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Facilitating Evidence-Based Medicine through Empirical Studies and Systematic Reviews: Librarians as Research Catalysts

D.C. Kuruppu¹

INTRODUCTION

Evidence-based practice (EBP) is recognized as a tool for decision-making across various scientific fields. This is highly associated with formulating policies and developing practice guidelines, ensuring the integration of the best available research evidence, clinical expertise, and stakeholder perspectives. Medical and Health Science librarians have been described as researchers who actively contribute to the growth of evidence-based medicine because they facilitate access to relevant and quality information, including studies and reviews. The collaborative effort between them, the clinicians, and researchers is very important as it ensures that the best evidence is used to make clinical decisions that lead to better patient care and advancement in science. They are involved in gathering research evidence and applying study designs and methodologies for research, including critical appraisal of evidence. Their role is crucial in enhancing the application of research in clinical practice and persuading practitioners to rely on evidence disseminated through clinical specialities.

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Librarians' Role in Facilitating Evidence-Based Medicine through Empirical Studies

The evolving role of medical librarians is increasingly recognized as being an integral part of healthcare and biomedical research teams, particularly in supporting Evidence-Based Medicine (EBM). Healthcare librarians contribute specialized expertise in information retrieval, critical appraisal, and data management, which are vital in both clinical and research settings. According to the 'Informationist' conference hosted by the National Library of Medicine (2002), librarians/informationists in research teams ensure access to high quality, relevant information that directly supports decision-making and research processes. Their role extends beyond traditional library services, as they actively engage in the research workflow, enhancing the quality and applicability of empirical studies in EBM (Shipman et al., 2002). This widened role highlights the essential contribution of medical librarians in advancing healthcare practices and outcomes through evidence-based research.

My contribution to the EBM movement is portrayed through an empirical research study on assessing the information needs of Breast Cancer (BC) patients in Sri Lanka. There is a scarcity of such studies, especially in developing countries. This study is however in-line with EBM's principles where clinical care and the best evidence is combined in the process of delivering healthcare through the identification of patients' knowledge gaps with respect to screening, diagnosis and treatment modalities. The construction of a patient-specific educational toolkit highlights the relevance of patients' preferences in healthcare practices, a core aspect of EBM. This research not only provided a great deal of evidence required for planning

educational activities but also contributed to increasing patient participation and optimizing health metrics, demonstrating how information specialists enhance the spread of EBM.

Empirical study conducted by the author¹: “An assessment of informational needs of BC patients and adults in the general public on breast cancer: screening, diagnosis and treatment modalities, and the effectiveness of a tailor-made information package for patients in Sri Lanka”.

Importance of this study

BC is known as a common yet emotionally traumatic disease. In addition to its clinical impact, it also raises significant psychological and social concerns. Understanding the real informational needs of BC patients is crucial for providing comprehensive healthcare. Nutbeam (2000) recognized that health literacy is a key factor in promoting health and preventing disease. It was also acknowledged in Sri Lanka and in health education forums as a fundamental component of any health service package (Vithana et al., 2013). Earlier, the educational materials were developed based on healthcare professionals' own perceptions. However, currently, there is more emphasis on understanding clients' perceptions of their informational needs and the importance they place on them when designing more effective health education materials.

Similar to European countries and the USA, BC I incidences and mortality rates in Sri Lanka increase with age, especially among women over 40 (National Cancer Control Programme Sri Lanka, 2015). It is widely

¹Kuruppu, DC (2017). An assessment of informational needs of Breast Cancer (BC) among patients and adults in the general public: screening, diagnosis and treatment modalities, and the effectiveness of a tailor-made information package for patients in Sri Lanka [Doctoral Thesis, Faculty of Medicine, University of Colombo]

accepted that knowledge plays a vital role in shaping health-seeking behaviours. Studies in Sri Lanka have revealed that awareness of BC among adults is less than satisfactory (Ranasinghe et al., 2013). For instance, a study by Seneviratne et al. (2016) found that awareness of BC symptoms and detection methods among female undergraduates at the University of Moratuwa was also insufficient. Even though some knew about breast self-examination as a method for early detection, few understood the correct technique. This indicates a significant gap in awareness and the need for comprehensive health education interventions. Specifically, assessing the public's information needs concerning BC and their perceived importance is vital for improving health education strategies. Ideally, these needs should be evaluated using locally validated tools to ensure that the educational interventions are relevant and effective. Previous studies have reported that information needs related to cancer can be broadly categorized into cognitive and affective types. Cognitive information needs to focus on factual knowledge about cancer prevention, detection, and treatment. On the other hand, affective needs pertain to emotional support in coping with cancer (Johnson & Meischke, 1991).

Our study evaluated cognitive information needs regarding BC prevention, detection, and treatment among adults in the public and the perceived importance of this information. The results aim to assist health educators in designing effective educational tools, targeting the right content and demographic groups to improve BC knowledge among the public. Considering the importance of this research project highlighted above, the Research & Higher Degree Committee of the Faculty of Medicine, University of Colombo, approved the research project after reviewing it with three subject specialists. Then, ethical clearance for the research project was obtained from

the Ethics Committee of the Faculty. This process directly and indirectly supports protecting participants, maintaining research integrity, ensuring legal and institutional compliance, enhancing credibility, minimizing risks, etc. Administrative approval from each institution where the data collection occurred was taken before starting data collection from each study setting. Research that receives ethics approval is more likely to be accepted for publication in reputable journals, as many publishers require ethical clearance. It also improves the credibility of the findings among peers and the public. In that way, without obtaining ethics approval, publishing the findings in reputable, indexed journals in the Web of Science is impossible. Research Grant for this study received from the University of Colombo is gratefully acknowledged on this occasion.

The research project was laid down into four phases as follows.

Phase I: A community-based cross-sectional study to assess the knowledge, practice, attitude/belief, and perceived importance of information required on BC among adults in the general public and to identify the preferred information sources.

Phase II: Development of a locally appropriate and customized instrument to assess the informational needs of BC Patients of Sri Lanka and a study to validate it.

Phase III: A Hospital-based study to assess the information needs of BC patients, and to identify the preferred sources of Information on BC.

Phase IV: Development and implementation of an educational package to fulfil the informational needs of BC Patients and to assess its effectiveness.

The first part of this research study was conducted in Colombo District in Sri Lanka using adults in the general public. The rest of the study was conducted at Apeksha Hospital, formerly the National Cancer Institute in Maharagama, Sri Lanka. The study sheds light on the above-mentioned needs, offering insights that can be used to uplift patient care and education. As the principal investigator, the fundamentals of study initiation were grasped and successfully launched as a research proposal. In conducting in-depth research on the topic, the purpose of the study, objectives, and research questions was defined and discussed with high-caliber research academics attached to the Faculty of Medicine at the University of Colombo. The Principal Investigator collaborated closely with other members of the research team at each stage of the study. These collaborators provided critical guidance and support in their roles as supervisors and advisors, ultimately contributing as co-authors in disseminating the research findings globally. The team included a Community Physician, an Endocrinologist from the Faculty of Medicine, and an Oncology Surgeon from the National Cancer Institute, Maharagama, Sri Lanka. With their expert guidance throughout the research process, the study successfully culminated in the development of a validated, tailor-made information package for BC patients in Sri Lanka.

As the principal investigator, I am proud to announce that this research project was recognized and awarded the ***‘Certificate of Excellence for the Innovative Project’ at the ‘National Symposium on Best Practices for Innovations on Cancer Prevention, Control & Palliative Care 2018’, organized by the ‘National Cancer Control Programme, Ministry of Health, Nutrition, and Indigenous Medicine’, held on 14th December 2018.***

Furthermore, the findings from Phase III of this study were published in a journal indexed in Web of Science², contributing to the scientific literature, and forming a basis for further discussion.

Objective and Methodology

The primary objective of this study was to assess the information needs of BC patients. A hospital-based cross-sectional study design was employed at the National Cancer Institute (NCI) Maharagama, Sri Lanka.

The Study population consisted of female BC patients and was selected using the inclusive and exclusive criteria of the study. The inclusion criteria were 1. Subjects were diagnosed within the period of one year prior to the study. 2. Subjects not having major mental health problems affecting their ability to respond to an interviewer-administered questionnaire. Exclusive criteria were 1. Patients having mental health problems. 2. Those who have participated in the development of the tool: Sri Lankan Information Needs Assessment Questionnaire for BC (SINAQ-BC) 3. Medical Professionals. The sample size for the cross-sectional descriptive study was calculated using the standard formula (Lwanga & Lameshow, 1991). A non-probability and consecutive sampling technique was used as the most feasible and appropriate technique to recruit study units.

To achieve this, the researchers employed an instrument that incorporated all the different sections. Section 1: Socio-demographic information; Section 2: validated tool (SINAQ-BC) (Kuruppu et al., 2017);

²Kuruppu DC, Wijeyaratne CN, Gunawardane N, Amarasinghe I. (2020). Assessment of Information Needs of Patients with Breast Cancer: A Hospital-Based Study in Sri Lanka. *Asia Pac J Oncol Nurs.* 7(4), 375-381. doi:10.4103/apjon.apjon_23_20.

Section 3: Level of the fulfilment of information needs on BC at the time of the survey; Section 4: Preferred sources of information on BC. Data was collected at the clinics from 8.00 am to 12.00 noon and at the wards from 1.00 pm to 4.00 pm with prior approval from the Director /NCIM and the Consultant Oncologists.

Key Findings

This study found that all BC patients expressed a strong need for information, with their highest priority on disease, treatment, and psychosocial services, aligning with European studies. Information needs peak during radiotherapy, especially at the first consultation with the radiation oncologist. Providing clear information during this period improves patient satisfaction and reassuring about the safety of treatments.

Younger women and those with higher education levels exhibited significantly greater information needs, particularly regarding treatment options, disease progression, and chemotherapy side effects. Age and education were the primary factors influencing information-seeking behaviours, with younger patients seeking more detailed, factual information compared to older patients, who often had fewer demands.

Though topics like contraception and sexual activity were not rated as highly important in this study, prior research has shown that patients are open to receiving counselling on fertility, contraception, and menopause. Culturally appropriate educational materials addressing these diverse needs are essential to optimize care.

With the increasing empowerment of younger, educated women in South Asia, healthcare systems must adapt to meet their growing demand for

information, particularly through tailored educational packages that support treatment decision-making and enhance overall patient satisfaction.

Demographic Insights

A significant finding was the variation in information needs based on age and education level. Younger women, particularly those aged 37 and below, demonstrated notably higher information needs. This may be attributed to greater access to digital information sources and a more proactive approach to health management among younger demographics.

Similarly, women with higher education levels demonstrated a greater demand for information. This correlation highlights the role of educational background in shaping patients' health information-seeking behaviours. Educated patients may possess the skills to seek, process, and understand complex information, leading to a greater need for detailed knowledge.

Conclusions and Implications

The study's conclusions highlight the necessity for tailored educational interventions in healthcare settings. The diverse information needs of patients, shaped by factors such as age and education, should be considered in developing educational packages. Specifically, such resources should cater to the unique requirements of younger women and those with higher educational qualifications.

This research project was finally transformed into an appropriate educational package (Kuruppu, 2017) that focuses on the informational requirements of BC patients in Sri Lanka. This package was developed based on the results obtained through various phases of the study about awareness and sources of information on BC among the public and patients.

Future Directions

Incorporating these findings into healthcare practices is essential moving forward. Hospitals and cancer care centres should consider establishing dedicated information hubs to support groups that address the specific needs highlighted in the study. In addition, leveraging technology, like mobile apps and online platforms, can facilitate access to information and support for patients beyond the hospital setting.

In conclusion, understanding and catering to the information needs of BC patients is a crucial step towards holistic care. By listening to and acting upon the distinct needs of various patient groups, healthcare providers can significantly uplift the quality of care and support offered to those confronting the complexities of BC. This study from Sri Lanka offers valuable insights that could inform both local and global healthcare strategies, fostering a more informed and supported patient community.

Librarians' Role in Facilitating Evidence-Based Medicine through Systematic Reviews

As medical librarians, we play a pivotal role in conducting systematic reviews. Spencer et al. (2018) identified eighteen (18) different roles of librarians in conducting systematic reviews, such as planning, question formulation, searching, source selection, de-duplication of search results, citation management, evaluation of search strategies, search filters and hedges, grey literature searching, peer review of search strategies, reporting and documentation, collaboration, data extraction, critical appraisal, document supply, helping with technological and analytical tools, teaching, and demonstrating impact and outcomes.

Librarians are highly trained in information retrieval, curation, and dissemination of information, allowing them to help healthcare professionals access a vast range of peer-reviewed journals, research databases, and specialized repositories. Systematic reviews and empirical studies form the backbone of EBM/EBP as they synthesize research findings and provide a comprehensive view of available evidence. By making this information accessible through effective search strategies, librarians ensure clinicians and researchers can find the latest and most relevant research findings. For example, systematic reviews often rely on complex search strategies to locate studies from databases such as PubMed, Cochrane Library, CINAHL, SCOPUS, EMBASE, Web of Science, and PsycINFO. Librarians use their expertise in designing and conducting comprehensive literature searches, ensuring that reviews are comprehensive and evidence-based. According to studies, involvement of librarians in the systematic review process improve the quality of search strategy, yield more accurate and exhaustive results, thus enhancing the reliability of the research findings (Beverley et al., 2003).

While assisting with systematic literature searches, librarians also collaborate actively in research teams. This is commonly seen in systematic reviews. Assistance in formulating research questions, identifying research evidence relevant to a specific study, and demarcating inclusion and exclusion criteria are some of the most important tasks carried out by librarians. Their input is essential in producing a comprehensive framework for a study, reducing bias and improving reliability. This indispensable role of librarians in systematic reviews is often acknowledged by recognizing them as co-authors of the research study.

A study by Rethlefsen et al. (2015) showed that systematic reviews involving a librarian had more precise and reproducible search strategies. The overall quality has always been improved due to the involvement of librarians. It is also proved through the guidelines developed for systematic reviews, such as 'PRESS Peer Review of Electronic Search Strategies: 2015 Guideline Statement' developed by McGowan et al. (2016), which emphasizes the significant role of an information specialist or librarian in systematic review teams, predominantly for the literature search process, ensuring thorough and accurate search strategies.

As mentioned by Spencer and Eldredge (2018), medical librarianship involves the utilization of specialized software tools that enhance the review process. Tools such as EndNote and Mendeley assist in eliminating duplicate entries, while Rayyan facilitates blind reviewing in collaboration with the research team. The analysis of the resulting data often involves advanced tools such as R (with 'meta' or 'metafor' packages), Stata, Review Manager, and Comprehensive Meta-Analysis (CMA). These tools employ explicit and systematic methods designed to minimize bias, such as Risk of Bias (RoB2), thus generating more reliable findings that inform decision-making processes (Antman et al., 1992; Oxman & Guyatt, 1993).

I recall attending my first workshop on systematic reviews, held at the Faculty of Medicine, University of Colombo, conducted by authorities from the Cochrane Library Review. This workshop comprehensively explains how empirical evidence related to a specific problem is collated in systematic reviews to address a particular research question. During the workshop, the critical role of librarians in systematic reviews was emphasized, underscoring the unique advantage they would have as integral members of research teams.

I would like to highlight the systematic reviews conducted in collaboration with esteemed faculty members. As a medical librarian, I ensured the rigour of literature searches, managed databases, and facilitated the inclusion of high-quality studies. My expertise in information retrieval enhanced the accuracy and comprehensiveness of these reviews, effectively bridging the gap between clinical practice and academic research and raising the standards of evidence-based medicine. Through the synthesis of extensive datasets, our reviews provided critical insights that guided clinical decision-making.

These systematic reviews, conducted in partnership with academic staff from the Faculty of Medicine, University of Colombo, and clinicians from government hospitals in Sri Lanka, would ultimately help improve patient care and advance medical knowledge.

High-Pressure Chronic Urinary Retention (HPCR)³

Objectives and Methodology

Today, we delve into a critical yet under-explored medical condition: high-pressure chronic urinary retention (HPCR), as discussed in the *Journal of Clinical Urology*. Despite being a relatively common condition, awareness of its clinical characteristics remains limited, often leading to delayed diagnoses and suboptimal treatment outcomes. This systematic review seeks to underscore the clinical features and outcomes associated with HPCR, with

³Madhushankha M, Jayarajah U, Kuruppu C, Goonewardena SA, Abeygunasekera AM. Clinical characteristics and outcome of high-pressure chronic urinary retention: A systematic review. *Journal of Clinical Urology*. 2022; 15(3):204-212. doi:10.1177/2051415821993741

the goal of assisting healthcare professionals in timely diagnosis and deciding on interventions.

As research facilitators, librarians play a key role in disseminating knowledge and ensuring access to essential information, which is crucial for addressing conditions like HPCR. This review conducted a comprehensive literature search across multiple databases, including PubMed, Scopus, and EMBASE. All search results were uploaded to Mendeley to remove duplicates, and the Rayyan application was employed to carry out a blind review with team members to systematically include or exclude studies based on their relevance. A coding system was then used to identify key features of HPCR, which were later analyzed statistically, providing a qualitative overview of the condition.

Key Findings

Eight studies with 271 patients were identified. The average age was 66 years, predominantly affecting males. The major common symptoms were a tense, painless bladder noted in nearly all cases. The most frequent cause was benign prostatic hyperplasia, followed by prostatic malignancy. Treatment outcomes were positive when the underlying cause was addressed, demonstrating the importance of accurate diagnosis and management.

Conclusions and Implications

Awareness of the clinical signs of HPCR leads to timely diagnosis and effective treatment options, which highlights the need for in-depth knowledge of the disease among healthcare providers. Key clinical indicators such as nocturnal enuresis and treatment-resistant hypertension should alert clinicians of the possibility of HPCR. Diagnostic imaging and blood tests further support

this diagnosis. Successful management hinges on addressing the underlying cause, with careful bladder decompression yielding improved cardiovascular and renal outcomes.

This study underscores the importance of awareness and early detection. By facilitating access to critical research findings, librarians play a key role in empowering healthcare professionals to target enhanced patient care and outcomes. In conclusion, continuing our knowledge dissemination and research collaboration efforts is essential, particularly in addressing conditions like HPCR. Through well-informed research and practice, we can make a significant impact on healthcare.

Vitamin D and COVID-19⁴

Objectives and Methodology

This study examined the key role of vitamin D during the COVID-19 pandemic. It aimed to investigate whether vitamin D deficiency or insufficiency increases susceptibility to COVID-19, affects its severity, and influences mortality. Furthermore, it explored the potential therapeutic role of vitamin D in treatment. As a medical librarian, I was fortunate to join a research group dedicated to this initiative.

As the information specialist within the research group, I developed and finalized the data collection strategy, utilizing multiple databases: CINAHL, Cochrane Library, EMBASE, PubMed, Scopus, and Web of

⁴Dissanayake HA, de Silva NL, Sumanatilleke M, de Silva SDN, Gamage KKK, Dematapitiya C, Kuruppu DC, Ranasinghe P, Pathmanathan S, Katulanda P. (2022). Prognostic and Therapeutic Role of Vitamin D in COVID-19: Systematic Review and Meta-analysis. *J Clin Endocrinol Metab.* 107(5), 1484-1502. doi:10.1210/clinem/dgab892.

Science. We retrieved articles from the databases ‘from its inception to 30th May 2021. The search strategy included terms such as COVID-19, vitamin D deficiency, severe acute respiratory syndrome, treatment, and randomized controlled trials. Articles written in languages other than English were excluded. All references were uploaded to the Mendeley Reference Management tool, and duplicates were removed. The remaining references were uploaded to the Rayyan web application. Two authors conducted the study selection process independently, with conflicts resolved by a third author.

Key Findings

Out of 1,877 search results, 76 studies met the inclusion criteria. A meta-analysis of 72 observational studies involving nearly 2 million individuals revealed that vitamin D deficiency or insufficiency significantly increased the odds of contracting COVID-19 and developing severe disease. The data indicated lower levels of 25-hydroxy vitamin D in COVID-19 patients compared to controls, with even lower levels observed in those with severe cases or who did not survive. Vitamin D deficiency was linked to an increased risk of COVID-19 and severe disease. However, the association with mortality was less robust due to the high risk of bias and heterogeneity across studies.

Conclusions and Implications

While the findings suggest a link between low vitamin D levels and increased susceptibility to and severity of COVID-19, the evidence concerning mortality is less convincing. The high heterogeneity in the data limits the ability to draw definitive conclusions, underscoring the need for further research. However, the findings emphasize vitamin D's potential role in

reducing the severity of COVID-19, highlighting the importance of further studies to clarify its impact on mortality. This study underscores the importance of maintaining optimal vitamin D levels for potential protective effects against COVID-19.

As librarians, our role in ensuring access to critical research during global crises is vital. By providing relevant and reliable information to healthcare professionals, we support informed decision-making and contribute to improved public health outcomes. Moving forward, we must continue to serve as research catalysts, bridging the gap between knowledge and practice and empowering communities during global challenges such as COVID-19.

Ladies and Gentlemen,

Now I would like to describe a topic that underscores the crucial role librarians play in connecting research to practice ‘The intricate relationship between childhood constipation and exposure to stress’.

Childhood Constipation and Stress⁵

Objectives and Methodology

Constipation in children is often overlooked and significantly associated with stressful events. This systematic review investigates various stressors that affect the development of constipation in children and adolescents. We explored the complicated relationship between childhood

⁵Liyanarachchi H, Rajindrajith S, Kuruppu C, Chathurangana P, Ranawaka R, Devanarayana NM, Benninga MA. (2022). Association between childhood constipation and exposure to stressful life events: a systematic review. *NeurogastroenterolMotil.* 2022, 34(4), e14231. doi: 10.1111/nmo.14231.

constipation and exposure to stress, empowering healthcare providers to address intricate health issues comprehensively.

A systematic review following PRISMA guidelines was conducted using PubMed, Embase, and PsycINFO databases with standard search terms related to “constipation” and “stress” in individuals aged 0 to 18. The eligibility criteria were defined and used to select relevant studies, and quality assessment was carried out using established methodologies.

Two authors independently screened the uploaded abstracts through the Rayyan application, which expedites the process of screening and selecting studies. Frequent meetings were held to resolve disagreements and uncertain matters.

Key Findings

Out of 2,296 titles and abstracts considered, 15 articles met the criteria for inclusion in this review, encompassing 2,954 children aged 6 months to 16 years. The findings revealed a clear association between constipation and exposure to stressors:

- **Home-related stressors:** Events such as parental divorce, severe illness in the family, and job loss.
- **School-related stressors:** Experiences of bullying, school changes, separation from friends, and academic failure.
- **Child maltreatment:** Including neglect and abuse.
- **Exposure to war/civil unrest:** Impacting children’s mental and physical health

The review identified associations between constipation and stressors like parental separation, bullying, and civil unrest, involving 2954 children aged 6 months to 16 years.

Conclusions and Implications

The study emphasized that everyday stressors, maltreatment, and societal unrest can contribute to constipation in children. These factors should be considered during clinical evaluations when providing holistic care. This research underscores the importance of considering psychological and environmental factors in pediatric healthcare.

As librarians, by gathering and disseminating essential information, we enable healthcare professionals to provide well-informed and empathetic care. In conclusion, we must continue to serve as catalysts for research, bridging the gap between academic insights and practical applications. Through our dedication, we can help improve the quality of care for children facing challenges such as stress-related constipation.

Conclusion

Both empirical studies and systematic reviews are key components of EBM, offering insights that shape patient care and policy decisions. Through their expertise, librarians play a pivotal role in advancing medical knowledge, improving healthcare outcomes, and facilitating Evidence-Based Medicine (EBM).

While librarians globally play a crucial role in supporting EBM, there is ample opportunity for Sri Lankan librarians to further enhance their involvement in this area. By strengthening our engagement with healthcare

professionals and researchers, we can become more integral to research and clinical processes, particularly in conducting systematic reviews and managing complex information systems. Sri Lankan librarians have the potential to contribute even more to evidence-based healthcare by actively seeking opportunities to collaborate with research teams and support the development of EBM practices. Taking these steps will empower us to make a greater impact on patient care, health policy, and the overall advancement of medical knowledge.

Message for all Librarians

The key message I need to highlight is that “Our diverse backgrounds enrich our roles”. I began my journey in Physical Sciences, Chemistry & Biochemistry, and transitioned to Information Management, Public Health Education and now focus on health systems and community research. Similarly, each of you carries expertise from numerous fields such as Engineering, Pure Science, Law, Social Sciences & Humanities (Arts, Management, and Education). Let us embrace our potential as “Librarians as Research Catalysts” and make meaningful contributions to these fields.

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Perceptions on Human Resource Management (HRM) Practices among Public Library Employees: Special References to the Eastern Province, Sri Lanka

J. Lavanya¹

ABSTRACT

HRM practices must be purposefully chosen and be used strategically to foster high levels of organizational and professional growth. Therefore, the present study was initiated to find out the employees' perceptions on HRM practices. A self-administrated questionnaire was used among all employees of the public libraries in the Eastern Province, Sri Lanka (n= 303). The analytical tool used for the study was Exploratory Factor Analysis. The findings reported that there were 4 factors that explained with a cumulative variance of 58.621%. Those factors were "Training and Development", "Rewards and Recognition", "Inappropriate practices" and "Recruitment and Selection". The results revealed the malpractices such as neglecting library staff by top administrators, not revising circulars and policies from time to time, not filling permanent carders with suitable persons and lack of promotional opportunities in the public library system in the Eastern Province, Sri Lanka. The study recommends that library management should take immediate actions to eliminate the malpractices in the existing public libraries system and revise the policies and procedures to attract the right talent.

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Additionally, improving the HRM processes within the public library system in the Eastern Province, Sri Lanka is essential.

Keywords: Human Resource Practices, Public library, Perception, Sri Lanka

Introduction

Nowadays, libraries are rich with highly experienced staff and are expected to keep pace with the changing needs and interests of patrons and the entire community. Staff recruitment, retention, and continuous personal development have become critical and strategic organizational concerns with respect to the survival of library and library staff in the information service industry. Thus, institutions are compelled to invest in hiring, training, and retraining staff to enable them to meet the ever-evolving challenges of the broad-based mission of libraries (Mbofung, 2015).

The literature, presents controversial discussions about how library personnel are recruited. Simpson and West (2014) stated that many libraries recruited candidates from their own talent pool, believing that nurturing internal leaders will create a sense of employee engagement and retention in a library. In contrast, other libraries favored the candidates from outside the organization. For example, in a study conducted by Galbraith et al. (2012), library employees indicated that they strongly preferred external candidates, as they bring fresh perspectives and new ideas to the library. In addition, external recruitment seeks to attract candidates with capacity and ambition to grow and advance within the organization (Deards & Springs, 2014). Although external candidates were preferred, recruitment of internal candidates for key positions brought its own advantages, and it was suggested that this internal recruitment sustained staff morale and promoted stronger

collegial performance (Galbraith et al., 2012). In Sri Lanka, recruitments to "Government Librarians Service" are carried out purely through an interview process and a competitive examination conducted by the Commissioner General of Examination on behalf of Director General of Combined Services. Seventy percent (70%) of the total vacancies is recruited on the basis of open stream and 30% on limited basis (Ministry of Public Administration, 2025). Further, the Public librarians are recruited under the scheme of recruitment for the Supervisory Management Assistant category of service in Department of Local Government.

Staff recruitment and selection, training and development, compensations and rewards, and competency based performance appraisal are considered as essential elements of a human resources management process. Mbofung (2015) also mentioned that staff recruitment, retention, and continuous personal development had become crucial to the survival of library professional and nonprofessional staff. Gonzalez (2010) indicated that all aspects of staffing including recruitment, hiring, promotion, staff development, and evaluation were acutely sensitive processes. Therefore, libraries need to reconsider the elements of HRM process strategically to enable the staff to perform their duties and make positive contributions towards successful organizational goals.

Not only the perceptions of human resources are important for organizational growth, but also the human resource practices have a direct impact on employee attitudes and behavior. Therefore, the accurate measurement of these practices is important. Costa et al. (2019) pointed out that HRM policies and practices were especially important when considering the demands of the current working world imposed on employees.

Based on the literature pertaining to Sri Lanka, malpractices such as political influence, and recruiting non-qualified staff were reported and it was recommended that administrators need to identify such lapses and take immediate actions to avoid such practices. Further it suggested recruiting a qualified staff to public libraries and encouraging them with promotions and proper training (Wanasinghe, 2018). It was further recommended that the Ministry of Provincial Councils and Local Government Authorities should directly involve and analyze the situation and prepare a national policy to develop the public libraries in Sri Lanka. As per the Baseline Study on Public Libraries (BSPL) in Sri Lanka carried out by Gamage (2018), it was revealed that a substantial percentage of (31%) persons heading libraries did not possess any professional qualification and the qualified professionals were over aged. Wanasinghe (2018) pointed out that more than 80% of libraries in Anuradhapura district were managed by non-qualified staff. Among them, there were around 30% of library administrators holding the posts of Library Attendant or below and 66% of public library administrators in the Anuradhapura district did not have professional competency. Similarly, Chandrasekar (2013) examined the status of the public libraries in the Jaffna District and identified the major challenges regarding human resources of public libraries such as dearth of professional and personal competencies among library staff, poor participation in continuous professional development programs and lack of motivation and staff cooperation .

Problem Statement

Even though human capital is considered as the backbone of libraries, there are hidden issues regarding HRM practices in public libraries. When considering the background issues, it should be emphasized that public

libraries in Sri Lanka have faced significant challenges for proper functioning, as public library employees had many disparities. The complaints from Public Librarians and Library Attendants in the Eastern province highlighted that some staff members have been serving as Library Attendants for a long time in the public libraries without having proper promotion pathways. Further, there have been numerous such grievances raised by public library employees in the past.

However, to address their perception of HRM practices, clear evidence is required. Therefore, identification of the perception of staff on HRM processes in public libraries in terms of recruitment and selection; training, development and education; competency-based performance appraisal; compensation and rewards, is crucial and it would be beneficial in identifying areas of improvement regarding the human resources in public libraries. It helps both the library and its parent organization in understanding each other's views on human resource practices. Therefore, this study would provide clear insight into what the employees feel and what areas to be developed further to satisfy them.

Objectives

The main objective of the study is to examine the employees' perceptions on HRM practices. It focuses on Librarians and Library Attendants of the public library in the Eastern Province of Sri Lanka.

The specific objectives are;

- To identify the latent factors of staff perception regarding HRM practices
- To find out the total variance explained by the latent factors
- To determine the factor scores and the best factor
- To examine the malpractices adopted by the public library sector

Literature Review

Existing literature about employees' perception on practices of HRM in public libraries have been explored by several local and international researchers under several topics such as staff recruitment and selection; trainings and development; competency-based performance appraisal; compensation and rewards.

Fischer (2018) conducted a survey to study all functions of HRM. These aspects of HRM included recruitment, hiring staff, retaining staff, training and development, performance appraisal design, strategic planning related to HRM, benefits plan, compensation, job analysis and job design, and employee rights/ human resource law. Similarly, the present study also intended to identify the perception of the library staff on the HRM practices in selected areas. This would replenish the vacuum in the previous literature.

Tayeh (2010) conducted a study on HRM practices and how they affect staff performance in Jordanian public academic libraries. It illustrated the role of HRM functions and how they may affect the effectiveness of personnel performance. According to the study findings, there is a strong correlation between effective practices of personnel administration functions and improvements in their performance, which in turn leads to a higher level of productivity. The tested variables also showed a negative correlation, which could improve the administration's performance in academic libraries.

Jiang et al. (2017) conducted a study to examine the contextual influence of managers and coworkers on employees' perceptions of HR practices, and explored demographic dissimilarities as boundary conditions of the contextual influence. The results also revealed that employee demographic

dissimilarity from coworkers in terms of age and organizational tenure weakened the positive relationship between coworker-perceived and employee-perceived HR practices. This was conducted in a profit-making organization; however, the present study aims to modify the concept and apply it to public library system with the purpose of exploring the situation in Sri Lanka. Olorunsola (2000) suggested that employee welfare and grievances was a major functional area in HRM, which was often neglected by library managers.

Chandrasekar (2013) initiated a study to investigate challenges faced by public libraries in Jaffna District, Sri Lanka. The results revealed that most of the cadre vacancies existed in the Urban Council and Pradeshiya Sabha public libraries for more than 20 years have been filled in the recent past with suitable candidates, who possessed the required qualification in Library Science. However, community center libraries were forced to manage by persons without professional competencies in the field of Library Science. This resulted in unsatisfactory services to the public. The same results have been reported by Wanasinghe (2018). The study also found that no staff has been recruited or promoted within the last fifteen years in the public library system in the North Central Province. Further, Ravikumar and Ramanan (2015) pointed out severe budget cuts, increased demand for services, lack of adequate staffing were the day to day problems and challenges in every library in sub-urban and rural areas.

Ufuoma & Omekwu (2022) carried out a study on the difficulties in hiring and choosing librarians for Federal University Libraries in South-South Nigeria. Their findings showed that if the university management truly wants to have the greatest librarians, they should try to eliminate the influence of

race, other biases, political patronage, and partiality, etc. These malpractices could be overcome if the library administration has avenues for reporting instances of corruption in the hiring process, an impartial court, and the possibility of application of the law to those who violate it. This will help clean up the system and allow good practices in hiring and selection of librarians.

Even though several studies have been conducted on the topic of HRM practices and policies by various researchers, the present study aimed to find out the perception of public library employees on practices of HRM. It also contributes as an innovative type of research about public libraries since most related studies of HRM practices are focused on the private sector.

Research Design and Methods

This was a cross-sectional study and survey strategy was adopted. The study population consisted of all the staff members (Librarians and Library Attendants) who work in public libraries in the Eastern Province of Sri Lanka. The questionnaire is an instrument of data collection consisting of a standardized series of questions related to the research. The questionnaires were distributed among the study population chosen. The questionnaire was prepared in both languages Tamil and Sinhala. There were 43 Librarians and 224 Library Attendants from 143 public libraries in the Eastern Province. The response rate was 88.12%. The reliability of the instrument was tested using an internal consistency measure. The Cronbach's alpha value was 0.71, which seemed that the tool is reliable for data collection as per decision rule for internal consistency (George & Mallery, 2003).

The HRM Policies and Practices Scale (HRMPPS) which was developed by Demo et al. in 2012 was used to measure the employeee

perceptions on polices and practices. It was modified by adding and removing items to best suit to Sri Lankan public library system. Exploratory factor analysis through the principal component method with Varimax rotation was used to analyze the employees' perception on HRM practices in public libraries. Factor Analysis was used to understand the contribution of each factor towards the perception of staff on practices of HRM in public libraries. All the inferential statistics were performed at a 95% confidence interval. All collected data were analyzed using the SPSS 24 version.

Results and Discussion

The employees' perceptions of HRM practices

The instrument comprised 17 items related to HRM practices. Respondents were requested to rate the degree to which they agreed with the statements made on a five-point Likert scale. The scale ranged from 1, indicating that they strongly disagreed with the statement to 5, indicating that they strongly agreed with the statement.

Table 1

KMO and Bartlett's Test for perception of staff regarding HRM practices

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.818
Bartlett's Test of Sphericity	Approx. Chi-Square	1539.684
	Df	136
	Sig.	.000

Factor analysis is useful for placing variables into meaningful categories. Factor analysis operates on the notion that measurable and observable variables can be reduced to fewer latent variables that share a common variance and are unobservable, which is known as reducing dimensionality (Bartholomew et al., 2011). Large datasets that consist of

several variables can be reduced by observing ‘groups’ of variables that is, factor analysis assembles common variables into descriptive categories.

The survey data were subjected to an Exploratory Factor Analysis using Principal Component Method and Varimax rotation with Kaiser Normalization to examine the dimensional structure of the construct. The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.818, indicating that the data were sufficient to perform factor analysis as indicated in Table 1. The inter-correlations between items were inspected using Bartlett’s test of sphericity. With this test, the statistics generated should be significant ($p < 0.05$) for an Exploratory Factor Analysis to be considered, an appropriate technique (Hair, 2009). According to Table 1, the Bartlett’s test of sphericity $\chi^2 (136) = 1539.684$, $p=0.000$ showed that there was sufficient correlation between the items to proceed with the EFA.

Table2

Rotated component matrix for perception of staff regarding HRM practices

Rotated Component Matrix ^a				
	Component			
	1	2	3	4
The library encourages interaction among staff	.729			
Feedback I receive is useful to improve my competencies	.717			
The library management is concerned with the well-being of their employees	.668			
The library helps me to develop skills needed for the success at work	.665			
The library promotes personal and professional growth	.623			
Our training needs are identified periodically				
The library management conducts competency-based performance appraisals.				
High level of recognition		.845		
The benefits are similar to what other organizations provided their staff		.831		

The existing rewards motivate us for better performance		.806		
Neglecting library staff by top administrators			.81	
The circulars and policies not being revised from time to time			.74	
Permanent carders are not being filled by suitable persons			.60	
Lack of promotional opportunities			.586	
Selection process is conducted by trained and impartial people.				.786
The library management communicates performance results to candidates				.763
There are competitive selection (Exam, Interview) processes				.559
Extraction Method: Principal Component Analysis.				
Rotation Method: Varimax with Kaiser Normalization.				
a. Rotation converged in 6 iterations.				

Using an Eigen-value cut-off 1.0, it was found that there were four factors that explain a cumulative variance of 58.62%. The total variance explained by three factors were 46.681%, and 11.941% of variance was explained by the 4th factor. The Table 2 showed the factor loading after Varimax rotation using significant factor criteria of 0.5. There were no complex variables identified, and cross loading were not identified. The statements, “Competency Based Performance Appraisal (CBPA) is conducted regularly” and “Training needs are identified regularly” were removed from the final analysis as the loading was below 0.5 and considered as “Not significant”. The idea of rotation is to reduce the number of factors on which the variables under investigation have high loadings. Rotation makes the interpretation of the analysis easier.

Accordingly, the first factor had grouped five statements, and it can be named as “Training and Development”. This factor explained around 19.367% of the variance in data and the staff perceived that staff interaction is encouraged, the library promoted personnel and professional growth, library

management was concerned about well-being, feedback was useful, and library helped develop skills. The elements such as “The library encourages interaction among its employees” and “Feedback received is useful to improve performance” had the highest factor loading.

On the other hand, factor 2, which exerted around 15.102% of the variance, had grouped and named as “Rewards and Recognition”. It indicated that the perception of staff comprised benefits similar to that of other organizations, high recognition & appreciation and motivation through rewards.

The Factor 3 denoted “In appropriate HRM practices” included malpractices, such as circulars are not being revised, lack of promotion opportunities, negligence of library staff and permanent carders are not being filled by suitable persons. It exerts 12.211% of the total variance. Besides this factor had negative perceptions of human resource practices. If the permanent cadres are not filled with suitable employees, it leads to work overload. It will create an unhealthy work environment. Therefore, this situation should be carefully addressed. Moreover, frequent training opportunities should be provided for human resource development.

The 4th latent construct was “Recruitment and Selection” related to perceptions and explained 11.941% of the variance in the data. It grouped the items namely, “Selection process is conducted by trained and impartial people”, “The library management communicates performance results to candidates” and “There are competitive selection (Exam, Interview) processes”.

Overall, all the elements except “Lack of promotional opportunities” and “There are competitive selection (Exam, Interview) processes” had least factor loadings as per Table 2. Therefore, library management should make necessary arrangements to eliminate the issues related to selection and promotion of the staff.

At last, the factor scores were added to the data. Table 3 showed how the data were interpreted. The Exploratory Factor Analysis determined the contribution of each factor towards the perception of staff on HRM practices in public libraries. It is concluded that “Factor-1” was rated best as it had higher Mean value (Mean=3.7378). It means that staff perceived that feedback and criticism were useful for their professional and personnel development. Further, they felt that the collaboration was encouraged by the public library. Library management is concerned about the well-being and promoted personal growth, and helped to develop skills of the staff. These scores can be used for further analysis.

Table3

Descriptive statistics for significant factors of employees’ perception on HRM practices

Descriptive Statistics			
	N	Mean	Std. Deviation
Factor-1 (Training and Development)	267	3.7378	.53328
Factor-2 (Rewards and Recognition)	267	3.1536	.68470
Factor-3 (Inappropriate practices)	267	3.1798	.66426
Factor-4 (Recruitment and Selection)	267	3.3034	.65012

Conclusions and Discussion

The data were subjected to factor analysis using Principal Component Factoring and Varimax rotation. The Kaiser –Mayer-Olkin measure (KMO) was 0.818, indicating the data were adequate for performing Exploratory Factor Analysis. Bartlett's test of sphericity $\chi^2 (136) = 1539.684$, $p=0.000$ showed that there were patterned relationships between items. Using an Eigen value cut off of 1.0, there were four factors that explained a cumulative variance of 58.621%. Items were considered to have loaded if they had a factor loading of 0.5 or more. The statements, “Competency Based Performance Appraisal (CBPA) is conducted regularly” and “Training needs are identified regularly” were removed from the final analysis as the loading was below 0.5 and considered as “Not significant”.

The first factor had grouped five statements, and it was named as “Training and Development”. This factor explained around 19% of the variance in data. It means that employees mostly thought about the training needs and their career development in HRM practices. On the other hand, Factor 2, which exerted around 15% of the variance, was grouped and named as “Rewards and Recognition”. It was confirmed that the staff perceived that they receive a high level of recognition and appreciation. Further, the findings indicated that the existing reward system in public libraries motivated them to achieve higher performance. Public library management can enhance their reward system for employees to make them engaged and satisfied and help achieve their goals. Factor-3 comprised of 4 variables that were considered as negative perceptions. Around 12 % of the variance was explained by the factor themed “Inappropriate practices”. It was evident that they perceived some elements as malpractices that were implemented in public library system in

the Eastern Province, Sri Lanka. These practices were categorized as negligence of staff by top administrators, not revising the policies and circulars from time to time, not filling the permanent cadres with suitable persons and lack of promotional opportunities.

Factor 4 converged together three items and themed as “Recruitment and Selection”, whereas it explained 11.941% of the total variance. It seemed that the selection procedure of public libraries was conducted in a competitive manner by qualified and impartial examiners. The modified 17 items HRM Practices Scale included the most widely studied HRM practices; it might support library administrators regarding identification of HRM areas where specific improvements are needed in order to achieve the targeted goals. It will provide evidence to library policy makers to forecast future developments and to have the ability to effectively intervene to modify factors, which affect the staff members.

As a whole, the results indicated that employees were concerned mostly about the training needs and their career development in HRM practices. They were extremely keen to attend training programs and workshops to improve their skills. It is confirmed that the staff perceived that they receive a high level of recognition and appreciation. Further, the findings indicated that the existing reward system in public libraries motivated them to reach higher performance. However, the staff perceived that some unethical practices are implemented in public library system in the Eastern province, Sri Lanka and that such issues need to be addressed in future for the betterment of public library staff.

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Effect of Organizational Culture on Employee Engagement: Perspectives of University Librarians in Sri Lanka

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ABSTRACT

Organizational culture is widely recognized as a significant factor in establishing a competitive advantage. A highly effective organizational culture fosters greater employee engagement and effectiveness, ultimately resulting in increased productivity. While several prior studies have focused on the link between organizational culture and employee engagement or treated these concepts separately, only few have explored the influence of organizational culture on employee engagement. This study attempted to assess the impact of organizational culture on employee engagement through perspectives of university librarians in Sri Lanka. The population consisted of all library academics in state universities in Sri Lanka and a sample of 100 was drawn using convenience sampling method for data collection. Findings demonstrated that all organizational culture variables, namely clan culture, adhocracy culture, hierarchy culture and market culture had significant positive influences on the employee engagement.

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In addition, clan culture was found to be the most important dimension of culture. Study findings can inform the development of strategies to improve employee engagement in libraries, specifically in areas of training and development, creating new roles and responsibilities and maintaining effective information systems. This will ultimately lead to fostering a positive and motivated work environment within the library, contributing to the prosperity and stability of the higher education sector in Sri Lanka.

Keywords: Organizational Culture, Employee Engagement, Service Quality

Introduction

Organizational culture is a multifaceted phenomenon, which is explained by a variety of aspects (Ginevičius & Vaitkūnaite, 2006). As cited by Polychroniou and Trivellas (2018), most theorists' and practitioners are interested in the topic of organizational culture literature, since the culture is closely related to the performance of an organization. As a social entity, an organization consists of a social entity; an organization consists of people from diverse cultural backgrounds, holding different values, beliefs and norms regarding how their job should be performed and the responsibilities that should be fulfilled on how the given job can be performed and responsibilities needed to be carried out. It has been affirmed by Hofstede *et al.* (2010) that every individual is in possession of a manner through which they act, feel and think, which they tend to acquire over the course of their life. Therefore, considering the differing viewpoints, beliefs and values, it becomes imperative for an organization to outline a common culture and strive to nurture it amongst all their employees.

The culture in organizations is considered as one amongst the most significant factors that results in the creation of a competitive advantage and continues to remain so, as it impacts the organizational performance and behaviour either negatively or positively (Bogdanowicz & Lu, 2014). Further, organizational culture impacts commitment and satisfaction of the employees (Messner, 2013), performance (Uddin et al., 2012), as well as employee engagement. The organizational objectives and purpose is what influences the organizational culture and substantially impacts the morale of the employees, their retention and engagement levels (Tsai, 2011). The objective here is not just to become a good employer, but it is more about ensuring that the employees are more committed towards achieving organizational goals and objectives. An organizational culture which is highly effective also leads to the creation of superior levels of engagement and effectiveness amongst the employees which essentially is translated into high levels of productivity (Kotter & Heskett, 2011). Superior levels of employee engagement are crucial to the organization (Ugargol & Patrick, 2018). Employees who are engaged remain committed and dedicated to their work, work with renewed enthusiasm and are thoroughly absorbed within the tasks they execute.

Findings from research that have been conducted in the past with respect to impact of organizational culture on employee engagement and effectiveness within successful institutions have proven a direct association between robust organizational cultures and high employee engagement (Nongo & Ikyanyon, 2012). Though the organizational culture as a field of research has received great attention from scholars since 1990 (Kahn, 1990), the focus has been confined to the performance outcomes at the organizational level and minimum amount of empirical investigations have focused on phenomena such as the relationship between organizational culture and

employee engagement related outcomes (Hartnell et al., 2011). Even though organizational culture is thought to be important in shaping employee related factors, research to identify the level of impact of the organizational culture on employee engagement is limited. Furthermore, there is scant research that concentrates on organizational culture and employee engagement with reference to the libraries in the university sector. Therefore, it has been a pressing need to investigate the organizational culture and engagement lopsided to library systems.

Background of the Study

Organization culture could be positive/negative and supportive/unsupportive. Positive and supportive cultures create active and enthusiastic employees. Robbins (2005) defined organizational culture as to a system of shared meaning held by members that distinguishes the organization from other organizations. Volberda et al., (2013) stated that employees are innovative and they push the organization forward where they perceive the organizational culture as supportive. Every organization has a unique culture and culture differ from one organization to another. Employee engagement is one of the most important concepts in human resource management all over the world. Employee engagement touches the bottom line of the organization and it is where employees work and express themselves mentally, emotionally and physically when they perform their activities (Kahn, 1990). These are the factors that would obviously fall under the organizational culture. Therefore, fostering a strong organizational culture is essential, as it promotes employee engagement.

The organizational culture of a library is a very special scenario since it is based on the fact that an educational unit is a self-organized system resting

on the principles of knowledge and learning, serving as a platform for various types of relationships (Vasyakin et al., 2016). The diversity and complexity of relationships among different parties have highlighted the need to study the culture within the libraries. Previous studies clearly convey that there is a relationship between organizational culture and employee engagement (Alarcon et al., 2010). However, very limited amount of research has been conducted to identify the relationship between organizational culture and employee engagement in the context of universities. Furthermore, it was very difficult to find any such studies that have been carried out with reference to libraries in Sri Lanka. This study attempts to fill the contextual gap by identifying the impact of organizational culture on employee engagement among university librarians in Sri Lanka.

Problem Statement

Most of the past studies have concentrated on the link between organizational culture and employee engagement or have treated the concepts separately. Researchers link the determinants of engagement to leadership, organizational environment, organizational policies and procedures, organizational structure, rewards and recognition among others (Anitha, 2014). These determinants of engagement are embedded within the culture of an organization. Relatively very few studies have focused on the impact of Organizational Culture (OC) on Employee Engagement (EE). There is a lack of empirical evidence that directly treated this type of investigations especially in Sri Lanka and particularly in the Library and Information Science (LIS) field. There is a scarcity of evidence in the literature on such studies regarding the university setting. Therefore, this study was conducted to fill this gap and

to find the impact of organizational culture on employee engagement with special focus on the viewpoints of university librarians.

Objectives

- To identify the impact of organizational culture on employee engagement from the perspectives of university librarians in Sri Lanka
- To identify the most influential culture on employee engagement within university libraries in Sri Lanka.

Research Questions

- What is the impact of organizational culture on employee engagement from the perspective of university librarians in Sri Lanka?
- What is the most influential culture on employee engagement within university libraries in Sri Lanka?

Literature Review

Organizational Culture

An organization as a social unit brings together people of diverse backgrounds to work towards a well-defined common goal. In order to achieve the common goal the organization must foster a common culture and strive to inculcate it to its constituents its employees. Culture is said to reside in the observable practices and in the way people identify what happens within their organization (Hofstede et al., 2010). By reading documents and observing how things are done within an organization, it is possible to interpret the culture within a particular organization. Organizational culture may be perceived to be supportive/unsupportive or positive/negative. Organizations with a positive

culture reward their employees and create an enabling environment where employees develop, grow and operate at their full potential (Robbins & Judge, 2012).

According to Quinn and Cameron (1999) organizational culture is defined as the stable set of the fundamental ideals, suppositions, interpretations and how members of an organization approach matters. Culture in any entity can be looked at from two dimensions. One focus is on interior conservation (leveling and incorporation) versus exterior relationships (competition and distinction) and an emphasis on organic processes (flexibility and dynamism) versus machine-like processes (firmness and control) (Cameron & Quinn, 2006). Combining these two sets of competing values result in four unique culture types (Krog, 2014).

Clan culture: Clan culture prioritizes on the internal environment of the organization. This culture can be inferred as a supportive culture that is shaped by the balance between organizational focus and flexibility/dynamism (Acar & Acar, 2014). According to Quinn and Spreitzer (1991), clan culture is strongly associated with teamwork and involvement. Further, this type of culture is characterized by a strong sense of family, with the organization's focus on maintaining stability, loyalty, cohesiveness, and involvement. These elements are considered essential for success (Aktas et al., 2011).

Adhocracy culture: Quinn and Spreitzer (1991), state that adhocracy culture exists in organizations that are focused on development and is characterized by innovation, risk-taking, and creativity. It refers to a culture within an organization that is inventive, open to new ideas, entrepreneurial, and creative, driven by an externally oriented and dynamic structure (Acar & Acar, 2014). In the words of Aktas et al. (2011), an adhocracy culture facilitate more

opportunities for individual development, allowing people to grow in their own unique ways, as long as it aligns with the organization's goals. Further, they explain that the organization's focus is on capturing opportunities to innovate by capitalizing the external environment. The use of the internet in business operations serves as an example of this culture.

Market culture: This culture prioritizes stability and control having an external focus. It has a rational nature, emphasizing efficiency and achievement (Quinn & Spreitzer, 1991). Competition among individuals is common, leading to reduced flexibility in personal relationships. Employees are driven by success, with target achievement serving as the key criterion for success.

Hierarchy culture: Acar and Acar (2014) state that the hierarchical, or control culture, is positioned between the internal organizational focus and the dimensions of stability/control. This culture is characterized by norms and values linked to bureaucracy (Quinn & Spreitzer, 1991). As noted by Cameron and Quinn (2006), it has an internal focus, emphasizing control through structured, formalized workplaces with clearly defined guidelines and rules outlining employees' responsibilities.

Employee Engagement

The earliest well-established definition of employee engagement was described as "harnessing the organization members' selves to their work roles; in engagement, individuals utilize and express themselves physically, cognitively, and emotionally during their role performances" (Khan, 1990, p. 694). Khan recognized that the concept of employee engagement is related concepts such as involvement, motivation, and satisfaction, while defining

disengagement as the withdrawal of oneself from the work or role. Maslach et al. (2001) later characterized employee engagement as a positive, motivational trait of employees. According to Harter et al. (2002), employee engagement is defined as "the individual's involvement, satisfaction, and enthusiasm for their work" (p. 269).

Later, Schaufeli et al. (2006) recognized the dimensions of employee engagement as vigor, dedication, and absorption. Vigor is defined as the level of an employee's willingness to work, the amount of effort and energy they are prepared to invest, and the extent to which they demonstrate mental resilience and adaptability. Dedication relates to maintaining a high degree of motivation, enthusiasm, and deep engagement with one's work, while also experiencing a sense of importance. Absorption, on the other hand, describes the extent to which employees are fully engrossed (happily, willingly immersed, and completely) and focused on their tasks, where time seems to fly by, and they feel unsettled/uncomfortable when there is no work to occupy them (Ferreira & Oliveira, 2014; Schaufeli et al., 2006). According to Aktar and Pangil (2017), employee engagement is considered a key factor in encountering competitiveness. Engaged employees can be identified as a crucial factor in achieving a competitive advantage, as all other production factors can be replicated by rivals', except for human resources. Therefore, human capital has been recognized as a driving force for change (Ncube & Jerie, 2012).

Organizational Culture and Employee Engagement

Although employee engagement is considered a relatively emerging area of study, number of research has explored the area of the impact of organizational culture on employee engagement. Specifically, there have been recognized studies examining the relationship between organizational culture and employee engagement in South African information technology institutions. Naidoo and Martins (2014) states that it is significant for an organization to foster a positive culture that helps employees feel engaged and remain engaged more committed to their work. Similarly, a study conducted by Krog (2014) on the relationship between organizational culture and work engagement, found that organizational culture influences individuals, stated that a moderate relationship existed between clan culture and employee engagement. Further, the market culture and the hierarchy culture have not reported any significant negative relationship with work engagement. According to previous studies, researchers did not uncover which organizational culture affect employee engagement or did not recognize its determinants. The environments that are recognized as more inclusive, participative, and supportive of autonomy (such as clan and adhocracy cultures) neither foster nor hinder realism, was the conclusion of the study carried out by Reis et al. (2016) with sample of 890 professionals from graduate and postgraduate programs at a business school in Brazil. This study focused on perceived organizational culture and engagement.

Cultures that emphasize control, order, and stability are negatively correlated with authenticity, which means: employees who exhibit more authentic behavior at work tend to be more engaged towards their jobs. Parent and Lovelace (2015) study on the impact of employee engagement and a

positive organizational culture on an individual's ability to adapt to organizational change identified that positive organizational culture boosts employees' ability towards the change. Further, they stated that both the job and organizational engagement of employees are fostered by positive organizational culture.

In a recent study, Abduraimi et al. (2023) explored the influence of OC on EE in the Republic of North Macedonia, where evidence of empirical research was not available on this relationship. Focusing on EE aspects (vigor, dedication and absorption) this research carried out a survey of 152 public secondary education employees. It was revealed that key OC components significantly affected EE. Findings outlined the positive effect of OC on EE both within and beyond school settings.

Literature shows that there is a lack of studies that specifically focused on identifying the impact of organizational culture on employee engagement in the field of LIS, which motivate this particular study to fill the existing gap.

Conceptual framework

The model and research hypotheses of the study were formulated based on the aforementioned related literature. Figure 1 denotes the proposed conceptual framework of the study. The dependent variable of the model is employee engagement. The independent variable is organizational culture which included four dimensions of cultures, namely clan culture, adhocracy culture, hierarchy culture and market culture.

The following five research hypotheses were proposed in the study.

Research hypotheses

H1: Clan culture has a significant positive influence on employee engagement

H2: Adhocracy culture has a significant positive influence on employee engagement

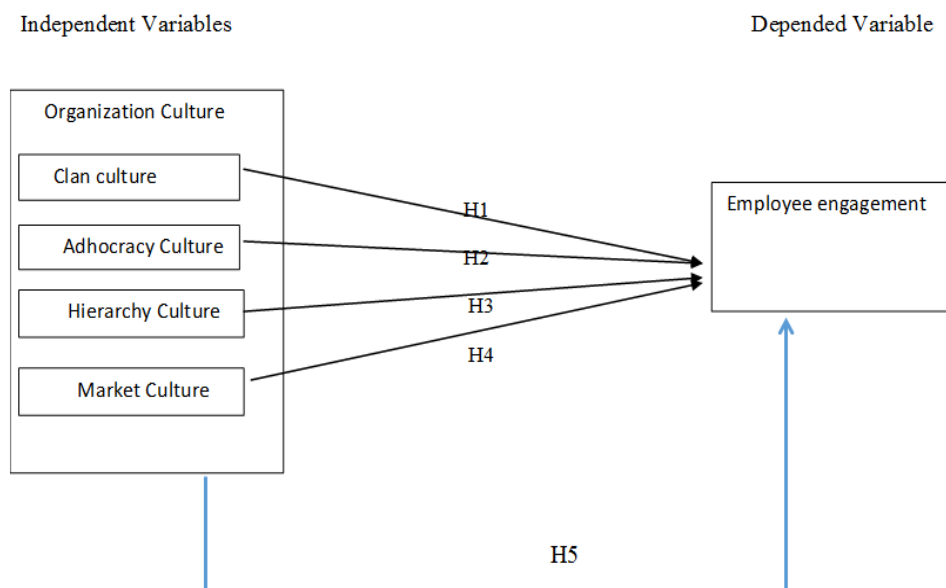
H3: Hierarchy culture has a significant positive influence on employee engagement

H4: Market culture has a significant positive influence on employee engagement

H5: Overall, organizational culture has a significant positive influence on employee engagement

Figure 1

Conceptual Framework of the Study



Research Design and Methods

This study was conducted in the natural environment with less interference of the researchers. As the researchers wanted to find out the impact of variables, the data was collected in the natural setting under a field survey. Hence, the study setting is non-contrived. The data for this study was collected at a single point of time, thus the study is a single cross-sectional one. This is a quantitative study and the survey research strategy was employed to gather data. The study was based on both primary and secondary data. The data necessary for testing the hypotheses were basically on primary data and the definitions and discussions of concepts on the literature review were from books, journals, research articles and past research. The primary data was collected through a self-designed structured questionnaire administered among the sample (library academic staff members) using a Google form. The study population consisted of all the library academic staff members including librarians, deputy librarians, senior assistant librarians and assistant librarians attached to the UGC accredited state universities of Sri Lanka. A sample of 100 university librarians was drawn from the population for data collection. The convenience sampling technique was used as the sampling technique for the study.

The questionnaire consisted three sections to measure demographic factors, organizational culture (independent variable) and employee engagement (dependent variable). Well-established measurement scales used in previous research studies were adapted for major variables. Employee engagement was measured using Utrecht Work engagement Scale (UWES) developed by Schaufeli et al. (2002). This is a scale measuring the positive state of mind of employees within the workplace and the scale has 17 items.

Organizational culture was measured using Organizational Culture Assessment Instrument (OCAI) developed by Cammeron & Quin (1999) which has 24 items (6 items for each culture variable). A multiple item 5-point Likert scale was used to collect responses for all the items.

Data analysis was done using Statistical Package for Social Sciences (SPSS) and the main techniques used for data analysis were, mean analysis and simple linear regression analysis. Frequency analysis was used to explore the demographic factors of the sample. Impact of OC on EE has been identified through a series of regression analysis.

Results and Discussion

The survey questionnaire was distributed among the sample of 100 library academic staff members in Sri Lankan state universities, a total of 79 duly filled questionnaires were received, and all these responses were in a usable form, producing a response rate of 79%.

Table 1
Demographic Profile of the Sample

Characteristics	Category	Cases	Percentage (%)
Gender	Male	34	43
	Female	45	57
Designation	Librarian	3	4
	Deputy Librarian	4	5
	Senior Assistant Librarian	47	60
	Assistant Librarian	25	31

Work experience	1-3 years	16	20
	3-6 years	26	33
	6-9 years	15	19
	9-12 years	5	7
	>12 years	17	21
Monthly income	100000-200000	20	26
	200000-300000	32	42
	300000-400000	22	28
	>400000	3	4

As summarized in Table 1, it was observed that out of the university library academics who responded to the survey 57% were females whereas 43% were males. Regarding their designations, most of the respondents were senior assistant librarians (47%), followed by 25% of assistant librarians. There were only few respondents who were in the positions of librarian (4%) and deputy librarian (5%). With respect to the respondents' work experience, the highest percentage of them (33%) had 3-6 years of work experience, whereas the lowest percentage of them (7%) had 9-12 years of work experience. It was also notable that almost similar percentages of respondents reported that they had work experience of 1-3 years (20%), 6-9 years (19%) and more than 12 years (21%). Considering the monthly income, majority (42%) of the respondents belonged to the range of Rs.200000-Rs.300000 per month, while considerable proportions of 27% and 28% of them belonged to ranges of Rs. 100000-Rs.200000 and Rs.300000-Rs.400000 respectively. In addition, only 4% of the respondents reported that they received a monthly income of more than Rs.400000.

Table 2
Cronbach's Alphas of the Variables

Variable	Number of Items	Cronbach's alpha	Reliability results
Clan Culture- CC	6	0.885	Good
Adhocracy Culture- AC	6	0.904	Good
Hierarchy Culture- HC	6	0.848	Good
Market Culture- MC	6	0.856	Good
Employee Engagement- EE	17	0.868	Good

In order to measure the reliability of the survey instrument used in the study, Cronbach's alpha test, which is a popular test of internal consistency, was applied. Table 2 demonstrates the Cronbach's coefficient alpha values for all the variables used in the study. All the Cronbach's alpha values of the construct items exceeded the acceptable level of 0.7 (Sekaran, 2000), exhibiting high internal consistency of the measures. This verified that the research instrument used in the study was a reliable tool of measurement. The content validity of the measurement tool was established based on the recommendations of two management experts, confirming the validity of the instrument.

Table 3
Mean Scores for Organizational Culture Variables

Variable	Mean	Standard Deviation
Clan Culture	2.55	0.778
Adhocracy Culture	3.32	0.824
Hierarchy Culture	3.63	0.693
Market Culture	3.41	0.705

Table 3 depicts the means scores corresponding to the organizational culture variables. Hierarchy culture obtained the highest mean score (3.63) which indicates that the respondents had more positive perceptions towards hierarchy culture. This suggests that respondents may perceive the library to have a stronger internal focus and control, creating structured and formalized work environments with clear guidelines and rules for tasks and responsibilities.

A series of simple linear regressions were run for culture variables against the dependent variable of employee engagement, in order to test the hypothesized relationships.

Table 4
Simple Linear Regression Results for Clan Culture and Employee Engagement

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.899	.229		12.662	.000
	CC	.249	.063	.411	3.957	.000

a. Dependent Variable: EE

H₁ assumed that clan culture would have a significant positive effect on the employee engagement and it was evident from the results (Table 4) that this path was significant ($\beta=0.411$, $p<0.05$). Thus, H₁ was supported and it implies that clan culture plays an important role in enhancing employee engagement. These findings suggests that clan culture which is characterized by a family-sense, sound interpersonal links and shared values play a major role in improving employee engagement. Employees who believe the library to have clan culture will be more inclined to be engaged in their work, reflecting commitment, satisfaction as well as motivation.

Table 5

Simple Linear Regression Results for Adhocracy Culture and Employee Engagement

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.036	.205		14.792	.000
	AC	.225	.060	.394	3.759	.000

a. Dependent Variable: EE

H₂ proposed that adhocracy culture would have a significant positive effect on the employee engagement. According to the findings (Table 5), this path is significant ($\beta=0.394$, $p<0.05$), supporting H₂. This indicates the importance of inculcating adhocracy culture within the library system to improve employee engagement. It suggests that fostering adhocracy culture which has features of flexibility, risk-taking and innovation is highly important in enhancing employee engagement. Employees who perceive the library to have adhocracy culture are likely to be engaged with their work, exhibiting innovation, initiative and adaptability.

Table 6

Simple Linear Regression Results for Hierarchy Culture and Employee

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.124	.276		11.309	.000
	HC	.182	.075	.267	2.435	.017

a. Dependent Variable: EE

H₃ theorized that hierarchy culture would have a significant positive effect on the employee engagement. Results (Table 6) show that this path is significant ($\beta=0.267$, $p<0.05$), supporting H₃. This indicates the importance of fostering hierarchy culture within the library system to improve employee engagement. Findings suggests that hierarchy culture, characterized by clear

structure and command, defined roles, responsibilities, and formal procedures plays a vital role in increasing employee engagement. Employees who believe the library to have hierarchy culture will be more engaged in their work, showing high levels of structure and adherence to established guidelines and procedures.

Table 7

Simple Linear Regression Results for Market Culture and Employee Engagement

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.279	.259		12.668	.000
	MC	.148	.074	.222	1.995	.050

a. Dependent Variable: EE

H₄ assumed that market culture would have a significant positive effect on the employee engagement and it was clear from the results (Table 7) that this path was significant ($\beta=0.222$, $p<0.05$). Thus, H₄ was supported and it implies that market culture plays a salient role in enhancing employee engagement. This suggests that market culture, which possesses characteristics of results-oriented contexts and values, customer satisfaction and focus of achievement, plays a significant role in enhancing employee engagement. Employees who perceive the library to have market culture will tend to be engaged in their work demonstrating motivation, goal orientation as well as a focus on providing value to users.

Table 8

Simple Linear Regression Results for Organizational Culture and Employee Engagement

Coefficients^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.751	.279		9.858	.000
	OC	.297	.079	.394	3.761	.000

a. Dependent Variable: EE

H₅ tested the overall effect of organizational culture on employee engagement. A composite variable (organizational culture-OC) was constructed using mean values of the culture variables and a simple linear regression was run for the composite variable of OC against the dependent variable of employee engagement. Results exhibited (Table 8) that organizational culture had a significant positive influence on employee engagement. So, H₅ was accepted (($\beta=0.394$, $p<0.05$). These results suggest that a favorable overall organizational culture as reflected by the composite variable OC, significantly contributes to improving employee engagement. Specific culture variables that were incorporated into the composite variable would have contributed to this positive effect. Each culture type may have different characteristics, which influence employee engagement differently.

Table 9

Standardized Beta Coefficients of the Culture Variables

Organizational culture variables	Standardized Beta value	Significance level ($p\leq 0.05$)
Clan Culture	0.411	0.000
Adhocracy Culture	0.394	0.000
Hierarchy Culture	0.267	0.017
Market Culture	0.222	0.05

Table 9 summarizes the standardized Beta (β) coefficients of the organizational culture variables. Comparison of β values reveals that clan culture had the strongest influence ($\beta=0.411$) on employee engagement. Clan culture is focused on the internal environment and it is more flexible. It elevates connection with teamwork, cohesiveness and employee involvement. In this culture, a strong family sense exists. Hence, according to the results, it is important to inculcate clan culture within the library system, as it will be a key to success.

Table 10

Results of Hypotheses Testing

Hypotheses	Path	Standardized Beta Coefficients	Result
H ₁	CC \longrightarrow EE	0.411 ($p \leq 0.05$)	Accepted
H ₂	AC \longrightarrow EE	0.394 ($p \leq 0.05$)	Accepted
H ₃	HC \longrightarrow EE	0.222 ($p \leq 0.05$)	Accepted
H ₄	MC \longrightarrow EE	0.267 ($p \leq 0.05$)	Accepted
H ₅	OC \longrightarrow EE	0.394 ($p \leq 0.05$)	Accepted

Table 10 summarizes the results of hypotheses testing and it shows that all the five hypotheses, which were proposed in the study, were accepted based on the results obtained.

Findings of the study provide some insights into library management regarding taking measures to develop and instill a positive culture within libraries. This could involve encouraging values such as innovation, collaboration and employee empowerment, which are linked with higher levels of engagement. Through the cultivation of a positive culture, libraries

can create an environment that motivates and engages employees, which will in turn lead to the enhancement of the overall success.

Conclusions and Discussion

This study sought to identify the influence of organizational culture on employee engagement with special reference to the perspectives of university librarians in Sri Lanka. In conclusion, the study renders valuable insights into the organizational culture on employee engagement among university librarians in Sri Lanka. Findings revealed that various aspects of organizational culture including clan culture, adhocracy culture, hierarchy culture and market culture significantly affected the employee engagement. In addition, the overall organizational culture was found to have a strong impact on employee engagement. These findings highlight the importance of fostering a positive and supportive organizational culture within the university library system to enhance employee engagement, which will lead to the success of university libraries in all aspects. Thus, if libraries develop and maintain a stronger organizational culture, their long-term survival and sustainability will be ensured.

Through this study, it is acknowledged that clan culture is the salient dimension of organizational culture. This means that libraries must focus more on developing their human resources through training and development while also encouraging teamwork to enhance efficiency and to ensure that the library users are treated in a pleasant and friendly manner. Ultimately, the efficiency of the service organization will increase by having an active and talented group of staff. Best performers should be rewarded and motivated in order to nurture a set of highly satisfied and engaged employees. If the service provider is satisfied, he or she will be able to provide high-quality services, ensuring that

the users are satisfied with the overall service and loyal in the long run. Further, it is recommended that new jobs with additional responsibilities, tasks and different functions be created for the staff. The findings of this study will be helpful in developing strategies and investing more in creating a friendly and pleasant environment and an active and talented workforce, which would enhance the employee engagement within the organization. Additionally, the finding would be useful in prepare training manuals for the staff which are essential for sustaining a win -win relationship.

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Scholarly Mapping of Research Productivity of the Eastern University, Sri Lanka using Scopus Metrics

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ABSTRACT

Universities are augmenting knowledge via high-caliber research publications, encouraging innovative methodologies, and enacting substantial reforms to facilitate national progress. Research productivity is widely acknowledged as a significant indicator of advancements in the quality of a university. The Eastern University, Sri Lanka (EUSL), established in 1986, has expanded with multiple faculties and actively engages in various research activities. Despite its academic endeavors, no formal assessment of its research productivity has been conducted. This study attempts to map the research productivity of EUSL based on the articles indexed in the Scopus database. The study employed bibliometric methods and VOS viewer network maps to analyze the data extracted from the Scopus database. It was found that total of 639 documents and 169 authors affiliated with EUSL (Scopus ID 60071086) from 1989 to 2023. The majority of publications are journal articles (85.2%), followed by conference papers (8.8%), reviews (2.4 %), book chapters (2%), Erratum (1.3%), Letter (0.2%) and Retracted (0.2%).

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The growth rate of EUSL's publications was moderately progressive up to 2023, with a peak in 2021 and 2023 with 126 publications. Citations for the publications consistently increased from 1989 to 2023. The primary field of study for authors affiliated with EUSL is "Physics and Astronomy" with 312 articles, followed by "Chemistry" with 96 articles and 87 papers were published in "Materials Science". The preferred journal for authors from EUSL is "Journal of High Energy Physics" (88 articles), followed by "Acta Crystallographica Section E Structure Reports Online" (43 articles). EUSL primarily contributed to the field of Physics, with less attention given to other disciplines especially Arts and Humanities. At the time authors in Chemistry, Mathematics, and Computing were contributing significantly to the university's research output. The study suggests that the academics of the EUSL should be encouraged to publish their research in reputed journals and international conferences. Also introducing faculty wise rewarding system for research publications, providing access to renowned databases, and subscribing anti-plagiarism software will enhance the research productivity of the university. Moreover, the library should take necessary steps to boost research productivity by offering workshops and fostering a research-oriented environment for the academics. University academics should also create profiles on research networks like Google Scholar, Research Gate, and Scopus to upsurge their visibility and university's rank.

Keywords: Research productivity, Bibliometrics, Scopus, Eastern University, Sri Lanka, VOS viewer

Introduction

Research is a cognitive pursuit and plays a crucial part in society, as its objective is to find solutions to specific challenges. In addition, research is crucial in crafting a more promising future for humanity by employing creative methods and the state of research has advanced in every progressive nation. Universities contribute to the advancement of knowledge by producing high-quality research publications that have a positive impact on society. They also encourage the development of creative approaches and assist national progress by implementing significant reforms in various fields (Shahzad et al., 2021). In this scenario, the research productivity is widely regarded as a significant measure of the advancement in the caliber of universities. Examining scholarly works offers advantages to academics, universities, organizations, policymakers, investors, and partners by broadening scientific understanding and improving international collaboration (Powell et al., 2017).

The Eastern University, Sri Lanka (EUSL) was founded on October 1, 1986 followed by the establishment of Batticaloa University College on August 1, 1981. Initially, the college consisted of two faculties. Presently, the EUSL has a Campus at Trincomalee and an institute named Swami Vipulanatha Institute for Aesthetics Studies (SVIAS) at Batticaloa. The university has six faculties in the field of Arts & Culture, Agriculture, Commerce & Management, Science and Health Care Sciences. In addition to these faculties, a new faculty has established for graduate studies in 2023. The Trincomalee Campus has three faculties namely faculty of Applied Science, faculty of Business Communication and Studies and faculty of Siddha Medicine (University Profile, Eastern University Sri Lanka, n.d.). The university organizes annual research conferences, international conferences, and research

symposiums. Additionally, each faculty publishes its own faculty journals. However, throughout the history of the EUSL, no efforts so far have been undertaken to examine its research productivity.

Numerous research studies employed scientometric methods to assess and quantify the research output and productivity of academic institutions or individual researchers (Pradhan et al., 2021). Further bibliometric mapping is useful for visualizing outcomes and deriving conclusions after analysis (Van Eck & Waltman, 2010). Scopus is the one of the popular sources for identifying the research productivity of institutions which has been used as a bibliometric data source in large-scale by the researchers (Baas et al., 2020). Hence, this study aims to fill the gap and conduct a mapping on the research publications authored by academics of EUSL that are indexed in the Scopus database using scientometric approach. The study provides a thorough examination of the research patterns of EUSL by systematically analyzing academic publications. It will assist the university in revising research related policies and strengthening areas of weakness in order to improve its ranking at both the national and international levels. Additionally, the findings of the research will be highly beneficial for librarians in acquiring the appropriate information resources to meet the specific demands of university scholars.

Literature Review

Research productivity in universities is crucial for a high-quality education, driving transformative advancements and nurturing national development through innovative approaches. Numerous studies have been conducted to determine the research productivity of different types of institutions at both national and international levels based on widely recognized reorganized Scopus and Web of Science (WoS) data sources. This section discusses selected literature pertaining to studies conducted to quantify research productivity of universities both globally and nationally.

Pradhan et al., (2021) conducted a study to evaluate the research productivity of VSS University of Technology (VSSUT), Odisha, using scientometric parameters such as Annual Growth Rate (AGR), author productivity, institution-wide collaboration, and collaboration patterns. Data from Scopus covering 2015 to 2020 were analyzed, encompassing 1889 publications. The study finds that the research published by VSSUT in high-quality journals lacks citations and major contributions were made from the field of engineering. Mahala and Singh (2021) analyzed 26,173 documents obtained from the Science Citation Index of WoS database to investigate the research output of Indian universities in the field of sciences from 2015 to 2019. The findings of the study indicate that papers with multiple authors have a greater research impact in terms of citations received. Additionally, the study reveals that the United States, South Korea, and Germany are the countries with the highest level of collaboration.

Various studies have been conducted locally to examine the research productivity of state universities in Sri Lanka, and some are reviewed here. A

study has been conducted by Seneviratne and Navaneethakrishnan (2018) to measure the research output of University of Moratuwa during the period 1981- 2017 based on Scopus. This study analyzed 1712 publications authored by 5491 researchers using scientometric methods. Chandani and Wijayasundara (2019) have conducted a study to analyze the pattern of scholarly publication indexed in Scopus from University of Sri Jayewardenepura during 1998 to 2018. This study used quantitative methods mainly descriptive analysis to achieve the objectives. Janen (2022) has conducted a study with the aim to quantify research output of University of Jaffna based on WoS during 2000-2019. This study used scientometric techniques to obtain the findings. Gupta (2012) examined scientific and technological research output of Sri Lanka between 2001 and 2010 based on Scopus database and underlined the need to invest in research and development, deploy skilled labor, collaborate internationally, and improve research infrastructure in order to increase research output of the country.

Research productivity of five state universities of Sri Lanka during the period 2015-2018 was studied by Wijetunge et al. (2020) using SciVal which is a tool built on the Scopus database. The study analyzed 4723 publications authored by 3831 authors and found that University of Colombo and University of Peradeniya had the highest number of publications. The study emphasizes the potential for university libraries to improve their services in order to promote research productivity. It suggests that librarians should focus on research data management, measuring research impact, and digital curation to assist their universities in achieving the best in research productivity. In addition, several studies were undertaken in Sri Lanka to assess the research productivity of the state universities and various academic fields. The majority

of the research relied on the Scopus database and employed similar bibliometric techniques to analyse the data. Nevertheless, few research studies have used visualization approaches to map the intellectual output of state universities in Sri Lanka. Further literature concerning the research productivity of EUSL has not been identified.

In measuring research productivity, most studies focused on several key metrics, including document types, publication growth rates, and citation counts. Studies often spotlighted the most productive authors, track keyword occurrences, analyze funding sources, and examine collaboration patterns, both local and international, that are crucial element of scientometric analysis.

Objectives

The main objective of the study is to analyze and map the scholarly research productivity of the Eastern University, Sri Lanka (EUSL) based on publications indexed in Scopus database since its first indexed publication to 2023. Following are the specific objectives of the study;

- To trace the growth rate and citation trend of research publications of EUSL
- To reveal the major areas of research produced by the university
- To determine the most preferred journals of the academics of EUSL
- To identify the most prolific authors of EUSL with high research productivity
- To map the co-authorship and collaboration pattern of the academics of EUSL
- To map the country-wise research collaboration of the university

Research Design and Methods

The research study is based on the scientometric approach, which is a widely used methodology for quantitatively evaluating research activities. It is a specialized field within bibliometrics that focuses on measuring and analyzing literature to assess new ideas, track research trends, and inform policy decisions and future research directions (Mahala & Singh, 2021).

Data Source

Data for the study were extracted from the Scopus database. Scopus is an abstract and citation database, which was introduced by Elsevier in 2004 as a novel search and exploration instrument. One notable aspect of Scopus is that it indexes all authors, institutional addresses, and bibliographic references for each publication, regardless of the type of article (Kulkanjanapiban & Silwattananusarn, 2022). Also Scopus continues to be the leading source for citation data and the most essential multidisciplinary bibliographic databases (Wang & Waltman, 2016).

Data Extraction

To retrieve bibliographic data “Eastern University, Sri Lanka” was used as the search phrase, in the Scopus search interface. The records were extracted with greater specificity by using the Scopus ID for Eastern University, Sri Lanka (60071086). Since the data were retrieved in July 2024, the results were limited to the period from the first indexed publication of EUSL in Scopus to 2023. Accordingly following query was used to obtain the records from the Scopus database.

AF-ID (“Eastern University Sri Lanka" 60071086) AND (EXCLUDE (PUBYEAR, 2024)).

Data Analysis

Various bibliometric tools were employed in this study to assess the records extracted from the Scopus database. The software programmes MS Excel and SPSS were utilized to analyze the trend of publication and citation. Moreover, three-term polynomial model was used to forecast the growth of publications in the forthcoming years. This is a regression model utilized to assess the relationship between a dependent variables and independent variables, particularly in non-linear contexts, and it has been frequently employed in trend analysis (Serrano et al., 2019). Additionally, the collaboration networks for co-authorship, co-occurrence, and geographical locations were visualized using VOSviewer which is a widely utilized knowledge mapping application that visualizes and generates networks composed of several nodes (Van Eck & Waltman, 2010).

Results and Discussion

General Information

The study found that total of 639 documents and 169 authors were affiliated with Scopus ID 60071086 for Eastern University, Sri Lanka up to 2023. In addition, this ID was associated with other name formats such as “Eastern University” and “Eastern University Sri Lanka”.

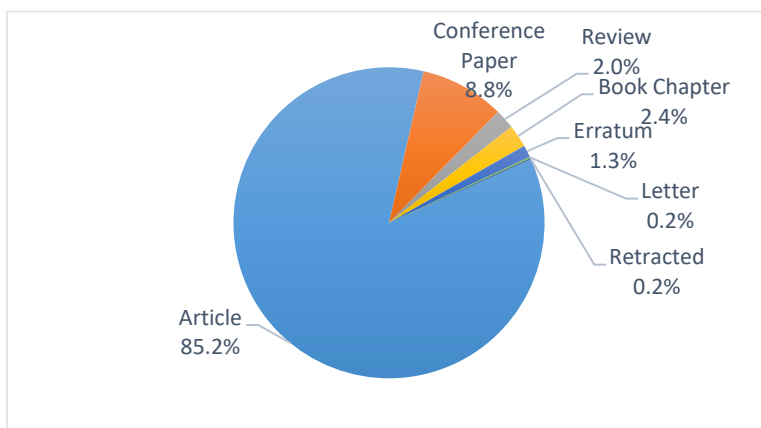
Types of Publications

Out of 639 documents, the majority are categorized as "Articles," making up 545 of the publications (85.2%). This is followed by "Conference papers", which account for 56 publications (8.8%). Additionally, the publications include 15 Book chapters (2.4%), 13 Reviews (2.0%), 8 Erratum

(1.3%), and 1 each for both Letters and Retracted papers (0.2%). The following figure 1 shows the various types of publications in the Scopus database.

Figure 1

Various types of research publications

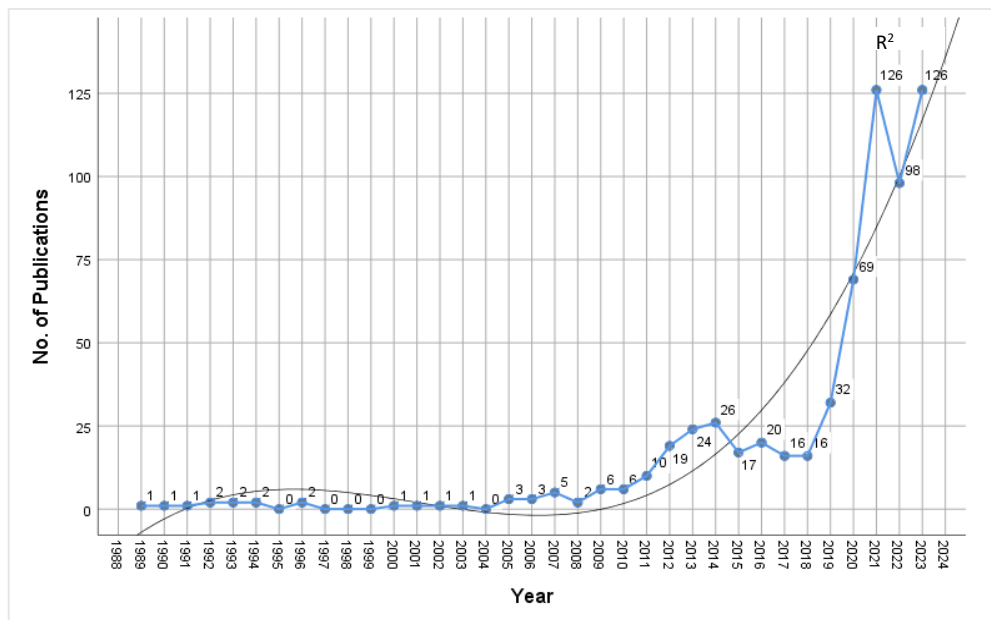


Publication Trend

The first publication indexed from EUSL in the Scopus database dates back to 1989. The publication growth did not show significant progress until 2010. From 2011 to 2018, there was an increase in publications, but the growth rate remained inconsistent. A persistent increasing trend of publications has been observed since 2018, with number of publications doubled each year and peaking in 2021 with 126 publications. However, there was a significant decline after 2021, but it picked up again in 2023 with 126 articles. Figure 2 depicts the growth of publications of EUSL from 1989 to 2023.

Figure 2

Growth of publications (1989 to 2023)



Furthermore, a three-term polynomial model was used to evaluate the relationship between the number of publications and the year. The model demonstrated a strong fit with the annual publication growth trend, as indicated by a high coefficient of determination ($R^2 = 0.837$). This fitting curve guarantees that growth of annual publications will increase in the future.

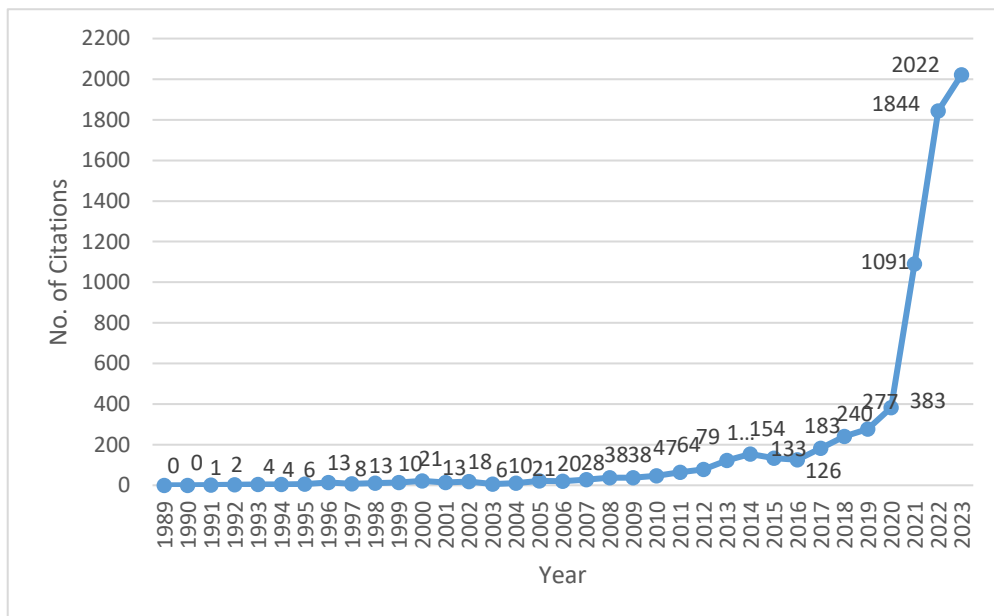
Citation Trend

Figure 3 clearly illustrates the research output of EUSL in terms of the total number of citations received for research publications each year. EUSL received its first citation in 1991. From 1991 to 2007, the citation counts were inconsistent. However, from 2008 to 2016, the number of citations gradually increased, although a slight decline was observed in the last two years of this period (2015 and 2016). After 2016, the citation count increased consistently,

culminating in a dramatic rise in the years 2021, 2022, and 2023, with 1091, 1844, and 2022 citations respectively. The analysis further reveals that average of 11.02 citations received per publication, which underscores the significance and quality of the research produced by EUSL scholars. These results suggest that EUSL has made substantial progress in establishing itself as a notable contributor to academic research, particularly in recent years.

Figure 3

Citation trend of research publications



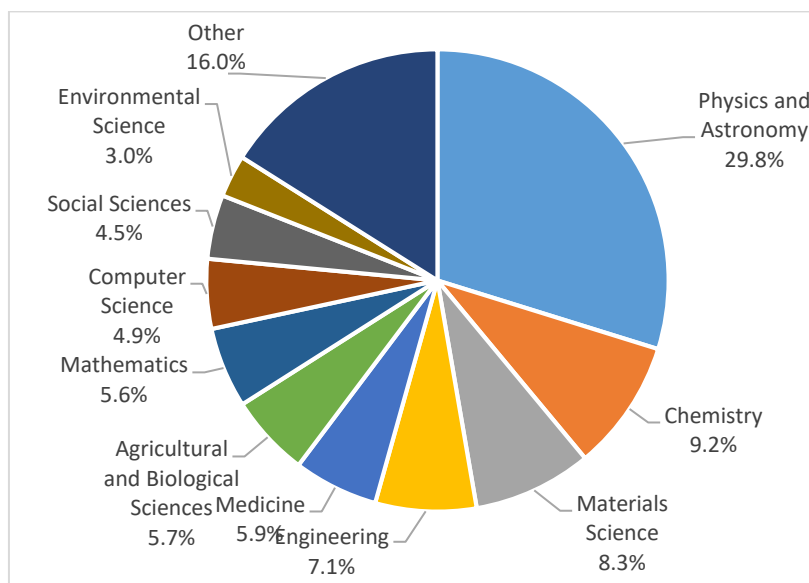
Major Areas of Research

According to Scopus, the research papers of EUSL are classified into 26 primary subject areas, with some publications falling into multiple subject categories simultaneously. The primary field of study for authors affiliated with EUSL is "Physics and Astronomy", with a total of 312 (29.8%) articles. This is followed by the field of "Chemistry", which has 96 (9.2%) publications.

Following the study of chemistry, a total of 87 (8.3%) papers were published in the topic category of “Materials Science”. Figure 4 illustrates the ten subject categories that have the highest number of publications authored by the scholars of EUSL.

Figure 4

Major subject categories of research publications



The aforementioned statistics indicate that the top ten research areas exclusively comprised of science disciplines and comparatively less publications from the fields of Social Sciences, Arts, and Humanities. One probable explanation could be the limited number of Scopus indexed journals in these fields and the faculties in these streams at EUSL use the local language (Tamil) as their medium of instructions.

Most Preferred Journals

Table 1 lists the ten most prominent academic journals where the highest number of articles published by researchers affiliated with EUSL. At the top is the "Journal of High Energy Physics", with 88 articles, followed by "Acta Crystallographica Section E Structure Reports Online" with 43 articles. The "European Physical Journal C" ranks third with 34 papers. Additionally, Table 1 provides comprehensive information about these journals, including their Impact Factor (for 2023), Scopus coverage, publisher, Cite Score (CS), SCImago Journal Rank (SJR), and Source-Normalized Impact per Paper (SNIP). This detailed data highlights the prominent sources of publications associated with EUSL, showcasing their impact and reach within the academic community.

Table 1

Top 10 preferred journals for the authors affiliated with EUSL

Source	No. of Articles	IF (2023)	Scopus Coverage	Publisher	CS	SJR	SNIP
Journal of High Energy Physics	88	5.0	1997-2023	Springer Nature	10.0	0.832	1.132
Acta Crystallographica Section E Structure Reports Online	43	0.5	2003 -2015	International Union of Crystallography	0.8	0.136	0.210
European Physical Journal C	34	4.2	1991-1995, 1998 -2023	Springer Nature	8.1	1.451	1.218
Physical Review D	31	4.6	1989, 2001 - 2003, 2008, 2015 - 2023	American Physical Society	9.2	1.639	1.185
Physical Review Letters	24	8.1	1958 - 2023	American Physical Society	16.5	3.040	2.162
Physics Letters Section B Nuclear Elementary Particle and High Energy Physics	15	4.3	1967 to Present	Elsevier	9.1	1.593	1.175
Journal of Instrumentation	9	1.3	2006 - 2023	Institute of Physics Publishing	2.4	0.580	0.917

Acta Crystallographica Section E Crystallographic Communications	7	0.5	2015 - 2023	International Union of Crystallography	1.9	0.233	0.439
Polyhedron	7	2.4	1982 to Present	Elsevier	4.9	0.379	0.579
Pramana Journal of Physics	6	1.9	1973 - 2023	Springer Nature	3.6	0.382	0.640

*CS- CiteScore; SJR- SCImago Journal Rank; SNIP- Source-Normalized Impact per Paper

(Note. www.scopus.com/sources and Journals website as at July, 2024)

Most Prolific Authors

The most prolific authors are determined by the quantity of articles in journals indexed in Scopus throughout the specified study period. Table 2 delineates the top ten most productive authors, including citation counts for their publications, and average citations per publication.

Table 2

Top 10 productive authors based on number of publications

Rank	Author	No. Articles	H-Index as per the Scopus	Total Citation	Avg. citation per publication
1	Sithambaresan, M.	77	16	615	7.99
2	Johnpillai, A.G.	41	14	554	13.51
3	Thirukkanesh, S.	39	18	859	22.03
4	Rifky, M.	26	8	134	5.15
5	Thavareesan, S.	23	14	812	35.30
6	Ragel, F.C.	21	11	408	19.43
7	Ranathunge, T.	15	7	176	11.73
8	Thadchanamoorthy, V.	14	4	35	2.50
9	Sotheeswaran, S.	13	5	46	3.54
10	Koneswaran, M.	11	7	690	62.73
10	Prasannath, K.	11	6	185	16.82
10	Sakuntharaj, R.	11	6	260	23.64
10	Seran, T.H.	11	5	60	5.45

The results reveal that academics from the Faculty of Science at EUSL are the most prolific in terms of research output, dominating the top 10 list of authors. Sithambaresan, M. from the Department of Chemistry leads with 77 publications, demonstrating a significant contribution to the university's research productivity. Johnpillai, A.G. and Thirukkanesh, S. from the Department of Mathematics follow with 41 and 39 publications, respectively, further highlighting the active research culture within the Faculty of Science.

When considering citation counts, Thirukkanesh, S. stands out with 859 citations, indicating the high impact and recognition of their research work. Thavareesan, S. from the Department of Computing follows closely with 812 citations, reflecting strong research engagement in the field of computing. Koneswaran, M. from the Department of Chemistry, with 690 citations, also demonstrates substantial research influence. Notably, Koneswaran, M. holds the highest average citation per publication at 62.73, underscoring the quality and significance of his research contributions. Overall, these results highlight that the Faculty of Science, particularly in the fields of Chemistry, Mathematics, and Computing, plays a crucial role in driving EUSL's research output and impact.

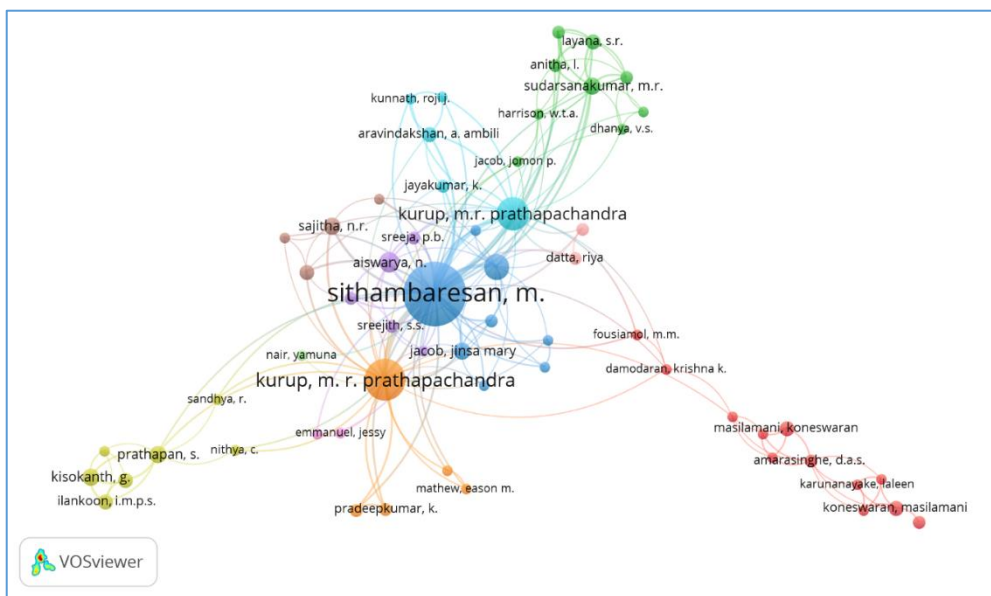
Co-authorship Mapping

Co-authorship map was developed through the analysis of data from academics who contributed a minimum of two publications and received at least one citation in the Scopus database, using VOSviewer. Among the authors in the data set, 252 met the threshold, with the largest set of connected items comprising 60 authors organized into 11 clusters. Figure 5 illustrates the results. The large number of citations and link strength demonstrated by

Sithambaresan, M. is noteworthy. Further, it was noted that connections among EUSL academics are not well established.

Figure 5

Co-authorship network map of authors

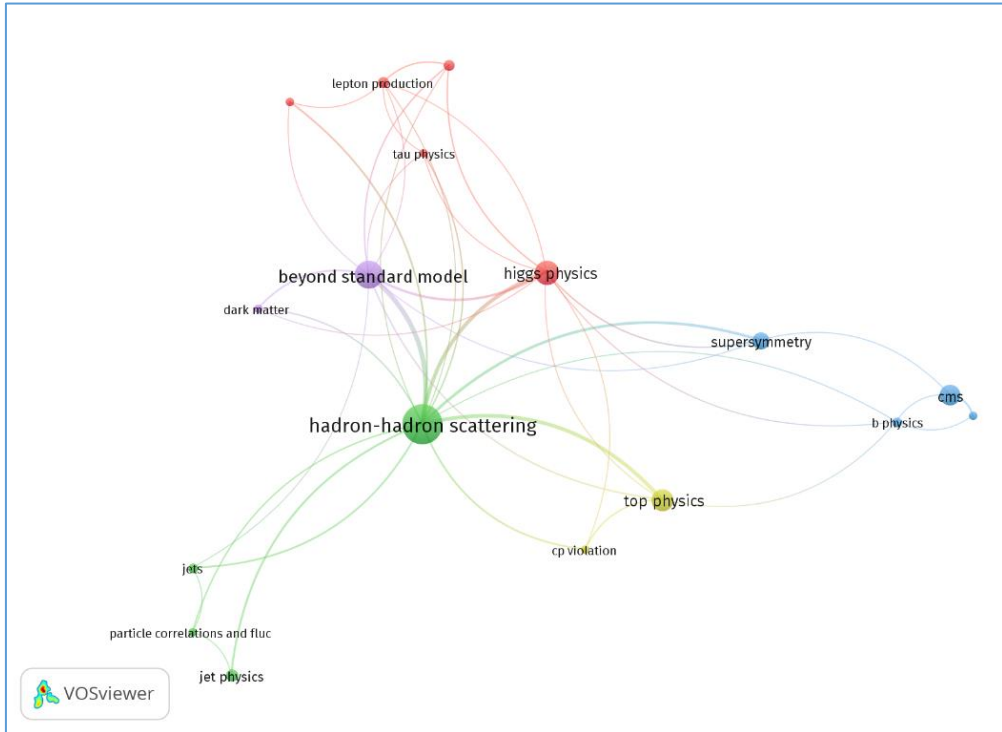


Keywords Cluster Mapping

The keywords, typically specific, are employed to enhance the visibility of research paper and ensure the content is adequately searchable. The data extracted from the Scopus database was analyzed to find out the co-occurrence of author keywords at least with three times. It was found that out of 1413 keywords 73 met the threshold. Largest set of connected items comprising 17 keywords categorized into 5 clusters. Following figure 6 shows the visualization obtained from VOSviewer.

Figure 6

Co-occurrence of author keywords network



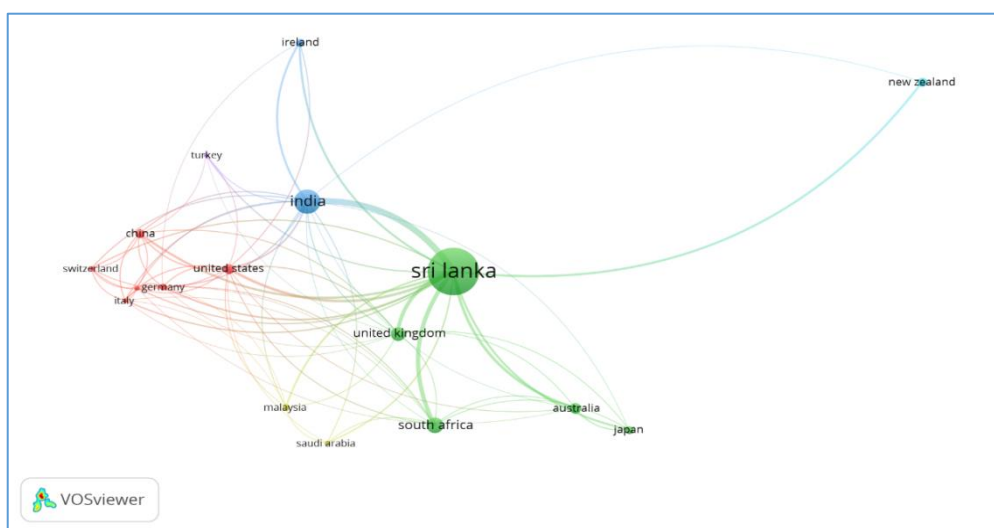
The diameter of the circle signifies the frequency of keywords used in research articles, while the thickness of the connecting lines denotes the strength of the intra-association among terms. The most frequently occurring keyword was "hadron-hadron scattering" with 58 occurrences, followed by "beyond standard model" (27), "higgs physics" (22), "top physics" (18) and "single-crystal X-ray study" (16).

Country Level Collaboration Mapping

The co authorship analysis was performed in VOSviewer using countries as unit of analysis and minimum number of documents of a country set to 5. It was observed that 17 items in 6 clusters met the threshold. Figure 7 depicts country level collaboration network visualization.

Figure 7

Country level collaboration network map



As expected, most collaboration take place within Sri Lanka with 440 documents. This strong local collaboration suggests that EUSL actively engages with other Sri Lankan universities and research institutions, nurturing a strong national research network. India emerges as the leading international collaborator, with 117 joint publications, highlighting a strong academic relationship between EUSL and Indian institutions. This could be attributed to geographical proximity, cultural ties, and shared academic interests. Beyond India, EUSL has also established notable collaborations with South Africa (50

documents), the United Kingdom (39 documents), Australia (22 documents), and the United States (21 documents). These collaborations, though fewer in number, reflect growing presence of EUSL in the global academic community and its efforts to engage with diverse research partners. The involvement of countries from different continents suggests that EUSL is gradually expanding its international research footprint, enhancing the quality and visibility of its research through global partnerships.

Conclusions and Discussion

The bibliometric analysis revealed that journal articles constituted the major publications affiliated with EUSL that are indexed in the Scopus database from 1989 to 2023. Growth of publications were progressive until 2021, after which there was a modest decline in 2022. However, it has risen in 2023, and the analysis confirms the potential for future increases. In addition, the significant surge from 2018 to 2021 clearly witnesses that EUSL scholars have shown enthusiasm in publishing articles in indexed journals. Similar to the publication trend, the number of citations has also been continuously increasing from 2016 to 2023. In the last three years, there has been a significant increase in the number of citations, with the growth of documents associated with EUSL and it will be expected to continue in future as per the statistical analysis.

The major research contributions of EUSL are in the field of Physics, while other fields have relatively less publications. However, the determination of the most productive authors highlights significant contributions in the field of Chemistry, Mathematics, and Computing, which play a crucial role in driving the university's research output and impact. Furthermore, the main

research areas were dominated by science disciplines, with fewer publications in Social Sciences, Arts, and Humanities, likely due to the limited number of Scopus-indexed journals in these fields and the use of local language Tamil as the medium of instruction at in these fields of studies at EUSL. The collaboration between authors from EUSL and other nations is remarkable. Nevertheless, collaboration among university scholars is not significant.

According to the findings of this study, it is recommended that the authorities of EUSL should make efforts to encourage the staff to publish their research work in reputed indexed journals and international conferences. Furthermore, introducing faculty-wise awards or honorariums for academics based on their publications, will enhance the research output. Providing access to reputed databases in the field of major research area and subscribing to anti plagiarism software will significantly improve the publication output of EUSL. The library should play a vital role in enhancing the research productivity of the EUSL by conducting workshops pertaining to publishing research papers and offering assistance towards fostering a research-oriented environment among young scholars. All university academics need to create a profile on the research networks, such as Google Scholar, Research Gate, Scopus, etc., in order to increase the visibility of their work and improve the university's rank.

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Awareness, Usage, and Satisfaction with Online Databases Subscribed by the UGC Consortium and National Science Foundation among Academics in Eastern University, Sri Lanka

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ABSTRACT

The massive proliferation of online databases has profoundly impacted academic research and scholarly communication. This study describes the results of a questionnaire-based survey, which was conducted to investigate awareness, usage and satisfaction with subscribed online databases among academics at Eastern University, Sri Lanka (EUSL). Self-administrated questionnaires were distributed among staff members from all six faculties of Eastern University, Sri Lanka and three departments of Swami Vipulananda Institute of Aesthetic Studies (SVIAS), Eastern University, Sri Lanka (n=149). Data were analyzed descriptively using SPSS software. The results revealed that the main purpose of using the subscribed databases was scholarly communication, which was around 60%. A substantial percentage (82%) of the staff visited the library website to access the links for these databases.

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Although the university provided remote access to these subscribed databases through user authentication, most respondents (61%) were unaware of the off-campus access. Further, the highest percentage (81.1%) of the staff were satisfied with the appropriateness of the databases. As an overall picture, these subscribed databases were rarely accessed by academics. The findings clearly stated that a few percent of staff were satisfied with the databases in terms of accessing all the articles they needed. The study recommends that the library should subscribe to more online databases that are relevant to the needs of the academic staff and students at the university. Academic libraries ought to implement innovative tactics to encourage the use of online databases to which they have subscriptions.

Keywords: Online Resources, Databases, Eastern University, Sri Lanka, Academics, Awareness

Introduction

Online research databases provide academics and scholars with the most recent and relevant information. Because of technological advancements, electronic databases have continued to gain prominence in tertiary education institutions worldwide, and many academics avail themselves of the opportunity to exploit these resources to access relevant and up-to-date information for diverse purposes. These databases are valuable resources for teaching, learning, research, and community building in any academic setting since they provide current information. Electronic databases provide access to vast amounts of academic information, which is vital for the overall academic performance of the faculty. Online databases provide additional advantages over print resources, such as reduced storage space, huge information capacity, strong sharing ability, high potential for collection extension, and

accessibility from anywhere and at any time (Zhang et al., 2011). At present, Artificial Intelligence (AI) has emerged as a key driver of innovation in the digital era, offering new possibilities for the development of Web 3.0. Generative AI has been used in many databases in its search process. Although researchers are attracted to the fascinating features of AI in delivering processed information, the importance of online databases cannot be underestimated. Because the large language models of AI tools deal only with open-access content in the public domain, they may not retrieve the content available in proprietary databases.

Realizing the importance of having access to electronic databases in teaching and research, the Standing Committee of Library and Information Science (SCOLIS) of the University Grants Commission (UGC) formed a consortium following a centrally supported concept. The Consortium of Sri Lankan Academic Libraries (CONSAL) was established in January 2014, and the SCOLIS spent significant amounts of money on online subscriptions for five internationally renowned databases and provided access to 15 UGC-accredited universities. The key goals of this initiative were to enhance access to academic journals at a low cost while also increasing the research productivity of participating universities through increased access to high-quality research articles. When this study was conducted, the UGC consortium provided access to Wiley Online, Emerald Insight, Sage Research Methods, Oxford University Press, and Oxford Medicine Online, while the National Science Foundation provided access to the Scopus database. Currently, the UGC Consortium provides access only to two databases, namely Emerald Insight and Oxford University Press.

Even though these online databases are easily accessible, they are still underutilized. There are several reasons leading to their underutilization. One of the most significant challenges is the lack of awareness and ability to use online resources. The most significant factors affecting e-resource usage among respondents were lack of access to archival issues and full text, the inability to access databases from home, lack of training in using e-resources, lack of computer and the Internet (Wijetunge & Sivasanthiran, 2020). Therefore, one of the most important responsibilities of librarians is to educate academics about available online databases and how to use them. Furthermore, librarians are liable for identifying problems associated with these databases and resolving such issues in order to provide better services to their customers (Lavanya & Santharooban, 2018).

This study was conducted to investigate the behaviour of academic staff in using online databases, highlighting user preferences and access patterns. Although this study was carried out in 2022, it remains relevant to the current context. Due to the economic crisis in the country, many databases were not subscribed by the UGC. However, as the country's financial situation gradually stabilizes, it is likely that subscriptions will resume, given the increasing demand for databases to support research and development activities. Therefore, the findings of this study will be useful in selecting suitable databases for the university and in planning effective marketing strategies to maximize their usage. Furthermore, the research findings will provide a valuable basis for comparing levels of awareness in the past and present at EUSL.

Problem Statement

Despite the huge investment of public funds to the subscription of databases, their usage was questionable. To ensure that these investments were worthwhile, there was a need to assess whether they served the purpose for which they subscribed and how relevant and useful these databases were in satisfying the information needs. This kind of assessment will serve as baseline information for making policy decisions in the future when subscribing to online databases. As per the previous literature, there was no scientific evidence regarding assessing awareness, usage and satisfaction with subscribed online databases among academics in EUSL. Only a limited number of researchers have explored the utilization of online databases by academics in various Sri Lankan universities (Arachchige & Karunaratne, 2014; Girakaduwa, 2019; Wijetunge, 2017; Wijetunge & Sivasanthiran, 2020).

Objectives

The main objective of the study was to study awareness, usage and satisfaction with subscribed online databases among academics in the EUSL.

The specific objectives were;

- To determine the awareness and usage of the online databases available to the staff
- To find out the level of satisfaction with the subscribed online databases
- To examine the barriers faced in using online databases

Literature Review

Awareness and usage patterns of scholarly databases by faculty members are important in any academic context. Numerous studies have been conducted to study the knowledge, usage, satisfaction, and impediments to electronic database resources in both local and international contexts. A study by Larson (2017) focused on examining the level of understanding and utilization of online resources that the library subscribed to at the University of Education in Winneba, Ghana. Based on the findings, it appeared that most participants were aware of the databases, while a minority were completely unaware of their existence. Additionally, some faculty members who used the databases were familiar with them and used them for research and teaching. The findings indicated that faculty members acknowledged the significance of databases for their information requirements. However, several obstacles hindered their effective utilization, such as the absence of off-campus database access, faulty passwords for certain databases, and the Internet connectivity problems.

Adetomiwa and Okwilagwe (2018) performed a survey among academic staff members at private universities in Nigeria to evaluate their understanding of electronic databases. The results indicated that teacher awareness was somewhat high, whereas the use of electronic databases was average. Most of the faculty members possessed a greater level of expertise in use of e-books and e-journals. The results also indicated a significant correlation between knowledge and the use of electronic databases among the faculty personnel. Tandi Lwoga and Sukums (2018) conducted a study to examine the factors that influence the uninterrupted availability of electronic resources at a health science university in Tanzania. The results indicated that

most of the faculty members were acquainted with several search engines and databases, including Wikipedia, Google, Google Scholar, and academic databases such as HINARI and PubMed. Nevertheless, fewer than 50% of participants were knowledgeable about other scholarly databases and search engines.

In a study conducted in 2020, Hendal aimed to examine the magnitude of advantages derived from electronic resources offered by the Kuwait University Libraries Administration, particularly considering the COVID-19 epidemic in the same year. The participants predominantly used electronic resources to write research articles, with e-journals being their favourite choice. Moreover, most individuals who did not utilize these tools expressed that they found them unhelpful, while the rest of the participants mentioned about their lack of knowledge on how to utilize them. The results also demonstrated that the majority of those who did not utilize electronic databases had a strong desire to acquire more knowledge about them. The findings also indicated that most non-users were eager to learn more about electronic databases. Most of the main challenges faced by the respondents were similar to those encountered by universities in other countries, such as the lack of access to full-text articles and the need for more database subscriptions (Hendal, 2020).

Sri Lankan literature primarily explored the utilization of electronic resources by undergraduate and postgraduate students across different disciplines. Nevertheless, only a few individuals had expressed their apprehension over the university academic staff. In 2017, Wijetunge conducted a study on the utilization of electronic resources available through CONSAL and other channels for professionals in the field of Library and

Information Sciences (LIS) at public universities in Sri Lanka. Around 60% of the respondents indicated that the accessible electronic resources adequately fulfilled their requirements. The study further highlighted the difficulties encountered by the staff members. Major obstacles identified include difficulty in accessing databases remotely, unavailability of some full-text articles, dearth of pertinent information, and lack of access to archival materials (Wijetunge, 2017).

Wijetunge and Sivasanthiran (2020) conducted a study on the use of electronic resources by academics at the University of Jaffna, Sri Lanka. Based on their studies, academics mostly utilized the Internet to fulfil their teaching and research requirements. The primary channels through which they acquired information about electronic resources were their peers and librarians. Around 44.1% of the respondents expressed a moderate level of satisfaction with the information coverage offered by the available e-resources, while 29.4% were happy and 26.5% were dissatisfied. The usage of databases was determined by several variables, including the unavailability of full-text databases, the difficulty in accessing databases from home, the lack of access to archiving concerns, and the absence of training in using electronic resources.

Additionally, Girakaduwa (2019) conducted a study on the utilization of electronic resources, services, and challenges encountered by library patrons at the University of Visual and Performing Arts (UVPA) in Sri Lanka. The sample included students, academics, and non-academic staff members. The findings indicated that the use of the database was rather low. The survey revealed that around 37.8% of participants had not utilized any electronic resources or services. Moreover, research revealed that 46% of participants

used e-journals and digital repositories. Thus, a significant percentage (62.2%) of the participants expressed satisfaction with the e-resources and other services provided by the library (Girakaduwa, 2019). Arachchige and Karunaratne (2014) conducted a study on the usage of electronic resources by engineering academics in Sri Lanka. The researcher investigated whether they used commercial or open-access databases. Based on their research, academics heavily used electronic resources and engineering academics specifically relied on open-access e-resources to fulfil their information requirements. This preference was due to the relatively high cost and complexity associated with accessing commercial e-resources in the country. An analysis of the existing literature highlighted deficiencies in knowledge about the purpose and frequency of using electronic resources, the extent of the levels of awareness and satisfaction, training requirements, and the factors that influence usage among academic staff in Sri Lanka. Consequently, our work aimed to address these drawbacks.

Research Design and Methods

A cross-sectional study was conducted among the academic staff of the Eastern University, Sri Lanka. The total number of academic staff were 241 and, the calculated sample size was 149 (Krejcie & Morgan, 1970) and the sample size was proportionally allocated for each faculty. The samples were selected by stratified random sampling. A self-administered questionnaire, which was developed by the authors, was used as a data collection tool. A pilot study was conducted among ten randomly selected academic staff members from the faculties, and the response was used to check the internal consistency of the tool. Descriptive and inferential statistics were used to analyze the data. Frequencies and percentages were calculated.

Correspondence analysis was performed to visualize the pattern to show the association between database usage and faculty. Satisfaction level was analyzed using a 5-point Likert scale ranging from ‘Strongly Disagree’ to ‘Strongly Agree’.

Results and Discussion

The response rate was 80.5% (149 academic staff responded to the survey). Table 1 shows the demographic profile of the respondents. Accordingly, the majority of the respondents were Senior Lecturers I or II. The Master's degree (including M.Phil) was the highest qualification most of them had, which was followed by a Doctoral degree. Regarding the respondent's work experience in the university system, 31.4% reported that they had 5-10 years of experience, whereas 28.6% were new recruitments. Around 4.3% of the staff had 16-20 years of experience. Most of the respondents belonged to the category who published one to three papers in previous years. It is important to note that nearly 10% of staff did not publish any papers in the previous year.

Table 1
Demographic profile

	Demographic details	Frequency	Percentage (%)
Faculty/ Institute	Faculty of Agriculture	10	8.3
	Faculty of Arts and Culture	16	13.3
	Faculty of Commerce and Management	10	8.3
	Faculty of Health-Care Sciences	36	30.0
	Faculty of Science	17	14.3
	Faculty of Technology	5	4.1
	SVIAS	26	21.7
	Total		120

Designation	Senior Professor	2	1.7
	Professor	3	2.5
	Associate Professor	2	1.7
	Senior Lecturer (Gr I or II)	56	46.3
	Lecturer (Confirmed/ unconfirmed)	16	13.4
	Lecturer (Probationary)	41	34.4
	Total	120	100
Educational qualification	Bachelor Degree	34	28.6
	Master's degree (including M.Phil)	48	40.0
	Doctoral degree	38	31.4
	Total	120	100
Experience in the University system	Less than 5 years	34	28.6
	5-10 years	38	31.4
	11-15 years	29	24.3
	16-20 years	5	4.3
	Above 20 years	14	11.4
	Total	120	100
Gender	Female	65	54.3
	Male	55	45.7
	Total	120	100
Number of research papers published in the previous year	1-3	91	75.7
	4-6	12	10.0
	More than 6	05	4.3
	Did not publish	12	10.0
	Total	120	100

Awareness and Use of Databases

The main purpose of using the subscribed database was for scholarly communication, which was around 60%. Additionally, the academics used databases for teaching (44%) and updating their subject knowledge (50%). The majority of the staff were getting information via library E-mail communication (38%), followed by library website and personnel communication with librarians, which were around 27% and 15%, respectively. Most of the staff preferred to access the UGC subscribed

databases within university premises and off campus, which was around 68%. It was encouraging to note that around 82% of the staff visited the library website to access these databases.

Regarding the awareness of the availability of databases, 42.9% and 38.6% of the respondents chose Oxford Journals and Wiley Online Library, respectively, at EUSL. Only 28.6% of the staff were aware that Scopus was available at EUSL. As per the findings, the majority of the staff were not aware of the availability of databases at the university. These findings recommended that the librarians must engage more in educating the users regarding the available databases. Regarding the Sage Research Methods database, 68.6% of the staff stated that they were unaware that this database was dedicated to research methods. Eastern University provided remote access to these subscribed databases through a user authentication provided by the Center for Information and Communication Technology (CICT). Although the university provided this facility, the majority of the respondents (61%) were not aware of the off-campus access.

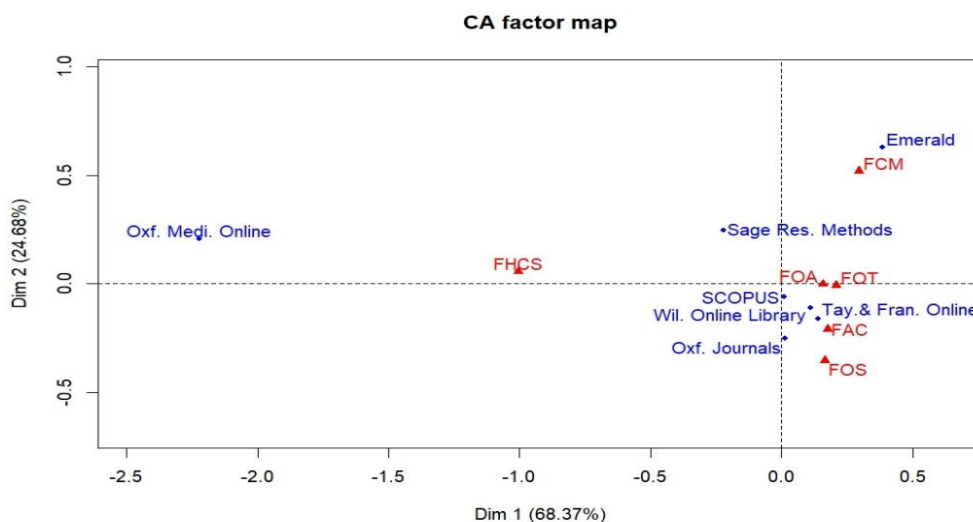
Association of Databases Preference with Faculty

A correspondence analysis was performed to assess the association between database preference and faculty. The results revealed that there was a significant association between database preference and faculty ($\chi^2 = 283.19$, $p < 0.0001$). Figure 1 indicates the two-dimensional factor map illustrating the association of database preferences with faculty. As per the plot, Oxford Medicine Online was preferred mainly by the academic staff of the Faculty of Health-Care Sciences, while the Faculty of Commerce and Management mostly used Emerald Insight. Usage of Taylor and Francis

Online, Scopus, Wiley Online Library and Oxford Journals were associated with the Faculty of Science, Agriculture, Technology, Arts, and Culture.

Figure 1

Biplot of Correspondence analysis to show the association of database usage with faculty



Frequency of Using the Databases

Around 32.5% of the faculty accessed the Scopus database a few times a week. Similarly, 31.1% of them accessed the Wiley Online Library. Overall, these subscribed databases were rarely accessed by academics, as indicated in Table 2. According to Table 2, nearly fifty or more percent of respondents never used the Emerald Insight and Sage Research Methods databases, although these databases are relevant to many fields. Frequent users of these databases were also few. Therefore, the reasons behind the low usage of these databases should be carefully analyzed by librarians in order to increase their usage. In addition, usage statistics of these databases should be monitored by the librarians.

Table 2
Frequency of using databases

Databases	Everyday N (%)	A few times a week N (%)	A few times a month N (%)	A few times a year N (%)	Never used N (%)
Emerald Insight	3 (2.5)	33 (27.5)	12 (10.0)	12 (10.0)	60 (50)
Oxford Journals	0	17 (17.4)	28 (28.3)	14 (13.0)	41 (41.3)
Oxford Medicine Online	0	7 (7.7)	7 (7.7)	23 (25.6)	53 (59.0)
Sage Research Methods	0	8 (7.7)	15 (12.8)	28 (25.6)	59 (53.9)
SCOPUS	2 (2.3)	31 (32.6)	15 (16.3)	9 (9.3)	38 (39.5)
Taylor & Francis Online	0	24 (30.2)	11 (14.0)	15 (18.6)	30 (37.2)
Wiley Online Library	0	30 (31.1)	19 (20.0)	8 (8.9)	38 (40.0)

Satisfaction with the Databases

The satisfaction of databases was measured using six statements on a Likert scale. Responses to agree and strongly agree were considered satisfied, and responses to disagree and strongly disagree were considered dissatisfied, while the undecided were considered neutral (Table 3).

Around 81.1% of the academics were satisfied with the databases as they were appropriate for their requirements. More than 50% of them were satisfied with the subject coverage and authenticity of databases (Table 3). However, only 39.2% of the respondents agreed with the statement relating to easy-to-get articles from other sites than these databases.

Based on the findings, it clearly stated that around 32% of the academics were dissatisfied with the database regarding accessing articles they needed.

Table 3
Satisfaction with the databases

Statements	Dissatisfied	Neutral	Satisfied
Provided databases are appropriate for my requirements	10 (10.5%)	8 (8.4%)	77 (81.1%)
I can find all the research articles necessary for me from these databases	29 (32.2%)	25 (27.7%)	36 (40.0%)
These databases provide authentic information	6 (6.6%)	17 (18.8%)	67 (74.4%)
I am satisfied with the subject coverage of these databases	18 (18.9%)	23 (24.2%)	54 (56.8%)
I save my time to find suitable research article through these databases	10 (10.2%)	24 (24.5%)	64 (65.3%)
It is easier to get articles from other sites than these databases	24 (24.7%)	35 (36.1%)	38 (39.2%)

Arachchige and Karunaratne investigated the use of e-resources among engineering academics in Sri Lanka in 2014. Their findings reported that academics obtained commercial e-resources mostly through personal purchasing or through channels other than the library since libraries were unable to provide a satisfactory amount of e-resources due to the lack of funds (Arachchige & Karunaratne, 2014).

Therefore, CONSAL should consider the opinions and recommendations of the user community before subscribing to databases from vendors. They can conduct an opinion survey among all university academics

before making the commitments. Librarians are also responsible for conducting opinion surveys on these databases to collect suggestions from users periodically. Otherwise, the databases will be underutilized, and there will be no point in spending a huge amount of funds on subscribing to them.

Barriers to Using Databases

The results revealed that most of the staff were unaware of the databases provided by EUSL, as indicated in Table 4. Another major barrier is the problems regarding accessibility of the full text of all the articles followed by the non-relevancy of the database. The non-relevancy was especially reported by academic staff from SVIAS. The research conducted by Wijetunge and Sivasanthiran (2020) examined the utilization of electronic resources among academics affiliated with the University of Jaffna in Sri Lanka. Observations revealed that none of them expressed satisfaction above 75% with the e-resources available to them. Moreover, they determined the variables that influenced the utilization of electronic resources. The main determinants influencing the use of e-resources were limited archive materials, failure to access complete texts, difficulty in accessing databases remotely, and insufficient training in e-resource utilization. In a similar vein, Girakaduwa (2019) initiated research on the use of electronic resources and services and the obstacles encountered by library users at the University of the Visual and Performing Arts (UVPA), Sri Lanka. The researcher highlighted that insufficient user education and awareness programmes were considered the primary obstacles to using e-resources.

Table 4
Barriers in using the databases

Barriers	Yes Frequency (%)
I am not aware of all the databases provided by EUSL	78 (71.4)
There are no research papers in my language	43 (38.9)
I am not aware of how to use databases/search articles	42 (44)
The available databases are not relevant to my field	65 (68.2)
The relevant databases do not cover my research field	42 (46.2)
Unable to read old research articles	37 (40.9)
Unable to download the full text of all the articles I needed.	65 (72.5)

Training Needs

According to the findings indicated in Table 5, around 85.7% of the academics preferred to receive training on currently subscribed databases.

Table 5
The topics for training

Topics	Yes N (%)
Awareness of databases provided by EUSL	94 (85.7)
Searching and retrieval of research papers	86 (95.8)
Awareness of open-access databases	85 (90)

Further, the relevant topics for training needs have been recorded. The majority of the staff were interested in having training programs on “searching and retrieval of research papers”, as indicated in Table 6. Therefore, Librarians should take necessary actions to organize workshops continuously to make them aware and educate them on searching skills.

Conclusions and Discussion

The results revealed that the main purpose of using the subscribed databases was scholarly communication, followed by updating subject knowledge. As per the findings, the majority of the academics were not aware of the databases available at the university. Therefore, there is a need to make them aware of available databases and how to access them on-campus and off-campus. As per the findings, academics rarely accessed the subscribed databases. Based on the findings, it clearly stated that the faculty were not highly satisfied with the databases regarding accessibility of the articles they needed and around 81.1% of the staff were satisfied with the fact that the databases were appropriate for their requirements. The major barriers to using the databases were the inability to download the full text of the articles, not being aware of all the databases provided by EUSL, and the fact that the available databases were not relevant to some of the fields.

Regarding the training needs, the majority of the staff were interested in having training programs on “searching and retrieval of research papers” followed by programs on “awareness of open access databases”. It shows that there is a need for the university management to subscribe to relevant databases, with the support of external funding, to fulfil the requirements of staff members. These subscriptions should be constantly renewed to avoid any inconvenience to users. It is recommended that library staff conduct more user studies and update the facilities accordingly with recent developments of the subscribed databases via current awareness services to the university community.

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Ancient Sinhala Numeral Systems Discovered from Palm-leaf Manuscripts in Sri Lanka

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ABSTRACT

Counting is as old as human civilizations and different numbering methods have been indigenous to respective cultures and lands. Until the modern numeric system was introduced, people successfully adopted their own numbering methods, which were used for many millennia. Hence, this study was undertaken as an explorative research project to find out (objective) how ancient monasteries in Sri Lanka indexed and organized the palm-leaf manuscripts in the pre-modern numeric period. In this regard, Sinhala numerals have special linguistic and logical ties with local communities, thus those numbers in the manuscripts are important in indexing and cataloguing the resources. Sri Lanka has historically used (and still uses, to extent) its own numeric system in its ancient palm-leaf manuscripts both in Sinhala and Tamil literary work. This research mainly focused on Sinhala palm-leaf manuscripts preserved in selected Buddhist monasteries in Sri Lanka.

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Since this was a qualitative research study carried out for three years, involving observation with the assistance of specialists, there was no predefined population to mention, hence, all the manuscripts available in the study areas were taken into consideration. Manual textual analysis of 4,568 manuscripts unveiled five different types of Sinhala numerals corresponding to different timelines, and disclosed the evolution of number system through various reigns. The numeral systems discovered through this study are Sinhala *illakkam*, *Lith illakkam*, *Pansal Hodiya*, Indo-Arabic numbers, and Tamil numbers. The Sinhala *illakkam* was the oldest numeral system found in palm leaf writings during 1754-1825 AD. It was specifically used for Pali and literary contents. The *Lith illakkam* was as old as Sinhala *illakkam* and was used for astrological and native medicinal content in palm-leaf manuscripts. The most prominent numeral system was *Pansal Hodiya*, which was later replaced by the Indo-Arabic numeral system, which took place gradually since 16th Century (Senevirathne, 2018). The Tamil numeral system was also identified. Digitalization process of palm-leaf manuscripts will be the next level of this study, which is crucial for information access and preservation of the palm-leaf manuscripts. Additionally, incorporating AI tools to analyze digitized materials could create new opportunities for future research in this domain, such as automated text detection and content analysis.

Keywords: Numeral Systems, Languages, Palm-leaf Manuscripts, Textual Analysis, Ola-leaf Manuscripts, Sri Lanka

Introduction

Buddhist monasteries and temples have been the custodians of numerous ancient manuscripts containing literature on spirituality, rituals, history, culture, medicine, and folklore of Sri Lanka. These manuscripts packed in palm-leaf bundles, contained different numeral systems corresponding to changing reigns and timelines in the island. The numeral systems reflected the linguistic and socio-cultural transformation of the region. Moreover, in the process of digitalization of palm-leaf manuscripts it is essential to recognize the numerals and special characters of it, especially when the sources are deteriorated, damaged, or even partially destroyed due to poor preservation methods. Therefore, exploration of the palm-leaf manuscripts is important in preserving the vulnerable material, developing their repository, and in indexing and organizing. During this three-year study, every palm-leaf was meticulously analyzed for their numeral system. Most importantly, such a study has not been carried out to this extent before to analyze the numeral system used in Sri Lanka.

Objectives

Investigating the significant and unique types of Sinhala numeral systems used in palm-leaf manuscripts in Sri Lanka was the primary objective of this study, along with the following specific objectives:

- To find out the evolution of Sinhala numerals used for pagination between different time zones, especially from 16th to 19th Century AD; and
- To identify the types of numerals used in palm-leaf manuscripts in Sri Lanka analyzed.

Literature Review

Over the past millennia, various number systems have evolved reflecting the cognitive abilities of civilizations, from ancient Mesopotamia and Egypt to India and the Modern World. The development of such arithmetic systems demonstrates the social and economic trends of those cultures. Meanwhile, the Roman and Greek number-systems, although not as efficient or convenient as others, offer unique historical perspectives on their scientific and legal development. During pre-modern numeric period, different cultures adopted their own systems of counting and performing mathematical operations (Lippman, 2020). Modern world adopted the Hindu-Arabic numerals where zero is a placeholder that led to a paradigm shift in numbering systems and calculations (Latif, 2023). Therefore, numerals of different cultures exhibit their connection to socio-anthropogenic and cognitive dimensions of respective cultures.

Sinha and Mishra (2023) point out that the Eurocentric view of arithmetic history has largely discounted the eastern hemisphere's mathematical development. This evinces the need to examine the local number systems and their connection to human development. The Sinhala number system has deep historical roots, evolving from early practices where humans distinguished "more" and "less" in daily tasks. Archaeological evidence suggests that the origin of counting in human civilization could be traced back to around 50,000 years. Over millennia, various number systems emerged, including those of the Egyptians, Babylonians, Hindus, Mayans, Romans, and the modern Western system (Ifrah, 2000). The development of counting is closely intertwined with the evolution of mathematics, which likely predates formalized number systems. Key milestones in mathematical progress such as

the measurement techniques of the Babylonians and Egyptians and the use of pattern recognition in prehistoric counting were foundational to the development of more complex systems of form, size, and quantity (Clarysse, 2006). LeVeque and Smith (2025) state that ancient cultures used sticks, pebbles, stones and pottery to maintain a record of counts since mathematics and taxations were not required in their simplest lives. These numerals later evolved into symbols and then modern numbers. Regardless of the forms, that those ancient people used, the numbering systems helped group and count things used in daily life.

Figure 1

Display of different number systems in Asia

Comparison of selected modern systems of numerals										
Hindu-Arabic	1	2	3	4	5	6	7	8	9	0
Arabic	١	٢	٣	٤	٥	٦	٧	٨	٩	٠
Devanagari (Hindi)	१	२	३	४	५	६	७	८	९	०
Tibetan	༡	༢	༣	༤	༥	༦	༧	༨	༩	༠
Bengali	১	২	৩	৪	৫	৬	৭	৮	৯	০
Thai	๑	๒	๓	๔	๕	๖	๗	๘	๙	๐

Note. From LeVeque & Smith (2025)

The evolution of number systems used among ancient and indigenous people reveal the development of their socio-cultural and economic aspects of human race. In this regard, exploration of local numerals helps identify the advancements in scholarship and tradition.

Likewise, Van Nooten (1993) discovered the *chandahsâstra*, or "science of verse meters" as a branch of the Indian binary system that immensely contributed to the today's computer programming. He also believes that *Piṅgala*, an ancient Indian scholar, used binary calculations in 2nd or 3rd BCE. However, the ancient eastern history of numbering systems did not receive sufficient attention from the western chronicles. This leaves a lacuna of historical records of indigenous numerals in the eastern hemisphere that includes Sri Lanka.

In Sri Lanka, it is believed that the writing and numbering systems had developed concurrently during the Anuradhapura period (ලංකාව, 2019). Ancient records, including the Pali chronicles like the *Mahāvamsa* (Great Chronicle) and the *Dīpavamsa* (History of the Island), suggest that both a spoken and written language were established as early as the 5th century BCE, following the arrival of Prince Vijaya from India. Historical evidence indicates that the Sinhalese people began using plant leaves as writing material around this time (De Silva, 1969). The evolution of these practices was significantly influenced by Venerable Mahinda Thero, who introduced the *Brāhmi* script to Sri Lanka and further promoted the literacy and the spread of Buddhist teachings. The first documented use of the palm leaf as a writing medium in Sri Lanka occurred in the 1st century BCE. Five hundred monks undertook the monumental task of inscribing the *Tripitaka* (Buddha's teachings) in Pali on talipot palm leaves at *Aloka Viharaya*, an ancient temple near Matale (Geiger, 1912). In such a voluminous literary task, it is necessary to have numbering and indexing systems that would ensure sequence and connection among those palm leaf manuscripts (Wijerathne, 1959).

Similarly, Mendis, Perera and Nonis (2023) found that excavated pottery and other artefacts containing ancient scripts were clear evidence to then social, cultural and economic status of the inhabitants. *Brāhmi* letters found on potsherds indicates references to the counterparts dug up in India, which speculates the trade and cultural connections between the two landmasses. Besides, the symbols and numbers demonstrated the evolution and impact of local number systems on linguistic and arithmetic development in Sri Lanka in the ancient times.

Moreover, Menninger (1992) expresses that number systems are closely knitted with linguistics and culture of society. Development of numerals to count and index literary work or otherwise demonstrates the evolution of ancient scholarship and transformation of economies. Therefore, it is paramount to explore the ancient Sinhala and Buddhist number system to record the history of counting and indexing used before the colonial periods.

Research Design and Methods

The study employed qualitative research method where observation and textual analysis applied to palm-leaf manuscripts found from selected temples and monasteries located in the western and southern strip of Sri Lanka. Textual analysis (archival communication research of verbatim recordings, in this case, the palm-leaf manuscripts) involved descriptive, analytical, interpretative, and evaluative stages. The content analysis is one of the types of textual analysis, which was applied in this research (Hawkins, 2017). Incidentally, necessary assistance from experts in Pali and ancient scripts were also sought when ambiguities arose about symbols and letters.

The researchers, who have the necessary knowledge and skills in documentary research, surveyed the selected temples located in Western, Northwestern, and Southern Provinces of Sri Lanka. The following temples were included in the investigation:

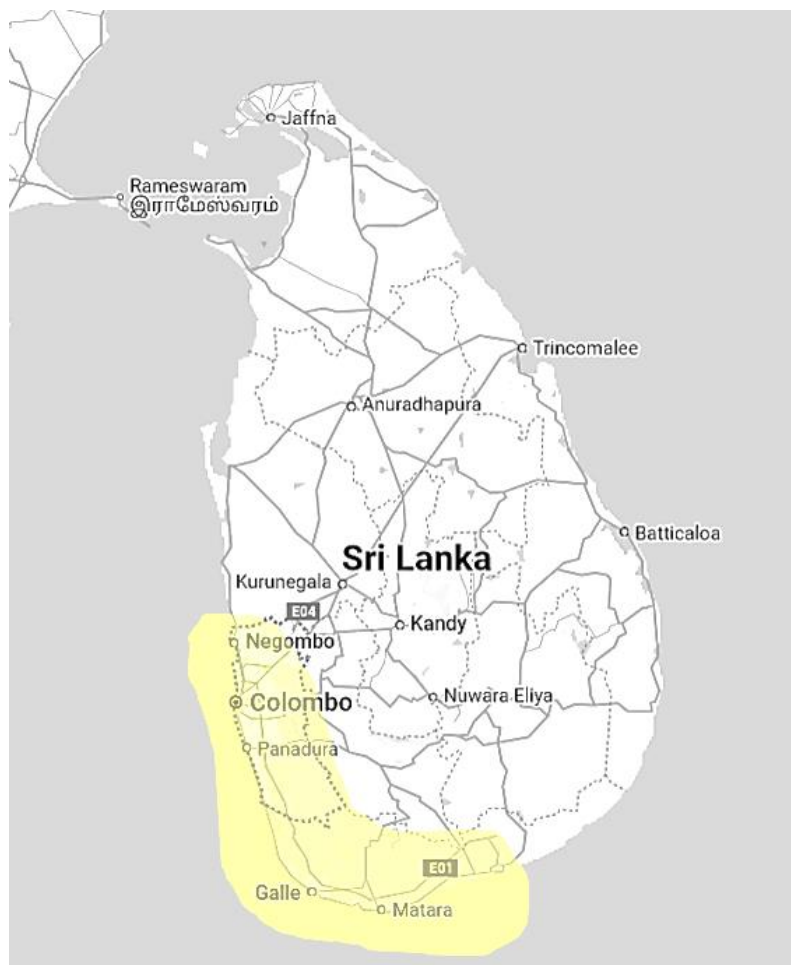
Table 1

Monasteries and corresponding number of manuscripts

Name of the Monastery	No. of Records
Kumara Kanda Rajamaha Viharaya, Dodanduwa	627
Ethkanda Rajamaha Viharaya, Kurunegala	780
Nikawewa Raja Maha Viharaya, Nikawewa	531
Ginipenda Viharaya, Kalugamuwa	532
Madawala Shilabimbaramaya, Madawala	235
Viharegama Raja Maha Viharaya, Narammala	350
Vidyananda Piriwena, Nittambuwa	390
Vidyalankara Pirivena, Kelaniya	480
Bothale Raja Maha Viharaya, Mirigama	425
Purana Mirigama Viharaya, Mirigama	218
Total	4,568

Figure 2

Monasteries selected in the Western, Northwestern & Southern Provinces



Note. From Google. (n.d.), <https://maps.app.goo.gl/UG3J8QbJYdZhp2xX9>

Having meticulously analyzed 4,568 palm leaf manuscripts for approximately three consecutive years, using textual interpretation and comparison (content analytical type), the researchers identified the special types of Sinhala number system used in palm-leaf manuscripts maintained by those temple monasteries.

Results and Discussion

After a meticulous analysis of numbers used in each leaf, the researchers identified five distinct numbering systems through those palm leaf manuscripts: namely, Sinhala *Illakkam* (සිංහල ඉලක්කම්), also known as Sinhala archaic numbers, *Lith Illakkam* (ලිඞ් ඉලක්කම්), or ephemeris numerals, *Pansal Hodiya* (පන්සල් හෝඩිය) (also known as the alphabet of the temple), Hindu-Arabic numerals and Tamil numerals. The *Pansal Hodiya* system was further categorized into two types:

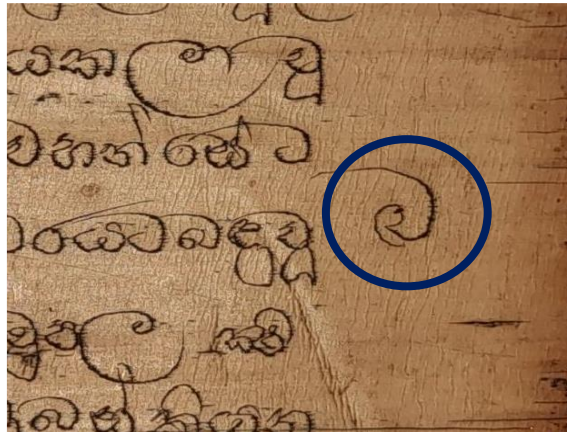
Pansal Hodiya Type 1: This was the most common numeral system, based on Sinhala characters according to the order of consonants and vowels in the Sinhala alphabet, excluding two vowel characters. The sequence began with 'Ka' (ක), and the number of combinations that could be formed from the consonants amounted to 544. Once the first 544 reached completion, the numbering would cycle back, starting with the word 'Dwi/Dvi' (ද්වි), meaning "second," in English. If the second cycle did not end the palm leaf book, the third cycle would begin, starting with the word 'Thri/Tri' (ත්‍රි).

Pansal Hodiya Type 2: This method was similar to Type 1 but included vowels in the sequence, beginning with 'A' (අ) and 'Ae/Aa' (ඈ).

The next numeration system identified is known as *Katapayadia* (කටපයාදිය), which was primarily used for inscribing the dates of palm-leaf manuscripts (Raman, 1997). In this system, numbers were assigned to specific Sinhala letters (Figure 3). The images of the palm-leaf manuscripts were captured by the researchers during the study.

Figure 3

Sinhala Illakkam (encircled in the image)

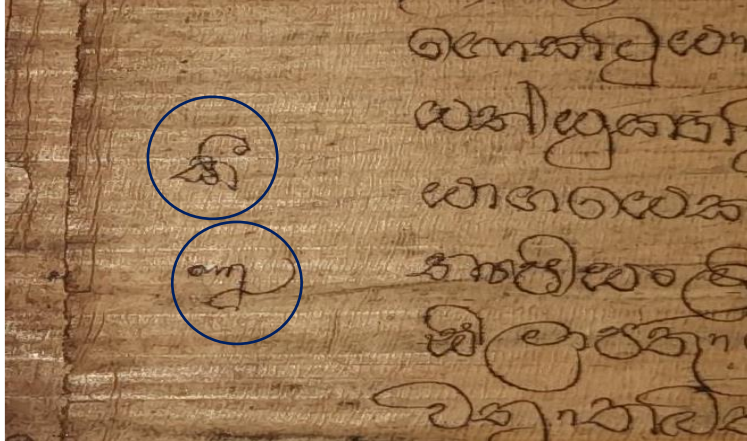


Note. Photographed by the researchers

Additionally, Indo-Arabic and Tamil numerals were also used for numbering palm-leaf manuscripts. These numerals were typically inscribed on the left-hand corner of the folios, though in some instances, they were found on both sides. A selection of manuscripts, dated between 1754 AD and 1974 AD, was examined for the location and the type of numerals that were inscribed. Traditionally, the compilation date of a manuscript was inscribed on the last folio; however, this tradition was inconsistently followed, with the date present in only 11% of the total manuscripts studied. Regarding the *Sinhala Illakkam* system, it was observed on manuscripts dated between 1754 AD and 1825 AD, representing 9% of the total manuscripts studied (Figure 4).

Interestingly, 3% of the manuscripts employed both the *Sinhala Illakkam* and *Lith Illakam* systems, with each method being used in different sections of the same manuscript. This suggests that *Sinhala Illakkam* was the most ancient numbering method, followed by the use of *Lith Illakam*, and later, the *Pansal Hodiya* system.

Figure 4
Sinhala *Illakkam* and *Pansal Hodiya* (encircled)



Note. Photographed by the researchers

The Sinhala *Illakkam* and *Pansal Hodiya* systems were found only in 12 palm leaf manuscripts (Figure 4). Notably, the Sinhala *Illakkam* system was predominantly used in manuscripts on astrology, Pali grammar, and literature. The relationship between the inscribed year and the number system used in Sinhala *Illakkam* is illustrated in Figure 4. Based on this data, it is evident that the Sinhala *Illakkam* was the earliest numbering system, followed later by *Lith Illakam* and *Pansal Hodiya*. It was traditionally the case where the numbering system was inscribed on the right-hand side of the folio. However, several samples were found with Sinhala *Illakkam* numerals inscribed on the left-hand side as well.

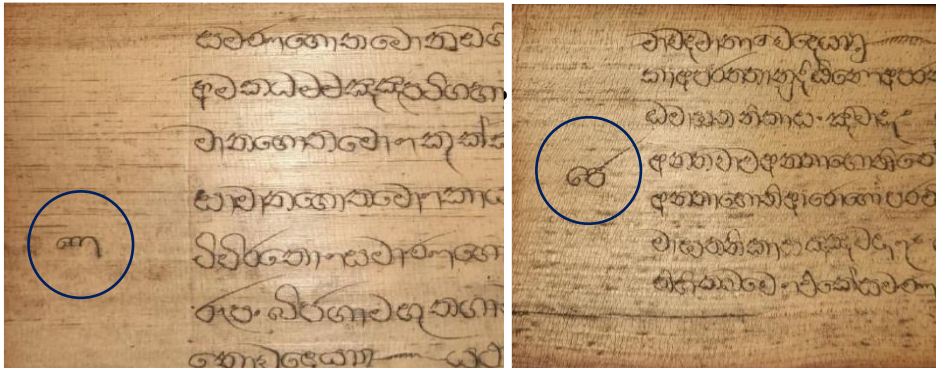
Based on the above analysis and interviews the researchers identified the periods of each set of palm-leaf manuscripts and their respective periods. This illustrated the evolution of Sinhala numbers and its different types.

Table 2
Types and Chronology of Sinhala Numbers

Numbering system	Year
Sinhala <i>illakkam</i>	1754-1825 AD
Combination of <i>Lith illakkam</i> and Sinhala <i>illakkam</i>	Beginning of 1800s AD
Combination of Sinhala <i>illakkam</i> and <i>Pansal Hodiya</i>	After 1820 AD

The *Lith Illakkam* system was found only in 15% of the sample. The subjects of these manuscripts were quite limited, with 95% of the samples using *Lith Illakkam* primarily for astrology, while the remaining manuscripts focused on native Sinhala medicine (Figure 5).

Figure 5
Lith Ilakkam



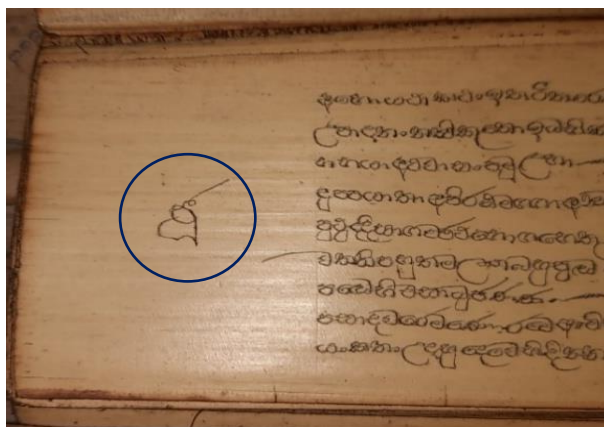
Note. Photographed by the researchers

Pansal Hodiya Type 1 was the most common numbering system identified in this study, found in palm-leaf manuscripts dated from 1820 to 1974, representing 85% of the selected sample. The following numbering pattern was observed: Typically, the numerals were inscribed on the right side of the folio (Figure 6). After the first 544 pages, the second cycle of numbering was indicated by inscribing "De" (දෙ, පුනර්) or "Dwi" (ද්වි) (Figure 7 and 8)

before the consonant characters. The third cycle began with the character "Thri" (ඡ්‍රී). In some rare instances, the same letter was inscribed twice to indicate the second cycle, and three times for the third cycle (Figure 9).

Figure 6

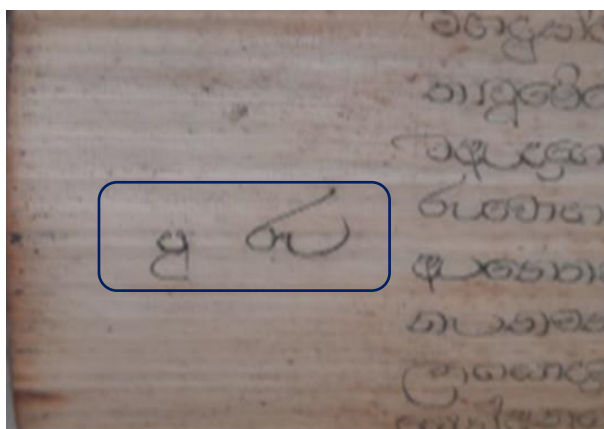
Numbering on the left side of the folio



Note. Photographed by the researchers

Figure 7

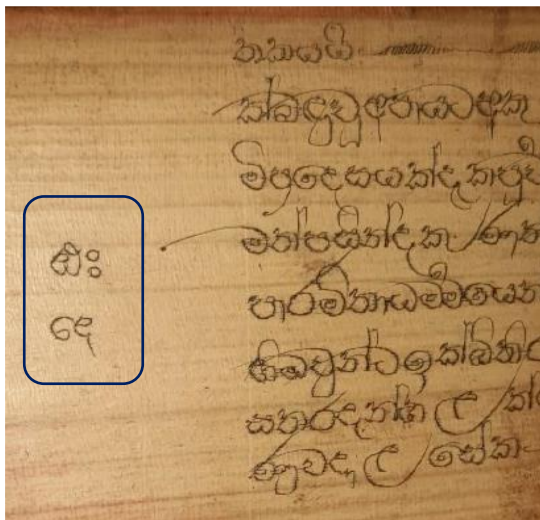
Second cycle of numbering (ඡ්‍රීඡ්‍රී)



Note. Photographed by the researchers

Figure 8

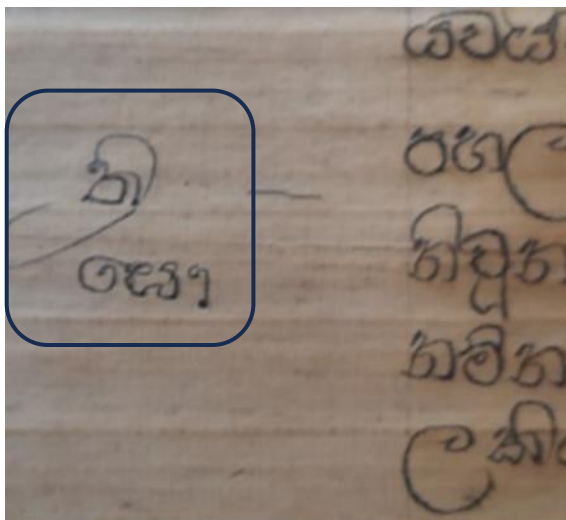
Second cycle of numbering (ද්වි)



Note. Photographed by the researchers

Figure 9

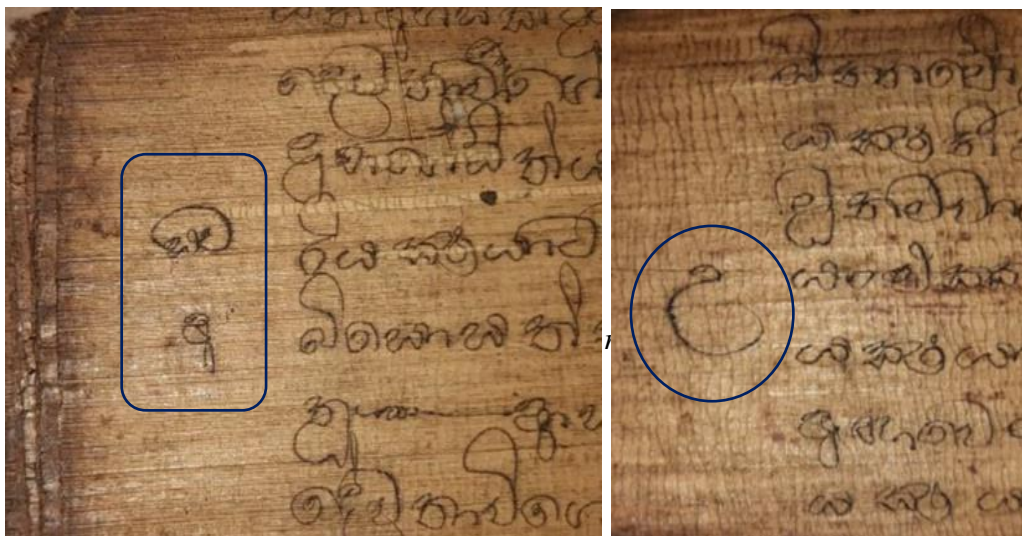
Third cycle of numbering (ත්‍රි)



Note. Photographed by the researchers

Of the total collection inspected, 10% of the manuscripts used the *Pansal Hodiya* Type 2 numbering method. In this system, numbering began with the vowel character "Ae" (අඞ), as seen in the *Wadan Kavi Pothe Hodiya* (Left side image in Figure 10).

Figure 10
Pansal Hodiya type-2



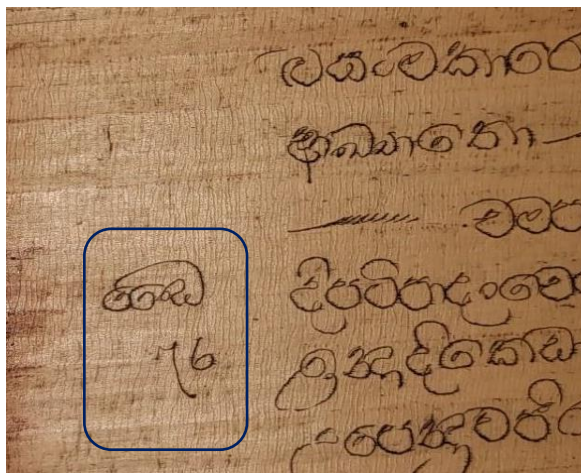
Note. Photographed by the researchers

Various patterns were observed during the study. Both the *Pansal Hodiya* and Arabic numeral systems were used for numbering in 4% of the sample. In most cases, the *Pansal Hodiya* system, with Sinhala characters, appeared at the top left of the folio, while the Arabic numeral was inscribed directly beneath it on the same side (Figure 11).

Additionally, in six manuscripts, the *Pansal Hodiya* numbering was inscribed on the left side of the folio whereas the Indo-Arabic numeral was on the right side of the same folio (Figure 12).

Figure 11

Pansal Hodiya and Indo-Arabic numeral



Note. Photographed by the researchers

Figure 12

Pansal Hodiya on left side (circled) and Arabic numeral on right side (squared)



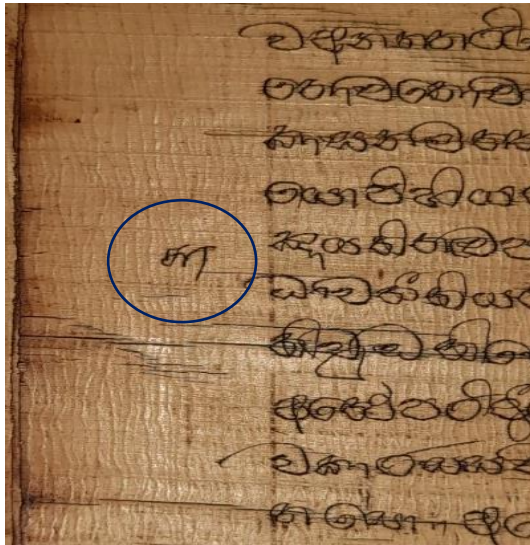
Note. Photographed by the researchers

Twenty (20) percent of the sample used the Arabic numeral system. In most cases, the Arabic numerals were inscribed on the left side of the folio, though in some instances they appeared on the right side. Most of these

manuscripts were Buddhist literature produced after 1950s. In some cases, palm leaf manuscripts from the same period were numbered using Tamil numerals, which were also seen on the left side of the folio (Figure 13).

Figure 13

Tamil numbering



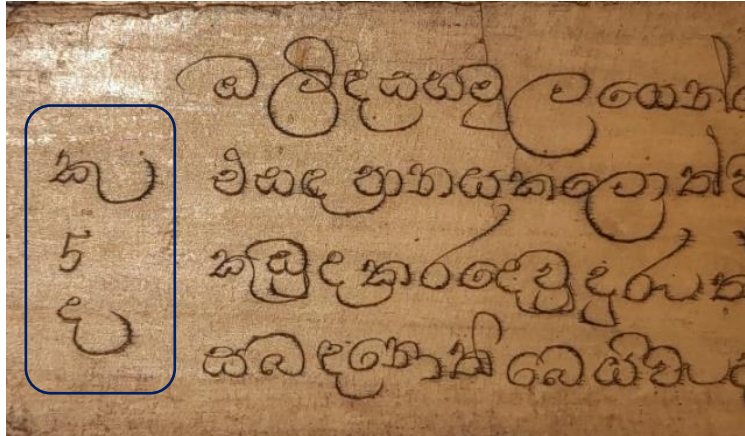
Note. Photographed by the researchers

In rare instances, two palm leaf manuscripts from 1920 were found to feature a combination of three numeral systems: Pansal Hodiya Type 1 at the top, Arabic numerals in the middle, and Lith Illakkam at the bottom, all inscribed on the left side of the same folio (Figure 14).

During the study, five distinctive numeral systems were found to have been used for numbering the palm leaf manuscripts of Sri Lanka: Sinhala *Illakkam*, Lith *Illakkam*, *Pansal Hodiya* (which existed in two types), Arabic numerals, and Tamil numerals. In some cases, combinations of two or even three numeral systems were used.

Figure 14

Three numbering systems



Note. Photographed by the researchers

Sinhala *Illakkam* was primarily used for numbering the oldest palm leaf manuscripts in the sample. The Lith *Illakkam* system was also in use during the same period, particularly for manuscripts related to astrology. With the introduction of the Sinhala mixed alphabet, inscribers began using *Pansal Hodiya* for numbering after the 18th century. Later, influenced by Western practices during the colonial period, the Arabic numeral system gradually replaced the traditional systems.

Conclusions

The findings indicated that several numeral systems have been used for palm leaf manuscripts over time, depending on the content of the manuscript. The numeral systems discovered were Sinhala *Illakkam*, Lith *Illakkam*, *Pansal Hodiya* (Type 1 and 2), the Arabic numeral system, and the Tamil numeral system.

According to the findings, it was clear that Sri Lanka had its own unique numeral system known as Sinhala *Illakkam*. The oldest palm leaf manuscript in the sample featured this numeral system, which dates back to the 16th Century AD. Sri Lanka also had another unique numeral system used alongside Sinhala *Illakkam*, called *Lith Illakkam*. During the mid-1900s, with the evolution of the modern Sinhala alphabet, *Pansal Hodiya* replaced the ancient numeral systems. Later, with the influence of Western nations during the colonial period, the Arabic numeral system was used for palm leaf manuscripts.

The content and numeral systems are interconnected. The ancient Sinhala *Illakkam* was predominantly found in Pali literature and native medicinal palm leaf manuscripts. *Lith Illakkam* was used exclusively for astrological purposes, and it was seen in palm-leaf manuscripts on astrology. Later, *Pansal Hodiya* was introduced along with the modern Sinhala alphabet, and appeared especially in Buddhist and Pali-Sinhala literature palm leaf manuscripts.

There was limited recorded evidence on Sinhala numbering system and its influence on local arithmetic and linguistic development in the ancient Sri Lanka. Prior to the European invasion, the local scholars used indigenous writing materials, especially palm leaves to record various genres of knowledge. The palm-leaf manuscripts examined in selected Buddhist monasteries and temples in Sri Lanka had followed unique number systems that evolved over centuries. The connections of these numbers to the intellectual contents of the palm-leaf manuscripts should be investigated extensively. Moreover, digitalization of palm-leaf manuscripts ensures the accessibility to these resources and their preservation in the electronic

environment. When digitalizing the palm-leaf manuscripts, letters representing numeric glyphs and Sinhala characters require special attention as they need to be properly identified and incorporated into Artificial Intelligence (AI) tools. Extensive research on digitalizing this valuable heritage with the help of AI tool is recommended for future studies. Therefore, future research utilizing AI and glyph recognition tools is highly encouraged.

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