technical fields. Although unemployment duration is not a significant factor in professional and managerial jobs and skilled job expectations in the common sample and only for men, being a female unemployed person who has had more than one year of unemployment duration is significant for occupational expectations while being less likely to be expected relating to the base category.

Societal expectations and pressures, particularly regarding gender roles and responsibilities, influence the career decisions and expectations of female individuals. As the duration of unemployment increases, societal pressures become more influential, resulting in lower expectations for higher-level roles. The observation is confirmed by Kamyar (2019) and Monika Mühlböck, Kalleitner, Steiber and Kittel (2022), who noticed that job expectations will be significantly lower for those who have been unemployed for a longer period.

- ***Geographical factors on occupational expectations between unemployed men and women***

The residential sector was exposed by this study with reference to the base category, being unemployed, being male unemployed and being female unemployed who live in the non-urban sector do not have a significant influence on occupational job expectations.

Finally, the results and findings of this study indicate that various demographic, socio-economic and geographical factors significantly influence job expectations among unemployed men and women in Sri Lanka.

Table 4: Multinominal-logistic regression models for occupational expectations of unemployed by gender

Model	**Multinominal logistic model 1**				**Multinominal logistic model 2**				**Multinominal logistic model 3**			
Name of the model	**Total**				**Male**				**Female**			
	Prof. & Mang:		**Skilled**		**Prof. & Mang:**		**Skilled**		**Prof. & Mang:**		**Skilled**	
	Coe:	**P**	**Coe:**	**P**	**Coe:**	**P**	**Coe:**	**P**	**Coe:**	**P**	**Coe:**	**P**
Independent Variable												
Demographic Factors												
Gender												
Female (D1)	1.208	0.000 ***	0.411	0.041 **		_					_	
Age (X1)	0.017	0.361	0.024	0.040 **	0.080	0.016 **	0.024	0.161	-0.006	0.810	0.022	0.191
Ethnicity												
Non-Sinhalese (D2)	0.947	0.003 ***	0.536	0.032 **	1.379	0.015 **	0.548	0.123	0.893	0.036 **	0.612	0.091 *
Marital Status												
Unmarried (D3)	0.830	0.026 **	0.268	0.156	1.756	0.063 *	0.261	0.564	0.755	0.081 *	0.415	0.223
Socio-Economic Factors												
Years of Schooling (X2)	0.768	0.000 ***	0.427	0.000 ***	0.963	0.000 ***	0.430	0.000 ***	0.710	0.000 ***	0.425	0.000 ***
Unemployment Duration												
More than 1 year	-0.246	0.343	-0.437	0.020 **	0.545	0.234	-0.159	0.551	-0.648	0.060 *	-0.692	0.015 **
Residential Sector												
Non-Urban (D4)	0.191	0.574	0.174	0.486	0.943	0.138	0.512	0.110	-0.338	0.485	-0.257	0.534
Constant	-11.230	0.000	-4.377	0.000	-17.250	0.000	-4.688	0.000	-7.901	0.000	-3.415	0.005
Sample Size		1,092					464				628	
LR chi2(12)		214.31					84.29				109.60	
Prob > chi2		0.0000					0.0000				0.0000	
Pseudo R2		0.1246					0.1250				0.1089	

Source: Author's calculations using LFS microdata, 2021

Notes:

- (D) and (X) indicate the dummy and continuous variables respectively.
- (Coe:) and (P) indicate the coefficient and probability value.
- ***, **, and * designate statistical significance at 1%, 5% and 10% levels respectively.
- Reference Category for Y: Expecting a non-skilled job.
- Reference category for Total: Being an unemployed person who is married, Sinhalese male living in the urban sector with less than 1-year unemployment duration.
- Reference category for Male: Being a male unemployed person who is married, Sinhalese, living in the urban sector with less than 1-year unemployment duration.
- Reference category for Female: Being a female unemployed person who is married, Sinhalese, living in the urban sector with less than 1-year unemployment duration.

CONCLUSION

The findings of this study reveal that demographic, socio-economic, and geographical factors have various positive and negative effects on job expectations among unemployed men and women in Sri Lanka. When considering the two dependent variables that have been taken to represent job expectations, it is clear that gender significantly affects job expectations. Regarding the first dependent variable, job sector expectations, the findings of the study revealed that, under the demographic aspect, gender significantly affects job sector expectations.

It implies that more females preferred government job expectations while giving less preference to private job expectations than men. While confirming the queuing hypothesis of females for government sector jobs rather than private job expectations, unemployed women are more likely to expect professional and managerial jobs than men, with reference to the reference category. In comparing the effect of age on government job expectations of unemployed men and women, the age of both is negatively significant for only unemployed men and positively significant for private job expectations. Being non-Sinhalese, unemployed men and women have an impact on government job expectations while being insignificant on private job expectations.

Interestingly, ethnicity can be identified as one of the influential factors in occupational expectations for both unemployed men and women. On the other hand, concerning the base categories of these two dependent variables, years of

schooling are also an important determinant of job expectations for both unemployed men and women. The years of education of unemployed females concerning the base categories have a more considerable influence on job expectations, mainly because they are enrolled in higher education more than males.

Being unemployed men and women with more than one year of unemployment duration have a significant negative impact on private job expectations, while government job expectations and unemployment duration are only significant for unemployed women. Being a female unemployed person and having more than one year of unemployment duration is significant for occupational expectations, but less likely to be expected concerning the base category. When considering the residential sector, being non-urban unemployed is a significant positive factor in job sector expectations for the common sample and unemployed women.

Based on the findings of this study, it can be concluded that demographic, socio-economic, and geographical factors influence job expectations differently for unemployed men and women in Sri Lanka. Overall, the study reveals a gender disparity in the job sector and occupational expectations between unemployed men and women in the country.

POLICY RECOMMENDATIONS AND FUTURE DIRECTIONS

Based on an in-depth examination of job expectations among unemployed men and women in Sri Lanka, along with a review of current policies and recommendations, several key policy suggestions are put forward to address the gender disparities in job expectations. To support women's participation in private companies, the Minister of Women and Child Affairs can provide childcare support centres or subsidies that can ease female family responsibilities. Both private companies and industry associations can adopt gender diversity initiatives, such as implementing flexible work arrangements, diversity training, mentorship programs, and inclusive hiring practices, which can create a more welcoming environment for women seeking private-sector employment.

Awareness programs should be implemented through Divisional Secretariat offices to improve understanding, social interactions, and attitudes of non-Sinhalese individuals regarding job expectations, with a particular focus on women. This initiative aims to reduce ethnic-related disparities in labour force participation. The Central Bank can collaborate with financial institutions to develop tailored financial products and services for rural job seekers. This can include microfinance and microcredit programs with favourable terms and conditions.

The Ministry of Education, along with relevant educational and vocational training authorities, can establish comprehensive career counselling and guidance programs at educational institutions and job centres to help unmarried males and females explore various career paths and set ambitious professional goals. Unmarried individuals can enhance their qualifications and readiness for higher-level positions by having access to skills development and training programs tailored to their needs.

Regarding the contribution of this research to the literature, as the unemployment rate is a key issue in Sri Lanka during the economic downturn, it must be focused on the effect of expectations on unemployment. On the other hand, the gap between gender-wise unemployment rates in Sri Lanka has also widened. In this context, a gender-specific study on job expectations is necessary. This research contributes to the literature by addressing a gap, as most economic theories tend to discuss job expectations in a more general context.

Few theories examine how job expectations vary between unemployed men and women, making this study a valuable extension of existing theories. In terms of empirical contributions, while recent research often relies on common determinants to analyze job expectations, this study identifies unique and less frequently explored factors. For instance, it highlights the impact of the duration of unemployment on job expectations, which has been less emphasized in both local and international studies.

The job expectations of the unemployed are analysed by job sector expectations and occupational expectations, which are identified as unique variables of job expectations compared to existing literature. Thus, this study offers a novel empirical contribution to understanding the job expectations of unemployed men and women in the country. Further, a separate multinomial logistic regression model is used in this study to account for the job expectations of unemployed men and women in the country.

Although most researchers have employed logit regression and correlation analysis to identify the determinants of job expectations, no studies have applied separate models for unemployed men and women in Sri Lanka. This study addresses this methodological gap by introducing new insights and approaches.

This research was successfully and methodically executed by drawing on the secondary microdata obtained from the Annual Labour Force Survey 2021. However, it has several limitations that can potentially be alleviated through future research directions. This study uses a unique and comprehensive data set from the SLLFS 2021, which focuses mainly on the economic downturn period in Sri Lanka, further increasing the study's importance. Certain variables should have been included in the examination of the determinants of job expectations, such as the impact of promotions, the condition of the working environment, work security, and so on. Due to insufficient data requirements in the survey data set, certain variables were not considered in this study. However, scholars could examine these aspects in the future using primary data.

Therefore, future research could complement survey questionnaires with in-depth interviews to validate, enhance, or challenge self-reported perceptions. In this regard, future studies of a longitudinal nature could provide an in-depth understanding of this topic. Additionally, case studies can be used with interviews with unemployed men and women to apply a qualitative method to get in-depth practical knowledge of limitations against job expectations to produce more suitable results.

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ANNEXES

Annex A

Table 5: Marginal effects of multinominal-logistic models for job sector expectations of unemployed by gender

Model	**Multinominal logistic model 1**			**Multinominal logistic model 2**			**Multinominal logistic model 3**		
Name of the model	**Total**			**Male**			**Female**		
	Marginal Effect			**Marginal Effect**			**Marginal Effect**		
	Public	**Private**	**Any**	**Public**	**Private**	**Any**	**Public**	**Private**	**Any**
Independent Variable									
Demographic Factors									
Gender									
Female (D1)	0.107	-0.078	-0.028	-	-	-	-	-	-
Age (X1)	-0.010	0.005	0.004	-0.011	0.007	0.004	0.007	0.003	0.004
Ethnicity									
Non-Sinhalese (D2)	-0.008	0.037	-0.028	-0.174	0.010	0.074	0.094	-0.002	-0.091
Marital Status									
Unmarried (D3	0.014	-0.030	0.016	0.053	-0.055	0.002	0.006	-0.004	-0.003
Socio-Economic Factors									
Educational At-tainment (X2)	0.061	-0.016	-0.045	0.053	-0.001	-0.051	0.071	-0.027	-0.043
Unemployment Duration									
More than 1 year (D4)	0.137	-0.120	-0.017	0.073	-0.149	0 .075	0.181	-0.098	-0.087
Residential Sector									
Non-Urban (D4)	0.099	0.023	-0.122	0.035	0.065	-0.101	0.142	-0.009	-0.132
Sample Size	1,000			465			535		

Source: Author's calculations using LFS microdata, 2021

Notes:

- (D) and (X) indicate the dummy and continuous variables respectively.
- (Coe:) and (P) indicate the coefficient and probability value.

Annex B

Table 6: Marginal effects of multinominal-logistic regression models for occupational expectations of unemployed by gender

Model	**Multinominal logistic model 1**			**Multinominal logistic model 2**			**Multinominal logistic model 3**		
Name of the model	**Total**			**Male**			**Female**		
	Marginal Effect			**Marginal Effect**			**Marginal Effect**		
	Prof. & Mang:	**Skilled**	**Non-Skilled**	**Prof. & Mang:**	**Skilled**	**Non-Skilled**	**Prof. & Mang:**	**Skilled**	**Non-Skilled**
Independent Variable									
Demographic Factors									
Gender									
Female (D1)	0.086	-0.033	-0.052	-	-	-	-	-	-
Age (X1)	-.0005	0.003	-0.003	0.003	0.0003	-0.003	-0.003	0.005	-0.001
Ethnicity									
Non-Sinhalese (D2)	0.047	0.014	-0.062	0.051	0.028	-0.079	0.045	0.010	-0.056
Marital Status									
Unmarried (D3)	0.050	-0.004	-0.045	0.087	-0.042	-0.045	0.051	-0.011	-0.039
Socio-Economic Factors									
Educational At-tainment (X2)	0.039	0.010	-0.049	0.033	0.028	-0.062	0.043	-0.003	-0.040
Unemployment Duration									
More than 1 year (D4)	0.015	-0.060	0 .045	0.039	-0.056	0.016	-0.002	-0.057	0.059
Residential Sector									
Non-Urban (D4)	0.003	0.015	-0.018	0.028	0.044	-0.072	-0.013	-0.009	0.023
Sample Size	1,092			464			628		

Source: Author's calculations using LFS microdata, 2021

Notes:

- (D) and (X) indicate the dummy and continuous variables respectively.
- (Coe:) and (P) indicate the coefficient and probability value.

Detecting Land-Use Changes in Greater Kandy Development Area

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Pilapitiya, P.G.D.[1*], Uduporuwa, R.J.M.[2] and Subasinghe, Shyamantha.[3]

[1,2]Department of Geography and Environmental Management, Sabaragamuwa University of Sri Lanka

[3]Department of Geography, University of Peradeniya

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Abstract

As urban growth became a threat to Kandy city, the Urban Development Authority (UDA) has introduced a new concept called the "Greater Kandy Development Area (GKDA)" to control and manage the rapid urban growth, as well as to minimize its' impacts towards the environment. This study examines the land use/ land cover changes in GKDA, in selected time periods using GIS and Remote Sensing techniques. Findings demonstrate that dynamic patterns of urban expansion cause progressive growth in built-ups and lowering in non-built-ups. In 2005, there were only 16.9 percent of built-up areas in GKDA but, it has increased up to 40 percent in 2020. 81.7 percent of non-built-up areas in 2005, has reduced up to 58.8 percent. As population growth happened inside the city limits, land use changes also happened within. These changes create clustered as well as sprawl development patterns.

Keywords: GKDA, LULC Changes, Urban Expansion, Sprawl Development Pattern

INTRODUCTION

The world is experiencing the most rapid urbanization it has ever seen. Much of this urbanization will occur in Africa and Asia, with enormous social, economic, and environmental consequences. The future of well-being, resource efficiency, and economic prosperity could be greatly impacted by urbanization. Cities are densely populated and have a high concentration of poverty. The rise in inequality is particularly obvious in cities, where slums and informal settlements divide rich from poor areas.

For prospective migrants from rural to urban regions, Sri Lanka's cities seem unappealing, as they are in other parts of South Asia. This is largely owing to the significant progress made in creating spatial equality between rural and urban regions in terms of the availability of essential public services and, more importantly, the overall quality of life. As a consequence, the incentives for rural migrants to travel to urban areas in search of greater income are typically lower in Sri Lanka than in other South Asian countries (Elkaduwa & Samarasinghe, 2016). According to the Ellis and Roberts (2016), Sri Lanka's cities appear to be unattractive to potential migrants from rural to urban areas. Their "messy" urbanization is represented by sprawl and ribbon development patterns, with indications of rapid expansion on the outskirts of the Colombo metropolitan zone in particular, as well as along important transportation corridors. Sri Lanka's overall urban area rose at a comparable rate to the rest of South Asia, but its urban population grew at a much slower rate than the rest of South Asia as a whole.

Colombo, Sri Lanka's main city, is experiencing rapid urbanization. In recent decades, not just Colombo, but other flourishing cities like Kandy and Galle, have started to see unstoppable fast urban expansion. Kandy's land area has decreased dramatically as a result of this and the city has begun to expand beyond its original borders in recent decades. Suburbanization has thus become more prevalent in certain places as a consequence of this development. When it comes to population, economy, administration, and other services, Kandy Metropolis is Sri Lanka's second-largest city. It has been determined that the city of Kandy, in particular, should have its growth and expansion controlled.

Sri Lanka is one of five countries in the area (the others being Bangladesh, India, the Maldives, and Pakistan) whose government estimates of the urban population share are much lower than alternative estimates. This points to mostly disguised urbanization, in which huge segments of the population live in settlements that, although having urban characteristics, are controlled as rural districts (Ellis and Roberts, 2016).

Not only Colombo, but other flourishing cities such as Kandy and Galle have begun to demonstrate unstoppable rapid growth in recent decades. Following the liberalization of economic policies in the 1970s, another phenomenon that happens as a result of urbanization is suburbanization. To

[*] **Corresponding author:** Tel.: +94 (77) 055 3942; Email: dhanushikapilapitiya@gmail.com
https://orcid.org/0000-0002-4728-8959

help people in cities and towns deal with the negative effects of suburbanization, the Urban Development Authority (UDA) has started a new project called "Urban Area Development."

In Sri Lanka, the present policy scenario places a strong emphasis on metropolitan regions. The Western area Megapolis project, in particular, will primarily focus on urbanization in the Western region. Besides the Western region, the continued policy emphasis intends to develop the wider Kandy Region, which extends beyond the Kandy Municipal Council's (MC) 26.8 square kilometres and 45 Grama Niladari Divisions (GND) to almost 210 square kilometres. (Elkaduwa and Samarasinghe, 2016).

Under the UDA Law, No. 41 of 1978, the Kandy Municipality area was declared an urban development area through Extraordinary Gazette No. 26/8 of March 7, 1979, on Section 3 (1) of Section No. 8 (a) of Amendment Act No. 04 of 1982. (2019-2030 Development Plan for Kandy) Kandy is the capital of Sri Lanka's Central Province and, after the Colombo Metropolitan Area, the country's second-largest city (UDA, Central Provincial Office, 2019).

This plan caused the acceleration of the suburbanization trend in the Kandy city area and a shift in land usage in the surrounding region. The rapid expansion of built-up regions, in particular, was made possible by diverting attention away from non-built-up areas and water bodies. The primary goal of this strategy was to keep the urban sprawl inside the city limits under control by extending the growth process out into the neighbouring regions as much as possible. However, this strategy was unable to halt the expansion of Kandy city's population. Kandy city is beginning to expand beyond its physical boundaries, establishing itself as Sri Lanka's first truly unbounded metropolis.

As the last capital of the ancient monarch's reign, Kandy is well-known as a sacred Buddhist site because of the temple of the Tooth Relic. Kandy has a lot of potential in terms of financial, social, and cultural development. However, recent improper, unplanned construction has resulted in overcrowding, excessive traffic congestion, and urbanisation, pushing this ancient heritage area's historic cultural area into disaster-prone regions. This historic heritage region's townscape has not been properly protected or repaired, reducing its value and appeal and preventing the area from fulfilling its full economic potential. A project called GKUP, which means "Greater Kandy Urban Plan," has been asked to be carried out by the Japanese government. It includes a review of the Kandy Metropolitan Area's urban development vision and a plan for the Heritage Area, which includes a plan for the whole area.

Kandy is one of the most distinctive cities in Sri Lanka for several reasons. One of the primary causes is the terrain's complexity. Kandy is shaped like a triangle basin and is in the central highlands of the country. The city is situated between several mountain ranges, including the Knuckles, Bahirawa Kanda, and Hanthana mountain ranges. The Udawatta-Kale sanctuary is in the south of Kandy city. The city's ability to expand is limited because of this complicated topography.

Kandy's cultural and religious values are another prominent feature. Kandy, the last capital of Sinhala kings, is known as Sri Lanka's cultural capital because of its strong cultural worth. Kandy is important because of the combination of Sinhala and Tamil cultures. Kandy was designated a World Heritage Site in 1988 because of its cultural and historical significance. Monetary worth is another feature. Kandy is the second-largest city located outside the Colombo Metropolitan Area. As the capital of the central province and the Kandy district, there are numerous significant enterprises. It mainly includes industries like apparel, gemstones, furniture, as well as jewellery. Also, there are several agriculture research centres nearby.

Kandy is the only colonial city that keeps its indigenous traits. Sena Sammatha Wickramabahu picked Kandy as his kingdom in 1473-1511 (Peiris, 2019). It became the capital of the Sinhalese monarchs in 1592, and they maintained their independence throughout European colonial rule except for brief Portuguese and Dutch occupations until 1815 when the British Removed Sri Wikrama Rajasingha. The Colonial era began with the insuring agreement in 1815, which was known as the Kandyan Convention. After a 150-year British ruling period, Sri Lanka became an independent nation in 1948. So, Kandy city can be called the only city in Sri Lanka that has all of the original, colonial, and post-independence Characteristics.

In recent decades, the suburbanization process has become dominant in this area. Because of the above discussed environmental barriers and historical value, the land extent of Kandy has become miniscule and, therefore, the city has grown outside its boundary. Conversely, Kandy, in particular, has been nominated as a city whose development and expansion should be regulated. Therefore, UDA introduced a concept called the Greater Kandy Development Area (GKDA) to manage and facilitate it. As a new concept and proposed concept, no proper study has been done on this topic.

Not only Kandy, but the Greater Kandy Area is also a highly environmentally sensitive area. So, as developed countries do, there is a special need for proper monitoring of the physical growth of urban areas in this area. If urban growth happens in this environmentally sensitive area, several problems can occur. But there hasn't been a proper study done before to keep track of and predict the growth of cities in this area. Therefore, the main objective of this study is to identify the spatiotemporal growth pattern of urban expansion in the GKDA.

LITERATURE REVIEW

The growth of major cities and their growing spatial effects indicate a random or organised movement of people from wide rural regions to mostly urban areas. Over the previous two centuries, this has occurred in almost every nation on the globe. This rapid and challenging process of urbanization results in the physical extension of the city spilling over into the surrounding territories, a phenomenon referred to as "urban growth." These spatial changes are only noticeable over a lengthy period, while the accompanying physical processes exhibit continuous spatial changes over time. As a consequence, urbanisation may be seen as a spatial-temporal phenomenon. Often, urban growth is uncontrolled

and dispersed, impeding long-term development (Weerakoon, 2017). They are:

1. Initial stage
2. Acceleration Stage
3. Mature Phase

There is a centrepiece for economic activity in each city; the Central Business District (CBD). Pettah, for example, is Colombo's CBD. During the day, this area is usually rather packed. However, it is not crowded or packed at night. Due to the high cost of land, this neighbourhood has less residential activity. On the other hand, it serves as the city's centre point. It is the city's business, office, and rental hub. It also serves as a hub for transportation networks. More employment is created in this region as a result of the economic activity in the CBD. Rural-urban migration occurs in this area to meet the labour shortage. Middle-class residents concentrate in the CBD's outskirts while low-income people construct their homes within city limits. Most of the time, these are just ordinary dwellings. Similarly, rural-urban migrations are important during the start of a city's development. The population density is steadily decreasing from the city centre to the city limit, where it is concentrated. The population of a city grows in lockstep with the expansion of the city, due to three causes:

1. Natural increase which happens inside a city.
2. Increasing migration due to rural-urban migration.
3. Urban expansion which happens due to expanding city boundaries.

Urban development happens when these three variables increase. Urban expansion is a rapid process in the early stages. However, at some point, the rate of expansion decreases. Environmental pollution, transportation congestion, and rising property prices are all factors that contribute to a reduction in rural-urban migration. As a result, migration from metropolitan areas to the suburbs is on the rise. People who relocate from cities begin to dwell in the suburbs. At this stage, the suburbanisation process occurs.

In general, the explanatory variables of urban growth are examined when studying urban expansion trends. Previous research has indicated that socioeconomic factors such as population and economics influence urban growth. Due to a lack of data in most situations, a qualitative approach was used to define those guiding aspects where a quantitative analysis would be more helpful.

Furthermore, not just economic considerations, but also physical elements such as elevation and proximity factors such as distance to a river or water, as well as access to important roadways, impact urban growth. According to Dissanayaka et al., (2019) when compared to other places, the Impervious Surface (IS) expanded toward the north in 2006 and 2017. Results of their study showed that IS areas expanded from 529 to 1514 ha (2.3% to 6.7% of the total land area) between 1996 and 2006, and to 5833 ha (23.9% of the total land area) in 2017, with an annual growth rate of 11.1% per year from 1996 to 2006 and 12.2% per year from 2006 to 2017. Forest cover showed a clear downward trend from 1996 to 2006, with an annual change rate of 1.6% from 1996 to 2006 and 1.8% from 2006 to 2017. During the study period, the total decrease rate was 1.7%. IS absorbed the majority of the decreased forest cover. The cropland area fluctuated between the three time-points. It increased from 5570.8 to 6486.3 ha (or 1.5% per year) from 1996 to 2006, but then decreased to 5372.6 ha in 2017, giving an average rate of change of −0.2% per year from 1996 to 2017.

As Dissanayaka (2020) explained, in the past two decades, Kandy city has experienced a substantial built-up area increase, resulting in spatiotemporal variations in the built-up area (BUA). Its size has been raised to 528.4 hectares (2.3%). For 1996, 2006, and 2017, respectively, 1513 ha (6.7%), 5377.5 ha (23.9%), and 1513 ha (6.7%). In 1996, there was a greater concentration of built-up areas in the city centre. Later, it grew north and southwest along the road, except the southern section. The mountain ranges may act as a deterrent to growth in the southern area. A linear growth trend was seen during the 14-year observation period. In 2017, a more developed pattern was also displayed.

Also, Dissanayaka (2020) had mentioned that, Kandy city has three major urban flows that flow along with three major transportation networks: Kandy-Jaffna, Kandy-Colombo, and Kandy-Mahiyanganaya. The urban flow pattern is based on the Kandy urbanization process and stresses the linear dispersion of built-up regions. A major urban form was discovered to emerge around the Katugastota growth node (D1), and it appears to be improving in the future. There is also the potential of converting Kandy city from single-core to multi-core in the future.

In 2015, Masakorala and Dayawansa generated land-use maps for 1976, 1992, 2001, and 2011 using 5 land-use classes. Those maps clearly show that the forest cover, and paddy fields in the study region demonstrate a progressive decline and there is a clear rise in built-up areas and homesteads. However, according to their study, after water bodies have expanded in size as a result of seasonal changes when they should be decreased. According to their findings, previously, Kandy's built-up area was limited to Kotugodella, the city's core. Then it extended south-west and north-east along the Peradeniya-Kandy and Kandy-Katugastota routes, respectively. The initial wave of urban expansion happened in the southwest, while subsequent phases occurred in the northeast. The radius has grown to eight kilometres along the Kandy-Peradeniya route and four kilometres north and northwest. Peradeniya, Katugastota, Ampitiya, and Kundasale are four urban centres located on the outskirts of the present urban boundaries in the southwest, northwest, southeast, and eastern directions, respectively. The population density map of Kandy city demonstrates that the population is crowded inside the city limits and that large densities can be observed outside them: northwest in the direction of Katugastota, southeast in the direction of Ampitiya, and southwest in the direction of Peradeniya (Masakorala and Dayawansa,2015).

The expansion of the built-up area is a necessary effect of urban growth, and Kandy city has done so as well. The "None built-up" category, which reflects the dense vegetation in the city, is the most impacted in this relation. It has dropped by 10% in a short period, from 28% in 2003 to 10% in 2007. (18%). It is clear that the city's built-up area has grown significantly in the previous two decades, and as a result, the city has lost a significant percentage of its dense plant cover (Uduporuwa and Manawadu, 2015).

Geographic Information Systems are made up of two primary components: GIS and Remote Sensing. (Hapner et al, 2005). The urban application of remote sensing has grown in popularity as a result of recent developments in remote sensing data, technology, and theories in wide-earth observations (Ju-Yang et al., 2021). The application of remote sensing to the urban environment, on the other hand, varies depending on the application's purpose. Remote sensing has various advantages for urban studies in general. Mainly, satellite photos can provide a synoptic view of a broad region at a given moment, which is impossible to do using traditional surveying approaches.

Recent improvements in remote sensing have provided greater information for urban area mapping using high-resolution satellite data (0.6m-2.5m; Quick-Bird, IKONOS, SPOT, and ALOS) and medium resolution (15m-30m; ASTER, IRS, and LANDSAT) (Guindon et al., 2004). Due to a lack of data and a high cost, studies employing high-resolution hyperspectral pictures in an urban context are still limited (Chengqi et al., 2003). The medium-resolution photos have been frequently used in urban applications. (Xian, 2015) Because of their great availability, Landsat pictures are routinely utilized to offer high-quality, regularly updated information on land surface habitats. They've been accessible regularly since 1972, and they've helped to characterise historical changes in urban regions at all scales, from local to global (Sohl and Sleeter, 2011).

The word "land cover" refers to the cover of characteristics that exist on the Earth's surface and near underground, such as biodiversity, geology, terrain, ground and surface liquid, and anthropogenic structure (Lambin et al., 2001). The phrase "land usage" refers to how people use the land cover. (Turner and Meyer, 1994) Land-use change is influenced by socioeconomic and biophysical factors and geographical location, size, and previous land use (Lambin et al., 2001). Changes in land use based on the built-up area are more rational and assist in compressively defining the urban process (Wu and Zhang, 2012). As a result of the increased population and urbanization in a particular region, the land would be under a lot of stress, and the land cover would change rapidly. As a result, examining land-use changes was another method of determining urban expansion (Masakorala and Dayawansa, 2015).

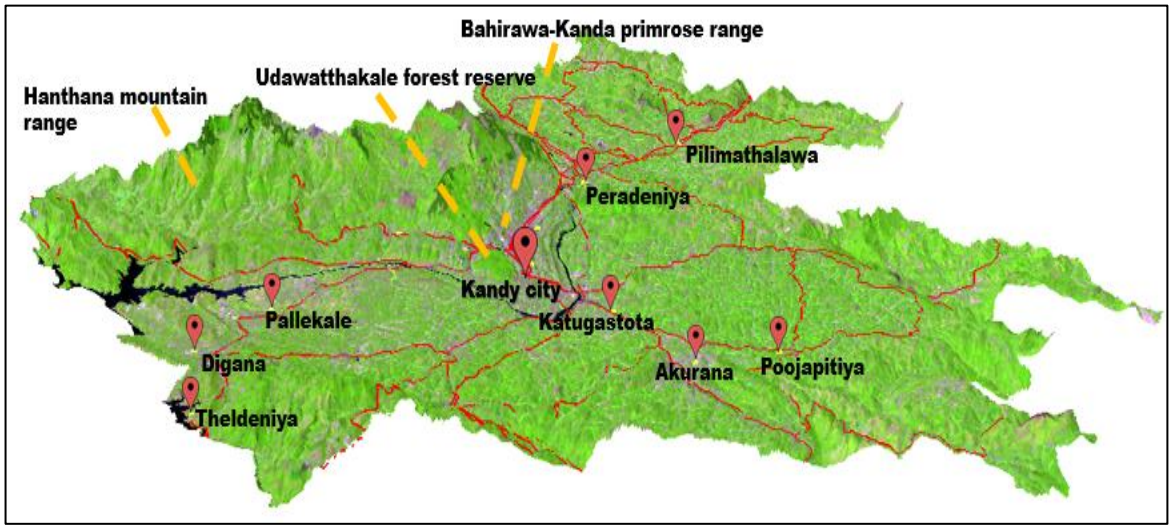
The traditional methodological approach, according to Dissanayaka (2020), is inconvenient for detecting land-use change in wide geographical regions. As a result, he used the same strategy as earlier studies. To begin, three time points were chosen (1996, 2006, 2017). After that, the United States Geological Survey (USGS) produced radiometrically corrected and atmospherically accurate Landsat level 2 data files were downloaded. A cloud-free picture with the bare minimum of cloud cover during the data download step was carefully selected. Due to cloud disturbance, which is a typical problem with RS data in the tropical region, it was difficult to locate the same day and time image. Thousands of successful LULC applications are still based on pixel-based categorisation (Blaschke, 2010). However, because of its technological and conceptual constraints, such as the "salt and pepper effect," the use of PB categorisation confronts significant obstacles (Blaschke, 2010).

MATERIALS AND METHOD

Study area

Kandy is the major city in central Sri Lanka, which is located 120km from Colombo. Kandy by the moniker “Maha Nuwara (“Great city”)”, is situated at the height of 1640 feet (500 meters). In ancient times, it was known as Kanda Pas Rata (Place on five hills) partly owing to the surrounding steep terrain. Kandy is located in a steep and thick woodland environment. The Kandy Municipal Council (KMC) area has a land area of 26.45 square kilometres or 2645 hectares. It is a triangle location that is virtually fully bounded on the west, north, and east by the Mahaweli River's main course, and the south half reaches a height of 1337 meters in the Hanthana mountain range. This municipality is situated at 70 21' North Latitude and 80 45' East Longitude. The inner city of Kandy is located in a 0.4 square-mile basin at a height of 1600 feet, created by the convergence of three valleys lying between the foothills encircling the northern extremity of the Hanthana range, the Primrose-Bahirawakanda range.

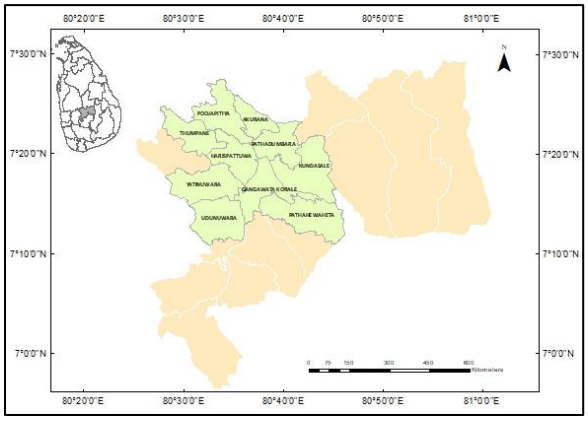
Figure 1: Topography of study area



Source: Developed by author; based on 1:50,000 digital data of survey, Department of Sri Lanka, 1996

With the rising demand for urban space, urban development in the KMC area, which was practically solely restricted to this narrow basin until the late nineteenth century, has extended outwards since then, across valley bottoms and adjoining lower hill slopes. KMC was classified as an urban development area in 1979. In terms of economic, social, and cultural development, Kandy has a lot of potential. However, the recent poorly planned building has led to overpopulation, excessive traffic congestion, and urbanisation pushing towards disaster-prone parts of the historic cultural area. Additionally, the townscape of the historical heritage region has not been adequately protected or restored, detracting from its value and appeal and hindering the area from realising its full economic potential. In this backdrop, the Government of Sri Lanka (GOS) has commissioned the Government of Japan (GOJ) to carry out the project for the Formulation of the Greater Kandy Urban Plan (GKUP), which comprises a revision of the Kandy Metropolitan Area's urban development vision and a comprehensive plan for the Heritage Area.

Figure 2: Study area



Source: Developed by author; based on 1:50,000 digital data of Survey, Department of Sri Lanka, 1996

Though the Kandy Development Plan was conducted in the Kandy municipal zone, the 10 divisional secretariat areas of Thumpane, Pathadumbara, Kundasale, Gangawata Koralaya, Haripatthuwa, Yatinuwara, and Udunuwara, with a total size of 608 square kilometres were evaluated and researched. There were 13 local government areas in this region, including a municipality, two urban councils, and 11 Pradeshiya Sabhas (UDA, Central Provincial Office, 2019).

Data collection

This study used secondary data gathered from websites (Table 1). Landsat images were mainly used for urban land use mapping. Landsat images of three selected time points were mainly used namely 2005, 2011, and 2020. In addition to Landsat imageries, Google Earth imageries were employed to develop urban land-use maps. To detect the urban land-use changes in GKDA, Landsat imageries and Google Earth images were mainly used.

Table 1: Information about data used to detect the land use in GKDA

Data type	Data source	Years
Landsat data	Official website of United States Geological Survey. (https://earthexplorer.usgs.gov/)	2005, 2011 and 2020
Google earth images	Google earth pro	2005, 2011 and 2020

Source: Prepared by authors, 2023

Three Landsat TM/ETM imageries of selected years (2005, 2011 and 2020) from the United States Geological Survey website were acquired (Table 2). All these images are with 30m resolution and cloud-free or minimum cloud cover. The basic information of those three images can be provided as below.

Table 2: Information about Landsat data

Acquisition date	Satellite/ sensor	Path	Row	Waveband		Spectral range(mm)		Spatial resolution
				SWIR	NIR	SWIR	NIR	
2005-03-17	Landsat-5TM	141	055	7	4	2.09-2.35	0.76-0.90	30
2011-03-14	Landsat-5TM	141	055	7	4	2.09-2.35	0.76-0.90	30
2020-03-10	Landsat -08	141	055	7	5	2.11-2.29	0.85-0.88	30

Source: Developed by author; based on Landsat images 2005-2011 and 2020

Data analysis

Land Use/Land Cover (LU/LC) mapping

Land cover mapping is the process of categorising and classifying human activities and natural features on the terrain across time. LULC mapping is the most extensively utilized method for studying changes in remote sensing.

Classification of Landsat imageries

The maximum-likelihood classification algorithm is used in this pixel-based supervised classification technique. This technique involves three main steps: training sites/sample preparation, signature development, and classification. Mainly, this was used to generate three maps (2005, 2011, and 2020) of land-use changes with three classes (Table 3 and Table 4). Namely, water, non-built-up, and built-up. Human-made constructions such as houses, roads, and other surfaces are included in built-up areas. Agricultural areas, woods, meadows, and barren lands are all examples of non-built terrain. Rivers, lakes, and other bodies of water are taken as water. Classification has been completed, with at least 100 samples in each class, each year.

Land Use /Land Cover classification scheme

Table 3: Land use land cover classification scheme

LU/LC classes	Description
Water areas	Natural and man-made bodies of water such as lakes, rivers, ponds
Built-up Area	All the manmade structures including buildings and roads
Agriculture lands	All croplands
Bare lands	Barren lands and other open spaces
Forest cover	All the forest areas

Source: Prepared by authors, 2023

Table 4: Land use classes

Old class name	New class name (reclassify)
Water areas	Water
Built-up Area	Built-up-areas
Agriculture lands	Non-built-up-areas
Bare lands	Non-built-up-areas
Forest cover	Non-built-up-areas

Source: Prepared by authors, 2023

Change matrix

By reclassifying land use maps of three years (2005,2011 and 2020) using the reclassify tool, those maps were combined as 2005-2011, 2011-2020, and 2005-2020 to identify the land-use changes. To analyse land-use changes, change Metrix was used. (Equation 1)

$$\left(\frac{t_2 - t_1}{t_1}\right) \times 100 \quad (1)$$

Where t1 refers to Period 1 and t2, refers to Period 2.

Annual change was calculated by using Equation 2

$$(t_2 - t_1) \div Y \quad (2)$$

Where t1 refers to Period 1, t2 refers to Period 2, and Y refers to the number of years.

Assessing the accuracy

The accuracy of the land-use classification was checked with 100 random sample points for each year (2005, 2011 and 2020) using create random points data management tool in ArcMap 10.4 software. Overall accuracy was calculated separately from each time point. All the random points generated for accuracy assessment were visually assessed by using Google Earth images. The data obtained from the comparison between reference and actual points on pixel-based classification land-use maps were then used to calculate the accuracy of the LULC map using overall accuracy (Congalton, 1991). To calculate overall accuracy first, calculate producer accuracy (Equation 3) and user accuracy (Equation 4).

$$\mathrm{PA} = \mathrm{CLU} \div \mathrm{TLU} \quad (3)$$

Where PA is Producer's Accuracy, CLU refers to Correct Land Use Pixel and TLU is Total Land Use pixel.

$$\mathrm{UA} = \mathrm{CLU} \div (\mathrm{CP} + \mathrm{MP}) \quad (4)$$

Where, UA refers to User's Accuracy, CLU Correct Land Use Pixel, CP refers to Correct Pixels and MP is Misclassify pixels.

Then overall accuracy was calculated using the values that are gained from producer accuracy (Equation 5).

$$OA = PC_1 + PC_2 + PC_3 \div TC \quad (5)$$

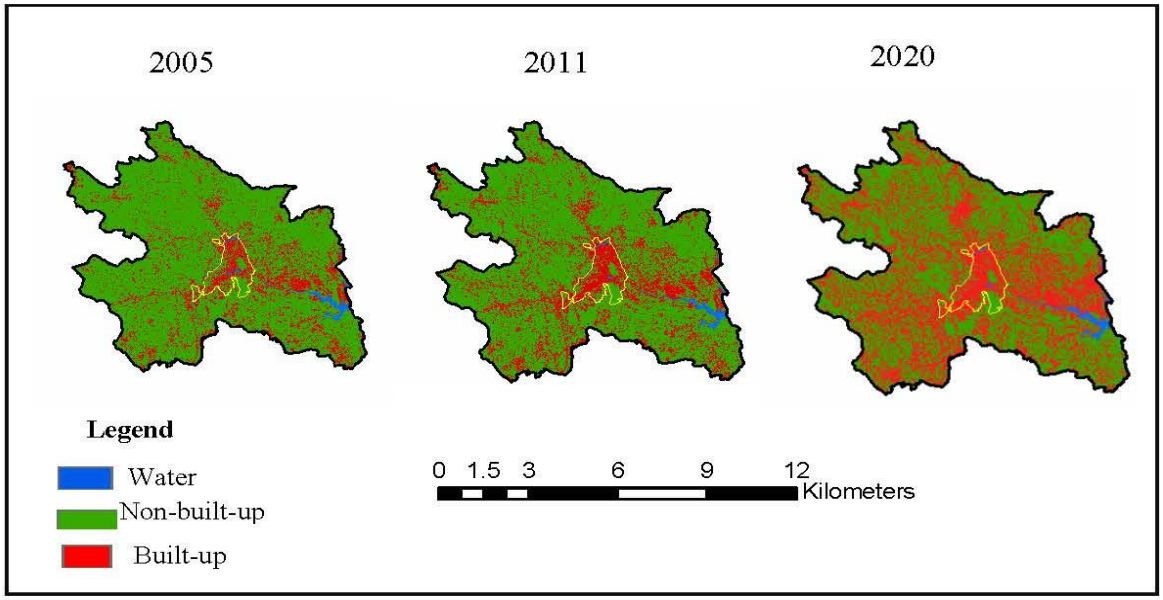
Where OA refers to overall accuracy, PC1 refers to producer's accuracy of class 1, PC2 refers to producer's accuracy of class 2, PC3 refers to producer's accuracy of class 3 and TC refers to the number of classes.

RESULTS AND DISCUSSION

Analysis of urban Land Use changes in greater Kandy development area

Figure 3 illustrates three classified maps for the GKDA for 2005, 2011, and 2020. It clearly shows the increase of built-up areas in GKDA and the areas that changed from non-built-up to built-up during the 2005-2020 period. It clearly shows the increase of built-up areas in GKDA and the changes from non-built-up to built-up areas during the 2005-2020 period. In 2005, built-up areas were widely distributed and enclosed by the Mahaweli river. The city centre is mainly comprised of built-up land compared to other areas. In 2011, a gradual rise in built-up areas outside of city boundaries was seen, especially on the city's outskirts. The east part of the city

Figure 3: LULC maps of year 2005, 2011 and 2020



Source: Developed by author; based on LULC classification of Landsat TM/ETM imageries-2005, 2011,2020

sees the start of the development of built-up areas. After 9 years, in 2020, built-up areas have expanded in the whole study area, more than in previous years.

With the growth of the city, demand for land has increased. Therefore, some urban-related problems like traffic congestion, air pollution, lack of land, and an unaffordable cost of land occur. On the other hand, as a UNESCO-designated world heritage site, old archaeological buildings cannot be eliminated. Sensible environmental sites, including mountains and forests, cause the city to limit the space in which it can grow. These limitations cause the suburbanisation process of Kandy to accelerate. According to Uduporuwa (2015), after 2011, the suburbanization process of Kandy became more visible in Kandy. Figure 3 justifies the growth of suburbs after 2011.

The Greater Kandy Development Plan, which ran from 2008 to 2020, sought to alleviate urban congestion while simultaneously enhancing Kandy as a world heritage site. Governmental activities, academic institutions, medical facilities, Singhe regiment headquarters, the prison system, and local council facilities such as the Bogambara outer bus stand have already been relocated within the city limits, and UDA will begin moving them to areas outside of the city borders, such as Kundasale, Peradeniya, Katugastota, and Digana under this plan. When this plan is implemented, it will result in the urbanisation of Kandy expanding outwards to the Kandy city border. As a result, there can be an increase in built-up areas outside Kandy city in the 2011 and 2020 LULC maps. Under this plan, Kandy town has been designated as a cluster area for culture and tourism, Peradeniya as a clustered area for higher education, Katugastota as a clustered area for trade and commercial operations, and Kundasale and Digana as clustered areas for industrial and associated activities. Those areas show a high concentration of built-up areas in LULC maps.

LULC maps, clearly show how the city centre is growing as a cluster. Another cluster that can be identified is Peradeniya.

A large number of educational centres are located in the Peradeniya area. As a result, Peradeniya starts to grow as a cluster. The Pallekale area is another main cluster. Due to the industrial zone, this area is starting to grow. Currently, one can see a high concentration of built-up areas in this area. As shown in Table 5, according to the LULC changes in GKDA in 2005, the built-up area was 99.84 thousand hectares, covering 16.97% of the entire landscape. By 2011, it had grown to 127.6 hectares or 21.37% of the landscape. In 2020, it rose further, reaching 6.99 thousand hectares, or 40.04% of the total area. There was a net change in the built-up area of 27.77 thousand hectares in 2005–2011 (Table 5). The net change in a built-up area in GKA during the period 2011–2020 (Table 4) was a record of 111.41 thousand hectares. The average net change in the built-up area between the 15 years from 2005-2020 is 139.18 thousand hectares (Table 5). However, there is a decline in the number of water bodies. In 2005, it had an area of 7.08 thousand hectares or 1.3% of the land area covered by water. The amount has been reduced to 7.03 thousand hectares. The percentage reached 1.18 percent. By 2020, water bodies represented only 6.99 thousand hectares of lands or 1.17% of the total area. Due to the decrease in water bodies, the net change in water bodies reached -0.79 thousand hectares in 2005–2011. From 2011 to 2020, the net variation in water bodies was -0.04 thousand hectares. Consequently, the average net change in water bodies from 2005 to 2020 was -0.8 hectares. Water bodies change mostly as a result of encroachment in water body locations. Natural encroachments, as well as human encroachments, are both possible. Human encroachments, on the other hand, have a greater influence than natural encroachments. As a result, flash floods have taken over several parts of GKDA. Flash floods are widespread in the Yatinuwara, Akurana, and Poojapitiya DSDs due to the obstruction of the Mahaweli River and the building of unlawful structures together with adjacent land areas of water sources.

In 2005, 489.34 thousand hectares of land was non-built-up, and that fell to 462.36 thousand hectares or 77.5% in 2011. In 2020, it will continue to decline to 350.99 thousand hectares or 58.8% of the total area. It has been reduced up to 111.41 thousand hectares between 2011 and 2020. The net change of the non-built-up areas in 2005-2011 was -26.98 thousand hectares, and in 2011-2020 the net change was -111.4 thousand hectares. The net change in non-built-up area over the 15 years 2005–2020 is -139.2 thousand hectares.

Table 5: LULC changes in GKDA, 2005-2011

Land use categories	2005		2011		Net change		Annual change
	Hectares '000	Percent of total	Hectares '000	Percent of total	Hectares '000	Percent of 2005	
Water	7.8	1.3	7.03	1.2	-0.8	10.1	1.7
Non-built	489.3	81.7	462.4	77.5	-26.9	5.52	0.9
Built-up	99.8	16.9	127.6	21.4	27.8	27.8	4.6
Total	597	100	597	100			

Source: Based on 2005 and 2011 LULC maps

Table 6: LULC changes in GKDA (2011-2020)

Land use categories	2011		2020		Net change		Annual change
	Hectares '000	Percent of total	Hectares '000	Percent of total	Hectares '000	Percent of 2011	
Water	7.0	1.2	6. 9	1.2	-0.04	0.5	0.6
Non-built	462.4	77.5	350.9	58.8	-111.4	24.1	2.7
Built-up	127.6	21.4	239.0	40.0	111.4	87.3	9.7
Total	597	100	597	100			

Source: Based on 2011 and 2020 LULC maps

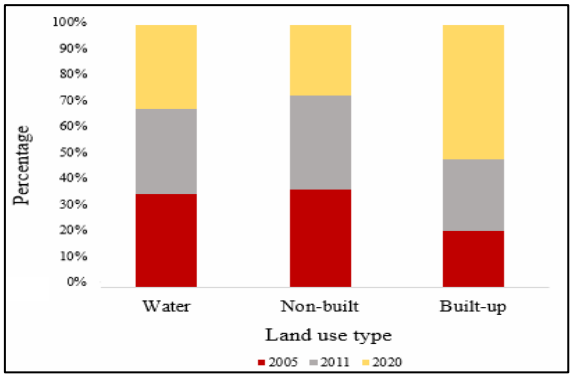
Table 7: LULC changes in GKDA (2005-2020)

Land use categories	2005		2020		Net change		Annual change
	Hectares '000	Percent of total	Hectares '000	Percent of total	Hectares '000	Percent of 2011	
Water	7.8	1.3	6.9	1.2	-0.8	10.6	0.8
Non-built	489.3	81.7	350.9	58.8	-138.4	28.3	1.9
Built-up	99.8	16.9	239.0	40.0	139.2	139.4	9.2
Total	597	100	597	100			

Source: Based on 2005 and 2020 LULC map

According to Figure 4, the percentage change in water bodies in the GKDA is not significantly verified. But there is a gradual decrease in non-built-up areas in GKDA. In 2005 and 2011, non-built-up areas covered a comparatively larger land extent. However, when compared with the other two classes, non-built-up areas cover the smallest land extent in 2020. The lowest percentage of built-up area can be observed in 2005. There is a gradual increase in the expansion of the built-up area, and by 2020, close to 50% of the increase in the built-up area is visible. When population growth happens in the city boundary areas, changes in land cover and land usage can be seen. These changes are visible in the LULC maps (Figure 3).

Figure 4: Land use changes of GKDA as a percentage in 2005, 2011 and 2020



Source: Developed by author; based on 2005, 2011 and 2020 LULC maps

As Masakorala and Dayawansa (2015) mentioned in 2015, LULC maps clearly demonstrate GKDA's great growth in the built-up areas and reduction of non-built-up areas. The extent of non-built-up areas has been replaced by the expansion of built-up areas. Non-built-up regions, for example, have decreased from 81.7% in 2005 to 58.79% in 2020. The increase in built-up from 16.97% in 2005 to 40.04% has replaced that reduction of non-built-up in 2020.

Change matrix

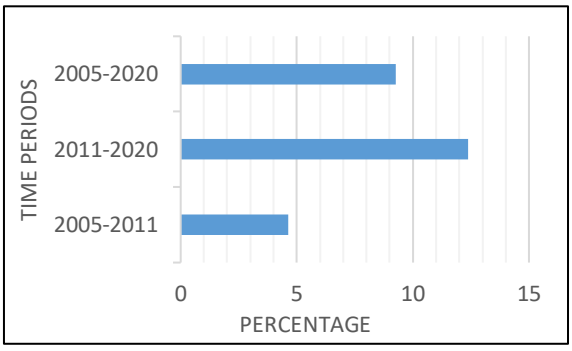


Figure 5: Increment of built-up area

Source: Developed by author; based on 2005, 2011 and 2020 LULC maps

Table 8 shows that 6.98 thousand hectares of land area occupied by water bodies in 2005 remained till 2011. In 2005, 0.34 thousand hectares of water bodies were converted to non-built-up areas. Among them in 2011, 0.49 thousand hectares of water bodies were converted to built-up areas or urban areas. In 2005, 0.01 thousand hectares of non-built-up areas were converted to aquatic areas. In 2011, 0.01 thousand hectares of non-built-up areas were turned into water bodies. 450.33 thousand hectares of non-built-up areas in the year 2005 remained the same till 2011. 38.99 thousand hectares of built-up area or urban land in 2011 were non-built-up areas in 2005. 0.03 thousand hectares of built-up land in 2005 became water bodies in 2011, while 11.69 thousand hectares of built-up land became non-built-up land in 2011. In 2005, 88.11 thousand hectares of land were built-up lands, and in 2011, 88.11 thousand hectares of land remained built-up.

Table 8: Change matrix of 2005-2011

2005	2011		
	Water ('000 ha)	**Non-built ('000 ha)**	**Built-up ('000 ha)**
Water	6.98	0.34	0.49
Non-built	0.01	450.33	38.99
Built-up	0.03	11.69	88.11

Source: Based on 2005 and 2011 LULC maps

Between 2011 and 2020, 6.68 thousand hectares of land that was water bodies in 2011 had remained as water bodies in 2020. However, according to Table 9, 0.03 thousand hectares of non-built-up land area and 0.03 thousand hectares of water bodies in 2011 were converted to built-up areas in 2020. 346.83 thousand hectares of non-built-up areas in 2011 remained non-built-up areas in 2020. Conversely, in 2020, 0.03 thousand hectares of land have become water bodies, and 115.23 thousand hectares have become built-up areas. Only 4.12 thousand hectares of built-up land are converted to non-built-up land by 2020, while 123.48 thousand hectares of land stays built up. In the period 2011–2020, no portion of the built environment changed to aquatic bodies.

Table 9: Change matrix of 2011-2020

2011	2020		
	Water ('000 ha)	**Non-built ('000 ha)**	**Built-up ('000 ha)**
Water	6.68	0.03	0.03
Non-built	0.3	346.83	115.23
Built-up	0	4.12	112.48

Source: Based on 2011 and 2020 LULC maps

When taking the 15 years of GKDA, there is a huge change in land-use. According to the change matrix in Table 10, 6.64 thousand hectares of water bodies of 2005 will remain as water bodies in 2020. However, 0.37 thousand hectares of water bodies in 2005 were converted into non-built-up areas by 2020. In 2020, 0.8 thousand hectares of water body areas will be converted to built-up areas. 334.79 thousand hectares of non-built-up areas in 2005 remained non-built-up in 2020, while 0.31 thousand hectares of non-built-up area converted to water areas and 154.23 thousand hectares converted to built-up areas. 0.03 thousand hectares of built-up areas in 2005 were converted into water bodies, and 15.82 thousand hectares of built-up areas were non-built-up in 2020. As of 2005, 83.98 thousand hectares of built-up areas remained built-up in 2020.

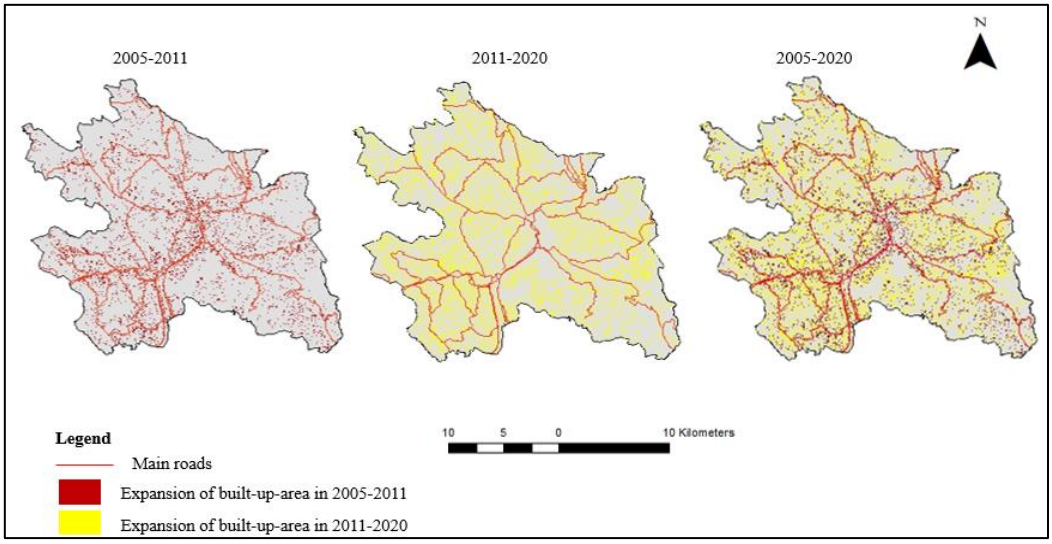
Table 10: Change matrix of 2005-2020

2005	2020		
	Water ('000 ha)	**Non-built ('000 ha)**	**Built-up ('000 ha)**
Water	6.64	0.37	0.8
Non-built	0.31	334.79	154.23
Built-up	0.03	15.82	83.98

Source: Based on 2005 and 2020 LULC maps

Figure 6 clearly shows that between 2005 and 2011 built-ups are spread along the main roads. Then after 2011 they started to further grow inwards. Therefore, as usual, in many Sri Lankan cities, GKDA also shows a linear growth pattern. Due to the obvious great need for development activities on both sides of main roads, there is a large concentration of built-up areas along main roads. A9 (Kandy-Jaffna), A26 (Kandy-Mahiyanganaya), A1 (Katugastota-Kurunegala), and B413 (Katugastota-Kurunegala) (Raja Mawatha) in particular. Along the Kandy-Digana, Kandy-Peradeniya, and Akurana-Alawathugoda routes, the most noticeable expansion can be seen. The high density of built-up areas can be seen along the Kandy-Peradeniya Road due to the presence of most educational, health, and administrative facilities. The Kandy-Katugastota route has seen a significant increase in trade business operations and, therefore, increasing built-up areas along that road. This pattern can be identified especially within the Mahaiyawa area.

Figure 6: Pattern of urban expansion in GKDA area



Source: Developed by author; based on LULC classification of Landsat TM/ETM imageries

Results of accuracy assessment

The accuracy assessment of each year is presented in Table 9, Table 10, and Table 11. The overall accuracy of 88.16percent, 90.34 percent, and 92.69 percent in 2005, 2011 and 2020 respectively. Thus, resultant images were employed for further analysis.

Table 11: Error matrix for the classification 2005 LULC map

Classified data	Reference data			Total	User's accuracy
	Built	**Non-built**	**Water**		
Built	12	5	0	17	70.58 %
Non-built	5	77	0	82	93.90 %
Water	0	0	1	1	100 %
Total	17	82	1	100	
Producer's Accuracy	70.58 %	93.90 %	100 %		

Overall accuracy: 88.16 percent

Source: Developed by author; based on LULC classification of Landsat TM/ETM imageries

Table 12: Error matrix for the classification 2011 LULC map

Classified data	Reference data			Total	User's Accuracy
	Built	Non-built	Water		
Built	18	5	0	23	78.82 %
Non-built	5	70	0	75	92.20 %
Water	0	0	2	2	100 %
Total	23	75	2	100	
Producer's Accuracy	78.82%	92.20%	100%		

Overall accuracy: 90.34%

Source: Source: Developed by author; based on LULC Classification of Landsat TM/ETM imageries

Table 13: Error matrix for the classification 2020 LULC map

Classified data	Reference data			Total	User's Accuracy
	Built	Non-built	Water		
Built	22	13	0	35	62.85 %
Non-built	1	61	0	62	98.38 %
Water	0	0	3	3	100 %
Total	23	74	3	100	
Producer's Accuracy	95.65 %	82.43 %	100 %		

Overall accuracy: 92.69%

Source: Developed by author; based on LULC classification of Landsat TM/ETM imageries

CONCLUSION

As a result of population growth occurring inside the city limits, changes in land cover and land-use may be seen. These modifications may be seen on the LULC maps. It reflects GKDA's tremendous expansion in the urbanized region. Because of the rise of urbanization, the amount of non-built-up land has been replaced by the extension of developed land. As an example, the proportion of non-built-up areas has declined from 81.7% to 58.79% in 2020. By 2020, the increase in built-up area from 16.97% to 40.04% will have completely compensated for the decline in 2005 to 20%.

When the British started to govern the Kandyan kingdom, forests covered a quarter of the present Kandy city area, a figure that has now dropped to 52% after the country's independence from Britain. In 2019, forests cover just 11% area of the city. At the start of the twentieth century, forests, shrublands, lake conservation, barren lands, wetlands, and agricultural regions, including rice fields, occupied about 75% of the land area in the Kandy Municipal area.

The majority of changes in water bodies occur as a consequence of encroachment on their boundaries. Both natural and human encroachments are conceivable, and both are detrimental. Human encroachments, on the other hand, have a higher impact on the environment than natural encroachments do. As a consequence, flash floods have engulfed various areas of the GKDA. Flash floods are widespread in the Yatinuwara, Akurana, and Poojapitiya DSDs, mostly due to the blocking of the Mahaweli river and the building of unlawful structures in parallel land areas with water sources.

The demand for land has grown as a result of the city's expansion. As a result, several urban-related issues, such as traffic congestion, air pollution, a scarcity of land, and an exorbitant cost of land, might arise. Examples include: on the other hand, ancient archaeological monuments cannot be demolished since the city has been designated as a UNESCO World Heritage Site. According to the World Heritage Committee, out of 490 historical structures, 79% of heritage buildings are located in the city centre. Sensible environmental features, such as mountains and woods, force the city to restrict the amount of territory that it may expand into. As a result of these restrictions, the suburbanization of Kandy is speeding up rapidly. Several researchers, including Uduporuwa (2014), have noted that the suburbanization trend in Kandy has been increasingly noticeable in the city since 2011.

According to the Greater Kandy Development Plan, which was created for the years 2008–2020, it was intended to reduce urban congestion while simultaneously promoting Kandy as a UNESCO World Heritage site. As mentioned above, administrative offices, educational centres, hospitals, Singhe regiment headquarters, Bogambara prisons, and municipal facilities such as the Bogambara outer bus stand are already located within the city limits, and under this plan, the Urban Development Authority (UDA) will begin relocating them outside the city limits to sub-towns such as Kundasale, Peradeniya, Katugastota, and Digana, among others. As a result of the execution of this plan, the urbanisation of Kandy will continue to spread outwards until it reaches the city border. As a consequence, you will notice a rise in the number of built-up regions outside of Kandy city on the LULC maps between 2011 and 2020. The changes that have occurred in the eastern section of the study region

have received considerable attention. This is mostly occurring as a result of the industrial zone's geographic position in Pallekale.

Due to the high demand for development activities on both sides of major roads, there is a significant concentration of built-up regions along major roads, particularly in urban areas. Particularly popular routes are the A9 (Kandy-Jaffna), the A26 (Kandy-Mahiyanganaya), the A1 (Katugastota-Kurunegala), and the B413 (Katugastota-Kurunegala) (Raja Mawatha). The most significant increase may be observed along the Kandy-Digana, Kandy-Peradeniya, and Akurana-Alawathugoda roads, which are all in the province of Kandy. Because of the presence of the majority of educational, health, and administrative institutions along the Kandy-Peradeniya route, there is a high density of built-up regions along this stretch of road. As a result of this expansion, trade and business activities along the Kandy–Katugastota route have increased significantly, resulting in an expansion of the built-up regions along that route. This pattern can be seen in the Mahaiyawa region in particular.

It is also possible to detect certain clustering tendencies in some places. The GKDP anticipated a development plan with a clustered pattern of development (2008–2020). Kandy town has been designated as a clustered development area for culture and tourism, while Peradeniya has been designated as a clustered development area for higher education, Katugastota has been designated as a clustered development area for trade and commercial operations, and Kundasale and Digana have been designated as clustered development areas for industrial and related activities, respectively. As a consequence, certain places have a high concentration of built-up areas as a result of their location. The development of Kandy city as a cluster may be seen on the land use map and the urban level map, which are both available online. The LULC maps clearly demonstrate how the city core is developing as a concentration of businesses. Peradeniya is another cluster that may be recognized on the map. Peradeniya has a great number of educational facilities, which are spread around the city. As a consequence, the city of Peradeniya begins to develop into a cluster. Another important cluster is located in the Pallekale region. This region is beginning to develop as a result of the presence of an industrial zone. This region currently has a high concentration of built-up areas, which can be seen across the city.

Due to the rapid urbanization of the GKDA, several social and environmental difficulties have arisen, including excessive traffic congestion, land mismanagement, and air pollution, which is a consequence of poorly built structures. GKDA is situated in a region that is described as "The Central Fragile Region" in the national physical plan 2030 and has been included in the protected area network to stress the significance of the region in maintaining the country's water supplies. Certain towns will continue to exist in this land, but the development and extension of these settlements will be strictly regulated. It has been acknowledged that Kandy, in particular, has grown into a metropolis whose growth and development should be overseen and governed. The future pattern of urban development, however, may dictate that urban expansion will prevail outside of the city limits, which might include extending the city's boundaries or growing the city outside of the city limits.

The terrain of the Greater Kandy Development Area determines the form of urbanisation in the area since it is designed to discourage urban expansion. The bulk of KMC's urbanized areas is concentrated in the city's central business district. The steep terrain that surrounds the city centre has been increasingly urbanized in recent years. A variety of structures, including hotels and residences, may be found scattered around the hills.

A long and thin pattern of development arises along major highways and in the area of suburban centres, resembling the typical sprawl pattern. In recent years, the spread of urban sprawl and ribbon development along vital transportation corridors has resulted in a slew of urban challenges, including mismanagement of land use.

As a result, the city centre of Kandy has a high concentration of socio-economic activity, which results in traffic congestion and pollution. Rural economies, on the other hand, are experiencing economic stagnation as a result of the underutilisation of their natural resources. It is necessary to decentralise some urban functions in the city centre to the cluster cities of Katugastota, Peradeniya, and Kundasale-Digana, and to relocate some urban functions in the city centre to the cluster cities of Peradeniya, Peradeniya, and Kundasale-Digana to the city centre and promote economic activities in Greater Kandy by linking them to local industries.

As part of the national physical plan 2030, GKDA is situated in a region referred to as "The Central Fragile Region." As a result, it has been designated as a protected area to stress its significance in maintaining the country's water supplies. Certain towns will continue to exist on this land, but the development and extension of these settlements will be strictly supervised. It has been noted that Kandy, in particular, has grown and developed in a way that has to be monitored and managed. However, if the present growth is continuous, shortly, Kandy can be identified as the second unbound city in Sri Lanka. There is a high potential for Kandy city to grow exceeding its boundary. Therefore, there is a special need for a new policy to further control the growth of the city.

It is critical to correctly define the environmentally sensitive regions and to improve the rules in place to prevent encroachment and development activities. Among other things, the upper Mahaweli river catchment region in the Akurana area has become a severely degraded environment, with urban flooding being the predominant hazard in this area. A major contributing factor to this phenomenon is the presence of unlawful encroachments on riverbanks.

Another crucial task is to keep track of the development of cities. Sri Lanka, like the vast majority of nations throughout the globe, lacks adequate monitoring of urban expansion. It may be possible to solve a variety of urban-related challenges by keeping track of even big cities' development for at least once in 10-year period in the future.

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