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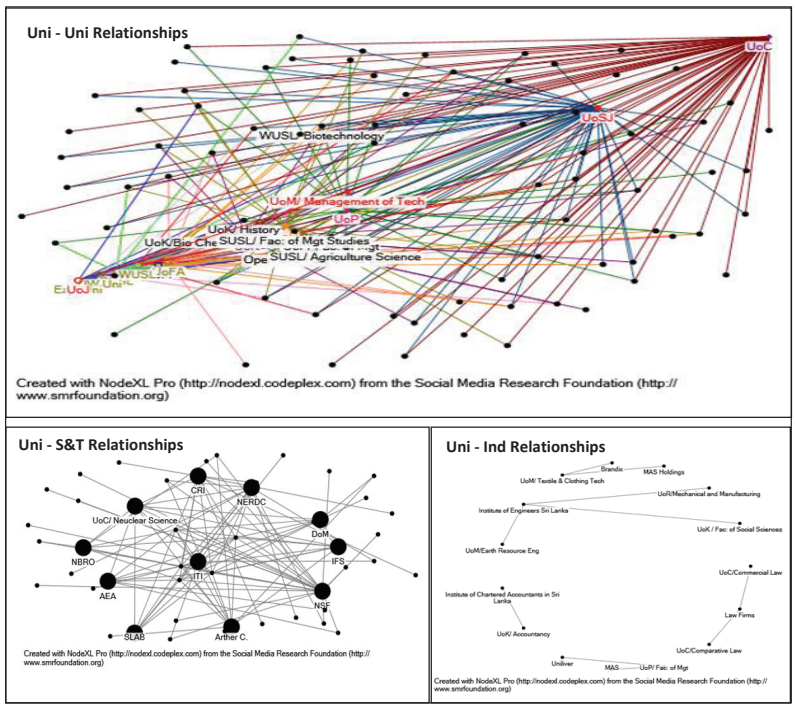

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CONTENTS

Guide to preparation of manuscript

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REVIEW ARTICLE

A review of state of "Abortion in Sri Lanka" in contemporary discussions

Sithmi Attanayake*
Department of Sociology, Faculty of Arts, University of Peradeniya, Peradeniya, Sri Lanka.

Abstract: Safe abortion is a controversial discourse in contemporary society. In many countries, including Sri Lanka, induced abortions are considered criminal acts. Due to these strict laws, individuals often resort to unsafe methods for abortions, posing significant life risks. Various organizations including governmental, non-governmental, international and grassroot entities advocate for the liberalization of these stringent abortion laws to ensure safe access while stressing the importance of women's bodily autonomy. Despite the critical nature of this issue, there are only a few studies in Sri Lanka focusing on safe abortions and abortion laws. These existing studies primarily examine the community's perspective and are based on social and cultural determinants. However, they do not sufficiently address the role and the impact made by the abortion-related laws in Sri Lanka, which creates a significant research gap. This study intends to bridge the identified research gap in the context of safe abortion legislation in Sri Lanka. This review synthesizes previously conducted studies on abortion at both global and national levels. The main objective of this review is to explore the role of the law related to safe abortion in Sri Lanka, when accessing safe abortion, employing a feminist legal theory framework.

Keywords: Abortions, safe abortions, safe abortion-related laws, liberalization, Sri Lanka.

INTRODUCTION TO ABORTION, SAFE AND UNSAFE ABORTION

Safe abortion has become a social issue, at national and global levels. Many international, governmental and non-governmental organizations are involved in finding a solution to this. Therefore, abortion has become a global discourse. The discourse surrounding safe abortion laws in Sri Lanka has gained significant attention from various stakeholders, including international, governmental and non-governmental organizations. While numerous studies have delved into the broader landscape of safe abortion and its legal implications, a notable research gap exists in understanding the role and the impact made by the existing safe abortion-related law in Sri Lanka. This paper aims to explore the role of the law related to safe abortion in Sri Lanka when accessing safe abortion employing a feminist legal theory framework. This study examines the interconnection between the law and the social and cultural determinants, which is very significant when liberalizing and reforming safe abortion-related laws in the country. Feminist legal theory seeks to address how laws perpetuate gender inequalities and restrict women's rights. This framework is beneficial in analysing abortion laws, as it highlights the intersection of legal restrictions with issues of bodily autonomy, reproductive rights and social justice.

"Abortion" is a social issue discussed worldwide. Access to safe abortion is a global discourse in the present society at the national and global levels. "Abortion is legally defined as the removal of the foetus from the uterus any time before its gestation is completed" (Thilakarathna, 2018: p. 4). Explaining further, "Termination of pregnancy is termed an abortion irrespective of the circumstances, namely spontaneous or induced" (De Silva *et al.,* 2023: p. 24). Generally, there are many ways of which an abortion or a miscarriage could occur during pregnancy.

* Corresponding author (a17049@arts.pdn.ac.lk; https://orcid.org/https://orcid.org/0009-0003-5584-397X)

Since legal restrictions are against abortions, there is a high tendency of seeking support to remove the foetus through unsafe methods.

> "Unsafe abortion is defined as a procedure performed by personnel lacking the necessary skills, or in an environment not meeting minimum medical standards or both. Often abortions performed legally are thought to be safe and those performed illegally are thought to be unsafe" (Marecek *et al.,* 2017: p.11).

Unsafe abortions do not follow proper medical guidelines or pre- and post-abortion care, which bring more risk to the mother's life and create the possibility for medical complications. However, it's essential to critically examine whether poor service quality directly causes unsafe abortions or if other factors contribute to both issues independently such as the restricted access to safe and legal abortion.

On the contrary, safe abortions are done by a qualified medical practitioner, with proper medical guidelines followed up with pre- and post-abortion care. According to the Penal Code of Sri Lanka; "if such miscarriage is not caused in good faith for the purpose of saving the life of the woman, be punished with imprisonment" (Center for Reproductive Rights, 2022) is the only moment that a safe abortion can be performed.

Existing research on safe abortion in Sri Lanka has predominantly focused on legal frameworks, maternal health outcomes and societal attitudes, providing valuable insights into the multifaceted nature of this complex issue. From the point of view of activists in the field of sexual and reproductive health and rights (SRHR), if citizens are given proper sexual education on contraceptives, the importance of family planning, the negative effects of unsafe sexual relationships, unexpected and teen pregnancies, most of the abortions could have been prevented. At the same time, people are not aware of that access to safe abortion is a right of women for their bodily autonomy. When abortion needs to be done people take illicit paths due to the strictness of the laws and also because of their unawareness of its risks and complications. Further analysing this statement through the lens of Feminist legal theory, it stresses the importance of bodily autonomy, asserting that women should have the right to make informed decisions about their bodies, including the decision to have an abortion and also, lack of awareness about safe abortion as a right, further compounds this issue. Feminist legal theory advocates for comprehensive sexual education as a means to empower women with knowledge about their reproductive rights and options. This supports the statement that current restrictive laws in Sri Lanka infringe upon this right, forcing women to seek unsafe and illegal abortion methods.

Mainly lack of sexual education and unawareness of people have led to the rising statistics of unsafe abortions in a country. For instance, "A staggering 45 per cent of all abortions are unsafe" (UNFPA, 2022). Moreover, "according to WHO, every year in the world there are around 73 million induced abortions. This corresponds to approximately 200,000 abortions per day" (Worldometer, 2023) proves the increasing number of abortions worldwide and this clearly shows why it has become a global discourse that needs to be addressed.

METHODOLOGY

A qualitative study design is used in this research. A qualitative study design is used to explore and get a deeper understanding of this study which involves collecting rich and in-depth data through interviews, to meet the objectives of this study successfully.

The study area of this research is "to explore the Role of the law related to safe abortion in Sri Lanka, when accessing safe abortion" through the lens of feminist legal theory. Since the research is conducted related to safe abortion access, family planning and sexual and reproductive health and rights (SRHR), the sample was chosen as a purposive sample; meeting professionals (doctors, lawyers, advocates) working in organizations that are working for SRHR, health, family planning and liberalizing safe abortion-related laws in the country.

The data collecting technique is structured interviews following a topic guide. This guide included the following questions covering broader aspects related to the research area. The interviews were conducted online or in person based on the convenience of the participants. The interviews were conducted in English or Sinhala per the participants' language preferences. Each interview took around 45 minutes to 1 hour of time duration. The interviews were recorded with the verbal consent of the interviewee and the recordings were transcribed and translated as necessary. The gathered data was analysed manually by using thematic analysis and grounded theory. The collected data was confidential and the confidentiality of the information was assured to the interviewee and the organization adhering to research ethics.

LEGAL ASPECTS RELATED TO ABORTION: GLOBAL, REGIONAL AND NATIONAL LEVEL

There are many laws related to abortions in every country. "Abortion was legally restricted in almost every country by the end of the nineteenth century" (Berer, 2017: p.14). "Over the past several decades, monumental gains have been made in securing women's right to abortion, with nearly 50 countries liberalizing their abortion laws. Some of these reforms has been incremental, enabling women to access legal abortion only when there is a threat to her life or when pregnancy results from rape. But many of these changes have been truly transformative, overturning absolute bans on abortion in favour of women's reproductive autonomy" (Center for Reproductive Rights, 2023).

Even though access to safe abortions was restricted in many countries, governments have decriminalized and/or liberalized the abortion-related laws in their countries. Also, in some countries complete freedom for safe abortions is allowed by the law, regarding the bodily autonomy of women. "Bhutan, India and Nepal have introduced comparatively liberal abortion laws. These countries allow a female the termination of pregnancy for broader circumstances, namely the risk to maternal life, to maintain maternal health, following incest or rape and in the presence of foetal defects." (De Silva *et al*., 2023: p.25). From a feminist legal theory perspective, Sri Lanka's highly restrictive abortion laws can be seen as a form of systemic gender oppression, limiting women's control over their reproductive health and reinforcing patriarchal norms. "Although an increasing number of women are seeking medical abortions outside of formal /informal private health systems in Sri Lanka, research agendas have yet to address the topic systematically. Medical abortion is likely expanding access to induced abortion, especially in countries where it is legally restricted like in Sri Lanka" (De Silva, 2019: p. 5). Therefore, access to safe abortion in Sri Lanka is one of the most controversial conversations in contemporary society, especially related to sexual and reproductive health and rights (SRHR).

More importantly, "Legal statutes and regulations are, of course, not the only factors affecting women's access to abortion, their agency and autonomy in making decisions about abortion and their abortion experiences" (Marecek *et al.*, 2017: p.7). "Among the countries of SEA region, Bhutan, India, Nepal and Thailand probably have the most liberal abortion laws and permit a woman to terminate a pregnancy on a broad range of grounds including to save a woman's life, preserve a woman's physical health or mental health, if pregnancy is a result of rape or incest and if there is foetal impairment/ abnormality" (WHO, 2021). "All nations in the South Asian region allow induced abortion in situations where maternal life is at risk. Only Afghanistan, Bangladesh and Sri Lanka have very restrictive laws that permit abortion only to save a woman's life" (De Silva *et al.,* 2023: p.24). "In spite of strict laws, illegal abortions are frequently performed in Sri Lanka…. The laws pertaining to abortions have remained unchanged for nearly one and a half centuries" (Thilakarathna, 2018: p.5). This clearly shows the importance of the legal aspects of a country in general. When constitutions or laws, regulations and/or policies are implemented, the state should consider the rights of citizens and benefits for citizens and also, they should address the realities, or the real areas that have not been addressed for so long. For example, restrictions on safe abortion in Sri Lanka have increased the number of unsafe abortions taking place in the country leaving women's lives at risk. Further, this strictness lies as a barrier for women's bodily autonomy according to SRHR and human rights activists. Criminalizing and stigmatizing access for safe abortion, needs to be addressed and many of the organizations are working towards liberalizing and amending the safe abortion-related laws in the Sri Lankan legal system.

Despite the strict legal framework, illegal abortions are frequently performed in Sri Lanka, indicating a significant gap between the law and the lived realities of women. This gap suggests that the law is not serving the needs of women, from the point of view of the feminist legal theory. Similarly, such legal systems are failing to protect women's reproductive health and rights. Instead of ensuring safe and legal access to abortion, the laws push women towards unsafe practices, highlighting the need for legal reforms that prioritize women's health and rights.

SOCIALLY CONSTRUCTED DETERMINANTS THAT OBSTRUCT THE LIBERALIZATION OF SAFE ABORTION-RELATED LAWS IN SRI LANKA

There are many determinants which impact the liberalization process of safe abortion laws in Sri Lanka. Most importantly, the level of awareness and knowledge about sexuality and reproductive health act as a determinant which obstructs women's decision-making process towards their bodily rights. But at the same time this would impact the liberalization process, because even if the organizations were able to achieve the liberalization of safe abortion-related laws in Sri Lanka, women would not get the benefit of it but follow the usual unsafe abortion methods, due to unawareness and lack of education. For

example; "Respondents with high levels of education, a smaller number of living children and lower age (youth) are more likely to accept liberalized laws on abortion. Similarly, never-married respondents are more likely to accept legalizing abortion than married respondents. Respondents with higher levels of exposure generally tend to hold liberal attitudes towards the abortion law" (Suranga *et al.,* 2016: p. 76). The above research findings prove how awareness and level of knowledge about SRHR act as a strong determinant which impacts the decision making even if the liberalization was achieved. Also, "People with higher education and higher accessibility to sources of information such as mass media, printed media and public health system are likely to have more liberal attitudes towards induced abortion" (De Silva *et al.,* 2023: p. 26). Organizational perspectives offer a unique lens through which researchers can gain deeper insights into the intricate dynamics involved in advocating for the liberalization of safe abortion laws in Sri Lanka.

Understanding how organizations navigate these relationships is vital for comprehending the broader context in which safe abortion advocacy takes place. It allows researchers to uncover potential alliances, conflicts of interest and collaborative opportunities that shape the success or challenges faced by advocacy efforts. Researchers have tried to bring knowledge to the general public and how it becomes challenging to liberalize safe abortion-related laws. Which is in a way not very practical and logical. Because it is always the organizations or community groups that work to liberalise safe abortion-related laws. It is very salient to study even the researchers haven't intended to study this area from the organizational perspective.

Furthermore, "Unsafe abortion is also a leading cause of maternal morbidity. While medical procedures for inducing safe abortion are straightforward, whether or not an abortion is available or safe or unsafe is influenced by a complex mix of politics, access, social attitudes and individual experiences" (Coast *et al.,* 2018: p.199). Religion, gender equity and equality, education & awareness, human rights, policy and law, societal attitude, political conditions, economic status and capacity are some major determinants that create an immense effect which is needed to be considered in the process of liberalizing safe abortion-related strict laws. These researchers try to understand this issue, staying outside of the organizations, in the point of view of the general public towards organizations. But to have a proper understanding and knowledge they need to have an insidious perspective.

Moreover, a detailed analysis of organizational interventions shows how these entities engage with the communities they serve. Research should explore how organizations build trust, foster community participation and disseminate accurate information about safe abortion. This community-level perspective is crucial for tailoring interventions that are culturally sensitive and responsive to the specific needs of diverse populations in Sri Lanka. This also provides insights into how they navigate public discourse, counter misinformation and work towards destigmatizing safe abortion, while influencing societal attitudes, rather than an outside perspective on organizations' work or just studying the social attitudes and determinants, which always limits the knowledge area and focus.

Many challenges and barriers lie ahead of the journey of liberalizing the safe abortion laws in the country. This is not only related to Sri Lanka but also to many other nations, especially developing countries.

> "The law labels the destruction of an embryo and/or foetus an ethically or morally significant act, which gives reason to regulate abortion as something more than a personal decision or a medical procedure, but as a social act" (Erdman, 2017: p.31).

This shows the awareness of people and decision making when they need an abortion is weak, as they are bound with the cultures and stigmas in the society. Therefore, in other words, even if the person who needs an abortion or the person who makes the decision is an individual issue, still it creates an impact on society because many socio-cultural determinants impact the decision-making and undergoing the abortion.

Many socially constructed determinants including social inequalities challenge the organizations in the process of liberalizing safe abortion-related laws in the country. For instance,

> "Socio-cultural context includes a broad range of factors influencing abortion trajectories and is tightly linked to other components such as the influence of institutions or healthcare practitioners' willingness to provide abortion services. Norms about abortion acceptability, including stigma and shame, are shaped by (in)equalities (e.g., gender, race, ethnicity)" (Coast *et al.,* 2018: p. 207).

Moreover, the cultural practices in a country and religious and superstitious beliefs of people in society affect abortion-related discourses.

> "Religious and cultural reasons account for the strict opposition towards liberalization which

> has negatively affected the political will of the rulers in bringing about changes. The greatest fear has been that liberalization would result in a sudden increase in the number of abortions" (Thilakarathna, 2018: p. 4).

Further analysing this statement about fear of a sudden increase in the number of abortions if the law is reformed is that if permission for safe abortion is granted, people will rapidly start using the service, instead of using contraceptives, which would escalate the abortion rates in Sri Lanka. On the contrary, Sri Lankans are still guided by their religious norms, superstitious beliefs, traditions and cultures, which control their behaviour in society, therefore, even if access to safe abortion is granted, there will be some kind of a limitation in getting its benefits, because of fear to go beyond cultures beliefs. From the point of view of most of the activists in the field of SRHR, before granting access to safe abortions and liberalizing safe abortion-related laws in the country, the best practice is to raise awareness and educate the community about family planning and SRHR.

There is a belief in religions that removing the foetus is considered as destroying a life. Further explaining this, "Buddhist attitudes to abortion are influenced by its belief in rebirth and the idea that life is a never-ending continuum. Many Buddhists, accordingly, feel that abortion is prohibited by the First Precept against taking life" (Keown, 2020). These beliefs must have influenced the formation of law in the country. Especially because the dominant culture of the country is shaped by Buddhism. That's the reason for the strictness of the laws related to safe abortions in Sri Lanka. "Religious institutions' messages on abortion can have multiple influences including how a woman perceives the morality of abortion and how women who have abortions are treated by society" (Coast *et al.,* 2018: p. 205). Discussing further about the religious ideologies in Sri Lanka obstructing the liberalizing efforts;

> "First time in the recorded Sri Lankan history, in the late 1970s, a member of the parliament of Sri Lanka, forwarded a private bill to the parliament to legalize induced abortion. However, it was unsuccessful due to the resistance from religious leaders" (De Silva *et al.,* 2023: p.25).

This intersection of religion and law has profound implications for women's rights, autonomy and gender equality. Analysing this through the lens of feminist legal theory reveals several critical insights, including the moral judgments embedded in religious teachings about abortion, which influence societal attitudes and the treatment of women who seek abortions. This stigmatization further restricts women's access to safe abortion services, impacting their sexual and reproductive health and rights. The intertwining of religious ideologies with legal standards undermines women's bodily autonomy and perpetuates societal stigma through the lens of feminist legal theory. To achieve gender equality and protect women's reproductive rights, legal reforms must prioritize women's health and autonomy, separating religious beliefs from the legal framework.

INFLUENCING THE LEGAL SYSTEM BY ORGANIZATIONS

Access to safe abortion is a human right of the women who don't want to continue their pregnancy. "In order for the Sri Lankan woman to enjoy the rights enjoyed by other women worldwide with regard to abortions a re-evaluation of the existing laws and policies is a major requirement" (Thilakarathna, 2018: p. 5). Since it is the bodily autonomy of women and unsafe abortion leads to many health risks, granting access to safe abortion is necessary. "The liberalization of the abortion laws has become both a contemporary and a necessary change for the protection and enhancement of the rights of women and their autonomy" (Thilakarathna, 2018: p. 4). But when granting access to safe abortions it is necessary to raise awareness and educate the society about family planning and SRHR.

The Sri Lankan government has attempted to make amendments to the prevailing abortion-related laws. But "There are no records of significant attempts to change the abortion law for almost 25 years following this initial attempt. During this period, all the actors primarily focused their interventions on the prevention of unintended pregnancies, mainly through increasing access to contraception." (De Silva *et al.,* 2023: p.25). This section in the Penal Code was published in 1883, which was during the colonial era and has not yet been subjected to any amendment. This is not addressing the needs and realities of the people at present, which is a timely need to be addressed.

Organizations can immensely impact the liberalizing process of safe abortion laws in a country. "Institutions (e.g., political, governmental, faith-based, private, civil society) operate and interact at global, regional, multilateral, national and sub-national levels to shape the availability of abortion care in local contexts. The influence of institutions on each other and each institution's position on abortion, is interwoven. International institutions can shape the availability of abortion in other national and sub-national contexts,

both ideologically and financially" (Coast *et al.,* 2018: p. 205). These actions taken by different organizations are significantly important, but the attempts, barriers, hardships and ultimate goals are yet to be studied.

CONCLUSION

Abortion is an important discourse in the world. Many countries including Sri Lanka have limited access to safe abortion. Therefore, this has become a major issue that needs to be addressed soon. Due to this strictness of the laws in the country, there is an increase of people seeking unsafe and illegal abortions, risking their lives and health. Many Organizations, including government, non-governmental, international organizations and grassroots-level organizations are working to liberalize these safe abortion laws in the country. That means reducing the strictness of these laws and providing women with access to safe abortion.

Current laws were introduced in the colonial era and were not amended to meet contemporary trends and needs. While the law currently allows for abortion in limited circumstances, illegal abortions are still common in Sri Lanka. This is a result of restrictions on access to safe and legal services. Therefore, there was a common suggestion from the activists and professionals that the prevailing legal system in the country needs to be liberalized and should provide women with access to safe abortions. They showed the importance of liberalizing and the achievements so far in the country when working towards the liberalization of safe abortion-related laws in the country. They also showed how this strictness could negatively impact women and girls who are especially in need of abortion for incidents such as sexual assault, rape, being underaged, etc. As per the feminist legal theory, by criminalizing and stigmatizing abortion, Sri Lankan laws undermine women's agency and autonomy and also women will have to bear the brunt of unintended pregnancies and the consequences of unsafe abortions, which can have long-term health and socio-economic impacts.

Many organizations and activists play a vital and admirable role in advocacy, policy designing and implementation, awareness raising, educating, ground-level initiatives, research and much more work to achieve liberalization. But, some of these efforts have been met with strong opposition, especially due to religious beliefs and the dominant role played by religions such as Buddhism in shaping up the culture of Sri Lanka. This acts as a significant challenge and a barrier for organizations and activists working for liberalization.

In conclusion, there are only very few studies in the country related to safe abortions and liberalizing abortions. The organizational perspective for liberalizing and reforming the law provides an avenue to explore the impact of legal and policy advocacy on the ground. Researchers can delve into how organizations monitor and evaluate the outcomes of their interventions, measuring success not only in terms of policy changes but also in improvements to women's health outcomes and access to safe abortion services. It will bring a better understanding and an insidious perspective to this discourse. Understanding the ripple effects of the interconnection between law and the socio-cultural determinants is crucial for refining strategies and ensuring that advocacy initiatives have tangible and positive impacts at both the policy and community levels.

REFERENCES

Berer, M. (2017) Abortion Law and Policy Around the World: In Search of Decriminalization, *International Family Planning Perspectives*, 19(1), pp. 13-27.

Center for Reproductive Rights (2023*) The World's Abortion Laws* [Online] Available from: https://reproductiverights.org/maps/worlds-abortion-laws/[Accessed: 20th January 2023]

Center for Reproductive Rights. (2022, January 18). *Sri Lanka's Abortion Provisions - Center for Reproductive Rights*. [Online] Available from: https://reproductiverights.org/maps/provision/sri-lankas-abortion-provisions/ [Accessed: 20th Jan 2023].

Coast, E., Norris, A. H., Moore, A. M. & Freeman, E. (2018) Trajectories of Women's Abortion-Related Care: A Conceptual Framework, *Social Science & Medicine,* 200, pp. 199- 210.

De Silva, I., Suranga, S. & Kumarasinghe, M. (2023) Back to Square One: Attempted Legal Amendments and Abortion Practices in Sri Lanka, *Asian Journal of Education and Social Studies*, 46, pp. 23-33.
DOI: https://doi.org/10.9734/ajess/2023/v46i1994

Erdman, J. N. (2017) Theorizing Time in Abortion Law and Human Rights. *Health and Human Rights*, 19(1), pp. 29–40.

Family Planning Association Sri Lanka (FPA) (n.d) *About FPA Sri Lanka*. [Online] Available from: https://www.fpasrilanka.org/about [Accessed: 15th January 2023].

Keown, D. (2020) 'Abortion', In *Buddhist Ethics: A Very Short Introduction.* 2nd Ed., Oxford.
DOI: https://doi.org/10.1093actrade/9780198850052.003.0006

Marecek, J., Macleod, C. & Hoggart, L. (2017) Abortion in Legal, Social, and Healthcare Contexts, *Feminism & Psychology,* 27(1), pp. 4–14.
DOI: https://doi.org/10.1177/0959353516689521

Suranga, S., Silva, T. & Senanayake, L. (2017) Gender Differences in Knowledge and Attitudes Concerning Induced

Abortion in Sri Lanka: A Community-Based Study in Colombo City, *Sri Lanka Journal of Social Sciences,* 40(2), pp. 93-102. DOI: https://dx.doi.org/10.4038/sljss.v40i2.7540

Thilakarathna, K. A. A. N. (2018) Liberalizing Abortion Laws in Sri Lanka; Prospects and Challenges, *Sri Lanka Journal of Forensic Medicine, Science & Law,* 9(2), pp. 4-9. DOI: https://doi.org/10.4038/sljfmsl.v9i2.7804

United Nations Population Fund (2022) *The Impacts of Unintended Pregnancy* [Online] Available from: https://www.unfpa.org/swp2022/impacts [Accessed: 07th April 2023].

United Nations Populations Fund (UNFPA) (2023) *About Us* [Online] Available from: https://www.unfpa.org/about-us [Accessed: 25th May 2023].

World Health Organization (WHO) (2021) 'Abortion-related Laws', In *Policies, Programme and Services for Comprehensive Abortion Care in South-East Asia Region.* New Delhi: WHO, Regional Office for South-East Asia, pp. 6–11.

Worldometer (2023) *Abortion Statistics* [Online] Available from:https://www.worldometers.info/abortions/[Accessed: 28th June 2023].

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RESEARCH ARTICLE

Pathway for Industry 4.0 implementation in a Lean Manufacturing environment: evidence from Sri Lankan apparel sector

M. R. F. Nasra and A. M. A. S. M. Bandara*
[1]*Department of Operations Management, Faculty of Management, University of Peradeniya, Peradeniya, Sri Lanka.*

Abstract: The fourth industrial revolution (I4.0) was based on several technological pillars developed over the years. Organizations are expected to embrace these technologies to realize the benefits associated with I4.0. However, manufacturing organizations that have optimized their operations through Lean management philosophies need a clear pathway to embrace the I4.0 technologies without disrupting the existing good practices. Therefore, this study aims to conceptualize a much-needed path for implementing I4.0 technologies in a Lean environment. To achieve that, researchers followed a qualitative approach and an exploratory framework. Researchers started with Apparel organizations with highest export revenue and employed a snowball sampling approach within each organization to identify the most suitable professionals for the study. The data collection was carried out through semi-structured interviews conducted through Zoom online platform. The collected data was analyzed through thematic analysis, allowing the identification of different themes. Our findings suggest that such a pathway involves four steps: (1) setting a Lean base, (2) strategic management, (3) human resource development, and (4) getting external support. Since the implementation of I4.0 technologies in a Lean environment is a relatively recent phenomenon, our study provides guidelines for managers and practitioners to help them prioritize efforts and narrow their attention more objectively to the proper mix of procedures and technologies.

Keywords: Lean manufacturing, Industry 4.0, technology implementation pathway, apparel industry

INTRODUCTION

The manufacturing sector is one of the fastest-growing industry sectors in the world where organizations efficiently manufacture high-quality products to fulfill customer requirements. Increased global competition has made organizations look for ways to remain at the top of the competitive market (Langstrand & Ugochukwu, 2012). Lean Manufacturing (LM) is a management philosophy adopted primarily by the manufacturing sector to improve customer value by identifying and eliminating diverse kinds of wastages associated with the manufacturing process through scientific management and continuous improvement (Du *et al*., 2023). However, the expected benefits of LM such as low inventories, customer satisfaction, optimized efficiency, high quality, reduced cost, improved delivery regarding time, quality, and quantity specifications, and increased flexibility (Langstrand & Ugochukwu, 2012) attracted service-oriented organizations such as retail, healthcare, travel, and financial services to adopt lean philosophy.

In line with the global trend, many apparel companies in Sri Lanka embraced the Lean philosophy with the expectation of improving competitiveness by streamlining their operations (Wickramasinghe & Wickramasinghe, 2011). Sri Lankan apparel sector emerged to be a supplier for many global brands as the apparel companies from developed countries such as the UK and the USA tend to outsource their production plants to countries with low manufacturing costs such as China, Sri Lanka, and India to reduce production costs (Dachs *et al.,* 2019). Presently, Sri Lanka's apparel industry has become the most substantial and driving contributor to the country's economy. Over the years, it has grown very rapidly, from

* Corresponding author (amilab@mgt.pdn.ac.lk; https://orcid.org/0000-0002-4028-5341)

local industry players to the number one export industry with a total export turnover of US$ 5000 Mn (Industry Capability Report Sri Lankan Apparel Sector, 2022) and contributing to 38% of the entire Sri Lankan exports (Export Performance Indicators-2021 Sri Lanka Export Development Board, 2021).

Being a part of the global supply chain, Sri Lankan apparel industry is expected to adapt to the changes in the global value chain. Often, these changes include the adoption of cutting-edge technologies that provide innovative solutions to overcome the challenges faced by the apparel industry (Lakmali *et al*., 2020). The Fourth Industrial Revolution, which is commonly referred to as Industry 4.0, was one of such technological advancements initiated by the German Federal Government. Hofmann & Rüsch (2017) define I4.0 as a shift in the manufacturing logic towards a more decentralized, self-regulating approach to value creation, aided by concepts and technologies such as the Internet of Things, Cyber-physical Systems, Internet of Service, Cloud Computing or Additive Manufacturing, and Smart Factories, to help companies meet the future production requirements.

It is observed that organizations have started integrating LM philosophies and I4.0 technologies as both methods to achieve superior performance and competitive advantages over their rivals in the market (Tortorella & Fettermann, 2018; Tortorella *et al.,* 2021). Consequently, growing debate among practitioners and academicians emerged on how to integrate I4.0 technologies and LM systems (Buer *et al*., 2018; Rossini *et al.*, 2019). This debate has caused a genre of publications that focused on studying the impact of integrating Lean and selected I4.0 technologies on performance improvement within a given context (Wagner *et al*., 2017; Gillani *et al*., 2020).

Productivity enhancement of employees and operations is the primary goal in the apparel industry. To realize this, a significant amount of training, development, and automation has to go hand in hand with better knowledge and application of Leaner manufacturing processes by employees (Gamage *et al*., 2020). Currently, the apparel industry of Sri Lanka is in a milestone of adopting the best manufacturing techniques, sustainability, and Lean concepts (Withanaarachchi *et al*., 2016). Contextually, challenges to adopting I4.0 technologies in emerging countries differ from those in developed countries (Dalenogare *et al.*, 2018). However, the literature base on the I4.0 adoption is largely biased towards developed economies while only a few studies focused on I4.0 implementation in developing economies. This number is further reduced when it comes to the adoption of I4.0 within an organization that has already mastered the Lean philosophy while operating in a developing economy.

The favorable influence of I4.0 technologies on LM was suggested by the strong direct effects between the two variables (Kamble *et al*., 2020). It is inferred that the implementation of I4.0 in manufacturing organizations will change the LM system into a lean virtual manufacturing network, connecting all the manufacturers and suppliers in a single network and allowing the sharing of tangible and intangible assets between the connected parties (Sanders *et al*., 2016). Therefore, combining LM and I4.0 enables the firm to aim for higher interchangeability and shorter information flows to meet future demands (Kolberg *et al*., 2017). Having said this the existing literature lacks a clear roadmap to direct the manufacturing organizations that have optimized their operations through LM philosophies to embrace the I4.0 technologies without disrupting the existing good practices. This study focuses on investigating this research gap in detail by answering the following research questions.

RQ1: How to implement I4.0 technologies in an apparel organization that has mastered LM philosophy?

RQ2: How to encapsulate the adoption process to depict a streamlined roadmap to be used by future adopters of I4.0 in LM environments?

RQ3: What are the specific drivers and challenges of implementing I4.0 in LM environments?

The remainder of the paper is structured as follows: after the introduction, Section 2 provides a review of the works of literature on which the paper is built. Section 3 explains the research methodology, while section 4 provides the main findings. In section 5, the paper discusses the pathway for implementing I4.0 technologies in a Lean environment. In the final section, the paper concludes with the contributions and the limitations of the study, also providing directions for future research.

LITERATURE REVIEW

This section reviews the existing body of literature relevant to the study. The researchers have searched the relevant literature in major journal databases such as SCOPUS, Web of Science, and Google Scholar using combinations of the keywords Lean Manufacturing, Industry 4.0 and Sri Lankan Apparel Industry. However, the scope of this section is set to be a narrative review that explores the existing literature and synthesizes the knowledge.

Lean Manufacturing philosophy

LM is a multi-faceted production approach that originated from the conceptualization of the Toyota Production System (TPS) by Taichii Ohno's efforts at Toyota Motor

Company, and gained popularity in recent decades (Sanders *et al.,* 2016). Lean practices gained traction in Western economies after the publishing of the book titled "The Machine That Changed the World" by Womack *et al.,* (1990) at Massachusetts Institute of Technology (MIT), USA. Womack *et al.* (1990) define LM as using less of everything. This means half the manufacturing space, human effort in the factory, investment in the tools, and engineering working hours to produce a new product in half the time. Additionally, LM results in fewer faults since it involves retaining less than half of the inventory on-site and creates a higher and continuously improving quality of products. As LM has a streamlined process flow, it allows the manufacturers to produce the products per the customer requirements with minimum or zero waste (Shah &Ward, 2003).

Objectives and significance of Lean Manufacturing

Liker (2004) states that the main objective of LM is reducing or eliminating waste/non-value-adding activities to produce products to meet or exceed customer expectations. LM creates higher value for the customers through holistic process optimization throughout the supply chain of an organization (Hu *et al.,* 2015). Hu *et al.* (2015) also state other direct and indirect advantages of implementing LM in organizational activities. Some such advantages are, improving the ability of the organization to compete efficiently and effectively, and close relationships with the supply chain members as LM requires the supply chain members to be collaborative and interdependent for the success of LM. In addition, Langstrand & Ugochukwu (2012) also identified different benefits of implementing Lean practices in the organization. Some such benefits are low inventories, customer satisfaction, optimized efficiency, high quality, reduced cost and improved delivery regarding time, quality, and quantity specifications, and high flexibility.

In LM, anything that does not benefit the end user can be deemed waste. Taiichi Ohno identified eight types of waste. They are Surplus production, excess transportation, waiting, excess processing, fallout, unnecessary movement, redundant stock, and insufficient use of employee potential (Leksic *et al.,* 2020). Further, a Shingo prize-winning study of the United States Environmental Protection Agency in 2003 added excessive energy consumption as the ninth type of Lean waste and claimed that LM can contribute to environmental sustainability by reducing energy waste.

Lean tools and techniques

LM encapsulates a multitude of tools and techniques to identify and eliminate wastages associated with organizational processes. Some such tools and techniques can be listed as Just-In-Time, Kanban, 5S, Value Stream Mapping, Total Productive Maintenance, Production Leveling, Kaizen, Poka-Yoke, Statistical Quality Control, Standardized Work, and Quality Circle, etc. (Langstrand & Ugochukwu, 2012; Palange & Dhatrak, 2021). Each of these tool or technologies has a designated role to be played in an organization that has embraces the LM philosophy.

Just-in-Time is a LM technique that aims to deliver the right product at the right time, cost, quality, and quantity (Mayr *et al*., 2018). Kanban on the other hand provides value to customers through a visual system that enhances flow, cuts lead times, and spots bottlenecks or prospective bottlenecks (Renteria-Marquez *et al*., 2020). 5S of LM ensures that everything has its place, must be kept there, be kept in good condition, and must be readily available anytime it is needed (Veres *et al*., 2018). is a visual way of illustrating a product's production process, including the materials and data from each workstation for diagnosing, implementing, and maintaining a lean approach. (Nihlah & Immawan, 2018). Heijunka also known as Production Leveling, is a crucial tool that aids in eradicating inconsistent customer pull and turning manufacturing into a predictable process (Renteria-Marquez *et al.,* 2020). Kaizen is one of the lean techniques that help to make sure that operations run more smoothly and efficiently by eliminating unnecessary activities that don't add value from the customer's point of view to aid in innovative performance (Habidin *et al*., 2018).

Lean in the Sri Lankan apparel industry

When considering Lean implementation within the apparel firms of Sri Lanka, many organizations have made many efforts to implement LM practices in their organizations ((Silva et al., 2012). These non-indigenous practices, like Lean practices, which are learned from diverse external contexts, can be internalized into the local SME sector of Sri Lanka (de Alwis Seneviratne *et al.*, 2021). LM improves productivity, and data collection reduces cycle time, minimizes material wastage, and provides higher clarity in material and information flow in the apparel industry (Ukey *et al.,* 2022). This study also states that implementing LM in the apparel industry results in enhancing employee morale and increases the organization's total profit and residual value as a result of reduced asset costs. In addition, Gunarathne *et al.* (2017) state that LM practices, such as waste elimination practices, positively impact the operational performance of apparel firms in Sri Lanka.

LM is a human-based system where people are involved in continuous improvements. Many researchers suggest that lean implementation is positively related to

operational performance in both developed (Demeter & Matyusz, 2011; Netland *et al.,* 2015) and developing economies' contexts (Panizzolo *et al*., 2012; Jasti & Kodali, 2016). Also, Jasti & Kodali (2016) suggest that manufacturing organizations should conduct frequent training programs for their workforce to understand how to practice LM concepts in detail in their organization and encourage them to continue to achieve the vision and mission of LM principles.

Industry 4.0

The commonly accepted notion is that industrialization began with the introduction of manufacturing equipment powered by the steam engine during the end of the 1800s. As the name suggests, there were three industrial revolutions before the I4.0. The discovery of the steam engine demarcates the beginning of the First Industrial Revolution (Gökalp *et al.,* 2018). The Second Industrial Revolution (I2.0) began when electricity started to be used in the industrial field (Gökalp *et al.,* 2018) and it involved using automated mechanics in manufacturing that consumes electric power. This was followed by the Third Industrial Revolution (I3.0) which increased the automation of manufacturing processes by implementing Information and Communication technologies. I3.0 replaced a large proportion of the labor force (Gökalp *et al.,* 2017), and technology transferred from analog to digital form.

The I4.0 also known as Industry 4.0, was initiated by the German Federal Government. Hofmann & Rüsch (2017) define I4.0 as a shift in the manufacturing logic towards a more decentralized, self-regulating approach to value creation, aided by concepts and technologies such as the Internet of Things, Cyber-Physical Systems, Internet of Services, Cloud Computing or Additive Manufacturing, and Smart Factories, to help companies meet the future production requirements.

The I4.0 widely explains the concept of a digital factory that involves automated manufacturing processes with reduced human intervention. It defined highly digitized production processes in which information flows between machines in a controlled environment with minimal human participation (Qin *et al.,* 2016). It allows people to communicate in real time. Industry 4.0 is not hype, but rather a potential success. Because of this, all firms must get ready to embrace this prospective industrial revolution to compete in the volatile and intensely competitive market (Ghobakhloo, 2018).

Significance of Industry 4.0

I4.0 and related technologies are expected to generate many advantages such as improved innovation capability, easy monitoring a diagnosis of system multifunction, high productivity, increased customer satisfaction, improved flexibility with decreased costs, unbiased, real-time, knowledge-based decision-making, increased quality, more customized products, smart factories, buildings, and cities increase the quality of life and easy access to personal information (Gökalp *et al.,* 2018; Oztemel & Gursev, 2020).

Stock *et al*. (2018) state that I4.0, as a new industrial paradigm, enables firms to deliver higher financial, ecological, and social performance. In addition, through the deployment of digital technologies, I4.0 facilitates new product and service developments (Dalenogare *et al*., 2018) and enables the mass customization of products and services (Zawadzki & Zywicki, 2016), which allows the firm to achieve higher levels of performance. Companies can profit greatly from I4.0's capabilities, which include the ability to customize products, analyze data in real-time, boost visibility, implement autonomous monitoring and control, create dynamic products, and increase efficiency (Dalenogare *et al*., 2018).

Adoption of I4.0 technologies within the Sri Lankan apparel industry

Apparel companies from developed countries such as the UK and the USA tend to outsource their production plants to low-cost countries such as China, Sri Lanka, and India to reduce production costs (Dachs *et al*., 2019). However, there is an increased focus on relocating the manufacturing plants since there is more emphasis on I4.0. As a result, the apparel industry is positioned to implement innovative solutions to overcome these challenges by implementing technologies (Lakmali *et al*., 2020). The Sri Lankan apparel sector will take the next step from its current milestone when the I4.0 concepts are implemented (Withanaarachchi *et al*., 2016).

To maximize productivity by making the most use of the available resources, the future goal of apparel manufacturing would be to decrease human intervention at all levels of manufacturing (Withanaarachchi *et al*., 2016). Therefore, parts of manufacturing processes are increasingly automated, resulting in improved efficiency and decreased labor costs regarding time manual tasks (Lakmali *et al*., 2020) and reshaping apparel production into a more sustainable and customer-driven business (Bertola & Teunissen, 2018). Firms have been able to generate new methods for designing, marketing, and managing complicated manufacturing systems due to wider technological diffusion.

When considering Sri Lanka's apparel industry readiness level for I4.0 implementation, the overall readiness of the Sri Lankan apparel industry is in level 2: Intermediate Level. Thus, the Sri Lankan apparel industry

is in a situation where computer-based technologies are in use, but human-machine interaction is still available (Lakmali *et al*., 2020). It is clear that Sri Lankan textile manufacturing companies have the capability and strength to adopt ideas like smart factories in order to align their business plans with I4.0 (Withanaarachchi *et al*., 2016).

Integrating Lean Manufacturing and Industry 4.0

Different industries have widely used LM since the 1990s because of its high effectiveness and simplicity. But to satisfy upcoming market demands, LM reached its limits. Even though LM can handle a broader range of items, it is not appropriate for producing individual single items due to its defined production sequence and fixed cycle times. In addition, LM has limited applicability for items with shorter product life cycles (Kolberg & Zühlke, 2015; Kolberg *et al*., 2017). Therefore, manufacturing organizations are in a position to seek out new approaches to face these challenges.

Recently, technology-driven I4.0 technologies have been increasingly implemented in many industries. Process standardization, waste reduction, and a constant emphasis on customer value are essential components of the adoption of Industry 4.0 (Mayr *et al.*, 2018). However, this new paradigm does not replace LM. Organizations are increasingly integrating I4.0 technologies with LM systems because both LM and I4.0 have improved performance and helped organizations achieve competitive advantages over their rivals in the market (Tortorella & Fettermann, 2018; Tortorella *et al*., 2021). In light of technological advancements related to I4.0, the relationship between I4.0 and LM has been increasingly highlighted as a prominent research area in operations management (Buer *et al*., 2018; Rossini *et al.,* 2019).

Successful execution of LM practices aids organizations in being ready to introduce the I4.0 implementation process (Kamble *et al*., 2020). Rossini *et al*. (2019) suggest that the manufacturing firms that aim to adopt I4.0 should simultaneously implement LM practices for process improvements. Buer *et al*. (2018) state that a setting with streamlined flows, standardized processes, and without waste is required for an effective digital transformation.

LM is acting as a prerequisite for successful digital transformation (Bittencourt *et al*., 2019; Rossini *et al*., 2019). Although I4.0 technologies have a direct and favorable impact on sustainable organizational performance, they might not contribute to sustainable organizational performance if they are developed as a standalone application without LM. Therefore, LM implementation enables organizations to be ready to begin the I4.0 implementation process (Kamble *et al*., 2020).

Significance of integrating Lean Manufacturing and I4.0 technologies

Sanders *et al.* (2017) and Wagner *et al*. (2017) state that integrating I4.0 and LM practices may allow the firms to overcome the traditional barriers in a Lean transformation achieving significant results. Implementing I4.0 technologies in a Lean environment will not only accelerate the improvement of the LM system but will also lessen the perceived risk brought on by the high implementation costs of I4.0 technologies (Kolberg & Zühlke, 2015). Integrating I4.0 with LM leads to more extensive improvements in organizational performance (Tortorella & Fettermann, 2018).

Kamble *et al*. (2020) state that when I4.0 is implemented without LM, it may not contribute to organizational performance. Further, this study states that, when simple LM techniques are difficult to execute, the integration of LM and I4.0 technologies offers significant cost-saving advantages. Further many studies suggest that combining I4.0 and LM increases the reliability (Wagner *et al*., 2017), productivity (Sanders *et al*., 2016), or flexibility (Kolberg *et al*., 2017). Most of the LM tools and techniques, such as Just-In-Time, Kanban, Value Stream Mapping, Total Productive Maintenance, Visual Management, Leveling, etc., will benefit from the introduction of I4.0 (Rosin *et al.*, 2020) while they act as a prerequisite for a move towards I4.0 (Sanders *et al.*, 2017).

While aiming for small, readily integrated components with lower levels of complexity, both LM and Industry 4.0 favor decentralized, simple structures over massive, complicated systems (Zuehlke, 2010). These two systems are focused primarily on the potential for data collection for resource efficiency matters (Prinz *et al*., 2018). In addition, increasing added value and shared goals are also identical for both systems. According to Mayr *et al.* (2018), value creation is fundamental for the introduction of I4.0 technologies in a lean environment since both LM and I4.0 technologies create value for the organization.

Drivers for implementing I4.0 technologies in a Lean Environment

There are many drivers for implementing I4.0 technologies in a lean environment. One important driver is LM. LM itself is acting as a driver for implementing I4.0 technologies. LM implementation enables organizations to be ready to begin the I4.0 implementation process (Kamble *et al*., 2020). LM facilitates the implementation of I4.0 technologies by providing waste-free, simplified

processes to implement I4.0 technologies. (Buer *et al*., 2018).

The apparel industry needs to enhance their operational performance to deliver high-quality goods with shorter lead times (Dissanayake & Ilangakoon, 2023). The apparel value chain process commences with the design phase and concludes with the delivery of the final product. It is necessary to have a highly innovative design phase and excellent standards in the manufacturing process for a successful product in the apparel industry (De Silva & Rupasinghe, 2016). Industry 4.0 gives businesses more operational control and enables them to use real-time data to boost output, streamline workflows, and drive growth. The apparel industry is likely to get the advantage of I4.0 for most of their processes in the apparel value chain to boost overall performances and to achieve competitive advantages over their rivals (Lakmali *et al*., 2020).

Some other key drivers for implementing I4.0 technologies identified by Rossini *et al.* (2021) include I4.0 technologies enhancing data availability, detecting waste, improving production capacity, improving efficiency and productivity performance, and improving flexibility, quality, and time. By conducting a literature review Ghadge *et al.* (2020) identified some key drivers for implementing I4.0 technologies. They are agility and customization, I4.0 provides accurate, real-time, consistent data for decision-making and efficiency improvement. Further, I4.0 technologies optimize cost savings and generate higher revenues (Ahmad *et al.,* 2020).

Apparel firms are facing frequent changes in customer demand for personalized and customized fashion. This has resulted in the implementation of I4.0 technologies to enhance customer satisfaction (Wijewardhana *et al.,* 2021). Further, labor shortage and increase in labor turnover are major issues faced by the Sri Lankan apparel industry. Many apparel firms are focusing on automation and other innovative methods to meet these challenges (Withanaarachchi *et al*., 2016).

Challenges for implementing I4.0 technologies in a Lean Environment

The higher investment cost is an important challenge faced by organizations when implementing I4.0 technologies. In addition to higher costs, resistance to change, change management, and lack of expertise are some other challenges to implementing I4.0 technologies (Ahmad *et al.,* 2020; Ghadge *et al.,* 2020).

Gökalp *et al*., (2018) identified some other challenges of implementing I4.0 technologies in the apparel industry. They are the initial investment costs for integrating I4.0 technologies such as CPS, robotics, BD infrastructures, IoT, etc., privacy and security issues of the collected data, technical challenges such as lack of skilled workers, lack of global standards developed for I4.0 technologies, and social issues such as unemployment because the demand for low-skilled workers will be replaced by high-skilled workers who can manage emerging technologies.

The major issue with integrating LM and I4.0 technologies is the lack of an understandable architecture that allows these integrations (Ma *et al*., 2017). Although there is growing attention among practitioners and academicians on the studies about integrating I4.0 and LP systems (Buer *et al*., 2018; Rossini *et al*., 2019), they are mostly focused on either individual technologies or performance enhancements brought about by the employment of a single digital technology (Wagner *et al*., 2017; Gillani *et al.,* 2020). Many organizations still struggle with I4.0 technologies and concepts (Sanders *et al*., 2016; Tortorella & Fettermann, 2018) because of the lack of proper guidelines or patterns for the success of companies' digital transformation (Rossini *et al.,* 2021).

RESEARCH METHODOLOGY

This section summarizes the systematic approach used in the study to ensure the reliability and validity of the findings. A clear and transparent description of the research design, sample selection procedure, and data collection and analysis procedures are provided to facilitate a comprehensive understanding of how the results were derived.

Research design

A qualitative approach has been adopted to systematically explain the process of integrating Industry 4.0 (I4.0) technologies into an existing Lean environment. The selection of this research strategy is driven by the study's objectives and questions, as outlined by Saunders *et al*., (2019). By utilizing an exploratory framework, this study aims to gather comprehensive insights addressing the following research questions: How to implement I4.0 technologies in an apparel organization that has mastered LM philosophy? How to encapsulate the adoption process to depict a streamlined roadmap to be used by future adopters of I4.0 in LM environments? What are the specific drivers and challenges of implementing I4.0 in LM environments? This approach allows for a detailed exploration of the synergy between Lean methodologies and advanced digital technologies, providing a clear, step-by-step guide to successful implementation.

Sample selection

The sample selection for this study commenced with a thorough screening of all 158 apparel manufacturers registered under the Sri Lankan Board of Investment

(BOI). The goal was to identify companies that had initially implemented Lean methodologies and subsequently adopted I4.0 technologies. Once identified, these organizations were sorted based on their export revenue. The next stage of the sampling process involved establishing inclusion criteria for respondents to be eligible for the sample. After careful deliberation, the researchers decided that eligible participants must possess substantial knowledge and experience in both Lean and I4.0 implementations, with a minimum of three years of relevant experience.

Starting with the organization with the topmost export revenue, researchers initiated the process of identifying at least two senior-level professionals from each selected organization. To maintain consistency and transparency, a snowball sampling approach was employed within each organization to identify the most suitable professionals for the study. During this process, the researchers deliberated with the management of the selected organizations and ensured that the most appropriate professionals from each organization that satisfy the pre-established inclusion criteria are recruited for the data collection process. This method ensured that the most knowledgeable and experienced individuals were included in the study.

However, data saturation, the point at which no new information or themes emerge, was reached after completing 10 interviews across four organizations. Consequently, the researchers ceased the data collection process at this stage. The anonymized profiles of the final study sample are indicated in Table 1.

Data collection and analysis

The data collection was carried out through semi structured interviews conducted through Zoom online platform. Respondents were presented with a clear statement that emphasized the confidentiality of their answers and the inexistence of a right answer. Further, all respondents were acknowledged as appropriate informants because of their background in LM and I4.0. All interviews were recorded using the facility-provided at the Zoom software.

Subsequently, the interview recordings were transcribed using online transcribing software and the researchers replayed the recordings and cross-checked the transcriptions to ensure the accuracy of the transcriptions and that they match with the audio. The researchers then used the NVivo12 qualitative analytical software to assist the thematic analysis. Thematic analysis is a technique for finding, analyzing, and reporting patterns (themes) within data (Clarke *et al*., 2013; Braun & Clarke, 2006). After the initial coding, the codes were reviewed and grouped into broader themes based on their similarities, as detailed in the annexures. To ensure the coherence of the themes with the coded extracts and the complete data set, the themes were consistently refined by referring back to the transcripts and aligning them with the research questions.

Table 1: Anonymized profiles of the final study sample

Organization	Respondent	Position	Experience
Organization A	Respondent 01	Manager- Lean Enterprise	13 years
	Respondent 02	General Manager- Group Lean Enterprise	20 years
	Respondent 03	Deputy General Manager- Operations	12 years
Organization B	Respondent 04	Deputy General Manager- Engineering and Process Improvements	12 years
	Respondent 05	Manager- Process Improvement	13 years
	Respondent 06	General Manager	17 years
Organization C	Respondent 07	General Manager	21 years
	Respondent 08	Divisional Manager	21 years
Organization D	Respondent 09	Senior Executive- Lean	4 years
	Respondent 10	General Manager- Process and Digital Adoption	12 years

RESULTS AND DISCUSSION

Results

This section presents the main themes and sub-themes based on the research objectives of the study.

The process of implementing I4.0 technologies in an Apparel organization that has mastered LM philosophy

The implementation of I4.0 technologies in a Lean environment necessitates a thorough strategic pathway that illustrates each new step on the way from both strategic and technological perspectives. Based on the participants' responses four main themes were identified as the stages of a pathway for implementing I4.0 technologies in an already existing Lean environment.

1. Setting the Lean base

The Lean principles help organizations to streamline their manufacturing process. Therefore, the majority of the respondents have specified the importance of strengthening the existing Lean base before introducing the I4.0 technologies. For example, the Respondent 02 stated that

> *"... in the initial stage, if you have Lean in the organization established, moving into industry 4.0 is a little bit of a plus because the Lean puts the foundation."*

Thus, setting and strengthening the Lean base has been identified as the first theme.

2. Strategic management

A lack of managerial mindset related to I4.0 will result in a company culture that will not promote new technology implementation. Therefore, many respondents stated the importance of managing the organizational strategies for successful I4.0 technology implementation. For example, the Respondent 01 stated that,

> *"It's the top management itself that set up these goals to move into digitalization at the moment."*

So, managing the strategies of the organization has been identified as the second theme.

3. Human resource development

I4.0 technology implementation might be burdensome for organizations due to a lack of skilled human resources. Therefore, human resource development is identified as the third theme in the process of I4.0 technology implementation.

> *"If it is a specific new technology, definitely we have to train everyone related to those operations in this technology..."* (Respondent 07)

4. Getting external support

Relationships with external stakeholders influence the I4.0 implementation given the technology knowledge imbalance within the organizations. Respondents also specified that getting external support is important when implementing I4.0 technologies in a Lean environment.

> *"We get training, advice, and consultations from external parties."* (Respondent 03)

Therefore, getting support from external parties has been identified as the fourth theme.

14.0 Technologies adopted in a Lean environment

The participants' responses about the I4.0 technologies implemented in a Lean environment are captured by 6 main themes namely 1. Cloud Computing, 2. Internet of Things, 3. Automation and Industrial Robotics, 4. Big Data Analytics, 5. Computer-aided Systems and 6. Additive Manufacturing and Augmented Reality.

Cloud Computing technologies such as cloud-based ERP, and power Business Intelligence are used by all the interviewed organizations during the data collection process. Automated Guided Vehicle, Sensors in the machines, and RFID are the main Internet of Things technologies used by the Sri Lankan apparel industries. Other I4.0 technologies such as robotic process automation, machine and process automation, fast track system, 3D printing, etc. are some other I4.0 technologies used.

Respondents specified these technologies' implementation in a Lean environment as follows.

> *"Our ERP is SAP. It's cloud-based not only the ERP, but our all emails, share drives, and IT infrastructure is also cloud-based."* (Respondent 10)

> *"We use AGVs to carry finished goods within the manufacturing facility."* (Respondent 02)

> *"Metal detecting sensors are used."* (Respondent 02)

> *"We are using automated systems to get our garments down."* (Respondent 07)

> *"And currently, most organizations use the fast-track planning system to support the data and the information flow around the planning."* (Respondent 02)

Drivers for implementing I4.0 technologies in a Lean environment.

Many drivers contribute to implementing I4.0 technologies in an already existing Lean environment. The participants' responses are captured by four main themes as follows.

1. Lean principle

Successful execution of LM practices aids organizations in being ready to introduce the I4.0 implementation process. Therefore, the majority of the respondents specified that Lean sets the base and foundation for technology implementation. For example, Respondent 02 stated that,

> *"... in the initial stage, if you have Lean in the organization established, moving into industry 4.0 is a little bit of a plus because Lean sets the foundation."*

Therefore, the Lean principle has been identified as the first theme for drivers for implementing I4.0 technologies in a Lean environment.

2. Organizational factors

Committed leadership, increasing production and operational costs quality, and efficiency improvements are some drivers for implementing I4.0 technologies in a Lean environment. Respondents also specified that organizational factors such as leadership, the requirement to reduce cost, enhancing data availability, and improving quality and efficiency are acting as drivers for implementing I4.0 technologies in a Lean environment.

> *"Companies are using technology to bring the cost down."* (Respondent 04)

> *"I4.0 technology helps you to give real-time data so that management can make a quick decision within a shorter period."* (Respondent 03)

Therefore, organizational factors have been identified as the second theme.

3. External forces

External forces such as competition and customer expectations require organizations to move towards technology implementations which has been identified as the third theme for drivers for implementing I4.0 technologies.

> *"Customers are also expecting us to adopt different technologies."* (Respondent 10)

4. Human resource factors

Further, human resource factors such as increasing labor costs are some other drivers for implementing I4.0 technologies in a Lean environment. The majority of the respondents also specified that increasing labor costs is an important driver for I4.0 technology implementations. For example, Respondent 04 stated that,

> *"Companies tend to invest in technology rather than investing in people because of humans or the labor party, the cost is increasing."*

Therefore, human resource factors have been identified as the fourth theme.

Challenges in implementing I4.0 technologies in a Lean environment

In an emerging economy like Sri Lanka, implementing high-end technologies is challenging. The participants' responses about the challenges in implementing I4.0 technologies are captured by three main themes namely 1. Cost, 2. People-related challenges, and 3. Technological challenges.

High cost is a significant challenge in implementing I4.0 technologies. The majority of the respondents specified a higher cost of investment and cost of training the employees as the main challenge in implementing I4.0 technologies. For example, Respondent 08 stated that,

> *"Technologies are very expensive."*

Therefore, higher cost has been identified as the first theme.

Further, people are neither familiar nor confident about technologies. Therefore, they are reluctant to adopt them which is another challenge faced by the organizations. Many respondents specified that people resisting the technologies and lack of technological expertise within the organization are also challenges when implementing I4.0 technologies. Respondents 05 and 04 stated as follows.

> *"The people in the organization worried that these technologies would be taking over their jobs."* (Respondent 05)

> *"Still, people are not aware to adapt to use of these kinds of processes or technology."* (Respondent 04)

Therefore, people-related challenges have been identified as the second theme.

Effects of I4.0 technologies on human resources in a Lean environment

Technology implementation will have pros and cons for human resources within the organizations. Respondents also specified there are positive as well as negative effects of I4.0 technologies on human resources. For example, respondents 08 and 04 stated as follows.

> *"People will be upgraded because, with this technology and these new learnings, people are getting new technologies and new things. They have new markets."* (Respondent 08)

> *"The negative part of it is, it will reduce the people… If you take it as a negative, it could be a threat to the people."* (Respondent 04)

Therefore, favorable impacts and unfavorable impacts emerge as themes related to the effects of I4.0 technologies on human resources.

Discussion

This section discusses the findings of the data analysis of the study.

The I4.0 technologies that can be introduced first for a Lean organization

The data analysis highlighted those technologies such as Cloud Computing, the Internet of Things, Automation, Industrial Robotics, Big Data Analytics, and Computer-aided Systems are heavily used by many apparel firms while technologies such as Additive Manufacturing and Augmented Reality are used only by certain apparel firms in Sri Lanka. The existing literature also confirms the use of I4.0 technologies in the Sri Lankan apparel industry (Withanaarachchi *et al*., 2016; Wijewardhana *et al.,* 2021). However, our finding provides a classification of I4.0 technologies based on the adoption rates.

Drivers for Implementing I4.0 technologies in a Lean environment

Regarding drivers for implementing I4.0 technologies in a Lean environment, data analysis highlighted that LM itself is acting as a driver for implementing I4.0 technologies by eliminating waste and refining the manufacturing process while identifying the requirements for implementing I4.0 technologies. These findings are in line with the existing literature such as Kamble *et al*., (2020), Buer *et al*. (2018), and Kolberg & Zühlke, (2015).

Further, leadership support, cost reduction, enhanced data availability, quality and efficiency improvement, facing competition, meeting customer expectations, increasing labor costs, and technology-reducing human dependency have been identified as other key drivers for implementing I4.0 technologies in a Lean environment. These findings also are in line with the findings of Rossini *et al.* (2021), Ghadge *et al.* (2020), Ahmad *et al.* (2020), Ghobakhloo (2018), Ghobakhloo & Fathi (2020); Wijewardhana *et al.* (2021) and Withanaarachchi *et al*. (2016).

Challenges for implementing I4.0 technologies in a Lean environment

Higher costs associated with the technology implementation is an important challenge highlighted by the data analysis. Other challenges for implementing I4.0 technologies in a Lean environment highlighted by the data analysis are technology resistance, technical issues, choosing among alternative technologies, infrastructure availability, and privacy and security issues. These findings agree with the earlier studies (Ahmad *et al*., 2020; Ghadge *et al.,* 2020; Gökalp *et al*., 2018).

Effects of I4.0 technologies on human resources in a Lean environment

Data analysis highlighted both the positive and negative effects of I4.0 technologies on human resources. The positive effects of I4.0 technologies on human resources are human resource development and making jobs easier. Marengo (2019) and Rossini *et al.* (2021) support these findings. Negative effects include a reduction in income and termination of people. These negative effects are supported by earlier studies (Leonhard, 2016; Sima *et al.,* 2020; Gökalp *et al*., 2018).

THE PATHWAY FOR IMPLEMENTING I4.0 TECHNOLOGIES IN AN APPAREL ORGANIZATION THAT HAS MASTERED LM PHILOSOPHY

Findings from the data analysis develop and introduce a pathway for implementing I4.0 technologies in a Lean environment. Figure 4.1 derived from the data analysis shows a pathway for implementing I4.0 technologies in a Lean environment. Setting the Lean base is important because it provides the foundation for implementing I4.0 technologies. Lean eliminates waste and standardizes the process. The second step of the pathway is the strategic management of the I4.0 implementation which starts with defining the organizational strategies. Similar findings were stated in some of the existing literature (Kamble *et al*., 2020; Bittencourt, *et al*., 2019; Rossini *et al.,* 2019; Buer *et al*., 2018; Schumacher *et al*., 2016; Ghobakhloo, 2018). The strategic management phase also includes cost-benefit analysis, defining the technologies to be implemented, etc.

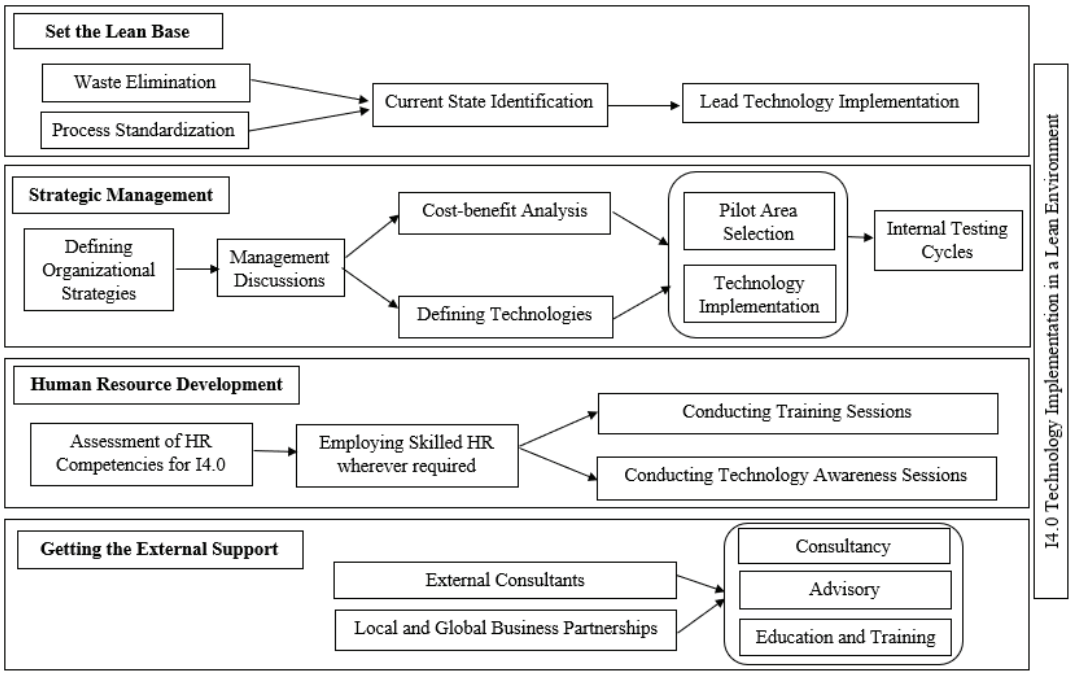

Figure 4.1: Pathway for I4.0 technology implementation in a lean environment

The third phase of the pathway for implementing I4.0 technologies in a Lean environment is human resources development. This includes assessing the HR competencies for I4.0, hiring new HR wherever required, and conducting employee training and awareness sessions for I4.0 technologies. Finally, as a part of implementing I4.0 technologies in a Lean environment, organizations should get the support of external consultants and local and global business partners in terms of consultancy, advisory, education, and training. The findings of Ghobakhloo (2018); Ghobakhloo & Fathi (2020) support these, which assess a strategic roadmap toward I4.0 and the enabling role of Lean-digitized manufacturing in the I4.0 era.

CONCLUSION

As both LM and I4.0 have been promised to improve organizational performance, many firms have started integrating both methods to achieve superior performance and competitive advantages over their rivals in the market. Although there is a large sum of research contributions on the I4.0 topic, companies are still facing issues with understanding and implementing I4.0 technologies. In addition, to the extent researchers know, only a few studies in the literature empirically investigate how I4.0 can be implemented in a Lean environment in a developing economy. The study is one of the first empirical studies in Sri Lanka to contribute to this debate.

This study contributes to the I4.0 technology and LM-related literature by identifying a pathway for implementing I4.0 technologies in a lean environment of the Sri Lankan Apparel Industry. The findings of the study highlight the I4.0 technologies that can first be implemented in a lean organization, drivers for implementing I4.0 technologies in a lean environment, the challenges in implementing I4.0 technologies in a Lean environment, and the effects of I4.0 technologies on human resources in a Lean environment.

The pathway for implementing I4.0 technologies in a lean environment of the Sri Lankan apparel industry provided in this study is a holistic view of the typical actions that apparel manufacturers can take to make the transition to I4.0. It is believed that the benefits of implementing I4.0 technologies in a lean environment may outweigh the costs involved, especially for top-tier manufacturers who have the expertise and manpower required to develop and implement underlying technological trends as well as the necessary stakeholder support to make significant investments in new technologies. Nonetheless, it cannot be denied that the fourth industrial revolution is accompanied by several difficulties such as privacy and security issues, technical issues, infrastructure availability, etc.

Therefore, this study recommends giving more priority to cyber security since there is less priority given to cyber security within organizations. Further, this

study recommends that organizations that implement I4.0 technologies can first create a lean base for the successful implementation of I4.0 technologies. As per the findings of the study, there's the termination of people and a reduction in the income level of employees due to technology implementations. Organizations can focus on increasing production capacity with technology implementations rather than terminating employees. Additionally, the infrastructure facilities in Sri Lanka to facilitate I4.0 technologies are comparatively lower than global standards. Hence, the authorities must initiate projects to improve the infrastructure facilities to facilitate the implementation of I4.0 technologies.

Theoretical and managerial implications

This research makes several contributions to the state-of-the-art I4.0 technology implementation and LM-related literature. The study proposes a new pathway to implementing I4.0 technologies in a Lean environment. Most of the studies that investigate I4.0 technologies and LM approach the topic without making any recommendations regarding a clear implementation sequence of practices and technologies. To our knowledge, few of these research studies have pointed to such a pathway, even though most of them have revealed a favorable association between LM and I4.0 in the direction of a successful I4.0 technology implementation. Further, only a very few such empirical research have been published so far about the apparel industry in Sri Lanka.

The study also provides a better understanding of how LM can support the implementation of I4.0 technologies, allowing companies undergoing I4.0 technology implementation to better manage their change process while they move towards the LM. There will be a greater need for integrating novel technologies as businesses continue to prioritize LM and effective business practices. This is one way in which I4.0 will transform manufacturing. It tends to increase productivity to various levels, while also generating fresh company ideas and innovative services. So, in this paradoxical situation where technology and human-based simplicity must coexist, finding the right balance for change may be the key to successfully competing.

This study has extended the knowledge regarding the pathway for implementing I4.0 technologies in a Lean environment. By starting from an empirical analysis, the study's findings provide indications for managers concerning how companies could implement I4.0 technologies in a Lean environment. In this sense, managers and practitioners from companies undergoing I4.0 technologies implementation in a Lean environment may find here guidelines that can help them to prioritize efforts and narrow their attention more objectively to the proper mix of procedures and technology. Thus, this study represents the new opportunities for implementing I4.0 technologies in a Lean environment.

Managers will be able to use this study and the associated results to initiate their implementations. Furthermore, the study provides a framework for the successful implementation of I4.0 technologies, especially for apparel manufacturing companies that have a Lean background by highlighting the challenges of implementing I4.0 technologies and the effects of I4.0 technologies on human resources. Companies can use this study approach to evaluate their I4.0 implementation as well as when they have already invested in such technologies and are unsure about their next steps. Also, this research gives crucial information for practitioners to comprehend the significance of integrating the I4.0 technologies with the Lean paradigm.

Overall, the findings may be necessary to manufacturers in the apparel industry, policymakers for national development, and even managers and investors in every industry when they initiate the I4.0 implementation process.

Limitations and future research directions

There are some limitations of this study that offer future research directions. The first limitation of the study is the sample size. Since this study has considered a sample of ten respondents from four apparel firms in Sri Lanka, the sample can be further expanded to conduct a more generalized study on the pathway for implementing I4.0 technologies in a Lean environment.

Secondly, the study only addresses the pathway for implementing I4.0 technologies in a Lean environment in the apparel industry. Future research could be performed for different industries and such findings can explain how these technologies can affect different industries.

Thirdly, this study has used a limited set of variables through a questionnaire-based survey. Future research could additionally examine the relationship's response between I4.0 technologies and LM to any moderating and mediating factors.

This study uses a qualitative study to conduct the research. Future research could be performed using a quantitative study to verify the results of this study.

Finally, the study focuses on the variables such as initial I4.0 technologies to be implemented, drivers and challenges, and the effect of I4.0 technologies on the

human resources of a Lean environment. There can be other variables that are not investigated in this study that will be necessary for implementing I4.0 technologies in a Lean environment that future research can focus on.

REFERENCES

Ahmad, S., Miskon, S., Alabdan, R. & Tlili, I. (2020) Towards sustainable textile and apparel industry: Exploring the role of business intelligence systems in the era of industry 4.0, *Sustainability*, *12*(7), pp: 2632.

DOI: https://doi.org/10.3390/su12072632

Apparel Product Suppliers in Sri Lanka - EDB Exporter Directory (2022) Available from: https://www.srilankabusiness.com/exporters-directory/apparel-exporters-in-sri-lanka/garment-suppliers/[Accessed: 29th December 2022].

Aryarathne, S.P. & Galahitiyawe, N.W.K. (2020) Impact of Lean Manufacturing Practices on Operational Performance: A Study in Sri Lankan Apparel Sector, *Peradeniya Management Review*, *2*(2), p: 103.

DOI: https://doi.org/10.4038/pmr.v2i2.42

Bai, C. & Sarkis, J. (2017) Improving green flexibility through advanced manufacturing technology investment: Modeling the decision process, *International Journal of Production Economics*, *188*, pp: 86-104.

DOI: https://doi.org/10.1016/j.ijpe.2017.03.013

Bertola, P. & Teunissen, J. (2018) Fashion 4.0. Innovating fashion industry through digital transformation, *Research journal of textile and apparel*, *22*(4), pp: 352-369.

DOI: https://doi.org/10.1108/RJTA-03-2018-0023

Braun, V. & Clarke, V. (2006) Using thematic analysis in psychology, *Qualitative research in psychology*, *3*(2), pp: 77-101.

DOI: https://doi.org/10.1191/1478088706qp063oa

Buer, S.V., Strandhagen, J.O. & Chan, F.T. (2018) The link between Industry 4.0 and lean manufacturing: mapping current research and establishing a research agenda, *International journal of production research*, *56*(8), pp: 2924-2940.

DOI: https://doi.org/10.1080/00207543.2018.1442945

Clarke, V., Braun, V. & Studies, S. (2013) Teaching thematic analysis: Overcoming challenges and developing strategies for effective learning [online] Available from: https://uwe-repository.worktribe.com/preview/937606/Teaching

Dalenogare, L.S., Benitez, G.B., Ayala, N.F. & Frank, A.G. (2018) The expected contribution of Industry 4.0 technologies for industrial performance, *International Journal of production economics*, *204*, pp: 383-394.

DOI: https://doi.org/10.1016/j.ijpe.2018.08.019

De Silva, R.J., Rupasinghe, T.D. & Apeagyei, P. (2019) A collaborative apparel new product development process model using virtual reality and augmented reality technologies as enablers, *International Journal of Fashion Design, Technology and Education*, *12*(1), pp: 1-11.

DOI: https://doi.org/10.1080/17543266.2018.1462858

Du, J., Zhang, J., Castro-Lacouture, D. & Hu, Y. (2023) Lean manufacturing applications in prefabricated construction projects, *Automation in Construction*, *150*, p: 104790.

DOI:https://doi.org/10.1016/J.AUTCON.2023.104790

Export Performance Indicators -2021 Sri Lanka Export Development Board (2021) [online] Available at: https://www.srilankabusiness.com/ebooks/preview-export-performance-indicators-of-sri-lanka-2012-2021.pdf

Gamage, E., Vidanagamachchi, K. & Nanayakkara, J. (2020). Readiness Assessment for Industry 4.0 in Sri Lankan Apparel Industry [online] Available from:https://www.researchgate.net/publication/342352216

Ghadge, A., Er Kara, M., Moradlou, H. & Goswami, M. (2020) The impact of Industry 4.0 implementation on supply chains, *Journal of Manufacturing Technology Management*, *31*(4), pp: 669-686.

DOI:https://doi.org/10.1108/JMTM-10-2019-0368

Ghobakhloo, M. & Fathi, M. (2019) Corporate survival in Industry 4.0 era: the enabling role of lean-digitized manufacturing, *Journal of Manufacturing Technology Management*, *31*(1), pp:1-30.

DOI:https://doi.org/10.1108/JMTM-11-2018-0417

Ghobakhloo, M. (2018) The future of manufacturing industry: a strategic roadmap toward Industry 4.0, *Journal of manufacturing technology management*, *29*(6), pp: 910-936.

DOI: https://doi.org/10.1108/JMTM-02-2018-0057

Gökalp, E., Gökalp, M.O. & Eren, P.E. (2018) Industry 4.0 revolution in clothing and apparel factories: Apparel 4.0, *Industry*, *4*, pp:169-183.

DOI: https://doi.org/10.3726/b15120/21

Gökalp, E., Şener, U. & Eren, P.E. (2017) Development of an assessment model for industry 4.0: industry 4.0-MM, In *Software Process Improvement and Capability Determination: 17th International Conference, SPICE 2017, Palma de Mallorca, Spain, October 4–5, 2017, Proceedings*, pp: 128-142, Springer International Publishing.

DOI: https://doi.org/10.1007/978-3-319-67383-7_10

Habidin, N.F., Hashim, S., Fuzi, N.M. & Salleh, M.I. (2018) Total productive maintenance, kaizen event, and performance, *International Journal of Quality & Reliability Management*, *35*(9), pp:1853-1867.

DOI: https://doi.org/10.1108/IJQRM-11-2017-0234

Hermann, M., Pentek, T. & Otto, B. (2015) Design Principles for Industrie 4.0 Scenarios: A Literature Review, Technische Universitat Dortmund, 1 (1), PP:4–16.

DOI: https://doi.org/10.13140/RG.2.2.29269.22248

Hofmann, E. & Rüsch, M. (2017) Industry 4.0 and the current status as well as future prospects on logistics, *Computers in industry*, *89*, pp:23-34.

DOI:https://doi.org/10.1016/j.compind.2017.04.002

Hu, Q., Mason, R., Williams, S.J. & Found, P. (2015) Lean implementation within SMEs: a literature review, *Journal of Manufacturing Technology Management*, *26*(7), pp.980-1012.

DOI: https://doi.org/10.1108/JMTM-02-2014-0013

Ilangakoon, S.M. & Dissanayake, K. (2023) Impact of Lean Utilization on Operational Performance: A Study of Sri Lankan Textile and Apparel Industry, In *Recent Advances in Civil Engineering,* pp: 38-44, CRC Press.

DOI: https://doi.org/10.1201/9781032657271

Industry Capability Report Sri Lankan Apparel Sector. (2022). Available at: https://www.srilankabusiness.com/ebooks/industry-capability-report-apparel-2021.pdf

Jasti, N.V.K. & Kodali, R. (2016) An empirical study for implementation of lean principles in Indian manufacturing industry, *Benchmarking: An International Journal*, *23*(1), pp.183-207.

DOI: https://doi.org/10.1108/BIJ-11-2013-0101

Jayawardane, K., Musthaffa, S. & Dias, M. (2022). Impact of Lean Manufacturing on Inventory Turnover Performances: Evidence from the Sri Lankan Apparel Industry. [online] IEEE Xplore. Available at: https://doi.org/10.1109/MERCon55799.2022.9906192

Kamble, S., Gunasekaran, A. & Dhone, N.C. (2020) Industry 4.0 and lean manufacturing practices for sustainable organisational performance in Indian manufacturing companies, *International journal of production research*, *58*(5), pp.1319-1337.

DOI: https://doi.org/10.1080/00207543.2019.1630772

Kolberg, D. & Zühlke, D. (2015) Lean automation enabled by industry 4.0 technologies, *IFAC-PapersOnLine*, *48*(3), pp.1870-1875.

DOI: https://doi.org/10.1016/j.ifacol.2015.06.359

Kolberg, D., Knobloch, J. & Zühlke, D. (2017) Towards a lean automation interface for workstations. *International journal of production research*, *55*(10), pp.2845-2856.

DOI: https://doi.org/10.1080/00207543.2016.1223384

Lakmali, E., Vidanagamachchi, K. & Nanayakkara, J. (2020) Industry 4.0 readiness assessment for apparel industry: A study in the Sri Lankan context. In *2020 International Research Conference on Smart Computing and Systems Engineering (SCSE),* pp. 174-181.

DOI: https://doi.org/10.1109/SCSE49731.2020.9313026

Lean Manufacturing and the Environment: Research on Advanced Manufacturing Systems and the Environment and Recommendations for Leveraging Better Environmental Performance Acknowledgments. (2003). Available at: https://19january2017snapshot.epa.gov/sites/production/files/2016-11/documents/lean_environment_report.pdf

Leksic, I., Stefanic, N. & Veza, I. (2020) The impact of using different lean manufacturing tools on waste reduction, *Advances in production engineering & management*, *15*(1), pp. 81–92.

DOI: https://doi.org/10.14743/APEM2020.1.351

Leonhard, G. (2016) *Technology vs. Humanity: The coming clash between man and machine*, Lodge, UK: FutureScapes. Available at: www.techvshuman.com

Liker, J.K. (2004) The Toyota way: 14 management principles from the world's greatest manufacturer. McGraw-Hill. Available at:https://library.lol/main/6249F2BE7C4499DDB85A165D09020E03

Marengo, L. (2019) 'Is this time different? A note on automation and labour in the fourth industrial revolution', Journal of Industrial and Business Economics, 46(3), pp. 323–331.

DOI: https://doi.org/10.1007/s40812-019-00123-z

Mayr, A., Weigelt, M., Kühl, A., Grimm, S., Erll, A., Potzel, M. & Franke, J.J.P.C. (2018) Lean 4.0-A conceptual conjunction of lean management and Industry 4.0, *Procedia Cirp*, *72*, pp.622-628.

DOI: https://doi.org/10.1016/j.procir.2018.03.292

Nihlah, Z. & Immawan, T. (2018) Lean manufacturing: waste reduction using value stream mapping. In *3rd International Conference on Energy, Environmental and Information System (ICENIS)-Strengthening Planning and Implementation Energy, Environment, and Information System Toward Low Carbon Society Conference Location Semarang, INDONESIA*. EDP SCIENCES Location CEDEX A.

Oztemel, E. & Gursev, S. (2020) Literature review of Industry 4.0 and related technologies, *Journal of intelligent manufacturing*, *31*(1), pp.127-182.

DOI: https://doi.org/10.1007/s10845-018-1433-8

Palange, A. & Dhatrak, P. (2021) Lean manufacturing a vital tool to enhance productivity in manufacturing, *Materials Today: Proceedings*, *46*, pp.729-736.

DOI:https://doi.org/10.1016/j.matpr.2020.12.193

Qin, J., Liu, Y. & Grosvenor, R. (2016) A categorical framework of manufacturing for industry 4.0 and beyond, *Procedia cirp*, *52*, pp.173-178.

DOI: https://doi.org/10.1016/j.procir.2016.08.005

Renteria-Marquez, I.A., Almeraz, C.N., Tseng, T.L.B. & Renteria, A. (2020) A heijunka study for automotive assembly using discrete-event simulation: a case study. In *2020 Winter Simulation Conference (WSC)* pp. 1641-1651.

DOI:https://doi.org/10.1109/WSC48552.2020.9383927

Rosin, F., Forget, P., Lamouri, S. & Pellerin, R. (2020) Impacts of Industry 4.0 technologies on Lean principles, *International Journal of Production Research*, *58*(6), pp.1644-1661.

DOI: https://doi.org/10.1080/00207543.2019.1672902

Rossini, M., Cifone, F.D., Kassem, B., Costa, F. & Portioli-Staudacher, A. (2021) Being lean: how to shape digital transformation in the manufacturing sector, *Journal of Manufacturing Technology Management*, *32*(9), pp.239-259.

DOI: https://doi.org/10.1108/JMTM-12-2020-0467

Rossini, M., Costa, F., Staudacher, A.P. & Tortorella, G. (2019) Industry 4.0 and lean production: an empirical study. *IFAC-PapersOnLine*, *52*(13), pp.42-47.

DOI:https://doi.org/10.1016/j.ifacol.2019.11.122

Sanders, A., Elangeswaran, C. & Wulfsberg, J. (2016) Industry 4.0 implies Lean manufacturing: Research activities in industry 4.0 function as enablers for Lean manufacturing, Journal of Industrial Engineering and Management, 9(3), pp. 811–833.

DOI: https://doi.org/10.3926/jiem.1940

Sanders, A., K. Subramanian, K.R., Redlich, T. & Wulfsberg, J.P. (2017) Industry 4.0 and lean Management–synergy or contradiction? A Systematic interaction approach to determine the compatibility of Industry 4.0 and lean Management in manufacturing environment. In *Advances in Production Management Systems. The Path to Intelligent, Collaborative and Sustainable Manufacturing: IFIP WG 5.7 International Conference, APMS 2017, Hamburg, Germany, September 3-7, 2017, Proceedings, Part II*, pp. 341-349.

DOI: https://doi.org/10.1007/978-3-319-66926-7_39

Saunders Philip Lewis Adrian Thornhill, K. (2019) Mark N. Available from: www.pearson.com/uk

Schumacher, A., Erol, S. & Sihn, W. (2016) A maturity model for assessing Industry 4.0 readiness and maturity of manufacturing enterprises. *Procedia Cirp*, *52*, pp.161-166.

DOI: https://doi.org/10.1016/j.procir.2016.07.040

Seneviratne, R.D.A., Dissanayake, K., Premaratna, S.P., Melegoda, N., Ranwala, S. & Fernando, A. (2021) Lean practices and benefits: study of Sri Lankan small and medium enterprises, *Journal of Business Studies*, *8*(0), p:1.

DOI: https://doi.org/10.4038/jbs.v8i0.65

Shah, R. & Ward, P.T. (2003) Lean manufacturing: context, practice bundles, and performance, *Journal of operations management*, *21*(2), pp.129-149.

DOI: https://doi.org/10.1016/s0272-6963(02)00108-0

Silva, N., Perera, H.S.C. & Samarasinghe, D. (2012) Factors Affecting Successful Implementation of Lean Manufacturing Tools and Techniques in the Apparel Industry in Sri Lanka, SSRN Electronic Journal [Preprint] *1824419*.

DOI: https://doi.org/10.2139/ssrn.1824419

Sima, V., Gheorghe, I.G., Subić, J. & Nancu, D. (2020) Influences of the industry 4.0 revolution on the human capital development and consumer behavior: A systematic review. *Sustainability*, *12*(10), p.4035.

DOI: https://doi.org/10.3390/SU12104035

Tortorella, G.L. & Fettermann, D. (2018) Implementation of Industry 4.0 and lean production in Brazilian manufacturing companies, *International journal of production research*, *56*(8), pp.2975-2987.

DOI: https://doi.org/10.1080/00207543.2017.1391420

Tortorella, G.L., Saurin, T.A., Godinho Filho, M., Samson, D. & Kumar, M. (2021) Bundles of Lean Automation practices and principles and their impact on operational performance, *International Journal of Production Economics*, *235*, p.108106.

DOI:https://doi.org/10.1016/j.ijpe.2021.108106

Ugochukwu, P., Engström, J. & Langstrand, J. (2012) Lean in the supply chain: a literature review, *Management and production engineering review*, *3*, pp.87-96.

DOI: https://doi.org/10.2478/v10270-012-0037-6

Ukey, P., Deshmukh, A. & Arora, A. (2022). Implementation of lean tools in apparel industry for improving productivity. Proceedings on Engineering Sciences, 3(2), pp.247–252.

DOI: https://doi.org/10.24874/pes03.02.012.

Veres, C., Marian, L., Moica, S. & Al-Akel, K. (2018) Case study concerning 5S method impact in an automotive company. *Procedia manufacturing*, *22*, pp.900-905.

DOI: https://doi.org/10.1016/j.promfg.2018.03.127

Wagner, T., Herrmann, C. & Thiede, S. (2017) Industry 4.0 impacts on lean production systems. *Procedia Cirp*, *63*, pp.125-131.

DOI: https://doi.org/10.1016/j.procir.2017.02.041

Wijewardhana, G.E.H., Weerabahu, S.K., Nanayakkara, J.L.D. & Samaranayake, P. (2021) New product development process in apparel industry using Industry 4.0 technologies. *International*

Journal of Productivity and Performance Management, *70*(8), pp.2352-2373.

DOI: https://doi.org/10.1108/IJPPM-02-2020-0058

Withanaarachchi, Amila, Jayatilake, H.S.B. and Withanaarachchi, A (2016) Industry 4.0 in the Apparel-Manufacturing Sector: Opportunities for Sri Lanka. Available at: https://www.researchgate.net/publication/310466591

Jayatilake, H. & Withanaarachchi, A.S. (2016) Industry 4.0 in the apparel-manufacturing sector: Opportunities for Sri Lanka. In *1st Interdisciplinary Conference of Management Researchers, At Sabaragamuwa University of Sri Lanka*. Available at: https://www.researchgate.net/publication/310466591ttps://www.researchgate.net/publication/310466591

Womack, J.P., Jones, D.T. & Roos, D. (2007) *The machine that changed the world: The story of lean production--Toyota's secret weapon in the global car wars that is now revolutionizing world industry*. Simon and Schuster. Available at: https://library.lol/main/4CAF8727DD79685FA425BD9F43B96194

Zhong, R.Y., Xu, X., Klotz, E. & Newman, S.T. (2017) Intelligent manufacturing in the context of industry 4.0: a review. *Engineering*, *3*(5), pp.616-630.

DOI: https://doi.org/10.1016/J.ENG.2017.05.015

Annexures: Themes and sub-themes developed under thematic analysis

Annexure 1: Pathway for implementing I4.0 technologies in a Lean environment

Main themes	Sub-themes
1. Set the Lean base	a. Waste elimination b. Process standardization c. Current state identification d. Lead technology implementation
2. Strategic Management	a. Defining organizational strategies b. Management discussions c. Conducting cost-benefit analysis and defining the technologies to be implemented d. Pilot area selection and technology implementation e. Conducting internal testing cycles
3. Human Resource Development	a. Assessment of HR competencies for I4.0 b. Employing skilled HR wherever required c. Conducting training sessions d. Conduct technology awareness sessions
4. Getting External Support	a. External consultants b. Local and global business relationships

Annexure 2: I4.0 technologies implemented in a Lean environment

Main themes	Sub-themes
1. Cloud Computing	a. Cloud-based ERP b. Power Business Intelligence
2. Internet of Things	a. Automated Guided Vehicle b. Sensors in machines c. RFID
3. Automation and Industrial Robotics	a. Machine and process automation b. Robotic process automation
4. Big Data Analytics	a. Shop floor system b. Fast track system
5. Computer-aided systems	a. Computer -aided designing systems b. Computer-aided quality control system
6. Additive Manufacturing and Augmented Reality	a. 3D Printing b. Digital technologies

Annexure 3: Drivers for implementing I4.0 technologies in a Lean environment

Main themes	Sub-themes
1. Lean principle	a. Improving waste detection b. Requirement identification
2. Organizational factors	a. Leadership b. Cost reduction c. Enhance data availability d. Quality and efficiency improvement
3. External forces	a. Competition b. Customer expectations
4. Human resource factors	a. Increasing labor cost b. Reduce human dependency

Annexure 4: Challenges in implementing I4.0 technologies in a Lean environment

Main themes	Sub-themes
1. Cost	a. High investment cost b. Cost of training
2. People-related challenges	a. Technology resistance b. Technical issues
3. Technological challenges	a. Choosing among alternative technologies b. Infrastructure availability c. Privacy and security

Annexure 5: Effects of I4.0 technologies on human resources in a Lean environment

Main themes	Sub-themes
1. Positive effects	a. Human resource development b. Makes the jobs easier
2. Negative effects	a. Reduction in income b. Termination of people

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RESEARCH ARTICLE

Effectiveness of National Innovation System of Sri Lanka: examining the roles of universities, S&T institutions and industry

R. N. Weerasinghe[1,2*] , A. K. W. Jayawardane[3] and Qiubo Huang[1]

[1]*School of Economics and Welfare, Zhejiang Shuren University, Hangzhou, Zhejiang, China.*
[2]*Department of Entreprneurship, University of Sri Jayewardenepura, Sri Lanka.*
[3]*Department of Civil Engineering, Faculty of Engineering, University of Moratuwa, Sri Lanka.*

Abstract: After resolving internal conflicts in 2009, Sri Lanka experienced significant economic growth through infrastructure development and other policy initiatives. However, the pace of growth has since decelerated, and the country now faces numerous challenges related to the sustainability of its progress. Scholars and policymakers have identified a primary issue: the need for a systematic approach to the country's development models. Consequently, this study was conducted to comprehensively examine the policy inputs necessary for optimizing the National Innovation System (NIS) in Sri Lanka, focusing on the three main actors: universities, S&T institutions, and industry. A robust conceptual model was formulated by exploring the existing literature on NIS, their functions, and roles, with particular emphasis on the imperatives of NIS in developing countries. This study aims to understand the roles of these three main actors within NIS, evaluate the effectiveness of their functions, and assess the strength of the networking relationships among them. Based on this conceptual framework, the empirical phase of the study was structured and implemented. This research proposes several policy recommendations based on data analysis to enhance the three primary NIS actors' role effectiveness and strengthen their network relationships, providing a solid foundation for future policy decisions.

Keywords: National Innovation System (NIS), Actors of NIS, Networking Relationships, R&D, Innovation, Sri Lanka.

INTRODUCTION

Innovation is the kickstarter for developing entrepreneurs who contribute to uplifting the social standards and economic development of any country. Accordingly, innovation studies have attracted the attention of many development-oriented researchers while opening a new array of studies on the systems approach of national innovation in the late 1980s. The system approach to studying national-level innovation initiatives has become a mature research domain in the context of developed countries. The theoretical understanding and empirical investigations in the same field of study appeal to more research attention in developing countries. Hence, these underrepresented developing countries must conduct sufficient studies on national-level innovation systems in their contexts and promote entrepreneurial activities based on their research findings (Lindberg *et al*., 2014; Andersson & Billou, 2007).

The composition of elements and their interactions for securing practical national-level innovation is configured as a National Innovation System (NIS), which is the central theme of this study. The authors—Freeman (1988), Lundvall (1992), and Nelson (1993)—have significantly contributed to concretizing the idea of the NIS by emphasizing its importance and figuring out its constituents and functions as a system configuration ensuring effective innovation performance at the national level.

As a result of converging the research focus on NIS in a developing country context, there were several research studies conducted in Asian countries, for example, in China (Boeing & Sandner, 2010; Song, 2013), in

* Corresponding author (rukmal@sjp.ac.lk; https://orcid.org/0000-0003-1696-0666)

Thailand (Intarakumnerd *et al*., 2002; Intarakumnerd *et al.,* 2012), in India (Rajan, 2012; Mehta, 2018; Bokachev, 2019), in Pakistan (Naqvi, 2011; Ul Huq *et al*., 2014), in Malaysia (Kanagasundram, 2013), in Philippine (Habaradas, 2008), and in Indonesia (Taufik, 2007; Zu Koecker, 2012). The concept of NIS was also one of the prominent research domains among the researchers in the African region (Toivanen & Ponomariov, 2011; Allard & Williams, 2020), and Latin American region (Lindberg *et al.,* 2014).

It was hard to find such NIS studies in Sri Lanka before 2010 and some postgraduate studies were observed in 2010s. Consequently, studies on different aspects of NIS have been conducted by researchers such as Weerasinghe & Jayawardena (2018), Wickramasinghe & Malik (2018), and Weerasinghe & Dedunu (2021). Against that backdrop, the main objective of this exploratory study is to assess the roles played by universities, S&T institutions, and industry based on empirical findings and to suggest policy changes needed for establishing a more conducive NIS for the economy's growth. The potential impact of our research on policy changes is significant, offering the possibility of establishing a more conducive NIS for rapid economic growth through commercially and socially important innovation.

LITERATURE REVIEW

The concept of NIS

Innovation results from a systematic approach at different levels of society rather than being accidental. Lundvall (1992) has mentioned that NIS includes institutions, interactions, policies, and procedures to promote innovations and use innovations for commercial gains. Edquist & Hommen (2008) extended this idea of NIS by emphasizing its significant determinants that influence the development and diffusion of innovation. Hence, actors have been mentioned as components of innovation systems. The functions that the actors should perform, including the relationships among them, are mentioned as system constituents. The interconnected actors of the NIS make collaborative efforts to create, store, and transfer the knowledge, skills, and resources toward the promotion of innovation at the national level (Metcalfe, 1995).

According to Balzat & Manusch (2004), the NIS research domain tries to understand innovation broadly instead of limiting it to the number of new products. This approach involves a non-linear and multi-disciplinary nature while studying behaviors of interactions and interplays among the system's actors. Increasing the complexity, the idea of NIS was modified with the concept of a 'national innovation ecosystem' presented by Fukuda & Watanabe (2008) to highlight the importance of harmonizing conflicting innovation variables for more sustainable innovation outcomes and practices. Jackson (2011) has enriched the same idea by conducting a critical inquiry to highlight the importance of the national innovation ecosystem and reemphasized the need to address innovation for well-being and sustainability through collaborative attempts.

Accordingly, irrespective of the country's size and economic development level, the concept of NIS becomes more critical to understanding socioeconomic development (Lundvall, 2007). Innovation has become one of the significant concerns among a few in many countries, highlighting the need to study the configuration of the NIS for making fruitful policy imperatives. Edquist & Hommen (2008) have also emphasized that theoretically based empirical research and comparative studies on various NISs are needed to ensure quality inputs for national innovation policies. The importance of formulating an effective innovation policy for persuading the innovation outcome through formal studies is also highlighted by Edler & Nowotny (2015), who suggested two significant functions of innovation policy to cover a wide area of actors and functions of a NIS. Facilitation to develop capabilities and connectivity among actors through a proper regulatory framework was indicated as the first function of a NIS while giving direction for the generation and diffusion of knowledge and innovation was suggested as the second function.

Compositions and functions of NIS

To conduct a complete study, the different compositions of an NIS should be figured out. Three major components of the NIS: constituents, functions, and the boundary are widely recognized. The constituents are of two types: system components or actors and relationships among the actors.

Actors of NIS

North (1994) has introduced many actors directly and indirectly involved in NIS as political bodies, bureaucratic bodies, regulatory bodies, social bodies, educational bodies, knowledge-oriented bodies, non-profit organizations, profit-oriented organizations, and bridging bodies. However, clustering the actors of NIS was one of the main focuses among many researchers in this study area from the inception of the concept of NIS. Concentration on the government, universities, and industry as the main three actors appeared in those studies; meanwhile, it was reemphasized by Etzkowitz & Leydesdroff (2000) with their Triple Helix model (Figure 1). They introduced three stages of triple helixes based

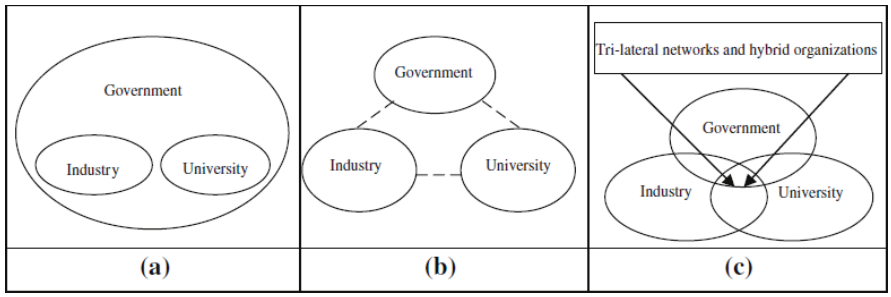

Figure 1: Triple Helix
Source: Etzkowitz & Leydesdroff (2000)

on the centrality and the roles played by the main actors of the NIS. According to the statist model presented in Figure 1(a), the government plays a dominant role, encompasses industry and academia, and directs the relationships between industry and academia. The rigidity embedded in this top-down approach discouraged innovation. Hence, this mode was considered a failed approach to economic development.

Figure 1 (b) presents laissez-faire relationships among three actors suppressing the government's dominant role. However, dispersed spheres with strong borders have created a separation of the actors due to the laissez-faire policy. It prevents solid connections and effective communication required to initiate collective efforts for impactful innovation with commercial viability.

Triple Helix in Figure 1(c) describes the importance of the openness and boundary overlap among the main actors. It encourages more collaborative and hybrid associations by aggressively linking and sharing resources, facilities, capabilities, and information through intermediate steps and interfaces between actors by removing the hard borderlines of the three spheres of the NIS. Creating an innovative environment to encourage university spinoff firms, tri-lateral initiatives, and strategic alliances among firms, government laboratories, and academic research groups was highlighted for an effective NIS.

Although many researchers appreciate the Triple Helix model in NIS studies, Carayannis & Campbell (2009) have introduced 'Mode 3' of NIS, named Quadruple Helix, which extends the Triple Helix by adding 'creative classes,' the fourth helix. The creative class represents the media, creative industries, culture, values, lifestyles, art (which will create public awareness of innovation), and knowledge to create an innovative culture. The Quadruple Helix model emphasizes the importance of these additional elements in fostering innovation. Strengthening the three main actors - the government sector, universities, and the industry- was noticed as relatively weak in the developing countries. Hence, prioritizing triple helix is justifiable in a developing country context as the fourth helix can be merged into a developed triple helix subsequently.

Functions of NIS

Functions performed by the actors in the NIS are essential to promote positive actions and eliminate and deflect hindrances within the system. All actors in the NIS must play multiple roles for their existence while creating an atmosphere for harmonious multiple interrelations and independence. These roles can be categorized into two functions: hard and soft functions. Hard functions are activities related to hard resources and facilities, such as physical laboratories and equipment needed for R&D and innovations. On the other hand, soft functions are linked with behavioral and other soft matters in the organizational settings involved in advising, consulting, networking, and interfacing roles. Soft functions are usually prioritized due to their complexities, although the balance between them is highlighted.

North (1994) discusses four primary functions of the NIS that are to be performed by different actors to ensure the system's effectiveness. Formal constraints linked to patent law, formal criteria for allocating resources for S&T, peer review procedure, technical standards, and norms are included in the first function, and the second function deals with informal constraints – norms, behavioral conventions, and codes of conduct. The third function is the enforcement activities of the first two functions, which include fiscal levies and traditional conventions. The fourth function, the incentive structure, is crucial as it promotes, awards, recognizes, and incentivizes innovative activities. It also introduces tax concessions, which further encourage innovation within the system. Galli & Teubal (1997) suggested some functions that the actors of an NIS should perform.

Accordingly, the role of bridging organizations, the basic market-oriented infrastructure, the availability of soft infrastructures such as information and communication technology, and advisory and consultancy to deal with increased complexity with large numbers of players and various types of networks among players are crucial for effective NIS.

NIS in developing country context

Although NIS studies have emerged from advanced economies since the 1980s, researchers have now turned their attention to NIS studies in developing country contexts. Lundvall (2007) has highlighted the importance of conducting NIS studies in developing country contexts with a focus on the economic development of those countries. With these developments, there has been increased attention to research in NIS and its related areas. For example, Viotti (2002) studied innovation patterns in technological laggards using Brazil and South Korea as two representative cases. A study on NISs in former socialist countries in Central and Eastern Europe was conducted by Freeman (1995) meanwhile, Intarakumnerd *et al.* (2002 and 2012) conducted studies in Thailand representing Asia.

Kayal (2008) identified weak institutional composition, less advancement of S&T activities, and linkages between organizational units, and he suggested that the actors of NISs should play a different role in less developed countries, emphasizing the active role these actors can play in shaping the future of NIS in these contexts. Furthermore, he has attempted to develop a conceptual model for studying NIS in a developing country and tested an empirical model with secondary data available.

Balzat & Hanusch (2004) and Intarakumnerd *et al.* (2012) have revealed that fragmented innovation systems are still present in developing countries and suggested that identifying the lack or weak development of factors affecting poor innovation and finding areas of improvements are needed for upgrading the NISs. Foray (2009) identified two major types of developing countries based on the distinctive features of their NISs. Large and developing middle-income countries are progressing because of their openness to foreign technologies through FDI and international trade, enabling them to improve absorptive capacity. On the other hand, some low-income economies have yet to show much progress in science, technology, and innovation.

The importance of allocating a considerable amount of funds and conducting R&D activities for developing context-based innovation mainly through general-purpose technologies and focusing on local market needs to introduce more inclusive innovation are highlighted by Foray (2009). The World Bank (2008) also emphasized the importance of absorbing knowledge and experiences through FDI and returned migrants for local technology developments and innovation in developing countries. Furthermore, a positive relationship between technology transfer and the reforms of intellectual property rights has been found in middle-income countries as inward FDI and trade are promoted through a more robust patent system (Branstetter *et al*., 2007).

Observing the experiences of newly industrialized Asian countries, Kayal (2008) has emphasized the requirement of inward transferring and exploitation of technologies developed from external sources. Cohen & Levinthal (1990) elaborated on this as absorptive capacity, although it initially focused on firm-level innovation. At the national level, the importance of learning from other countries and acquiring technologies with the capacity of modifying and adapting the knowledge and technologies developed somewhere else to the local contexts is a more practical solution, providing a source of enlightenment and information. Mazzoleni & Nelson (2007) have reemphasized the need for the absorption of knowledge and technologies developed in other countries, highlighting that latecomers perform better than the first inventors of the knowledge as they can learn from first movers and rectify errors and solve the problems with less effort and risk than the first movers.

Galli & Tuebal (1997) have suggested that NIS actors in developing countries work remotely and separately, with weak ties maintained among them. They name the traditional weak ties System 1 (S1) and propose a new, more robustly connected model called System 2 (S2). The transformation of the traditional S1 into the new S2 (Figure 2) is not just a change, but a leap forward. This transformation, with more interactions with subsystems through interface units, a system's functioning that is more central and coupled with techno-economic capabilities, the presence of interfacing units, and a restructured business sector, holds the potential to revolutionize the NIS landscape in developing countries.

The S2 model highlights strong relationships between the industry and university sector, such as collaborative research studies, training programs, and knowledge and technology transfers, by establishing a University Interface Unit (UIU) for mutual benefits. The roles of large firms and capital goods suppliers are also prominent, especially in providing the required facilitation for SMEs through funds and knowledge transfer within the business sector.

Kim & Dahlman (1992) have also highlighted the requirement for policy intervention to develop NIS in developing countries. They have considered the resource-constrained environments in developing countries and suggested that well-formulated policies and strategies

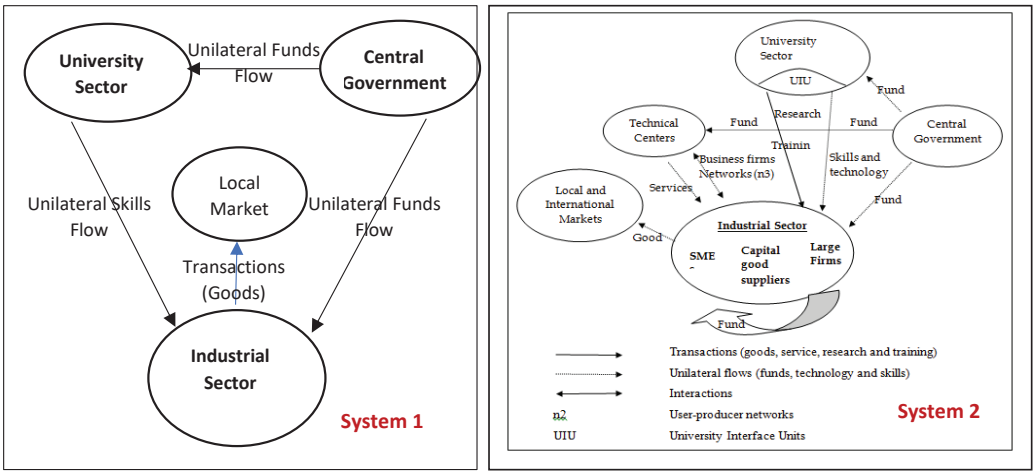

Figure 2: System 1 and System 2 Configurations

Source: Galli & Tuebal (1997)

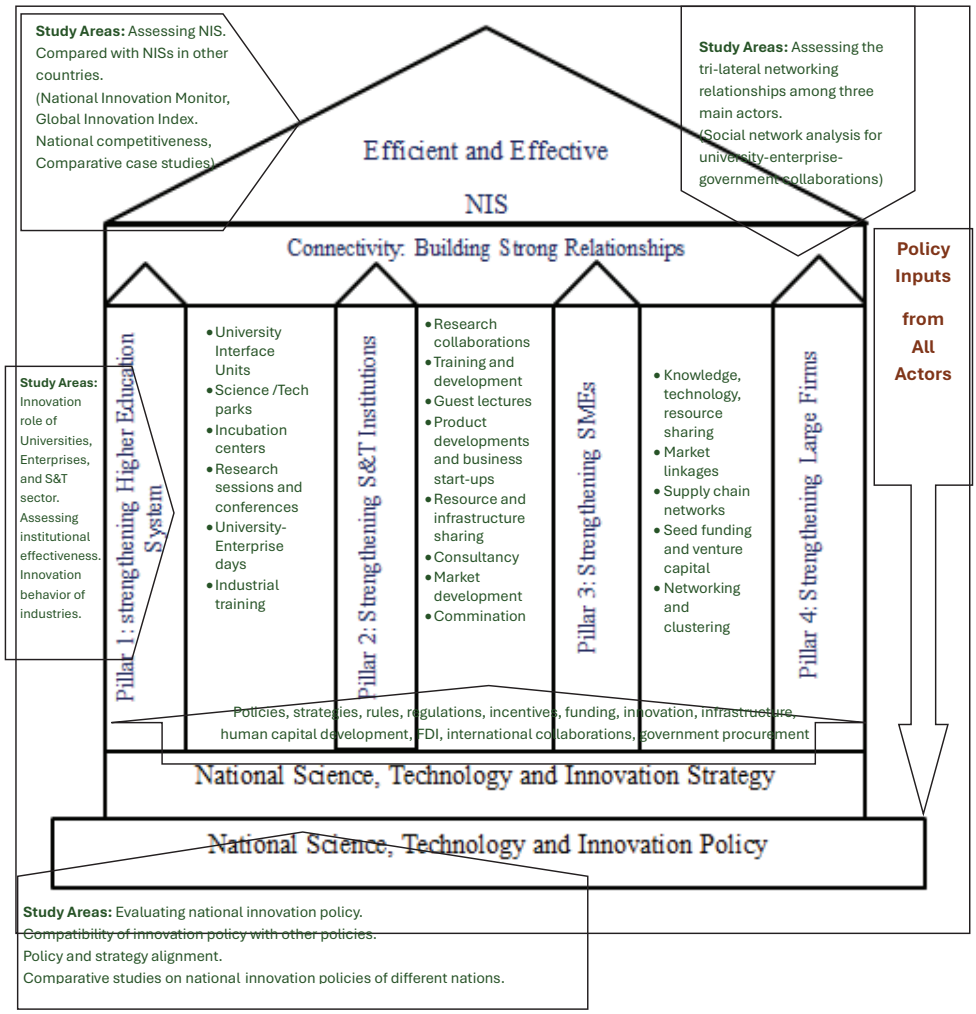

Figure 3: Conceptual model for NIS studies in developing countries

Source: Developed by authors

are essential for managing national-level innovation by configuring well-designed system configurations. Confronting the challenge of making policies in more complex situations and grasping the benefit of unarticulated knowledge and innovation systems is more needed.

Research model

Based on the literature review, the need for concrete conceptualization of NIS in developing countries was recognized. Accordingly, the study model presented in Figure 3 was developed by the authors, who paid attention to multiple dimensions while understanding the need to be practical in conducting this study.

The three main actors and the functions performed by the actors are considered the main body of the framework developed. The government's invention of the NIS was contributed to by several players, such as S&T institutions, the legislation system, the line ministries, and the country's financial sector. However, most innovation-related government actions are implemented through the S&T institution sector of many countries. Previous studies (Nelson, 1993; Kostova, *et al.,* 2008) have also confirmed the role of the S&T sector as the best government representative of the NIS. Aligning with the previous studies and considering the study limitations, the S&T institutions sector was selected as the government representation in this study. Three actors or actor groups should be coherently built upon the foundation created by the innovation policy and strategies. Networking relationships are significant concerns in the NIS concept, and trilateral relationships are highlighted herewith while emphasizing the importance of the iterative process of functioning and re-functioning the process through policy inputs.

METHODOLOGY

As outlined in Figure 3, the three main sectors—the university sector, S&T institutions, and the industry—were assessed by their roles and performance. The networking relationships among the actors were also investigated as a main composition of the NIS. This complexity requires employing both quantitative and qualitative methods to conduct studies. This paper is based on a series of studies conducted by the authors in

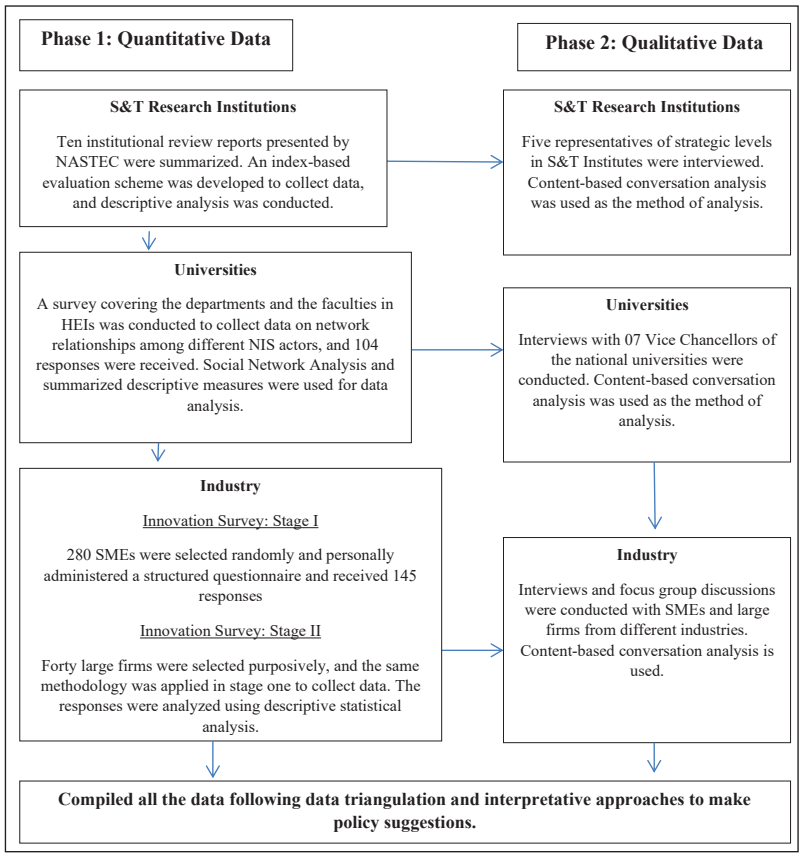

Figure 4: The process of sampling, data collection and data analysis
Source: Developed by authors

collaboration with various stakeholders, using different research methods.

Figure 4 illustrates the set of mixed methods followed by the authors for the collection and analysis of data. The mixed-method approach shows how the quantitative and qualitative phases of the research have been linked. Primary and secondary data were collected using document reviews, surveys, and in-depth interviews. Independent reviewers, experts in the field, evaluated S&T institutions to assess their roles and effectiveness. Their review reports, which were based on rigorous evaluation criteria, were used as one of the leading secondary data sources. Their content analysis was conducted to ascertain empirical findings.

The research process was adaptive and resilient, facing challenges such as dealing with the qualitative and quantitative nature of data, the broad scope of the study, busy executive-level respondents, and large samples with a high non-responsive rate. However, every attempt was made to overcome such challenges and avoid any negative impact on the findings. Primary data was collected through three surveys using the structured questionnaire developed for national innovation surveys. Three units of analysis, namely, the manufacturing SMEs, the large manufacturing firms, and the university units were investigated to collect data on innovative activities and related dynamics in these surveys. Furthermore, in-depth interviews were conducted with the Vice Chancellors, representatives of S&T Institutions, and the representatives of entrepreneurs and entrepreneurial managers to facilitate the explorative research design.

An interview was used to collect opinions on the roles played in R&D and other innovative activities, outcomes of R&D and innovation activities, methods used to evaluate the effectiveness, collaboration with industry, collaborations with other universities, collaboration with policy-making and S&T public institutions, collaboration with supportive interface/bridging institutions, strength of the alumni network, planned changes, challenges, and strategies. The role of academics/researcher, human capital, investments and funding for R&D and innovation, R&D outputs, technology transferring, challenges for R&D and strategies to overcome them, innovation and collaborations, and collaborative and networking activities: with universities, government S&T institutions, private sector firms etc. are the main themes used for analyzing qualitative data of the study collected through interviews.

FINDINGS

Data were collected from different sources according to the study design depicted in Figure 4. They were analyzed to meet the main objective of the study, which was to assess the roles played by universities, S&T institutions, and the industry and to propose policy changes for a more conducive NIS. The three sectors' assessment of the roles played are presented in the following sub-sections.

The role of the university system in NIS

The role of the university system of Sri Lanka was studied through in-depth interviews conducted with seven vice-chancellors to derive the following findings. The vice-chancellors were selected based on those leading, established and recently established universities, ensuring a diverse representation of the university system.

The changing role of academics: Summarized data indicated a considerable tendency to transform traditional teaching and learning into research and innovation. One Vice Chancellor highlighted that:

> *"Our academics and students are highly encouraged and engage themselves in research and development activities with funds provided to them for carrying out research projects, publishing research articles both nationally and internationally, as well as conducting research conferences and symposiums for both the academics and the students."- Vice Chancellor A, interview data.*

Most vice-chancellors expressed ideas that were aligned with the above statement. They provided evidence through their corporate plans, research grant schemes, travel grants, and conference proceedings published by the university, ascertaining the increasing trend in total funds allocated for university research and development activities. However, the opinion of another Vice-Chancellor on the same point should be highlighted. He pointed out that:

> *"…there is a big challenge on how to transform the mindset of some academics and students as it gets reinforced over time –since it is just preparing to teach and learn for a paper qualification instead of the full utilization of knowledge and intellectual capacity for contributing to solving social and economic issues of the country." - Vice Chancellor B, interview data.*

Accordingly, most of the R&D activities recorded in the university system are more internally focused. There is an increasing trend to use R&D facilities and funds mainly to publish research papers and conduct research

conferences instead of focusing on commercial or social benefits. A few research projects showed the emerging intention for collaborative work with external institutes and industry, though more was needed.

This study identifies positive trends in changing the role of academics, especially in R&D and innovation involvements, and the tendency to generate funds through different sources. The remuneration system, grants for research and publications, awarding, and increased recognition for R&D and Innovation activities have encouraged a new R&D culture, instilling a sense of optimism about the future of R&D and innovation.

Funding for innovation

Although there is a tendency in trying to generate funds through various sources from all the public universities that have highly depended on government funds, interviews revealed that funding still needs to be improved due to the difficulties in developing the required infrastructure. Vice Chancellor' C' revealed that:

> *"We are provided much money for our infrastructure development now. Further, we can allocate the funds we generate for our research and development activities. It is a great strength as we earn the required funds through different sources". - Vice Chancellor C, interview data.*

Challenges to innovation are mainly associated with the need for more funding, as the government must also pay attention to other priorities. If we have more funds, we can do far better than the present work on R&D and Innovation. This challenge emphasizes the urgent need for more financial support for innovation in Sri Lanka.

Most universities, especially established universities, have prioritized generating funds through fee-levying courses such as master's degrees, external degrees, diplomas, and certificate programs, which restrict academics' time for research. Conducting higher-level or postgraduate courses helps improve the university's research capability, although other fund-generating programs have little relevance for R&D activities.

The government and some donor agencies have addressed this issue in the university system and have taken some actions to establish incubators and other R&D facilities in the university sector. One such incubator was established with funding from the National Enterprise Development Authority. As revealed in the study, some private partnerships have been established with the University of Moratuwa, the University of Colombo, and the University of Peradeniya.

Research and innovation outcomes

It is revealed that the present level of research and innovation outcomes needs to be increased. A proper system of recording these statistics must be present in the university system. These research and innovation involvements are more on an individual basis than through organized and proper institutional procedures. This issue has been addressed by universities and the University Grants Commission (UGC). The UGC, as the primary regulatory body for higher education in Sri Lanka, has taken several actions to collect annual data on R&D and innovation activities. However, most monographs and academic papers are the primary outcome of research and development. Incidents about new products, services, and processes developed by students and academics in the university system are rarely recorded, although they are increasing.

Changing the mindset

It is revealed that students' examination-oriented learning approach needs to be changed to include research-led knowledge development and innovation-oriented sophistication techniques. As the key stakeholders, future researchers, and innovators, students must engage in a self-oriented, research-led learning process.

> *"A major challenge for the university education system is the students' current mindset. It is arguable, and we need to determine correctly whether the students demand learning or seek the paper qualification. The educational culture of the country has been guiding them to seek paper qualifications instead of engaging themselves in knowledge creation through research and innovation." - Vice Chancellor D, interview data.*

The academic mindset in the system is also required to be relevantly adapted to friendly circumstances for research and innovation, moving away from the traditional teaching role. Most academics engage in research and innovation to fulfil promotion requirements.

Overall, the efficiency and effectiveness of the innovative activities and commitment of the national university sector should be further improved to meet the expectation of building a strong NIS. This need is reasoned out by several factors, such as internal resource limitations, the traditional culture of the university system, poor external orientation, and the perception of outside parties on the traditional university system, as

also confirmed in (Intarakumnerd *et al*., 2012; Dutz & O'Connell, 2013; Weerasinghe & Dedunu, 2021).

The role of S&T institutions for innovation

The findings are summarized below, based on the data collected by interviewing the executive representatives of selected S&T institutions and the evaluation reports published by the National Science and Technology Commission (NASTEC). The evaluations were carried out to assess S&T institutions using nine criteria, a process that was greatly informed by the insights and perspectives of our stakeholders: Institutional response to external and internal environment in planning organizational strategy (MP1), Planning S & T programs and priorities (MP2), Planning S & T projects (MP3), Project management and maintenance of quality (MP4), Human Resource Management (MP5), Management of organizational assets (MP6), Coordinating and integrating the internal functions/ units/activities (MP7), Managing information dissemination and partnerships (MP8), and Monitoring, evaluation and reporting (MP9). A summary of the evaluations with weighted average performance indicators is tabulated in Table 1.

The content analysis of qualitative data, combined with statistical analysis, has yielded specific findings. These findings which are the crux of our research, are as follows:

Managerial performance

Based on the evaluations carried out by NASTEC on the managerial performance of nine S & T institutions (Table 1), five aspects of managerial activities have been described as showing an average or below average performance in all the ten organizations evaluated. These are namely, 1) performance in the project planning, 2) human resource management, 3) coordinating and integrating internal functions, 4) managing partnerships and information, and 5) monitoring, evaluation, and reporting of institutions. Thus, compared to the performance among ten institutions, NSF has recorded satisfactory ratings in these areas according to the evaluation results.

Institutional framework

Many institutions are established for S&T and innovation research and facilitation for R&D activities, which are operated under the purview of the Ministry of Science and Technology. The NASTEC is the apex body for policy formulation and advisory services on science and technology matters in Sri Lanka. Whenever

Table 1: Summary of evaluations of nine managerial performance indicators

Measurement	Criteria	Measurement	Criteria	IFS	NERDC	NSF	Arthur C.	Atomic	SL Acc	ITI	NBRO	METEO	Coconut Re
	MPI_1			1.89	1.89	2.44	1.78	2.25	2.5	2	1.78	1.56	2
	MPI_2			1.9	1.44	2.43	1.7	2	2.2	1.56	2.2	1.4	2.1
	MPI_3			2.1	1.5	2.4	1.7	2	1.88	2	1.9	1.33	2.7
	MPI_4			2.1	1.9	2.33	2.3	2	2.63	2.5	1.8	1.4	2.1
	MPI_5			2	1.25	2	1.63	1.88	2.14	2	1	1.13	1.88
	MPI_6			2	2.43	2.2	1.86	2.57	1.5	2.8	2.14	1.33	1.57
	MPI_7			1.83	1.67	2.5	1.83	1.83	2	2.2	1.33	1.33	2
	MPI_8			2	1.25	2	1.5	1.75	1.33	2	1.75	2	2
	MPI_9			2	1.4	2	1.4	1.8	2.2	1	1.2	1	1.8

Source: Author developed based on NASTEC Evaluation Reports (2012)

an institutional framework is available, it always emphasizes the necessity of coordinating with other institutions. This fact was also confirmed by the officers interviewed. However, the study findings revealed poor interrelationships and partnerships for information sharing among evaluated institutions. An official from NASTEC who was interviewed in this study stated that,

> *"We are trying to ensure uniformity across the institutions becoming involved in the process of the evaluation of the performance of S&T institutions and publishing the information to the public to convert those institutions as responsible entities to capitalize public funds more effectively and efficiently by contributing 'impactful' S&T and innovation outcomes to the society. However, we feel that most institutions are still isolated, and many duplications and repetitions remain in the institutional system." – Officer from NASTEC, Interview data.*

This reluctance to work collaboratively is present in several institutions, and most interviewees were interested in working independently. Many institutes operate with rather conventional scientists and researchers who need to adapt more readily to changing their old working style. It has created a comfortable zone for those scientists and researchers to maintain a life of comfort and convenience with only a few or no work-related issues.

Funding and other operational limitations

The study revealed several problems encountered by S&T institutions, including funding limitations (from both the public and private sectors), a shortfall in required skills, inflexibility created by rules, regulations, and procedures, and a lack of motivation arising from the prevalent culture for innovative projects. However, the need for consistent strategic direction has been more concerned due to frequent government changes and non-scientific ways of shuffling and re-shuffling Cabinet portfolios, underscoring the urgency and importance of this issue.

Insufficient funds due to solely relying on government funds for research and innovation is the leading cause for the dearth of quality research and innovation outcomes. The interviewed officers expressed their anxieties, concerns, and problems and revealed the stark reality of S&T institutions in the country, highlighting the gravity of the situation.

> *"We are faced with a big threat of recruiting and retaining high calibre scientists and technologists because of dearth or restriction of funds. Most young graduates stay with us to the utmost for less than two years till they find another well-paid job in the private sector or secure a placement for their higher education. We are losing capable people as we do not have enough funds to start attractive research projects or pay them as they expect, making these institutions ineffective." NERDC Official, Interview data.*

However, one officer from NSF mentioned that people are reluctant to apply for positions, and the available funds obtained through different grant schemes for R&D and innovation are rarely used. Thus, all kinds of lengthy formal procedures are in practice, and they are revealed to be the barriers to applying for such grants, as stated by the respondents. They revealed that funds are primarily utilized for higher educational purposes as it is a more convenient way of utilizing funds than engaging in impactful research and innovation projects.

Inward orientation

Many institutes are highly inward-oriented and follow the 'wait and see' course of action. Scientists and technologists mainly work inside the institutions and activate only if funds and inquiries reach their workplace. An officer from NERDC mentioned:

> *"We are eagerly waiting for problems to come to us from the industry as we can solve most of the industrial problems. However, we do not have a system, capacity, or enthusiasm whereby we could go to the sites and see the problems faced at the grass-root level and develop solutions accordingly." NERDC Official, Interview data.*

This point of view is further supported by the statistics collected (Table 1) through NASTEC evaluations on the innovation and research outcomes of the ten S&T institutions. It presents a minimal number of impacted outcomes produced by these institutions during the evaluation period. They mainly focus on services such as testing products, consultancy, and issuing certificates to the industry.

Intellectual property rights

The need for improved communication and trust in the patenting procedure in Sri Lanka is a significant finding.

Delays in the patenting process, often attributed to the unavailability of skilled scientists and technologists for evaluating patent applications, can be discouraging for patent applicants. This particular finding underscores the importance of public awareness and understanding of the patenting process to encourage more patent applications.

The officer-in-charge interviewed by the National Intellectual Property Office (NIPO) accepted these ideas and supported the entrepreneurs' opinions.

> *"We need to understand the problems embedded in our processes due to the limited capability of the IP Office and the problems we face in obtaining the services of experts even though we are a government organization. It takes time to send the applications to suitable evaluators, sometimes externally and following the dilatory procedures. However, we try our utmost to ensure innovation protection, although some inventors and innovators have qualms about information leakages." – Officer from NIPO, Interview data.*

Public-private partnerships

The importance of promoting Public-Private partnerships for R&D and innovation cannot be overstated. Despite this, only two such collaborative organizations have been established. The establishment of more such partnerships, like the successful examples of Sri Lanka Institute of Nanotechnology (Pvt) Limited (SLINTEC) and Polipto Lanka (Pvt) Limited, could significantly boost the S&T sector. It's worth noting that the role of these institutions has remained marginal and has yet to be considered for NASTEC evaluation.

Innovation outputs of S&T institutions

Based on the innovation output data for ten selected S&T institutions summarized in the NASTEC Annual Reports (2013), the recording process of innovation inputs and outputs of those S&T institutions needs to be revised. Measuring the effectiveness of achieving goals and objectives and efficiency in resource utilization of the institution remained utterly impossible due to a lack of data. Maintaining a standard system for collecting innovation input and output data in the government S&T institutions is imperative to ensure their effectiveness.

The above findings on the role of S&T institutions were also confirmed in previous studies by Jackson (2011), Etzkowitz & Leydesdroff (2000), Carayannis & Campbell (2009), and Galli & Teubal (1997) conducted in various country contexts. Policy and strategic intervention are emphasized to make this sector more effective in contributing to NIS in Sri Lanka. More attention must be paid to developing their human resources capacity and other modern facilities to create a creative environment for research and innovation.

Assessing the role of industry for innovation

This section elaborates the research findings of the two surveys conducted on 140 manufacturing SMEs in the Western province of Sri Lanka and 40 private sector large-scale manufacturing firms in the Colombo district. Further, interviews conducted with the firm's representatives are also included in the findings.

Study findings on the role of SMEs

The first survey of this study gathered data from manufacturing SMEs in the Western province of Sri Lanka using a well-tested CIS survey instrument. A sample of one hundred forty-five completed questionnaires was collected with information related to innovation inputs, outputs, and networking relationships. Despite their commitment to enhancing innovative capacity, SMEs must sufficiently acquire external knowledge for improvements. Data from 136 respondents indicate that only 19 organizations acquired new machinery and equipment, whether locally or from abroad; 14 organizations allocated funds for in-house R&D activities; and 12 organizations invested in acquiring external knowledge, such as purchasing patents, designing, and paying for consultancies.

The investigation into firms' innovative activities revealed a remarkable level of involvement in product and process development, with 38.6 percent to 52.9 percent of the observed firms actively participating. Notably, 95 percent of these innovative activities were new to the firm, demonstrating their resilience and determination to survive in a competitive market. While these innovations did not always lead to significant financial gains, they played a crucial role in helping the firms meet the demands of their customers and stay competitive.

In addition to the focus areas, the study identified innovations in management, operations, marketing, and daily routines. Many firms need to participate in innovative activities within these non-production areas actively. Instead, most organizations continued to rely on traditional management practices rather than exploring new, cost-effective solutions. A few firms demonstrated strength in management and marketing innovations within

the selected industries. However, many firms remained stagnant or experienced downturns due to inadequate marketing and management practices. Additionally, 57 respondents found new markets within Sri Lanka, while only 14 firms accessed foreign markets in the past three years. This finding highlights the solid local market orientation of SMEs in Sri Lanka, which limits their potential by confining them to a small domestic market rather than seeking opportunities in the global arena.

The survey further revealed limited connections between SMEs and the university system. Thirty-five organizations reported a need for more understanding about the potential university support for promoting innovation. Conversely, the 18 organizations that maintained good relationships with universities expressed a keen interest in strengthening these ties to improve their products and processes through innovative solutions. The perceived importance of university support is highlighted in seven key areas.

The survey confirmed the perceived low importance of facilities and support the university system provides for business innovation and development. Most organizations needed to show more appreciation for external information sources used for innovation. Accordingly, organizations relied heavily on internal data sources, with 54.2 percent ranking them highly important. This reliance on internal sources contributed to limited innovative capability and insufficient innovations within the sector.

Approximately 10 percent of the companies had strong relationships with external organizations, such as consultancy firms, research institutes, universities, and government institutions. However, 29.2 percent of respondents had formal relationships with their suppliers, 24.3 percent maintained linkages with clients or customers, and 16 percent connected with competitors and firms in the same industry. This limited networking contributed to their restricted exposure to innovation through knowledge spillovers from sources where new knowledge is generated.

The study also investigated the obstacles hindering the innovative efforts of manufacturing SMEs in the Western Province of Sri Lanka. According to the survey, key barriers included the high cost of innovation, lack of internal and external funding sources, shortage of skilled personnel, insufficient information on technology, and the country's poor economic condition, which limits the purchasing power of the population.

Level of innovation

Based on the findings discussed above, the innovative activities of SMEs are fundamental, low-cost oriented, and low-tech, new to the firm product and process innovation compared to other types of innovation. This sector shows a low level of innovation as in many developing countries, and it can be further improved through different strategies.

R&D investments

Due to funds constraints, investments in R&D and the acquisition of new technology are rarely reported. Hence, most SMEs use low-cost and locally developed reconditioned or foreign-used technologies, such as repairing and using old machines elsewhere. Moreover, SMEs are confronting competitive pressure, as mentioned in a respondent's opinion below.

> *"We are always struggling with local competition in the market to reduce our production costs. Especially how we can easily recover the investment in innovation and new technologies; it is a risky job, as we mostly compete with low-cost products. Customers are not ready to pay an additional price for innovation." Entrepreneur B, Interview data.*

Relationships

The study found that SMEs with other firms, S&T institutions, and universities maintained minimal networking relationships. SMEs were highly inward-oriented and maintained relationships only with their main value chain activities, such as purchasing and selling. They still need to understand how other firms, universities, and S&T technology institutions can help them engage in innovation.

Constraints for innovation

The study found that the constraints of the high cost of innovation, dearth of internal and external funding sources, paucity of skilled personnel, lack of information on technology, and the prevalence of the country's poor economic condition restrict the purchasing power of the people, triggering many significant restraints on innovations.

Absorptive capacity

The SMEs' poor absorptive power was revealed due to their feeble volition regarding R&D investment and acquisition of S&T human capital. Thus, insufficient attention to knowledge creation and accumulation by the private sector in Sri Lanka was reported. Many respondents believe such relationships are mildly essential or unnecessary for their business operations. More evidence of investment in knowledge acquisition is needed.

Operating in foreign markets

Foreign markets prevailed shallowly, and almost all the SMEs were locally oriented. Only seven organizations recorded some foreign collaborations related to ownership or management. A few firms exported mainly agricultural products such as dehydrated vegetables, processed foods, and beverages.

Anderson & Billou (2007), Intarakumnerd *et al.* (2012), Dutz & O'Connell (2013), Intarakumnerd *et al.* (2002), and Cohen & Levinthal (1990) confirm the above findings in their studies of SMEs in developing countries. Overcoming these challenges through the right policies and strategies can significantly benefit SMEs and developing countries' economies.

Study findings on the role of large firms in industry

Following the first survey, a second was conducted to investigate large-scale local enterprises using the same CIS questionnaire. Data were collected from 40 large manufacturing firms in the Colombo district of Sri Lanka. The findings revealed a significant commitment to human capital development in these firms, with five organizations employing more than 80 graduates, demonstrating their dedication to strengthening innovative capabilities. Similarly, there was a considerable increase in diploma holders employed by these firms, indicating a promising future for innovation in Sri Lanka.

The survey data revealed that 37 respondents engaged in R&D activities to some extent. However, eight firms did not have any employees in R&D, while 21 firms reported having 1-10 R&D employees. The remaining eleven firms employed more than ten R&D personnel. Additionally, 27 firms did not report any R&D expenditure for the year, while the other 13 firms made some investments. Only three companies recorded investments ranging from Rs. 300,000 to Rs. 1,000,000. There was minimal expenditure on acquiring R&D from external sources, with just four firms making nominal investments. Expenditure on acquiring external knowledge, introducing new markets, and new design costs remained minimal, while only a few companies recorded costs for training and development and purchasing new machinery.

Respondents were asked whether they had licensing agreements with other parties to assess the connectivity of the selected firms in terms of knowledge creation. Twenty firms reported agreements with principal companies to produce or sell global products in Sri Lanka. Another significant investment in technology acquisition involved purchasing machinery and equipment. Thirty-six firms indicated they had acquired new machinery and equipment during the study period. Of these, 17 firms imported their machinery, 18 purchased both local and imported machinery and only one bought machinery solely from the local market. This result indicates that local firms are exposed to global technologies by acquiring advanced machinery and equipment.

Responses regarding funding support from various organizations revealed the stark reality of limited opportunities for obtaining such facilities. Six firms received financial assistance from local and regional authorities, while only three were supported by the central government. Additionally, only two firms benefited from international or other organizational funding. Most companies reported insufficient R&D funding, training, subsidies, tax rebates and incentives, technical support, and infrastructure facilitation needed to be more robust. However, 17 firms notably praised the availability of government loans and grants for innovation.

Regarding innovative outcomes, the study found that only one patent application was recorded yearly, with a single patent granted. One industrial design was registered. No copyright registrations were recorded during the study period, while four Trademark registrations were included. Many respondents expressed a need for more awareness and confidence in the formal intellectual property protection process, indicating a low interest in safeguarding intellectual property. The survey aimed to assess each firm's involvement in innovation activities. Seventy-five percent of companies rated institutional support from S&T institutions poorly, with about 25 percent indicating that such support needed to be more present. A few organizations reported having strong relationships with universities to bolster innovation.

The responses indicate noticeable innovations, including the introduction of new products, improvements to existing products, and implementing new or enhanced processes. Among these, improving existing products received the highest average ranking. Additionally, respondents reported engagement in quality initiatives, new routines, procedures, and operations, new management and marketing innovations, and in-house innovative programs. However, the focus on domestic and international market development and reverse engineering practices is less intense than other types of innovation. There is moderate involvement in new approaches to building relationships with external parties.

The study also examined relationships with government, S&T research institutes, universities, and other firms across different industries to explore their impact on firm innovation. However, it found limited linkages among firms in different industries, a concerning

trend that hampers collaborative innovation. Instead, firms primarily connect with suppliers, clients, dealers, and other firms within the same value chain to maintain efficient daily operations. There were no significant alliances among firms within the same industry or with competitors to create new knowledge and engage in collaborative innovation, highlighting a key area for improvement in the Sri Lankan innovation landscape.

Level of innovation

According to the findings, there is a more positive indication than what was revealed in SMEs. The introduction of new products, improvements of existing products, introducing new processes, and improvement of existing processes are discernible in these responses. In addition, it was confirmed that there was considerable engagement in innovation activities such as quality initiation, new routines, procedures and operations, new management and marketing innovation, and the introduction of in-house innovative programs.

Human capital

The large firms in the sample have employed many knowledgeable workers with university degrees and diploma qualifications. Compared with SMEs, large firms are good at employing trained people, diploma holders, and graduates in their firms, enabling them to engage in in-house innovation in different areas. However, due to several other factors, private organizations are restricted in employing competent experts such as PhD holders, restraining their journey for innovation. The tendency for skill migration is considered a critical constraint.

Technology transfers and absorptive capacity

The study found several licensing agreements with different principal companies facilitating the production or sale of commodities as global products in Sri Lanka. Similarly, the purchase of new machinery and equipment as a method of technology borrowing is used by 36 firms during the period. Large firms are more capable of investing funds for innovation and the correct calibre of employees who hold diplomas and degrees and are competent enough to absorb new knowledge.

Networking relationships

The study revealed that almost all sources of innovation are considered necessary by the respondents and that firms' orientation for joint innovation activities supports the idea that there is a moderate level of involvement in new approaches to relationship building with external parties. Large firms have also used information within the firm to find new ideas for innovation, such as those of SMEs. Learning through competitive actions was also stressed by many firms, and it supported the idea of staying competitive through innovation. Connections with competitors, government institutions, and private research institutions must still be higher.

Funding for R&D and innovation

Responses to the questionnaire substantiated the idea that most firms need help with the inability to bear high costs related to innovation and a dearth of expedient funding sources. Allocation of R&D funds is recorded as inadequate among many firms. As confirmed by previous studies, only a few firms have received some financial assistance from the local and regional authorities, the central government, and international and other organizations.

Intellectual properties

Similar to the IP recorded in SMEs, only one patent per year was recorded during the study period. Many respondents were unaware of patents and expressed self-assurance that the formal process of safeguarding intellectual properties prevails at a low ebb. However, almost all respondents identified the importance of innovation for improving organizational performance to different degrees.

Support rendered by the government and S&T institutions

According to the responses, the government's support for innovation through R&D funding, training for R&D, subsidies, tax rebates and incentives, technical support, and infrastructure facilitation is very low. The institutional support provided by the S&T institutions is also ranked at a low level. Moreover, the unavailability of the requisite information and unfavorable domestic market conditions contributed to the weakening of innovation in the firms.

The above findings related to industry firms have also been confirmed or tested in previous studies conducted by Galli & Teubal (1997), Cohen & Levinthal (1990), Dutz & O'Connell (2013), and Intarakumnerd *et al.* (2012).

Strength of the networking relationships among key actors of NIS

Data collected from the departments and faculties were used to assess networking relationships among universities, S&T institutions, and industry. There were 104 responses, resulting in an 18 percent response rate. These relationships were evaluated based on five dimensions: 1) the frequency of joint research activities; 2) the frequency of inviting personnel for guest lectures;

3) the extent of mutual joint research conferences; 4) the frequency of workshops, meetings, training, and consultancies for skill and knowledge sharing; and 5) the frequency of shared research and development infrastructure. Social Network Analysis (SNA) was employed to analyze the data and measure the strength of relationships among the selected actors, using summary statistics and standard drawings in NodeXL application software.

The findings, as summarized in Table 2, underscore the need for stronger collaboration for innovation and competitiveness. The highest number of connections (269) were recorded among academic units, followed by S&T institutions with 104 connections. However, no significant relationships were found between the university sector and industry. This highlights the urgent need for stronger collaboration to foster innovation and competitiveness. Only five private sector firms maintained ten networking relationships, confirming the limited networking relationships between the university sector and industry firms.

Figure 5 presents the graphical outputs for these three partnerships, clearly showing that the industry is more isolated than the other two sectors. This isolation could potentially hinder the flow of knowledge and resources, which are crucial for innovation and competitiveness.

Networking relationships among university units

The most vital networking relationship found among all the network relationships tested in this study is the one among university units. The overall strength of the relationships showed that most connected universities are well-established. The University of Colombo maintains a leading relationship in building the university's capabilities, according to statistics. The most frequent type of relationship is related to exchanging academics for visiting lecturing purposes. The second highest number of relationships is maintained for conducting workshops and training. A moderate level of relationship is maintained in conducting joint research and joint-research conferences, while a minimum relationship is maintained in sharing R&D facilities within the university system. Hence, the commitment to engage in collaborative activities for S&T-led innovation is recorded as a minimum.

Networking relationships between the universities and the S&T institutions

The survey results presented the overall relationships maintained by the university sector with the S&T institutions. NSF is the most connected institution with the university sector, and it gains 22 direct relationships with the departments and faculties of many universities. These relationships are more scholarly-oriented collaborative work than technologically-oriented relationships, instilling confidence in academic collaboration.

Networking relationships between the universities and the industry

As per the data gathered, relationships among these two sectors were marginal. Out of the 104 responses from the university Departments and Faculties, the recorded relationships between the university sector and the industry are 65 (Joint-research-12; Visiting/guest lecturing -15; Joint Conferences – 13; Conducting workshops and training-15; and Sharing R&D infrastructure – 10). The findings of this study prove the existing weak relationships between the university system and the industry sector.

Networking relationships between the S&T institutions and the industry

Surveys covering both SMEs and Large firms revealed minimal connections between SMEs and S&T Institutions, while a few relationships were recorded with large firms studied. This study has underscored the urgent need for science and technology inputs to be increasingly multi-disciplinary and multi-institutional with multi-sectoral approaches.

In summary, all those networking ties are weaker

Table 2: Networking relationships among actors

Graph Dimensions	Uni-Uni	Uni-S&T	Uni-Ind
Vertices	95	49	15
Unique Edges	265	104	10
Edges With Duplicates	4	0	0
Total Edges	269	104	10
Applied NodeXL Version 1.0.1.350			

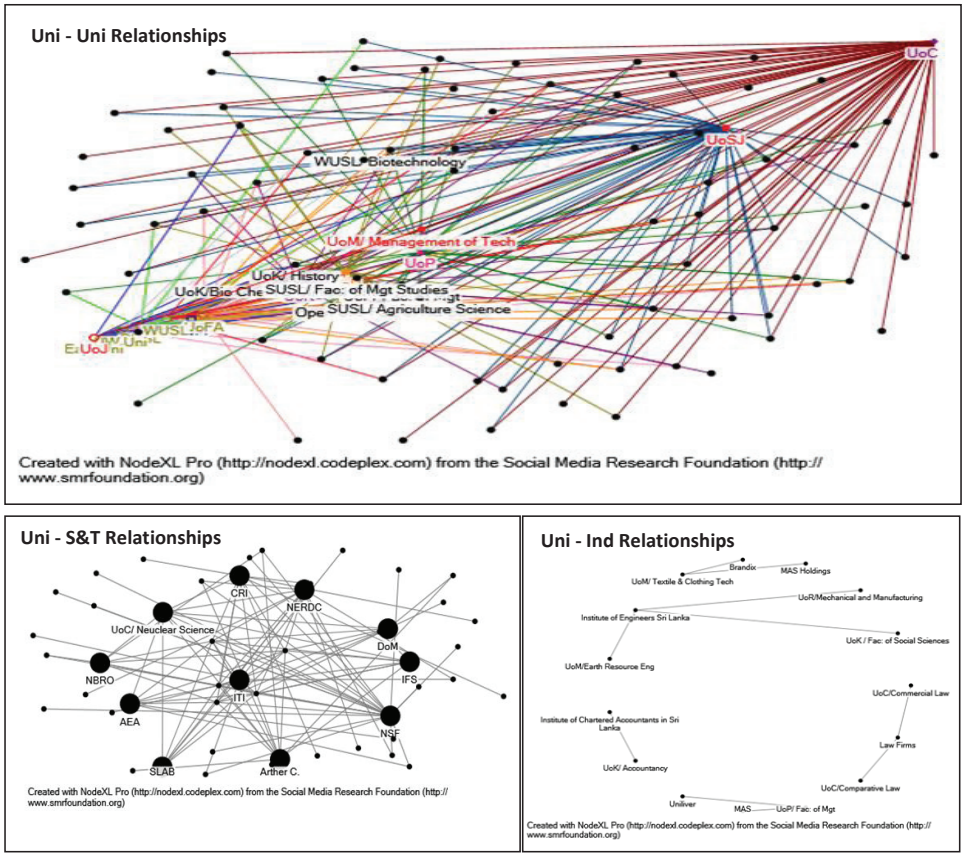

Figure 5: Three types of networking relationships
Source: Survey data

than the requisite level for a nation to become innovative and competitive and achieve better NIS. This is a similar situation described by 'laissez-faire' mode in the Triple Helix II (Etzkowitz & Leydesdroff, 2000) and confirmed with ideas of Kayal (2008) and Intarakumnerd *et al.* (2012) regarding NIS of developing countries characterized by isolated individual actions for innovation with fragmentation and separations among the key actors of the system.

Recommendations for policy changes and practitioners

The recommendations provided in the study underscore the necessity of a multifaceted approach to strengthening the NIS of Sri Lanka through enhanced connectivity and robust institutional frameworks. The analysis identifies four primary pillars—higher education systems, S&T institutions, SMEs, and large firms—as critical components for fostering innovation. Each pillar's unique challenges and proposed strategic interventions are designed to create a synergistic environment conducive to innovation and development.

Firstly, the higher education sector is pivotal in cultivating a culture of innovation. The study recommends a transformative approach to the role of academics, emphasizing the alignment of promotion and rewarding schemes with the triad missions of universities: teaching, research, and community engagement. This role complexity entails redefining academic workloads to incorporate rigorous R&D activities and community engagements. Additionally, the introduction of education reforms aims to nurture graduates with modern skills such as creativity and problem-solving, moving away from examination-oriented teaching. Establishing research centers and tech transfer offices is also crucial to bridging the gap between academia and industry, fostering an environment that supports innovation and practical research outcomes.

Secondly, strengthening S&T institutions requires a robust coordination mechanism and continuous monitoring. The study advises against creating new institutions and advocates for enhancing existing frameworks like the National Science and Technology Commission (NASTEC). NASTEC, as the primary body

responsible for coordinating and promoting scientific and technological research in Sri Lanka, can play a crucial role in this enhancement. Key recommendations include bolstering these institutions with the necessary human capital, funding, and infrastructure and fostering a motivational environment to attract and retain skilled researchers. Furthermore, bridging the gap between S&T institutions and industry through establishing techno-parks and incubators can facilitate practical research applications, thereby enhancing public-private partnerships and intellectual property rights management.

The third pillar focuses on SMEs, often the backbone of economic innovation. However, they need help in R&D investments and innovation capacity. The recommendations highlight the need for intermediaries like technology centers, which provide SMEs with access to advanced technologies and technical expertise, and business incubators, which offer a supportive environment for the growth and development of SMEs, to support SMEs. Enhancing communication about existing funding schemes, introducing new financial incentives, and fostering linkages with government institutions and universities are crucial. Additionally, building a research and innovation infrastructure accessible to SMEs can mitigate the uncertainties associated with innovation efforts, promoting a more vibrant and competitive SME sector.

Lastly, large firms are essential drivers of innovation within the NIS. The study suggests enhancing client-based advisory services, which are consultancy services provided to large firms by experts in their respective fields, innovation infrastructure, and funding opportunities to motivate large firms to expand their innovation activities. Policies should focus on developing human capital tailored to industrial needs through collaborations between education institutions and industries. Encouraging technology transfers via collaborative research projects and promoting network relationships through incentives like tax concessions and joint research projects can significantly improve the absorptive capacity and innovation output of large firms.

The policy and strategic recommendations of the study are aimed at creating a cohesive and well-connected NIS that leverages the strengths of its primary actors—higher education institutions, S&T institutions, SMEs, and large firms. The recommendations provide a comprehensive roadmap for fostering a dynamic and effective innovation ecosystem by addressing each pillar's specific challenges and enhancing their interconnectivity. Implementing these recommendations is essential for achieving sustainable economic growth and technological advancement.

CONCLUSION

This study delved into the roles of universities, S&T institutions, and industry within the NIS of Sri Lanka, highlighting their interplay and effectiveness in fostering economic growth and innovation. The research findings underscore a crucial point: while there have been significant strides in infrastructure development and economic growth post-2009, there is an urgent need for a systematic approach to enhance the effectiveness of the NIS. This is a recommendation and a call to action to ensure sustainable progress.

The conceptual framework employed in this study underscore the importance of robust interactions and relationships among the three primary actors: universities, S&T institutions, and industry. The empirical phase of the research revealed a stark reality: the existing networking relationships among these actors should be more cohesive and developed. This fragmentation not only hampers the potential for collaborative innovation but also severely limits the ability of the NIS to contribute to the country's economic and social development.

Universities in Sri Lanka play a crucial role in knowledge creation and dissemination. However, their contributions to applied research and commercialization of innovations are limited by inadequate funding, lack of infrastructure, and insufficient collaboration with industry. Enhancing university-industry linkages through collaborative research projects, internships, and knowledge transfer programs is essential to bridge this gap. University Interface Units, which serve as intermediaries between universities and industry, could facilitate stronger partnerships and mutual benefits by coordinating joint projects and facilitating technology transfer.

S&T institutions are pivotal in advancing technological capabilities and providing the necessary support for innovation. However, the study identified a need to integrate these institutions within the NIS framework more effectively. Policy interventions to strengthen the infrastructure and operational capabilities of S&T institutions, coupled with incentives for collaborative ventures with universities and industry, such as joint research funding and tax benefits for joint projects, are necessary to boost their contributions to national innovation.

While demonstrating innovation potential, the industrial sector is constrained by regulatory challenges,

limited access to advanced technologies, and a need for a more skilled workforce. Policies fostering a conducive environment for R&D within the industry are imperative to address these issues. Tax incentives, grants, and subsidies for R&D activities can stimulate industrial innovation. Moreover, fostering a culture of continuous learning and skill development through industry-academia partnerships can enhance the innovation capacity of the workforce.

Based on the findings, this study proposes several policy recommendations to enhance the effectiveness of the NIS in Sri Lanka. First, the government should implement policies that encourage more vital collaboration among universities, S&T institutions, and industry. Second, increasing investment in R&D and innovation infrastructure is crucial. Third, establishing formal mechanisms for knowledge transfer and commercialization of research outputs, such as technology transfer offices and industry liaison offices, to bridge the gap between academia and industry. Finally, creating an enabling environment through regulatory reforms and incentives to attract investments in innovation and technology.

The study highlights the importance of a cohesive and well-integrated NIS for Sri Lanka's sustainable economic development. By addressing the identified gaps and implementing the proposed policy recommendations, Sri Lanka can harness the full potential of its universities, S&T institutions, and industry to drive innovation and economic growth. The findings of this research contribute to the broader discourse on NIS in developing countries, providing valuable insights for policymakers and stakeholders aiming to optimize their national innovation ecosystems.

REFERENCES

Allard, G. & Williams, C. (2020) National-level innovation in Africa, *Research Policy*, *49*(7), p.104074.

DOI: https://doi.org/10.1016/j.respol.2020.104074

Anderson, J. & Billou, N. (2007) Serving the world's poor: innovation at the base of the economic pyramid, *Journal of Business Strategy*, *28*(2), pp.14-21.

Balzat, M. & Hanusch, H. (2004) Recent trends in the research on national innovation systems, *Journal of evolutionary economics*, *14*, pp.197-210.

Boeing, P. & Sandner, P.G. (2011) The innovative performance of China's national innovation system.

Bokachev, I.N. (2019) National innovation system of India: genesis and key performance indicators, *RUDN Journal of Economics*, *27*(4), pp.774-785.

Branstetter, L.G., Fisman, R., Foley, C.F. & Saggi, K. (2007) *Intellectual property rights, imitation, and foreign direct investment: Theory and evidence*.

Carayannis, E.G. & Campbell, D.F. (2009) 'Mode 3'and'Quadruple Helix': toward a 21st century fractal innovation ecosystem, *International journal of technology management*, *46*(3-4), pp:201-234.

Ch, F. (1988) Japan: a new national system of innovation. *Technical Change and Economic Theory*, pp:38-66.

Cohen, W.M. & Levinthal, D.A. (1990) Absorptive capacity: A new perspective on learning and innovation, *Administrative science quarterly*, *35*(1), pp:128-152.

Dutz, M.A., & O'Connell, S.D. (2013) Productivity, innovation and growth in Sri Lanka: An empirical investigation, *Policy Research Working Paper 6354*, The World Bank, Retrieved from http://econ.worldbank.org

Edler, J. & Nowotny, H. (2015) The pervasiveness of innovation and why we need to rethink innovation policy to rescue it, Austrian Council for Research and Technology Development (Ed.), *Designing the Future, Economic, Societal and Political Dimensions of Innovation*, pp:431-45.

Edquist, C. & Hommen, L. eds. (2009) *Small country innovation systems: globalization, change and policy in Asia and Europe*. Edward Elgar Publishing.

Etzkowitz, H. & Leydesdorff, L. (2000) The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university–industry–government relations, *Research policy*, *29*(2), pp:109-123.

Foray, D. (2009) Knowledge policy for development. Paper presented at the OECD-UNESCO International Workshop on Innovation for Development: Converting Knowledge to Value, 28-30 January 2009, Paris: OECD.

Freeman, C. (1995) The 'National System of Innovation in historical perspective, *Cambridge Journal of economics*, *19*(1), pp:5-24.

Fukuda, K. & Watanabe, C. (2008) Japanese and US perspectives on the national innovation ecosystem, *Technology in Society*, 30 (1), pp:49-63.

Galli, R. & Teubal, M. (1997) Paradigmatic shifts in national innovation systems, *Systems of innovation: Technologies, institutions and organizations*, pp:342-370

Habaradas, R. (2008) Strengthening the national innovation system (NIS) of the Philippines: Lessons from Malaysia and Thailand, A*sian Journal of Technology Innovation*, 16(1), pp:1-22.

DOI: https://doi.org/10.1080/19761597.2008.9668644

Intarakumnerd, P. & Virasa, T. (2002) Broader roles of RTOs in developing countries: from knowledge-creators to strengtheners

of national innovation system, In *Science, Technology and Innovation Conference, JFK School of government, Harvard University*, pp: 23-24.

Intarakumnerd, P., Chairatana, P., & Tangchitpiboon, T. (2002) National innovation system in less successful developing countries: The case of Thailand. *Research Policy*. 31(8-9), pp: 1445-1457.

Jackson, D.J. (2011) What is an Innovation Ecosystem? National Science Foundation, Arlington, VA [online]. Available from*: http://urenio. org/wp-content/uploads/2011/05/What-is-an-Innovation-Ecosystem. pdf*.

Kayal, A.A. (2008) National innovation systems a proposed framework for developing countries, *International Journal of Entrepreneurship and Innovation Management*, *8*(1), pp:74-86.

Kim, L. & Dahlman, C.J. (1992) Technology policy for industrialization: An integrative framework and Korea's experience, *Research Policy*, *21*(5), pp.437-452.

Kostova, T., Roth, K., & Dacin, M. T. (2008) Institutional theory in the study of multinational corporations: A critique and new directions, *Academy of Management Review*, 33(4), pp: 994-1006.

DOI: https://doi.org/10.5465/amr.2008.34422006

Lindberg, M., Lindgren, M. & Packendorff, J. (2014) Quadruple helix as a way to bridge the gender gap in entrepreneurship: the case of an innovation system project in the Baltic Sea Region, *Journal of the Knowledge Economy*, *5*, pp:94-113.

Lundvall, B.A. (1992) National systems of innovation: Towards a theory of innovation and interactive learning, *Francis Printer*.

Lundvall, B.Å. (2007) National innovation systems—analytical concept and development tool, *Industry and innovation*, *14*(1), pp:95-119.

Mazzoleni, R. & Nelson, R.R. (2007) Public research institutions and economic catch-up. *Research policy*, *36*(10), pp:1512-1528.

Mehta, S. (2018) National innovation system of India: An empirical analysis, *Millennial Asia*, *9*(2), pp:203-224.

DOI: https://doi.org/10.1177/0976399618786343

Metcalfe, J.S. (1995) Technology systems and technology policy in an evolutionary framework, *Cambridge journal of economics*, *19*(1), pp:25-46.

Naqvi, I.B. (2011) National innovation system in a least developing country: the case of Pakistan. *International Journal of Technology, Policy and Management*, *11*(2), pp:139-154.

Nelson, R.R. (2013) National innovation systems, In *Regional innovation, knowledge and global change*, pp: 11-26.

North, D. (1994) *Institutions matter*, Mimeo Washington University.

Rajan, Y.S. (2012) Shaping the national innovation system: The Indian perspective, *The Global Innovation Index*, pp:131-141.

Song, H. (2013) China's National Innovation System, *Encyclopedia of creativity, invention, innovation, and entrepreneurship, New York: Springer*.

DOI: https://doi.org/10.1007/978-1-4614-3858-8_497

Taufik, T.A. (2007) Indonesia's sub-national innovation system policy and programmes, In *National Workshop on Subnational Innovation Systems and Technology Capacity Building Policies to Enhance Competitiveness of SMEs, Jakarta*.

Thiruchelvam, K., Ng, B.K. & Wong, C.Y. (2013) An overview of Malaysia's national innovation system, *Innovation Systems in Southeast Asia*, pp:53-88.

Toivanen, H. & Ponomariov, B. (2011) African regional innovation systems: bibliometric analysis of research collaboration patterns 2005–2009. *Scientometrics*, *88*(2), pp:471-493.

DOI: https://doi.org/10.1007/s11192-011-0390-1

Ul-Haq, M.A., Jingdong, Y., Phulpoto, N.H. & Usman, M. (2014) Analysing National Innovation System of Pakistan, *Developing Country Studies*, *4*(4), pp:133-139.

Viotti, E.B. (2002) National learning systems: A new approach on technological change in late industrializing economies and evidence from the cases of Brazil and South Korea, *Technological Forecasting and Social Change*, 69 (7), pp:653-680.

Weerasinghe, I., & Dedunu, H. (2021) Contribution of academics to university–industry knowledge exchange: A study of open innovation in Sri Lankan universities, *Industry and Higher Education*, 35(3), pp:233-243.

DOI: https://doi.org/10.1177/0950422220964363

Weerasinghe, R. N. & Jayawardane, A. K. W. (2018) University-Industry Partnerships for Innovation: Sri Lankan Experiences, *Annals of Spiru Haret University Economic Series*, 18(1),pp:25-45.

DOI:https://doi.org/10.26458/1811

Wickramasinghe, V. & Malik, K. (2018) University-Industry Collaboration in Sri Lanka-A Developing Country Perspective. I*nternational Journal of Innovation and Technology Management*, 15(4), p.1850032.

DOI: https://doi.org/10.1142/S0219877018500323

World Bank (2008) *World development report 2008: Agriculture for development*, Washington, DC: World Bank.

Zahra, S. A., & George, G. (2002). Absorptive Capacity: A Review, Reconceptualization, and Extension, *Academy of Management Review*, 27(2), pp:185-203.

Zu Koecker, G.M. (2012) Analyzing the Innovation System of Indonesia-Summarizing Report of the Determinants of the Indonesian Innovation System Summarizing Report of the Determinants of the Indonesian Innovation System, *Institute for Innovation and Technology and International Bureau of BMBF*, p.6.

DOI: http://dx.doi.org/10.13140/RG.2.2.23854.66886

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RESEARCH ARTICLE

Behavioural intention to adopt mobile trading apps: an integrated theoretical and digital framework, privacy concerns, and information richness model

Imran Ul Amin[1*], Ishfaq Hussain Bhat[2], Rais Ahmad Itoo[1] and Anisa Jan[1]

[1] *Department of Management Studies , Islamic University of Science and Technology, Awantipora, Jammu & Kashmir, India.*
[2] *School of Commerce, SVKM'S Narsee Monjee Institute of Management Studies, Navi Mumbai Campus, Maharashtra, India.*

Abstract: This research investigates the transformative impact of mobile trading apps on the Indian financial landscape, particularly in the context of the unprecedented surge in DMAT (dematerialisation) accounts following the COVID-19 pandemic. Due to the advancement of online platforms and fast internet connectivity, stock exchanges across the globe have seen a dramatic inflow of retail investors and brokerage firms. The choice of using a particular mobile trading app draws significant importance because various factors determine the ability and ease of use of a specific app. The study underscores the role of FinTech services, particularly mobile trading apps, in revolutionizing stock trading by offering real-time access, increased trading activity, and enhanced features. Despite the proliferation of research on FinTech apps, a notable gap exists in understanding the adoption dynamics of mobile trading apps, especially in the Indian context. To address this gap, our research applies an adapted and extended version of the Unified Theory of Acceptance and Use of Technology (UTAUT-3) framework to examine the factors influencing investors' intentions and usage of mobile trading apps. We introduce novel elements such as information richness and privacy concerns, which are crucial in the financial domain. A convenient sample size of 573 actively brokerage app-using respondents was selected to investigate and conclude the consumers' behavioural intention to use mobile trading apps. The findings highlight the significant impact of practical value, effort expectancy, social influence, hedonic motivation, trust, information richness, privacy concerns, facilitating conditions, and personal innovativeness in IT (Information technology) on investors' intentions to use trading apps. These factors influence behavioural intentions and mediate the relationship between various constructs, emphasizing their multifaceted roles in shaping user perceptions. Theoretical implications of the research contribute to extending the UTAUT-3 model and providing a comprehensive framework for examining technology adoption in the financial domain. Moreover, practical implications guide developers, financial institutions, and policymakers in creating secure, user-friendly, and information-rich mobile trading systems. While acknowledging sampling and self-reported data limitations, this research lays the groundwork for future longitudinal studies. It encourages the exploration of diverse FinTech services to gain a holistic understanding of adoption dynamics in the evolving financial technology landscape. This study adds empirical knowledge to mobile trading app adoption and catalyzes further research, shaping the trajectory of FinTech studies and practical applications in the ever-evolving financial ecosystem.

Keywords: FinTech, mobile trading, stock markets, mobile applications, UTAUT.

INTRODUCTION

Mobile platforms have improved investing by enabling access to more "retail investors" who did not previously have it (Siva *et al.,* 2020; Bulim *et al.,* 2023). DMAT (dematerialisation) accounts in India's equity market have skyrocketed from 40 million (4 crores) in 2020 to 160 million (16 crores) in 2022 (Sumant *et al.,* 2022). The rise in DMAT accounts is due to the favourable investment environment and globally transparent, technology-anchored trading system. Both depositories, National Securities Depository Ltd. (NSDL) and Central Depository Services Ltd. (CDSL), announced that the total number of DMAT accounts in India reached a record 100 million, up 145 per cent from the 40.9 million accounts recorded in the days before the COVID

* Corresponding author (immylone@gmail.com; https://orcid.org/0009-0008-7232-9485)

pandemic. DMAT accounts have increased in number during the past three years. The benchmark Sensex and Nifty 50 indices have increased 66 per cent over the past three years, dramatically boosting the equity markets (Ashtiani & Raahmei, 2023).

The unprecedented increase in retail engagement in securities markets and the spread of equity investment culture to Tier-3 and Tier-4 cities, which increased financial inclusion, are two significant trends that have emerged since the pandemic's beginning. The rise in mobile and digital investing platforms, increased interest in new-age company IPOs, and the penetration of equity as an asset class in low-interest rates all contributed to this development (Kumar *et al.,* 2021). This tendency was further shown in fiscal year (FY) 2022 when 346 lakhs new DMAT accounts were added jointly by the CDSL and the NSDL, significantly increasing the number of DMAT accounts that were opened. The distribution of turnover across various client segments in the cash category likewise changed. Individual investors increased their proportion from 33% in FY 2016 to 41% in FY 2022.

At Bombay Stock Exchange (BSE), mobile trading's percentage share climbed while it decreased at the National Stock Exchange (NSE). In the cash division of the NSE, mobile trading routes accounted for 20.2% of all deals in 2021–2022 compared to 23.1% in 2020–2021. On the other hand, at BSE, mobile trading routes accounted for 18.6% of all cash sector trades in 2021–2022 compared to 15.2% in 2020–2021 (SEBI Annual Report, 2021-22).

The rise in DMAT accounts is due to the favourable investment environment and globally transparent, technology-anchored trading system in India (Fagbemi & Bello, 2019) (Mahesh *et al.,* 2023), which has attracted investors from around the world. The increase in demand for DMAT accounts can also be attributed to efficient financial initiatives across emerging economies, specifically the implementation of diverse government schemes in India aimed at financial inclusion and a surge in fintech products and services (Tay *et al.,* 2022), which have made accessing financial services cheaper and more efficient. These factors have contributed to the growth of DMAT accounts, particularly in rural and semi-urban areas where banking services were previously inaccessible (Niyaz & Siddiq, 2021). Additionally, the opening up of the insurance sector to 100% foreign direct investment in India has provided a further impetus for investors to invest in the country, as it offers more opportunities for diversification and growth (The FDI Regime In India - Inward/ Foreign Investment - India - Mondaq, 2020).

Mobile trading apps have gained significant importance in the Indian context and have notably impacted the security markets. The main reasons for mobile trading are accessibility and convenience, increased trading activity, market information and real-time updates, enhanced trading features, increased investor participation, etc. The advent of numerous mobile platforms offered by various institutions, such as Zerodha Kite, Groww, Angel One, Upstox, and others, has empowered retail investors to engage in trading conveniently through their mobile phones (Gillian, 2020). This simplicity of mobile investing has levelled the playing field for small investors, granting them an advantage previously exclusive to institutional players before the introduction of mobile trading technology. Mobile trading has opened up investment opportunities that were once accessible only to a privileged few. Mobile stockbroking and investing apps are crucial in facilitating investors' financial market participation and aiding clients in growing their capital. It is worth noting that the investment industry and its participants operate within distinct economic systems that vary across countries (Mitchell, 2020; Investopedia, 2021).

Despite the extensive research focused on fintech apps for mobile banking services, mainly through the application of the Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT) models, there exists a notable research gap concerning the utilisation of these technology models in the context of mobile trading apps. These apps have gained prominence as convenient tools for accessing stock markets. The scarcity of studies addressing the application of TAM and UTAUT models to mobile trading apps is striking, considering the increasing importance of these platforms. Furthermore, within the Indian context, the surge in dematerialised accounts (DMAT) following the COVID-19 pandemic accentuates the necessity for such research. This research gap signifies a unique opportunity to explore and comprehend the factors influencing mobile trading app adoption and usage, contributing to theoretical advancements and practical insights.

FinTech services have vastly transformed the stock trading landscape, providing valuable solutions such as mobile trading apps. These apps leverage financial technologies, or FinTech, to offer real-time access to trading platforms, the ability to execute trades at any time, real-time market data, and analytic tools. All these utilities afford a level of convenience, speed, and autonomy that traditional brick-and-mortar brokerages might not be able to offer. Moreover, FinTech has also allowed for the inclusion of AI and Machine Learning tools which

assist in trading by analyzing large volumes of data to predict market trends and offer personalized investment advice. These technologies have made stock trading more accessible, leading to an increase in retail investors. Yet, while the benefits of FinTech services in stock trading are many, they also raise new challenges, especially in the areas of security, data privacy, and regulatory compliance. This is why models and theories such as UTAUT-3, privacy concerns, and information richness models are important to understand the user's intention to adopt these services. The UTAUT model particularly explains the acceptance and use of technology, helping understand how FinTech services like mobile trading apps are adopted and used by investors. Applications like these give individuals control over their investments and provide comprehensive, easily accessible interfaces, which can significantly influence user intentions to adopt.

The significance of researching to bridge the identified gap is manifold. Firstly, despite the extensive examination of fintech apps primarily within the realm of mobile banking services using the Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT) models, the underexplored domain of mobile trading apps warrants attention. By extending these models to mobile trading apps, a comprehensive understanding of user perceptions and behaviours can be achieved in the context of stock market access.

In the current environment of financial technology adoption, the research conducted is highly significant. This work fills a significant vacuum in the literature by incorporating the UTAUT-3 model, privacy issues, and the information richness perspective. Understanding the factors influencing users' behavioural intentions to embrace these apps is crucial as mobile trading apps grow in popularity as entry points into the stock market. Given the delicate financial nature of trading activities, the research's importance is increased by adding privacy issues and information richness. The study's conclusions can help financial institutions, policymakers, and app developers create and promote safe, user-friendly, and information-rich mobile trading systems. Additionally, the research adds to theoretical developments by extending the UTAUT-3 model and offering a comprehensive framework for examining technology adoption in the financial domain. Eventually, it will shape the trajectory of fintech research and practical applications.

LITERATURE REVIEW

Singh *et al.* (2021), concluded that the immense growth in the number of investors is one of the reasons for the stock market is at an all-time high right now. The most common reason has been the sheer rise in the number of individual investors, particularly organized sector and government sector employees, with more disposable income and also more time to trade due to work from home arrangements since March, 2020; as well as a large number of millennials opportuning for short-term gains and an alternative source of income. Opening of a DEMAT account and access to it has also been made very easy and convenient for people. The process is digitalized, one doesn't need to step out of their home or worry about documents and brokerage charges. Many mobile applications dedicated to stock market trading have also contributed to this ease of trading for the people.

The emergence of FinTech services for online and mobile brokerage services has revolutionised how individuals invest in financial markets (Lee & Shin, 2018; Bakri *et al*., 2024; Wilkins 2024). FinTech services are modern digital solutions for managing finances and making financial transactions straightforward and secure for individuals and organisations (Hua & Huang, 2021; Alkhwaldi *et al*., 2022; Hassan *et al*., 2022). FinTech companies leverage cutting-edge technologies like artificial intelligence, big data analytics, and blockchain to offer customers innovative and user-friendly financial solutions (Awotunde *et al*., 2021). FinTech services encompass many offerings, including mobile banking, online investment platforms, digital payment systems, and peer-to-peer lending platforms, among other innovative solutions (Soloviev, 2018; Hendriyani & Raharja, 2019; Harsono & Suprapti, 2024).

FinTech services have also transformed the traditional financial sector by providing practical and innovative ways to manage funds, complete transactions quickly and efficiently, and get loans (Romnova & Kudinska, 2016). Prior research has argued that using fintech services significantly impacts consumers' behavior, intention to use, and attitudes. (Chuang *et al*., 2016; Lim *et al*., 2019; Khan *et al.,* 2022; Shahzad *et al*., 2022), It has been investigated and concluded from several perspectives. For example, Khan *et al.* (2022) emphasised that one of the key factors contributing to consumers' increased behavioural intention to use FinTech services is convenience services designed to be user-friendly and accessible through mobile devices.

The widespread adoption of mobile devices has transformed the financial landscape, with the emergence of mobile trading applications playing a significant role in this revolution (Dwivedi *et al.,* 2020). These applications offer investors and traders the convenience of conducting financial transactions on the go, providing

access to real-time market data and the ability to make informed trading decisions (Nguyen *et al.,* 2020) (Zhao & Bação, 2021).

Understanding the factors that influence the behavioural intention to adopt mobile trading applications is crucial for financial institutions and app developers to enhance user engagement and drive further adoption (Penney *et al*., 2021). This literature review seeks to integrate the Unified Theory of Acceptance and Use of Technology model with additional constructs, namely privacy concerns and information richness, to develop a comprehensive framework for examining the determinants of mobile trading app adoption.

The Unified Theory of Acceptance and Use of Technology has been widely employed to investigate the adoption of various mobile technologies, including mobile banking (Baptista & Oliveira, 2015), mobile money services (Penney *et al*., 2021), and mobile health (Dwivedi *et al*., 2020). The model posits that performance expectancy, effort expectancy, social influence, and facilitating conditions are key determinants of behavioural intention and usage behaviour (Baptista & Oliveira, 2015). Building upon this foundation, the UTAUT-3 model further incorporated additional constructs, such as hedonic motivation, price value, and habit, to enhance the explanatory power of the original UTAUT model (Dwivedi *et al*., 2020)

The UTAUT model can be used to examine FinTech services' effect on users' behavioural intentions to utilise the services (Baba *et al*., 2023; Hasan *et al*., 2024). Digitalized agriculture must integrate with FinTech to balance resource use and profitability, supporting sustainable models. This study analyzes how social influence, performance expectancy, and convenience affect farmers' adoption of FinTech, highlighting its importance for sustainable development (Sharma *et al*., 2024). A well-known paradigm for forecasting people's intentions to accept and use technology is the UTAUT model (Macdonald *et al*., 2019). It offers several crucial elements that affect people's behaviour, including performance expectations, effort expectations, social influence, and facilitating conditions. The UTAUT model, in contrast, was expanded and changed by several writers by including new constructs to account for customers' behavioural intentions to use FinTech services (Modyski, 2018; Akhtar *et al*., 2019; Salgado *et al*., 2020). The earlier researchers could comprehend and conclude the acceptability and use of systematic theorising of FinTech services by doing integrations and modifications to UTAUT (Hassan *et al*., 2022). In this sense, the present study expanded the UTAUT model by including Privacy concerns and information richness, as recommended by (Venkatesh *et al*., 2021).

Investing involves using a certain amount of capital to make money using various financial strategies, such as buying real estate, opening savings accounts with interest, investing in bonds, or trading stocks (Napoletano, 2020; Smith, 2021; Richter, 2024).

In today's technologically advanced era, mobile trading apps have gained significant popularity and are widely used by individuals for financial transactions. (Hadi *et al.,* 2022; Klimontowicz & Harasim, 2019; Misra *et al.,* 2022) With the increasing shift towards digital platforms, mobile trading apps have become an integral part of the financial industry (Folwarski, 2021; Hadi *et al*., 2022; Bi, 2022). These apps allow users to conveniently manage their investments, trade stocks, and monitor the financial markets from the palm of their hands (Lv *et al*., 2019; Bi, 2022).

However, the adoption of mobile trading apps is influenced by various factors, including user intentions, privacy concerns, and information richness (Wang & Qi, 2021). Understanding the factors that influence user intentions to adopt mobile trading apps is crucial for both researchers and practitioners (Wang & Qi, 2021; Le *et al*., 2022).

RESEARCH MODEL AND HYPOTHESES DEVELOPMENT

By modifying the UTAUT paradigm, we have presented a research model for this study. The UTAUT model developed by Venkatesh *et al.* (2021) aimed to explain users' intentions to deploy information systems based on their actual behavioural intentions. However, earlier studies (Sulaiman & Ninglasari, 2020; Darmansyah *et al*., 2020; Singh *et al*., 2020; Fianto *et al*., 2020; Submitter *et al*., 2021a, 2021b; Alkhwaldi *et al*., 2022) concentrated on examining users' behavioural intentions towards FinTech services using the UTAUT model. To enhance the model, we have extended the UTAUT by incorporating two additional constructs: Privacy concerns and information richness (Venkatesh *et al*., 2021). Furthermore, our model examines the mediating role of investor's experience with adapting mobile trading apps/ stock brokerage apps. Further, the present study shall examine the moderating effects of age on behavioural intentions towards trading apps.

Utilitarian value

The perceived utility or advantages people associate with utilising mobile trading or broker apps, such as ease, effectiveness, information access, and cost savings, are considered utilitarian values (Chopdar *et al*., 2018). Users are more likely to interact with and keep using an

app when they believe it has high utilitarian value. Users of mobile trading apps can execute trades, keep an eye on market movements, and manage their portfolios (Kim & Mauborgne, 2014). Users perceive the app as efficient and convenient when it offers time-saving benefits and reduces the need for manual processes. This perception of efficiency contributes to the intention to use and adopt the app (Fu, 2020). When users perceive that the app helps them stay informed and make better-informed investment decisions, it increases their intention to use the app as a reliable source of information (Diaz *et al*., 2021). The utilitarian value offered by mobile trading apps is crucial in determining the investor experience (Tai & Ku, 2013). The ease of access, real-time information, and portfolio tracking offered by these apps improve investors' overall trading experiences (Aldridge & Krawciw, 2017). The utilitarian-driven approach enhances the investor experience by empowering users to monitor their investments and make informed decisions (Fan, 2022). As a result, this enhanced experience cultivates positive behavioural intentions, encouraging investors to engage more frequently and confidently with these mobile trading apps, creating a symbiotic relationship between utilitarian value, investor experience, and the intention to use these platforms (Chong *et al*., 2021).

H1: Utilitarian value has a significant impact on behavioural intention to use.

H9: Utilitarian value has a significant impact on investor experience.

H18: Investor Experience mediates the relationship between utilitarian value and behavioral intention.

Social influence

Social influence is the influence of others' thoughts, feelings, and behaviours on a person's attitudes and behaviours (Hsu & Lin, 2008). A positive mindset and intention to use it can emerge if a person's social network anticipates their use of a mobile trading app (Martins *et al*., 2014). Peers' achievement with these apps increases their perceived reliability, which increases their desire to use them (Zhang & Xu, 2020). Behaviour replication is sparked by social proof, and attitudes and intentions are significantly influenced by the endorsements of opinion leaders (Contractor & DeChurch, 2014). When peers use apps in competition, social comparisons encourage app adoption (Dam *et al*., 2018). In today's dynamic investment environment, comprehending and utilising this influence can result in more informed and effective investment strategies (Mithas *et al*., 2013). These factors work together to shape attitudes and direct choices regarding the use of mobile trading apps among investors based on their behavioural intentions. The study also examines the investor experience's role in mediating the relationship between social influence and the decision to use mobile trading apps.

H2: Social influence significantly behavioural intention to use mobile trading apps.

H10: Social influence significantly impacts investor experience.

H19: Investor Experience mediates the relationship between social influence and behavioural intention to use.

Hedonic motivation

Hedonic motivation refers to the pleasure or positive emotions individuals experience when engaging in a particular activity or using a product or service (Tamilmani *et al*., 2019). When users find the app enjoyable, entertaining, or emotionally rewarding, they are more likely to use it frequently and engage in its features (De Canio *et al*., 2021). Mobile fintech apps that offer a pleasant and enjoyable user experience tend to attract more users and keep them engaged for longer periods (Dirin *et al*., 2022). Users are more likely to interact with the app frequently if it provides a sense of enjoyment or fun (De Canio *et al*., 2021). When users feel positive emotions while using the fintech app, it leads to higher satisfaction levels (Lim *et al*., 2019). Satisfied users are more inclined to continue using the app and recommend it to others, positively influencing their behavioural intentions (Chen & Tsai, 2019). Users who experience hedonic motivation are more likely to share their positive experiences with others through word-of-mouth or social media platforms. This, in turn, can strengthen their behavioural intention to continue using the app (Mishra *et al*., 2022). Positive emotions associated with the app can lead users to perceive a sense of psychological ownership, wherein they feel that the app is a part of their identity or daily routine. This feeling of ownership can further enhance their behavioural intention to use the app consistently (Gu *et al.,* 2022). Hedonistic motivation, which is motivated by pleasure seeking and pain avoidance, has an impact on investor's experience. While negative experiences may discourage future participation, positive ones can increase confidence and engagement (Corr & Krupić, 2017).

The quality of the investor experience serves as a path for the hedonic motivation-driven positive emotions that drive the intention to use the service. The investor experience is a crucial link between motivational factors and actual usage intentions (Minami *et al*., 2021). This research emphasises the critical role of the emotional

aspect in shaping investment-related behavioural intentions.

H3a: Hedonic motivation has a significant impact on behavioral intention to use mobile trading apps.

H11: Hedonic motivation has a significant impact on investor experience.

H20: Investor Experience mediates the relationship between hedonic motivation and behavioural intention to use.

Facilitating conditions

Facilitating conditions include the resources and support that make engaging in a specific behaviour easier (Tarhini *et al.,* 2017). Easy access via well-known app stores improves these facilitating conditions in the context of a mobile trading app (Tang *et al*., 2020). If users can easily find and install the app on their smartphones, they are more likely to use it (Breitinger *et al*., 2020). The app's usability, characterised by a user-friendly interface, simple navigation, and clear instructions, strengthens favourable conditions and encourages user engagement (Gómez-Rico *et al.,* 2023). The availability of technical support, such as a help desk or customer service, significantly influences user intention and inspires confidence (Alalwan *et al*., 2018). The removal of device-related constraints is further facilitated by compatibility with various devices and operating systems (Wei *et al*., 2019). Facilitating conditions wield substantial influence over the investor experience (Boh *et al*., 2020). These factors, encompassing user-friendly platforms, accessible information, and efficient customer support, powerfully shape how investors engage with financial markets. When these conditions are favourable, investors encounter fewer hurdles in executing trades, conducting research, and managing their portfolios (Lu *et al*., 2023). This fosters a more positive and seamless investment journey, enhancing the investor experience. Thus, optimising facilitating conditions is vital in cultivating a favourable and enriching investor experience (Kafi & Adnan, 2022). The connection between Facilitating Conditions and the intention to use a service is influenced by Investor Experience. The quality of the investor's experience with the service determines how easily they can access and adopt it (Madigan *et al*., 2017). A positive investor experience enhances the impact of facilitating conditions on their intention to use the service. This highlights the significance of both user-friendly conditions and a satisfying investor experience in shaping behavioral intentions in the financial realm.

H4: Facilitating Conditions have a significant impact on behavioral intention to use mobile trading apps.

H12: Facilitating Conditions has a significant impact on investor experience.

H21: Investor Experience mediates the relationship between Facilitating Condition and behavioral intention to use.

Personal innovativeness in IT

Personal innovativeness in IT refers to an individual's readiness to embrace latest information technology (IT) innovations (Acheampong *et al*., 2017). Those inclined to IT innovation tend to perceive mobile trading apps as valuable tools for enhancing their financial activities (Fan, 2022). They see these apps as convenient, efficient, and capable of delivering real-time information, thus increasing their intent to adopt them (Fu, 2020). This personal innovativeness also affects how easy these individuals find it to use mobile trading apps; their tech openness and comfort with IT innovations make app navigation and utilization easier, further boosting their intent to adopt (Natarajan *et al*., 2018). It also correlates with higher self-efficacy in using technology, instilling confidence in effectively utilizing these apps. Moreover, personal innovativeness can make individuals more susceptible to social influence; if they are early IT adopters, peers trust their judgment and are more likely to follow suit, reinforcing their adoption intent (Shahzad *et al.,* 2023). This study uncovers that personal innovativeness affects service adoption intent through the filter of investor experience.

H5: Personal innovativeness in IT has a significant impact on behavioral intention to use mobile trading apps.

H13: Personal innovativeness in IT has a significant impact on investor.

H22: Investor Experience mediates the relationship between personal innovativeness in IT and behavioral intention to use.

Privacy concern

Privacy concerns play a pivotal role in shaping the behavioral intention to use mobile trading apps (Hanif *et al.,* 2022). According to the Unified Theory of Acceptance and Use of Technology (UTAUT), individuals are more likely to adopt a technology if they perceive it as easy to use, useful, and aligned with their needs (Testa & Tawfik, 2017). However, when privacy concerns arise, they become a major barrier, affecting users' perceptions of security and trust (Balapour *et al.,* 2020). These concerns undermine the perceived usefulness of the app and consequently dampen the intention to use it

(Kang & Namkung, 2019). Hence, addressing privacy apprehensions is vital for enhancing the acceptance and utilization of mobile trading apps by UTAUT principles. Privacy issues significantly influence the investor experience. If people believe their personal information is adequately protected, they are more likely to interact with financial platforms when investing (Ng *et al*., 2020). Privacy concerns can undermine trust, prevent information sharing, and ultimately affect investors' behaviour (Lutz *et al*., 2018). In order to improve user acceptance and foster a favourable investment environment, these issues must be addressed.

H6: Privacy concerns significantly impact on behavioral intention to use mobile trading apps.

H14: Privacy concerns significantly impact on investor experience.

H23: Investor Experience mediates the relationship between privacy concerns and behavioral intention to use.

Trust

User trust plays a pivotal role in shaping their adoption and sustained usage of mobile brokerage apps (Khan *et al*., 2022). Trust is inherently linked to a user's perception of platform security (Nair *et al.,* 2023). When users feel confident that their personal and financial data is well safeguarded, they exhibit a stronger inclination to use the app. Conversely, if an app is seen as insecure or susceptible to cyber threats, user adoption diminishes (Al-Natour *et al*., 2020). Trust is also tied to the app's reliability and performance, with smooth, error-free transactions fostering greater trust and continued usage (Mbete & Tanamal, 2020). Open communication about services, fees, and policies fosters trust, as does accessible customer support. Social recommendations, intuitive interfaces, and positive word-of-mouth further bolster trust and the user's intention to use the app (Oldeweme *et al*., 2021). The investor experience is significantly shaped by the investor's level of trust in the brokerage platform. As a result, building and maintaining trust is crucial for a successful and rewarding investor journey. The investor's perception of the app's credibility significantly impacts their choice, but their actual usage of the service mediates this relationship (Khan *et al*., 2022). The investor's experience impacts the relationship between trust and the intention to use a service. A successful investor experience acts as a bridge between investor trust and the behavioural intent to use the service.

H7: Trust has a significant impact on behavioral intention to use mobile trading applications.

H15: Trust has a significant impact on investor experience.

H24: Investor Experience mediates the relationship between trust and behavioural intention to use.

Information richness

Information richness in mobile trading apps significantly shapes user behavioural intentions, aligning with the UTAUT model (Bajunaied *et al*., 2023). This model asserts that technology adoption hinges on performance expectations, ease of use, social influence, and facilitating conditions. In the case of mobile trading

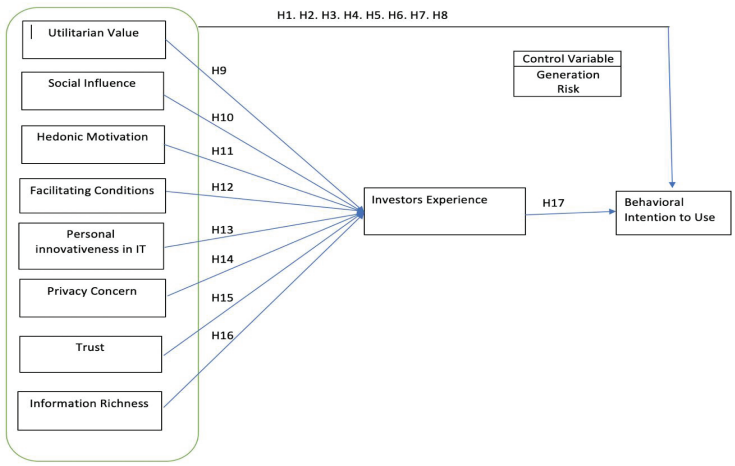

Figure: Research framework

apps, comprehensive, relevant information enhances perceived benefits and usability, moulding users' intent to engage in trading activities through these apps actively (Tam *et al*., 2020). A fundamental idea upheld by the UTAUT model is that information richness significantly impacts the investor experience (Almaiah *et al*., 2019). Information-rich environments give investors a thorough understanding of market dynamics, enabling them to make wise decisions (Hradecky *et al*., 2022). According to UTAUT, a positive perception of information richness increases user acceptance and engagement, ultimately improving the overall investor experience (Mlekus *et al*., 2020). The availability of a wealth of relevant information is essential for influencing attitudes and behaviours in the complex world of finance. The investor's experience mediates the link between information richness and the intent to use a service.

H8: Information richness has a significant impact on behavioral intention to use mobile trading apps.

H8: Information richness has a significant impact on investor experience.

H25: Investor Experience mediates the relationship between Information richness and behavioral intention to use.

Investors often evaluate the impact of factors such as user interface, security features, and real-time information on their intention to use mobile trading applications (Tai & Ku, 2013). Positive experiences, like ease of navigation and quick execution, can enhance their willingness to use these apps, while negative encounters may deter adoption (Koghut & AI-Tabbaa, 2021).

H17: Investor's experience throughs significant impact on behavioral intention to use mobile trading apps.

METHODOLOGY

Research design

The research adopted a quantitative research design to investigate the behavioral intention to adopt mobile trading apps. The study aims to examine the relationship between behavioral intention to adopt mobile trading apps and the integrated UTAUT-3, privacy concerns, and information richness model. It utilized a cross-sectional survey approach to collect data from a sample of participants. The quantitative research design was used to collect numerical data to analyze and test the proposed model. The study employed a purposive sampling technique to select participants who are active users or potential users of mobile trading apps. The sample size was determined based on the statistical power analysis to ensure adequate representation.

Measurement scales

To obtain the present study's aim, nine hypotheses were drawn from previous studies for the measurement of UTAUT constructs (i.e., Utilitarian value, effort expectancy, social influence, facilitating condition, trust, hedonic motivation, personal innovativeness in IT and behavioral intention to use) (Venkatesh *et al*., 2003); thus, we extended the model by adding two well-known constructs called privacy concern and information richness (Bajunaied *et al*., 2023). Prior studies have constantly reported the significance, reliability, and validity of the above constructs when testing users' behavioral intention toward FinTech services (Ali *et al*., 2018; Hassan *et al*., 2022; Chan *et al*., 2022). All the measurement items for the constructs were adopted from the previous studies presented in (Appendix A), while we also modified some items considering the present study context. All the measurement items were measured using a "five-point Likert scale (1 =strongly disagree and 5 =strongly agree)" (Alkhwaldi *et al*., 2022).

The questionnaire was divided into 2 sections; in section I, we asked qualifying and demographic questions from the respondents presented in Table 1. In section II, we presented measurement items for the present study's constructs. Before distributing the questionnaire to the targeted respondents, we performed a pilot test on 98 participants to validate the measurement instrument for the present study (Williams-McBean, 2019). Finally, after the pilot test, we modified several items and revised some of them after the preliminary validity test in the pilot sample.

Sample and data collection

The population of interest in the current study is users who used FinTech services (particularly the brokerage apps) in pan India. India is Ranked the World's Second-Most Stock Market Obsessed Country (Shah, 2016). To obtain the present study objectives, the researcher calculated the sample size using G*Power software version 3.1. The present study's model has nine predictors; the software suggested an effect size of 0.15 and a power of 0.95. As a result, a total of 286 sample sizes was suggested. Therefore, the selected sample size for the present study was above the minimum requirements. In addition, past studies on consumers' behavior suggested that the minimum sample size should be 300 to investigate and conclude the consumers' behavioral intention to use (Hameed *et al*., 2019; Zhao *et al.,* 2022). Therefore, the convenience sampling technique was employed to

Table 1: Measurement items

Variable name		Variable item	Source
Utilitarian value	UV1	I expect to find Mobile trading apps useful in my financial management	Venkatesh & Xu (2012)
	UV2	Using Mobile trading apps would enable me to accomplish investment tasks more quickly	
	UV3	Using Mobile trading apps would increase my efficiency in investment management	
	UV4	If I would use Mobile trading apps, I increase my chances of getting more competitive investment offers	
Social influence	SI1	My friends and family would value the use of Mobile trading apps	Chan *et al*. (2022)
	SI2	I expect that the people that influence me would use Mobile trading apps	
	SI3	I expect that Mobile trading apps would be trendy	
	SI4	I expect that using Mobile trading apps would make me look professional in managing my investments	
Hedonic motivation	HM1	Mobile trading is interesting to me.	Venkatesh & Xu (2012)
	HM2	Mobile trading is an enjoyable service.	
	HM3	Mobile trading provides joyful service.	
Facilitating condition	FC1	I have the resources to use Mobile trading apps	Azman & Zabri, (2022)
	FC2	Mobile trading apps are compatible with other technologies that I use	
	FC3	I can get help from family when I have difficulties using Mobile trading apps	
	FC4	Mobile trading apps can work 24/7 without problems	
	FC5	Mobile trading apps are always up to date	
	FC6	Mobile trading apps is easy to register as a new user	
Personal innovativeness	PI1	I was searching for ways to play with the facilities of mobile trading apps.	Agarwal & Prasad (1998); Venkatesh & Xu (2012)
	PI2	Usually, I am the first of my colleagues to try online mobile trading facilities.	
	PI3	I like playing with emerging innovativeness in Mobile stock trading apps.	
Privacy concerns	PC1	I would be comfortable giving personal information on Mobile trading apps	Venkatesh *et al*., (2021)
	PC2	I would be comfortable in investing through Mobile trading apps	
	PC3	The Mobile trading apps clearly explains how user information is used.	

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Perceived risk	PR1	Investing through Mobile trading apps would increase financial risk.	Venkatesh *et al*., (2021)
	PR2	Trading through Mobile trading apps would increase order execution risk.	
	PR3	My overall perception of risk related to investing through Mobile trading apps are high	
Trust	TR1	The Mobile trading apps are trustworthy.	Venkatesh *et al.*, (2021)
	TR2	I trust the Mobile trading apps keep my best interests in mind.	
	TR3	This Mobile trading apps' behaviour meets my expectations.	
Information richness	IR1	My interaction with the Mobile trading apps is close to an actual face-to-face interaction.	Venkatesh *et al.*, (2021)
	IR2	My interaction with the Mobile trading apps felt like a face-to-face interaction.	
	IR3	Investing through Mobile trading apps felt like an in-person interaction.	
Behavioral intention	BI1	I will use Mobile trading apps on regular basis in the future	Davis (1989), Im *et al.* (2011)
	BI2	I plan to use/continue in future if i have the opportunity	
	BI3	I may use Mobile trading apps for handling my investment requirements to continue in the future	
	BI4	Over the next 12 months, i will use Mobile Trading apps more regularly	Venkatesh *et al.* (2003), Davis (1989)
	BI5	For next 12 months, i have a good view of using Mobile Trading apps	
	BI6	I expect to use Mobile trading app facilities more often for the next 12 months.	

gather the data. Only volunteer participation was taken to fill out the survey forms. Thus, we administered the survey online to a sample of 682 FinTech users in India; from them, 109 responses were identified as suspicious response patterns or incomplete (Bauermeister *et al.,* 2012); thus, we performed the final statistical analysis based on the 573 valid responses. "How often do you use FinTech services'' 2% use it daily, weekly 7%, 16% monthly, 28% every 3 months, 19% use it every six months, 16% use it in 12 months, and 12% use once in 24 months. Of them, 87% were male, 13% were female, 72% were graduated, 28 were undergraduates, 28% were 18 – 28 years old, and only 13% were over 50 overs. Thus, Table 1 summarizes the overall demographic information of the respondents.

Data collection

Data will be collected through a structured questionnaire consisting of multiple sections. The questionnaire will include validated scales and items to measure variables such as behavioral intention, UTAUT-3 constructs (performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, and habit), privacy concerns, and information richness. The questionnaire will be administered electronically or in person, depending on the feasibility.

Measurement model

The research model demonstrates a notable degree of reliability and consistency, with Cronbach's alpha surpassing the recommended threshold of 0.7 (0.968 with 36 items) as outlined by DeVellis (2016). Furthermore, the instrument's validity was assessed, leading to its inclusion in the measurement of the proposed constructs. To explore their relationships with the dependent variables, BI, and inner item correlations were computed. The calculated Cronbach's alpha coefficients for each variable ranged from 0.695 to 0.950, as shown in Table

Table 2: Demographic items

		No	Percentage
Gender	Male	418	72.94
	Female	155	27.05
Income	less than 20 thousand	42	7.33
	21 to 40k	81	14.14
	41-60	96	16.75
	60-80	157	27.40
	80 and above	197	34.38
Age	18-27	154	26.88
	28-37	246	42.93
	38-47	109	19.02
	48 and above	64	11.17
Education	Senior secondary	65	11.34
	Graduate	218	38.05
	Postgraduate	198	34.55
	Doctorate	92	16.06

2. These values signify a sufficient (Cronbach's alpha > 0.6) to good (Cronbach's alpha > 0.8) level of reliability and construct reliability, aligning with Cortina's criteria (1993).

To evaluate the dependability and validity of the reflective constructs, various aspects were examined, including indicator loadings, composite reliability (CR), and average mean-variance (AVE). According to the findings presented in Table 2, CR values ranged from 0.81 (for FC) to 0.97 (for BI), surpassing the recommended threshold of 0.7. As per Hair *et al.* (2010), such values strongly indicate a high level of internal reliability. Convergent validity was assessed through CR and AVE values, both of which exceeded 0.7 and 0.5 respectively. These results suggest that the instrument possesses acceptable construct validity, in accordance with the works of Hair *et al.* (2017). Moreover, to assess the appropriateness of the selected variables for the factor analysis, the Kaiser-Meyer-Olkin (KMO) adequacy test and Bartlett's test for sphericity were employed (Bryman, 1989). The KMO test yielded a value of 0.9245, surpassing the minimum adequacy threshold of 0.5. Additionally, Bartlett's test exhibited strong sphericity ($\chi^2 = 2440.665$, df = 45, $p < 0.001$), confirming the suitability of the variables for the analysis.

To assess the investors' perception and acceptance of trading app platforms, mean values and standard deviations were calculated, as detailed in Table 2. The outcomes indicate that a significant portion of the participants hold a moderate level of acceptance toward trading app platforms, as evidenced by the mean value of the PE indicator (mean PE = 3.09). Notably, students exhibit strong agreement regarding the user-friendliness and investing-facilitation aspects of the trading apps platform, as indicated by the notably high mean value for EE (mean EE = 4.24). The influence of others' opinions on the use of trading app platforms seems relatively minimal among the masses (mean SI = 2.56).

Descriptive statistics further highlight that individuals' convictions concerning the requisite knowledge, resources, and support for utilizing trading app platforms are notably positive, as suggested by the high mean value for FC (mean FC= 4.01).

Structural model

A structural equation modelling in AMOS was conducted to evaluate the relation between nine primary factors (Utilitarian value, Social Influence, Hedonic Motivation, Facilitating Condition, Personal innovativeness, Privacy Concerns, Trust and Information Richness) and the investors' experience and intention (BI) to utilize trading app platforms. Additionally, the β-values for each factor are displayed in Table 3 in graphical form. According to the findings presented in Table 4, six out of thirteen hypotheses received support. The initial step involved testing the formulated hypotheses. All hypotheses garnered support, as outlined in Table 5 and depicted in Figure 2. Specifically, the study revealed that Utilitarian value (UV) with a coefficient of β =

Table 3: Measurement items and Constructs

Construct	Items	Loading	Cronbach alpha	CR	AVE
Utilitarian value	UV1	0.620	0.893	0.858	0.795
	UV2	0.654			
	UV3	0.630			
	UV4	0.788			
Social influence	SI1	0.799	0.9	0.885	0.695
	SI2	0.760			
	SI3	0.531			
	SI4	0.650			
Hedonic motivation	HM1	0.596	0.871	0.851	0.713
	HM2	0.645			
	HM3	0.700			
Facilitating condition	FC1	0.673	0.886	0.862	0.747
	FC2	0.646			
	FC3	0.612			
	FC4	0.635			
	FC5	0.699			
	FC6	0.672			
Personal innovativeness	PI1	0.723	0.907	0.860	0.847
	PI2	0.670			
	PI3	0.726			
	PC1	0.671			
	PC2	0.647			
	PC3	0.660			
Privacy concerns	PR1	0.629	0.877	0.856	0.675
	PR2	0.621			
	PR3	0.674			
Trust	TR1	0.751	0.893	0.859	0.782
	TR2	0.624			
	TR3	0.702			
Information richness	IR1	0.640	0.869	0.893	0.762
	IR2	0.668			
	IR3	0.655			
Behavioural intention	BI1	0.726	0.862	0.862	0.703
	BI2	0.681			
	BI3	0.711			
	BI4	0.640			
	BI5	0.638			
	BI6	0.635			

0.596, Social Influence (SI) with β = 0.601, Hedonic Motivation (HM) with β = 0.447, Facilitating Condition (FC) with β = 0.312, Personal innovativeness (PI) β = 0.615, Privacy Concerns (PC) β = 0.472, Trust (TR) β = 0.515 and Information Richness (IR) with β = 0.518, all exhibited significant positive direct impacts on Investors Experience (INE). On the other hand, the effects of Facilitating Conditions (FC) and Hedonic Motivations (HM) were found to be statistically insignificant. This implies that the intention to use trading apps in India is primarily shaped by factors such as utilitarian value, Social Influence, Hedonic Motivation, Facilitating

Table 4: Acceptance level of trading apps

Constructs	UV	SI	HM	FC	PI	PC	TR	IR	IS	BI
UV	0.891									
SI	0.049	0.833								
HM	0.050	0.349	0.844							
FC	0.039	0.004	0.254	0.864						
PI	0.095	0.025	0.176	0.107	0.920					
PC	0.058	0.000	0.233	0.154	0.030	0.821				
TR	0.049	0.020	0.191	0.101	0.125	0.075	0.884			
IR	0.088	0.508	0.298	0.135	0.208	0.198	0.046	0.872		
IE	0.046	0.000	0.130	0.027	0.135	0.105	0.010	0.272	0.838	
BI	0.060	0.160	0.137	0.075	0.082	0.056	0.145	0.242	0.152	0.891

Table 5: Hypothesis testing

Hypotheses	Path	b	P value	Vif	**Support**
H1	Utilitarian value--> BI	0.696	0.010	1.857	Accepted
H2	Social Influence--> BI	0.701	0.003	2.778	Accepted
H3	Hedonic Motivation--> BI	0.537	0.004	1.605	Not accepted
H4	Facilitating Condition--> BI	0.586	0.001	0.728	Not accepted
H5	Personal innovativeness--> BI	0.602	0.006	0.937	Accepted
H6	Privacy Concerns--> BI	0.614	0.038	2.859	Accepted
H7	Trust--> BI	0.658	0.019	2.247	Accepted
H8	Information Richness--> BI	0.571	0.009	4.657	Accepted
H9	Utilitarian value--> IE	0.696	0.000	2.321	Accepted
H10	Social Influence--> IE	0.701	0.010	0.663	Accepted
H11	Hedonic Motivation--> IE	0.537	0.023	2.514	Accepted
H12	Facilitating Condition--> IE	0.586	0.014	1.197	Accepted
H13	Personal innovativeness--> IE	0.602	0.001	2.063	Accepted
H14	Privacy Concerns--> IE	0.614	0.104	0.732	Accepted
H15	Trust--> IE	0.658	0.038	2.478	Accepted
H16	Information Richness--> IE	0.571	0.003	1.857	Accepted
H17	IE--> BI	0.594	0.019	2.528	Accepted

Condition, Personal innovativeness, Privacy Concerns, Trust and Information Richness hold strong relevance in this context. Notably, it's worth highlighting that among the path loadings, trust and performance expectations emerged as the most influential factors in explaining and predicting trading app platforms.

Furthermore, the analysis also demonstrated a significant and positive influence of UTAUT3 constructs (Utilitarian value, Social Influence, Hedonic Motivation, Facilitating Condition, Personal innovativeness, Privacy Concerns, Trust and Information Richness) with investors experience (INE) with a coefficient of (β = 0.696, β = 0.701, β = 0.537, β = 0.586, β = 0.602, β = 0.614, β = 0.658, β = 0.571, respectively.

In the subsequent phase of analysis, the research model's performance was assessed through several metrics. The R2 value gauged the extent of explanatory power, the Q2 predict value evaluated predictive relevance, and the f2 value determined effect size. In terms of the R2 value, which ranges between zero and one, higher values indicate greater explanatory capacity., a combined contribution of 43.5% to the total variance in Performance Expectancy (PE) is accounted for by Effort Expectancy (EE) and Trust (TR), demonstrating a moderate level of influence (Chin, 1998). Furthermore, the study highlights that PE, EE, Habit (HB), Price Value (PV), and TR collectively elucidate 65.3% of the overall variance in Consumer Usage Intention (CUI). Similarly, CUI and HB explain 32.5% of the overall variance in Consumer Usage Behavior (CUB). The Q2 predicted values of the dependent constructs, all exceeding 0. This observation signifies the suitable predictive relevance of the study model.

MEDIATION ANALYSIS

The goal of mediation analysis is to uncover the underlying mechanisms that explain how investor experience affects the relationships between predictor variables of UTAUT 3 and behavioral intention. This provides insights for designing platforms and strategies to engage users effectively. The study employed a bootstrapping technique with 5000 sub-samples and bias correction at a 95% confidence interval, as outlined by Preacher & Hayes (2008), to analyze the mediating effect. The findings revealed a statistically significant

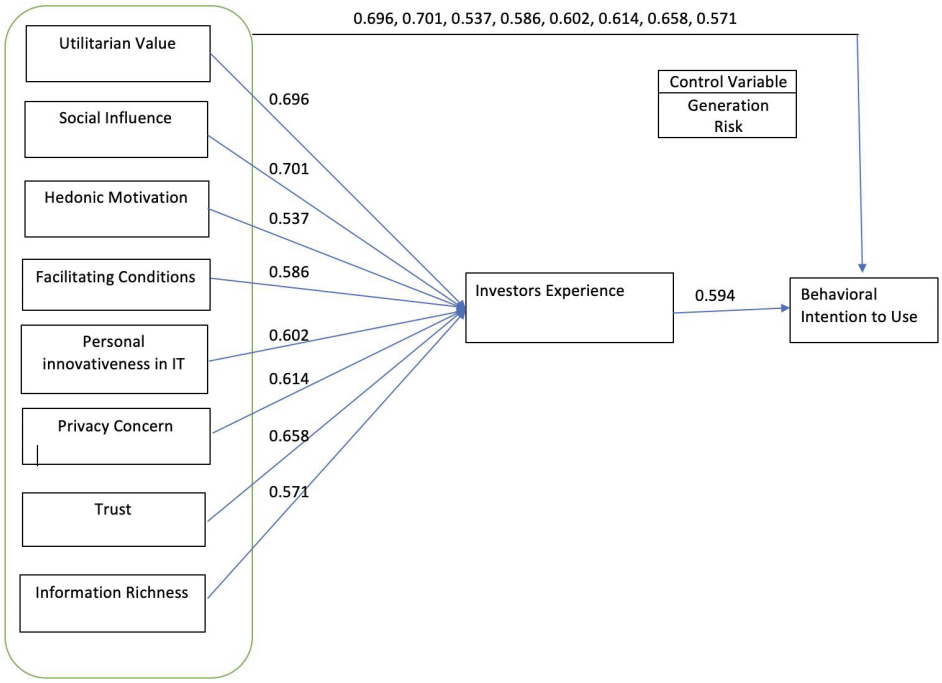

Figure 2 : Structural model

Table 6: Mediation analysis

Hypotheses	Mediation analysis	Direct effect	Indirect effect	P value	Outcome
H18	Utilitarian value--> IE--> BI	0.28	0.10	0.001	Supports
H19	Social Influence--> IE--> BI	0.20	0.06	0.001	Supports
H20	Hedonic Motivation--> IE--> BI	0.15	0.04	0.001	Supports
H21	Facilitating Condition--> IE--> BI	0.12	0.03	0.005	Supports
H22	Personal innovativeness--> IE--> BI	0.18	0.18	0.001	Supports
H23	Privacy Concerns--> IE--> BI	0.10	0.03	0.05	Supports
H24	Trust--> IE--> BI	0.25	0.08	0.001	Supports
H25	Information Richness--> IE--> BI	0.22	0.07	0.001	Supports

direct influence of predictor variables of UTAUT3 on behavioral intention $\beta = 0.28$ ($p < 0.001$), $\beta = 0.20$ ($p < 0.001$), $\beta = 0.15$ ($p < 0.01$). $\beta = 0.12$ ($p < 0.05$) $\beta = 0.18$ ($p < 0.01$) $\beta = -0.10$ ($p < 0.05$) $\beta = 0.25$ ($p < 0.001$), $\beta = 0.22$ ($p < 0.001$). Additionally, there was a noteworthy indirect impact of constructs of UTAUT3 model on Behavioral intention through investor experience, $\beta = 0.10$ (CI: 0.06, 0.15), $\beta = 0.06$ (CI: 0.03, 0.10), $\beta = 0.04$ (CI: 0.02, 0.08), $\beta = 0.03$ (CI: 0.01, 0.07), $\beta = 0.18$ ($p < 0.01$), $\beta = -0.03$ (CI: -0.06, -0.01), $\beta = 0.08$ (CI: 0.05, 0.12), $\beta = 0.07$ (CI: 0.04, 0.11), indicating that investor experience partially acts as a mediator in the connection between constructs of UTAUt3 and behavioural intention (refer to Table 6). As a result, H18, H19, H20, H21, H22, H23, H24, H25 is substantiated. Investor experience plays a mediating role in this relationship suggesting that a positive investor experience enhances the positive effect of utilitarian value on behavioral intention. This emphasizes the importance of having seamless and functional trading app platforms. Investment platforms should consider integrating social features to capitalize on this influence. Hedonic motivation significantly predicts BI. Investor experience partially mediates this link, suggesting that a more enjoyable experience heightens the effect of hedonic motivation on BI. App developers should focus on enhancing the platform's experiential aspects. The mediation analysis indicates that investor experience partly mediates this relationship, highlighting the role of a smooth and supportive platform environment in enhancing the investor experience and subsequently, the behavioural intention to use trading apps. Personal innovativeness positively influences BI. The mediation results reveal that investor experience mediates this relationship, suggesting that a more innovative and personalized experience amplifies the impact of personal innovativeness on BI. Platform developers should focus on incorporating innovative features. Mediation analysis indicates that investor experience mediates this relationship, indicating that a secure and trustworthy experience can mitigate the negative impact of privacy concerns on BI. Platform providers should prioritize robust privacy measures. Trust significantly predicts BI. Investor experience mediates this relationship, highlighting the importance of fostering trust through an enhanced platform experience. The study underscores the role of platform transparency and reliability. Information richness positively influences BI. Investor experience mediates this relationship, indicating that providing rich and valuable information contributes to a positive experience, thereby enhancing the impact on BI. Platforms should prioritize information accessibility and quality.

The findings of this study demonstrate that investor experience serves as a vital mediator in the relationships between psychological and contextual factors and the behavioural intention to use trading app platforms. By optimizing the investor experience, platform developers and providers can significantly enhance the impact of various antecedents on investor behavior, ultimately contributing to improved adoption rates and customer satisfaction.

MODERATION ANALYSIS

Composite scores were computed for UTAUT 3, generation, and BI, to establish and examine the potential impact of the moderating factor, Generation (Blunch, 2016; Byrne, 2013; Little, 2013). Subsequently, these scores were transformed into z-scores using SPSS, followed by the assessment of the interaction effect between UTAUT 3 and Generation, as outlined by Dugard et al. (2022). The results indicate that the interaction effect of Generation on the UTAUT 3 and BI relationship shows a statistical significance ($p > .001$).

The moderating role of two generational cohorts, namely generation Y (b = 0.337; t = 7.561 > 6.63; p < 0.01) and generation Z (b = 0.459; t = 10.786 > 2.71; p < 0.01), becomes evident in the relationship between constructs of UTAUT3 and behavioral intention. This outcome suggests that Generation Z had more effect on adoption behavior, 1.43 times stronger than Generation Y. Consequently, the H24 hypothesis is supported. The research findings indicate that the characteristics, preferences, and behaviors of Generation Z have a more significant impact on how trading apps are adopted and used. This could be attributed to Generation Z's familiarity with technology, their comfort with digital platforms, and their propensity to embrace new technological trends. As a result, businesses and app developers targeting the trading app market should pay special attention to Generation Z's preferences and tailor their strategies to effectively engage this generation. Additionally, it highlights the need to consider generational differences when designing marketing campaigns, user interfaces, and features for trading apps to ensure optimal user experience and adoption rates among both Generation Z and Generation Y users.

DISCUSSION

This research utilized an adapted and extended version of the UTAUT3 framework to investigate the factors that influence financial traders' inclination towards and utilization of trading app platforms for their trading activities. This analysis holds significant importance as the acceptance of such platforms could enhance finiancial trading participation in the digital environment. Particularly in online trading scenarios, investors' experience plays a pivotal role as it has the potential to enhance the overall behaviour,and usage of trading apps (Bond, 2020). This study contributes to the existing empirical knowledge by applying the UTAUT model in a distinct setting of India, and within the context of trading app platforms. Additionally, the study introduces two new factors related to investment, namely information richness and privacy concerns. The insights gained from this study promotes valuable implications for the enhancement of online investing and financial literacy, especially in the context of a post-pandemic scenario. Considering that online investing adoption, in the form of trading apps, is likely to persist even after the pandemic subsides. The findings provide insights that can contribute to the improvement of these modes of investing. The study's proposed model indicates that factors such as Utilitarian value, Social Influence, Hedonic Motivation, Facilitating Condition, Personal innovativeness, Privacy Concerns, Trust and Information Richness significantly influence investors' intention to engage with trading apps. Furthermore, both Facilitating Conditions (FC) and Learning Value (LV) have a direct impact on the actual usage of these platforms by students.

To be more specific, utilitarian value (UV) has a significant impact on investors' Behavioral Intention (BI) to utilize trading app platforms, suggesting that the use of these platforms is linked to improved usage of investments. This finding aligns with numerous global studies (Dajani & Abu Hegleh 2019; Raza *et al*., 2021; Hassan, 2021). These collective findings consolidate the notion that the utilitarian benefits derived from these platforms have a consistent and positive association with investors' intentions to utilize them for optimizing their investment practices.

Utilitarian value (UV) has a significant impact on investors' propensity to use trading app platforms, demonstrating a link to increased investment utilisation. Research highlights UV's positive impact on investor experience as well as its important mediating function between UV and behavioural intention (BI), aligning with many global studies (Dajani & Abu Hegleh 2019; Raza *et al*., 2021; Hassan, 2021). These collective findings consolidate the notion that the utilitarian benefits derived from these platforms have a consistent and positive association with investors' intentions to utilize them for optimizing their investment practices.

Effort expectancy (EE) has a significant impact on investors' propensity to use trading app platforms, demonstrating a link to increased investment utilisation. Research highlights EE's positive impact on investor experience as well as its important mediating function between EE and behavioural intention (BI). This finding aligns with numerous global studies (Dajani & Abu Hegleh 2019; Raza *et al*., 2021; Hassan, 2021). These collective findings consolidate the notion that the perceived ease and simplicity of using these platforms have a consistent and positive association with investors' intentions to utilize them for optimizing their investment practices.

Social Influence (SI) has a significant impact on investors' propensity to use trading app platforms, demonstrating a link to increased investment utilization. Aligning with numerous global studies (Dajani & Abu Hegleh 2019; Raza *et al.,* 2021; Hassan, 2021), research highlights SI's positive impact on investor experience as well as its important mediating function between SI and behavioural intention (BI). The findings reveal the perceived ease and simplicity of using these platforms have a consistent and positive association with investors' intentions to utilize them for optimizing their investment practices.

Hedonic motivation (HM) has a significant impact on investors' propensity to use trading app platforms, demonstrating a link to increased investment utilization. Research highlights HM's positive impact on investor experience as well as its important mediating function between HM and behavioural intention (BI). This finding aligns with many global studies such as Dajani & Abu Hegleh (2019), Raza *et al*. (2021) and Hassan (2021). The findings reveal that the pursuit of pleasure in using these platforms has a consistent and positive association with investors' intentions to utilize them for optimizing their investment practices.

Trust has a significant impact on investors' propensity to use trading app platforms, demonstrating a link to increased investment utilization. Research highlights Trust's positive impact on investor experience as well as its important mediating function between Trust and behavioral intention (BI). This finding aligns with numerous global studies (Dajani & Abu Hegleh 2019; Raza *et al.,* 2021; Hassan, 2021). The findings reveal that the basis of interactions in using these platforms has a consistent and positive association with investors' intentions to utilize them for optimizing their investment practices.

Information richness (IR) has a significant impact on investors' propensity to use trading app platforms, demonstrating a link to increased investment utilization. Research highlights IR's positive impact on investor experience as well as its important mediating function between IR and behavioral intention (BI), aligning with many global studies (Dajani & Abu Hegleh 2019; Raza *et al*., 2021; Hassan, 2021). The findings reveal that the depth and complexity of communication and messages in conveying information using these platforms have a consistent and positive association with investors' intentions to utilize them for optimizing their investment practices.

Privacy concern (PC) has a significant impact on investors' propensity to use trading app platforms, demonstrating a link to increased investment utilization. Research highlights PC's positive impact on investor experience as well as its important mediating function between PC and behavioral intention (BI). This finding aligns with numerous global studies (Dajani & Abu Hegleh 2019; Raza *et al.,* 2021; Hassan, 2021). The findings reveal that the worries and apprehensions individuals have about the protection and control of their personal information in various contexts using these platforms have a consistent and positive association with investors' intentions to utilize them for optimizing their investment practices.

Facilitating conditions (FC) has a significant impact on investors' propensity to use trading app platforms, demonstrating a link to increased investment utilization. Research highlights FC's positive impact on investor experience as well as its important mediating function between FC and behavioral intention (BI). This finding aligns with numerous global studies (Dajani &Abu Hegleh 2019; Raza *et al.,* 2021; Hassan 2021). The findings reveal that the factors and circumstances faced while using these platforms have a consistent and positive association with investors' intentions to utilize them for optimizing their investment practices.

Personal innovativeness in IT (PI) has a significant impact on investors' propensity to use trading app platforms, demonstrating a link to increased investment utilization. Research highlights PI's positive impact on investor experience as well as its important mediating function between PI and behavioral intention (BI). This finding aligns with numerous global studies (Dajani & Abu Hegleh 2019; Raza *et al*., 2021; Hassan, 2021). The findings reveal that the propensity to adopt and embrace mobile trading apps has a consistent and positive association with investors' intentions to utilize them for optimizing their investment practices.

THEORETICAL IMPLICATIONS

Investors' intentions to utilize trading apps were significantly positively affected by utilitarian value (UV), which points to the usefulness of these applications. Enhancing practical features should be a developer's priority if they want to attract and keep users. The relationship between UV and BI is mediated by utilitarian value, underscoring the importance of this concept in influencing investor views and choices. Promoting the trading apps' practical advantages can have an indirect impact on investors' motivations. EE plays a significant role in influencing investor behavior. This emphasizes how critical it is to develop trading software systems that require the least amount of work from investors. User experience and usability should be prioritized during app development. The effect of SI on investor intentions demonstrates how social networks and peer recommendations influence investment decisions. User engagement can be increased via social elements in trading apps, such as discussion forums or sharing options. The relevance of HM suggests that investor intentions can be influenced by how much fun trading apps provide. To draw and keep consumers, developers should give top priority to creating interesting and pleasurable user experiences. For investor behavior to be successful, trust is essential. To establish and uphold trust, trading app developers should put security first. This will guarantee

user confidence and continuing usage. The need for clear and complete communication on trading apps is highlighted by information richness (IR). Platforms should provide complex information in a user-friendly way to promote usage. Investor sensitivity to personal data protection is highlighted by privacy concern (PC). To address these problems, comprehensive data security procedures are required. Behavioral intention is substantially impacted by facilitating conditions (FC). To improve the user experience, platform providers should set up enabling factors like helpful customer service and readily available resources. Investor intentions are influenced by individual IT innovation (PI). With specialized features and experiences, developers may draw in tech-savvy people to trading apps.

PRACTICAL IMPLICATIONS

Motivating investors with a practical mindset, developers should enhance their data analysis, investment advice, and trade execution tools. User-friendliness should be first put to save time and promote platform adoption. There should be encouragement on social interaction through forums and sharing tools to increase platform usage through peer pressure. Fun elements, such as leaderboards and virtual portfolios, should be included in your design. Security, privacy, open communication and clear financial data should be prioritised at the top of the list to foster confidence and allay privacy worries. Cutting-edge analytics should be used to deliver thorough and clear financial data. Stern privacy safeguards and transparent data policies should be put in place. For a flawless user experience, the platform conditions should be continually improved. To draw in tech-savvy investors, platform innovation and provide instructional tools should be promoted. To assist users in maximizing platform advantages, clear user manuals and educational materials should be offered.

LIMITATIONS AND FUTURE STUDIES

Convenience sampling might generate bias in the selection process, which would restrict generalizability to all FinTech users. Causal inferences and tracking changes over time are hampered by a single point of data collection. Using only self-reported data could result in response bias and reduce the validity of the results. The generalizability of results may be impacted by the sample's unequal distribution of gender and age. Findings, concentrating particularly on mobile trading apps, may not apply to all FinTech services. Despite pilot testing attempts, self-developed notions like privacy concerns and information richness may have validity problems.

Future studies should take a longitudinal stance to monitor changes in behavioral intentions about the use of mobile trading apps over time, providing a more thorough knowledge of the adoption process. Through the reduction of selection bias and improvement of the external validity of results, the use of random sampling techniques can increase sample representativeness. A complete picture of the elements influencing behavioral intentions can be obtained by fusing quantitative data with qualitative insights, bridging the gap between "what" and "why." Investigating how distinct FinTech services are adopted and contrasting factors affecting adoption between services might yield insightful results.

REFERENCES

Acheampong, P., Zhiwen, L., Antwi, H. A., Otoo, A. A. A., Mensah, W. G., & Sarpong, P. B. (2017) Hybridizing an extended technology readiness index with technology acceptance model (TAM) to predict e-payment adoption in Ghana, American Journal of Multidisciplinary Research, 5(2), pp: 172-184.

Al-Natour, S., Cavusoglu, H., Benbasat, I., & Aleem, U. (2020) An empirical investigation of the antecedents and consequences of privacy uncertainty in the context of mobile apps, *Information Systems Research*, *31*(4), pp: 1037-1063.

Alalwan, A. A., Dwivedi, Y. K., Rana, N. P., & Algharabat, R. (2018) Examining factors influencing Jordanian customers' intentions and adoption of internet banking: Extending UTAUT2 with risk, *Journal of Retailing and Consumer Services*, *40*, pp: 125-138.

Aldridge, I., & Krawciw, S. (2017) *Real-time risk: What investors should know about FinTech, high-frequency trading, and flash crashes*, John Wiley & Sons.

Almaiah, M. A., Alamri, M. M., & Al-Rahmi, W. (2019) Applying the UTAUT model to explain the students' acceptance of mobile learning system in higher education. *Ieee Access*, *7*, pp:174673-174686.

Ashtiani, M. N., & Raahmei, B. (2023) News-based intelligent prediction of financial markets using text mining and machine learning: A systematic literature review. *Expert Systems with Applications*, 217, p.119509.

Baba, M. A., Haq, Z. U., Dawood, M., & Aashish, K. (2023) FinTech adoption of financial services industry: exploring the impact of creative and innovative leadership, Journal of Risk and Financial Management, 16(10), p.453.

Bajunaied, K., Hussin, N., & Kamarudin, S. (2023) Behavioral intention to adopt FinTech services: An extension of unified theory of acceptance and use of technology, *Journal of Open Innovation: Technology, Market, and Complexity*, *9*(1), p.100010.

Bakri, A. A., Hasanah, N., & Lasmiatun, K. M. T. (2024) Financial technology innovation and banking industry

transformation: a literature study on financial markets, *Multifinance*, *1*(3 Maret), pp: 230-238.

Balapour, A., Nikkhah, H. R., & Sabherwal, R. (2020) Mobile application security: Role of perceived privacy as the predictor of security perceptions. *International Journal of Information Management*, *52*, p.102063.

Ballard, B. (2007) *Designing the mobile user experience*, John Wiley & Sons.

Baptista, G., & Oliveira, T. (2015) Understanding mobile banking: The unified theory of acceptance and use of technology combined with cultural moderators. Elsevier BV, 50, pp: 418-430.

DOI:https://doi.org/10.1016/j.chb.2015.04.024

Bi, J. (2022) Stock Market Prediction Based on Financial News Text Mining and Investor Sentiment Recognition, Mathematical Problems in Engineering, 2022(1), p.2427389.

DOI: https://doi.org/10.1155/2022/2427389

Boh, W. F., Huang, C. J., & Wu, A. (2020) Investor experience and innovation performance: The mediating role of external cooperation. *Strategic Management Journal*, *41*(1), pp:124-151.

Breitinger, F., Tully-Doyle, R., & Hassenfeldt, C. (2020) A survey on smartphone user's security choices, awareness and education, *Computers & Security*, *88*, p. 101647.

Bulim, J., Maddox, J., North, M.M., Garofalo, D., North, S.M., Watson, C., Gonzalez, G.,

Brown, B., Patel, N., Alli, E. & Hammer, M. (2023) Stock Investment Industry Augmented by Mobile Technology, *International Management Review*, *19*(1), pp.53-115.

Catherine, N., Geofrey, K. M., Moya, M. B., & Aballo, G. (2017) Effort expectancy, performance expectancy, social influence and facilitating conditions as predictors of behavioural intentions to use ATMs with fingerprint authentication in Ugandan banks, *Global Journal of Computer Science and Technology*, *17*(5), pp: 5-23.

Chen, C. C., & Tsai, J. L. (2019) Determinants of behavioral intention to use the Personalized Location-based Mobile Tourism Application: An empirical study by integrating TAM with ISSM. *Future Generation Computer Systems*, *96*, pp: 628-638.

Chong, L. L., Ong, H. B., & Tan, S. H. (2021) Acceptability of mobile stock trading application: A study of young investors in Malaysia, *Technology in Society*, *64*, p.101497.

Chopdar, P. K., Korfiatis, N., Sivakumar, V. J., & Lytras, M. D. (2018) Mobile shopping apps adoption and perceived risks: A cross-country perspective utilizing the Unified Theory of Acceptance and Use of Technology, *Computers in Human Behavior*, *86*, pp:109-128.

Contractor, N. S., & DeChurch, L. A. (2014). Integrating social networks and human social motives to achieve social influence at scale, *Proceedings of the National Academy of Sciences*, *111*(supplement_4), pp:13650-13657.

Corr, P. J., & Krupić, D. (2017) Motivating personality: Approach, avoidance, and their conflict. In *Advances in motivation science*, 4, pp. 39-90

Dam, L., Roy, D., Atkin, D. J., & Rogers, D. (2018) Applying an integrative technology adoption paradigm to health app adoption and use, *Journal of Broadcasting & Electronic Media*, *62*(4), pp: 654-672.

De Canio, F., Fuentes-Blasco, M., & Martinelli, E. (2021) Engaging shoppers through mobile apps: the role of gamification, *International Journal of Retail & Distribution Management*, *49*(7), pp: 919-940.

Diaz, A. C., Sasaki, N., Tsusaka, T. W., & Szabo, S. (2021) Factors affecting farmers' willingness to adopt a mobile app in the marketing of bamboo products, *Resources, Conservation & Recycling Advances*, *11*, p. 200056.

Dirin, A., Nieminen, M., & Laine, T. H. (2022) Feelings of being for mobile user experience design, *International Journal of Human–Computer Interaction*, *39*(20), pp.4059-4079.

Dwivedi, Y K., Rana, N P., Tamilmani, K., & Raman, R. (2020) A meta-analysis based modified unified theory of acceptance and use of technology (meta-UTAUT): a review of emerging literature, Elsevier BV, 36, pp: 13-18.

DOI:https://doi.org/10.1016/j.copsyc.2020.03.008

Fagbemi, F., & Bello, K M. (2019) Foreign Direct Investment - Growth Linkage in Sub-Saharan Africa: Is Governance a Mediating Factor?, *International Journal of Business*, *6*(2), pp.111-129.

DOI:https://scite.ai/reports/10.18488/journal.62.2019.62.111.129

Fan, L. (2022) Mobile investment technology adoption among investors. *International Journal of Bank Marketing*, *40*(1), PP:50-67.

Folwarski, M. (2021) The FinTech Sector and Aspects on the Financial Inclusion of the Society in EU Countries. [Online] Available from:https://scite.ai/reports/10.35808/ersj/2055

Fu, X. M. (2020). Does heavy ICT usage contribute to the adoption of ride-hailing app?, *Travel Behaviour and Society*, *21*, pp:101-108.

Gómez-Rico, M., Santos-Vijande, M. L., Molina-Collado, A., & Bilgihan, A. (2023) Unlocking the flow experience in apps: Fostering long-term adoption for sustainable healthcare systems, *Psychology & Marketing*, *40*(8), pp:1556-1578.

Gopi, M., & Ramayah, T. (2007) Applicability of theory of planned behavior in predicting intention to trade online: Some evidence from a developing country, *International Journal of Emerging Markets*, *2*(4), pp:348-360.

Gu, Z., Bapna, R., Chan, J., & Gupta, A. (2022) Measuring the impact of crowdsourcing features on mobile app user engagement and retention: A randomized field experiment, *Management Science*, *68*(2), pp:1297-1329.

Hadi, M.A., Al-Baltah, I.A. and Zahary, A.T. (2022) A survey on mobile payment applications and adopted theoretical models, *Sustainable Engineering and Innovation*, *4*(2), pp.112-126.

Hanif, M. S., Wang, M., Mumtaz, M. U., Ahmed, Z., & Zaki, W. (2022) What attracts me or prevents me from mobile shopping? An adapted UTAUT2 model empirical research on behavioral intentions of aspirant young consumers in Pakistan, *Asia Pacific Journal of Marketing and Logistics*, *34*(5), pp:1031-1059.

Harsono, I., & Suprapti, I. A. P. (2024) The role of fintech in transforming traditional financial services, *Accounting Studies and Tax Journal (COUNT)*, *1*(1), pp:81-91.

Hassan, M. S., Islam, M. A., Abdullah, A. B. M., & Nasir, H. (2024) End-user perspectives on fintech services adoption in the Bangladesh insurance industry: The moderating role of trust, Journal of Financial Services Marketing, pp:1-19.

Hradecky, D., Kennell, J., Cai, W., & Davidson, R. (2022) Organizational readiness to adopt artificial intelligence in the exhibition sector in Western Europe, *International journal of information management*, *65*, p.102497.

Hsu, C. L., & Lin, J. C. C. (2008) Acceptance of blog usage: The roles of technology acceptance, social influence and knowledge sharing motivation, *Information & management*, *45*(1), pp:65-74.

Kafi, M. A., & Adnan, T. (2022) Empowering Organizations through IT and IoT in the Pursuit of Business Process Reengineering: The Scenario from the USA and Bangladesh, *Asian Business Review*, *12*(3), pp: 67-80.

Kang, J. W., & Namkung, Y. (2019). The role of personalization on continuance intention in food service mobile apps: A privacy calculus perspective. *International Journal of Contemporary Hospitality Management*, *31*(2), pp:734-752.

Khan, R. U., Salamzadeh, Y., Iqbal, Q., & Yang, S. (2022) The impact of customer relationship management and company reputation on customer loyalty: The mediating role of customer satisfaction, *Journal of Relationship Marketing*, *21*(1), pp:1-26.

Kim, W. C., & Mauborgne, R. (2014) *Blue ocean strategy, expanded edition: How to create uncontested market space and make the competition irrelevant*, Harvard business review Press.

Klimontowicz, M. & Harasim, J. (2019) Mobile Technology as Part of Banks' Business Model. *Acta Universitatis Lodziensis. Folia Oeconomica*, *1*(340), pp.73-90. [online] Available from: https://scite.ai/reports/10.18778/0208-6018.340.05

Koghut, M., & AI-Tabbaa, O. (2021) Exploring consumers' discontinuance intention of remote mobile payments during post-adoption usage: An empirical study. Administrative Sciences, 11(1), p.18.

Kumar, V., Ramachandran, D., & Kumar, B. (2021) Influence of new-age technologies on marketing: A research agenda, *Journal of Business Research*, *125*, pp:864-877.

Le, M T T., Pham, H., Tran, M T N., & Le, T T. (2022) Intention of Personal Information Disclosure in Mobile Payment Apps, *International Journal of E-Services and Mobile Applications (IJESMA)*, *14*(1), pp.1-14. [online] Available from: https://scite.ai/reports/10.4018/ijesma.296581

Li, X., Zhao, X., & Pu, W. (2020) Measuring ease of use of mobile applications in e-commerce retailing from the perspective of consumer online shopping behaviour patterns, *Journal of Retailing and Consumer Services*, *55*, p. 102093.

Lim, S. H., Kim, D. J., Hur, Y., & Park, K. (2019) An empirical study of the impacts of perceived security and knowledge on continuous intention to use mobile fintech payment services. *International Journal of Human–Computer Interaction*, *35*(10), pp:886-898.

Lu, Z., Wu, J., Li, H., & Galloway, B. (2023) Digital finance and stock market participation: The case of internet wealth management products in China. *Economic Systems*, *48*(1), p. 101148.

Lutz, C., Hoffmann, C. P., Bucher, E., & Fieseler, C. (2018) The role of privacy concerns in the sharing economy, *Information, Communication & Society*, *21*(10), pp: 1472-1492.

Lv, D., Yuan, S., Li, M., & Xiang, Y. (2019) An Empirical Study of Machine Learning

Algorithms for Stock Daily Trading Strategy. *Mathematical problems in engineering*, *2019*(1), p.7816154. [online] Available from: https://scite.ai/reports/10.1155/2019/7816154

Madigan, R., Louw, T., Wilbrink, M., Schieben, A., & Merat, N. (2017) What influences the decision to use automated public transport? Using UTAUT to understand public acceptance of automated road transport systems, *Transportation research part F: traffic psychology and behaviour*, *50*, ppp:55-64.

Mahesh, K M., Aithal, P S., & Sharma, K. (2023) Government initiatives and digital Innovation for Atma Nirbhar MSMEs/ SMEs: To Achieve Sustainable and Inclusive Economic Growth. International Journal of Management, Technology, and Social Sciences, pp:68-82.

DOI:https://doi.org/10.47992/ijmts.2581.6012.0256

Martins, C., Oliveira, T., & Popovič, A. (2014) Understanding the Internet banking adoption: A unified theory of acceptance and use of technology and perceived risk application, *International journal of information management*, *34*(1), pp:1-13.

Mbete, G. S., & Tanamal, R. (2020) Effect of easiness, service quality, price, trust of quality of information, and brand image

of consumer purchase decision on shopee online purchase, *Jurnal Informatika Universitas Pamulang*, *5*(2), pp:100-110.

Minami, A. L., Ramos, C., & Bortoluzzo, A. B. (2021) Sharing economy versus collaborative consumption: What drives consumers in the new forms of exchange?, *Journal of Business Research*, *128*, pp:124-137.

Mishra, A., Shukla, A., & Sharma, S. K. (2022) Psychological determinants of users' adoption and word-of-mouth recommendations of smart voice assistants, *International Journal of Information Management*, *67*, p.102413.

MISHRA, L. (2024, July 19). Tax administration must be smoothened for capital markets growth, *The Hindu*. [online] Available from: https://www.thehindu.com/business/budget/tax-administration-must-be-smoothened-for-capital-markets-growth/article68417710.ece

Misra, R., Mahajan, R., & Singh, N. (2022) Analysis of factors affecting intent to use mobile commerce services in India, International Journal of E-Services and Mobile Applications, 14(1), pp:1-21. DOI: https://doi.org/10.4018/ijesma.300268Mithas, S., Tafti, A., & Mitchell, W. (2013) How a firm's competitive environment and digital strategic posture influence digital business strategy. *MIS quarterly*, PP:511-536.

Mlekus, L., Bentler, D., Paruzel, A., Kato-Beiderwieden, A. L., & Maier, G. W. (2020) How to raise technology acceptance: user experience characteristics as technology-inherent determinants, *Gruppe. Interaktion, Organisation, Zeitschrift für Angewandte Organisationspsychologie (GIO)*, *51*(3), pp:273-283.

Nair, P. S., Shiva, A., Yadav, N., & Tandon, P. (2023) Determinants of mobile apps adoption by retail investors for online trading in emerging financial markets. *Benchmarking: An International Journal*, *30*(5), pp:1623-1648.

Natarajan, T., Balasubramanian, S. A., & Kasilingam, D. L. (2018) The moderating role of device type and age of users on the intention to use mobile shopping applications, *Technology in Society*, *53*, pp:79-90.

Ng, M., Coopamootoo, K. P., Toreini, E., Aitken, M., Elliot, K., & van Moorsel, A. (2020) Simulating the effects of social presence on trust, privacy concerns & usage intentions in automated bots for finance, In *2020 IEEE European symposium on security and privacy workshops (EuroS&PW)*, pp: 190-199

Nguyen, T. T., Nguyen, H. T., Mai, H. T. & Tran, T. T. M. (2020) Determinants of Digital Banking Services in Vietnam: Applying UTAUT2 Model, *Asian Economic and Financial Review* , 10(6), pp. 680–697.

DOI: 10.18488/journal.aefr.2020.106.680.697

Niyaz Panakaje, D. & Siddiq, A. (2021) Awareness and Utilization on Cooperative Banking Services and Schemes in Rural Area, *International Journal of Management, Technology, an Social Sciences*. [online] Available from: https://scite.ai/reports/10.47992/ijmts.2581.6012.0157

Oldeweme, A., Märtins, J., Westmattelmann, D., & Schewe, G. (2021) The role of transparency, trust, and social influence on uncertainty reduction in times of pandemics: empirical study on the adoption of COVID-19 tracing apps, *Journal of medical Internet research*, *23*(2), p.e25893.

Penney, E. K., Agyei, J., Boadi, E. K., Abrokwah, E., & Ofori-Boafo, R. (2021) Understanding Factors That Influence Consumer Intention to Use Mobile Money Services: An Application of UTAUT2 With Perceived Risk and Trust, Sage Open, 11(3).

DOI: https://doi.org/10.1177/21582440211023188

Richter, A. (2024) *Financial Literacy, Money Matters Made Simple: A Young Adult's Guide to Financial Success, Learn Easily Stock Market Investing, Day Trading, Dividend, Make Money Online, Passive Income*. Arnold Richter.

Shah, S. (2016). *Win-win Corporations: The Indian Way of Shaping Successful Strategies*. Penguin UK.

Shahzad, K., Zhang, Q., Zafar, A. U., Ashfaq, M., & Rehman, S. U. (2023) The role of blockchain-enabled traceability, task technology fit, and user self-efficacy in mobile food delivery applications. *Journal of Retailing and Consumer Services*, *73*, P.103331.

Sharma, A., Mohan, A., Johri, A., & Asif, M. (2024) Determinants of fintech adoption in agrarian economy: Study of UTAUT extension model in reference to developing economies, *Journal of Open Innovation: Technology, Market, and Complexity*, *10*(2), P.100273.

Shiva, A., Narula, S., & Shahi, S. K. (2020) What drives retail investors¨ investment decisions? Evidence from no mobile phone phobia (Nomophobia) and investor fear of missing out (I-FoMo). *Journal of Content, Community and Communication*, *10*(6), pp.2-20.

Singh, S.S., Singh, S.K., Singh, V. (2021) Paradox of Stock Market Boom amidst Covid-19 Pandemic: An Indian Perspective in Global Context. Academia Letters, Article 2706.

DOI: https://doi.org/10.20935/AL2706

Sumant, C., Bhavsar, V., Sinha, B. K., & Bhatt, V. (2022). Impact of Stock Trading Apps on Indian Millennial Consumer Behavior in the Stock Market, In *2022 International Conference on Decision Aid Sciences and Applications (DASA),* pp. 382-386

Tai, Y. M., & Ku, Y. C. (2013) Will stock investors use mobile stock trading? A benefit-risk assessment based on a modified UTAUT model, *Journal of Electronic Commerce Research*, *14*(1), p.67.

Tam, C., Santos, D., & Oliveira, T. (2020) Exploring the influential factors of continuance intention to use mobile Apps:

Extending the expectation confirmation model, *Information Systems Frontiers*, *22*, pp:243-257.

Tamilmani, K., Rana, N. P., Prakasam, N., & Dwivedi, Y. K. (2019) The battle of Brain vs. Heart: A literature review and meta-analysis of "hedonic motivation" use in UTAUT2, *International Journal of Information Management*, *46*, pp:222-235.

Tang, J., Zhang, B., & Akram, U. (2020) User willingness to purchase applications on mobile intelligent devices: evidence from app store, *Asia Pacific Journal of Marketing and Logistics*, *32*(8), pp:1629-1649.

Tarhini, A., Masa'deh, R. E., Al-Busaidi, K. A., Mohammed, A. B., & Maqableh, M. (2017) Factors influencing students' adoption of e-learning: A structural equation modeling approach, *Journal of International Education in Business*, *10*(2), pp:164-182.

Tay, L., Tai, H., & Gek-Siang, T. (2022). Digital financial inclusion: a gateway to sustainable development. Heliyon, 8(6), e09766. DOI:https://doi.org/10.1016/j.heliyon.2022.e09766

Testa, N., & Tawfik, A. (2017) Mobile, but are we better? Understanding teacher's perception of a mobile technology integration using the Unified Theory of Acceptance and Use of Technology (UTAUT) framework, *Journal of Formative Design in Learning*, *1*, PP:73-83.

The FDI Regime in India - Inward/ Foreign Investment - India - Mondaq. (2020, August 4). [online] Availabe from:https://www.mondaq.com/india/inward-foreign-investment/972652/the-fdi-regime-in-india

Wang, C. & Qi, H. (2021) Influencing factors of acceptance and use behavior of mobile health application users: systematic review. Healthcare, 9(3), p. 357.

DOI: https://doi.org/10.3390/healthcare9030357

Wei, L., Liu, Y., & Cheung, S. C. (2019) Pivot: learning api-device correlations to facilitate android compatibility issue detection, In *2019 IEEE/ACM 41st International Conference on Software Engineering (ICSE)*, PP:878-888.

Wilkins, C. (2024) Fintech and the financial ecosystem: evolution or revolution?, *Methods*.

Zhang, X., & Xu, X. (2020) Continuous use of fitness apps and shaping factors among college students: A mixed-method investigation, *International journal of nursing sciences*, *7*, pp: S80-S87.

Zhao, Y. & Bacao, F. (2021) How does the pandemic facilitate mobile payment? An investigation on users' perspective under the COVID-19 pandemic, *International journal of environmental research and public health*, *18*(3), p.1016.

DOI: https://doi.org/10.3390/ijerph18031016

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RESEARCH ARTICLE

Impact of digital transformation on financial performance of licensed commercial banks in Sri Lanka pre and post COVID-19 pandemic

H. M. D. K. Herath[1] and Muthubandara Gamlath[2*]

[1]*Nipuna Rice Products (Pvt) Ltd, Polonnaruwa, Sri Lanka.*
[2]*Department of Finance and Accountancy, Faculty of Business Studies, University of Vavuniya, Vavuniya, Sri Lanka.*

Abstract: Enhancing the quality of goods and services through innovation and the integration of electronic applications is a fundamental aspect of digital transformation. This topic has increasingly captivated the attention of management and organizational scholars. This focus is especially relevant in improving organizational performance by digitalizing core operations. The global and Sri Lankan economies have faced severe disruptions due to the COVID-19 pandemic, which has compelled commercial banks to adopt innovative digital strategies as a means of mitigating the resultant risks and maintaining stability. This study explores the impact of digital transformation on the financial performance of 10 Licensed Commercial Banks in Sri Lanka, comparing outcomes before and after the pandemic's onset. By employing a robust methodological framework that includes descriptive statistics, correlation analysis, and T-test analysis, the research investigates key variables to discern trends and patterns across different timeframes. The assessment of digital transformation is conducted through a multi-dimensional approach, focusing on metrics such as the volume of digital transactions, income from fees and commissions, and the proliferation of Automated Teller Machines (ATMs) and Cash Deposit Machines (CDMs). Financial performance, on the other hand, is gauged using critical indicators like Return on Assets (ROA) and Return on Equity (ROE). The analysis reveals nuanced insights: while the increase in ATMs and CDMs correlates positively with financial performance, this relationship lacks statistical significance. In contrast, a substantial and positive effect on financial performance is observed from the volume of digital transactions and the income generated from fees and commissions. Significantly, the findings indicate that digital transformation initiatives have enabled commercial banks to not only weather the pandemic but also enhance their financial performance during this period of unprecedented challenge. These results emphasize the imperative for financial institutions to strategically integrate advanced technologies, such as artificial intelligence, into their digital transformation agendas. By doing so, they can secure and potentially elevate financial performance, even amidst unforeseen global crises like a pandemic.

Keywords: COVID-19, digital transformation, financial performance, licensed commercial banks, Sri Lanka.

BACKGROUND OF THE STUDY

Banking firms have been the dominant force in Sri Lanka's financial industry, as it comprises 33 licensed banks in 2013. This includes 12 foreign Licensed Commercial Banks (LCBs) and 21 domestic banks, featuring 9 licensed specialized banks and 12 local LCBs (N&A 2015). Significantly, the banking sector represented nearly two-thirds of the total assets within the financial system. Consequently, the stability of banking institutions wields a substantial influence on the overall strength of Sri Lanka's financial landscape.

Digital transformation, as defined by Kitsios *et al.* (2021), pertains to systems enabling bank customers to access their accounts and obtain information on bank products and services through the bank's website,

* Corresponding author (methikalak@gmail.com; https://orcid.org/0000-0001-6937-4551)

eliminating the need for traditional methods such as letters, faxes, original signatures, and telephone confirmations. This transformation involves integrating digital technology across all aspects of a business, fundamentally altering its operations and value delivery to customers. Online banking services have evolved to encompass a range of transactions, from basic functions like transfers and bill payments to more complex operations such as account openings and credit card applications.

The development of Internet technologies has reshaped the traditional delivery channels of banking services, prompting financial institutions to explore the appeal of these alternative channels for widespread consumer adoption (Mateka *et al*., 2017). As banks globally vie for market share, studies emphasize the pivotal role market share plays in a bank's profitability, growth, and survival (Nazari & Mashali, 2020). This research seeks to compare the impact of digital transformation on the financial performance of commercial banks in Sri Lanka before and after the COVID-19 pandemic. While posing challenges to the banking sector in 2020 the pandemic also accelerated the pace of digital transformation across industries. Financial institutions, in particular, leveraged digital technologies such as robotic process automation (RPA) and artificial intelligence to enhance customer services, ensure compliance, and navigate the evolving landscape.

Digital transformation brings advantages to commercial banks such as increased efficiency and reduced costs, make it a crucial strategy. Past studies have demonstrated the decline in traditional banking transactions, and the efficiency gains realized through technology adoption (Lika *et al.,* 2023; Caliskan & Kirer, 2020). To assess the impact on financial performance, this research focuses on key indicators, including return on assets (ROA) and return on equity (ROE), utilizing data from the period 2017 to 2022. The study examines the number of ATMs/CDMs, digital transaction volumes, and fees and commission income as dependent variables. All data is sourced from the annual reports of specific banks, ensuring a comprehensive analysis. In conclusion, this study aims to shed light on the correlation between digital transformation and the financial performance of commercial banks in Sri Lanka, particularly in the context of the pre-and post-COVID-19 scenarios. The findings are expected to contribute valuable insights into the evolving landscape of banking in the digital age.

The research theme is presented comprehensively, with a background section outlining the research problem, research questions, objectives, and the scope of the study. The literature review covers past research related to the theme, while the methodology section details the research method, design, population, sample, data collection and analysis methods, conceptual framework, hypotheses, and operationalization of variables. The data presentation and analysis section generalizes the findings to align with the objectives, and the conclusion section provides conclusions, implications, and implications for future research based on the findings. The dissertation outline concludes with a comprehensive overview of the research topic.

RESEARCH PROBLEM, QUESTIONS, AND OBJECTIVES

The impact of digital transformation on the financial performance of licensed commercial banks in Sri Lanka is a significant research gap. Existing studies acknowledge the positive influence of digital transformation, but there is a lack of research on how the impact may vary among different sizes. Larger banks may have more resources for implementing digital technologies, leading to different outcomes. The study should investigate resource allocation and implementation challenges, customer segmentation, adaptability and agility, and risk management strategies among different banks. This understanding is crucial for policymakers, regulators, and banking executives to optimize the impact of digital transformation on the financial health of licensed commercial banks in the post-pandemic era. The banking sector is experiencing significant changes due to the rapid expansion of digital transformation. However, there is limited research on the impact of digital transformation on the performance of banks, especially in the Sri Lankan banking industry. This study aims to fill this gap by investigating the effect of digital transformation on performance of selected commercial banks in Sri Lanka before and after the COVID-19 pandemic, thereby extending the existing literature on digital transformation and contemporaneous studies in Sri Lanka. Based on the above research gap that the researcher is exploring to find out the issues to identify the research questions for this study are,

The primary focus of this research is to examine the impact of digital transformation on the financial performance of licensed commercial banks in Sri Lanka, both before and after the onset of the COVID-19 Pandemic. The study aims to delve into the multifaceted aspects of digital transformation and its consequences on the financial metrics of commercial banks, providing insights into the extent and nature of these effects. Additionally, the research endeavors to gauge the depth of digital transformation's impact on the financial performance of commercial banks, exploring the specific dimensions and variables that play a pivotal role in influencing the overall financial health of these

institutions. By addressing these questions, the research seeks to contribute a nuanced understanding of the intricate relationship between digital transformation initiatives and the financial dynamics of licensed commercial banks in the Sri Lankan context. Therefore, the primary objective of this study is to comprehensively evaluate the influence of digital transformation on the financial performance of licensed commercial banks in Sri Lanka, both in the pre- and post-COVID-19 pandemic periods. Specifically, the research aims to investigate the dual facets of this impact: firstly, by scrutinizing the direct effect of digital transformation on the financial performance of licensed commercial banks; and secondly, by assessing how the unique circumstances brought about by the COVID-19 pandemic have influenced the trajectory of digital transformation initiatives within the licensed commercial banking sector. Through a focused analysis of these interrelated dynamics, the study seeks to provide a nuanced understanding of the intricate relationships between digital transformation, financial performance, and the external factors introduced by the pandemic, contributing valuable insights to the evolving landscape of banking in Sri Lanka.

LITERATURE REVIEW

This chapter conducts a comprehensive literature review, offering readers an insight into the theoretical foundation of the research problem while presenting a synthesis of previous studies and an analysis of their relevance to the current issue. The overarching goal is to avoid redundancy with previously covered material. The literature study involved a meticulous examination of prior research activities focused on establishing relationships between digital transformations. Historical reference sources, including magazines, newspapers, journals, and online platforms, were scrutinized to compile relevant data. The review critically evaluates the existing literature while acknowledging any inherent limitations in the research. The prominence of digital transformation in recent scholarly investigations is evident. According to Xie & Wang (2023), the advent of digital technologies, notably big data, artificial intelligence (AI), and the Internet of Things (IoT), has ushered in profound changes across various industries in recent years. Within the financial sector, these digital advancements have given rise to novel financial services, such as digital payments, online big-tech lending, and robo-advisors, compelling banks to enhance competitiveness and customer service through digital transformation. Further, a study by Kalapper & Miller (2021) highlights the impact of the COVID-19 pandemic on the adoption of digital payments, with a surge in new users during the epidemic. Notably, the study examines specific questions regarding how individuals in Argentina and Mexico access government social benefit transfers, receive payments, or settle energy bills, emphasizing the evolving landscape of digital payments. In this context, several studies emphasize the motivations that drive banks towards digital transformation. These motivations include the need to align with clients' lifestyles, provide more cost-effective services, streamline operations by eliminating branches, and achieve cost savings. Romanova & Kudinska (2016) point out that the pandemic accelerated the adoption of digital banking, as people increasingly relied on banks for routine transactions, such as bill payments and purchasing essential goods. The pandemic prompted rapid digital changes, including front-end enhancements, to offer customers a contemporary and trustworthy digital interface. The evolution of Internet banking applications has further facilitated the development of new, efficient payment methods, simplifying transactions for users.

The context of digital transformation

In essence, digitization involves the automation of manual processes by converting analogue information into digital data, and streamlining workflows and operations (Plekhanor *et al.,* 2022). Gartner's Information Technology (IT) Glossary defines digitization as the shift from analog to digital forms. Digitalization, as described by Eidhoff *et al.* (2016), encompasses the use of digital technologies and information to transform business operations, restructuring social and economic life around communication and media infrastructure. The technological, organizational, and environmental (TOE) framework highlights technological, organizational, and environmental factors influencing the digitalization process. Gunawardene's (2017) research study positions digital transformation as a strategic, customer-driven, end-to-end business transformation involving organizational changes at the core level. Scholars view it as an opportunity arising from digitization, impacting organizational patterns, cultural barriers, business models, and legal measures. Digital transformation primarily focuses on altering market-facing elements of an organization, affecting its purpose, boundaries, and activities (Kraus *et al.,* 2022).

Examining separate conceptual constitutions, Kallinikos *et al.* (2013) distinguishes digital transformation from IT-enabled organizational change. IT-enabled organizational change centers on the creation, application, and usage of IT, encompassing hardware and software artifacts grouped into systems for operational effectiveness. In contrast, digital transformation is an ongoing, dynamic process involving continuous adaptations to new technologies and trends. This summary encapsulates scholars' analyses of digital transformation over time, recognizing the evolving nature of this field.

Further concentrating on the theoretical underpinning that the researcher found, the relationship between digital transformation and financial performance can be understood through a theoretical framework. Digital transformation involves the integration of digital technologies into all areas of a business, transforming how it operates and delivers value to customers. Financial performance is measured by metrics such as profitability, return on investment, revenue growth, and cost efficiency. The framework is based on the Dynamic Capabilities Theory, Resource-Based View (RBV), and Contingency Theory. The impact of digital transformation on financial performance can be attributed to operational efficiency, customer experience, innovation, and risk management. The relationship can be influenced by industry type, organizational structure, market conditions, and organizational culture. The hypothesis development suggests that digital transformation positively impacts financial performance through increased operational efficiency, with stronger effects in technology-intensive industries. Organizational flexibility and market conditions also moderate the relationship. A visual model can be created to illustrate these relationships. Therefore, this theoretical framework needs clarity on the existence of such a relationship, while the research mentions a conceptual framework as explained in Figure 1, elaborating on the specific theories or models that support the relationship between digital transformation and financial performance would further strengthen the study scenario.

Why has digital transformation come into the business world?

In a study conducted by Westerman *et al.* (2014), it was observed that companies with a high level of digital maturity consistently outperform their counterparts regarding revenue growth and profitability. Digital transformation emerges as a catalyst for innovation, process optimization, and agility in responding to market changes, thereby contributing to enhanced overall performance. The positive impact of digital transformation on a corporation's performance and competitive advantage is underscored by various research findings. Notably, Ivanov *et al.* (2019) demonstrated that companies embracing digital transformation were better positioned to meet customer expectations, provide personalized experiences, and offer convenient engagement channels, fostering increased customer loyalty and retention. Furthermore, research by Nambisan *et al.* (2019) emphasizes the transformative potential of digital technologies in enabling firms to experiment with new business models, products, and services. This adaptability allows companies to leverage new technologies, swiftly adjust to market dynamics, and stay ahead of competitors. Brynjolfsson & McAfee (2014) highlight the significant productivity boost afforded by digital technologies like automation and data analytics. Digitizing procedures, streamlining supply chains, and automating repetitive tasks contribute to more efficient and cost-effective operations. As underscored by Tripathi's research in 2021, businesses face disruptions in traditional models, necessitating a digital transformation for continued relevance. The imperative for organizations to embrace digital transformation becomes apparent as they navigate changing market landscapes, explore new markets, and proactively adjust to digital technologies to avoid industry disruptions. Collectively, these research insights highlight the critical role of digital transformation in enhancing performance, customer satisfaction, and overall competitiveness in the evolving business landscape.

Impact of digital transformation on commercial Banks

According to Nayanajith *et al.* (2021), the process of transitioning to a digital business context is termed "digitalization." This involves utilizing digital technologies to reshape business models, offering new avenues for revenue and value creation. The banking industry is experiencing significant disruptions due to the development of digital technologies, leading to a paradigm shift in banks. The introduction of novel products and services, evolving business models, rapid technology adoption, and dynamic regulatory changes contribute to this transformative landscape. To effectively mitigate adverse business effects, digitalization necessitates robust change management and value chain analysis. The entire banking value chain is expected to be disrupted by digitalization, impacting infrastructure development, personnel management, and technological advancements. Full-fledged digital banking, customer-centric Omni-channel banking, and payments banking models are gaining prominence, altering business models in response to the adoption of digital services. Information and Communication Technology (ICT) and fintech advancements play a crucial role in facilitating digitalization, utilizing technologies such as cloud computing, mobile applications, blockchain, artificial intelligence, and big data analytics to create agile, customer-centric architectures. Banks must ensure adaptability and optimization of back-office processes to provide an omni-channel customer experience, leveraging robotic process automation for increased precision and efficiency in digital banking services. In parallel, the need for a robust governance and risk management structure has intensified in the context of

comprehensive digitalized banking, requiring competent leaders with cross-functional capabilities. Thanh *et al*. (2023) further emphasizes the increased demand for effective governance and risk management structures in the face of rapid technological evolution. Researchers have identified emerging forms of banking digitalization, underlining the necessity for adaptable leadership in managing these synchronous structures, transcending specific banking functions. This summary captures the multifaceted implications and evolving landscape of digitalization in the banking industry.

Impact of COVID-19 in the banking industry

According to Ferrari (2022), digital transformation is described as a deliberate adjustment of managerial and economic activities, business models, processes, and competencies to harness opportunities presented by digital technologies and their growing economic impact. The COVID-19 pandemic has induced severe instability and volatility in the global financial system, impacting banks and retail institutions. Recognizing the crucial role of banks as primary sources of financing for many businesses, the pandemic has created challenges with businesses unable to make payments due to quarantine measures. Addressing this, the government may need to consider debt moratoriums to ensure liquidity for banks. Consequently, the adverse consequences of the pandemic present opportunities for digital platforms, pushing towards a cashless society as consumers seek contactless payment options. The personal mobile device becomes a central mode of payment, and exploring biometric validation methods for remote operation of machines is suggested. The pandemic acts as a catalyst for advancements in digital technology, fostering social distance measures required to combat the virus. Consumers' adaptation to technological developments is anticipated to redefine how businesses operate, making people more digitally connected. In Sri Lankan context, private commercial banks have prioritized digitalization, emphasizing customer convenience. Initiatives include the launch of mobile virtual wallets, interactive credit card statements, and innovative services like "MySpace," which incorporates ATMs, CRMs, kiosks, and versatile teller services for enhanced customer experience. Therefore, in response to the pandemic, strategies implemented to increase employee engagement include providing necessary tools such as laptops, tablets, and data for remote work, ensuring security is maintained. The bank invests in employee education on business intelligence tools and customer analytics, contributing to digital collaboration platforms for enhanced communication between clients and staff. Overall, the research highlights the transformative impact of the pandemic on banking operations and the accelerated adoption of digital technologies to meet evolving demands.

Strategies for digital transformation

According to the Dumind *et al.* (2020) research paper, local banks have strategically advanced their digital initiatives for the coming years, aligning with new technologies and trends. The bank's digital strategy is built on four pillars: digital channels, digital payments, digital operations, and digital services, leading to the introduction of numerous products and services. In the short term, the bank prioritizes addressing cash withdrawal requests through mobile ATMs from the call center, especially in areas under curfew. Information is actively disseminated via the internet, utilizing pop-ups to display banking hours and promotions. The bank offers online chats to assist customers with Coronavirus relief measure queries and has introduced platforms for opening accounts and credit cards online. Website video chat and live chatbots, available in three languages across all social media platforms, enhance customer interactions. Phase II introduces new features for ATMs, including credit card payments, virtual wallet payments, balance inquiries, third-party fund transfers, and service registrations. The Virtual Wallet consolidates various digital banking features, making it more user-friendly. Cheque deposit machines will be available at 15 new locations, and customers can utilize M teller for cash withdrawals and Virtual Wallet for CEFT payments. Mega Pay's Pay-and-Go machines, integrated with Lanka QR and Just Pay, allow customers to top up mobile phones and pay bills at 25 locations. Looking ahead, the future of banking technology is shaped by consumers, particularly Generation Z, who view technology as a life-enhancing tool. The use of Application Programming Interface (API) technology is highlighted, allowing banks to share proprietary data securely with authorized parties. The adoption of APIs is a trend among fintech, inspiring competition among banks to develop their APIs. Furthermore, advancements in blockchain and artificial intelligence are expected to significantly impact banking, with 48% of banking executives anticipating these technologies' dominance by 2020. As a response to the global spread of COVID-19, digital communication and social media platforms have seen a surge in usage. Banks are leveraging these platforms to increase brand awareness and engage with the audience. Digital activities, such as those launched by Sri Lankan banks on Facebook, have witnessed a substantial increase in reach, interactions, and video views. The paper emphasizes the pivotal role of digital communication in the new norm, where people increasingly rely on social

media for communication. Under the Matt *et al.* (2021) research, the bank's efforts to enhance brand awareness include digital activities that have garnered significant attention on social media platforms. The adoption of Temenos' T24 core banking system integrates a Customer Relationship Management (CRM) system, an advanced online banking system, and a mobile app developed in tandem with the core system. The core banking system is set to integrate with a new Anti-Money Laundering (AML) system in 2021, focusing on customer-centric offerings and personalization. Finally, the local bank actively embraces digital innovations, continually enhancing its digital banking services while prioritizing customer convenience. The strategy revolves around simplicity, ease of use, and prioritizing the customer experience, aligning with both domestic and international banking trends. The commitment to personalization and customer-centric services remains integral to the bank's digital strategies, reflecting its dedication to being at the forefront of digital advancements in the banking sector.

Financial performance in commercial banks

Financial performance serves as a critical metric for evaluating how effectively a company utilizes its resources, implements its business model, and generates revenue. The CAMEL framework, encompassing Capital Adequacy, Asset Quality, Management, Earnings, and Liquidity, is widely used to assess various facets of a firm's financial health. In the context of the banking sector, market risk sensitivity has been added as a crucial component. In 2020, Sri Lankan banks demonstrated a net interest income of Rs. 427.4 billion, resulting in a profit after tax of Rs. 190 billion. However, when compared to developed countries, these banks exhibit a lower profit percentage related to E-banking, with studies indicating a lack of motivation among Sri Lankan individuals to use E-banking facilities. In this context, the studies, such as those by Kariyawasam & Jayasiri (2016); Premarathne & Gunatilake (2016), reveal that there is no significant relationship between the implementation cost of E-banking facilities and financial performance. Momo *et al.* (2022) utilize Return on Assets (ROA) as a key indicator of financial performance, considering profit before taxes to eliminate tax effects. Positive macroeconomic environments in Sri Lanka have been linked to higher profitability in the banking sector (Andrew, 2014), and bank-specific characteristics and favorable economic policies are found to enhance banking industry performance (Suganya & Kengatharn, 2018). Recommendations for banks include focusing on increasing their equity-to-total-asset ratio and prioritizing credit risk management. Further, examining the Bangladeshi banking sector, studies reveal that bank loans intensity, credit risk, and cost have positive impacts on performance, while bank size exhibits a negative impact on return on average equity (ROAE). Corporate governance mechanisms also play a vital role in bank performance, with total assets, total deposits, and loans influencing profitability indicators in Nepalese finance companies. Recognizing the need for a competitive edge in the banking sector, banks are advised to develop innovative programs to maintain superior customer service levels while ensuring profitability, as suggested by guidelines from the Central Bank of Kenya (2010).

In the wake of an extensive empirical review, this study delves into the relatively unexplored realm of the impact of digital transformation on the financial performance of commercial banks in Sri Lanka, both before and after the tumultuous period marked by the COVID-19 pandemic. The empirical foundation of this research addresses a significant gap in the existing literature, particularly within the context of Sri Lanka. Recognizing the scarcity of studies empirically investigating the specific dynamics of digital transformation and its correlation with financial performance in Sri Lankan commercial banks, the researchers embark on an endeavor to contribute meaningfully to this emerging field of knowledge. This study aims to bridge the gap in the contemporary literature, offering valuable insights into the repercussions of digital transformation on financial performance within the banking sector. Focused on selected licensed commercial banks in Sri Lanka, this research strives to provide a nuanced understanding of the implications and outcomes of digital transformation, thereby enriching the understanding of this critical intersection between technology and finance in the Sri Lankan context.

Fulfillment of theoretical and empirical gap in study

The relationship between digital transformation and financial performance is gaining interest in both academic and practical domains. However, several theoretical and empirical gaps need to be addressed. Theoretical gaps include the lack of comprehensive frameworks that integrate multiple theories, overlooking of contextual factors, and the focus on immediate effects. Empirical gaps include inconsistent measurement of digital transformation, the struggle to establish clear causal relationships, and the lack of cross-industry comparisons. Theoretical models should consider dynamic and evolving nature of digital transformation, examining how sustained investments contribute to long-term financial stability and growth. Empirical research should employ more rigorous methodologies, such as longitudinal studies, experiments, or advanced econometric techniques, to isolate the causal effects of digital transformation on financial performance. Cross-industry comparisons are needed to identify industry-specific drivers and barriers to

successful digital transformation. Finally, the researchers view that the necessity of having conducted this research by exploring how digital transformation influences various financial metrics, potentially revealing trade-offs or complementarities between different outcomes that show the cruciality of advancing our understanding of the relationship between digital transformation and financial performance.

RESEARCH METHODOLOGY

Research Methodology is a procedure that describes how research is being conducted. This chapter describes the researcher's methodology. It involves equipment and methods for performing specific studies or obtaining specific results. You can understand the sample and population as well as the conceptual framework that explains the relationships between independent and dependent variables by mentioning this chapter before and after the COVID-19 period. The researcher discusses the guidelines for research design, conceptual framework, sample selection, data collecting, and data analysis in this chapter. This mostly concentrated on the major changes in regression findings before the pandemic period compared to after the COVID-19 period. The research design employed for this study is descriptive, aiming to provide a comprehensive understanding of the Impact of Digital Transformation on the Financial Performance of Licensed Commercial Banks in Sri Lanka before and after the COVID-19 Pandemic. The primary focus of the study is to investigate the relationship between digital transformation and the financial performance of selected commercial banks in Sri Lanka. The researchers conducted an examination to determine the existence and nature of this link, with a specific emphasis on understanding the financial impact of digital transformation on quoted commercial banking firms in the Colombo Stock Exchange (CSE) from 2017 to 2022. The study utilized secondary data, sourced from the balance sheets and profit and loss accounts of the selected commercial banks. Panel data, encompassing both cross-sectional and time series data, was employed to conduct a thorough analysis over multiple periods. The target population for this study comprised 10 licensed commercial banks listed on the CSE, and the evaluation spanned a five-year period. "The justification on this stream can be approached this specific way of concentration as follows; "The study focuses on Licensed Commercial Banks in Sri Lanka, a highly regulated industry with limited firms. The chosen sample size includes the most influential banks, ensuring a comprehensive view of the impact of digital transformation on financial performance. The study covers major market players and a wide range of digital transformation strategies, allowing for a detailed analysis of the relationship between digital initiatives and financial performance. The depth of analysis is achieved through in-depth analysis and detailed data collection. The sample size is practical due to resource constraints and accessibility. The methodological rigor of the study is maintained through power analysis, ensuring consistency with previous research. The findings from these 10 banks can be generalized to other banks within similar economies or sectors, providing valuable insights for policymakers and industry stakeholders. Thus, selecting a small sample size is justified as necessary and sufficient for achieving the study's objectives."

This research spans two distinct periods, encompassing a time frame of six years from 2017 to 2022. Specifically, to delineate the impact before and after the Covid-19 pandemic, the study focuses on a pre-pandemic duration of three years (2017 to 2019) and a post-pandemic span of three years (2020 to 2022). To facilitate the analysis, the researchers employed various statistical techniques, including graphical representation, descriptive statistics, correlation analysis, and T-test methods. The findings of the study, derived from these analytical tools, revealed a negative and significant association between capital structure and financial performance. This suggests that an increase in digital transformation correlates with robust financial performance, potentially attributed to agency conflicts that drive firms to optimize their financial performance by being highly consistent. The conceptual framework of the study elucidates the relationships between digital transformation and the financial performance of licensed commercial banks. It outlines the latent variables, their operationalization, and the hypothetical relationships derived from empirical findings. This framework serves as a guide for understanding the intricate dynamics at play in the realm of digital transformation and financial performance within the context of licensed commercial banks in Sri Lanka.

Conceptual framework

The conceptual framework is a graphic that illustrates the relationship between predictor variables and dependent variables (Dumind *et al*., 2020). Based on the in-depth literature review with its underpinnings (Nayanajith *et al.*, 2021), Figure 1 shows the conceptual relationship between digital transformation of licensed commercial banks (independent variable) and financial performance (dependent variable). The dependent variable was the financial performance of licensed commercial banks in Sri Lanka as measured by the return on asset ratio and return on equity ratio. However, the independent variable is the number of digital transactions, including the number of ATMs/CDMs, fees and commission income.

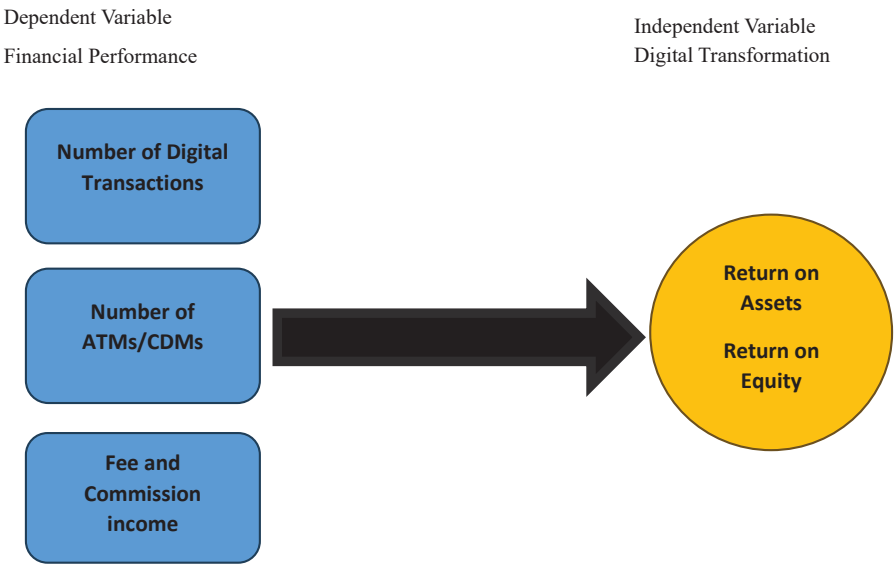

Figure 1: Conceptual framework developed by researchers (2024)

In this conceptual framework, denominations of proxies of independent variable (digital transformation) and measures of outcome variable (dependent variable Financial Performance) are follows;

• Number of Digital transactions

[Digital transformations are automated transaction take place between people and organizations without use of paper. Those are internet banking, mobile banking, banking card and cloud computing.]

• Number of ATMs /CDMs

[An automated teller machine (ATM) is a customized computer that enables you to carry out banking operations without having to speak with a bank staff. CDM, or cash deposit machine, serves the opposite purpose of an ATM or automated teller machine by accepting deposits against a customer's bank account rather than dispensing cash from the same account.]

• Fee and Commission income

[Fees and commission are one revenue stream for banks. These can include account fees, transactional costs (including those associated with ATM withdrawals), penalty fees, and exchange rate fees. The majority of fees incomes from digital banking services.]

• Financial performance

Return on Assets = [Net Profit Before Tax / Total Assets] -
Return on Equity = [Net Income / Shareholders' Equity]

Hypotheses development

Building upon the relationships elucidated in the aforementioned conceptual framework, which accentuates the empirical underpinnings of this study, the subsequent hypotheses have been formulated to extrapolate the findings and achieve the objectives of this research. The primary hypotheses, along with their specific counterparts, are outlined below.

Hypothesis (H): There is an impact of digital transformation on the financial performance of licensed commercial banks of Sri Lanka before and after the COVID-19 pandemic situation.

Hypothesis (H_{a1}): There is an impact of the number of digital transactions on the Return on Asset (ROA) of the licensed commercial banks of Sri Lanka before the COVID-19 pandemic.

Hypothesis (H_{b1}): There is an impact of the number of ATMs /CDMs on the Return on Assets (ROA) of licensed commercial banks of Sri Lanka before the COVID-19 pandemic.

Hypothesis (H_{c1}): There is an impact of fees and commission income on the Return on Asset (ROA) of licensed commercial banks of Sri Lanka before the COVID-19 pandemic situation.

Hypothesis (H_{d1}): There is an impact of number of digital transactions on the Return on Equity

(ROE) of the licensed commercial banks of Sri Lanka before the COVID-19 pandemic.

Hypothesis (H_{e1}): There is an impact of the number of ATMs/CDMs on the Return on Equity (ROE) of licensed commercial banks of Sri Lanka before the COVID-19 pandemic.

Hypothesis (H_{f1}): There is an impact of fees & commission income on the Return on Equity (ROE) of licensed commercial banks of Sri Lanka before the COVID-19 pandemic situation.

Hypothesis (H_{a2}): There is an impact of number of digital transactions on the Return on Asset (ROA) of the licensed commercial banks of Sri Lanka after the COVID-19 pandemic.

Hypothesis (H_{b2}): There is an impact of number of ATMs /CDMs on the Return on Assets (ROA) of licensed commercial banks of Sri Lanka after the COVID-19 pandemic.

Hypothesis (H_{c2}): There is an impact of fees & commission income on Return on Asset (ROA) of licensed commercial banks of Sri Lanka after the COVID-19 pandemic situation.

Hypothesis (H_{d2}): There is an impact of number of digital transactions on the Return on Equity (ROE) of the licensed commercial banks of Sri Lanka after the COVID-19 pandemic.

Hypothesis (H_{e2}): There is an impact of number of ATMs/CDMs on the Return on Equity (ROE) of licensed commercial banks of Sri Lanka after the COVID-19 pandemic.

Hypothesis (H_{f2}): There is an impact of fees and commission income on Return on Equity (ROE) of licensed commercial banks of Sri Lanka after the COVID-19 pandemic situation.

DATA ANALYSIS AND FINDINGS

This section comprises the process of data collection and presentation, data analysis, and the derivation of outcomes. It aims to address the research question by interpreting the results obtained. The primary objective is to investigate the impact of digital transformation on the financial performance of licensed commercial banks in Sri Lanka, considering the period spanning from 2017 to 2022, with a specific focus on the influence of the COVID-19 pandemic. The data were meticulously analyzed and presented using tables, graphs, and figures. The analytical tools employed for this study included using SPSS software to derive meaningful insights from the collected data.

Graphical analysis

The graphical representation for each variable is shown in the following with their data presentations that the researcher computed based on the data collected from the audited annual financial statements of the selected licensed commercial banks. Figure 2 illustrates the dynamics of digital transactions both pre- and post the COVID-19.

In the COVID-19 period, shedding light on the substantial impact of high digital transaction volumes on the financial performance of commercial banks. The graphical representation and accompanying table distinctly portray the average digital transaction changing every year. Notably, the digital transactions for the years 2017 and 2018 exhibit a similar trajectory, whereas in 2019, there is a marked increase compared to the preceding years. Before the COVID-19 era, spanning from 2017 to 2019, digital transactions consistently grew each year. However, the scenario underwent a shift in 2020, during the initial wave of the pandemic, witnessing a decline. Yet, in 2021, digital transactions rebounded, reaching 147.618 million (Mn), surpassing the volumes of previous years. This trend continued into 2022, registering the highest figure of this period at 154.698 million (Mn). Noteworthy is the discernible alteration in digital transaction behavior post-COVID-19 outbreak in 2020–2022, indicating a direct correlation with the pandemic's impact. The substantial change in behavior during this period is evident from the graph. It is crucial to acknowledge that the global onset of the COVID-19 virus occurred in December 2019, but its direct impact on Sri Lanka was observed in April 2020. Consequently, the discernible shift in digital transactions from 2020 to 2022 underscores the profound influence of COVID-19 on the financial performance of commercial banks.

Figure 3 presents the data regarding the number of ATMs and CDMs both before and after the COVID-19 period, offering insights into the fluctuations in their averages. The period from 2017 to 2019 is designated as the period preceding the pandemic, while 2020 to 2022 represents the post-COVID-19 era. In 2017,

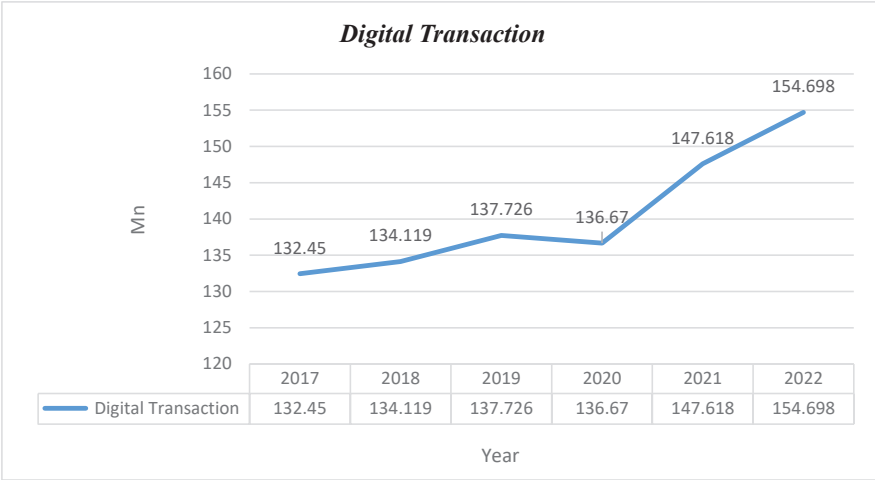

Figure 2: Number of digital transactions

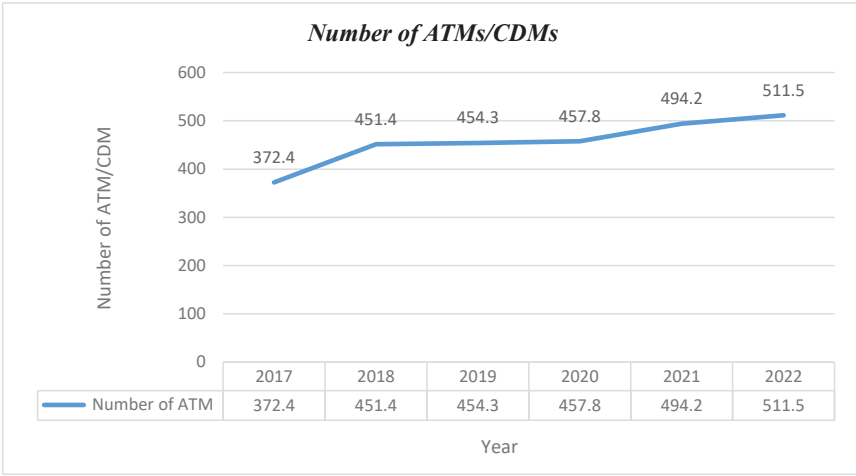

Figure 3: Number of ATMs/CDMs

Sri Lanka had 372.4 ATMs and CDMs, a number that increased in 2018 and further rose to 454.3 in 2019. This progression indicates a gradual increase in the number of ATMs and CDMs over the preceding years. Analyzing the subsequent years, the data reveals 457.8 ATMs and CDMs in 2020, with a continued increase in 2021. Notably, in 2022, the figure reached 511.5, marking the highest count in this timeframe. The discernible rise in the number of ATMs and CDMs post-2020 is indicative of the transformative impact of COVID-19 on these banking facilities. It is important to note that while the global onset of COVID-19 occurred in December 2019, its direct impact on Sri Lanka was observed in April 2020. Therefore, the observed changes in the number of ATMs and CDMs align with the period when COVID-19 directly influenced the financial performance of commercial banks in Sri Lanka.

Fees and commission income denote the revenue generated by financial institutions, encompassing fees and commissions charged for various customer services, particularly those associated with specific digital transactions. The analysis of how substantial amounts of fees and commission income impact the financial performance of banks spans the years 2017 to 2019, regarded as the period preceding COVID-19, and 2020

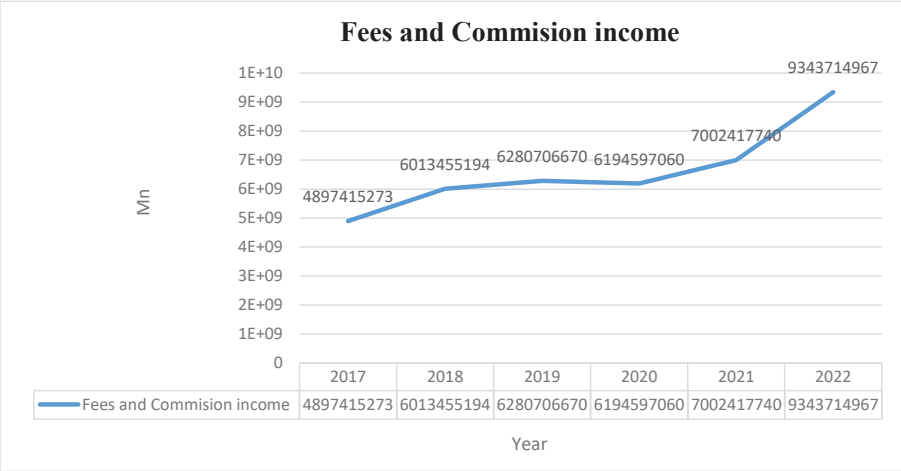

Figure 4: Fees and Commission Income

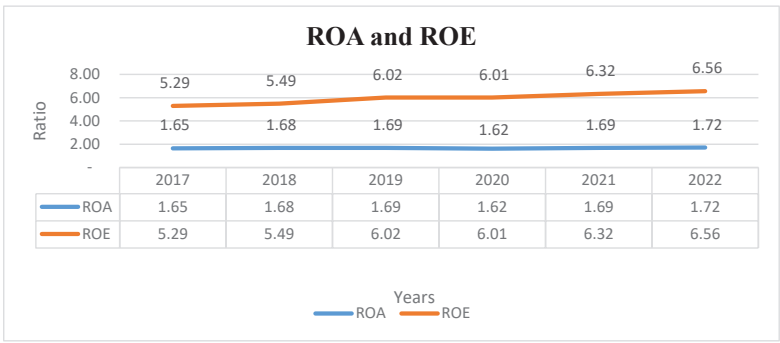

Figure 5: ROA and ROE

to 2022, designated as the era during the pandemic. Figure 4, along with an accompanying table and graph, illustrates the fees and commission income during this timeframe. The graph reveals a gradual increase in the years 2017 and 2018, a trend that persisted in 2019 with a similar incremental rise. Notably, in 2019, the fees and commission income amounted to 6,280,706,670 million. After the onset of COVID-19 in 2020, there was a decrease in the fees and commission income. However, a noteworthy rebound occurred in 2021, reaching a substantial 7,002,417,740 million, and achieving the highest recorded amount in 2022 at 9,343,714,9967 million. The peak in fees and commission income in 2022 signifies a notable impact of COVID-19 on these financial indicators. It is important to highlight that while the global emergence of COVID-19 transpired in December 2019, its direct influence on Sri Lanka was observed in April 2020. Thus, the observed fluctuations in fees and commission income align with the period when COVID-19 directly affected the financial performance of commercial banks in Sri Lanka.

ROA (Return on Assets) and ROE (Return on Equity) are pivotal financial ratios employed to assess a company's profitability relative to its total assets and shareholders' equity, respectively. Figure 4.2.4 delineates the ROA and ROE dynamics before and after the COVID-19 period. The graph and table distinctly portray the average ROA and ROE ratios. The period spanning 2017 to 2019 is deemed as the antecedent to the COVID-19 era, while 2020 to 2022 represents the aftermath of the pandemic. The observed behavior of ROA and ROE ratios is elucidated in the graph and table for this timeframe. The graph indicates that the ROE ratio in 2017 was 5.29, followed by a slight increase to 5.49 in 2018, indicating a relatively similar change. However, in 2019, a more substantial increase was evident. In 2020, the ROE ratio exhibited a minor increment, reaching 6.01. Subsequently,

Table 1: Descriptive analysis

Before COVID -19					
	N	Minimum	Maximum	Mean	Std. Deviation
Digital Transaction	30	132.45	137.73	134.76	2.69
Number of ATMs/CDMs	30	372.40	454.30	426.03	46.47
Fees and Commission income	30	4897415273	6280706670	5730525712	733764670
ROA	30	1.65	1.69	1.67	.02
ROE	30	5.29	6.02	5.60	.37
After the COVID 19					
	N	Minimum	Maximum	Mean	Std. Deviation
Digital Transactions	30	139.67	154.70	147.32	7.51
Number of ATMs/CDMs	30	457.80	511.50	487.83	27.41
Fees and Commission income	30	6194597060	9343714967	7513576589	1635603382
ROA	30	1.62	1.72	1.67	.05
ROE	30	6.01	6.56	6.29	.27

a noteworthy surge transpired in 2021 with an ROE ratio of 6.32, culminating in the maximum recorded amount of 6.52 in 2022. Conversely, the ROA ratio in 2017 was 1.65, incrementally increasing to 1.68 in 2018, and further to 1.69 in 2019. However, 2020 witnessed a slight decrease to 1.62. Subsequently, a pronounced uptick occurred in 2021, reaching 1.72 in 2022—the highest recorded ROA ratio during this period. This data analysis underscores the impact of COVID-19 on ROA and ROE ratios, with global ramifications beginning in December 2019 but directly affecting Sri Lanka in April 2020. The intricate interplay between digital transactions, the number of ATM/CDMs, fees and commission income, and their influence on the financial performance of commercial banks is discerned through this comprehensive analysis. The study encompasses data from 10 commercial banks over a 6-year span, elucidating the nuanced behavior of ROA and ROE ratios both pre- and post-COVID-19.

The provided information indicates that COVID-19 impacted both ROA (Return on Assets) and ROE (Return on Equity) ratios. Although the global impact of the COVID-19 virus began in December 2019, Sri Lanka experienced its direct effects in April 2020. During this period, the pandemic had a direct influence on the financial performance of commercial banks. The analysis presented in the graph helps discern the impact on digital transactions, the number of ATM/CDMs, and fees and commission income on the financial performance of commercial banks. In this analysis, data from 10 commercial banks over a 6-year period was utilized. Additionally, the behavioral patterns of ROA and ROE ratios before and after the COVID-19 period were examined.

Descriptive statistics

Descriptive analysis serves to provide a statistical overview of both dependent and independent variables utilized in the study, offering broad observations on the acquired data through various descriptive statistics such as mean, maximum, minimum, and standard deviation values. The descriptive statistics for the variables used in the analysis, both before and after the COVID-19 pandemic, are presented in Table 4.3, computed from the annual reports of a sample of selected commercial banks in Sri Lanka.

The descriptive analysis was conducted using a total of 60 samples—30 samples each for the periods before and after COVID-19. In the table, before COVID-19, the mean value of digital transactions was 134.7650 (Million) with a standard deviation of 2.69667. After COVID-19, the mean value increased to 147.3287 (Million) with a standard deviation of 7.51818. The minimum and maximum values of digital transactions also reflect changes before and after COVID-19. For the independent variable representing the number of ATMs/CDMs, the mean value before COVID-19 was 426.0333, with a standard deviation of 46.47046. After COVID-19,

the mean value increased to 487.8333, with a standard deviation of 27.41028. The minimum and maximum values for both periods are presented in the table. Fees and commission income, another independent variable, displayed changes in mean, minimum, and maximum values before and after COVID-19. Before COVID-19, the mean value was 5730525712.333, with a standard deviation of 7337646670.00713. After COVID-19, the mean value increased to 7513576589.000, with a standard deviation of 1635603382.46470. The minimum and maximum values also experienced fluctuations between the two periods. Regarding dependent variables, Return on Assets (ROA) and Return on Equity (ROE), descriptive statistics show variations before and after COVID-19. Before COVID-19, the mean value for ROA was 1.6753, with a standard deviation of 0.02082. After COVID-19, the mean value changed slightly to 1.6767, with a standard deviation of 0.5132. For ROE, before COVID-19, the mean value was 5.6000, with a standard deviation of 0.37723. After COVID-19, the mean value increased to 6.2967, with a standard deviation of 0.27574. Minimum and maximum values for both ROA and ROE exhibit variations between the two periods, reflecting changes in financial performance. Finally, the descriptive analysis provided a comprehensive statistical overview of the variables, offering insights into the changes and trends before and after the COVID-19 pandemic in the context of selected commercial banks in Sri Lanka.

Correlation analysis

Correlation analysis, a statistical method employed to examine the relationship between variables, aids in understanding how changes in one variable correspond to changes in another. It quantifies the strength and direction of the linear relationship between variables. Table 2 illustrates the correlation of digital transaction amount, number of ATMs/CDMs, fees and commission income, and return on equity/return on assets before and after the COVID-19 pandemic. Before COVID-19, the correlation values for digital transaction amount and return on assets, and return on equity were 0.012 and 0.029, respectively. Both values are less than 0.05, signifying significance. Another independent variable, the number of ATMs/CDMs, showed correlation values with

Table – 2: Correlation analysis (before COVID - 19)

	Before Covid 19			
	ATMs/CDMs	FC	ROA	ROE
DT	.764	.853	.882	.999*
	.447	.350	.012	.029
	30	30	30	30
ATM/CDM	1	.988	.978	.733
		.097	.235	.476
		30	30	30
FC		1	.998*	.828
			.038	.029
			30	30

Table 3: Correlation analysis (after the COVID - 19)

	After covid 19			
	ATM/CDM	FC	ROA	ROE
DT	.986	.953	.981	.999*
	.108	.196	.023	.025
	30	30	30	30
ATM/CDM	1	.889	1.000*	.992
		.303	.316	.732
		30	30	30
FC		1	.877	.940
			.019	.021
			30	30

return on assets and return on equity (0.235 and 0.476) that were higher than 0.05, indicating insignificance. Fees and commission income exhibited significant correlation values with return on assets and return on equity before COVID-19, with values of 0.038 and 0.029, respectively. In Table 3, representing the period after the COVID-19 pandemic, the correlation values between digital transaction amount and return on assets, and return on equity were 0.023 and 0.025, respectively. Other variables, such as the number of ATMs/CDMs, showed significant values of 0.316 and 0.732 for return on assets and return on equity, respectively, which were higher than 0.05 and thus deemed insignificant. After the COVID-19 pandemic, fees and commission income displayed significant correlation values of 0.019 and 0.021 with return on assets and return on equity, respectively, both less than 0.05. Finally, the correlation analysis provided insights into the relationships between the studied variables, both before and after the COVID-19 pandemic, shedding light on their significance and implications for the financial performance of the selected commercial banks in Sri Lanka.

T – Test analysis

A t-test analysis is a statistical method employed to assess whether there exists a significant difference between the means of two groups or conditions. It aids researchers in determining whether the observed difference between two sample means is likely due to chance or if it represents a genuine distinction in the populations from which the samples were drawn.

The first three pairs in the table represent the mean values of digital transactions, number of ATMs/CDMs, and fees and commission income before the COVID-19 period and their significant differences in the mean value of the ROA ratio. The t-values for these pairs are -16.069, -15.824, and 13.527, with corresponding significant values of 0.000, 0.004, and 0.005, all of which are less than 0.05, signifying statistical significance. Pairs 4, 5, and 6 in the table represent the mean values of digital transactions, number of ATMs/CDMs, and fees and commission income after the COVID-19 period, examining their significant differences in the mean value of the ROA ratio. The t-values for these pairs are -33.782, -30.778, and -7.975, with corresponding significant values of 0.001, 0.001, and 0.015, all indicating statistical significance. Moving on to the next three pairs (7, 8, 9), they represent the mean values of digital transactions, ATMs/CDMs, and fees and commission income before the COVID-19 period, assessing their significant differences in the mean value of the ROE ratio. The t-values for these pairs are -16.435, -15.764, and -13.527, and their corresponding significant values are 0.000, 0.004, and 0.005, all below 0.05, indicating statistical significance. Finally, pairs 10, 11, and 12 represent the mean values of digital transactions, ATMs/CDMs, and fees and commission income after the COVID-19 period, exploring their significant differences in the mean value of the ROE ratio. The t-values for these pairs are -33.727, -30.735, and -7.957, and their corresponding significant values are 0.001, 0.001, and 0.015, again demonstrating statistical significance.

Hypotheses testing

By interpreting results derived from the data analysis through the secondary data collected from the audited financial statements of the prescribed licensed commercial banks in Sri Lanka, Table 6 shows the testing of each hypothesis formulated through the literature review.

Firstly, Hypothesis H_{a1} was accepted, signifying a significant impact of the number of digital transactions on the Return on Assets (ROA) of licensed commercial banks in Sri Lanka before the COVID-19 pandemic, at a 5% significance level. Secondly, Hypothesis H_{c1} asserted a significant impact of fees and commission income on the ROA of licensed commercial banks in Sri Lanka before the COVID-19 pandemic, also accepted at a 5% significance level. Thirdly, Hypothesis H_{d1} was accepted, indicating an impact of the number of digital transaction systems on the Return on Equity (ROE) of licensed commercial banks in Sri Lanka before the COVID-19 pandemic, at a 5% significance level. Fourthly, Hypothesis H_{f1} was accepted, demonstrating an impact of fees and commission income on the ROE of licensed commercial banks in Sri Lanka before the COVID-19 pandemic, at a 5% significance level.

Moving forward, Hypothesis Ha_2 was accepted, suggesting a significant impact of the number of digital transactions on the ROA of licensed commercial banks in Sri Lanka after the COVID-19 pandemic, at a 5% significance level. Similarly, Hypothesis H_{c2} indicated a significant impact of fees and commission income on the ROA of licensed commercial banks in Sri Lanka after the COVID-19 pandemic and was accepted at a 5% significance level. Furthermore, Hypothesis H_{d2} was accepted, signifying an impact of the number of digital transaction systems on the ROE of licensed commercial banks in Sri Lanka after the COVID-19 pandemic, at a 5% significance level. Lastly, Hypothesis H_{f2} was accepted, demonstrating an impact of fees and commission income on the ROE of licensed commercial banks in Sri Lanka after the COVID-19 pandemic, at a 5% significance level.

Contrarily, Hypotheses H_{b1}, H_{e1}, H_{b2}, and H_{e2} were rejected based on their non-significant p-values at the

Table 5: T-test analysis

		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	Sig
					Lower	Upper		
Pair 1	ROA-DT	-133.09	2.67	1.54	-139.74	-126.43	-16.06	.000
Pair 2	ROA-ATM/CDM	-424.36	46.45	26.81	-539.74	-308.97	-15.82	.004
Pair 3	ROA-FC	-5730525710.66	733764669.98	423639229.73	-7553298198.92	-3907753222.39	-13.52	.005
Pair 4	ROA- DT	-145.65	7.46	4.31	-164.20	-127.10	-33.78	.001
Pair 5	ROA –ATM/CDM	-486.15	27.35	15.79	-554.12	-418.19	-30.77	.001
Pair 6	ROA-FC	-7513576587.32	1635603382.41	944316053.12	-11576640631.05	-3450512543.58	-7.95	.015
Pair 7	ROE-DT	-129.16500	2.319	1.33	-134.92799	-123.40201	-16.43	.000
Pair 8	ROE –ATM/CDM	-420.43333	46.19	26.67	-535.18699	-305.67968	-15.76	.004
Pair 9	ROE- FC	-5730525706.73	733764669.69	423639229.57	-7553298194.27	-3907753219.19	-13.52	.005
Pair 10	ROE- DT	-141.03200	7.24	4.181	-159.02378	-123.04022	-33.72	.001
Pair 11	ROE-ATM/CDM	-481.53667	27.13	15.66	-548.94836	-414.12498	-30.73	.001
Pair 12	ROE-FC	-7513576582.70	1635603382.20	944316053.00	-11576640625.90	-3450512539.50	-7.95	.015

5% significance level. While existing literature indirectly supports these findings to a certain extent, the empirical results highlight the severe impact of the pandemic on all business sectors, including banking. Researchers adjusted for both favorable and adverse effects to interpret the results comprehensively. Consequently, the results align conceptually with the impact of digital transformation on the financial performance of commercial banks in SRI LANKA before and after the COVID-19 pandemic. In this study, ten commercial banks were analyzed, with digital transactions, the number of ATM/CDM, and fees and commission income as independent variables, and Return on Asset ratio (ROA) and Return on Equity (ROE) as dependent variables.

The graphical analysis illustrates notable shifts in the behaviors of both dependent and independent variables before and after the COVID-19 period. These variables were evidently impacted by the pandemic, and the graphical representation encapsulates the comprehensive details. Descriptive analysis and value assessments discerned changes in variables before and after COVID-19. The mean values of independent variables noticeably increased after the onset of the pandemic, while dependent variables displayed an increase before COVID-19, albeit with a lesser magnitude in 2020 due to the direct impact of COVID-19 on Sri Lanka in April 2020. It's noteworthy that the 2020 annual report was prepared, covering the period from April 1st of the prior year to March 31st, 2021.

Correlation analysis indicates that digital transactions and fees and commission income significantly impact both Return on Assets (ROA) and Return on Equity (ROE) before and after the COVID-19 pandemic, as evidenced by their significance values being less than 0.05. On the other hand, the number of ATM/CDM insignificantly impacts both ROA and ROE before and after the COVID-19 pandemic.

In a study by Karimzadeh & Sasouli (2013), Return on Assets was the chosen dependent variable. Similarly, the present study adopts Return on Assets as the financial performance indicator. To account for tax effects, ROA was calculated considering profits before taxes. Furthermore, findings from Sufian & Habibullah's (2009) investigation, covering the performance of 37 Bangladeshi commercial banks from 1997 to 2004, revealed that digital transformation had a positive and significant impact on bank performance. Subsequent research explored the relationship between selected internal and external corporate governance mechanisms and bank performance, measured by ROE and ROA, spanning the period from 2005 to 2011. Notably, there was a positive and significant impact of total assets on the profitability indicator ROA in Nepalese finance companies.

CONCLUSION AND RECOMMENDATIONS

Conclusion

This study examines the impact of digital transactions on the financial performance of licensed commercial banks in Sri Lanka before and after the COVID-19 pandemic. The research uses secondary data from 2017 to 2022, using twotime periods before and after the pandemic. There are 24 licensed commercial banks in Sri Lanka, and a random sample method was used to select 10 banks for the study. The relationship between digital transformation (digital transactions amount, number of ATMs/CDMs, fees, and commission income) and financial performance (return on assets and return on equity) is explained by this study. Digital transaction measures the number of digital transactions, number of ATMs/CDMs, and fees and commission income. Using correlation analysis, there is convincing evidence that the financial performance and digital transaction amount have a significantly positive relationship before and after the COVID-19 period. The number of ATMs/CDMs has a negative relationship, while fees and commission income have a positive relationship. The other objective is to determine the impact of digital transformation on the return on equity of licensed commercial banks before and after the COVID-19 pandemic. The results show a positive significant relationship between the digital transaction amount and return on equity both before and after the COVID-19.

Implications

The results of this study elucidate the influence of digital transformation on the financial performance of licensed commercial banks both before and after the onset of the COVID-19 pandemic in Sri Lanka. The study's findings underscore the significant impact of digital transactions on financial performance, emphasizing the imperative for banks to focus on enhancing their digital transformations. Recognizing the direct influence of digital transformations on financial performance, banks are urged to prioritize improvements in this domain. Specifically, recommendations for banks include embracing mobile banking and expanding online banking services. Developing user-friendly mobile banking applications that facilitate a variety of financial transactions, such as fund transfers, bill payments, account management, and loan applications, is crucial. The provision of these services through intuitive interfaces not only enhances operational efficiency but also reduces costs associated with manual processes. Considering the diverse demographic landscape in

Sri Lanka, characterized by middle and low-income populations, some of whom lack basic knowledge of digital transformations, collaboration between the government and banks becomes pivotal. Efforts should be directed towards educating people about the benefits and security features of digital transactions. Workshops, webinars, and informative content dissemination can play a key role in building awareness and fostering the adoption of digital banking practices. Before the COVID-19 pandemic, traditional banking methods, such as using passbooks and in-person visits to fulfil banking requirements, were prevalent. However, the current analysis confirms a shift towards increased usage of mobile banking and cashless payments. Recognizing that many individuals lack technical knowledge of digital transactions, it is recommended that banks enhance customer support services to facilitate smoother transitions to digital banking. Addressing concerns related to security is paramount in overcoming customer reluctance towards digital transformation. Banks should invest in robust security measures to safeguard customer information and transactions. Strengthening the security infrastructure not only instils confidence in customers but also catalyses increased engagement with digital transactions, ultimately contributing to the enhanced financial performance of commercial banks.

Suggestion for the future research.

The examination of the correlation between digital transformation and the financial performance of licensed commercial banks in Sri Lanka, both before and after the COVID-19 outbreak, constitutes only a fraction of the hypotheses outlined in this study. Consequently, the following recommendations are crucial for guiding future research endeavors:

1. **Diversify financial markets:** Expand the scope of the study beyond Sri Lankan licensed commercial banks. Future researchers should explore additional financial markets to attain a broader understanding of the impact of digital transformation on financial performance.

2. **Extend temporal analysis:** This study encompassed a six-year time-frame, focusing on three years before and three years after the onset of COVID-19. To garner a more comprehensive perspective, future researchers are encouraged to extend the temporal analysis, considering periods longer than three years before COVID-19, to provide more nuanced insights.

3. **Increase sample size:** The study examined a sample size of 10 licensed commercial banks, whereas Sri Lanka boasts a total of 24 licensed commercial banks. The current sample size is notably limited. Therefore, it is recommended that future researchers expand their scope to include all banks in Sri Lanka, and potentially consider a larger sample size including institutions from other developed or developing banking and financial markets.

4. **Consider financial measurement Tools:** Future researchers delving into this topic should pay particular attention to the selection of appropriate financial measurement tools. The intricacies of this study underscore the challenges associated with connecting measurement tools to other variables. Addressing this consideration will enhance the precision and reliability of future research findings.

Therefore, these suggestions encourage a more expansive, temporally nuanced, and methodologically rigorous approach in future research endeavors exploring the intricate relationship between digital transformation and financial performance in the banking sector.

REFERENCES

Abdallah, A. A. J. (2013) The impact of using Accounting Information system on the quality of Financial Statement submitted to the income and Sales Tax Department in Jordan, *European Scientific Journal*, 1(4), pp:41-48

Alexander, D., Døhl Diouf, L. & Prescod, K. (2023) Digital inclusion in Caribbean digital transformation frameworks and initiatives: a review.

Caliskana, M.T. & Lecunab, H.K.S. (2020) The determinants of banking sector profitability in Turkey1, 2, *Business and Economics Research Journal*, *11*(1), pp:161-167.

DOI: https://doi.org/10.20409/berj.2020.242

Diener, F., & Špaček, M. (2021) Digital transformation in banking: A managerial perspective on barriers to change, *Sustainability*, *13*(4), p.2032.

DOI: https://doi.org/10.3390/su13042032

E. M. N. N., E. & A. A., A. (2015). Determinants of Non-Performing Loans in Licensed Commercial Banks: Evidence from Sri Lanka, *Asian Economic and Financial Review*, *5*(6), pp: 868–882.

DOI: ttps://doi.org/10.18488/journal.aefr/2015.5.6/102.6.868.882

Eidhoff, A.T., Stief, S.E., Voeth, M. & Gundlach, S. (2016) Drivers of digital product innovation in firms: an empirical study of technological, organizational, and environmental factors. *International Journal of Economics and Management Engineering*, *10*(6), pp:1888-1892.

DOI: https://doi.org/10.5281/zenodo.1124623

Ferrari, V. (2022) The platformisation of digital payments: The fabrication of consumer interest in the EU FinTech agenda, *Computer Law & Security Review*, *45*, p.105687.

DOI: https://doi.org/10.1016/j.clsr.2022.105687

Gobble, M. M. (2018) Digital Strategy and Digital Transformation, *Research-Technology Management*, *61*(5), 66–71.

DOI: https://doi.org/10.1080/08956308.2018.1495969

Gunawardana, K. (2007) Current status of information technology and its issues in Sri Lanka, *International Journal of the Computer, the Internet and Management*, *15*(3), pp:1-25.

Hakuduwal, K. (2014) Impact of 1nternal Factors on Profitability of Nepalese Finance Companies, *The KIC Journal of Management and Economic Review*, *98*(3), pp:88-97.

Ivanov, D., Dolgui, A. & Sokolov, B. (2019) The impact of digital technology and Industry 4.0 on the ripple effect and supply chain risk analytics, *International journal of production research*, *57*(3), pp:829-846.

DOI: https://doi.org/10.1080/00207543.2018.1488086

Jayalath, J. A. R. C. & Premaratne, S. C. (2021) Analysis of Digital Transformation challenges to overcome by Banks and Financial Institutions in Sri Lanka, *International Journal of Research Publications*, *84*(1).

DOI: https://doi.org/10.47119/ijrp100841920212260

Jin, C., Chen, R., Cheng, D., Mo, S., & Yang, K. (2020) The dependency measures of commercial bank risks: Using an optimal copula selection method based on non-parametric kernel density, *Finance Research Letters*, *37*, p. 101706.

DOI: https://doi.org/10.1016/j.frl.2020.101706

Kallinikos, J., Aaltonen, A., & Marton, A. (2013) The Ambivalent Ontology of Digital Artifacts, *MIS Quarterly*, *37*(2), pp: 357–370. https://doi.org/10.25300/misq/2013/37.2.02

Kariyawasam, N. J. & Jayasiri, N. K. (2016) Awareness and Usage of Internet Banking Facilities in Sri Lanka, International Journal of Scientific Research and Innovative Technology, 3, pp: 173-190.

Kitsios, F., Giatsidis, I., & Kamariotou, M. (2021) Digital Transformation and Strategy in the Banking Sector: Evaluating the Acceptance Rate of E-Services, *Journal of Open Innovation: Technology, Market, and Complexity*, *7*(3), p. 204.

DOI: https://doi.org/10.3390/joitmc7030204

Klapper, L., & Miller, M. (2021) *The impact of COVID-19 on digital financial inclusion*, *World Bank Report*, *2021*.

Kraus, S., Durst, S., Ferreira, J. J., Veiga, P., Kailer, N., & Weinmann, A. (2022) Digital transformation in business and management research: An overview of the current status quo. *International Journal of Information Management*, *63*, P. 102466.

DOI: https://doi.org/10.1016/j.ijinfomgt.2021.102466

Lipunga, A. M. (2014) *Determinants of Profitability of Listed Commercial Banks* in developing countries*: Evidence from Malawi*, *Research Journal of finance and Accounting, 5*(6), pp:41–49.

Mamo, W. B., Feyisa, H. L. & Yitayaw, M. K. (2021) Financial performance of commercial banks in the emerging markets, *Corporate Governance and Organizational Behavior Review*, *5*(2, special issue), pp: 244–257.

DOI: https://doi.org/10.22495/cgobrv5i2sip12

Mateka, M., Gogo, D. J., & Omagwa, J. (2017) Effects of Internet Banking on Financial Performance of Listed Commercial Banks in Kenya. *American Journal of Finance*, *1*(2), pp: 53 - 71. DOI: https://doi.org/10.47672/ajf.123

Matt, C., Hess, T. & Benlian, A. (2015) Digital Transformation Strategies, *Business & Information Systems Engineering*, *57*, PP: 339–343.

DOI: https://doi.org/10.1007/s12599-015-0401-5

Nambisan, S., Wright, M. & Feldman, M. (2019) The digital transformation of innovation and entrepreneurship: Progress, challenges and key themes, *Research Policy*, *48*(8), P. 103773.

DOI: https://doi.org/10.1016/j.respol.2019.03.018

Nayanajith, D. A. G., Dissanayake, D. M. R., Wanninayake, W. M. C. B. & Damunupola, K. A. (2021) Acceptance of mobile banking application services offered by Sri Lankan commercial banks, Sri Lankan Journal of Technology, 2 (sp issue) pp: 11-17.

Nazaritehrani, A. & Mashali, B. (2020) Development of E-banking channels and market share in developing countries, *Financial Innovation*, *6*(1), P.12.

DOI: https://doi.org/10.1186/s40854-020-0171-z

Ortaköy, S. & Özsürünç, Z. (2019) The Effect of Digital Channel Migration, Automation and Centralization on the Efficiency of Operational Staff of Bank Branches, *Procedia Computer Science*, *158*, pp. 938–946.

DOI: https://doi.org/10.1016/j.procs.2019.09.134

Plekhanov, D., Franke, H. & Netland, T. H. (2023) Digital transformation: A review and research agenda, *European Management Journal*, 41(6), pp: 821-844.

DOI: https://doi.org/10.1016/j.emj.2022.09.007

Premarathne, W. & Gunatilake, M. M. (2016) Consumer Adoption of Internet Banking in Sri Lanka, International Journal of Advanced Research. 4 (11), pp: 758-765.

Silva, D. & Perera, N. (2021) A Case Study on Strategies to Deal with the Impacts of COVID-19 Pandemic in The Banking Industry in Sri Lanka, *GSJ*, *9*(7).

Suganya, S. & Kengatharan, L. (2018). Impact of bank internal factors on profitability of commercial banks in Sri Lanka: a panel data analysis, *Journal of Business Studies*, *5*(1), pp: 61-74.
DOI: https://doi.org/10.4038/jbs.v5i1.25

Thulani, D., Tofara, C. & Langton, R. (2009) Adoption and use of internet banking in Zimbabwe: An exploratory study, *Journal of Internet Banking and commerce*, *14*(1), p.1.

Tomych, I. (2024) Robotic Process Automation for Fintech. [online] Available at: https://dashdevs.com/blog/robotic-process-automation-is-to-become-a-growth-strategy-for-the-financial-industry/[Accessed [Accessed: 08th March 2023]. [Accessed: 08th March 2023].

Tran, P. T. T., Le, T. T. H. & Phan, N. H. T. (2023) Digital Transformation of the Banking Industry in Developing Countries, *International Journal of Professional Business Review*, São Paulo (SP), 8(5), p. e01503.
DOI: https://doi.org/10.26668/businessreview/2023.v8i5.1503

Tripathi, S. (2021) Determinants of Digital Transformation in the Post-Covid-19 Business World: Digital Transformation, *IJRDO - Journal of Business Management*, 7(6), pp: 75-83.
DOI: https://doi.org/10.53555/bm.v7i6.4312

Westerman, G., Bonnet, D., & McAfee, A. (2014) Leading Digital: Turning Technology into Business Transformation, Harvard Business Press.

Xie, X., & Wang, S. (2023) Digital transformation of commercial banks in China: Measurement, progress and impact, *China Economic Quarterly International*, *3*(1), pp: 35–45.
DOI: https://doi.org/10.1016/j.ceqi.2023.03.002

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RESEARCH ARTICLE

Presenting future brides: The English matrimonial advertisement as a window to social class in Sri Lanka

Malshani Gamage[1] and Kaushalya Perera[2*]

[1]*Independent Researcher.*
[2]*Department of English, Faculty of Arts, University of Colombo, Colombo, Sri Lanka.*

Abstract: Publishing matrimonial advertisements in newspapers is a popular method used to seek and locate potential marriage partners in Sri Lanka. This article focuses on English-language matrimonials published by or on behalf of aspiring brides. Advertisers typically seek compatibility in aspects such as ethnicity, religion, and caste, along with social class as a factor that is implicitly signalled through educational and professional qualifications, employment and career, residence, and marital status. English is intricately tied to these aspects of social class as well. Factors related to marriage as shown in matrimonials have not been investigated frequently in contemporary scholarship. This article analyzes 729 English-language matrimonials published in January 2019 in Sri Lankan newspapers to investigate the presentation of the potential bride, potential groom and their families. The article is in two parts. First, we present the connection between Sri Lankan English and the other social categories discussed in the matrimonials. In doing so, we also analyze the specific linguistic register used to present matrimonials. Secondly, we present the intricate ways in which social class is signalled via education, occupation, residence, and migrant status of the prospective bride or family. English-language matrimonials serve middle-class families in upward social mobility or the maintenance of classed status, so this paper illustrates the need for more in-depth research into this fascinating phenomenon.

Keywords: Marriage, Sri Lanka, social class, matrimonial advertisements, women.

INTRODUCTION

> Bodu Govi Durawa parents from Colombo seek academically and professionally qualified son for their slim pleasant daughter born 1992, height 5'7" studied at a Colombo leading Buddhist School, B.Sc Degree CIMA qualified and MBA working as an Assistant Manager in a private company. Only brother is working in a multinational company as a Financial Analyst. Inherits substantial assets. Kindly reply with family details, horoscope and contact number. (email address removed)

For someone new to Sri Lankan culture, some information in the above matrimonial, as in 'Bodu Govi Durawa', will be incomprehensible. Other references, such as that of a single sibling, 'CIMA' and remarks about schooling, may appear strange choices to present. For many Sri Lankans, however, the categories invoked here are so 'normal' as to be commonsensical. It is this 'taken for grantedness' that we aim to trouble through this article.

Arranging marriages on behalf of an offspring, a sibling, or a relative is a common practice in many Asian and African countries. Sri Lankan English newspaper matrimonial advertisements for prospective brides are published in a widely accepted format in newspapers,

* Corresponding author (kaushalya@english.cmb.ac.lk; https://orcid.org/0000-0002-6632-9912)

usually on Sundays, by a family member on a woman's behalf, or less often by the woman herself, in search of a potential spouse for heterosexual and monogamous marriage. Besides inviting applications for marriage, these advertisements also present a quantity of personal information—including membership in a social class or ethno-religious community, levels of education, and physical attributes—to readers and potential applicants.

At present, research on English-language matrimonials, especially those published in Sri Lanka, is virtually non-existent. There is a general belief that ethnicity, caste and religion are the deciding factors in arranged marriages, but the impact of social class as a foundational element of contemporary marriage has been generally overlooked, except in the recent work of Asha Abeyasekera (2016; 2021). In a matrimonial advertisement, the family relies on signifiers of social class, such as their education, career prospects and their fluency in English, to signal class affiliations - not only their own, but what would be expected of the prospective suitors. By analysing English-language matrimonials in Sri Lankan newspapers, our objective is to illustrate such class-related characteristics as shown via the matrimonials and through this, to contribute to marriage-related research from Sri Lanka.

Before we present an analysis of social class-related criteria given in these matrimonials, we provide a brief description of the matrimonial advertisement itself. Then, the literature review draws connections between the English language, class and marriage. The methodology and data are presented after that. The analysis discusses the categories of education, occupation and migration that appear as major points of interest in matrimonial advertisements, and aspects of the prospective bride (and groom) that are considered less acceptable. Concluding remarks follow.

THE MATRIMONIAL ADVERTISEMENT

'Arranged' marriages were - and in some instances still are - typically arranged through kinship networks, using trusted intermediaries (Caldwell, 2005; Jayawardena, 2007).

Anecdotal evidence suggests that a contemporary version of this is through an introduction, via mutual acquaintances. However, a popular method of seeking a potential marriage partner is through the newspaper matrimonial. Abeyasekera (2021) describes English newspaper matrimonials, or 'matrimonial classifieds', appearing in the 1940s and becoming popular amongst the petit-bourgeoisie since they lacked the kinship ties that made marriage arrangements easier, in their relocated Colombo setting. In the present day, newspaper matrimonials remain important for the arranged marriage process. Dissanayake (1982) stated that the role performed by newspaper matrimonials is similar to that of the other conventional forms in locating suitable potential spouses. They allow access to one's social group while adhering to a socially and culturally approved framework in arranging a marriage. They also help to keep people's cultural identity and pride in tradition intact (Reyes-Hockings, 1961). Another advantage of newspaper matrimonials is that, regardless of one's geographical location, the seeker can easily access her desired group (Dissanayake, 1982). They are now also available online.

As seen in the introductory example, matrimonials have a specific form and are written in a specialised 'type' of Sri Lankan English, (SLE) which is the variety of English that Sri Lankans use both as a first language and as a later-learned language (see Gunesekera, 2005 for an overview). The socially accepted – or prestige form – of Sri Lankan English is Standard Sri Lankan English (SSLE) and is the variety the English-speaking middle class typically uses. Concerning marriage, for example, SLE uses the term 'settled', indicating that heterosexual marriage is considered to have a stabilising function. The matrimonial, however, is not written in the usual SSLE; it uses a 'register': "a linguistic repertoire that is associated, culture internally, with particular social practices and with persons who engage in such practices" (Agha, 1999: p.215)[1]. In other words, registers index social identities and social functions.

The most distinctive of the register used in matrimonials is the use of Sri Lankan terminology related to marriage and Sinhalese culture, which infuses this register with a Sri Lankan identity. The register includes words, phrases, and abbreviations mainly related to physicality, character, personality, relationships, assets, astrology, religion and caste. Many terms are borrowed into SLE from Sinhala. Like any specialised register, this also makes frequent use of abbreviations and acronyms. Table 1 categorises SLE terms identified in the matrimonials. A more general meaning of the term is provided in square brackets, where necessary.

The person writing the matrimonial must also understand the genre that is expected.

The matrimonial is a genre which is characterised by its brevity as well as its format. Analysis of the collected matrimonials shows information that must be typically included: seeker(s) and their details, a description of the prospective bride, what is sought in the groom, details of the horoscope and the method of contact.

Table 1: Categories of SLE words, phrases and abbreviations in the matrimonials published on prospective brides

Characteristic	Example SLE words, phrases and abbreviations
Physicality	Chubby [plump], tan complexioned
Character	Charm [unpretentious], virtuous, unblemished [not promiscuous/virgin]
Habits	NS/TT [non-smoker and teetotaler]
Kinship terms	Senior daughter, junior sister, one and only daughter
Assets	Upstairs house [house with two floors], bungalow, coconut properties (12) acres, precious land, dowry
Astrology	Malefic[2] HC [malefic horoscope], Kuja and Shani in the 7th House
Religion	B [Buddhist)], RC [Roman Catholic]
Caste	G [Govi], K [Karava], S [Salagama][3], no barriers [a specific characteristic is not considered]
Miscellaneous	No encumbrances (sic) [no children out of previous marriage], own tuition classes, lakhs

We present two examples to illustrate the use of the matrimonial genre and its register.

Example 1 (Ad 441)

> GALLE close by November 1986 5' 3 ½" in height *fair complexioned* slim *charm* B.Sc. M.Sc. Graduate daughter of *Buddhist Govi Karawa* Teacher parents. Assistant Registrar of a State University. (Kuja 01) Seek State University Graduate, devoid of all vices honest slim Engineer/ Doctor/ Lecturer/ Accountant son. Please call after 7.30 pm. [phone number removed] (emphasis added)

Example 1 includes information on the seekers (the parents), the level of education, status and character sought in the groom, describes the prospective bride, and provides a specific alignment of the horoscope and a phone number. It explains the qualities sought in the prospective groom and how to contact the advertisers. These functions are done through register-specific features such as abbreviated syntactic structures (e.g. "Galle close by", i.e., living close to the town of Galle), terminology related to caste (e.g. "Govi" and "Karawa"), astrology-related terminology (Kuja 01 i.e., Mars in the first house), information related to age (e.g. "November 1986"), terms related to appearance (e.g. "fair complexioned"), and personality (e.g. "charm").

For an informed user of this register, this matrimonial advertisement also conveys the message that the place of residence matters (by placing it first), that the bride's horoscope is considered malefic and therefore she would need a horoscope compatible with that specific factor, and that they are looking for a groom who does not smoke, drink alcohol, gamble or womanise ("devoid of all vices"). It also specifically states preferred professions.

Some other characteristics are presented in the next example.

Example 2 (Ad 470)

> Govi Roman Catholic parents residing in immediate suburbs of Colombo is (sic) looking for a partner for their daughter professionally qualified, married and divorced in less than 03 years – *innocent party no encumbrances*. She is tall slim very pleasant smart kind-hearted and caring. Very well brought up. Younger brother is married and settled, willing to reside any part of the World. *Dowry* a house worth over Rs. 25 M. Please contact E-mail [email address removed] Tel. No. [phone number removed] (emphasis added)

This advertisement also presents caste, religion, residence, appearance and personality. The terms "innocent party" and "no encumbrances" are common to the register and signify that it was not the woman's fault that her previous marriage ended and that she has no children out of that marriage (see section 5.2). 'Dowry' is another register-specific term, and informs the reader about her financial assets, in addition to her professional

qualifications. As in example 1, the abbreviated syntax ("please contact email") brings attention to the limitation on words entailed by advertising in this manner.

In this manner, the use of English and the specific register used in advertising for a potential spouse indicate mastery of English. The fact that these are published in English indirectly reveals a desire to be viewed as a part of the urban middle class of Sri Lanka (or its diaspora). The association with this register also conveys to the reader that prospective brides and their families are confident in handling English and indicates the possibility of upward social mobility. Those unaccustomed to the traditions and language associated with an arranged marriage in Sri Lanka would thus find it difficult to fully comprehend these matrimonials. The next section provides a synthesis of related prior research.

LITERATURE REVIEW

Class, women, and marriage

The phenomenon of 'late marriage' in Sri Lanka has resulted in curiosity in researchers (Caldwell, 1996; Malhotra & Tsui, 1996). Since late colonial times, it appears that at least in urban areas, women marry in their mid to late twenties, which is much later than the late-adolescence or early twenties age-at-marriage of the region (Caldwell, 1999). Considering this exception, contemporary Sri Lankan marriage has received remarkably little attention until Abeyasekera's recent work (Abeyasekera, 2021). Both Abeyasekera's work and de Munck's (1996) work on Muslim marriages in a rural community challenge the usual assumptions on the arranged versus choice issue in Sri Lankan marriages.

The criteria for partners as expressed in the matrimonials show how social class and gender shape women's choices in marriage. Kumari Jayawardena (2007)'s influential work, *Nobodies to Somebodies*, describes how a caste-based Ceylonese society transformed into a class-based society during colonial times and the importance of 'judicious marriage' for this transformation (p.155; also see Chapter 16). As Jayawardena (2007) records meticulously, the shift to a class-based social structure included the accumulation of capital via lands, professional status, education and the English language. In the twenty-first-century Sinhalese community, which is the user of a majority of the advertised proposals, caste still intersects with class in complicated ways (see also Abeyasekera, 2021). More than compatibility in terms of religion or ethnicity, it was compatibility in terms of class that is sought after in marriage (Abeyasekera, 2021). It could be said that post-1980 economic liberalisation produced far-reaching changes in the middle classes of Sri Lanka. Yet, there is no work that focuses on this transition, either generally or in relation to marriage and kinship. The lack of literature theorising changes to Sri Lankan social classes during the past four decades makes it difficult for us to provide definitive characteristics that distinguish the present-day middle classes from other classes, except in broad strokes. Nevertheless, the next section, and our analysis, confirm that some of these characteristics of class persist to the present.

As an aside, we note that commentaries on Sri Lankan marriage are, however, mostly relevant to the Sinhalese. Less is written about the marriage practices of urban middle-class women of minority communities.[4] An exception is the study by Malhotra & Tsui (1996) in which almost 20% of the participants were Moors.

Sri Lankan English, education, employment and norms for marriage

English plays a central role in marriage arrangements in Sri Lanka. Access or desire for the English language has been, and continues to be, a key characteristic of upward mobility and as such, of being and becoming middle-class (Parakrama, 1995; Gunesekera, 2005; Jayawardena, 2007). Exemplifying this, Malhotra & Mather (1997) show that the married women in their 1990s survey were generally of the same level or better educated than their husbands. If the class is an important factor in deciding compatibility in marriage, as has been shown, it follows that fluency in English is important for marital prospects and that English is also important for education, employment, and other characteristics necessary for better marital prospects, which we discuss in this section. Therefore, this section will discuss the literature on the place of English as a class marker (and maker) of English, and thereafter discuss the place of education, career, and residency in marriage in Sri Lanka.

The role played by the English language in Sri Lanka is similar to that in other British post-colonies. Classified as a 'link language' in the Constitution of 1978, English plays a far more significant role than that. The power and privilege associated with English was previously transferred primarily through the family. English is, and has been, the language of upward mobility and an indicator of social accomplishment that elevates social capital among present-day Sri Lankans (Gunesekera, 2005; Kandiah, 2010). Unlike in the immediate post-independence era when English divided classes into a small elite with access to English and larger groups with little access to it, the contemporary landscape of the English language in the country is more complex

(Parakrama, 1995; Medawattegedera, 2023). Access to English differs significantly according to an individual's socioeconomic status and education, hence the term 'English speaking background', earlier used to indicate that the family used English as a dominant language and therefore was of a professional or upper-middle-class family, may not be as pertinent as it used to be. English is now transferred to the next generation through education and professional opportunities so, it is not uncommon to have fluent users of Standard Sri Lankan English in families where a parent does not use English. Rural and poorer Sri Lankans have little access to English because they lack access to the routes through which the middle classes have been accessing English: through private English language classes, bilingual (i.e., English medium) education in schools, international schools, and other such avenues (see for e.g. Wettewa, 2016). These establish the consensus among the population that the knowledge of English is one of the most potent factors in achieving social mobility.

As such, English is an important characteristic of marital compatibility. Abeyasekera (2021) states that the urban middle classes in South Asian countries such as Sri Lanka needs "knowledge of English" to secure distinction within their social class. It indicates the potential partner's ability to aid upward social mobility and attainment of status for the whole family.

Siri Hettige's (2000) mapping of social class and type of education post-1977 is useful here. He argues that the working class, lower middle class and the conventional middleclass use state education; that the new urban middle class (shaped by post-1977 private and transnational economic sectors) access private education and that the capitalist class accesses both private and transnational (or international) education. Not enough work has been done to exemplify or test such a mapping. Nevertheless, as Abeyasekera (2021) comments, "the anxiety to get children into prestigious schools, the determination for them to learn English, their enrollment into a range of extracurricular activities, the insistence on their higher education and the attention paid to personal appearance" all illustrate parental determination to improve their social prestige and class status (p.105). As this shows, English is intricately tied up in this endeavour, because it is through these modes of education that English is also accessed. Our study shows that fluency in English is also signalled indirectly.

Private schools and well-resourced urban schools have long served the purpose of enabling entry to privilege and Westernisation, as the authors above claim - not only through education but also consequent to that, to employment networks and marriage. School type is granted mention in matrimonials that we studied as well. Siri Gamage (2011) says that the international school[5] "contributes to the creation and maintenance of a privileged strata of society whose values, interests and aspirations as well as ideologies are pro-Western, not Sri Lankan" (p.26) but as we show later, it is not only international schools that are mentioned in matrimonials.

Education is seen as a contributing factor to later marriage in Sri Lankan women from colonial times (Malhotra & Tsui, 1996; Silva, *et al*., 1998). Caldwell (2005) found that women cited 'completing education' as a factor for lateness in marriage. In a study conducted in the late 1990s with undergraduates as participants, Silva, *et al*., (1998) found that their participants expected to be married in the latter twenties. While it may be expected then that women selecting their partner may marry at a later age, in the Sri Lankan case, it appears that it is the women opting for arranged marriages that marry later (Malhotra &Tsui, 1996; Caldwell, 2005).

Employment is another significant factor in the matrimonials. This is not surprising when we consider the larger percentage of women completing secondary education. Anju Malhotra's work shows that even in the 1990s, women gave importance to the idea of work (Malhotra & Tsui, 1996; Malhotra & Mather, 1997). In Malhotra & Mather's (1997) analysis of a survey of over 500 married women from Kalutara, over 90% "favour the idea of paid work for women" (p.615) though the reality is far less (which the researchers consider a problem of the economy and lack of work opportunities, rather than the women's choice).

In terms of residence, findings in related work show that unlike in neighboring countries, married couples in Sri Lanka do not necessarily have to or choose to reside with the husband's family, which has consequences on the independence of their decision-making during the marriage (Malhotra & Tsui, 1996; Malhotra & Mather, 1997). We note here the need for research that directly explores the connections between residency and marital prospects and hope this article contributes to that.

Finally, an aspect shown clearly in the matrimonials is the expectation in terms of virtue in middle-class women (de Alwis, 2002; Abeyasekera, 2021). In a study conducted during 1989-1993 by Malhotra & Tsui (1996) involving nearly 1500 urban, mostly middle-class (80%) woman participants, half of the women who were married had their marriages arranged by their families. Of the others, they found that the parents of 'older

daughters'(presumably late twenties or thirties) tend to initiate a search for partners, illustrating that middle-class women are still expected to enter heterosexual marriage and that they must marry 'appropriately' (also see Caldwell, 2005). In the anthropological literature on women of the Sinhala middle classes, appropriate behaviour is framed as having *laejja-baya* (shyness/shame-fear) (de Alwis, 2002; Sirisena, 2016; Abeyasekera, 2021).

Rather than meaning that women should be shy, this is a requirement of decorous behaviour. Despite the women's educational attainments and career choices, they must also show that they have not become 'too modern' by choosing an appropriate partner for marriage in terms of education, employment prospects and social class, i.e., 'background'. Additionally, the strictures of moral behaviour for women also mostly apply to marriage. Mihirini Sirisena's (2016) undergraduate participants (of lower to lower-middle-class backgrounds) used the term *haediyawa* (upbringing) to refer to the genteel ways in which not only women but men too, were expected to behave. As we show in the matrimonials, it is not only women but also men who have to display their suitability for marriage (see 5.2).

METHODOLOGY

This study is a qualitative analysis of matrimonial advertisements, using a corpus of selected matrimonials. 729 matrimonials published on behalf of prospective brides in January 2019 were collected from two national Sunday newspapers, the *Sunday Times* and *Sunday Observer*. Matrimonials with blurred text were removed in making the corpus. The cleaned data were transferred to an Excel sheet and subjected to inductive (open) coding so that sixty-four codes emerged from the data itself. These codes were recorded separately. The codes were then grouped into thirty-three categories, followed by a close examination to identify patterns and relationships, from which three themes related to the presentation of the bride emerged.

Since the matrimonials were taken from published newspapers, they can be considered public data. However, they are meant for potential spouses and their families and are hence more personal than commercial advertisements or news articles. Although the details of the prospective bride and her family are not provided in the matrimonial, the contact numbers, email addresses or serial numbers can identify the parties. Hence, in the data cleaning stage, phone numbers and email addresses in the matrimonials were replaced with generic phrases such as [phone number removed] and [email address removed] to eliminate any link to identities. Serial numbers assigned to the matrimonials by the newspaper publishers for their tracking purposes were also removed. This process ensured that the data was systematically analysed while maintaining the privacy of individuals, allowing for a nuanced understanding of Sri Lankan matrimonial advertisements.

ANALYSIS

Presentation of the bride and family

This section provides other aspects related to class affiliation presented by the advertiser, usually the bride's family. Many references to the potential bride's social class can be identified in the data. We pay special attention to the educational and professional qualifications, residence and marital status of a prospective bride, and indicate where English is implicated. This section will discuss those aspects.

Educated brides

A main indicator of the social status of a prospective bride is the place(s) and extent of education. Examples abound, such as "studied in Kandy Leading School" (Ad 43), "Convent educated" (Ad 414), "graduate of J'pura, Colombo and SLIIT", i.e., three universities (Ad 428) and "presently reading for PhD in Chemistry in a Westcoast University in USA" (Ad 547). 'Leading schools' are still coveted status markers, despite the rising importance of private education in the middle classes. The matrimonials referring to 'leading schools' illustrate that the family has wealth or connections, since entering a child to a 'leading' school means that the family resides in close proximity to a large school in an urban setting, was admitted through intellectual merit (via scholarship), or that the family used their privilege or connections to gain the child admittance. The larger public schools are known to attract better-trained teachers their social status would be thereby enhanced; so it leads to a belief that education at such schools would be superior to others. A statement such as "convent educated" conveys the notion of a strict religious upbringing. With such a term, the advertiser hopes to present the prospective bride as disciplined and religious. In addition, since gaining admission to these educational institutes is usually difficult, it demonstrates membership in alumni networks or the financial ability of the family. Such attendance also carries the possibility of admission of future progeny, as alumni have better opportunities to educate children in these same schools.

Since tertiary education is limited in Sri Lanka, university education signals that the prospective bride is better educated. State universities only admit a small

percentage of students from the larger school population and thus, graduation from a state university such as "J'pura" (University of Sri Jayewardenepura) and "Colombo" (University of Colombo) shows the bride's higher intellectual capacity. "SLIIT", on the other hand, is a private university associated with prestige and status because it is a reputed non-governmental university that is quite expensive. The fact that the prospective bride has graduated from both state and private universities indicates that her family is able and willing to afford more educational opportunities for their daughter and reflects her perseverance in academic pursuits. A PhD from the English-speaking, developed country of America signals that the prospective bride is capable of handling the language of power, prestige, and privilege (i.e., English) and is highly educated, as well. Such references can be construed as overt indications of social class and familial attitudes regarding women's education and career prospects. Therefore, the mention of schools and/or universities indicates more than just the prospective bride's education. Since her place(s) of education convey the prospective bride and her family's financial worth, social affluence and attitude towards education, such details also position her better for hypergamous (or 'class-climbing') marriage opportunities. We return to the topic of education in 5.1.3 when discussing place of residence.

Working brides

The Sri Lankan English newspaper matrimonials placed by or for prospective brides convey many details related to their occupation. Most matrimonials name the job or profession even if it is simply to mention that the prospective bride is 'occupied' or 'employed'. This information illustrates the importance of employment or career for middle-class women and supports findings in prior research. The employment types are diverse, ranging from "Medical Laboratory Technician" (Ad 192) to "Highly Employee Officer daughter" (sic) (Ad 255) to "Financial Analyst" (Ad 409).

While the first and last examples demonstrate an aptitude towards science and finance respectively, the second example positions the prospective bride in a role of stability and status. While a "government pensionable job" (as stated in Ad 369) and a "grama niladhari" (aka "grama sevaka"[6], Ad 671) may not convey wealth or prestige, they may be considered attractive in a prospective bride, especially by the older generation, as such jobs represent financial stability via public employment and job security. Also highly desirable are the working hours of state employment, with conventional office hours and non-working weekends, which are considered suitable for women, allowing them to deal with childcare post-marriage.

The data shows that a significant proportion of the prospective brides (35.9%) are those in the traditionally sought-after professions, such as doctor (55 items), engineer (45 items), teacher (45 items), and accountant (22 items). Example phrases describing these professions from the matrimonials include "Government university senior lecturer... daughter" (Ad 16) and "MBBS Doctor daughter" (Ad 518). The high number of female engineers can be considered a change in gendered education (and perceptions) in recent times, given that women are still approximately 20% of the entrants to engineering programs, and is a discipline with a larger proportion of male students (University Grants Commission, 2022). To the contextually astute reader, this signals that the prospective bride is academically competitive in the sciences (traditionally of higher status than the arts). Other professions that are still dominated by men, such as banker (5 items), scientist (5 items), and researcher (3 items), can be considered unusual as well, and are fewer in number.

The teaching profession is a sought-after profession for women, with its lengthy holidays and the (mis)perception that a teacher's job ends once school ends in the early afternoon. Forty-two (5.76% of the total) of the matrimonials stated that the prospective bride was a teacher. Out of this number, eight (1.09% of the total matrimonials under scrutiny) mentioned that she works at a government school, while another twelve (1.65% of the total) stated that she worked at an international or private school. Eight (1.09% of the total) of the 42 matrimonials mentioning the prospective bride's occupation as a teacher stated that she teaches English or in the English medium section. While working at a government school can indicate stability and job security, stating that the woman works at an international or private school and/or teaching English or in the English medium section of the school associates her with the prestige and power of English (though not necessarily a better salary). Such individuals can be assumed to be far more fluent in English and be associated also with the ability to teach an English-medium curriculum and possess a more 'Westernised' demeanour. In turn, this indicates some level of middle-class sophistication which might be assumed to be lacking in government school teachers. Such jobs may therefore be presented as a plus factor over the other prospective brides in the newspaper. Hence, a prospective bride with a safe, established occupation (e.g. teacher) or a prestigious one (e.g. doctor) indicates that although she is financially independent and professionally qualified, her secondary

role as the woman of a family post-marriage will not be compromised.

However, the rarity of professions such as "specialist doctor" (Ad 185), and "senior lecturer" (Ad 293), two and five matrimonials respectively, alongside the absence of professions such as principal and professor in the matrimonials, may indicate that women of higher status within these fields access potential spouses through other means. At the same time, women who attain career stages such as principals, professors, and specialised medical doctors are older, and may either be already married or be considered too old or too high in status to advertise for marriage in newspapers.

Very few prospective brides are presented as being in the top tiers of the corporate industries. Only 38 (5.2%) matrimonials mention the prospective bride's post as manager, administrator, consultant or director of a company. Examples include matrimonials where the prospective bride is in a "managerial position" (Ad 58), "a Director in private firm in Colombo" (Ad 201), "Senior Consultant in USA" (Ad 227) and "Assistant Director/ Administrator in a reputed facility" (Ad 648). For an informed reader, being a director in a private firm in Colombo can indicate higher salaries, status and fluency in English. Being a senior consultant in the USA indicates that the prospective bride is a resident of a sought-after country, which would be a migrating opportunity for the suitor. It also demonstrates her capacity at her work, prestige and fluency in English enabling her to thrive in an English-speaking country such as the USA.

The smaller percentage of such matrimonials can be read in two ways. On one hand, women in high-ranking jobs such as principals, professors and managers both in state and the corporate sectors—being in the upper-strata English-speaking middle class—utilise means other than newspaper matrimonials to select potential grooms. On the other hand, it could also mean that there are fewer women in these positions. In comparison, 63 (8.64%) matrimonials mention executive-level career positions of the prospective bride: "(two) executive daughters" (Ad 2), "a Travel Executive in a Leading Travel Company" (Ad 414) and "Graduate executive officer" (Ad 29). Being a "graduate executive officer" (Ad 29) indicates not only the prospective bride's educational expertise and therefore her intellectual capabilities, but also her professional expertise and leadership qualities. The data seems to indicate that urban middle-class women advertised in the newspaper matrimonials occupy positions in the lower-to-middle-tiers of the private sector more often than in the upper echelons of it.

By naming the type of employment or area of work, the matrimonial can be kept succinct yet effective, since it still provides key insights into not only the prospective bride's educational qualifications but also the status of herself and her family. Thus, mentioning the prospective bride's profession can signal her worth as a potential spouse with many prospects. As a society that assigns considerable value to such professions, a prospective bride thus presented in the Sri Lankan English newspaper matrimonials indicates prestige, financial stability, growth opportunities and a capacity for upward social mobility – all of which will be available to the suitor. It is, in essence, shorthand for multiple other factors.

Nevertheless, these advertisements reflect the gendered nature of these professions even among twenty-first century urban middle-class Sri Lankans, presenting these women as societal gender norm abiders, suitable for marriage within a patriarchal system. At the same time, we note that our data is not only an indication of gendered professions but also an indication of the sub-groups within the middle-class who seek arranged marriages through matrimonial advertisements.

Migrating brides

As already signalled in the previous sections, migration is a frequent feature in matrimonials and is also connected to education and career. Both internal (within the country) and external (out of Sri Lanka) migration are prominent in the matrimonials.

Six matrimonials (0.82% of the total matrimonials) mention internal migration. Using phrases such as "parents in Dehiwela…originally from Galle" (Ad 559), the prospective bride's family indicates their history of internal migration. Sri Lankans still place value on regional affiliations, shown through 'gama' (village) or 'hometown' as places of familial origin. The reference to being 'originally from Galle' in Ad 559 can be seen as a subtle indication of desirability for furthering a Southern connection. At the same time, migration from a regional place of origin to the capital or suburbs signals urbanisation, and through this, a more sophisticated identity than that of a purely regional affiliation.

Decisions pertaining to external migration are presented in 33 (4.5%) matrimonials explicitly, while another 21 (2.9%) state that the prospective bride is a holder of a US Green card or permanent residence (PR) / citizenship of a foreign country. The countries/continents most commonly referred to are (from highest to lowest frequency): Australia, USA, UK, England, Canada,

New Zealand, Japan and Europe, with a single mention each for Hong Kong, Singapore and the Middle East. Taken together, these demonstrate the preferred migratory destinations of the middle classes. These migrations are undertaken in search of better jobs, quality education and an elevated lifestyle (Agadjanian, *et al*., 2008), which will assist in their upward social mobility. Hence, prospective brides and their families advertising themselves as proponents of migration may be presenting themselves as better established and open to more opportunities, which may elevate their social status to be exchanged with other desirable characteristics of the potential spouse. Thus, external migration (and even internal migration towards urban areas) can indicate elevated social status and an opportunity for hypergamous marriage. However, this may be different in migration for marriage in minority communities in Sri Lanka (see Maunaguru, 2020). Issues related to marriage and migration, and the differences amongst Sri Lankan ethnic communities are identified as under-researched topics.

The prospective brides' residence abroad is mentioned by one hundred and sixty-eight (23.1%) matrimonials and is closely connected to education and career. Table 2 below tabulates the academic and professional qualifications mentioned among prospective brides residing abroad at the time of publication of the advertisement. A higher number of those residing abroad for study purposes are seen to be pursuing postgraduate qualifications, including PhDs. A majority of those residing abroad for work purposes hold postgraduate qualifications. Of these 168 matrimonials, 116 (69.1%) of the prospective brides with PR or citizenship in countries such as America, Australia, England, and Canada possess graduate- or higher-level qualifications. Only 28 (16.7%) of the 168 matrimonials did not refer to academic or professional qualifications, which may be construed as a presentation strategy that simply utilises the highly-valued social capital attached to a migrant status in affluent countries.

The numbers in Table 2 reveal the inclination among prospective brides of the Sri Lankan urban middle class to pursue higher studies (postgraduate especially) abroad. Women who have migrated to Western countries are usually viewed as highly accomplished. Accordingly, these women present their worth as future wives not only through the social capital attached to migration but also through the intellectual identities, socio-economic values and prospects of such an education.

Brides and grooms at risk of exclusion

Many strategies are employed in these matrimonials to circumvent characteristics in the prospective brides that could otherwise be traditionally considered unappealing in marriage. A prospective first-time bride's sexual history seems to be of extreme importance. Some of the more common criteria found unattractive relate to the prospective bride's prior marriage and, if so, whether she is 'encumbered' with children. Another trait that seems to be presented in a redeeming light is her age, which may have passed the socially accepted age for marriage. However, as this section will demonstrate further, these matrimonials also state or imply several exclusionary criteria for potentially interested grooms, which may seem hypocritical when considering the many measures those placing the matrimonials themselves take to avoid as much stigma as possible in the potential brides' presentation.

Due to the cultural taboo attached to premarital sex, especially regarding women (Hindin & Hindin, 2009), advertisers attempt to assure the potential partner of the prospective bride's virginity and lack of promiscuity through a range of terms. Such terms and phrases include "religious…daughter of moral values" (Ad 28), "unblemished character" (Ad 75), "with excellent character and brought up with Sri Lankan values" (Ad 88), and "possesses an excellent character" (Ad 127). By invoking the religious and cultural values of

Table 2: Highest academic and professional qualifications of prospective brides residing abroad for various reasons at the time of publishing the matrimonial

	PhD	Postgraduate qualifications	Graduate	Other qualifications	Mentions "qualified"	No qualifications mentioned
Living abroad	1	4	6	4	1	9
PR holder/ citizenship	1	3	8	3	1	5
Work-related	4	17	8	2	2	10
Residing abroad to gain qualifications	22	30	11	12	-	4

the prospective bride, the attempt is to present her as virtuous.

Being presented in this manner is advantageous to the prospective bride, since a woman entering matrimony who will occupy the roles of a wife, and a potential mother is required to be virtuous. However, requiring premarital celibacy from a prospective bride may deprive her of pre-marital sexual rights or force her into presenting a falsified version of herself in the matrimonials, mainly to secure socially acceptable marriage prospects.

This is further seen in the presentation of prospective brides who are divorced or widowed. Among the 68 (9.3%) matrimonials of prospective brides seeking second marriages, certain phrases seem to indicate an attempt to mitigate the reluctance that a prospective groom might consider a once-married woman. This resonates with the findings by Vaillant & Harrant (2008), which demonstrate that being previously married or having dependent children can hinder securing a potential marriage partner. This may be one reason why statements like "no children" (as in Ad 7) and "no encumbrances" (as in Ad 55) are commonly employed in such matrimonials. However, within the data examined, eight prospective brides mentioned having children from their first marriage. Examples of such smatrimonials include those stating that the prospective bride is "having a daughter in custody" (Ad 357) or is "mother of one son" (Ad 689). One even requests that the potential groom be an individual "who can become a loving father for (the prospective bride's) daughter" (in Ad 319). The marriage ads seem to take it for granted that a potential husband may find marrying a woman with children undesirable. At the same time, the prospective bride with children may however present herself as fertile and capable of handling familial responsibility. Therefore, the presentation of a prospective bride with children in the matrimonials is a necessary risk.

As already mentioned, the age at potential marriage also seems to negatively affect women. Prospective brides ranging from 29 to 60+ years are presented as young in appearance. Phrases such as "very young looking" (in Ad 87 for a 48-year-old), "exceptionally young looking" (in Ad 161 for a 39-year-old), "young at heart" (in Ad 707 for a prospective bride in her mid-fifties) and "younger looking" (in Ad 177 for a 60-year-old) are examples of this phenomenon. By employing such expressions, these prospective brides and their families may be attempting to present youthful energy, health, and fertility—implying that she is still desirable despite being late to marry according to cultural norms. Prospective brides who have passed the socially dictated age for marriage and are in search of a first marriage are introduced as the "unmarried daughter" (Ad 87) or as "never married" (Ad 133) to avoid the stigma attached to second marriages. In two matrimonials, the reason for the prospective bride's delay in marrying is presented as due to "family responsibilities" (Ad 87) and "studies" (Ad 169), possibly to deflect any concern that a potential groom may have regarding their character and horoscope. Additionally, stating that "…even a divorce (sic) or widower…" (Ad 578) will be considered for the 49-year-old unmarried woman advertised in this matrimonial indicates the inferiority assigned to unmarried women, as this statement implies that men seeking second marriages are usually not an unmarried woman's first option. Hence, many strategies seem to be employed in these matrimonials to mitigate the impact that 'late' age at potential marriage may have on these prospective brides. We note that despite findings in prior research that women marry later in Sri Lanka, there is still an ideal age for marriage for women as envisaged by society, and women who aspire to marry later than that age must provide 'evidence' or a 'rationale' for that.

When analysing these matrimonials, many forms of othering and exclusion of men who may be interested in replying can also be seen. While age, ethnic group, religion, caste, height, complexion, occupation or profession, residence, migration status or preferences, marital status, and horoscope details (among others) construct a formidable set of standards, these also serve as exclusionary standards. For example, potential grooms may be excluded if they do not fall within the desired height or complexion, as in this matrimonial: "seek fair complexioned handsome…son of more than 5' 7" in height" (Ad 38). Caste-based exclusion is common when matrimonials say "Govigama (caste) only" (Ad 59). Other exclusionary examples are "Non-malefic horoscopes only" (Ad 62), "academic Doctor professional is sought" (Ad 76), and "Divorcees please do not reply" (Ad 667).

Furthermore, a fruitful illustration of exclusion as performed in matrimonials can be shown using the 'migration' criteria of these advertisements. Of the 168 matrimonials citing migration, 51 (6.99% of the 729) matrimonials with parents in the diasporic community or with the prospective bride resident abroad, prefer a potential husband located in the diaspora. This is demonstrated by examples such as "Australian PR Holders or citizen preferred" (Ad 171), "preferred [potential groom] already in Melbourne" (Ad 424), "Those living in US/UK/Canada preferred" (Ad 514), and "Preferably based in USA" (Ad 547). Our data shows that only four matrimonials consider locally settled prospective grooms to be acceptable. This is a clear

example of exclusion. Hence, it may be construed that convenience, the similarity of a diasporic lifestyle, the norms and values of a diasporic community coupled with other middle-class characteristics are gradually taking precedence over preserving one's identity and culture by marrying into Sri Lanka-based/Sinhala families with similar characteristics (though this may be different outside the Sinhalese community).

Hence, it can be deduced that, apart from these matrimonials serving as sites for circumventing "undesirable" characteristics on the part of the prospective brides, they simultaneously exclude interested potential grooms based on several traditionally enforced criteria and the implicit requirement of belonging to the English-speaking middle class. This is outside the main focus of this paper but is a fruitful area for future research.

CONCLUDING REMARKS

In this paper, we looked at matrimonial advertisements published in English-language newspapers as a means of analysing the presentation of potential brides in terms of class-related characteristics. Through this, we offer an examination of the portrayal of the social status of a prospective bride and her family. Several attributes that make up social status are showcased through the matrimonial advertisement, where the bride, the family and the potential groom are described. This includes fluency in English, places of education, financial assets, family status, and profession; all of which are characteristics of class membership since colonial times. While English may be rarely addressed explicitly, we illustrate how it is intricately tied to other markers that are desirable in the potential bride. In the last section, we also presented gendered and classed aspects that are considered undesirable in prospective brides and grooms. We also used this study as an opportunity to present a specialised register of Sri Lankan English as related to marriage, the register used in the specific genre of matrimonials.

This study therefore records how marriageable women are presented in Sri Lankan society (even when they are expatriates) and also in what way the social expectations of marriage affect present-day Sri Lankans. While the study has limitations tied to its choice to consider only English-language matrimonials, it still illustrates trends in marriage in contemporary Sri Lanka. It also exemplifies the dire need for more research on marriage in connection to social class and related matters of education, career, migration issues, language(s), and gendered norms, including any shifts that have been taking place over the last century.

ENDNOTES

1 A well-known example of a register is 'legalese', or the legal register. A less well-known example of a register is the register used in acknowledgements.

2 The placement of the Sun, and the planets Mars (Kuja), Saturn (Shani) and two mythical celestial aspects of the lunar nodes (Rahu and Ketu) are considered harmful, i.e. malefic, when placed in specific regions ('houses') of the horoscope.

3 Govi, Karava and Salagama are Sinhala castes. The 'Govigama' caste ('Govi' in short) is originally said to denote the agricultural people; the 'Karava' caste is traditionally associated with the fishing trade; 'Salagama' is traditionally associated with the cultivation of cinnamon, weaving and being soldiers.

4. Victor Munck's work (de Munck, 1988; 1996) is on a rural community of Muslim people.

5. 'Private schools' are government-approved schools providing education in the local curriculum, that function independently. 'International schools' are educational institutions available in urban areas that offer education via Edexel or Cambridge curriculum (and sometimes the local national syllabus) and teach in the English medium. They are registered as companies.

6. The Grama Sevaka (i.e., GS) is a public official appointed by the Sri Lankan government to carry out administrative duties in a sub-unit of a divisional secretariat.

REFERENCES

Abeyasekera, A. (2013) *The choosing person : Marriage, middle-class identities, and modernity in contemporary Sri Lanka*. University of Bath.

Abeyasekera, A. L. (2016) 'Narratives of choice: Marriage, choosing right and the responsibility of agency in urban middle-class Sri Lanka', *Feminist Review*, 113(1), pp. 1–16.

DOI: https://doi.org/10.1057/fr.2016.3

Abeyasekera, A. L. (2021) *Making the right choice: Narratives of marriage in Sri Lanka*. Rutgers University Press.

DOI: https://doi.org/10.36019/9781978810341

Agadjanian, V., Nedoluzhko, L. and Kumskov, G. (2008) 'Eager to leave? Intentions to migrate abroad among young people in Kyrgyztan', *International Migration Review*, 42(3), pp. 620–651.

DOI: https://doi.org/10.1111/j.1747-7379.2008.00140.x

Agha, A. (1999) 'Register', *Journal of Linguistic Anthropology*, 9(1/2), pp. 216–219.
DOI: https://doi.org/10.1525/jlin.1999.9.1-2.216

de Alwis, M. (2002) 'The changing role of women in Sri Lankan society', *Social Research*, 69(3), pp. 675–691.
DOI: https://doi.org/10.1353/sor.2002.0036

Caldwell, B. (1996) 'The family and demographic change in Sri Lanka.', *Health Transition Review*, 6 Suppl, pp. 45–60.

Caldwell, B. (1999) *Marriage in Sri Lanka, A Century of Change*. Australian National University.

Caldwell, B. K. (2005) 'Factors affecting female age at marriage in South Asia: Contrasts between Sri Lanka and Bangladesh', *Asian Population Studies*, 1(3), pp. 283–301.
DOI: https://doi.org/10.1080/17441730500441160

Dissanayake, W. (1982) 'Newspapers as matchmakers - A Sri Lankan illustration', *Journal of Comparative Family Studies*, 13(1), pp. 97–108.
DOI: https://doi.org/10.3138/jcfs.13.1.97

Gamage, S. (2011) 'Internationalization (Privatization) of school education in Sri Lanka: An analysis of the differing discourses and the impact on society', *Modern Sri Lanka Studies*, 3(1), pp. 25–42.

Gunesekera, M. (2005) *The postcolonial identity of Sri Lankan English*. Colombo: Katha Publishers.

Hettige, S. T. (2000) 'Economic Liberalisation, Qualifications and Livelihoods in Sri Lanka', *Assessment in Education: Principles, Policy and Practice*, 7(3), pp. 325–333.
DOI: https://doi.org/10.1080/09695940050201334

Jayawardena, K. (2007) *Nobodies to Somebodies*, *The Rise of the Colonial Bourgeoisie in Sri Lanka*. Colombo: Social Scientists' Association & Sanjiva Books.

Kandiah, T. (2010) '"Kaduwa": Power and the English language weapon in Sri Lanka', in Fernando, S., Gunesekera, M., and Parakrama, A. (eds) *English in Sri Lanka: Ceylon English, Lankan English, Sri Lankan English*. SLELTA, pp. 36–43.

Malhotra, A. and Mather, M. (1997) 'Do schooling and work empower women in developing countries? Gender and domestic decisions in Sri Lanka', *Sociological Forum*, 12(4), pp. 599–630.
DOI: https://doi.org/10.1023/A:1022126824127

Malhotra, A. and Tsui, A. O. (1996) 'Marriage Timing in Sri Lanka: The Role of Modern Norms and Ideas', *Journal of Marriage and the Family*, 58(2), pp. 476–490.
DOI: https://doi.org/10.2307/353511

Maunaguru, S. (2020) 'Thinking With Time: Reflections on Migration and Diaspora Studies Through Sri Lankan Tamil Marriage Migration', *American Behavioral Scientist*, 64(10), pp. 1485–1496.
DOI: https://doi.org/10.1177/0002764220947757

Medawattegedera, V. V. (2023) 'Kaduwa, humor and language policing: Memes and Folk linguistics in Sri Lanka', *University of Colombo Review*, 4(1), pp. 64–99.
DOI: https://doi.org/10.4038/ucr.v4i1.119

de Munck, V. C. (1988) 'The economics of love: An examination of Sri Lanka Muslim marriage practices', *South Asia: Journal of South Asia Studies*, 11(1), pp. 25–38.
DOI: https://doi.org/10.1080/00856408808723106

de Munck, V. C. (1996) 'Love and marriage in a Sri Lankan Muslim community: Toward a reevaluation of Dravidian marriage practices', *American Ethnologist*, 23(4), pp. 698–716.
DOI: https://doi.org/10.1525/ae.1996.23.4.02a00020

Parakrama, A. (1995) *De-hegemonizing language standards: Learning from (post) colonial Englishes about English*. Springer.
DOI: https://doi.org/10.1057/9780230371309

Reyes-Hockings, A. (1961) 'The newspaper as surrogate marriage broker in India', *Sociological Bulletin*, 15(1), pp. 25–39.
DOI: https://doi.org/10.1177/0038022919660102

Silva, K. T., Sivayoganathan, C. and Schensul, S. (1998) 'Peer culture and social context of love and sex in a sample of university students in Sri Lanka', *Sri Lanka Journal of Social Sciences*, 21(1–2), pp. 59–82 [Online] Available from: http://thakshana.nsf.ac.lk/pdf/JSS1-27/JSS 21/JSS21_59.pdf [Accessed: 5th January 2015].

Sirisena, M. (2016) 'Making Colombo Intimate', *South Asia: Journal of South Asian Studies*, 39(1), pp. 167–182.
DOI: https://doi.org/10.1080/00856401.2015.1132404

Wettewa, V. (2016) 'Postcolonial emotionalism in shaping education: An analysis of international school choice in Sri Lanka', *International Education Journal: Comparative Perspectives*, 15(1), pp. 66–83 [Online] Available from: https://files.eric.ed.gov/fulltext/EJ1098928.pdf [Accessed: 20th May 2016].

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RESEARCH ARTICLE

Impact of urbanization on energy intensity in SAARC countries: an empirical analysis

K. F. Rinosha Ahzan[1] and Anuruddha Kankanamge[2]

[1]*Department of Economics and Statistics, Faculty of Arts and Culture, South Eastern University of Sri Lanka, Oluvil, Sri Lanka.*
[2]*Department of Economics and Statistics, Faculty of Arts, University of Peradeniya, Peradeniya, Sri Lanka.*

Abstract: This study aims to examine the effect of urbanization on energy intensity in SAARC countries and compare Sri Lanka's status with other SAARC countries between 1990 and 2015. This study used the urban population as a proxy variable for urbanization. Other control variables in the model are per capita income and squared value of per capita income (PCI), capital formation, industrialization, labour and carbon dioxide emissions, squared value of carbon dioxide emissions and six country dummy variables to detect country effect. Fixed effects model and Least Squared Dummy Variable model (LSDV) with country-urbanization interactive variables model were employed in the estimation. Our results indicate urbanization in the SAARC region increases energy intensity in all countries except Sri Lanka. With urbanization, Pakistan has the fastest increase in energy intensity. Our results confirm Environmental Kuznets Curve (EKC) hypothesis which is consistent with the literature. Industrialization and labour force participation lower energy intensity. Carbon dioxide emission and the squared value of that variable show a U-shaped behaviour with energy intensity. This implies higher energy use further increases energy intensity and needs mitigating policies to curb higher energy use. According to the results, Pakistan has the lowest energy intensity and Sri Lanka has higher energy intensity among SAARC countries. Sri Lanka needs to lower the energy intensity by reducing inefficient energy use in all possible sectors such as transportation. Since urbanization significantly reduces energy intensity in Sri Lanka, efficient public transportation coupled with planned urbanization will help to lower our energy intensity in the long run.

Keywords*:* Capital formation, energy intensity, fixed effect, per capita income, urbanization.

INTRODUCTION

Urbanization is one of the major causes of energy consumption in South Asia. The region's urban population is expected to grow from 400 million in 2015 to 700 million by 2050. This growth exerts a lot of pressure on the region's energy resources and leads to increased energy consumption, which results in higher levels of greenhouse gas emissions. In many countries, economic prosperity is coupled with urbanization and industrialization, which drives up the energy demand. Yet, countries face a trade-off between economic development and emissions due to higher energy consumption. Energy intensity measures the amount of energy required to produce a unit of economic output. A standard measurement that is widely used to compare the amount of utilized energy at the aggregate level, relative to the country's output (GDP) is energy intensity. When discussing energy intensity, it usually refers to all forms of energy consumed in an economy. This includes electricity, fossil fuels (such as coal, oil and natural gas), renewable energy sources and any other forms of energy used in production, transportation and other sectors of

* Corresponding author (frinosha@seu.ac.lk; https://orcid.org/0000-0002-3899-8553)

the economy. It can be interpreted as a proxy for the effectiveness of the amount of energy used in a country. The equation for energy intensity is as follows;

$$Energy\ intensity = \frac{Total\ Energy\ Consumption\ (MJ)}{Economic\ output\ (USD)}$$

Here, Energy Consumption refers to the total amount of energy used by a country. It encompasses all forms of energy, including electricity, natural gas, oil, coal and renewable sources and economic output measured by the Gross Domestic Product (GDP) of a country that represents the total value of all goods and services produced over a specific period (Zheng & Walsh, 2019). Energy consumption is typically measured in units such as joules (J), kilowatt-hours (kWh), British Thermal Units (BTU), or tons of oil equivalent (toe), while Gross Domestic Product (GDP) is measured in US dollars (USD). To calculate energy intensity, energy consumption is first quantified in a standard unit such as megajoules (MJ). By dividing the total energy consumption in megajoules by the GDP in US dollars, energy intensity is expressed in MJ per USD. MJ per USD as a measurement of energy intensity was used by Xiongfeng Pana *et al.*, (2019), Huang & Chen (2020) and Elliott, Sun & Zhu (2017). This conversion allows for a clear comparison of how much energy is consumed for every dollar of economic output.

A lower energy intensity means that less energy is required to generate economic output, which often implies a sustainable and more efficient economy. Conversely, a higher energy intensity suggests that more energy is needed for the same economic production, which shows inefficient energy-intensive processes.

A country should always target its energy policy to achieve a lower energy intensity. The good news is, in the SAARC countries, it has been recorded that there was a 1.5% decline in the energy intensity from 1990 to 2010. This is a remarkable achievement in the middle of growing energy demand in the region. This study empirically examines the links between energy intensity and urbanization in order to get some insights into how urbanization process places countries in different positions in emission and climate prospects.

Urbanization has been identified as one of the crucial factors that affects energy intensity, even though it has shown mixed effects in different countries. Urbanization changes the lifestyles of the people, i.e., domestic energy usage for different applications, such as cooking, lighting, heating & cooling and transportation. In an effort to cope with urban living, urban dwellers have to make changes within their budget in response to urban energy prices. On the other hand, urban planners make efforts to plan future green cities with some novel concepts such as smart cities, which could expect to depend on less energy.

The papers that examine the effect of urbanization on energy intensity reflect somewhat mixed results in different countries. This could be due to differences in energy efficiency achievements and economic structure. For example Koyuncu, Beşer & Alola, (2021), Elliott, Sun & Zhu, (2017) and Rafiq, Salim & Nielsen, (2016) found a positive impact of urbanization on energy intensity in Turkey and China. At the same time, research done by Bilgili *et al.*, (2017) shows a negative impact in ten Asian countries, namely Vietnam, Bangladesh, Malaysia, Nepal, Thailand, China, South Korea, Indonesia, India and the Philippines. Liu & Xie (2013) in China and Sadorsky (2013) found that there is a mixed impact of urbanization on energy intensity in 76 developing countries.

Urbanization is the process by which an increasing amount of a country's population is concentrated in urban areas, such as towns and cities, rather than rural areas. It includes the migration of people from rural to urban areas due to improved living conditions, economic opportunities and access to various amenities and services. Urbanization is accompanied by the growth and expansion of cities, the development of industries and infrastructure and changes in cultural and social dynamics (UN Department of Economic and Social Affairs, 2018).

As shown earlier, many studies use urban population as a proxy for the urbanization. In Sri Lanka, urban areas are defined to comprise municipal and urban council areas. In India, urban areas are defined as towns, which include places with a municipal corporation, municipal area committee, town committee, notified area committee, or cantonment board. Additionally, any place with 5,000 or more inhabitants, a density of not less than 1,000 persons per square mile or 400 per square kilometre, pronounced urban characteristics and at least three-fourths of the adult male population employed in pursuits other than agriculture is considered urban. In Pakistan and Bangladesh, urban areas are referred to as places with a municipal corporation, town committee, or cantonment (Weeraratne, 2016). The highest share of the urban population is recorded in Bhutan as at 43 percent, Sri Lanka shows the lowest share of urban population as at 18.9 percent. Maldives, Pakistan and India had 41.1 percent, 37.4 percent and 35.4 percent urban population, respectively, in 2021. Figure 1 shows an increasing trend in urban population share in the SAARC region in all countries except Sri Lanka where it shows a minimal decline in value over time.

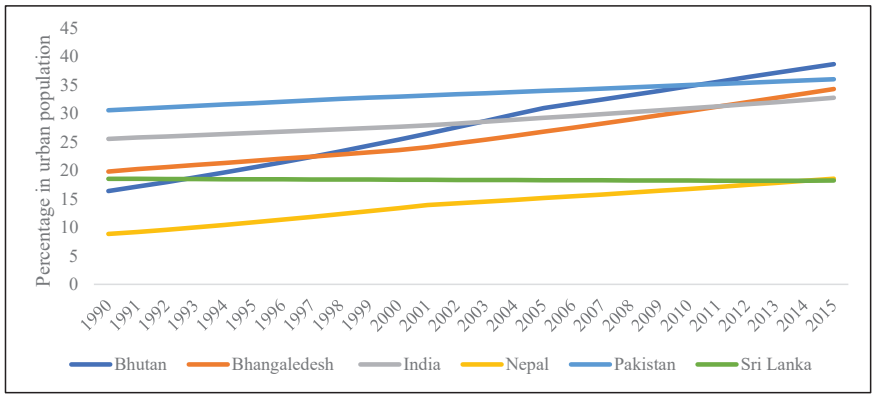

Figure 1: Trend of urbanization in SAARC countries (1990-2015)

Source: World Bank data,1990-2015

The relationship between urbanization and energy intensity has not been investigated in the literature for the SAARC countries and this paper focuses on this issue. Many studies do not identify the differential effects of urbanization on energy use. Analysis in this study is helpful to introduce integral policy measures in both urban and energy use planning to identify the level of effort that each country must put into the SAARC region. Such efforts will help to achieve sustainable economic prosperity in the long run by mitigating adverse consequences of higher energy intensity. Therefore, this examines new insights into urbanization and energy use in the SAARC region.

To understand the pattern of energy intensity, it is crucial to first understand the trends in energy consumption. Therefore, the Figure 2.a and Figure 2.b illustrate the pattern of primary energy consumption. It is important to note that primary energy sources such as coal, oil, natural gas, nuclear energy and renewables before they get converted into secondary forms of energy such as electricity and petroleum products for convenience in transport, delivery and convenience at points of end-use. This focus on primary energy provides an insight into the foundational energy inputs driving economic activity and helps in analysing the broader energy intensity trends. Figure 2 shows the trend of energy consumption in the SAARC countries from 1990 to 2015. (This study derived the energy intensity directly from World Bank data which is directly sourced from https://databank.worldbank.org/source/sustainable-energy-for-all/Series/6.1_PRIMARY.ENERGY.INTENSITY and it was not computed it directly from this primary energy consumption figures.)

According to the Figure 2.a, the highest amount of primary energy consumption is in India. It was 2,300.7 TWh in 1990 and increased to 8,030.2 TWh in 2015 due to the rapid population growth. Except in India, total primary energy consumption in other SAARC countries shows a very small increase.

LITERATURE REVIEW

Energy

Energy is a fundamental concept representing the capacity to perform work or produce change, existing in various forms that can be converted from one type to another. Key forms of energy include kinetic energy, associated with the motion of objects; potential energy, stored due to an object's position or configuration; thermal energy, related to temperature and particle movement; chemical energy, stored in chemical bonds and released during reactions; electrical energy, resulting from the flow of electrons; and nuclear energy, released during nuclear reactions. Energy resources are the natural or synthetic sources from which energy is derived. They are categorized into renewable resources, such as solar energy, wind energy, hydropower, geothermal energy and biomass, which are replenished naturally and sustainably. Non-renewable resources, include fossil fuels (coal, oil, natural gas) and nuclear fuels (uranium, plutonium), which are finite and deplete over time. A clear understanding of these concepts is essential for analysing the energy intensity which is defined as the total energy consumption divided by the GDP of a given country (Bhattacharyya, 2011). This study utilizes country- wide energy intensity data

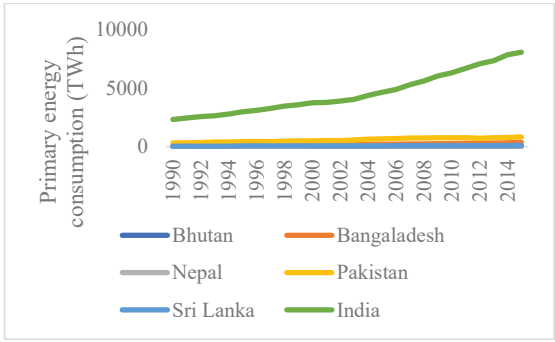

Figure 2.a: Trend of energy consumption in SAARC countries including India (1990-2015)
Source: World Bank data,1990-2015

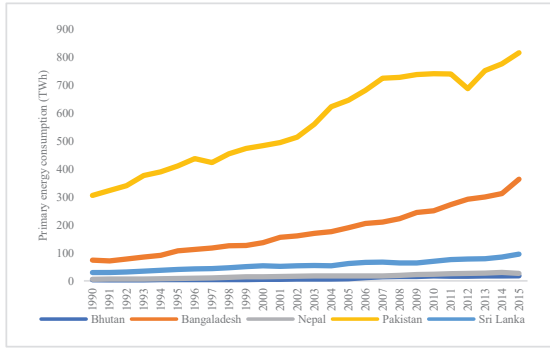

Figure 2.b: Trend of energy consumption in SAARC countries excluding India (1990-2015)
Source: World Bank data,1990-2015

published by the World Bank and the unit of measure is MJ / $ (2011 PPP). (See Appendix I)

Energy intensity and energy efficiency

Reducing energy intensity is linked with advanced energy conversion and energy efficiency methods. Such activities help to increase GDP of a country with a lower energy use (Martínez, Ebenhack & Wagner, 2019).

Energy efficiency refers use of less energy to produce a given level of production. At aggregate level, the amount of energy used to produce one unit of GDP is defined as energy efficiency. Energy efficiency improves when a given level of service is provided with reduced amounts of energy inputs or services are enhanced for a given amount of energy input (U.S. Department of Energy, 2023).

Further, Energy efficiency is the ratio of output of performance, service, goods or energy, to input of energy. Energy efficiency is measured as the amount of energy output for a given energy input. On the contrary, energy intensity calculated as units of energy per unit of GDP, is used to measure the energy inefficiency of a country (Erbach, 2015).

Improvement of energy efficiency is an important factor that contributes to reducing energy intensity. Also, reducing energy intensity is a proxy for improvement of energy efficiency. Lower energy intensity represents an efficient allocation of energy resources to generate wealth and a high quality of life (Martínez, Ebenhack & Wagner, 2019). Further, energy intensity improvement refers the decrease of energy supply per unit of GDP as the indicator to measure the energy efficiency.

Simply we can differentiate the energy intensity and energy efficiency as energy intensity involves the use of energy to produce a given level of output, but energy efficiency involves using technology that requires less amount energy to perform the same function. However, identifying the link between energy intensity and efficiency is more complex and controversial.

Energy intensity by region

Improving energy efficiency of the world to a double rate is one of the target goals of 7th Sustainable Development Goal: affordable and clean energy. To achieve this target, the global energy intensity should be reduced by 3.2 percent per year.

But the annual reduction of energy intensity was 2.6 percent in 2019. It shows that the world has fallen short to achieve SDG 7 as a consequence of failing to reduce the energy intensity. According to the International Energy Agency, reasons for the recent trend of energy intensity are rapid increase in energy-intensive economies and weaker energy efficiency policy in world economies (IEA, 2022).

On the other hand, improvement of energy intensity recorded 3.4 percent in developing Asia in 2020. It was the fastest progress among developing economies. The reason for this improvement was significant energy efficiency policies including Nationally Determined Contributions (NDCs) declared at COP26.

Above graph shows energy intensity improvement of the world in the past 20 years (between 1990 and 2010). According to the graph, the fastest rate of energy

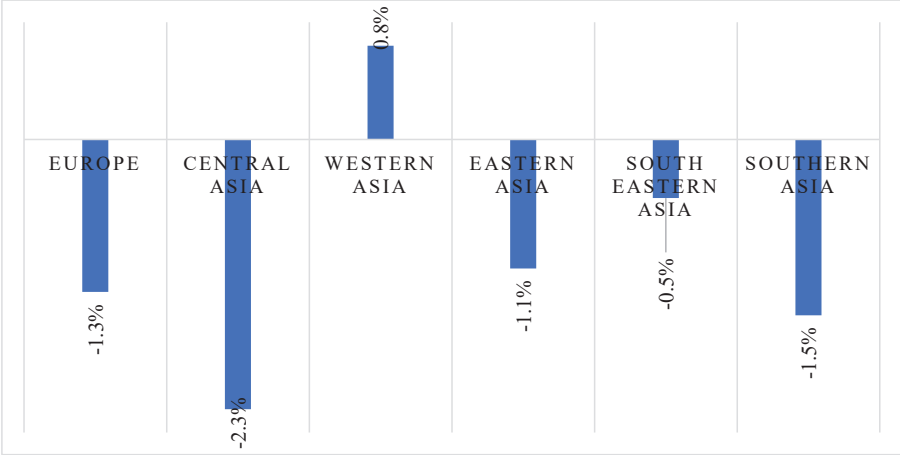

Figure 3: Annual Average Growth rate of Energy intensity between 1990 and 2010
Source: International Energy Agency, 2012

intensity improvement has been recorded in Central Asia as a 2.3 percent reduction between 1990 and 2010. Southern Asia and Europe region rank second and third in terms of improving energy intensity as 1.5 and 1.3 percent respectively. The slowest performing region to improving energy intensity is South Eastern Asia. It was a 0.5 percent improvement in energy intensity over 20 years. On the other hand, Western Asia is the region to show a deterioration in the energy intensity improvement.

Between 2010 and 2018, average improvement of energy intensity in Eastern Asia and South Eastern Asia recorded a rate of 3.1 percent. In Southern Asia and Central Asia, the average annual improvement rate was 2.6 percent. Nonetheless, Western Asia was still at a 0.8 percent increase in energy intensity between 2010 and 2018.

Since 2000, The EU and the USA have shifted towards less energy-intensive industry production and reduced energy intensity by two percent. But in 2020, it was much slower in both regions as recorded at -4.2 percent and -0.6 percent respectively. The high energy intensity recorded in China, Taiwan, South Korea and the Middle East countries is a consequence of the domination of energy-intensive industries. Lower energy prices and commodity-exporting-based economies failed to promote energy efficiency in 2020. In Asia, energy intensity shows an increasing trend, especially in China and India (Enerdata, 2021).

Energy intensity in SAARC countries

South Asian Association for Regional Cooperation is an organization of eight South Asian nations from economic and political perspectives. The member countries are Bangladesh, Bhutan, India, the Maldives, Pakistan, Afghanistan, Nepal and Sri Lanka. South Asia includes three of ten countries with the highest population in the world and their average annual growth was 5.9 percent between 2000 and 2018. In this region, the energy requirement is high to meet the demand of its 23.9 percent (in 2020) population. South Asian region depends on imports of commercial fossil fuels with lower energy efficiency.

Above graph shown that Bhutan recorded a high energy intensity in 2015. After Bhutan, rank in energy intensity from highest to lowest were Nepal, India, Maldives, Pakistan and Sri Lanka. According to the World Bank, Energy intensity registered 3.6 MJ / $ (2011 PPP), 3.3 MJ / $ (2011 PPP) and 2.3 MJ / $ (2011 PPP) in 1990, 2000 and 2010 respectively in Sri Lanka. It is shown that Sri Lanka also recorded slow and unstable energy intensity improvement. Accordingly, it has taken almost 20 years to drop approximately 56 percent in energy intensity from 1990 to 2010 (from 3.6 MJ / $ (2011 PPP) to 2.3 MJ / $ (2011 PPP)) of energy intensity. Energy intensity values in Bhutan in 1990,2000 and 2010 were 30 MJ, 21.7 MJ and 12.5 MJ. It shows that Bhutan recorded a faster improvement in energy intensity over every ten years than other SAARC countries, but it was

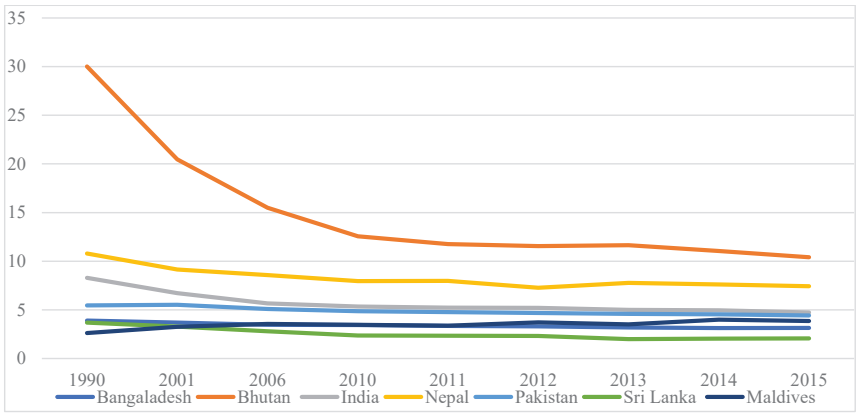

Figure 4: Energy intensity in Sri Lanka and other South Asian countries from 1990-2015
Source: World Bank data (1990-2015)

the highest level among them. Seasonality and weather conditions are the main barriers for reducing the energy intensity in Bhutan. Power generation in Bhutan has no peaking plants or reservoirs but mostly depends on the seasonality of the river. It pushes direct risk to energy efficiency and energy security as a result, as energy intensity is higher than other SAARC countries.

Bhutan is one of the countries to export energy to earn revenue, but it is importing a significant amounts of fossil fuel for generators, transportation and cooking needs. It also causes a worse Balance of trade and energy security than other SAARC countries (Shrestha *et al.*, 2021). Nepal recorded the highest energy intensity next to Bhutan among SAARC countries. It was 10.7 MJ / $ (2011 PPP), 9.2 MJ / $ (2011 PPP) and 7.9 MJ / $ (2011 PPP) in 1990, 2000 and 2010 respectively. Nepal is a country that has a large potential for hydropower. Unfortunately, less than two percent of hydropower is currently used. Moreover, The United Nations warns Nepal that "energy efficiency efforts in the country are still in their infancy". Nepal is identified as the poorest country in energy intensity due to lack of human resources and awareness of clean energy, the absence of an energy efficiency strategy and the agency to institutionalize energy efficiency (Shrestha *et al.*, 2021). Moreover, Nepal's urban population uses solid fuels and it causes 7,500 deaths annually due to low energy efficiency and lack of capable human resources to use modern energy technologies (Ministry of Population and Environment, 2017). Due to those situations, Nepal ranks as the country with the highest energy intensity level next to Bhutan.

India's energy intensity recorded 8.2 MJ / $ (2011 PPP), 6.5 MJ / $ (2011 PPP) and 5.3 MJ / $ (2011 PPP) in 1990, 2000 and 2010 respectively. In India, 44.7 percent rural population and 7.3 percent urban population do not have electricity and they still use firewood. They mostly depend on fuel wood and animal waste for their energy needs, although India is one of the countries with the top potential for using renewable and clean energy technologies like solar and wind, because of their supportive geographical, natural resources and climate conditions. From 1982 India developed a policy based on cost-effective PV technology, including Demonstration and Technology Utilization, Testing and Standardization, Industrial and promotional activities and Research and Development (Shrestha *et al.*, 2021). Those activities help to maintain lower energy intensity in India than Bhutan and Nepal.

In case of Pakistan, their energy intensity values in 1990, 2000 and 2010 were 5.3 MJ / $ (2011 PPP), 5.5 MJ / $ (2011 PPP) and 4.8 MJ / $ (2011 PPP) respectively. In this way, ten percent urban population lives without electrification and they use traditional energy sources like biomass in inefficient stoves. This reliance on biomass releases harmful pollutants, leading to indoor air pollution, which is associated with respiratory and cardiovascular issues, causes more than 50,000 deaths per year (WHO, 2005; Energypedia, 2017). However, successful energy policies help to maintain a less energy intensity level than Bhutan, India and Nepal namely; the Alternative and Renewable Energy Policy in 2011 and Pakistan Net Metering Policy for Solar PV and Wind Projects and power generation policy in 2015.

Bangladesh energy intensity level is lower than the other SAARC countries except Sri Lanka. It recorded 3.8 MJ / $ (2011 PPP), 3.5 MJ / $ (2011 PPP) and 3.4 MJ / $ (2011 PPP) in 1990, 2000 and 2010 respectively. 60-66 percent urban people of Bangladesh still use cow dung,

agricultural waste and wood for cooking and only seven percent of urban people use clean cooking fuels and technologies because of their lack of awareness about accessing modern and clean energy technologies (Aziz, Barua & Chowdhury, 2022). Even though successful energy policies lead to a better stage in energy intensity than other SAARC countries namely; Renewable Energy and Energy Efficiency Programme-2006, (Intended) Nationally Determined Contributions to promote off-grid solar energy as well as improved cook stoves, The Private Sector Power Generation Policy, Country Action Plan for Clean Cook stoves (CAP) in November 2013 (http://www.sreda.gov.bd/). In an overall sense, SAARC countries including Sri Lanka slowly reduce energy intensity levels (Asian Development Bank, 2019).

Energy intensity in Sri Lanka

Sri Lanka has the high energy intensity among the countries with per capita GDP between $3,000 and $4,500 in the world (ADB, 2019). Sri Lanka fulfilled its 46 percent of its energy requirement through domestic resources while 54 percent of energy resources and commodities were imported in 2017 (ADB, 2019). Sri Lanka has a greater dependence on imported energy resources and commodities, which annually requires around USD 3.7 Billion (CBSL, 2021). Therefore, reducing energy intensity (defined here as energy consumption per unit of GDP) should be one of the highest priority policies in Sri Lanka and other SAARC countries. Lower energy intensity signifies improved energy efficiency, allowing the economy to produce more output with less energy.

Empirical evidence

Literature about the relationship between energy intensity and urbanization was done by Liu & Xie (2013) in China. This study used a cointegration test to check long-term relationships and Asymmetric Analyses and Vector Error Correction Model were applied to check the deviation of variables with equilibrium. This study found that urbanization shows an asymmetric impact on energy intensity and there was a nonlinear relationship between urbanization and energy intensity in the research area. This study also found that when the threshold was reached, the adjustment process of energy intensity towards equilibrium was high and the growth rate of energy intensity was higher than urbanization.

Sadorsky (2013) also analysed the impact of income, urbanization and industrialization on Energy Intensity in developing countries. This study has chosen 76 developing countries for the panel data analysis. This study found that income has a negative impact on energy intensity that a one percent increase in income leads to reduce energy intensity by 0.45 percent to 0.35 percent and industrialization harms energy intensity that a one percent increase in industrialization corresponded to decrease energy intensity by 0.007 percent to 0.12 percent. At the same time, urbanization shows a mixed impact on energy intensity using heterogeneous panel regression techniques namely common correlated effect estimators and mean group estimators.

However, the study which was done by Bilgili *et al.* (2017) to analyse the effect of urbanization on energy intensity using ten Asian countries namely Vietnam, Bangladesh, Malaysia, Nepal, Thailand, China, South Korea, Indonesia, India and the Philippines. This study employed cross-sectional dependence and heterogeneity test, unit root and cointegration and causality test. The dependent variable of this paper was energy intensity and the independent variables were urbanization, ruralisation, GDP per capita and Squared value of GDP per capita, renewable energy consumption, non-renewable energy consumption and export. This study found that urbanization negatively impacts energy intensity.

Research done by Rafiq, Salim & Nielsen (2016) examined the impact of urbanization, openness and population density on emissions and energy intensity in developing countries. This study used a heterogeneous linear panel model and non-linear panel estimation. This study reveals that urbanization significantly increases energy intensity. Moreover, population density and non-renewable energy consumption also positively influence energy intensity and increase the emission level while renewable energy consumption is insignificant in energy intensity in the research area.

Zhu *et al.* (2021) analysed the impact of urbanization on energy intensity in OECD countries using Generalized Method of Moments (GMM), examined the differences in the impact of urbanization on energy intensity in both energy intensity degree and development level using a heterogeneity test and finally this study corresponded to find the impact of the process of urbanization on energy intensity using an innovation level as a moderating variable. This study has chosen 38 OECD countries as a sample and collected data from 1990 to 2015. This research summarized that urbanization shows a significant U-shaped effect on energy intensity. In addition, this study found that in countries having high energy intensity values, urbanization shows a significant impact, but it does not significantly impact on energy intensity when the countries have lower energy intensities. Finally, this research found that improvement in innovation leads to a negative impact of urbanization on energy intensity.

Elliott, Sun & Zhu (2017) have done a provincial level study for China to find the direct and indirect effects of urbanization on energy intensity using 30 provinces in China. This study employed mean group estimation techniques. This research found that the

direct impact of urbanization on energy intensity was positive while the indirect impact of urbanization tends to have negative impacts in China. The indirect impact of urbanization is measured through industrial upgrading, changing lifestyles, construction and transport. The results highlighted that indirect impact of urbanization through construction was higher than other indirect measurement. Koyuncu, Beşer & Alola (2021) also analysed the economic regime with urbanization and energy intensity. This study collected data for Turkey between 1990 and 2015. This study used per capita income, energy intensity and urbanization variables to examine the environmental Kuznets Curve by Threshold Autoregressive Model. Result of this study employed that increasing energy intensity and urbanization obstruct environmental sustainability of the country and income growth lead to decrease environmental degradation.

Shah, Naqvi & Anwar (2020) used the Johnson co-integration and Vector Error Correction Model to find the link between emission, urbanization, income per capita, imports, exports, trade openness and energy intensity in Pakistan based on environmental transition and the ecological modernization theories. The data collected from 1980 to 2017 as a sample. Findings of this research confirm that there is a U shape and dynamic relationship between per capita income, carbon emission and urbanization. This study also corresponded that financial development, inflation and urbanization positively impact the energy intensity. On the other hand, carbon emission, trade openness and labour force participation negatively impact the energy intensity.

The study of Chen & Zhou (2021) explored the relationship between urbanization and energy intensity using 72 countries. Data were collected in this study from 2000 to 2014. The panel threshold method showed that there is a positive relationship between urbanization and energy intensity. However, the quality of the threshold value exceeds energy intensity by 0.033. This study also found that income and energy types impact the institutional threshold and it decreases energy consumption and promotes energy reduction in both OECD and Non-OECD countries. A research done by Aboagye & Nketiah-Amponsah (2016) examined the impact of economic growth, industrialization and urbanization on energy intensity in Sub-Saharan Africa. This study employed the Generalized Method of Moment. This study revealed that urbanization and industrialization positively impact energy intensity while FDI and trade openness negatively impact energy intensity. This study highlighted the existence of the Environmental Kuznets Curve between economic growth and energy intensity.

Lv *et al.*, (2018) have conduct a research to investigate the impact of urbanization on energy intensity by adopting a new technology using 30 provinces in China from 1990 to 2015. This study employed homogeneous-heterogeneous slope with static-dynamic model specifications as an analysing method. This study used economic growth, industrialization and FDI as control variables. The results of this study observed that economic growth and FDI negatively impact the energy intensity while urbanization and industrialization negatively impact the energy intensity.

Further, Farajzadeh & Nematollahi (2018) investigated energy intensity and its components including energy efficiency and structural change in Iran. This study focused regression analysis through multilayer perceptron and wavelet-based neural networks. This study highlighted that non-linear relationship between energy intensity and capital-output ratio as well as income. Nonetheless, insignificant results observed the impact of trade and energy price index on energy intensity. In case of urbanization, it negatively impacts the energy intensity. Rudenko & Tanasov (2022) applied cointegration regression method to find out the long-term relationship between energy intensity and its determinant in Indonesia between 1990 and 2016. This study examined the impact of industry value added, FDI, domestic credit to the private sector, share of nuclear energy and real price of crude oil. According to the finding of this study, industrialization and globalization positively impact the energy intensity. At the same time energy intensity is negatively determined by financial development, energy consumption and price of crude oil.

According to literature, rapid urbanization is a crucial contribution factor on energy intensity. Understanding energy intensity is important to implement the policies to achieve sustainable development. In addition, there are no empirical studies in Sri Lanka related to energy intensity. Therefore, the objective of this study is to examine the effect of urbanization on energy intensity in SAARC countries and then compare Sri Lanka's status with other SAARC countries. Empirical evidence in this study reveals the mixed impact of urbanization on energy intensity in the world. Aboagye & Nketiah-Amponsah (2016), Koyuncu, Beşer & Alola, (2021), Elliott, Sun & Zhu, (2017), Shah, Naqvi & Anwar (2020), Chen & Zhou (2021) and Rafiq, Salim & Nielsen (2016), found a positive impact of urbanization on energy intensity in Sub-Saharan Africa, Turkey, China, Pakistan, both OECD & Non-OECD countries and selected developing countries. At the same time, researches done by Bilgili *et al.*, (2017) in ten Asian countries namely Vietnam, Bangladesh, Malaysia, Nepal, Thailand, China, South Korea, Indonesia, India and the Philippines, Lv *et al.* (2018) in China and Farajzadeh & Nematollahi (2018) in Iran shows a negative impact. Further Liu & Xie (2013)

in China, Sadorsky (2013) in 76 developing countries and Zhu *et al.* (2021) in OECD countries found that there is a mixed impact of urbanization on energy intensity.

MATERIALS AND METHODS

Theory

This study used "the Intensity of Energy Use model (IEU)" derived from the "Environmental Kuznets Curve" as a theory. IEU explained the relationship between energy intensity and per capita income like a Kuznets Curve.

This graph indicates that in the early stage of economic growth, energy intensity increases. However, beyond some level of income per capita, energy intensity decreases. Distribution of income, international trade, structural changes, technical progress and improvements in energy efficiency, institutions and governance and consumer preferences, industrialization, globalization and urbanization are the causes of this inverted U-shape (Chima, 2011).

Based on this theory; urbanization, per capita income, squared value of per capita income, capital formation, industrialization, labour, carbon dioxide emission and squared value of carbon dioxide are selected as independent variables and the dependent variable is energy intensity level of primary energy (measurement of energy intensity: MJ / $ (2011 PPP), i.e., megajoules in 2011 USD at purchasing power parity).

Relevance of panel data analysis

A panel data or longitudinal data set consists of time series for each cross-sectional group in the data set (Wooldrige, 2013). This study analyses the impact of urbanization on energy intensity in selected SAARC countries, namely, Bhutan, Bangladesh, Nepal, India, Pakistan and Sri Lanka for the 1990-2015 period. For this study we collected data for 26 years. Therefore, it is a balanced panel data set since each country has observations for 26 years.

Advantages of panel data are more accurate inference of model parameters, greater capacity for analysing the complexity in data, controlling the impact of omitted variables, generating more accurate forecasting for outcomes and less measurement errors. However, panel model has some econometric issues such as autocorrelation, heteroscedasticity and cross-correlation in cross sectional units at the same point over time. Panel data analysis Error Component Model (ECM) namely Fixed Effect Model (FEM) and the Random Effect Model (REM) use to solve those econometric issues.

Fixed Effect Model is commonly used where the individual specific intercept may be correlated with one or more regressors, but it consumes a lot of degrees of freedom (df) when the sample is very large. This model allows to differ among individuals to reflect the unique feature of individual units. This is done by using a group of dummy variables to identify cross sectional units. Therefore, the Fixed Effect Model using dummy variables is called a "Least Squared Dummy Variable model (LSDV)"(Gujarati & Porter, 2009).

In the Random Effect Model, it assumes that the intercept value of an individual unit is a random drawing from a larger population. It is used where the intercept of each cross-sectional unit is uncorrelated with the regressors. Random Effect Model is more economical than the Fixed Effect Model in terms of the number of parameters estimated and also time-invariant regressors can be used in the Random Effect Model. Therefore, if it is assumed that error and regressors are uncorrelated the Random Effect Model is appropriate. But, the Fixed Effect Model can be used when error and regressors are correlated (Gujarati & Porter, 2009). Hausman test is also used to choose the appropriate method between Fixed Effect and Random Effect for the research. According

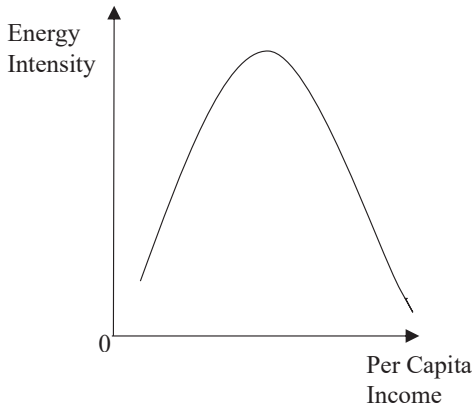

Figure 5: Intensity of Energy Use Model

Source: Chima (2011)

Table 1: Definition of variables

Variable	Variable description, units and hypothesis	Abbreviation used in the equation
Dependent Variable: Log (Energy Intensity)	Energy intensity level of primary energy (MJ/$2011 PPP GDP)	ln(EI)
Independent Variables: Log (Urbanization)	Urban population (percent of urban population) Hypothesis: urbanization has no effect on energy intensity	ln(Urb)
Log (Per Capita Income)	GDP per capita, PPP (current international $) Hypothesis: per capita income has no effect on energy intensity	ln(PCI)
Squared Value of log (Per Capita Income)	GDP per capita, PPP (current international $): Energy intensity has a different effect at higher per capita income levels (compared to low per capita income) Hypothesis: Squared value of per capita income has no effect on energy intensity	Sqrd ln(PCI)
Log (Capital formation)	Gross capital formation (current US $) Hypothesis: Capital formation has no effect on energy intensity	ln(CF)
Log (Industrialization)	Industrial value added (current US $) Hypothesis: Industrialization has no effect on energy intensity	ln(IND)
Log (Labour)	Total labour force Participation Hypothesis: Labour has no effect on energy intensity	ln(L)
Log (carbon dioxide)	Carbon dioxide emission level (Kt) Hypothesis: Carbon dioxide has no effect on energy intensity	ln(C02)
Squared value of log (carbon dioxide)	Carbon dioxide emission level (Kt) Hypothesis: Squared value of carbon dioxide has no effect on energy intensity	Sqrd ln(C02)

Data for required variables were obtained from World Bank data base. Accessed date: 04.06.2021-11.01.2022

to the test, if the computed chi-square value exceeds the critical chi-square value for given degrees of freedom and the level of significance, Fixed Effect Model is more appropriate.

Data

This study uses secondary data from six SAARC countries, namely, Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka. Afghanistan was not included due to non-availability of data. The annual data were collected from the World Bank official website (https://data.worldbank.org/) for the 1990-2015 period (the World Bank data required for the variables of this study is only available from 1990-2015). Each country is treated as a balanced panel and the study uses panel data analysis techniques in econometrics. The variables used in the analysis and their definitions are given in Table 1.

$$ln\,(EI)_{it} = \alpha_1 + \sum_{j=1}^{N} \alpha_i D_j + \beta_1 \ln(Urb)_{it} + \beta_2 \ln(PCI)_{it} + \beta_3 Sqrd\ ln(PCI)_{it} + \beta_4 ln\,(CF)_{it} + \beta_5 \ln(IND)_{it} + \beta_6 \ln(L)_{it} + \beta_7 \ln(Co2)_{it} + \beta_8\ Sqrd\ ln\,(Co2)_{it} + U_{it} \quad (01)$$

$$ln\ (\widetilde{EI})_{it} = \dot{\alpha_1} + \sum_{J=1}^{N} \alpha_i D_j + \beta_1 \ln(\dot{Urb})_{it} + \beta_2 \ln(PCI)_{it} + \beta_3 Sqrd\ ln(PCI)_{it} + \beta_4 ln\ (CF)_{it} + \beta_5 \ln(IND)_{it} + \beta_6 \ln(L)_{it} + \beta_7 \ln(Co2)_{it} + \beta_8\ Sqrd\ ln\ (Co2)_{it} + U_{it} \quad (02)$$

$$\ln\ (EI)_{it} = (\beta_0 + \alpha_j) + \left[\beta_1 \ln\ (Urb)_{it} + \delta_j\right] + \beta_2 \ln(PCI)_{it} + \beta_3 Sqrd \ln(PCI)_{it} + \beta_4 ln\ (CF)_{it} + \beta_5 \ln(IND)_{it} + \beta_6 \ln(L)_{it} + \beta_7 \ln(Co2)_{it} + \beta_8\ Sqrd\ ln\ (Co2)_{it} + U_{it} \quad (03)$$

Variables and model specifications

This study examines the effect of urbanization on energy intensity in the SAARC region countries by using country wise panel data. Urban population is the proxy variable used for urbanization. To test the hypothesis related to Environmental Kuznets Curve (EKC) the study used two variables i.e., per capita income and the squared value of per capita income which could identify the inverted U shape behaviour of energy intensity with income. The model also includes six country dummy variables to detect country effect. Five other controlled variables are included based on the evidence from the literature that could affect energy intensity. The definitions of the variables used in all models are given in Table 1. The data were analysed using STATA software. Considering the panel data structure in the estimation first model (Equation 1) was estimated using country fixed effects.

Second model (Equation 2) includes country dummies and estimated as an LSDV model. The difference between equations 1 and 2 is LSDV model shows the estimated country coefficients and the fixed effect model does not show it. The second model captures only the differences in energy intensity across countries (differences in the intercept terms). Since Sri Lankan dummy variable was omitted to avoid the dummy variable trap, the coefficients of the remaining country dummies can be interpreted relative to Sri Lanka.

A third model was estimated (Equation 3) to examine how urbanization process has affected countries differently, i.e., differences in the slope coefficients of urbanization between countries.

In addition to the Table 1,

Where,

= Intercept

= Dummy Variables for countries j = *1 .....6*

N= No. of Dummy Variables (06)

= Intercept for countries *j = 1 .....6*

= slope, use to measures the difference in the return to urbanization between countries

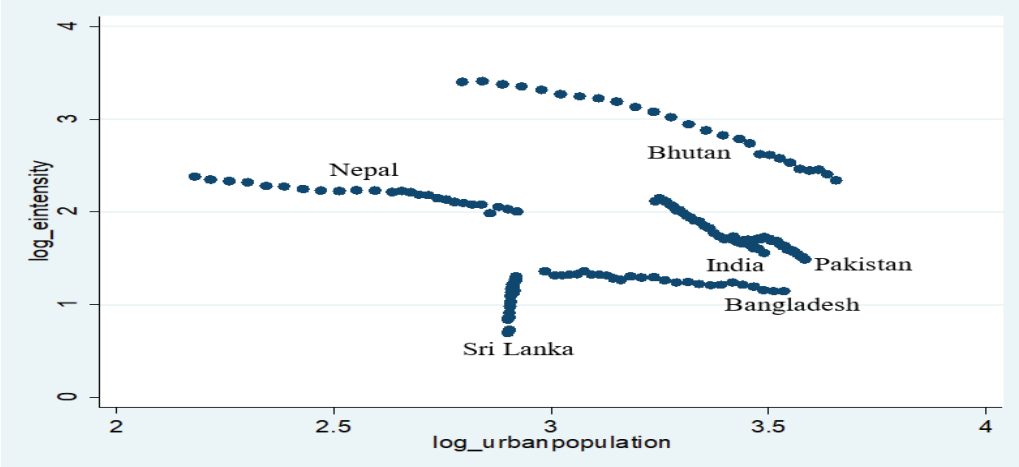

Figure 6: Scatter plot of urbanization and energy intensity
Source: Computed by authors, 2022

Table 2: Summary statistics (1990-2015)

Variables	Mean	Minimum	Maximum	Std.Dev	Skewness	Kurtosis
EI	7.7749	1.993	30.289	6.2907	2.0474	6.7606
Log(EI)	1.8201	0.6896	3.4108	0.6423	0.6667	2.8972
URB	24.703	8.854	38.678	7.5856	-0.1389	1.8651
Log(URB)	3.1532	2.1809	3.6553	0.3128	-0.6851	2.7951
PCI	3178.456	751.8356	11557.49	2252.306	1.6836	5.7898
Log(PCI)	7.856	6.6225	9.3551	0.6374	0.2438	2.4837
CF	7.14E+10	7.75E+07	7.22E+11	1.49E+11	3.2276	12.7947
Log(CF)	23.3386	18.1662	27.305	2.175	-0.5339	2.8794
IND	5.19E+10	6.26E+07	5.75E+11	1.20E+11	3.2343	12.788
Log(IND)	22.6812	17.953	27.0781	2.2501	-0.1179	2.452
L	8.79E+07	214298	4.77E+08	1.48E+08	1.8004	4.487
Log(L)	16.6422	12.2751	19.9837	2.2513	-0.5491	2.6605
Co	221681.3	130	2.15E+06	472803.2	2.5136	8.5872
Log(Co)	9.7918	4.8675	14.5811	2.6018	0.069	2.1466

Observation:156
EI= Energy Intensity; URB= Urbanization; PCI= Per Capita Income; CF= Capital Formation; IND= Industrialization; L=Labour; Co= Carbon dioxide emission
Source: Computed by authors,2022

In the study we used cluster standard error for fixed effect model and other two models used Newey-West standard errors to reduce Heteroscedasticity and autocorrelation.

RESULTS AND DISCUSSION

Descriptive analysis

Annual data were collected from Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka as sample countries for the period from 1990 to 2015. All variables were used in natural log form. The panels are balanced panels which means that all the countries have data for all the years.

Summary statistics are given in Table 2. All vaiables are close to 0 in skewness and it shows that the variables are normally distributed. At the same time, all the variables have less than 3 kurtosis value. Accodingly, these variables are playtikurtic.

The study uses a scatter diagram to explore the relationship between urbanization and energy intensity in six SAARC countries: Bhutan, Bangladesh, India, Nepal, Pakistan and Sri Lanka. The plot reveals a moderately negative linear relationship overall but highlights country-specific differences. India and Pakistan show similar impacts of urbanization on energy intensity, while Sri Lanka deviates due to its unique energy mix and urbanization dynamics. This divergence suggests that Sri Lanka's relationship between urbanization and energy intensity differs significantly from the other nations in the region. Figure 1 shows that urbanization in Sri Lanka increased only slightly between 1990 to 2015, rising

from about 15% to just over 18%. This slow growth rate makes it appear almost unchanged in Figure 6 scatter plot. So, urbanization hasn't stopped in Sri Lanka, but it has progressed very slowly compared to other SAARC countries. According to some studies, urban housing cost has gone up in Sri Lanka (Weeraratne, 2020). Higher rental rates as well as property values in urban areas may make urban living less attractive to low- and middle-income populations, which could have contributed to the slower rate of urbanization in Sri Lanka, among other factors.

Regression analysis on energy intensity

The Fixed Effect Model assumes a constant intercept and slopes. This Fixed Effect Model $R^2 = 0.9555$ implies, that model accounts for 95 percent of the total variance in the energy intensity of SAARC countries. However, variables were not significant except urbanization. To test the differences across countries in energy intensity, this study used the LSDV model incorporating country dummy variables to a Fixed Effect Model. The results of this model are reported in column 03 in Table 3. In the third model, country dummies interacted with urbanization variable in order to examine how urbanization has affected countries differently. Model 01 was estimated using cluster standard error and the other two models were estimated using Newey-West standard errors that do some correction for heteroscedasticity and autocorrelation (Since the model 01 was estimated using fixed effects, STATA doesn't allow to use of Newey-West standard errors. Therefore, this study used cluster standard error in model 01). The Newey standard error is a method for adjusting standard errors in regression models to account for both heteroscedasticity and autocorrelation in the residuals (Newey & West, 1987). The F test accepts all three models. If compared the AIC of LSDV with fixed effect, it chooses the LSDV model. Further, we observe a change in the significance of variables from fixed effect to LSDV as a result of adding country dummies in the second model (Equation 2). The third model in column 04 indicates an even better fit than LSDV model in column 03 with a lower AIC value. There are similarities as well as differences in the results between the two models.

The effect of urbanization in the LSDV model (column 03) and LSDV model with country-urbanization interactive variables (column 04) are somewhat different. The coefficient of urbanization variable in both the models has negative signs; meaning that energy intensity in SAARC countries declines with urbanization. This result is consistent with many studies in the literature (Bilgili *et al.*, 2017 and Elliott, Sun & Zhu, 2017), which could have multiple explanations. Presumably urbanization can change the lifestyle of the people which could affect energy demand. Their daily energy requirements in cooking, heating, cooling and transportation are some items in their energy basket. The net effect of these adjustments seems negative. This means that urban dwellers lower the energy usage in some elements in the commodity basket. For example, a higher concentration of urban population could reduce the energy requirement in transportation. Another possibility is urban people could be more conscious of energy usage. Also, urbanization often leads families to transition from traditional fuels, like firewood which might be typically less efficient to commercial fuels such as LP and natural gas, which offer higher efficiency. For example, in a typical setting of a household where working parents' use of LP gas in cooking is efficient and time-saving compared to the use of firewood. Such changes can contribute to reducing energy intensity, as households adopt more efficient energy sources. Column 04 model indicates that one percent increase in urbanization reduces energy intensity by 4.8935 percent in Sri Lanka (The coefficient of urbanization represents Sri Lanka, since Sri Lanka is considered as the base group for the country dummies. The country-urbanization variable coefficients of the other five countries reflect the difference in the slope compared to Sri Lanka). In the three models, urbanization has the highest effect on energy intensity in the model in column 04 in Table 3.

In order to test the Environmental Kuznets Curve hypothesis (EKC hypothesis) this study used two variables, i.e., per capita income and the squared value of per capita income as in the literature. The per capita income variable is positive and statistically significant at five percent and one percent respectively. The squared value of the same variable is negative and significant at one percent in the second and third models. The signs of these two variables comply with the EKC hypothesis and imply inverted U-shaped behaviour in energy intensity with per capita income for all the SAARC countries. In the third model when per capita income increases by one percent there will be a 0.6360 percent increase in the energy intensity. The squared per capita income variable has a coefficient value of -0.0536, which means that for a one percent increase in this variable, it will decrease energy intensity by 0.0536 percent. This result is consistent with the other studies in the literature, i.e., at the initial level of income energy intensity increases and after some income level it starts declining. This is an important finding for the SAARC region, as rising living standards and income levels in these countries could lead to a decline in energy intensity, thereby contributing to improve the environmental quality standards such as the air quality index. Capital formation variable has somewhat

Table 3: Impact of urbanization on energy intensity

Column -01	Column -02	Column -03	Column -04
Independent variables	Fixed Effect	LSDV	LSDV with country-urbanization interactive variables
Intercept	-0.3452 (2.2149)	-0.6413** (1.606)	22.4245* (6.6897)
Urbanization	-0.4391** (0.1691)	-0.4391* (0.0924)	-4.8935** (2.1797)
Per capita income	0.7984 (0.8124)	0.7984** (0.3749)	0.6360* (0.2381)
Squared of per capita income	-0 0.771 (0.0389)	-0. 0771* (0.0201)	-0.0576* (0.0131)
Capital formation	0.4181 (0.0446)	0.0418*** (0.0246)	0.0079 (0.0130)
Industrialization	-0.1012 (0.0708)	-0.1012** (0.0339)	-0.1091* (0.0198)
Labour force participation	0.0929 (0.0774)	0.0929*** (0.0476)	-0.3507* (0.0650)
Carbon dioxide emission	0.1256 (0.129)	0.1256** (0.0534)	-0.2739* (0.0639)
Squared of carbon dioxide emission	0.0059 (0.0064)	0.0059*** (0.0033)	0.0239* (0.0045)
Bangladesh		-0. 5054* (0.1413)	-14.4923** (6.5530)
Bhutan		2.6663* (0.1643)	-13.3716** (6.4883)
India		-0. 7211** (0.2633)	-8.9958 (6.8316)
Nepal		0.4306* (0.1136)	-13.4981** (6.4668)
Pakistan		-0. 0944 (0.1487)	-18.7590* (6.7781)
Bangladesh*Urbanization			5.0976** (2.2392)
Bhutan*Urbanization			4.7824** (2.2211)
India*Urbanization			3.6354 (2.3276)
Nepal*Urbanization			4.9547** (2.2159)
Pakistan*Urbanization			6.3577* (2.3058)
Number of observations	156	156	156
R squared	0.9555	0.9961	0.9990
AIC (without cluster and Newey-West standard error)	-545.2374	-535.2374	-732.6684
F value		3390.08	13549.59

*- 1 percentage significant level; **- 5 percentage significant level ; ***- 10 percentage significant level respectively: Cluster Standard Error for model 01 and Newey-West Standard Error for models 02 & 03 are given in parenthesis.

different results in columns 02 and 03. It is significant only in column 02. This result between energy intensity and capital formation needs further investigation.

To check the impact of industrialization on energy intensity, this study takes an industrial value added as a measure of industrialization. Industrial sector activities share more energy than the agriculture and service sectors. Therefore, if industrial activities use green technologies, it can reduce the energy intensity. Otherwise, energy intensity will increase. The coefficient of this variable in columns 03 and 04 has almost the same effect on energy intensity. The relationship is negative and significant at five percent and one percent levels. One percent increase in an industrial value-added corresponds to a decrease in energy intensity by 0.1091 percent. This implies industrialization in the SAARC region has shifted towards less energy intensive industries which is a positive development, yet needs an in-depth investigation.

The two models in columns 03 and 04 show a mixed result in labour force participation. The variable has a negative and significant effect on energy intensity in column 04 which is the best fit of all the three models. According to this model, a one percent increase in labour force participation corresponded to a -0.3507 percent decrease in energy intensity. According to literature in SAARC countries, increases the labour force participation leads to increases in the energy intensity while our study finds a different result which needs further investigation.

Scientific evidence proves that increasing carbon dioxide is a key factor in global warming and other environmental pollution. Result in column 04 indicates U shape behaviour between carbon dioxide and energy intensity when considered the two variables together. This model shows that, one percent increase in CO_2 decreases the energy intensity by 0.2739 percent. The squared value of the same variable indicates one percent increase would increase energy intensity by 0.0239.

Cross country differences in energy intensity and urbanization

Cross country differences were examined using six country dummies where Sri Lanka is considered as the base group in the LSDV model in column 03. The model in column 04, includes both country dummies and country-urbanization interactive variables. Since the best fit according to AIC among all the three models is the model in column 04, we interpret column 04 results in this case too.

In all the five SAARC countries energy intensities are lower than Sri Lanka. This raises the question whether Sri Lanka is the least efficient country in energy usage among SAARC countries. Being a country with high dependency on fossil energy resources, Sri Lanka needs an accelerated action plan to be implemented to bring down the energy intensity. Among all the SAARC countries Pakistan has the lowest energy intensity. The other countries, from the lowest intensity to the highest in the order are, Bangladesh, Nepal, Bhutan and India. The coefficients of four countries namely, Pakistan, Bangladesh, Nepal and Bhutan are statistically significantly different from Sri Lanka. Coefficient of India was not significantly different from Sri Lanka. This implies there is a significant cross-country variation in energy intensity in the SAARC region.

The group of interactive variables indicates that urbanization has differential impact on energy intensity in different countries. Except for India, slope coefficients of the country-urbanization interactive variables in the other four countries (Bhutan, Bangladesh, Nepal and Pakistan) are statistically significantly different from the slope of the same variable in Sri Lanka.

Also, the fact that these interactive variable coefficients being positive is referred to urbanization which has a higher impact in the above four countries compared to Sri Lanka, i.e., rapid urbanization will bring down energy intensity at a faster rate in Sri Lanka.

In this context, Pakistan has the highest rate of increasing energy intensity with urbanization. If we rank the impact of urbanization on other countries from lowest to highest, we find the ranking order of India, Bhutan, Nepal and Bangladesh. Therefore, higher urbanization will have adverse consequences on the environment in these countries due to increased energy intensity.

When compared to Sri Lanka, countries with lower energy intensity may have been affected by some favourable policies adopted by those countries, namely: Bangladesh, Nepal, Bhutan and India. For example, in Bangladesh, Renewable Energy and Energy Efficiency Programme and Country Action Plan for Clean Cookstoves (CAP) were started in 2006 and 2013 respectively (http://www.sreda.gov.bd/). In 1982 India developed a policy that cost-effective PV technology with promotional activities and research and development (Shrestha *et al.*, 2021). Those activities may have helped to reduce energy intensity in Bangladesh and India than in Sri Lanka.

Summary of results and discussion

Based on the model fitting criterion like AIC, we were able to choose the third model as our best fit for the panel data structure. Thus, in addition to the panel-

fixed effects procedure, we used LSDV procedure which will give country coefficients. In the three models, sign and the size of the coefficient of urbanization and per capita income variables were consistent. Most of the other main variables (except country dummies) had similar coefficients in all three models. Country dummy coefficients were different in the third model and we chose the third model (column 04) as the best fit for interpretation. Urbanization in the SAARC region increases energy intensity in all the countries except Sri Lanka. However, the effect of urbanization is not the same in all the countries as expected. According to the results of this study urbanization increases energy intensity in Pakistan at the highest rate in the SAARC region. Per capita income and the squared value of per capita income variable results confirm EKC hypothesis in the third model. Industrialization and labour force participation lower energy intensity. Carbon dioxide emission and the squared value of that variable show U-shaped behaviour with energy intensity. According to country dummies, Pakistan has the lowest energy intensity while Sri Lanka has the highest energy intensity.

CONCLUSION AND POLICY RECOMMENDATIONS

The objective of this paper was to examine the impact of urbanization on energy intensity in the SAARC countries. Thus, a lower energy intensity is always preferred in a country's energy policy. It is also a fairly good proxy to compare the energy efficiency at the aggregate energy consumption level, between countries. Many countries face the problem of trade-off between achieving higher economic prosperity with a lower energy intensity. Among many factors that affect energy intensity, urbanization is identified as one of the major factors in the literature. Therefore, this paper focused on estimating the effect of urbanization on energy intensity in the SAARC countries since there were no other studies in this regard. The study used 1990-2015 annual data for the SAARC countries. Due to the panel structure in the data this study used the fixed effects model, LSDV model and LSDV with country-urbanization interactive variables model (Table 3, column 04). The fixed effects and the LSDV model results were the same. The reason to estimate the LSDV model is to obtain the country dummy variable coefficients for comparison across countries which hides in the fixed effects model.

Overall results from the three regression models indicate that the best fit of the three models is the LSDV model with country-urbanization interactive variables. This model includes eight control variables, five country dummies and five country-urbanization interactive variables while considering Sri Lanka as the base group. According to the results of LSDV model with country-urbanization interactive variables, cross-country comparison indicates that there is a significant variation in energy intensity in the SAARC region. Sri Lanka has the highest energy intensity and Pakistan has the lowest. The other countries, from lowest intensity to highest in the order are Bangladesh, Nepal, Bhutan and India. This implies that Sri Lanka uses the highest amount of energy to produce a unit of GDP in the SAARC region. Accordingly, among the SAARC countries Sri Lanka is not efficiently using the energy.

Our key variable urbanization indicates differential effects in SAARC countries. It lowers energy intensity in Sri Lanka, which is a piece of good news. Rapid urbanization will bring down energy intensity at a faster rate in Sri Lanka. In this context, Pakistan has the highest rate of increasing energy intensity with urbanization. If we rank the impact of urbanization on other countries from lowest to highest, we find the ranking order of India, Bhutan, Nepal and Bangladesh. Higher urbanization will lead to adverse environmental consequences. These countries need high profile coordinated government intervention to lower the impact of urbanization to move toward lower energy intensity in the long run. Our analysis with the help of country-urbanization interactive variables was able to show that the effect is not constant across countries. Many studies in the literature estimate a constant country effect of urbanization, which will yield poor estimates given the heterogeneous nature in the economies. Analysis in this study is helpful to introduce integral country-specific policy measures in both urban and energy use planning to identify the level of effort that each country has to put. Such efforts will help to achieve sustainable economic prosperity in the long run by mitigating adverse consequences of higher energy intensity.

In the context of Sri Lanka, this is vital since the country is entirely importing fossil energy resources and products which account for USD 3.7 billion. Sri Lanka has the potential to lower the energy intensity by cutting down the energy use especially in the transportation sector. Particular attention can be given to improving the conditions in the public transportation which will cut down our energy consumption significantly. The PCI variable together with the squared value of PCI results comply with the EKC hypothesis as in the literature. In the SAARC region, India too has to give higher attention to achieving higher energy efficiency and lower energy intensity since India ranks next to Sri Lanka in terms of inefficiency in energy consumption (being the second highest country in energy intensity).

REFERENCES

Aboagye, S. & Nketiah-Amponsah, E. (2016) The implication of economic growth, industrialization and urbanization on energy intensity in Sub-Saharan Africa, *Journal of Applied Economics and Business Research*, 6(4), pp: 297–311.

Asian Development Bank (2019) *Sri Lanka: Energy Sector Assessment, Strategy, and Road Map*. [Online] Available from: www.adb.org [Accessed: 23rd August 2022]

Aziz, S., Barua, S. & Chowdhury, S. A. (2022) Cooking energy use in Bangladesh: Evidence from technology and fuel choice, *Energy*, 250, p. 123696.
DOI:https://doi.org/10.1016/j.energy.2022.123696

Bilgili, F., Koçak, E., Bulut, Ü. and Kuloğlu, A. (2017) The impact of urbanization on energy intensity: Panel data evidence considering cross-sectional dependence and heterogeneity, *Energy*, 133(August), pp: 242–256.
DOI:https://doi.org/10.1016/j.energy.2017.05.121

Bhattacharyya, S. C. (2011) *Energy Economics*, London: Springer.

Central Bank of Sri Lanka (CBSL) (2021) *Annual Report*. [Online] Available from: https://www.cbsl.gov.lk/en/publications/economic-and-financial-reports/annual-reports/annual-report-2021 [Accessed: 22nd September 2022]

Chen, Z. & Zhou, M. (2021) Urbanization and energy intensity: evidence from the institutional threshold effect, *Environmental Science and Pollution Research*, 28(9), pp: 11142–11157.
DOI:https://doi.org/10.1007/s11356-020-11386-8

Chima, C. M. (2011) Intensity of energy use in the U.S.A.: 1949 - 2003, *Journal of Business & Economics Research (JBER)*, 5(11), pp: 17–30.
DOI:https://doi.org/*10.19030/jber.v5i11.2599*

Elliott, R.J.R., Sun, P. & Zhu, T. (2017) The direct and indirect effect of urbanization on energy intensity: A province-level study for China, *Energy*, 123(15 March), pp: 677–692.
DOI:https://doi.org/10.1016/j.energy.2017.01.143

Enerdata (2021) *Global Energy Statistical Yearbook 2021*. Available from: https://yearbook.enerdata.net/total-energy/world-energy-intensity-gdp-data.html [Accessed: 21 July 2022]

Energypedia (2017) *Pakistan Energy Situation*. Available from: https://energypedia.info/wiki/Pakistan_Energy_Situation [Accessed: 15th December 2021]

Erbach, G. (2015) *Briefing: Understanding energy efficiency, European Parliament Research Service.* [Online] Available from: http://www.europarl.europa.eu [Accessed: 21st May 2023]

Farajzadeh, Z. & Nematollahi, M. A. (2018) Energy intensity and its components in Iran: Determinants and trends, *Energy Economics*, 73(May), pp: 161–177.
DOI:https://doi.org/10.1016/j.eneco.2018.05.021

Gujarati, D. N. & Porter, D. C. (2009) *Basic Econometrics*. 5th edn. USA: McGraw-Hill.

Huang, J. & Chen, X. (2020) Domestic R&D activities, technology absorption ability, and energy intensity in China, *Energy Policy*, 138(March).
DOI:https://doi.org/10.1016/j.enpol.2019.111184

International Energy Agency (IEA) (2022) *SDG7: Data and Projections*, Paris: International Energy Agency [Online] Available from: https:www.iea.org/reports/sdg7-data-and-projections [Accessed: 22nd May 2023]

Koyuncu, T., Beşer, M. K. & Alola, A. A. (2021) Environmental sustainability statement of economic regimes with energy intensity and urbanization in Turkey: a threshold regression approach, *Environmental Science and Pollution Research*, 28(31), pp: 42533–42546.
DOI:https://doi.org/10.1007/s11356-021-13686-z

Liu, Y. & Xie, Y. (2013) Asymmetric adjustment of the dynamic relationship between energy intensity and urbanization in China, *Energy Economics*, 36(March), pp: 43–54.
DOI: https://doi.org/10.1016/j.eneco.2012.12.003

Lv, Y., Si, C., Zhang, S. & Sarwar, S. (2018) Impact of urbanization on energy intensity by adopting a new technique for regional division: evidence from China, *Environmental Science and Pollution Research*, 25(36), pp: 36102–36116.
DOI:https://doi.org/10.1007/s11356-018-3412-1

Martínez, D. M., Ebenhack, B. W. & Wagner, T. P. (2019) *Energy Efficiency*. Cambridge, MA : Elsevier Ltd.

Ministry of Population and Environment (2017) *Biomass Energy Strategy 2017*. [Online] Available from: http://www.aepc.gov.np [Accessed: 20th November 2022]

Newey, W. & West, K. (1987) A simple, positive semidefinite, heteroskedasticity and autocorrelation consistent covariance matrix, *Econometrica*, 55(3), pp: 703–708.
DOI:https://doi.org/10.2307/1913610

Rafiq, S., Salim, R. & Nielsen, I. (2016) Urbanization, openness, emissions, and energy intensity: A study of increasingly urbanized emerging economies, *Energy Economics*, 56(May), pp: 20–28.
DOI:https://doi.org/10.1016/j.eneco.2016.02.007

Rudenko, D. & Tanasov, G. (2022) The determinants of energy intensity in Indonesia, *International Journal of Emerging*

Markets, 17(3), pp: 832–857.

DOI: https://doi.org/10.1108/IJOEM-01-2020-0048

Sadorsky, P. (2013) Do urbanization and industrialization affect energy intensity in developing countries?, *Energy Economics*, 37(July), pp: 52–59.

DOI:https://doi.o *mental Science and Pollution Research*, 27, pp: 40907–40929.

Shrestha, R., Limbu, T.R., Pradhan, B.B., Paudel, A., & Karki, P. (2021) *Energy Efficiency in South Asia*. Philippines: Asian Development Bank.

U.S. Department of Energy (2023) *Energy Efficiency vs. Energy Intensity Analysis*. [Online] Available from: https://www.energy.gov/eere/analysis/energy-efficiency-vs-energy-intensity[Accessed: 19th May 2023]

UN Department of Economic and Social Affairs (2018) *World Urbanization Prospects*. Available from: https://population.un.org/wup/Publications/Files/WUP2018-Report.pdf [Accessed: 29th April 2022]

Weeraratne, B. (2016) *Re-Defining Urban Areas in Sri Lanka*. Institute of Policy Studies of Sri Lanka. [Online] Available from: https://www.ips.lk/wp-content/uploads/2017/01/RE-DEFINING-URBAN-AREAS-INSRI-LANKA_ips_E_Book.pdf [Accessed: 02nd May 2023]

Weeraratne, B. (2020) 'Urban housing in Sri Lanka', in Bandyopadhyay, S., Pathak, C., & Dentinho, T. (eds.) *Urbanization and Regional Sustainability in South Asia*. Cham: Springer, pp: 233–250.

DOI:https://doi.org/10.1007/978-3-030-23796-7_8

World Health Organization (WHO) (2005) *Situation Analysis of Household Energy Use and Indoor Air Pollution in Pakistan*. [Online] Available from: http://libdoc.who.int/hq/2005 [Accessed: 05th December 2022]

Wooldridge, J. M. (2013) *Introductory Econometrics: A Modern Approach*. 5th edn. USA: Cengage Learning.

Zhu, J., Huang, Z., Li, Z. & Albitar, K., (2021) The impact of urbanization on energy intensity: An empirical study on OECD countries, *Green Finance*, 3(4), pp: 508–526.

DOI: https://doi.org/10.3934/gf.2021024

Appendix I: Energy Intensity in SAARC countries from 1990-2015 (MJ / $ (2011 PPP)

Year	Bhutan	Bangladesh	India	Nepal	Pakistan	Sri Lanka
1990	30.0153	3.89947	8.2916	10.7913	5.46013	3.68928
1991	30.289	3.71422	8.54837	10.4738	5.32913	3.58036
1992	29.3292	3.71804	8.40019	10.3058	5.27022	3.51902
1993	28.5173	3.74897	8.21116	10.1858	5.44234	3.47052
1994	27.5679	3.76898	7.99411	9.74633	5.46182	3.15595
1995	26.3128	3.90083	7.85816	9.71617	5.43487	3.08816
1996	25.6503	3.75414	7.53016	9.44647	5.45533	3.32932
1997	25.1515	3.75324	7.52418	9.28322	5.54413	3.24261
1998	24.3211	3.72007	7.25604	9.2455	5.52327	3.14843
1999	22.858	3.60124	7.05055	9.342	5.62594	3.22343
2000	21.7941	3.53894	6.94959	9.28628	5.54025	3.34922
2001	20.4761	3.68413	6.72481	9.15264	5.52118	3.28862
2002	18.9806	3.63289	6.672	9.24301	5.40881	3.22147
2003	17.7911	3.65484	6.33392	9.14376	5.39291	3.22045
2004	16.8308	3.53715	6.18111	8.86063	5.38477	3.09498
2005	16.2144	3.44757	5.87752	8.85274	5.18595	2.98024
2006	15.5068	3.4628	5.66185	8.56398	5.0881	2.79317
2007	13.7379	3.37924	5.50765	8.44205	5.11363	2.66663
2008	13.6392	3.34562	5.56214	8.23468	4.94368	2.47724
2009	13.2004	3.35071	5.64671	8.11063	4.87983	2.37458
2010	12.5511	3.43732	5.35318	7.96568	4.87212	2.36731
2011	11.7594	3.34942	5.23299	7.97206	4.77747	2.34441
2012	11.5601	3.29958	5.19964	7.27267	4.66899	2.31163
2013	11.6454	3.17849	4.98863	7.76571	4.58216	1.99298
2014	11.0602	3.12944	4.96015	7.6037	4.53627	2.03284
2015	10.4079	3.13981	4.73091	7.42383	4.42216	2.06413

Source: World Bank open data, (1990-2015)

In this paper, energy intensity is measured as the ratio between energy consumption and GDP, expressed in MJ per $2011 PPP GDP, which is directly sourced from https://databank.worldbank.org/source/sustainable-energy-for-all/Series/6.1_PRIMARY.ENERGY.INTENSITY - Accessed: 04.06.2021

Appendix II: Hausman test to check the reliability of fixed effect model

In order to select the dependable regression between fixed effect and random effect, the model employed the Hausman test. According to this test, if the null hypothesis is rejected, it leads to the conclusion that the random effect is unsuitable due to potential correlations between the random effects and one or more regressors. Consequently, in such instances, the fixed effect becomes more suitable for conducting panel data analysis (Gujarati & Porter, 2009).

According to that, hypothesis for Hausman test and results given below,

Ho: Random effect model is appropriate

H1: Fixed effect model is appropriate

	(b)fe	(B) re	(b-B) Difference	sqrt(diag (V_b-V_B)) S.E.
log_pci	.798389	-1.51542	2.313809	.1481929
log_cforma~n	.0417959	.228905	-.187109	.0215909
log_indvalue	-.1011917	-.3801916	.279	.0014422
log_labour	.0928909	-.4552884	.5481793	.
log_co	.125591	-.4355446	.5611355	.
log_urbanp~n	-.4391358	.5066983	-.9458341	.0701244
log_pci_sq~d	-.0770621	.0618442	-.1389062	.
log_co_squ~d	.0059355	.0419315	-.035996	.0023415

b = consistent under Ho and Ha; obtained from xtreg B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic chi2(8) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 414.13

Prob>chi2 =0.0000

(V_b-V_B is not positive definite)

According to the results, Probability value of Hausman test is 0.000, therefore, null hypothesis rejected and alternative hypothesis accepted that fixed effect model is appropriate than random effect for this research.

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RESEARCH ARTICLE

Extent and predictors of socio economic deprivation in urban geriatric subjects: evidence from Varanasi, India

Priya Keshari[1*] and Hari Shankar[2]

[1]*Department of Family and Community Sciences, Faculty of Science, University of Allahabad, Prayagraj, India.*
[2]*Department of Community Medicine, Institute of Medical Sciences, Banaras Hindu University, Varanasi, India.*

Abstract: Old age Socio Economic Deprivation (SED) is a significant issue because geriatric subjects (60 years and above) are more vulnerable to SED than the other age group. Socio-economic_deprivation refers to deprivation in terms of economic parameters, food, water sanitation, shelter and information. The predictors of SED in geriatric subjects have been the least researched area. The objective of the present study was to find out predictors of SED. This study was carried out by adopting a cross-sectional study design on 616 (279 male and 337 female) geriatric subjects (60 years and above) selected by a multistage sampling procedure from urban Varanasi, India. Pre-designed, pre-tested proforma was used for assessing socio-economic deprivation in subjects by using interview techniques. Data was analyzed by using SPSS version 22.0. In order to find out predictors of all significant variables in bivariate analysis, viz., associates of socioeconomic deprivation were subjected to a logistic regression model. According to Rangrajan Committee criteria 38.0% subjects were below the poverty line. Food, water and sanitation deprivation were to the extent of 44.8%, 29.2% and 14.8%, respectively. As many as 32.6 % and 40.9% of subjects were deprived of shelter and education, respectively. There existed a significant association of gender, marital status, caste, religion, type of family and literacy status of study subjects with SED. However, the logistic model nullified the significant association of these variables with SED. In comparison to family size < 3 risk of SED was 3.31 (CI: 1.13-9.68) and 10.17 (CI: 2.44-42.45) times more in subjects with family size 3-6 and >6, respectively. When upper, upper middle and lower middle socio-economic status categories were considered as reference it was found that risk for SED was significantly ($p<0.01$) more in lower and upper lower SES categories. Odds of SED for lower and upper lower SES were 84.13 (CI: 15.9-244.63) and 18.24 (CI: 8.69-38.24) times higher than their counterparts, respectively. People with socioeconomic deprivation need to have focused attention based on the predictors of SED. Limiting family size, ensuring income generation activities and economic security are key inputs for optimum dividends in tackling SED.

Keywords: Ageing, geriatric subjects, socio economic deprivation, urban area.

INTRODUCTION

In the present era, one of the most urgent global goals is to tackle socio-economic deprivation (SED). National governments and their partners have been working to reduce the global problem of SED measured in terms of poverty. Although poverty is often thought of as a lack of material resources, it correlates closely with all aspects of a person's life. People with SED are more likely to be malnourished. They are deprived of services like education, electricity, sanitation and health care. Their vulnerability to conflict and climate change is likely to be of higher magnitude (World Bank, 2018). Giving due consideration to these issues in alleviating worldwide poverty, Millennium Developmental Goals (MDGs) and Sustainable Development Goals (SDGs) came into effect in 2000 and 2015, respectively. Further, World Bank

* Corresponding author (priya.bhu2010@gmail.com; https://orcid.org/0000-0001-8952-5660)

Group's twin goals for 2030 are in alignment with the central theme of the UN's Sustainable Developmental Goals viz., ending extreme poverty and promoting shared prosperity in every country in a sustainable manner. Despite tremendous efforts, poverty prevails in several corners of the world. Paradoxically, in the progressing world, people are getting either rich and richer or poor and poorer. These are the two extremes on which the world is progressing. According to Human Development Report (2021-22), across 107 developing countries, 1.3 billion (22%) live in multidimensional poverty; 82.3 percent are deprived in at least five indicators simultaneously (United Nations Development Report, 2022).

Socio-economic deprivation is a global phenomenon in which a group of people force to live a compromised life due to their low purchasing power. It realizes one's feeling of discrepancy between 'what one has and what one should have'. Although the experience of deprivation is uniquely varied for everyone, all poor people have feelings of 'powerlessness' and 'resourcelessness' (Qureshi, 2004). It is the root cause of social evils and creates number of socio-cultural and economic problems in the society. In absolute terms, deprivation reflects the inability of an individual to satisfy basic minimum needs of the life and it prevents people from participating in the development process (Khan & Hassan, 2014).

Since gaining independence, eradication of poverty and end of food deprivation have been the main aims of government of India. Several anti poverty programmes have been launched by the Government of India to uplift the living standard of people (Mishra, 2012). Measurement of poverty includes many socioeconomic facets, which have been changing from place to place and time to time. Therefore, despite availability of several approaches, successful execution of anti poverty programmes and schemes, SED still remains in many parts of country. As per revised estimates for India, the percentage of people living below $ 1.25 a day decreased from 60% in 1981 to 42% in 2005. Even at a dollar day (2005 prices) poverty has declined from 42% over the same period. Contrary to this 1.4 billion people (1 in 4) in the developing world were living below US $ 1.25 a day in 2005 down from 1.9 billion (one in two) in 1981. Based on estimates of national poverty line India's poverty rate was 28% in 2004/05 (World Bank, 2008). In the previous years as per Sustainable Developmental Goals report (2022) there had been reversal of years of progress in eradicating poverty (United Nations, 2022).

The word geriatric was coined by Naseler in 1914 and is derived from Greek words *gera* and *iatros* which means old age and treatment, respectively. The word "aged" is relative depending upon the society, its culture, the time and prevalent conditions. For standardization the United Nations have defined an aged person as one which is 60 years and above. (Lal *et al.,* 2022). The increased population growth rate and demographic transition including reduced fertility and technological advancements have increased the proportion of geriatric subjects. By 2051 approximately 20 per cent of the population, will be above 60 years of age (Irudaya & Mishra, 1995). Along with demographic shift, India is also experiencing epidemiological, economic transitions and social and institutional changes. Socio-economic changes such as increased urbanisation, and migration of young family members are leading to breakdown of traditional family system (Knodel *et al*., 1992; Pandey, 2009). This has increased number of old persons living alone or in small households and have to endure economic vulnerability and rising poverty (Sherlock, 2000; Dreze, 1990).

Old age (≥ 60 years of age) itself is considered a complex category due to several inevitable physiological, psychosocial and economic changes; which make them vulnerable to SED, food and nutrition insecurity, poor nutritional status, morbidities, physical dependence, mental and psychological problems; these have a significant influence on their overall wellbeing and may lead them to a disadvantaged position (Keshari & Shankar, 2021). During old age, the number of working hours gets reduced with increasing age (Singh & Sharma, 1987). Apart from the changes in the work status, the social role of geriatric subjects may also change. In such situations, geriatric subjects face a higher incidence of poverty in comparison to other age groups (Barrientos *et al*., 2003; Mujahid *et al*., 2008). Old age SED is a significant issue in developing countries; policy and research mainly focus on the pension schemes in the organised sector that have little relevance for the poor elderly (Sherlock, 2000). Hence, poverty among the elderly tends to be more permanent than that among the non-elderly and the elderly are unlikely to come out of the poverty trap (Hurd, 1990). Urban geriatric subjects are likely to experience more adversities due to the high cost of living and priorities of the family. Understanding poverty is fundamental to understanding how societies/ groups can progress. However, there is a paucity of information about extent and predictors of socio-economic deprivation in urban geriatric subjects. With this background, this study was undertaken to assessing the extent and predictors of socio-economic deprivation in the urban geriatric population.

LITERATURE REVIEW

Socio-economic deprivation in ageing population is a major global issue of the twenty-first century. Eradication of poverty is one of the key agendas of governments of different countries. Rapid ageing population pose a threat to old age people. In several situations, socioeconomic deprivation has been expressed by poverty which may be absolute or overall. Absolute poverty refers to a condition characterised by severe deprivation of basic needs including food, safe drinking water, sanitation, facilities, education and information. There exists operational definitions of different types of deprivation (Gordon, 2005). According to official estimates of poverty based on Tendulkar committee poverty line as many as 29.8% of the population were below the poverty line in India (Planning Commission, 2014). The country registered a significant decline of 9.89% percentage points in India's multidimensional poor from 24.85% in 2015-2016 to 14.96% in 2019-2021(United Nations Development Programme, 2023).

Several studies conducted outside India have reported socio-economic adversities, this was to the extent of 36.4% (Adbayo *et al*., 2013) and 41.0% (Akerele *et al.*, 2012) in studies from Nigeria. In general, the income of old age persons decreases while the consumption expenditure increases predominantly due to increase in health expenditure. Although in response to national policy for older persons for ensuring the financial and social protection of older persons, several initiatives have been taken, but their coverage and outreach are limited (Sunder Lal, 2022). There are evidences of higher socio-economic deprivation in terms of poverty estimates in older age groups (Barrientos *et al*., 2003; World Bank, 2006; Mujahid *et al*., 2008 and Gasparini *et al*, 2007) and it is perpetual in nature (Hurd, 1990). It is also evident from Indian data that 40% of old people live below poverty line and 90% are not covered by any pension scheme (Pandey, 2009).

The recent past several studies have pointed out socio-economic adversities in older person (Longitudinal Ageing Study in India Report, 2020; Arokiasamy *et al*., 2016, Brinda *et al*., 2016). Longitudinal Ageing Study in India (LASI Report, 2020) shows that the monthly per capita consumption expenditure (MPCE) among older adults in India is Rs. 2,967, Rs. 2,543 in rural areas and Rs. 3,544 in urban areas. The MPCE of households with an elderly member (Rs. 3,001) is higher than that of households without an elderly member (Rs. 2,948). Forty-five percent of households have a BPL card, and among those, 65% have used it in the 30 days before the survey (LASI Report, 2020). According to United Nations Development Program report (2023), India registered a significant progress in the decline of multi-dimensionally poor in four years (UNDP-2023).

The extent of poverty among geriatric subjects varies according to socio-cultural context. According to finding of research, socio-economic deprivation among younger old is less frequent than older old (75 years and above). Older women are at greater risk of poverty than older men. The findings on gender and old age poverty highlight that in general, women experienced a higher prevalence of poverty and have lower scores in successful ageing compared to their low-income male counterparts (Kawan & Walsh, 2018).

According to a study in southwest urban Nigeria incidence and depth of poverty are higher among female-headed households. The dependency ratio, household assets and educational status of heads, among others are the socio-economic factors influencing poverty (Akerele *et al.*, 2012). Mok *et al*. (2007) conducted a study among urban households in Malaysia and reported that household size, race and religion were important determinants of poverty. In a study in Kenya (Mberu *et al*., 2016) formal employment, education, family size and number of births in households are significant predictors of moving into and out of poverty. According to Srivastava & Mahanti (2012) education, religion and caste are significant predictors of poverty in old age. Contrary to this age is not a significant predictor of poverty. Socio-economic condition of older women is more vulnerable in the context of demographic and socio-cultural change.

Understanding socio-cultural context of the population over time and space is of considerable importance. However, the identification of socio-economic vulnerability through appropriate models is desired for focused attention. There is a paucity of such initiatives in Indian context.

This calls for examining socio-cultural context with reference to predictors of socio-economic deprivation.

MATERIAL AND METHODS

Study design and setting

This community-based cross-sectional study was conducted in urban Varanasi, India. The total population of Varanasi district was 3682194 of which the urban population was 1599260 (43.4%). The average literacy rate of Varanasi district was 77.05%. The geriatric population comprises 7% of the total population of the district. (Registrar General and Census Commission of India, 2011). The study area Varanasi has a diverse

population with rich historical and cultural significance. The demographic composition and socio-economic dynamics of the study area are best fitted to examine the extent and spectrum of socio-economic deprivation-related challenges faced by geriatric subjects. Varanasi is one of the districts of eastern Uttar Pradesh state, India there exists a paucity of information about SEDs and their influencing factors. The findings of the present study will provide valuable insights that contribute to the broader discourse on aging and social disparities for future research.

Subjects and sample size

As per United Nations (2020) person with ≥ 60 years is defined as geriatric (old) subjects (UNHCR, 2020). This criterion was used for the selection of study subjects residing in urban areas. Taking a prevalence of 40% for SED (Pandey, 2009), 5% permissible error (absolute), design effect of 1.5 and 10% non-response rate of estimated sample size the final sample size worked out to be 616. Of 616 selected subjects' complete information was obtained from 604 subjects in the first visit. In 12 subjects (male 5 and female 7) information could not be obtained due to their non-availability at the time of first visit. In order to get complete information from 616 subjects additional visits (1-2) were made for these remaining 12 subjects.

Selection of study sample

The selection of subjects was done through a multistage sampling procedure with the following stages. [**i**] Out of 90 census enumeration wards in Varanasi city, 9 wards were selected by simple random sampling; **[ii]** In the selected census enumeration wards households were selected according to probability proportion to size adopting systematic random sampling method; **[iii]** In the selected households one family was selected randomly using lottery method and **[iv]** In the selected family one study subject was selected randomly using lottery method. Subjects who gave their consent for the study were included in the study, whereas subjects with a terminal illness or having serious mental abnormality and also if their duration of stay in the study area was less than six months he/she was excluded from the study.

Ethical approval

This study was approved by the Ethical Committee of Banaras Hindu University, India and consent was obtained from participants using bilingual (Hindi and English version) consent form.

Tools and technique

A predesigned and pretested proforma was the primary tool in this study. This comprised of three sections: [a] Demographic variables (viz., age, gender, marital status, religion, caste, education, occupation, family size and type and socio-economic status) [b] Questions related to different forms of deprivations (i.e., economic, food, water and sanitation, shelter and information deprivation) [c] Recording of weight and height of subjects. After obtaining consent each study subject was interviewed using this primary tool to obtain information about socio-demographic characteristics (viz., age, gender, material status, religion, caste, educational status, occupation; type of family and size of family). Besides this information about other types of deprivations viz., information, water, sanitation etc. were also obtained by the same technique. For obtaining information pertaining to socio-economic variables head of the family or any responsible member of the family was interviewed and subjects with SED were assessed based on several norms. Per capita income was used to categorise subjects on the basis of Rangrajan Committee Report 2014, modified BG Prasad Classification, 2014 (Mangal *et al.*, 2015) and using cut-off of less than one dollar and 1.25 dollars per capita per day (World Bank, 2018).

In order to compute socio-economic status as per the Kuppuswamy Classification, the education and occupation of the head of the family as well as total family income were assessed through the interview technique using above-mentioned tool (Kohli, 2015). Information was also elicited from the subjects about availability of ration card, safe drinking water, drainage and toilet facility, type of house and exposure to media. For recording weight and height of subjects Libra weighting scale and steel anthropometric rod with parallel bars were used, respectively, following standard techniques. Body Mass Index of subjects was computed by dividing their weight in kg by height in m^2.

In order to find out associates of the SED subjects were categorised below and above poverty line by adopting the criteria given in the report of Rangrajan Committee (2014). A subject was considered below poverty line if per capita income was less than Rs 1410 per month. Association of SED in the terms of poverty estimates with various variables was obtained and test of significance was applied to find out associates of SED.

Statistical analysis

Data thus obtained were entered in personal computer and analysis was done by using Statistical Package SPSS

version 22.0 IBM Corp., Armonk, NY. Associates of the SED were obtained by bivariate analysis; χ^2 test was applied and $p< 0.05$ was taken as significant. In order to pinpoint predictors of socioeconomic deprivation binary logistic regression model was used. All significant variables were put in the logistic regression model which is an equation-based statistical analysis. In this case, the default method of conducting the regression was "enter" which is the same as forced entry where all the possible predictors are placed in the regression model in one block. In this study, the outcome variable has been dichotomous and there were several predictor variables. Since this study attempted to predict membership of only two categorical outcomes of socio-economic deprivation, binary logistic regression analysis was performed. The logistic regression equation used here is:

$$P\ (Y) = \frac{1}{1 + e^{-}}z$$

In which P (Y) is the probability of Y (outcome) occurring, e is the base of natural logrithms, Z = b1+b2+b3 under the pretext that when a subject belongs to a risk category, then there will be no effect of constant and other risk categories whereas b1, b2, b3 refers to coefficient (or weight) attached to the predictors. To out regression coefficient (β) of a possible predictor the values of b1, b2, b3 were put in the logistic regression equation. Odds ratio was obtained from exponential of β. (Field, 2009). In order to pinpoint predictors of SED Adjusted Odds Ratio with 95% Confidence Interval were computed. Interpretation of Adjusted Odds Ratio was done following standard guidelines (Goodwin & Ryu, 2023). Of all significant associates of SED only those remaining significant in the logistic regression analysis were identified as predictors of SED.

RESULTS

Familial characteristics of study subjects

Out of 509 (82.6%) were Hindu and remaining 107 (17.4%) were Muslim. None of the subjects belonging to Muslim religion were from SC/ST caste, whereas 74.8% and 25.2% from this religion were from Other Backward Caste and Other caste categories, respectively. As much as 15.9%, 51.6% and 32.5% were from SC/ST, OBC and other caste category, respectively (Table 1 A).

As many as 217 (35.2%) subjects were from nuclear family. In case of 80 (13.0%), 225 (36.5%) and 311 (50.5%) subjects family size was < 3, 3-6 and >6, respectively. As per Kuppuswamy scale socioeconomic status of 42 (6.8%), 156 (25.3%) and 160 (26.0%) subjects was upper, upper middle and lower middle, respectively. Subjects from upper lower and lower SES families were 217 (35.2%) and 91 (6.7%), respectively.

Individual characteristics of study subjects

In 41.4% cases, the subjects themselves were head of the family. The proportion of male and female subject was 45.3% and 54.7%, respectively. As much as 63.6% 28.4% and 7.9% subjects were from the age group 60-69, 70-79 and ≥ 80 years, respectively. In all 64.6% subjects were with a spouse whereas 32.6% of male and 37.7% of female subjects were without a spouse. As much as 40.9% of subjects were illiterate; corresponding values for male and female subjects were 16.8% and 60.8%, respectively. In contrast to this 38.0% of males and 11.6% of female were educated secondary level and above. The majority (84.6%) of female subjects were homemakers whereas 39.4% of male subjects were not engaged in gainful employment; 14.7% of male subjects were retired from service. A considerable proportion (79.2%) of female and 39.9% of male subjects had no contribution to the income of their families; overall this value was 61.5% (Table 1 (B)).

Majority (89.0%) subjects had own house. Electricity was predominant (96.9%) source of lighting. Two third of subjects had no liabilities. Nearly 3 out of 4 subjects were financially dependent on their family. As much as 83.0% 43.3% and 64.6% subjects were aware about old age pension, disability benefits and widowed pension, respectively, whereas 56.5% subjects were aware about health insurance scheme. Only 11.7% subjects received

Table 1 (A): Distribution of subjects according to religion and caste

Caste	Religion					
	Hindu		Muslim		Total	
	No.	%	No.	%	No.	%
SC/ST	98	19.2	0	0.0	98	15.9
OBC	238	46.8	80	74.8	318	51.6
Others	175	34.0	27	25.5	200	32.5
Total	509	100.0	107	100.0	616	100.0

Table 1 (B): Distribution of subjects according to Individual characteristics:

Particulars	Number	Percentage
Head of the family (n=616)		
Self	255	41.4
Spouse	205	33.2
Son/daughter	256	25.3
Gender (n=616)		
Male	279	45.3
Female	337	54.7
Age in years (n=616)		
60-69	392	63.6
70-79	173	28.1
≥80	51	8.3
Literacy status (n=616)		
Illiterate	252	40.9
Just literate	59	9.6
Primary	99	16.1
Middle	61	9.9
High School	52	8.4
Intermediate	29	4.7
Graduate	43	7.0
Postgraduate	21	3.4
Occupation status (n=616)		
Self-employed	102	16.5
Service	26	4.2
Retired	45	7.3
Skilled worker	45	7.3
Unskilled worker	3	0.5
Homemaker	285	46.3
Unemployed	110	17.9
Subjects contribution of income to their own family		
Overall (n= 616)	377	61.2
Male (n=279)	110	39.4
Female (n=337)	267	79.2

Table 1 (C): Living arrangement of study subjects (616)

Particulars	Number	Percentage
Dwelling		
Own	548	89.0
Rented	68	11.0
Source of lighting		
Electricity	597	96.0
Kerosene	19	3.1
Liabilities		
Child marriage	75	12.2
Child employment	41	6.7
Education +Marriage	47	7.6
Education +Marriage+ Employment	16	2.6
Marriage + Employment	21	3.4
None	416	67.5
Financial status of subjects in their family		
Dependent	379	61.5
Semi dependent	84	13.6
Independent	153	24.8
Awareness about		
Old age pension	511	83.0
Disability benefits	267	43.3
Accidental death benefits	319	51.8
Widow/	398	64.6
Health insurance scheme	348	56.5
Recipient of any financial support from government scheme	72	11.7
Awareness regarding getting financial support from government/ private	171	27.8

financial benefits from government/private sector and 27.8% stated that they were aware about someone getting received financial benefits from government/private sector (Table 1 (C)).

Extent of socio-economic deprivation

Considering Socio-Economic Deprivation (SED) as the root cause of many problems in geriatric subjects in general and urban subjects in particular, the extent of SED was assessed using a variety of parameters and the results are given in Table 1**.** Per capita income (PCI) has been extensively used in assessing SED. B.G. Prasad classification characterizes people in different social classes (I to V) and subjects belonging to social classes IV and V are in economically disadvantaged positions. Out of 616 subjects, 280 (45.5%) subjects were from classes IV and V and they were deprived on the economic scale. In urban areas, Kuppuswamy scale for determining socioeconomic status is of widely applicable. This scale is based on the education of the head of the family, the occupation of the head of the household (last occupation if retired) and family income per month. Based on this, scale subjects are classified as upper, upper middle, lower middle, upper lower and lower SES strata and subjects belonging to upper lower and lower SES are considered to be in the state of SED. Two hundred fifty eight (41.9%) subjects belonged to this category.

According to the report of Rangrajan Committee, subjects residing in urban areas should be considered below the poverty line if their income is less than Rs. 47 per person per day meaning thereby their per capita monthly income is less than Rs. 1410/-. By adopting this criterion, 38.0% subjects were below poverty line. According to World Bank, subjects are categorized below and above poverty line on their basis of per capita income per day. The cut of point has been fixed at 1 dollar and 1.25 dollar per capita per day. Out of 616 subjects 314 (51.0%) had income less than1 dollar per capita per day whereas in 357 (58.0%) cases per capita per day income was less than 1.25 dollar. In order to ensure food security public distribution system has been in vogue and under this scheme beneficiaries were provided yellow, white, red/ pink cards; subjects with yellow card were considered as above poverty line and rest were below poverty line. Out of 616 subjects in this study, 598 (97.1%) were provided card and of these 85 (14.2%) were below poverty line.
Problems of poverty serve as indicator for assessing the progress of any nation on socioeconomic front. Therefore, it can be treated as synonym to SED. However, the later includes many other conditions such as deprivation of food, water, sanitation, shelter, education and access to information. Subjects were considered in food deprivation when their body mass index was less than18.5 kg/m^2. By this criterion, 44.8% subjects had food derivation. Water deprivation (no safe water supply) was to the extent of 29.2%. Ninety one (14.8%) subjects were without drainage and toilet facilities and thus subjects were deprived from sanitation facilities. Presence of Kutcha/ semi pucca house indicates shelter deprivation. Kutcha house is made of easily available raw materials like mud, straw, stones and wood whereas a Pucca house is built with iron, bricks, cement, steel etc to form a concrete structure and semi pucca house is a combination of materials used in both. As much as 32.6% subjects had shelter deprivation. Education deprivation, measured on the basis of extent of illiteracy, prevailed in and 40.9%. Extent of information deprivation (non exposure to media) was 51.3% (Table2).

Associates of socio-economic deprivation

Except for age, all other socio-demographic and socio-economic variables pertaining to study subjects were significantly associated with Socio Economic Deprivation (SED). In this study a subject having per capita income Rs < 1410 per month has been considered as below poverty line (BPL). By this criterion, 37.2% of subjects in the 60-69 years age group were BPL; the corresponding value for subjects belonging to the age group 70-79 years and > 80 years were 37.6% and 45.1%, respectively (P>0.05). In comparison to male subjects (32.6%) significantly (P< 0.05) more females (42.4%) were BPL. As many as 35.2% of married, 31.9% of widower and 51.2% of widowed subjects were BPL. There existed a significant (p<0.01) gradient in the proportion of BPL subjects belonging to different caste categories. In this study 48.0%SC/ST, 43.4% Other Backward Caste (OBC) and 24.5% other caste category subjects were BPL. There existed a significant (P<0.01) declining trend in the extent of BPL with higher literacy status; this was maximum in the case of illiterates (48.8%) and nil in subjects having post graduate degrees. Subjects below the poverty line were maximum (46.0%) where the size of the family was > 6 and this was least (27.5%) in those with family size < 3**.** There existed no significant (p>0.05) association between subjects engaged and not engaged in gainful employment with SED. About 36.2% of subjects engaged in gainful employment and 39.0% of subjects not engaged in gainful employment were BPL; the extent of BPL was least (13.3%) in retired subjects. Eighty seven (47.8%) subjects from joint family were BPL; the corresponding value for subjects from three generations and nuclear family was 37.8%and 30.0%, respectively (Table 3).

Table2: Extent of socio-economic deprivation (N= 616)

Particulars	Indicators	Findings	
		Number	Percentage
	Social Class (V and IV)	280	45.5
	SES (Upper lower +Lower)	258	41.9
	PCI (< 47 per person per day)	234	38.0
	PCI (< 1 dollar per person per day)	314	51.0
Economic deprivation	PCI (< 1.25 dollar per person per day)	357	58.0
	Subjects with ration card (n=598), BPL card holders.	85	14.2
Food deprivation	BMI less than18.5 (n=612)	274	44.8
Water deprivation	Don't have safe drinking water supply	180	29.2
Deprivation of sanitation facilities	Drainage and toilet facility	91	14.8
Shelter deprivation	Kuccha house/ semi pucca	201	32.6
Education deprivation	Illiterate	252	40.9
Information deprivation	Non exposure to media	316	51.3

Associates of socio-economic deprivation

The association of socio-economic class with Socio Economic Deprivation is given in table 4A. As much as 4.5% of upper middle, 19.4% of lower middle 72.8% of upper lower and 92.7% lower class subjects (on the basis of Kuppuswamy classification) had per capita income < Rs 1410 per month meaning thereby they belonged to below poverty line families as per Ragrajan committee report. None of the subjects from the upper class were below the poverty line (Table 4 A).

Per capita income was considered an important variable to classify subjects in social class based on BG Prasad classification 69.7% of subjects belonging to class IV and all subjects from class V were categorised as below the poverty line by the criteria adopted by Rangrajan committee. On the basis of Ragrajan committee 74.5% and 65.5% of subjects having per capita income per day < 1 dollar and < 1.25 dollar, respectively were categorised as BPL (Table 4 B).

Type of card is often taken as a proxy indicator of socio-economic status. In this study even 32.7% of subjects with yellow card were labelled as BPL; the corresponding value for subjects with White, Red/Pink and without cards were 70.4%; 71.4% and 33.3%, respectively. All the socio-economic variables were significantly ($p<0.01$) associated with SED measured utilizing the conceptual framework of poverty as per Ragrajan committee criteria (Table 4 C).

Predictors of socio-economic deprivation

Adjusted Odds ratios (AORs) of gender, marital status, caste, religion, type of family, family size, literacy status and socio-economic status (Kuppuswamy classification) were computed by the SPSS package by exponentiation of corresponding regression coefficients and are given in table 5. Significant association of gender, marital status, caste, religion, type of family, and literacy status of study subjects with SED in bivariate analysis got eliminated in the logistic model.

Adjusted odds ratio for SED was more than one for widower (AOR= 1.25; CI 0.501-3.10), SC/ST (AOR= 1.797; CI: 0.73-4.41) OBC (AOR= 1.646; CI: 0.84-3.22), joint family (AOR=1.80; CI: 0.55-5.89). Only family size and socio-economic status were significantly ($p <0.05$) associated with SED in the logistic regression model. In comparison to family size < 3 risk of SED was 3.31 (CI: 1.13-9.68) and 10.17 (CI: 2.44-42.45) times more in subjects with family size 3-6 and >6, respectively. This implies that there was 231% and 917% increase in the odds of SED in subjects with family size 3-6 and > 6, respectively. When upper, upper middle and lower middle socio-economic status categories were considered as reference it was found that risk for SED was significantly (<0.01) more in lower and upper lower SES categories. Odds of SED for lower and upper lower SES were 84.13 (CI: 15.9-244.63) and 18.24 (CI: 8.69-38.24), respectively. In order to see group effect of significant predictors (family size and SES), category-wise regression coefficient (β), for family size > 6 and 3-6 were 2.32 and 1.20 when compared to reference family size < 3. In case of SES β was 4.43 for lower and 2.90 for upper lower in comparison to reference category (Table 5). Since the β was positive in both conditions, there is a direct relationship between predictors and SED. Family size more than three and lower plus upper lower SES (Kuppuswamy classification) subjects had higher AOR for SED measured on the basis of subjects having per capita income Rs < 1410 per month. In order to check the

Table 3: Association of socio-economic deprivation with demographic variables

Particulars (616)	Below poverty line PCI(<47/day) No.	(%)	Above poverty line PCI(>47/day) No.	(%)	Total No.	(%)	Test of significance
Age (Years)							
60-69	146	37.2	246	62.8	392	100	χ^2:1.199
70-79	65	37.6	108	62.4	173	100	df:2
> 80	23	45.1	28	54.9	51	100	p:>0.05
Gender							
Male	91	32.6	188	67.4	279	100	χ^2: 6.24df:1 p:<0.05
Female	143	42.4	194	57.6	337	100	
Marital status							
Married	140	35.2	258	64.8	398	100	χ^2: 12.17
Widower	29	31.9	62	68.1	91	100	df:2
Widowed	65	51.2	62	48.8	127	100	p:<0.01
Religion							
Hindu	179	35.2	330	64.8	509	100	χ^2:9.89; df:1 p:<0.01
Muslim	55	51.4	52	48.6	107	100	
Caste							
SC/ST	47	48.0	51	52.0	98	100	χ^2:23.53
OBC	138	43.4	180	56.6	318	100	df:2
Others	49	24.5	151	75.5	200	100	p:<0.01
Educational status							
Illiterate	123	48.8	129	51.2	252	100	
Just literate	26	44.1	33	55.9	59	100	
Primary	40	40.4	59	59.6	99	100	
Middle	22	36.1	39	63.9	61	100	
High school	14	26.9	38	73.1	52	100	χ^2:52.01 df:7 p:<0.01
Intermediate	7	24.1	22	75.9	29	100	
Graduate	2	4.7	41	95.3	43	100	
Post graduate	0.0	0.0	21	100	21	100	
Occupational status							
Engaged in gainful employment	80	36.2	141	63.8	221	100	χ^2:20.57 df: 1 p:> 0.05
Not engaged in gainful employment	154	39.0	241	61.0	395	100	
Type of Family							
Nuclear	65	30.0	152	70.0	217	100	χ^2:13.39
Joint	87	47.8	95	52.2	182	100	df:2
Three generation	82	37.8	135	62.2	217	100	p:<0.01

continued -

- continued from page 121

Size of family							
< 3	22	27.5	58	72.5	80	100	χ^2: 17.29
3-6	69	30.7	156	69.3	225	100	df:2
> 6	143	46.0	168	54.0	311	100	p:<0.01

(PCI: Per Capita Income)

Table 4 A: Association of socio-economic class of subjects with their socio-economic deprivation

Particulars (616)	Below poverty line PCI(<Rs1410/month)		Above poverty line PCI(>Rs1410/month)		Total		Test of significance
	No.	(%)	No.	(%)	No.	(%)	
Socio Economic Class							
Upper class	0	0.0	42	100	42	100	
Upper middle	7	4.5	149	95.5	156	100	χ^2: 287.4
Lower middle	31	19.4	129	80.6	160	100	df:4
Upper lower	158	72.8	59	27.2	217	100	p:<0.01
Lower class	38	92.7	3	7.3	41	100	

Table 4 B: Associates of socio-economic deprivation with social class and per capita income per day in dollar

Particulars (616)	Below poverty line PCI(<Rs1410/month)		Above poverty line PCI(>Rs1410/month)		Total		Test of significance
	No.	(%)	No.	(%)	No.	(%)	
Social Class							
I	0	0.0	93	100	93	100	
II	0	0.0	120	100	120	100	χ^2: 479.8
III	0	0.0	123	100	123	100	df:4
IV	106	69.7	46	30.3	152	100	p:<0.01
V	128	100.0	0	0.0	128	100	
1Dollar per day							
< 1 dollar	234	74.5	80	25.5	314	100	χ^2:362.9;df:1;p:<0.01
>1dollar	0	0.0	302	100	302	100	
1.25 Dollar per day							
< 1.25 dollar	234	65.5	123	34.5	357	100	χ^2:273.8df:1;p:<0.01
>1.25dollar	0	0	259	100	259	100	

Table 4 C: Type of card and socio-economic deprivation of the subjects

Particulars (616)	Below poverty line PCI(<Rs1410/month) No.	(%)	Above poverty line PCI(>Rs1410/month) No.	(%)	Total No.	(%)	Test of significance
Type of Card							
Yellow	168	32.7	345	67.3	513	100	
White	50	70.4	21	29.6	71	100	χ^2: 44.50
Red/pink	10	71.4	4	28.6	14	100	df:3
No card	6	33.3	12	66.7	18	100	p:<0.01

Table 5: Results of the logistic regression analysis for socio-economic deprivation

Particulars		Estimate of β	SE of β	P value	AOR	95% CI	
						Lower	Upper
Gender	Female	-0.09	0.64	0.894	0.92	0.26	3.22
	Male (Reference)	---	---	---	---	---	---
Marital status	Widower	0.22	0.47	0.64	1.25	0.50	3.10
	Widowed	-0.13	0.42	0.76	0.88	0.39	1.99
	Married (Reference)	---	---	---	---	---	---
Caste	SC/ ST	0.59	0.46	1.796	1.796	0.73	4.41
	OBC	0.49	0.34	1.646	1.646	0.84	3.22
	Others (Reference)	---	---	---	---	---	---
Religion	Muslim	-0.003	0.44	0.995	0.99	0.42	2.36
	Hindu (Reference)	---	---	---	---	---	---
Type of Family	Joint	0.59	0.60	0.329	1.80	0.55	5.89
	Nuclear	-0.16	0.47	0.791	0.88	0.35	2.22
	Nuclear (Reference)	---	---	---	---	---	---
Family size	>6	2.32	0.73	0.001	10.17	2.44	42.45
	3-6	1.20	0.55	0.029	3.31	1.13	9.68
	<3 (Reference)	--	---	---	---	---	---
Literacy status	Illiterate + just literate	-0.76	0.49	0.119	0.47	0.18	1.22
	Primary+ Middle	-0.50	0.46	0.278	0.60	0.24	1.50
	High school & above (Reference)	--	---	---	---	---	---
Kuppuswamy SES	Lower	4.43	0.85	0.000	84.13	15.92	244.65
	Upper lower	2.90	0.38	0.000	18.23	8.69	38.24
	Upper+ Upper Middle+ Lower Middle (Reference)	--	---	---	---	---	---

appropriateness of the fitted logistic model, the predicted outcomes were generated and those were compared with actual outcomes the result revealed that the overall correct prediction percentage was 88.4% which is quite satisfactory.

DISCUSSION

There has been considerable variation in the extent of SED by different parameters. Deprivation based on economic parameters was the least (1 out of 7) when ration card was taken as a parameter. Due to the potential risk of misclassification in using cards as a proxy indicator of socio-economic status and SED it should be used cautiously for estimating SED. The extent of SED, as observed in this study on the basis of socio-economic status as per modified Kuppuswamy classification has been very close to the figure (4 out of 10 households) in a study conducted South-West urban Nigeria (Akerele *et al*., 2012). Contrary to this lower figure of extent of poverty has been observed in Nigerian study (Adbiyo *et al*., 2013) whereas study from Kenya revealed worsening of household poverty over time (Mberu *et al*., 2016). It is interesting to note from a study done in poor urban households of Nairobi that nearly one out of three households remain in chronic poverty, one out of five fell into poverty and one out of six successfully escaped poverty and merely three out of ten fully remained out of poverty trap (Mberu *et al*., 2016).

Millennium Development Goals (MDG) has been the most successful global anti-poverty push in history. They help to lift more than 1 billion people out of extreme poverty (Kumar, 2016). It is estimated that, one third of world poor live on less than $1 a day and 8 out of 10 live on less than $2 a day (UNDP, 2007). Poverty has been estimated by different criteria, and it has remained a significant problem over decades (Mishra, 2012; Planning Commission, 2012). However, according to a press note, there has been gradual decline in the poverty ratio in rural-urban India since 2003-2004 (Vina & Silpa, 2013).

In present study age was not a significant associate of SED contrary to this a study by Srivatava & Mohanty (2012) reported elderly in the age group 80 years and above are less likely to be poor compared to elderly in the age group 60-69yrs (Srivatava & Mohanty, 2012). Imperial evidence supports a U-shaped relationship of age and poverty; elderly population faces a higher incidence of poverty compared to the other group. (Barientos *et al*., 2003: Gasparini *et al*., 2007; Mujahid *et al*., 2008 and World Bank, 2006). Similar findings have been reported from a study conducted in the South-West urban Nigeria (Akrele *et al*., 2012). The significant ($p < 0.05$) association of gender and SED obtained in this study, and this was nullified in logistic regress analysis. Nearly one third of male and 3 out of 7 females were victim of SED. Older women are at risk of socio-economic deprivation (Tout, 1993). There existed no significant ($p > 0.05$) association of religion and caste of subjects with SED. However, the religion wise difference in the occurrence of SED has been reported from a study from Malaysia by Mok *et al*. (2007) and a study from India by Srivastava & Mohanty (2012). Caste has been also identified as significant predictor of SED in other studies as well (Pandey, 2009; Srivastava & Mohanty 2012). Contrary to the finding of the present study influence of type of family on SED has been reported by Srivastava and Mohanty (2012). In conformity with the finding of the present study association of household size and SED has been also substantiated in studies conducted in Malaysia (Mok *et al*., 2007) and in Nairobi in informal settlement in Kenya (Mberu *et al.*, 2016). With the increasing level of education there was decline in the extent of SED. The significant association between education and SED in the bivariate analysis has not been substantiated in logistic regression analysis in this study. Educational attainment in general (Mberu *et al*., 2016; Srivastava & Mohanty, 2012) and educational status of household head (Akrel *et al*., 2012) have significant association with SED. Formal employment makes a difference of occurrence of SED reported by Mberu *et al.* (2016). However, no significant ($p > 0.05$) association between occupation and SED was observed in present study.

In the fitness of the thing's dependency ratio, household assets and socioeconomic status have been identified associates of SED in the study conducted in South-West urban Nigeria (Akrel *et al*., 2012). Some of the other factors have also been considered with reference to socio-economic deprivation. Race (Mok *et al.*, 2016) and social group (Srivastava & Mohanty 2012) have been also found linked with SED (Srivastava & Mohanty, 2012). Nearly one out of six rural elderly and one out of ten urban elderly males are indebted as per 16th National Sample Survey (1997). These findings of the present study are also supported by Srivastava & Mohnaty, (2012) indirectly. According to them elderly living alone and having low education level were at higher risk of SED. Logistic regression analysis identified that family size and socio-economic status as per modified Kuppuswamy's classification were predictors of SED. Higher risk of SED was identified in subjects with more than 3 family size and belonging to lower and upper lower SES. As socio-economic vulnerability of geriatric subjects is a function of lower level of education and lesser engagement in gainful employment of the head of family, per capita income of the family as well as subject's income, subjects with more family size, focused actions

for economic upliftment of geriatric subjects is need of the hour. Findings of the present study clearly highlight that besides economic deprivation many other types (viz., food, water and sanitation, shelter, education and information) deprivations prevailed in the study subjects. However, in order to find out associates and predictors of SED, socio-demographic and economic issues were taken in account. Although findings of the study emphasises focused attention for subjects in economically disadvantage position and with higher family size it will be worthwhile to address the various other aspects which are major determinants of health. In fact, optimum health is an input as well as output measure of socio-economic development. The findings of the present study highlight that subjects with family size > 3 and belonging to upper lower and lower had higher vulnerability for socio-economic deprivation. These findings have significant policy and programmatic implications. In India majority of the older persons are from the unrecognized sector and they don't have regular source of income. About 1 out of 8 belonged to organized sector and have distinct benefit from service pension and health benefits. In response to national policy for older persons, several initiatives have been taken to ensure financial security and social protection. Expanded old age pension scheme, taxation benefits in terms of increased standard tax deduction and higher interest rate for long-term saving for senior citizens have been initiated. However, their impact in combating socioeconomic deprivation in geriatric subjects from lower and upper-lower SES categories is likely to be limited (Lal *et al*., 2022).

CONCLUSIONS

Socio Economic Deprivation is widespread in urban geriatric subjects when measured from different angles. Further subjects with SED need to have focused attention based on the predictors of SED (viz., family size and socio-economic status). Limiting family size, ensuring income generation activities and economic security are key inputs for optimum dividends in tackling SED.

REFERENCES

Akerele, D., Momoh, S. & Phillip, B. (2012) Socioeconomic determinants of poverty among urban households in South-West Nigeria. *International Journal of Social Economics,* 39(3), pp: 168-181.

DOI: https://doi.org/10.1108/03068291211199341

Arokiasamy, P., Uttamachary & Kowal, P. (2016) Age and Socioeconomic Gradients of Health of Indian Adults: An Assessment of Self-Reported and Biological Measures of Health. *Journal of Cross-Cultural Gerontology,* 31, pp: 193–211.

DOI: https://doi.org/10.1007/s10823-016-9283-3

Berrintos, A., Gorman, M. & Heslop, A. (2003) Old age poverty in developing countries: Contribution and dependence in later life. *World Development*, 31(3), pp: 555- 570.

DOI: https://doi.org/10.1016/S0305-750X(02)00211-5

Dreze, J. (1990) Widows in rural India. Discussion paper-Development Economics Research Programme, Suntory-Toyota International Centre for Economics and Related Disciplines, London School of Economics, 26, pp:1-171.

Field, A. (2009) *Discovering statistics using SPSS*, Third Edition, Sage Publication Ltd. pp: 1-854.

Goodwin, G. & Ryu, S. Y. (2003) Understanding the odds: statistics in public health, *Front Young Minds*, 10, pp:1-7.

DOI: https://doi.org/10.3389/frym.2022.926624

Gasparini, L., Alejo, J., Haimovich, F., Olivieri, S. & Tornarolli, L. (2007) Poverty among the elderly in Latin America and the Caribbean. Background paper for the World Economic and Social Survey 2007. *The World Ageing Situation*, pp:1-87

Gordon, D. (2005) Indicators of Poverty & Hunger. In *Proceedings of the Expert Group Meeting on Youth Development Indicators*, New York, NY, USA, 12–15, pp: 12–14.

Hurd, M. D.(1990) Research on the elderly: Economic Status, retirement and consumption and saving. *Journal of Economic Literature*, XXVIII, pp: 565-637.

Irudaya Rajan S., Mishra, U. S. (1995) Defining old age: An Indian assessment, *Journal of UN Institue of Aging,* 5, pp: 31–35.

Khan, J. H. & Shamshad, T. H. (2014) Incidence of poverty and level of socio-economic deprivation in India, *The Journal of Developing Areas*, 48(2), pp: 21-38.

DOI:https://doi.org/10.1353/jda.2014.0031

Keshari, P. & Shankar, H. (2021) Inter-linkages among socioeconomic deprivation, food insecurity, physical and psychosocial status in urban geriatric subjects: Varanasi, India. *Sri Lanka Journal of Social Sciences*, 44(1), pp: 55-69.

DOI: https://doi.org/10.4038/sljss.v44i1.8067

Keshari, P., Shankar, H. (2016) Strategic Gaps in Provision of Universal Nutrition Security: Indian Perspective. *IJFANS*, 5(1), pp: 56-65.

Kohli C., Kishore J., Kumar N. (2015) Kuppuswamy's Socioeconomic Scale-Update for July 2015, *Int. J. Preven. Curat. Comm*.Med,1(2), pp:26-28.

Kwan, C. & Walsh, C. A. (2018) Old age poverty: A scoping review of the literature, *Cogent Social Sciences*, 4:1, 1478479, pp: 1-21.

DOI: https://doi.org/10.1080/23311886.2018.1478479

Lal, S., Adarsh. & Pankaj (2022) *Text Book of Community Medicine*, 7th Edition, CBS Publisher Distributors Pvt Ltd, New Delhi, India.

Longitudinal Ageing Study in India (LASI) Wave 1, Mumbai, India (2020). International Institute for Population Sciences (IIPS), NPHCE, Ministry of Health and Family Welfare, Harvard T. H. Chan School of Public Health (HSPH), and The University of Southern California (USC), pp: 1-630.

Mberu, B., Ciera, J., Elungata, P. & Ezeh, A. (2014) Patterns and determinants of poverty transitions among poor urban households in Nairobi, *Kenya African Development Review,* 26 (1), pp: 172-185.
DOI: https://doi.org/10.1111/1467-8268.12073

Mangal, A., Kumar, V., Panesar, S., Talwar, R., Raut D. & Singh S. (2015) Updated BG Prasad socioeconomic classification, 2014: A Commentary, *Indian Journal of Public Health,* 59 (1), pp: 42-44.
DOI: https://doi.org/10.4103/0019-557X.152859

Mishra C. P. (2012). Nexus of Poverty, Energy Balance and Health, *Indian Journal of Community Medicine,* 37(2), pp:71-78.
DOI:https://doi.org/10.4103/0970-0218.96083

Mok, T. Y., Gan, C. & Sanyal, A. (2007). The Determinants of urban household poverty in Malaysia, *Journal of Social Sciences*, 3(4), pp: 190-196.
DOI: https://doi.org/10.3844/jssp.2007.190.196

Mujahid, G., Pannirselvam, J. & Doge, B. (2008) *The Impact of social pensions: Perceptions of Asian older persons*, Bangkok, Thailand: UNFPA Country Technical Services Team for East and South East Asia, pp: 1–59.

National Sample Survey Organization (NSSO) (1997) *The aged in India: A socio economic profile 1995-96*. Government of India, New Delhi.
National Sample Survey Organization (2011) *Annual Report 2010 2011: Ministry of Statistics and Programme Implementation*. Government of India; 2011.

Office of Registrar General, India. (2009) Report on Causes of Death in India. 2001-2003. New Delhi: RGI. Planning Commission, Government of India. (2007).

Poverty estimates for 2004–2005. [Online] Accessed from: http://planningcommission.nic.in/news/prmar07.pdf[Accessed: 19th May 2017].

Planning Commission (2013). Press Note on Poverty Estimates, 2011-12 (No.id: 5421)

Pandey, M. K. (2009) Poverty and disability among Indian elderly: Evidence from household survey, *ASARC Working Paper 2009/09*, pp: 1–19.

Qureshi, M. U. (2004) *India's Social Problems in Twenty First Century*, Anmol Publications Pvt. Ltd., New Delhi, India. pp.

Rangarajan Committee (2014) Report on Poverty, New Delhi: Press Information Bureau Government of India Planning Commission, pp: 1–4 [Online] Available from: *http://pib.nic.in/newsite/PrintRelease.aspx?relid=108291* [Accessed: 19th May 2017].

Registrar General and Census Commission of India. Census of India (2011), Ministry of Home Affair, Government of India [Online] Available from: h*ttp://censusindia.gov.in*[Accessed: 19th May 2017].

Sherlock, P. L. (2000) Old age and poverty in developing countries: New policy challenges, *World Development*, 28(12), pp: 2157–2168.
DOI: https://doi.org/10.1016/S0305-750X(00)00077-2

Singh, K., Singh, R. & Sharma, M. L. (1987) Problems of aged women in Haryana, In M. L. Sharma & T. M. Dak (eds) *Aging in India*, Ajanta Publications, New Delhi India.

Srivastava, A. & Mohanty S.K. (2012) Poverty among elderly in India. *Social Indicators Research,* 109, pp: 493-514.
DOI:https://doi.org/10.1007/s11205-011-9913-7

Tout, K. (1993) Ageing in developing countries, OUP, Oxford.

United Nations (2010) *Millennium Development Goals Report 2010*, Fact Sheet, Goal 1: "We Can End Poverty," New York, p:1-2 [Online] Available from:http://un.org/millenniumgoals/pdf/MDG_FS_1_EN.pdf [Accessed: 29th December 2022].

United Nations Development Programme (2023) *National Multidimensional Poverty Index- A Progress Review 2023,* pp: 26-49.

United Nations (2022) *The Sustainable Development Goals Report 2022,*pp:1-68 [Online]. Available from: *https://reliefweb.int/report/world/sustainable-development-goals-report-2022*[Accessed: 24th December 2022].

United Nations Development Programme. (2011) *Human Development Report 2011: Sustainability and equity: A better future for all* [Online], pp:1-2 Available from: *https://hdr.undp.org/content/human-development-report-2011h* [Accessed: 24th October 2023].

United Nations Development Programme (2022) *Human Development Report 2021/2022, Uncertain times, Unsettled lives: Shaping our future in a transforming world,* pp:1-320 [Online] Available from: https://hdr.undp.org/system/files/documents/global-report document/hdr2021-22pdf_1.pdf [Accessed: 24th December 2022].

United Nations High Commissioner for Refugees (UNHCR) (2020) *Emergency Hand Book* United Nations Development Programme [Online] Available from: https://emergency.unhcr.org/protection/personsrisk/olderpersons#:~:text=An%20older%20person%20is%20defined,over%2060%20years%20of%20age [Accessed: 12th January 2024].

Veena, K P. & Shilpa, D. (2015) Women Empowerment: A Boom for socio-economic development in India, *Asian Journal of Multidisciplinary Studies*, 3 (2), pp:135-140.

World Bank (2008) *Poverty Estimates* 2008 [Online Newsletter] Available from: *https://www.worldbank.org/en/news/press-release/2008/09/16/new-data-show-14-billion-live-less-us125-day-progress-against-poverty-remains-strong* [Accessed: 24th December 2022].

World Bank Report (2018) *Poverty and Inequality-2018* [Online Newsletter]. Available from: *https://datatopics.worldbank.org/world-development-indicators/themes/poverty-and-inequality.html* [Accessed: 24th December 2022].

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RESEARCH ARTICLE

The trichotomy of Needs Theory and irrational investor behavior through investor category: evidence from Sri Lanka

N. P. K. Ekanayake[1*] and P. A. N. S. Anuradha[2]

[1]Department of Commerce and Financial Management, Faculty of Commerce and Management Studies, University of Kelaniya, Sri Lanka.
[2]Department of Finance, Faculty of Management Studies and Commerce, University of Sri Jayewardenepura,Gangodawila, Sri Lanka.

Abstract: The trichotomy of Needs Theory has been applied in various studies to analyze psychological features across different professions. However, there is a notable gap in the literature regarding its impact on irrational investor behavior. This study presents a groundbreaking contribution by exploring how individual investors' unique characteristics, defined by the trichotomy of Needs Theory, impact their stock market decisions. This research offers crucial, interdisciplinary insights into the psychological principles driving human behavior, making it significant for market analysts, investors, stockbrokers, and decision-makers. Utilizing David McClelland's trichotomy of Needs Theory, the study assesses the behavioral aspects of individual investors. It investigates the impact of said theory on irrational investor behavior at the Colombo Stock Exchange, with the investor category as a moderator. Data was collected through a structured questionnaire from a sample of 386 investors at the Colombo Stock Exchange using systematic random sampling. Structural Equation Modeling was employed to test the hypotheses. The findings indicate that both the need for affiliation and the need for achievement significantly increase irrational investor behavior at the Colombo Stock Exchange. Further, the results embrace a significant positive moderation effect from the investor category on the relationship between the need for affiliation and irrational investor behavior. Moreover, the investor category positively impacts the relationship between the need for achievement and irrational investor behavior in the Colombo Stock Exchange.

Keywords:Investor behavior, needs theory, investment decision, investor irrationality, Colombo stock exchange.

INTRODUCTION

Traditional thoughts in the discipline of finance which elaborate the investors' behavior were mainly reliant upon widely acclaimed theories such as the modern portfolio theory (Markovitz, 1952) and efficient market hypothesis (Fama, 1980). Moreover, traditional finance theories presume that markets are efficient; hence, market prices reflect and embrace all relevant and available decision-making information (Bloomfield, 2010). However, it has been demonstrated that several traditional financial assumptions are less reliable and impractical when used in the stock market decision-making process (Jain *et al.*, 2015). The bounded rational theory (Ricciardi & Simon, 2000) has proposed a few limitations as an alternative to assuming perfect information and rationality of individuals (Verma & Rangnekar, 2015). Therefore, many researchers asserted that instead of making the promised rational investment decisions, institutional as well as individual investors act irrationally while making decisions about their investments (Ganesh *et al.*, 2018) and such decisions may be influenced by their individual traits (Muktadir-Al-Mukit, 2022).

Behavioral finance attempts to acknowledge and describe observed investor and market behaviors (Barberis & Thaler, 2003). Observed behaviors often differ from the idealized behaviors assumed under

* Corresponding author (neranjanae@kln.ac.lk; https://orcid.org/0000-0003-2268-6659)

traditional finance theories. According to behavioral finance, markets are not always observed to be efficient, whereas anomalous markets can be observed (Ritter, 2003). Behavioral finance argues that some financial phenomena can plausibly be understood using models in which some investors are not entirely rational (Barberis & Thaler, 2003), contrary to what has been explained in traditional finance.

The Colombo Stock Exchange (CSE), the market base of this study, has 294 companies as of August 31st, 2023, with a market capitalization of Rs. 3,964.04 billion. CSE is a frontier market smaller than an emerging market but more developed than countries considered 'least developing countries' (Abeysekera & Nimal, 2017). Uninformed investors make their decisions based on market sentiment, creating irrational price volatility (Hewamana *et al.*, 2022; Aggarwal & Mohanty, 2018). Buddhika (2020) emphasizes that individual psychological aspects play a significant role in shaping investors' investment decisions in the CSE. The critical area of psychology in a stock market is how the human aspect affects stock market decision-making. Hence, to address the psychological aspect of an individual investor, this study applied the Trichotomy of Needs Theory of David McClelland (1961). McClelland's Needs Theory (1961) is dominant in human psychology, organizational behavior, and human resource management with a strong emphasis on the psychological aspect of decision-making (Slocum & Hellriegel, 2009; Steers & Braunstein, 1976). The Trichotomy of Needs Theory (McClelland, 1961) is a motivational model that attempts to explain how the needs for power, affiliation, and achievement affect managerial decision-making (McClelland *et al*., 1976; McClelland, 1975).

The Trichotomy of Needs Theory (McClelland, 1961) was not previously drawn to the subfield of behavioral finance which was initially proposed with general management and human resource management (Salas *et al*., 2017). Given that the Trichotomy of Needs Theory (McClelland, 1961) is primarily founded on human psychology and its influence on decision-making, it is worthwhile to examine its application to the irrationality of stock market investors. Hence, the key objective of this study is to test the impact of the Trichotomy of Needs Theory on stock market investors' irrationality.

Investors can be categorized as passive or active investors depending on their investment strategies and approach to managing their portfolios (Wermers & Yao, 2010). According to Wermers & Yao (2010), passive investors can be characterized as individuals who have become wealthy passively by inheriting a professional career or by risking the money of others rather than their own money. Active investors have achieved significant wealth throughout their lifetime (Huda *et al*., 2020; Wermers & Yao, 2010). Researching and categorizing active and passive investors is crucial for tailoring investment strategies to align with different goals and risk tolerances. Active investors seek to outperform the market through frequent trades, while passive investors aim for steady, long-term growth by tracking market indices. Understanding these categories helps financial advisors and institutions design appropriate products, allocate resources effectively, and manage risks. Additionally, it provides insights into market behavior and aids in evaluating the performance of various investment approaches (Azouagh & Daoui, 2023; Flood & Ramachandran, 2000). Consequently, this study further evaluates the moderation impact of the investor category on the relationship between the Trichotomy of Needs Theory and stock market investors' irrationality.

This study has three primary objectives based on the Trichotomy of Needs Theory. First, it examines the impact of the need for power on investors' irrationality. Second, it examines the impact of the need for affiliation on investors' irrationality. Third, it intends to examine the impact of the need for achievement on investors' irrationality. In addition, this study examines the moderation impact of the investor category on the relationship between the Trichotomy of Needs Theory and investors' irrationality. Consequently, the moderation impact of the investor category is tested between each component above (i.e. the need for power, the need for affiliation, and the need for achievement) and the investor irrationality.

The structure of the paper is organized as follows: Section 2 investigates the empirical point of view of the Trichotomy Need Theory. The methodology is covered in section 3, while the data analysis and discussion are included in sections 4 and 5, respectively. The conclusion is the final section.

LITERATURE REVIEW

Stock market investors' irrationality

Research consistently demonstrates that investors often display irrational behavior in financial markets. Empirical studies reveal systematic errors in investor decision-making, such as prematurely exercising rights, selling assets below their intrinsic value, or failing to exercise rights altogether (Rantapuska, 2005). These irrational behaviors include low investor sophistication, information costs, and cognitive biases, such as overconfidence, anchoring, and herd behavior (Levisauskaite & Kartasova, 2015; Rantapuska, 2005). Some scholars argue that such irrationality might play a crucial role in market efficiency by enhancing liquidity and incorporating private information (Rachlinski & Lablanc,

2005). Empirical evidence of investor irrationality has been documented across various markets, including Finland, Lithuania, and Kenya. For example, research on the Nairobi Stock Exchange indicates that investors tend to overreact to both positive and negative news, leading to a phenomenon where loser portfolios outperform winner portfolios over time (Aduda & Muimi, 2011). These findings challenge the conventional notion of investors as purely rational agents and underscore the significance of psychological factors in understanding financial markets. However, there is a vacuum in the literature researching the irrationality of individual investors in CSE. Hence, the authors of this study attempt to address the irrational decision-making behavior of individual investors in CSE based on such investors' psychological traits. Further, to test the psychological traits of individual investors, the well-established Trichotomy of Needs Theory has been applied.

Trichotomy of Needs Theory

McClelland's Trichotomy of Needs Theory elucidates individual decision-making by correlating it with three core needs: power, affiliation, and achievement. Individuals with a pronounced need for power are driven to seek roles that allow them to exert influence and control, aiming for leadership opportunities (Johnson & Lee, 2021; Harrell & Stahl, 1984). In contrast, those with a strong need for affiliation prioritize social harmony and relationship building, leading them to make decisions that foster collaboration and positive group dynamics (Steinmann, Kleinert, and Maier, 2020). Literature also shows that individuals with a high need for achievement are motivated to set ambitious goals and undertake challenging tasks, making decisions that enhance their capabilities and provide clear performance feedback (Slapnicar, Oblak and Licen, 2022). Recent empirical studies underscore that these dominant motivational needs significantly impact decision-making processes, problem-solving approaches, and interpersonal interactions (Di Domenico *et. al*., 2016).

This theoretical framework is beneficial for analyzing irrational decision-making. Empirical evidence highlights how motivational needs can lead to deviations from rational economic models: (Ainslie, 2016) found that high achievement needs often result in excessive risk-taking and irrational financial decisions. Maner *et al*. (2007) observed that a strong need for power can drive individuals to adopt high-risk strategies for influence, regardless of potential negative outcomes. Similarly, Macdonald & Wood (2018) demonstrated that a high need for affiliation may lead individuals to conform to group pressures and prioritize social harmony over rational decision-making. These studies illustrate how McClelland's theory effectively captures the impact of motivational needs on irrational behavior, providing insights into how individual priorities and behaviors deviate from traditional economic rationality. Therefore, the empirical evidence on the impact of each personal trait (need for power, affiliation, and achievement) on investors' irrationality is revealed as follows.

Need for Power

The need for power, characterized by the tendency to influence or control outcomes affecting others, has been extensively examined in literature (Shernoff, Ruzek, & Sinha, 2017; Daft, Murphy, & Willmott, 2010; Daft, 2008). Research indicates that individuals with a high need for power are often driven by a desire to effect change and make a significant impression on others (Achua and Lussier, 2014). Stahl and Harrell (1982) applied McClelland's (1961) Trichotomy of Needs Theory to various groups, including high school seniors, academy cadets, management undergraduates, and accounting partners, finding a significant correlation between the need for power and decision-making behaviors across these populations. Additionally, Jha (2010) reported that the need for power positively influences the decision-making behavior of frontline employees in five-star hotels. In contrast, McNeese-Smith (1999) observed a negative correlation between the need for power and decision-making behaviors among managers and staff nurses. Furthermore, Winter (1993) provided evidence of a balanced, positive impact of the need for power on the decision-making behavior of political leaders. These findings underscore the complex role that the need for power plays in shaping decision-making processes across different contexts and roles. Consequently, as a psychological trait, the need for power plays a significant role in an individual's decision-making. Hence, the authors aim to test the impact of the need for power on individual investors' irrationality in the CSE.

Need for Affiliation

McClelland *et al*. (1976) define the need for affiliation as an individual's desire to initiate, maintain, and restore positive and effective relationships. Extending this concept, Daft (2008) elaborates that individuals with a high need for affiliation typically avoid confrontation, seek to form closer personal relationships and foster quality friendships. Literature indicates that the need for affiliation is significantly correlated with decision-making among high school seniors, academy cadets, management undergraduates, and accounting partners (Stahl & Harrell, 1982). However, Jha (2010) found no significant positive correlation between the need for affiliation and the decision-making behavior of frontline employees in five-star hotels. Conversely, McNeese-

Smith (1999) reported a negative correlation between the need for affiliation and decision-making behavior among managers while finding a positive correlation with the decision-making behavior of staff nurses. These findings underscore the varying impact of the need for affiliation on decision-making across different roles and contexts. Consequently, as a psychological characteristic, the need for affiliation substantially influences an individual's decision-making. Therefore, the authors seek to examine the effect of the need for affiliation on the irrationality of individual investors in the CSE.

Need for Achievement

The need for achievement, defined as a behavior oriented towards competition and maintaining a high standard of excellence was conceptualized by McClelland (1961). This drive for achievement is characterized by a motivation to excel, accomplish goals, and strive for success according to established expectations (Hansemark, 2003). Research has demonstrated that the need for achievement significantly influences the decision-making of high school seniors, academy cadets, management undergraduates, and accounting partners (Stahl & Harrell, 1982). Additionally, Jha (2010) found that this need has a notable and positive effect on the decision-making behavior of frontline employees in five-star hotels. McNeese-Smith (1999) similarly observed a positive impact of the need for achievement on managerial decision-making, and this effect also extends to staff nurses. Furthermore, the literature provides evidence of a balanced, positive influence of the need for achievement on the decision-making behavior of political leaders (Winter, 1993). These findings highlight the significant role that the need for achievement plays in shaping decision-making across various professional roles. Therefore, this study aims to explore the impact of the need for achievement on the irrational behavior of individual investors of CSE.

Investor category as the moderator

Understanding and categorizing investors into active and passive types is crucial for developing tailored investment strategies that align with diverse goals and risk tolerances. Active investors aim to outperform the market through frequent trading, while passive investors seek steady, long-term growth by tracking market indices. This classification helps financial advisors design appropriate products, allocate resources effectively, manage risks, and gain insights into market behavior and investment performance (Azouagh & Daoui, 2023; Flood & Ramachandran, 2000).

The literature reveals a significant correlation between an investor's risk acceptance, behavioral type, and biases with their active or passive characteristics (Tupe, 2021). Research in psychology and finance has explored how these characteristics serve as moderating factors. For instance, Ng, Niven, & Notelaers (2022) investigated how active and passive bystanders influence the effects of bullying in group settings. Hauff and Nilsson (2017) found that the impact of a robust financial brand in mitigating the country-of-origin effect is moderated by whether an investor adopts an active or passive approach. Additionally, Linda, Marroquin, and Miranda (2012) explored how active and passive problem-solving styles, in conjunction with a history of suicide attempts, affect the relationship between life stress and suicidal ideation. These studies underscore the importance of considering an individual's active or passive nature in financial and behavioral research.

Active investors

Active investors are characterized by their accumulation of substantial wealth, which leads them to take greater investment risks due to their past experiences and sacrifices (Parashar, 2010). They typically exhibit a low need for safety and a high-risk tolerance, preferring to maintain control over their portfolios. This often results in heightened involvement in investment management and analysis (Akhtar, Thyagaraj, and Das, 2014). Their strong self-confidence and need for power drive their active engagement in investment decisions (Akhtar *et al*., 2014; Parashar, 2010). However, their excessive involvement can sometimes create tension with wealth managers, potentially disrupting professional management (Akhtar *et al*., 2014).

Wermers & Yao (2010) and Barnewell (1987) also identify professions such as small business owners, independent professionals, medical surgeons, self-employed consultants, and entrepreneurs as more likely to exhibit active investing behaviors (Akhtar *et al*., 2014; Pompian, 2012). However, Lim (1992) found no significant difference in occupational characteristics between active and passive investors, suggesting that personal engagement in financial dealings is not necessarily linked to specific occupations. Active investors often believe they understand market trends better than their advisors, leading to reluctance to delegate investment management tasks (Akhtar *et al*., 2014). Nevertheless, as they age and gain more experience, they may become more open to their wealth manager's advice. Typically, around 40 years old (Lim, 1992), active investors exhibit greater self-confidence and are generally more willing to take risks compared to passive investors.

Passive investors

Passive investors are typically individuals who have accumulated wealth through inheritance, professional careers, or by using others' money rather than their own

(Wermers & Yao, 2010; Barnewell, 1987). For these investors, preserving the safety of their investments is more important than achieving higher returns, reflecting a risk-averse attitude. They are often found in occupations such as corporate executives, non-surgical doctors, accountants, and lawyers, where they may have accumulated wealth later in their careers and prioritize financial stability (Pompian, 2012). Due to their limited initial capital and need for financial security, passive investors tend to be more cautious, favoring diversified portfolios in reputable companies to mitigate risk (Pompian, 2012; Bluethgen *et al*., 2008). They are also more likely to rely on financial advisors and avoid high-risk investments, which may result in missed opportunities for higher returns.

Literature indicates that passive investors are more conservative in their financial behavior and prefer to follow market trends rather than adopting contrarian positions (Bluethgen *et al*., 2008). They often seek guidance and are less likely to explore new investment markets independently. Therefore, the investor category is crucial in studying how psychological traits affect irrational decision-making. Differentiating between active and passive investors helps understanding how their psychological traits influence their investment choices and behaviors, providing clearer insights into the reasons behind irrational financial decisions.

Consequently, this study examines how the investor category moderates the relationship between the need for power, the need for affiliation and the need for power on individual investors' irrationality. The independent variables are the need for power (nPow),the need for affiliation (nAff), and the need for achievement (nAch). The dependent variable is stock market investors' irrationality (SMII), and the moderating variable is investor category (IC). The conceptual framework of the study is illustrated in Figure 1.

The conceptual framework presented in Figure 1 formulates six hypotheses. The first three hypotheses examine the impact of individual components of Needs Theory on stock market investors' irrational behavior. Hypotheses 4, 5, and 6 address the moderating effects of investor categories on the relationship between Needs Theory and the irrationality of stock market investors.

Needs Theory on decision making

The 'Needs Theory', as articulated by McClelland, posits that individuals cannot be strictly categorized into the originally proposed three categories of need motivations: achievement, affiliation, and power (Osemeke & Adegboyega, 2017). Rather, it asserts that all individuals exhibit varying needs, which collectively shape their motivational profiles and influence their decision-making processes (Osemeke & Adegboyega, 2017). Notably, while high affiliation motivation can detract from rational decision-making, a strong need for power is associated with effective leadership skills (McClelland, 1975). He further contends that individuals with a primary need for achievement tend to be the most effective decision-makers, despite the common misconception that all individuals are equally driven by achievement (McClelland, 1975). Critics of McClelland's theory argue that it may lack practical applicability, as it suggests that the components of the Needs Theory operate subconsciously, complicating their measurement and application across different demographic factors (Osemeke & Adegboyega, 2017).

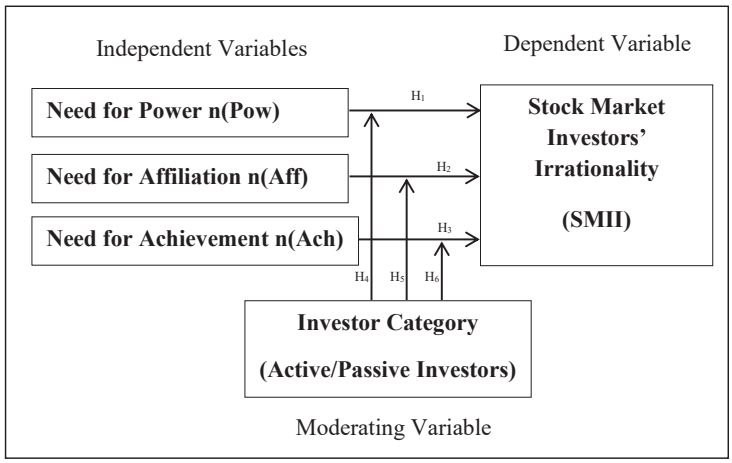


Figure 1: Conceptual framework

Recent research on achievement motivation has yielded mixed findings that both support and challenge McClelland's framework. Studies indicate a marginal positive correlation between risk avoidance and success, yet the environmental variables influencing motivation were not addressed in McClelland's theory (Aditya, 2006). Additionally, the validity of achievement motivation has been recorded at low levels, particularly in smaller enterprises, with more pronounced significance in larger organizations (Aditya, 2006). Some scholars, such as Shane *et al.* (2003), affirm that understanding these motivations can elucidate entrepreneurial decision-making behavior, thereby reinforcing aspects of McClelland's theory. Furthermore, some researchers suggest that McClelland underestimated the predictive capacity of psychological ability, proposing that psychological assessments could offer valid insights comparable to those derived from traditional intelligence and academic measures (Shane *et al*., 2003). Therefore, according to the empirical evidence, the impact of the Trichotomy of Needs Theory on irrationality still needs to be addressed.

METHODOLOGY

Development of hypotheses

According to the empirical evidence, the impact of the Trichotomy of Needs Theory on stock market investors' irrationality still needs to be addressed. Hence, this study attempts to enrich the literature on behavioral finance by hypothesizing the following.

It has been found that there is a positive impact of the need for power in political leaders' decision-making (Winter, 2002). Moreover, it has been noted that the need for power is significantly correlated with decision-making behaviors of individuals in high school seniors, academy cadets, management undergraduates, and accounting partners (Stahl & Harrell, 1982). Some authors discuss the potential negative consequences of leaders in International Business Machines (IBM) Corporation driven by a strong need for power, as described in McClelland's theory (Spreier *et al.*, 2006). Nevertheless, the literature is lagging in testing the impact of the need for power as a psychological factor towards the stock market investors' irrational decisions. Therefore, to test whether there is a significant impact of the need for power on stock market investors' irrationality, the author has formulated hypothesis 1 (H_1) as follows:

H_1: The need for power has a significant impact on stock market investors' irrationality.

The existing research has explored the psychological influence of the need for affiliation in various decision-making contexts. For instance, it has been found that the need for affiliation is positively associated with psychological empowerment and intrinsic motivation, leading to effective decision-making among frontline employees in luxury hotels (Jha, 2010). Additionally, this need has been significantly correlated with decision-making behaviors across diverse groups, including high school seniors, academy cadets, management undergraduates, and accounting professionals (Stahl & Harrell, 1982). Moreover, it has been found that the success of managers at IBM is significantly influenced by their need for affiliation. (Spreier *et al.*, 2006). Despite these findings, there remains a notable gap in the literature regarding the impact of the need for affiliation on stock market investors' irrational decisions. To address this gap, the following hypothesis is proposed:

H_2: The need for affiliation has a significant impact on stock market investors' irrationality.

A few studies have identified positive relationships between the need for achievement and managerial decision making (Jha, 2010; Stahl & Harrell, 1982). Interestingly, research indicates that leaders at IBM are primarily motivated by a desire for achievement, rather than by desires for power or affiliation (Spreier *et al.*, 2006). However, in the literature, the author could identify a loophole in testing the impact of the need for achievement as a psychological factor towards the stock market investors' irrational decisions. Therefore, in order to test whether there is a significant impact of the need for achievement on stock market investors' irrationality, the author has formulated hypothesis 3 (H_3) as follows:

H_3: The need for achievement has a significant impact on stock market investors' irrationality.

The empirical review highlights that, although the moderating effect of investor category (active versus passive) has been studied in various finance contexts, its impact on the relationship between Needs Theory and stock market investors' irrationality remains underexplored (Agarwal & Mannil, 2023). To address this gap, the following hypotheses are proposed:

H_4: The investor category moderates the relationship between need for power and stock market investors' irrationality.

H_5: The investor category moderates the relationship between need for affiliation and stock market investors' irrationality.

H_6: The investor category moderates the relationship between need for achievement and stock market investors' irrationality.

Sample and data

This study belongs to the positivism paradigm, a top-down approach that begins with a specific theory that already exists and has been proved by researchers. Therefore, the authors have used the quantitative research method and deductive reasoning approach since this study is based on the well-established Needs Theory by David McClelland (1961). Data for this quantitative study was collected through a primary survey of individual stock investors who invest in the CSE. The questionnaire covers three main independent variables (need for power, affiliation, and achievement), the dependent variable (stock market investors' irrationality), and the moderating variable (investor category). The unit of analysis of this study is individual investors. The population of this study is all the individual investors who invest in CSE. Practically, the number of investors (local individuals) registered in CSE is 623,470 as of October 2023, excluding multiple registrations. The researchers of this study have selected 400 individual investors using the systematic random sampling technique. Since systematic random sampling is a technique for selecting samples at predetermined intervals, (Etikan & Bala, 2017) when selecting the sample, the questionnaire has been sent to every 1500th local individual investor registered in CSE. The study could obtain the response of 386 individual investors who make investment decisions in CSE. The questionnaire has been compiled by aligning questions to test independent variables, i.e., the need for power (nPow), the need for affiliation (nAff), the need for achievement (nAch), and the dependent variable, stock market investors' irrationality (SMII) with the use of five-point Likert scale questions.

Data analysis technique

This study tested hypotheses to examine the relationships among key variables. Specifically, the researchers investigated how the independent variables: need for power (nPow), need for affiliation (nAff), and need for achievement (nAch) affect the dependent variable, stock market investors' irrationality (SMII), using Structural Equation Modeling (SEM) in AMOS software. Additionally, the study explored whether the investor category moderates the relationship between the Needs Theory and stock market investors' irrationality. To assess this, regression analysis was conducted within the SEM framework. SEM is a comprehensive approach to test hypotheses about observable data's means, variances, and covariances based on a conceptual or theoretical model (Kaplan, 2001). It extends factor analysis by evaluating theoretical constructs through empirical data, allowing for the assessment of complex relationships among variables (Sinharay, 2010; Kaplan, 2001). This methodology is particularly effective in verifying theoretical models and understanding the impact of psychological traits on various outcomes. In this study, SEM was utilized to analyze the influence of the need for power, need for affiliation, and need for achievement on stock market investors' irrationality. These traits are habitual patterns of behavior, thought, and emotion (Sinharay, 2010). SEM's robust framework provided a detailed understanding of how these traits affect investor behavior.

Structural Equation Modeling (SEM) was employed to analyze the relationships between psychological traits and stock market investors' irrationality. SEM consists of two main phases: the structural model,

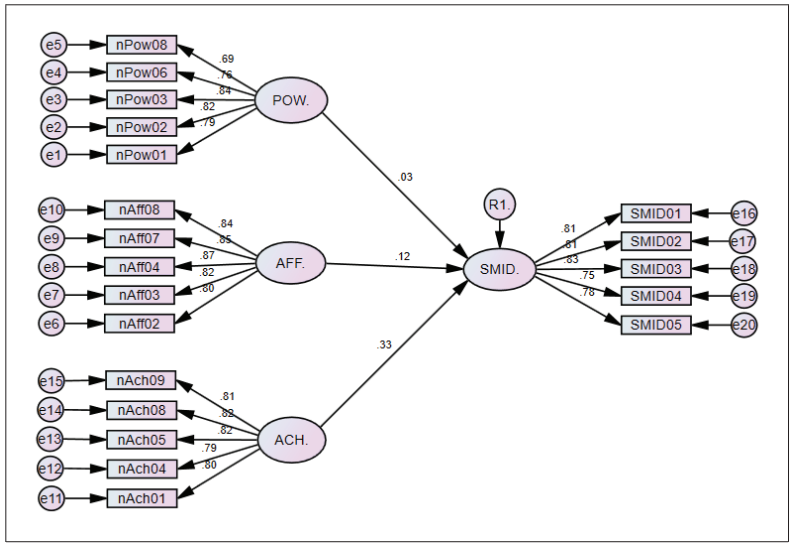


Figure 2: Structural Model for the impact of Needs Theory on SMII.

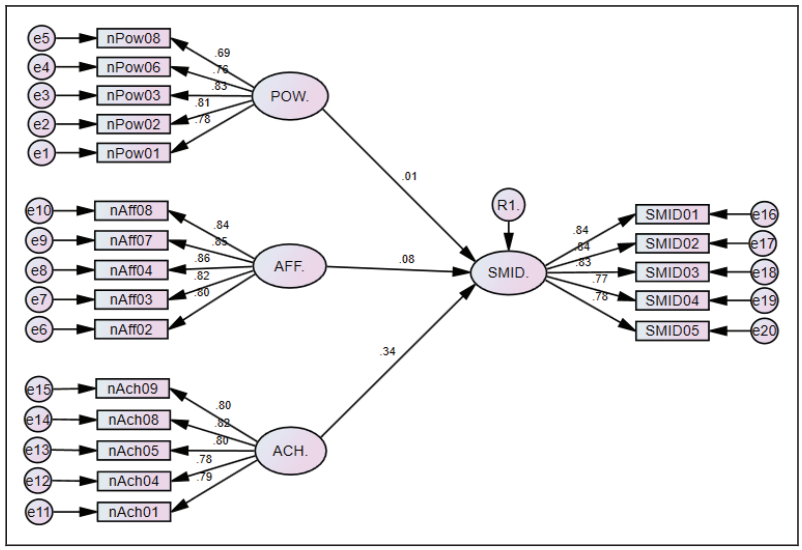


Figure 3: Structural Model for the moderation impact of the investor category.

which specifies relationships between dependent and independent constructs, and the measurement model, which connects these constructs to observed variables. Path diagrams visualize these relationships, and data is analyzed to estimate the model and draw inferences. For this study, a factor analysis was conducted to select the most appropriate items for each variable. Following this analysis, five suitable items were evaluated for each independent variable (from a total of nine) and five items for the dependent variable. Ultimately, the factor analysis ensured that the items effectively represented the constructs under investigation and provided a solid foundation for the SEM analysis. The authors developed two distinct structural models. Figure 2 illustrates the structural model designed to test the impact of the Needs Theory on stock market investors' irrationality, while Figure 3 depicts the moderating effect of investor category on the relationship between the Needs Theory and the irrationality exhibited by stock market investors.

Operationalization of variables

Operationalization of the key variables is depicted in Table 1 below. The normality has been checked for independent variables: the need for power (nPow), the need for affiliation (nAff), the need for achievement (nAch), and the dependent variable, stock market investors' irrationality (SMII), and the moderating variable, investor category (IC) based on Skewness and Kurtosis values. The graphical approach has further ensured Normality via P-P plots (Annexure 1) and Q-Q plots (Annexure 2).

Table 2 shows that all the skewness values are negative values, but all the values are within the range of -2 to +2. It is further noticeable that all the kurtosis values also range between -2 and +2. In terms of both skewness and kurtosis values, it is visible that the data set is normally distributed even with the AMOS statistical analysis (Kaplan, 2001).

DATA ANALYSIS AND RESULTS

Descriptive analysis

This section provides a profile of the sample using descriptive statistics such as, gender, age, educational attainment, monthly income, employment status, investment experience, and investor category. This profiling aids in justifying the use of systematic random sampling in the study.

The sample exhibits a higher representation of females and a predominant age group between 31 and 45 years. In terms of educational background, the majority of respondents hold a bachelor's degree, highlighting the educational qualifications of individual investors within the sample. Income analysis reveals that most respondents fall into the income bracket exceeding Rs.250,000 per month, with 83% of the sample currently employed in salaried positions. Regarding investment experience, the sample predominantly comprises individual investors with less than five years of experience. Additionally, the majority of the sample identifies as passive investors. This finding aligns with the broader investor behavior observed on the CSE, where a significant proportion of investors are characterized as passive (CSE, 2020).

Validation of the model

The data collected was subjected to statistical analysis using AMOS software to validate the proposed model, as illustrated in Figure 2 and 3. Model validation was

Table 1: Operationalization of variables

Variable	Items	Source
IV 01: Need for Power (nPow)	I am quite effective in getting others to agree with me.	(Slocum & Hellriegel, 2009; Steers & Braunstein, 1976)
	I feel confident when directing the work of others.	
	Status and recognition have meaning and significance.	
	Opportunities to become widely known are important to me.	
	I often take new employees under my wing and mentor them.	
IV 02: Need for Affiliation (nAff)	I feel uneasy when I have to tell others what to do.	(Slocum & Hellriegel, 2009; Steers & Braunstein, 1976)
	I spend a lot of time visiting with friends and family.	
	I choose hobbies that I can share with other people.	
	I am uncomfortable complaining if I receive bad service in a restaurant.	
	I seldom try to draw attention to myself.	
IV 03: Need for Achievement (nAch)	I often set goals that are very difficult to reach.	(Slocum & Hellriegel, 2009; Steers and Braunstein, 1976)(Slocum & Hellriegel, 2009; Steers & Braunstein, 1976)
	I enjoy making challenging decisions.	
	I continuously look for ways of doing things better and faster.	
	I will not be satisfied until I am the best in my field.	
	I enjoy competing with others.	
DV: Stock Market Investors Irrationality	When making an investment, I trust my inner feelings and reactions.	(Rasheed *et al*., 2018)
	I generally make investments that feel right to me.	
	When making investments, I rely upon my instincts.	
	When I make an investment, it is more important for me to feel the investment is right than have a rational reason for it.	
	When I make Investment, I tend to rely on my intuition.	
MV: Investor Category	When investing I have used my inherited money.	(Parashar, 2010)
	Money earned through my profession/career/borrowed money.	

Source: Developed based on the literature

Table 2: Normality statistics

Variable	Items	Skewness	Kurtosis
Need for Power (nPow)	nPow01	-0.611	0.403
	nPow02	-0.807	0.664
	nPow03	-0.789	0.298
	nPow06	-0.866	0.192
	nPow08	-0.646	0.394
Need for Affiliation (nAff)	nAff02	-0.143	-0.956
	nAff03	-0.149	-1.179
	nAff04	-0.248	-1.122
	nAff07	-0.150	-1.170
	nAff08	-0.240	-1.069
Need for Achievement (nAch)	nAch01	-0.817	0.515
	nAch04	-0.863	0.187
	nAch05	-1.119	0.616
	nAch08	-1.016	0.685
	nAch09	-0.979	0.605
Stock Market Investors' Irrationality (DV)	SMII01	-1.093	1.586
	SMII02	-1.233	1.542
	SMII03	-0.665	0.546
	SMII04	-0.969	1.105
	SMII05	-0.690	0.560

Source: Compiled by the Authors based on survey data, 2023

Table 3: Model Evaluation Criteria: Goodness of Fit

	Absolute fit indices		
CMIN/DF	RMESA	GFI	AGFI
2.116	0.054	0.914	0.891
	Incremental fit indices		
TLI	CFI	RFI	NFI
0.956	0.961	0.919	0.929
	Parsimony fit indices		
PGFI	PNFI		PCFI
0.727	0.816		0.845

Source: Author compiled based on survey data, 2023

conducted through the application of the goodness-of-fit test.

The CMIN value indicates (Table 3) the discrepancy between the unrestricted sample covariance matrix and the restricted covariance matrix. According to Hair *et al*. (2006), the model is considered acceptable if the CMIN/DF ratio is below 3. In this study, the CMIN/DF value was 2.116, which is below the threshold, suggesting that the model demonstrates an adequate fit. Additionally, the model's goodness-of-fit was evaluated using Absolute, Incremental, and Parsimony indices, which approached a value of 1, further supporting the model's suitability (Hair *et al*., 2006). The RMSEA value, which should fall between 0.05 and 0.08 to indicate a good fit, also met this criterion. Consequently, the model validation is deemed satisfactory based on all the specified criteria.

Convergent validity

Convergent validity is a key aspect of construct validity that evaluates whether different measures of the same theoretical construct are consistently related. This involves examining if measures theoretically expected to be associated with one another indeed show significant correlations. Essentially, convergent validity ensures that the construct is accurately and comprehensively represented by the various measurement tools used. To assess this, researchers analyze the correlations between different indicators of the same construct to confirm their alignment with theoretical expectations (Gefen *et al.,* 2000).

Table 4 presents the results of the convergent validity assessment for the measurement model. According to Hair

Table 4: Results of the Convergent Validity Test

Construct	No. of Items	Standardized Factor Loading		Average Variance Extracted	Composite Reliability
		Min	Max		
nPow	05	0.695	0.841	0.585	0.849
nAff	05	0.762	0.856	0.660	0.907
nAch	05	0.787	0.821	0.652	0.903
SMII	05	0.748	0.837	0.640	0.899

Source: Author compiled based on survey data, 2023

Table 5: Discriminant Validity Test

	nPow	nAff	nAch	SMII
nPow	0.65	-	-	-
nAff	0.13	0.58	-	-
nAch	0.01	0.05	0.66	-
SMII	0.12	0.03	0.02	0.64

Source: Author compiled based on survey data, 2023

et al. (2010), the ideal standardized factor loadings for reflective indicators should be 0.5 or higher, with values exceeding 0.7 considered optimal. Table 4 indicates that all standardized factor loadings exceed 0.6 and are statistically significant at the 5% level. Additionally, all Average Variance Extracted (AVE) values are above 0.5, as recommended by Zaiţ & Bertea (2011), and all composite reliability measures surpass 0.7, in line with the standards set by Valentini & Damasio (2016). These findings collectively affirm the presence of convergent validity in the measurement model.

Discriminant validity

To evaluate discriminant validity, the square of the inter-construct correlation estimates between each construct was compared to the Average Variance Extracted (AVE) for each construct. According to Zaiţ & Bertea (2011), the AVE of each construct should exceed the squared inter-construct correlation estimates between that construct and all other constructs.

Table 5 provides this comparison, with diagonal entries representing the AVE for each construct and sub-diagonal entries indicating the squared inter-construct correlation estimates among constructs. Table 5 demonstrates that the AVE for each construct is greater than the squared correlations with other constructs, confirming that discriminant validity is upheld.

Having established the model's validity through convergent and discriminant validity assessments, the analysis is now prepared to advance to hypothesis testing. Consequently, the following section presents the results of the hypothesis tests.

Trichotomy of Needs Theory on SMII

Using SEM, the authors conducted a regression analysis to test the proposed hypotheses. Initially, this analysis examined the direct impact of need for power, need for affiliation, need for achievement on stock market investors' irrational behavior. This methodological approach enables a thorough assessment of how need for power, need for affiliation, need for achievement influences investor irrationality, shedding light on the psychological factors driving financial decision-making. Table 6 reveals that both the need for affiliation and the need for achievement have a statistically significant impact on stock market investors' irrationality, as

indicated by p-values less than 0.05. Conversely, the need for power does not show a statistically significant effect on investor irrationality, with a p-value exceeding 0.05.

Investor category on Trichotomy of Needs Theory and SMII

This study also examines the moderating effect of investor category, that is, investors' active/passive nature, on the relationship between the need for power, the need for affiliation, the need for achievement and stock market_investors' irrationality. In this context, the authors aim to explain investor behavior through the lens of Needs Theory. Therefore, the following regression analysis results were derived from the structural equation modeling. However, the need for power does not show a statistically significant impact on investor irrationality, as per the results of Table 6. Therefore, investigating the moderating effect of the need for power on investor irrationality was deemed unnecessary, leading to Hypothesis 4 (H_4) being excluded from further analysis (Table 7). Instead, the moderating effects of the need for affiliation and the need for achievement were examined and the results are presented in Table 7.

As shown in Table 7, the investor category significantly moderates the relationship between the need for power, the need for affiliation, the need for achievement, and stock market investors' irrationality. Specifically, it moderates the effect of the need for affiliation on investors' irrational behavior, suggesting that the impact of this need on irrationality varies depending on the investor's category. Similarly, the investor category also moderates the relationship between the need for achievement and investors' irrationality, indicating that the investor category moderates the influence of the need for achievement on irrational behavior.

The analysis reveals that the investor category moderates the relationship between the independent

Table 6: Regression Analysis – Direct Impact

Hypotheses	Path	Status	Standardized Path Coefficients	P-value
H_1	nPow →SMII	Direct	0.03	0.63
H_2	nAff → SMII	Direct	0.12	0.03
H_3	nAch→ SMII	Direct	0.33	0.00

Source: Author compiled based on survey data, 2023

Table 7: Regression Analysis – Moderation Effect

Hypotheses	Path	Status	Standardized Path Coefficients	P-value
H_5	nAff → SMII	Direct	0.08	0.02
H_6	nAch →SMII	Direct	0.34	0.00

Source: Author compiled based on survey data, 2023

variable and the dependent variable, indicating that both the strength and direction of this relationship change depending on the level of the investor category (Henseler & Fassott, 2010). Specifically, in the context of stock market investors' irrationality, the effect of the need for affiliation and the need for achievement on irrationality is contingent upon the investor category. This implies that the association between these needs and irrational behavior changes depending on whether the investor is categorized as active or passive, highlighting the significant moderating impact of investor engagement on these relationships.

Based on the coefficient values and their corresponding significance levels for each variable, the following findings emerge from the hypothesis analysis. In Hypothesis 01, the null hypothesis is retained, indicating insufficient evidence to support that the need for power influences stock market investors' irrationality. Conversely, in Hypothesis 02, the null hypothesis is rejected, demonstrating statistically significant evidence that the need for affiliation does affect stock market investors' irrationality. Similarly, Hypothesis 03 also leads to rejecting the null hypothesis, indicating that the need for achievement significantly impacts stock market investors' irrationality. For Hypothesis 05, the null hypothesis is rejected, highlighting a statistically significant moderating effect of the investor category on the relationship between the need for affiliation and stock market investors' irrationality. Likewise, in Hypothesis 06, rejecting the null hypothesis suggests a statistically significant moderation effect of the investor category on the relationship between the need for achievement and stock market investors' irrationality.

DISCUSSION

This analysis primarily examines the influence of the need for power, the need for affiliation, and the need for achievement on stock market investors' irrationality. Furthermore, the study seeks to evaluate the moderating effect of the investor category on the relationship between these needs and investors' irrational behavior. To achieve this, the authors employed descriptive statistics to profile the sample, incorporating different variables. These included common factors, such as gender, age, educational level, monthly income, and employment status, as well as less common factors, such as investing experience and investor category. This comprehensive approach, facilitated by systematic random sampling, ensures a robust representation of the population. Interestingly the sample includes a majority of female investors, while statistics from 2020 indicate a growing proportion of investors aged 18-30, while the number of mature investors is decreasing (CSE, 2020). Consequently, the sample used in this study reflects a higher representation of younger investors. In addition to personal psychological characteristics, education level significantly influences irrational decision-making, as it can affect how decisions are approached. The majority of the sample holds a bachelor's degree, highlighting the impact of educational background on decision-making patterns. In this study, the investor category is a key moderating variable, categorized into active and passive investors. Statistics from the CSE indicate that most investors are passive, typically accumulating wealth through inheritance, professional careers, or investing in others' funds rather than their own. The CSE is currently promoting a shift towards active investing (CSE, 2020). Consequently, the sample predominantly comprises passive investors.

The findings of this study indicate that both the need for affiliation and the need for achievement have a significant positive impact on stock market investors' irrational decision-making. In contrast, the need for power does not exhibit a significant effect on investors' irrationality. Furthermore, the results demonstrate that the investor category plays a significantly moderating role in the relationship between the need for affiliation and irrational decision-making, as well as in the relationship between the need for achievement and irrational decision-making. Therefore, utilizing the investor category as a variable is important for understanding how psychological needs influence investment behavior.

Past literature has established a significant correlation between the need for power and decision-making behavior across various groups, including high school seniors, academy cadets, management undergraduates, and accounting partners (Harrell & Stahl, 1984). Conversely, McNeese-Smith (1999) found a negative impact of the need for power on the decision-making behavior of managers and staff nurses. In contrast to these findings, this study reveals that the need for power does not significantly impact stock market investors' irrationality. Additionally, Jha (2010) reported a significant positive relationship between the need for power and the decision-making behavior of frontline employees in five-star hotels. This result suggests that, despite its influence on decision-making in various other groups, the need for power does not affect the irrational decision-making of stock market investors. One explanation for this discrepancy is the unique context of the stock market, where emotional and cognitive biases often outweigh personality traits like the need for power. Research shows that investors rely on heuristics and are influenced by herd behavior and overconfidence (Barberis & Thaler, 2003), which can undermine rational decision-

making. Furthermore, the analytical nature of investment decisions may conflict with the assertive behaviors typically associated with a high need for power, as rapid, data-driven decisions take precedence over interpersonal dynamics (Thompson *et al*., 2009). Thus, while the need for power may drive behaviors in other contexts, its influence is diminished in stock market investments due to the predominance of emotional and cognitive factors. Recent research has refined the concept of the need for power by distinguishing between a personalized need for power and a socialized need for power. Studies indicate that a personalized need for power is positively correlated with management behaviors and work performance. In contrast, a socialized need for power is positively associated with positive work-related personality traits (Khan & Batool, 2022). Further, it has been found that the personalized need for power predicts counterproductive work behaviors in corporate managers, mediated by humility (Khan & Batool, 2022).

Previous research has established a significant correlation between the need for affiliation and decision-making behavior across various groups, including high school seniors, academy cadets, management undergraduates, and accounting partners (Harrell & Stahl, 1984). Additionally, McNeese-Smith (1999) reported a positive correlation between the need for affiliation and decision-making behavior among staff nurses, and similar findings were observed among frontline employees in five-star hotels (Jha, 2010; McNeese-Smith, 1999). Consistent with these studies, this research demonstrates a significant positive relationship between the need for affiliation and irrational decision-making among stock market investors. This study corroborates the findings of Harrel & Stahl (1984), McNeese-Smith (1999) and Jha (2010) by revealing a significant positive relationship between the need for achievement and irrational decision-making among stock market investors. However, some studies and scholarly texts have highlighted that personal opinions are inherently biased, which can undermine the applicability of Maslow's Needs Theory (Upadhyaya, 2014). Consequently, the theory may lack relevance for certain individuals due to challenges encountered in its practical application (Upadhyaya, 2014). Further, it has been found that the need for achievement impacts entrepreneurial behavior, mediated by the entrepreneurial passion of potential entrepreneurs from different nationalities living in China (Saif & Ghania, 2020). This is particularly evident in the context of the CSE, where unique market dynamics and cultural factors influence investor decision-making. While the need for achievement positively impacts entrepreneurial behavior among diverse nationalities in China (Saif & Ghania, 2020), its effectiveness may be diminished in the CSE due to market volatility and cognitive biases. Additionally, cultural attitudes toward risk and competition in Sri Lanka may further shape how the need for achievement influences investment behaviors in this specific environment.

Overall, while this study aligns with past research by confirming the significant positive impacts of the need for affiliation and the need for achievement on irrational decision-making among stock market investors, it diverges from existing literature by finding no significant effect of the need for power on investors' irrationality. This suggests that the influence of psychological needs on decision-making may vary across different contexts and populations. This difference may be linked to the distinctive features of the CSE, where market fluctuations and cultural norms emphasize social relationships and achievement rather than assertiveness. As a result, the impact of psychological needs on investor behavior differs in this particular setting, underscoring the necessity of comprehending these dynamics.

The active and passive characteristics of investors have been explored in various psychological and behavioral finance studies. However, the moderating effect of investor category on the relationship between the Trichotomy of Needs Theory and stock market investors' irrational decisions has not been previously investigated. This study reveals a significant moderating effect of investor category on the relationship between the need for affiliation and irrational decision-making among stock market investors. Additionally, it demonstrates a significant moderating effect of investor category on the relationship between the need for achievement and irrational decision-making in the stock market.

The significant moderating effect of investor category on the relationship between the need for achievement and irrational decision-making is particularly relevant in the context of the CSE, where active investors, who comprise a substantial portion of market participants, often engage in frequent trading. These active investors, driven by a high need for achievement, may make impulsive decisions in response to market volatility, leading to increased irrational behavior. Conversely, passive investors in the CSE tend to focus on long-term strategies, resulting in more rational decision-making than active investors, thereby illustrating the critical role that these distinct investor categories play in shaping market dynamics and outcomes.

CONCLUSION

In conclusion, this study provides compelling evidence that the need for power, need for affiliation, need for

achievement significantly influences stock market investors' irrational behavior. By demonstrating a positive relationship between Needs Theory and irrational decision-making, the research underscores how psychological and emotional needs, particularly the need for affiliation and the need for achievement, drive investors away from rationality. The findings reveal that these psychological needs are central to the Trichotomy of needs, as proposed by David McClelland's theorem (1961), and show that this model fits well within the context of behavioral finance.

Additionally, the study identifies a significant moderating effect of investor category on the relationship between the need for power, need for affiliation, need for achievement and irrational decision-making. This highlights the complexity of investor behavior, suggesting that different types of investors are influenced by their needs in varied ways. These insights into how personal characteristics and psychological constructs affect investment decisions offer valuable implications for enhancing investor education and refining behavioral finance forecasting models. By incorporating these psychological factors, predictions about investor behavior can be more accurate, contributing to better market strategies and understanding.

This study offers valuable insights for stakeholders, including market analysts, individual investors, stockbrokers, and stockmarket policymakers. For market analysts, the study provides a framework for understanding how different investor types (active vs. passive) exhibit distinct decision-making behaviors and how these characteristics influence stock market outcomes. Individual investors can leverage these insights to evaluate and refine their decision-making processes on the CSE, based on their psychological profiles. Stockbrokers, who rely on their expertise and knowledge to navigate the stock market, will benefit from an enhanced understanding of how psychological characteristics and investor behavior impact market dynamics. This expanded knowledge will aid them in making more informed decisions in the stock market. Finally, stock market policymakers can utilize the findings of this study to inform their decisions and policies concerning individual investors, ensuring that regulatory frameworks and interventions are tailored to account for the psychological and behavioral nuances identified.

Future research should aim to broaden the scope of this study by applying its objectives to stock markets beyond the CSE. This expansion would enhance the generalizability of the findings. Additionally, while this study focused exclusively on local individual investors within the CSE, future researchers should include foreign investors and institutional investors to provide a more comprehensive understanding of irrational decision-making. Furthermore, researchers are encouraged to select stock markets that adequately represent both active and passive investors, as the CSE currently has a lower proportion of active investors when compared to passive investors. In the context of behavioral finance, this study utilized McClelland's Trichotomy of Needs Theory to explore psychological influences. Future research should consider incorporating other psychological theories, such as Bounded Rationality Theory, Adaptive Markets Hypothesis, Prospect Theory, or Regret Theory, to examine the possibility of explaining the stock market investors' irrational behavior using these theories. This analysis could offer additional insights into the psychological dimensions of irrational investment decisions.

REFERENCES

Abeysekera, A. P. & Nimal, P. D. (2017) The four-factor model and stock returns: Evidence from Sri Lanka. *Afro-Asian Journal of Finance and Accounting*, 7(1), pp: 1-15.

DOI: https://doi.org/10.1504/AAJFA.2017.082924

Achua, C. F. and Lussier, R. N. (2014) Entrepreneurial drive and the informal economy in Cameroon. *Journal of Developmental Entrepreneurship*, 19(04).

DOI: https://doi.org/10.1142/S1084946714500241.

Aditya, R. (2006) Personality and the Transformational Leader. *Comprehensive handbook of personality and psychopathology*, 345.

Aduda, J. and Muimi, P. (2011) Test for investor rationality for companies listed at the Nairobi Stock Exchange. *Journal of Modern Accounting and Auditing*, 7(8), p. 827.

Agarwal, S. and Mannil, N. (2023) Household financial decision making. In *Handbook of Financial Decision Making*, pp.:375-410, Edward Elgar Publishing.

DOI: https://doi.org/10.1504/AAJFA.2017.082924

Aggarwal, D. and Mohanty, P. (2018) Do Indian stock market sentiments impact contemporaneous returns?. *South Asian Journal of Business Studies*.

DOI: https://doi.org/10.1108/SAJBS-06-2018-0064

Ainslie, G. (2016) The cardinal anomalies that led to behavioral economics: Cognitive or motivational?. *Managerial and Decision Economics*, 37(4-5), pp: 261-273.

DOI:https://doi.org/10.1002/mde.2715

Akhtar, F., Thyagaraj, K. S. & Das, N. (2014) Developing an Empirical Framework for Investment Strategy Based on BB&K Five-Way Model. *IPE Journal of Management*, 4(2), p. 47.

Azouagh, I. and Daoui, D. (2023) Comparative analysis of active and passive portfolio management: A theoretical approach. International *Journal of Accounting, Finance, Auditing, Management and Economics*, 4(3-1), pp: 504-517.

Barberis, N. and Thaler, R. (2003) A survey of behavioral finance. *Handbook of the Economics of Finance*, 1, pp: 1053-1128.

DOI: https://doi.org/10.1016/S1574-0102(03)01027-6

Barnwell, M. M. (1987) Psychological characteristics of the individual investor. *Asset allocation for the individual investor*, pp: 62-69.

Bluethgen, R., Gintschel, A., Hackethal, A. & Mueller, A. (2008) Financial advice and individual investors' portfolios. Available at SSRN 968197.

DOI:https://doi.org/10.2139/ssrn.968197

Buddhika, H. J. R. (2020) The Determinants that Affect the Disposition Bias of Individual Investors in Sri Lankan Colombo Stock Exchange (CSE). In *Proceedings of the International Conference on Business and Information (ICBI)*.

DOI: https://doi.org/10.2139/ssrn.3844272

Bloomfield, R. (2010) Traditional versus behavioral finance. *Behavioral Finance: Investors, Corporations, and Markets*, pp: 23-38.

DOI: https://doi.org/10.1002/9781118258415.ch2

Cse.lk (2020) A turnaround year for the Sri Lankan Stock Market, Media Release, December 31st 2020.

Daft, R. L. (2008) *The leadership experience*. Mason, OH: SouthWestern, Cengage Learning.

Daft, R. L., Murphy, J. and Willmott, H. (2010) Organization theory and design. 10, Mason, OH: South-Western Cengage Learning.

Di Domenico, S. I., Le, A., Liu, Y., Ayaz, H. and Fournier, M. A. (2016) Basic psychological needs and neurophysiological responsiveness to decisional conflict: an event-related potential study of integrative self processes. *Cognitive, Affective, and Behavioral Neuroscience*, 16, pp: 848-865.

DOI: https://doi.org/10.3758/s13415-016-0436-1

Etikan, I. and Bala, K. (2017) Sampling and sampling methods. *Biometrics and Biostatistics International Journal*, 5(6), 00149.

DOI: https://doi.org/10.15406/bbij.2017.05.00149

Fama, E. F. (1980) Efficient Capital Markets: A Review of Theory and Empirical Work. *Journal of Finance*, 25(2), pp: 383-417.

DOI: https://doi.org/10.1111/j.1540-6261.1980.tb02171.x

Flood Jr, E. and Ramachandran, N. (2000) Integrating active and passive management. *Journal of Portfolio Management*, 27(1), p. 10.

DOI: https://doi.org/10.3905/jpm.2000.319782

Ganesh, R., Gopal, N. and Thiyagarajan, S. (2018) Bulk and block holders herding behavior. *South Asian Journal of Business Studies*.

DOI: https://doi.org/10.1108/SAJBS-12-2017-0139

Gefen, D., Straub, D. and Boudreau, M. C. (2000) Structural equation modeling and regression: Guidelines for research practice. *Communications of the Association for Information Systems*, 4(1), p. 7.

DOI: https://doi.org/10.17705/1CAIS.00407

Hair, Jr. Joseph F., Anderson, Rolph E., Tatham, Ronald L. and Black, William C. (2006) *Multivariate Data Analysis*. (5th Ed.) Dorling Kindersley (India) Pvt. Ltd, Pearson Education, Inc., New Delhi, pp: 1 – 700.

Hair, J., Black, W. C., Babin, B. J. and Anderson, R. E. (2010) Multivariate Data Analysis (7th Ed.) Upper Saddle River, New Jersey: Pearson Educational International.

Hansemark, O. C. (2003) Need for achievement, locus of control and the prediction of business start-ups: A longitudinal study. *Journal of Economic Psychology*, 24(3), pp: 301-319.

DOI: https://doi.org/10.1016/S0167-4870(02)00188-5

Hauff, J. C. and Nilsson, J. (2017) The impact of country-of-origin cues on consumer investment behavior: the moderating influence of financial brand strength and investment management style. *European Journal of Marketing*.

DOI: https://doi.org/10.1108/EJM-01-2016-0033

Harrell, A.M. and Stahl, M.J., 1984. McClelland's Trichotomy of Needs Theory and the job satisfaction and work performance of CPA firm professionals. *Accounting, Organizations and Society*, 9(3-4), pp: 241-252.

DOI: https://doi.org/10.1016/0361-3682(84)90010-2

Henseler, J. and Fassott, G. (2010) Testing moderating effects in PLS path models: An illustration of available procedures. *Handbook of partial least squares: Concepts, methods and applications*, pp: 713-735.

DOI: https://doi.org/10.1007/978-3-540-32827-8_31

Hewamana, H. M. R. R., Siriwardhane, D. R. J. and Rathnayake, R. M. A. K. (2022) Nexus between asymmetric information and stock market volatility: evidence from Sri Lanka. *Economic Research*, 9, p. 2.

DOI: https://doi.org/10.4038/sljer.v9i2.164

Huda, M., Maseleno, A., Rathod, H.S. and Chauhan, R. (2020) A Conceptual Research Study on Identification of Biases with towards Assets Allocation and Portfolio Management of Investors. *European Journal of Molecular and Clinical Medicine*, 7(10), pp: 985-994.

Jain, R., Jain, P., and Jain, C. (2015) Behavioral Biases in the Decision Making of Individual Investors. *IUP Journal of Knowledge Management*, 13(3).

Jha, S. (2010) Need for growth, achievement, power and affiliation: Determinants of psychological empowerment.

Global Business Review, 11(3), pp: 379-393.

DOI: https://doi.org/10.1177/097215091001100305

Johnson, A., and Lee, M. (2021) The impact of power motivation on leadership styles. *Journal of Leadership Studies*, 15(2), pp: 45-60.

DOI: https://doi.org/10.1177/097215091001100305

Kaplan, D. (2001) Structural Equation Modeling. *International Encyclopedia of the Social & Behavioral Sciences*, Pergamon, 15215-15222.

DOI: https://doi.org/10.1016/B0-08-043076-7/00776-2

Khan, M. Z. and Batool, I. (2022) Need for Power, Personality Traits, and Organizational Work-Related Behaviors among Employees. *Pakistan Languages and Humanities Review*, 6(3), pp: 27-44.

DOI: https://doi.org/10.47205/plhr.2022(6-III)03

Levišauskaitė, K., and Kartašova, J. (2011) Evaluation of irrational individual investors' behavior driving factors in Lithuania. *Applied Economics: Systematic Research*, 5(2).

Lim, C. F. (1992) *Demographic and lifestyle profiles of individual investors in the KLSE*. Unpublished MBA Thesis. University of Malaya, Kuala Lumpur.

Linda, W. P., Marroquín, B., and Miranda, R. (2012) Active and passive problem solving as moderators of the relation between negative life event stress and suicidal ideation among suicide attempters and non-attempters. *Archives of Suicide Research*, 16(3), pp: 183-197.

DOI: https://doi.org/10.1080/13811118.2012.695233

Macdonald, C. T., and Wood, J. K. (2018) The Moderating Effect of Need for Affiliation on Conformity in Response to Group Reactions. *New Zealand Journal of Psychology*, 47(3).

Maner, J. K., Gailliot, M. T., Butz, D. A., and Peruche, B. M. (2007) Power, risk, and the status quo: Does power promote riskier or more conservative decision making?. *Personality and Social Psychology Bulletin*, 33(4), pp: 451-462.

DOI: https://doi.org/10.1177/0146167206297405

Markowitz, H. (1952) Portfolio Selection. *Journal of Finance*, 7(1), pp: 77-91.

DOI: https://doi.org/10.1111/j.1540-6261.1952.tb01525.x

McClelland, D. C. (1961) *The Achieving Society*. New Jersey: Princeton.

DOI: https://doi.org/10.2307/2573612

McClelland, D. C. (1975) *Power: The inner experience*. New York: Irvington.

DOI: https://doi.org/10.1177/105960117600100215

McClelland, D. C., Atkinson, J., Clark, R., and Lowell, E. *(1976) The achievement motive*. New York: Irvington.

DOI: https://doi.org/10.1037/11144-000

McNeese-Smith, D. K. (1999) The relationship between managerial motivation, leadership, nurse outcomes and patient satisfaction. Journal of Organizational Behavior. *The International Journal of Industrial, Occupational and Organizational Psychology and Behavior*, 20(2), pp: 243-259.

DOI: https://doi.org/10.1002/(SICI)1099-1379(199903)20:2%3C243::AID-JOB888%3E3.0.CO;2-2

Muktadir-Al-Mukit, D. (2022) Do sociodemographic factors have influence on risk tolerance level of stock market investors? An analysis from a developing country perspective. *South Asian Journal of Business Studies*, 11(2), pp: 149-173.

DOI: https://doi.org/10.1108/SAJBS-11-2019-0193

Ng, K., Niven, K., and Notelaers, G. (2022) Does bystander behavior make a difference? How passive and active bystanders in the group moderate the effects of bullying exposure. *Journal of Occupational Health Psychology*, 27(1), p. 119.

DOI: https://doi.org/10.1037/ocp0000296

Osemeke, M., & Adegboyega, S. (2017) Critical review and comparison between Maslow, Herzberg and McClelland's theory of needs. *Funai Journal of Accounting, Business and Finance*, 1(1), pp: 161-173 [Online] Available from: https://fujabf.org/wp-content/uploads/2018/01/Critical-Review-and-Comparism-between-Maslow-Herzberg-and-McClellands-Theory-of-Needs.pdf[Accessed:].

Parashar, N. (2010) An empirical study on personality variation and investment choice of retail investors. *Journal of Management and Information Technology*, 2(1), pp: 33-42.

Pompian, M. M. (2012) *Behavioral finance and investor types: managing behavior to make better investment decisions*. John Wiley & Sons.

DOI: https://doi.org/10.1002/9781119202417

Rachlinski, J. J. and La Blanc, G. (2005) In praise of investor irrationality. https://scholarship.law.cornell.edu/lsrp_papers/21

Rantapuska, E. (2005) Which investors are irrational?: evidence from rights issues.

Rasheed, M. H., Rafique, A., Zahid, T., and Akhtar, M. W. (2018) Factors influencing investor's decision making in Pakistan: Moderating the role of locus of control. *Review of Behavioral Finance*, 10(1), pp: 70-87.

DOI: https://doi.org/10.1108/RBF-05-2016-0028

Ricciardi, V. and Simon, H. K. (2000) What is behavioral finance?. *Business, Education and Technology Journal*, 2(2), pp: 1-9 [Online] Available from: https://ssrn.com/abstract=256754. [Accessed:].

Ritter, J. R. (2003) Behavioral finance. *Pacific-Basin Finance Journal*, 11(4), pp: 429-437.

DOI: https://doi.org/10.1016/S0927-538X(03)00048-9

Saif, H.A. and Ghania, U. (2020) Need for achievement as a predictor of entrepreneurial behavior: The mediating role of entrepreneurial passion for founding and entrepreneurial interest. *International Review of Management and Marketing*, 10(1), p. 40.

DOI: https://doi.org/10.32479/irmm.8949

Salas, E., Kozlowski, S.W. and Chen, G. (2017) A century of progress in industrial and organizational psychology: Discoveries and the next century. *Journal of Applied Psychology*, 102(3), p. 589.

DOI: https://doi.org/10.1037/apl0000206

Shane, S., Locke, E. A., & Collins, C. J. (2003) Entrepreneurial motivation. *Human Resource Management Review*, 13(2), pp: 257-279.

DOI: https://doi.org/10.1016/S1053-4822(03)00017-2

Shernoff, D. J., Ruzek, E.A. and Sinha, S. (2017) The influence of the high school classroom environment on learning as mediated by student engagement. *School Psychology International*, 38(2), pp: 201-218.

DOI: https://doi.org/10.1177/0143034316666413

Sinharay, S. (2010) An overview of statistics in education.

DOI: https://doi.org/10.1016/B978-0-08-044894-7.01719-X

Slapničar, S., Oblak, K. and Ličen, M. (2022) The Moderating Effect of Achievement Motive on Performance Feedback in Choices of Challenging Tasks. *Journal of Management Accounting Research*, 34(2), pp: 201-220.

DOI: https://doi.org/10.2308/JMAR-2020-084

Slocum, J. W., and Hellriegel, D. (2009) *Principles of organizational behavior*. Mason, OH: South-Western Cengage Learning.

Spreier, S. W., Fontaine, M. H. and Malloy, R. L. (2006) Leadership run amok. *Harvard Business Review*, 84(6), pp: 72-82 [Online] ttps://www.getyourbigon.com/Downloads/sg/misc/Leadership_Run_Amok.pdf [Accessed:].

Stahl, M. J., and Harrell, A. M. (1982) Evolution and validation of a behavioral decision theory measurement approach to achievement, power, and affiliation. *Journal of Applied Psychology*, 67(6), p. 744.

DOI: https://doi.org/10.1037/0021-9010.67.6.744

Steers, R. M., and Braunstein, D. N. (1976) A behaviorally-based measure of manifest needs in work settings. *Journal of Vocational Behavior*, 9(2), pp: 251-266.

DOI: https://doi.org/10.1016/0001-8791(76)90083-X

Steinmann, B., Kleinert, A., and Maier, G. W. (2020) Promoting the underestimated: A vignette study on the importance of the need for affiliation to successful leadership. *Motivation and Emotion*, 44, pp: 641-656.

DOI: https://doi.org/10.1007/s11031-020-09833-7

Thompson, C. (2010) The Power of Authority: challenging educational theory and practice. *Power and Education*, 2(1), pp: 63-74.

DOI: https://doi.org/10.2304/power.2010.2.1.63

Tupe, V. A. (2021) A Study of Impact of Psychological Biases on investor's Investment Decision. *EPRA International Journal of Economic and Business Review (JEBR)*, 9(8), p. 1.

DOI: https://doi.org/10.36713/epra8324

Upadhyaya, C. (2014) Application of the Maslow's hierarchy of need theory; impacts and implications on organizational culture, human resource and employee's performance. *International Journal of Education and Management Studies*, 4(4), p. 353.

Valentini, F., and Damasio, B. F. (2016) Average Variance Extracted and Composite Reliability: Reliability Coefficients/ Variancia Media Extraida e Confiabilidade Composta: Indicadores de Precisao. *Psicologia: Teoria e Pesquisa*, 32(2).

DOI: https://doi.org/10.1590/0102-3772e322225

Verma, N., and Rangnekar, S. (2015) General decision making style: evidence from India. *South Asian Journal of Global Business Research*, 4(1), pp: 85-109.

DOI: https://doi.org/10.1108/SAJGBR-09-2013-0073

Warren, W. E., Stevens, R. E. and McConkey, C. W. (1990) Using demographic and lifestyle analysis to segment individual investors. *Financial Analysts Journal*, 46(2), pp: 74-77.

DOI: https://doi.org/10.2469/faj.v46.n2.74

Wermers, R. R., and Yao, T. (2010) *Active vs. Passive Investing and the Efficiency of Individual Stock Prices*.

DOI: https://doi.org/10.2139/ssrn.1573357

Winter, D. G. (2003) Personality and political behavior. In D. O. Sears, L. Huddy, & R. Jervis (Eds.), *Oxford Handbook of Political Psychology ,* pp: 110-145, Oxford University Press.

Winter, D. G. (1993) Power, affiliation, and war: Three tests of a motivational model. *Journal of Personality and Social Psychology*, 65(3), p. 532.

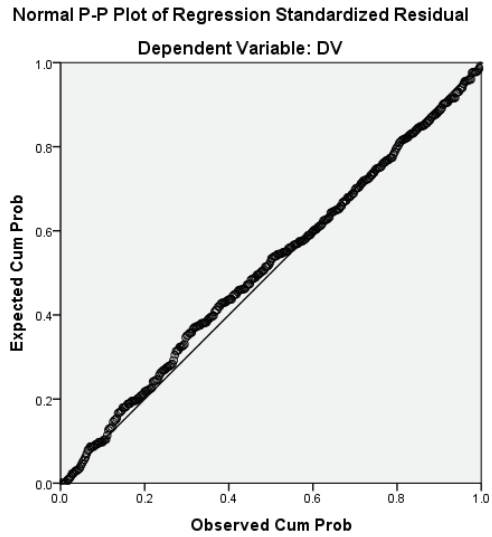
DOI: https://doi.org/10.1037/0022-3514.65.3.532

Zaiţ, A., and Bertea, P. S. P. E. (2011) Methods for testing discriminant validity. *Management and Marketing Journal*, 9(2), pp: 217-224.

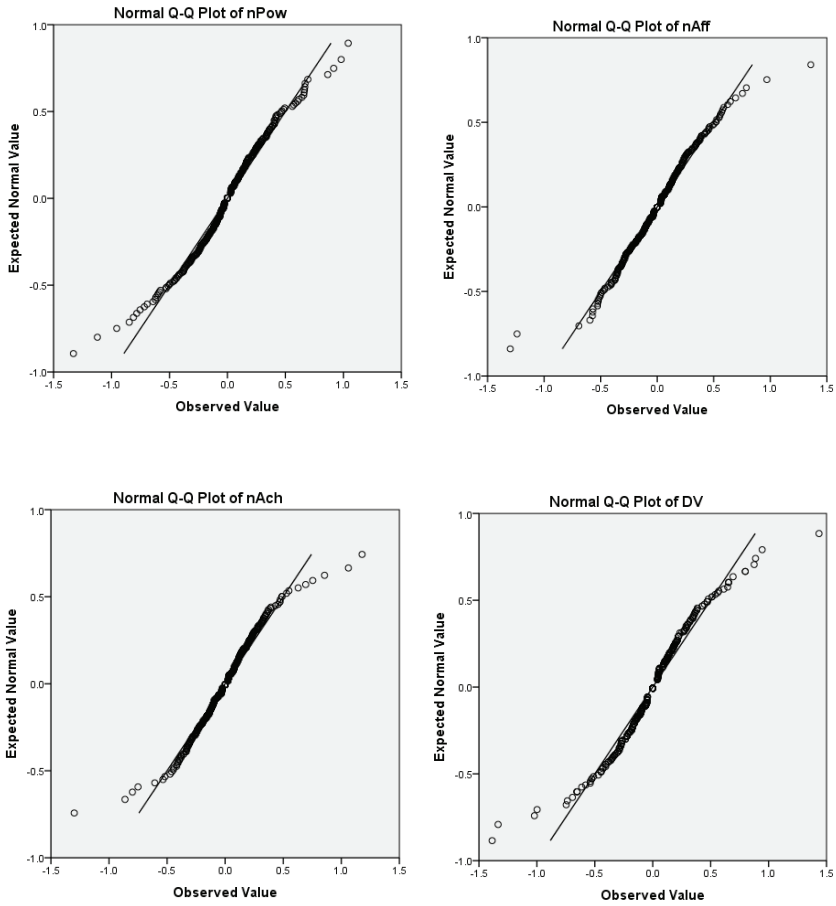
Zohaib Khan, M. and Batool, I. (2022) Workplace Arrogance, Need for Power, and Counterproductive Work Behaviors in Corporate Managers: The Mediating Role of Humility. *International Journal of Organizational Leadership*, 11(4), pp: 462-482.

DOI: https://doi.org/10.33844/ijol.2022.60345

Appendix 1: Normal P-P Plot



Appendix 2: Normal Q-Q Plot



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RESEARCH ARTICLE

Proposed variant of Myers' Index

Jamal Abdul Nasir, Maira Imtiaz* and Maliha Javaid
Department of Statistics, Government College University, Lahore, Pakistan.

Abstract: This paper extends the Alternative Myers' index Pal *et al*. (2014) as a common measure of the quality of age reporting in addition to Pal *et al*. (2014) past development using the data of selected Asian countries. The most recent wave of country-specific demographic and health survey data is used for the present study. Three different versions of the Myers' index are proposed. The proposed versions are calculated by replacing the original population with a person-year approach. When proposed variants are compared with the alternative version, the proposed modified variants seem to be appropriate as they fall closer to the original Myer index values. In contrast, alternative index values are distant from the standard Myers' index values. Moreover, the results of the analysis extended to compare the proposed variants and alternative index across the place of residence and the education status of the respondents. Finally, in all these comparisons the results revealed to be in the same direction that the modified variants are better in terms of distance than an alternative index with the standard Myers' index values.

Keywords*:* Age heaping, Myers' index, person years, demographic and health survey, asian countries.

INTRODUCTION

For many researchers such as demographers, statisticians, humanists, economists and so forth, age reporting errors have been a persistent reason for worry, particularly in progressive nations. To evaluate the extent of digit preference and aversion to the age statistics several measures were used for instance, Myers' index (Myers, 1940), Whipple's index (Whipple, 1919), Bachi index (Bachi, 1951), Ramachandran measure (Ramachandran, 1967) and Carrier index (Carrier, 1959) for single-year age distributions. Among these mentioned age misreporting measures, Myers (Myers, 1940) and Whipple index (Whipple ,1919) are enormously used empirically in literature since 1950s (Ramachandran, 1967; Yusuf, 1967; Shryock & Siegel, 1980; Srinivasan, 1998; Spoorenberg & Dutreuilh, 2007; Francis *et al*., 2019; Singh *et al*., 2022). Very often, Myer's index is calculated for censuses data (Bailey & Makannah, 1993; Bekele, 2006; Susuman *et al*., 2015; Dahiru & Dikko, 2013). Among these measures, the focus of this present study is on Myers' index. Myers' index (1940) summarizes the absolute deviations in the population to give an index of preference as a measure of age misreporting in a particular census or survey. In terms of numerical structure, one of the key assumptions of linearity is assumed in the estimation of Myers' blended index. In literature, different extensions have been proposed for the Whipple index such as Whipple types, modified Whipple index and further modified Whipple (Noumbissi, 1992; Spoorenberg & Dutreuilh, 2007; Nasir & Hinde, 2014). Whipple modifications are accessible, however, Myers' index is standing alone where no extension is available for that method except an alternative approach (Pal *et*

* Corresponding author (mairaimtiaz12345@gmail.com; https://orcid.org/0009-0009-4595-1444))

al., 2014). Hence, the broad objective of the paper is that this study concentrates only on Myers' blended method and proposes some new extensions by comparing it with the existing Myers' alternative index. The fundamental goal of this study is to get the method in the statistics and to discover the case, if there is any improved method to measure erroneous age reporting in different Asian countries. Errors in specifying age in demographic health surveys can be observed for ever-married women during the age group between 15 and 49. Age distortions have been identified in research literature since the 1950s (Bachi, 1951; Kpedekpo, 1982; Bailey & Makannah, 1993; Bekele, 2006; Susuman *et al*., 2015; Dahiru & Dikko, 2013; Francis *et al*., 2019; Fayehun *et al*., 2020; Singh *et al*., 2022). In this study, the motivation for considering Myers' variants resembled Whipple's variants. Whipple and its variants give the same level of age misreporting, but the variants are easy to compute. To the best of our knowledge, the study signifies the development of variants of Myers' index. Age distortions

Table 1: Total sample sizes of ever-married women in different Asian countries Demographic and Health Survey.

Name of the country	Total DHS* waves	Most recent DHS	Total number of ever-married women	Compiling Agencies of DHS***
Armenia	4	2015-16	6,116	National Statistical Service, Armenia
Azerbaijan	1	2006	8,444	State Statistical Committee (SSC)
Bangladesh	12	2017-18	20,127	National Institute of Population Research and Training (NIPORT)
India	5	2019-21	724,115	International Institute for Population Sciences (IIPS)
Indonesia	12	2017	49,627	National Population and Family Planning Board (BKKBN)
Jordan	7	2017-18	14,689	Department of Statistics (DOS) and Inner City Fund (ICF)
Maldives	2	2016-17	7,699	Ministry of Health (MOH)
Afghanistan	3	2018-19**	29,461	Central Statistics Organization (CSO)
Pakistan	5	2017-18	15,068	National Institute of Population Studies (NIPS)
Nepal	8	2021**	12,862	Ministry of Health, Nepal
Myanmar	1	2015-16	12,885	Ministry of Health and Sports (MoHS), Nay Pyi Taw, Myanmar
Philippine	7	2017	25,074	Philippine Statistics Authority (PSA)
Sri Lanka	3	2016**	5,865	Department of Census and Statistics, Ministry of Plan Implementation, Colombo, Sri Lanka
Thailand	1	1987	6,775	Institute of Population Studies Chulalongkorn University, Bangkok, Thailand
Turkey	6	2018**	9,746	Hacettepe University Institute of Population Studies
Vietnam	3	2005	13,996	General Statistical Office (GSO), Vietnam
Yemen	3	2013	25,434	Ministry of Public Health and Population (MOPHP)
Cambodia	5	2014	17,578	National Institute of Statistics

*Demographic and Health Survey

**Data not available

***Compiled by the author using data from: CSO, MoPH & ICF (2017); DCS & Institute for Resource Development (1988); DOS & ICF (2019); GSO, NIHE & ORC Macro (2006); Hacettepe University Institute of Population Studies (2014); Institute of Population Studies, Chulalongkorn University & Institute for Resource Development/Westinghouse (1988); IIPS & ICF (2017); MOH & ICF (2018); MoHS & ICF (2017); Ministry of Health, New ERA & ICF (2017); MOPHP, CSO, PAPFAM & ICF International (2015); (NIPORT), Mitra and Associates & ICF International (2016); NIPS & ICF (2019); National Institute of Statistics, Directorate General for Health & ICF International (2015); BKKBN, BPS, Kemenkes & ICF (2018); National Statistical Service, Ministry of Health & ICF (2017); PSA & ICF (2018); SSC & Macro International Inc. (2008)

remained a key challenge in most Asian and African countries. This is the reason for the inclusion of Asian countries for application purposes in the present article.

DATA AND METHODS

Demographic and health survey data of selected Asian countries

To test the proposed indices presented in the introduction section, the main variable of interest is the age of the respondents collected through census or surveys. Under the assumption that age heaping is pronounced in developing countries, about 18 different countries were taken in the study. Single-year age returns were selected for the most recent round of the country-specific Demographic and Health Survey (DHS). Table 1 presents the list of selected Asian countries including the most recent DHS. Table 1 entries are arranged in descending order of the survey year. Among 18 countries, DHS in India was observed to be the most recent survey held in 2019-20. Data from Sri Lanka and Thailand's 1987 DHS waves had to be used in the present study. Even if, about three rounds of DHS (1987, 2006-07 and 2016) were conducted in Sri Lanka but only the data from 1987 DHS is available. Thailand completed only one wave of DHS in 1987. The maximum number (12) of DHS were held in Bangladesh (Table 1). The key respondent of the DHS has been ever-married women aged (15-49) years.

METHODS

Myers' Index

Myers' index is mentioned as a "blended index" since it originated by Myer (1940) to escape bias in the computed index. Robert J. Myers (1940) developed the method for measuring age heaping. It gives the extent of digit preference for all terminal digits 0 to 9. It can be used to report errors for all ages 10 – 89 years (Kpedekpo, 1982). This technique has been made on the assumption that in the absence of systematic irregularities in the reporting of age, the population is equally distributed and the collective population of each age ending in terminal digits from 0 to 9 should be displayed as 10 % of the population (Myers, 1954; Bello, 2012; Fayehun *et al*., 2020). If the sum at any given digit exceeds 10% of the total blended population, it indicates the selection of ages that represent digit preference. While the sum at any given digit is less than 10% of the total population it indicates under selection as digit avoidance (Bello, 2012; Susuman *et al*., 2015). A blended strategy to avoid bias and the limitation of indices is calculated in a way that defines the point in which numbers finishing at '0' would ordinarily be higher than those ending in 1 to 9 due to the impact of mortality. This technique is extremely valuable in computing the degree of digit preference error in single-year age information. The range of the Myers' index is from 0 to 180, where 0 shows no digit presence and 180 demonstrates the extreme situation. It is calculated as.

$$\text{Myers' blended index} = \sum_{i=0}^{9} \left| \left[\frac{P_i}{\sum_{i=0}^{9} P_i} \times 100 \right] - 10\% \right| \quad (1)$$

P_i Represent blended population and $_i$ range from 0 to 9.

Myers' Alternative Index

Traditionally, Myers' index was used to assess the level of age misreporting which is accessible for single-year age distributions. A few modifications and corrections have been made to this specific index. The first modification in the Myers' index was proposed by (Pal *et al*., 2014) with the key assumption of linearity. An alternative approach based on the same essential principles of the original Myers' index wherever the blended sum at each terminal digit should be approximately equal to 10% of the total blended population. In an alternative approach, all age preference and avoidance effects can be constructed by taking original population data replaced with person-years. However, the remaining steps of the calculation of the alternative approach are the same as the original method.

Modified Myers' Index: proposed versions

By following Myers (1940) and Pal *et al*. (2014) work, in this study, the extensions of Myers' index (Linear, Exponential, Alternative-type) have been developed based on the similar principles of Myers' blended method, the sum of every terminal digit that is equivalent to 10% of the complete population. Compelling single-year age data of all women replaced with the person-years and computed the original and proposed versions of the Myers' index. Applying person-years to the selected age data could be better in the sense that it would diminish the amount of margin of error. The proposed versions are compared with the alternative approach as well as the original Myers' index. The following three versions are proposed:

Version 1

Under the condition of linearity, we have

$$_nL_x = \frac{n}{2}(l_x + l_{x+n}) \quad (2)$$

In equation (2) $_nl_x$ is linear person-year; l_x and l_{x+n} is

the linear population age interval $(x, x+1)$; n specified as the number of years.

$$P_k^* = \mathrm{n}L_x w_i + \mathrm{n}L_x w_j \quad (3)$$

Where w_i and w_j are weights of two-terminal digit (0 to 9) groups; i values refer to as first group terminal digits ranging from (10-39); whereas j values represent the second group terminal digits from (20-49); k specifies as total values vary from 0 to 9.

The generic expression for the Myers' linear index would be:

$$\text{Myers' linear blended index} = \sum_{k=0}^{9} \left| \left[\frac{P_k^*}{\sum_{k=0}^{9} P_k^*} \times 100 \right] - 10\% \right| \quad (4)$$

In equation (4) P_k^* Specifies as a linear blended population while; $\sum_{k=0}^{9} P_k^*$ is the total sum of the liner blended population; k specifies as total values vary from 0 to 9.

Version 2

In the case of exponential, we have

$$\mathrm{n}L_x = \frac{5n}{12} l_{x+n} - \frac{n}{12} l_{x-n} + \frac{2n}{3} l_x \quad (5)$$

Where in equation (5) l_x is exponential person-year; l_x, l_{x+n} *and* l_{x-n} is the exponential population age interval $(x, x+1, x-1)$; n specifies as the number of years.

$$P_k^{**} = \mathrm{n}L_x w_i + \mathrm{n}L_x w_j \quad (6)$$

Where w_i and w_j are weights of two-terminal digits (0 to 9) groups; i values refer to as group one terminal digits from (10-39); j values refer to as group two-terminal digits ranging (20-49); k specifies as total values vary from 0 to 9.

The generic expression for Myers' exponential index would be:

$$\text{Myers' exponential blended index} = \sum_{k=0}^{9} \left| \left[\frac{P_k^{**}}{\sum_{k=0}^{9} P_k^{**}} \times 100 \right] - 10\% \right| \quad (7)$$

Where in equation (7), P_k^{**} specify as an exponential blended population; $\sum_{k=0}^{9} P_k^{**}$ is the total sum of the exponential blended population; k values range from 0 to 9.

Version 3

In the case of Alternative-type, we have

$$Px_i = A_i * N_i \quad (8)$$

In equation (8), A_i is current age; N_i is the number of persons; Px_i is the number of persons reporting their age in completed years.

$$P_k^{1*} = Px_i w_i + Px_i w_j \quad (9)$$

Where w_i and w_j are weights of two-terminal digits (0 to 9) groups; i values refer to as group one terminal digits that range from (10-39); j values refer to as group two-terminal digits that range from (20-49); k specifies as total values vary from 0 to 9.

$$MI_0^{10} = P_{10}^{1*} + P_{20}^{1*} + P_{30}^{1*} + P_{40}^{1*} \quad (10)$$

$$MI_1^{10} = P_{11}^{1*} + P_{21}^{1*} + P_{31}^{1*} + P_{41}^{1*} \quad (11)$$

$$\begin{array}{ccccc} . & . & . & . & . \\ . & . & . & . & . \\ . & . & . & . & . \end{array}$$

$$MI_9^{10} = P_{19}^{1*} + P_{29}^{1*} + P_{39}^{1*} + P_{49}^{1*} \quad (12)$$

In equations (10, 11 and 12) Px^{1*} is the number of persons reporting their age in completed years.

$$\text{Myers' Alternative} - \text{type index} = \sum_{k=0}^{9} \left| \left[\frac{MI_k}{\sum_{k=0}^{9} MI_k} \times 100 \right] - 10\% \right| \quad (13)$$

In equation (13) MI_k specify as Myers' Alternative-type index population; $\sum_{k=0}^{9} MI_k$ refer to as a total sum of Myers' Alternative-type index population; k values ranging from 0 to 9.

Application of proposed indices

Table 2 represents the calculated values of the Myers' index, the alternative version (Pal version) and proposed versions of the index. We show measured figures from Linear (version-I) Myers' index, which is built by the person-year-based linear approach. First, calculate the

linear equation no (2) on the original population data and replace it with the person-years while the remaining steps are the same as the original Myers' Index method. For instance, using the 2017-18 Pakistan DHS, there are 214 ever-married women at age 24 years and 198 women at age 23 years, there will be 206 women at age 23 years using a linear approach (equation no 2), there will be 201 ever married women using an exponential approach (equation no 5). After obtaining linear and exponential age-specific counts, the blended sums are calculated in a similar way to the original Myers' blended population. Linear and exponential blended sums are multiplied with weights as in the original Myers' approach. Finally, deviations from 10% of the linear and exponential blended population are calculated to estimate the modified versions of Myers' index. Finally, we illustrate the structure of the Alternative-type Myers' index (version 3). To some extent, the calculation of version 3 differs from other variants, which is the base point of the alternative index. Firstly, equation (8) is calculated on the original population and then weights are assigned to columns according to the given age group. Then multiply the calculated column with the weighting columns (Group-i; 10-39) and (Group-ii; 20-49) and add these two columns together. Finally, construct 10 terminal digits. To calculate the blended population all 0-digit numbers are added from the previous column using equation (10). The next stage is revised for the next digit-1 and so on for all terminal digits and the remaining stages are identical to the original method.

RESULTS

Index-wise comparisons

The results of the Myers' index and its extension values from a single-year women's age are presented below in Table 2. The table shows the comparison of standard Myers' and Alternative with the proposed indices. There is a discrepancy in the results concerning the alternative index, where values are away from the original Myers' value. All findings in the proposed versions are close to and lower than the original index values. Following the values of the linear and exponential index from a table, it is a slightly different discussion that values are decreasing relative to the original values. The exponential method could be the deletion of the erroneous age statement so the values of these variants are lower. Through the

Table 2 : Results of Myers' Blended Index and its proposed indices, for ever-married women, age 15 - 49, in selected Asian countries

Name of the country	Myers' Index (Original)	Pal *et al*. (2014) Index	Myers' Index proposed versions		
					Person year approach
		Alternative	Linear	Exponential	Alternative-type
Armenia	6.13	16.6	2.88	2.76	8.06
Azerbaijan	6.94	16.29	2.27	2.59	9.79
Bangladesh	6.42	16.66	3.14	3.60	6.30
India	16.14	20.55	7.94	8.40	18.13
Indonesia	7.34	16.55	2.87	3.14	6.59
Jordan	2.77	17.07	1.49	1.72	4.23
Maldives	5.69	16. 51	2.74	3.32	5.41
Afghanistan	38.07	39.67	19.63	22.67	40.46
Pakistan	15.39	19.77	7.37	8.61	15.71
Nepal	11.28	16.52	5.79	6.78	8.77
Myanmar	6.59	16.80	2.86	3.82	6.69
Philippine	11.48	16.69	6.32	6.60	6.35
Sri Lanka	4.73	16.85	3.29	3.99	5.62
Thailand	2.54	16.85	2.25	2.47	5.80
Turkey	6.84	16.67	2.95	3.49	7.29
Vietnam	8.20	16.57	3.23	3.85	10.10
Yemen	27.87	30.81	16.24	18.63	31.03
Cambodia	4.06	16.63	5.0	6.78	16.43

Table 3 : Results of Myers' Blended Index and its proposed indices, for the ever-married women, age 15 - 49, in selected Asian countries

Name of the country	Myers' Index (Original)		Pal *et al*. (2014) Index		Myers' Index proposed versions Person year approach					
			Alternative		Linear		Exponential		Alternative-type	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Armenia	9.13	5.90	16.62	16.58	5.81	2.39	5.96	3.05	8.83	9.22
Azerbaijan	7.43	7.98	16.42	16.15	2.83	4.32	3.58	4.55	9.17	11.92
Bangladesh	6.21	7.00	16.69	16.65	3.31	3.09	4.01	3.71	7.03	7.42
India	13.53	17.0	18.72	21.16	6.77	8.33	7.81	9.65	14.89	19.24
Indonesia	7.56	7.09	16.51	16.59	3.32	2.38	3.51	2.80	6.59	6.58
Jordan	4.16	4.43	17.09	17.0	1.78	1.84	1.96	2.18	5.61	4.05
Maldives	11.88	6.00	17.20	16.53	8.85	2.93	8.85	3.43	15.87	4.79
Afghanistan	39.28	37.6	40.12	39.52	19.81	19.8	22.34	22.78	42.25	39.88
Pakistan	14.71	16.4	22.68	18.91	8.01	7.10	9.51	8.00	15.01	17.27
Nepal	10.58	13.4	16.54	16.48	5.37	6.67	6.75	7.12	8.65	10.39
Myanmar	8.06	5.98	16.73	16.82	4.37	2.49	4.38	3.79	5.73	7.35
Philippine	9.27	12.7	16.72	16.67	5.10	7.14	5.04	7.52	6.57	6.48
Sri Lanka	5.60	5.21	16.73	16.88	4.81	3.85	5.10	4.64	6.13	6.15
Thailand	5.09	4.00	16.73	16.91	4.07	2.07	4.43	2.42	6.48	5.51
Turkey	7.22	5.70	16.62	16.83	3.14	3.16	3.40	4.25	6.58	9.40
Vietnam	6.33	9.73	16.76	16.48	2.82	4.52	2.77	5.13	11.34	9.47
Yemen	19.27	32.0	23.49	34.43	10.10	18.4	12.0	21.81	23.35	35.09
Cambodia	5.33	3.57	16.55	16.67	6.45	4.35	8.22	6.09	18.43	15.47

Table 4: Results of Myers' Blended Index and its proposed indices, for the selected ever-married women, age 15 - 49, in Asian countries

Name of the country	Myers' Index (Original)		Pal *et al*. (2014) Index		Myers' Index proposed versions Person year approach					
			Alternative		Linear		Exponential		Alternative-type	
	NE	ED	NE	ED	NE	ED	NE	ED	NE	ED
Armenia	120	6.12	105.7	16.61	90.45	2.81	101.49	2.72	120	7.98
Azerbaijan	27.51	6.99	25.95	16.29	24.46	2.19	25.25	2.60	42.45	9.50
Bangladesh	5.40	7.36	17.85	16.44	4.22	3.88	4.93	4.45	6.95	7.15
India	27.46	14.43	29.91	17.54	13.58	7.17	15.55	8.05	28.51	15.14
Indonesia	12	7.37	20.76	16.50	11.34	2.83	11.15	3.24	13.82	6.61
Jordan	14.01	2.68	21.43	17.0	5.67	1.46	7.62	1.73	14.27	4.04
Maldives	17.09	5.67	21.07	16.35	12.54	2.94	13.03	3.69	17.16	5.64
Afghanistan	39.72	31.27	41.45	28.81	21.02	12	23..97	16.40	41.98	34.16
Pakistan	19.32	11.64	22.59	17.84	10.10	5.18	11.66	6.47	19.67	11.82
Nepal	9.15	13.34	17.32	16.04	4.34	7.18	5.25	9.55	8.76	13.81
Myanmar	13.79	6.06	20.19	16.70	8.47	2.64	9.61	4.17	13.28	7.00
Philippine	19.59	11.61	21.96	16.68	9.26	6.37	11.61	6.68	17.42	6.34
Sri Lanka	10.59	4.33	18.30	16.78	4.86	3.29	5.23	3.89	13.22	4.83
Thailand	9.47	2.81	19.16	16.71	5.91	2.78	6.92	2.91	10.29	6.34
Turkey	11.04	8.21	19.38	16.56	6.96	3.49	7.65	3.83	12.17	6.80
Vietnam	14.12	8.64	17.18	16.57	7.79	3.46	8.03	4.37	14.11	10.06
Cambodia	5.97	4.34	17.48	15.50	6.14	5.00	5.56	7.00	9.06	17.86

NE: no education

ED: At least primary education

exponential index reducing a digit preference by a general pattern additionally, a linear method diminishes digit preference more than the exponential method. Nevertheless, the values of the linear index are lower than the values of the exponential index.

Comparison of an alternative-type index with other indices

The alternative-type method (version 3) works closely with and below the original index. These methods show the original factor of age heaping that reduces the index values which minimizes the problem in datasheets**.** The first row of Table 2 shows an alternative type from Armenia is 8.06 and is close to Myers' 6.13 while the linear and exponential indices are 2.88 and 2.76. Thus, these are somewhat close to the original value, however, the alternative index is 16.6 which indicates a huge difference from the original value. If we take the index values of Bangladesh the original value is 6.42 and the alternative type is 6.30 while the linear and exponential are 3.14 and 3.60. The alternative-type value is almost equal to original value and its alternative value is 16.66 which shows an enormous difference from the original. Like Armenia and Bangladesh, the remaining countries, approximately compute the equivalent results (Azerbaijan, Indonesia, Pakistan, Jordan, Maldives, Myanmar, Sri Lanka and Turkey). All alternative-type version values are very close to the classical Myers' index so far, while a huge difference is noted in the alternative index.

Country-wise comparison

We compare the results of two standards (alternative and original indices) with three proposed extensions (linear, exponential and alternative type) in different Asian countries. A noticeable pattern occurs in Tables 2, 3 and 4 by analyzing the level of education and the urban-rural categories in various Asian countries. A notable fact, in Table 2 is that there is only one shift in the case of Cambodia, where our findings are larger than the original values. However, in Cambodia, there are some exceptions in terms of having more index values compared with the other countries. Except for Cambodia, the Myers' indices for all Asian countries are higher than the linear and exponential indices**.** In Table 2 among the analyzed countries, only Jordan (2.77), Thailand (2.54), Sri Lanka (4.73) and Cambodia (4.06) are considered to have relatively accurate data. This implies that the reported ages in these countries, across different demographic factors, are less disposed to age misreporting. India (16.14) and Pakistan (15.39) are noted to have fewer rough data compared to Yemen (27.87) and Afghanistan (38.07). The calculation highlights the varying degrees of data reliability across countries, emphasizing the importance of examining data quality. The minor difference in calculating age misreporting index values is observed between urban and rural study samples (Table 3). From Table 3, urban populations in Azerbaijan (7.43), Bangladesh (6.21), India (13.53), Jordan (4.16), Pakistan (14.71), Nepal (10.58), the Philippines (9.27), Vietnam (6.33) and Yemen (19.27) exhibit less age heaping compared to their rural areas. Indonesia, Sri Lanka and Thailand represent almost equal data reporting, that both urban and rural areas indicate better data quality in both sectors. This indicates that urban areas tend to have better-quality data with fewer instances of age misreporting. The observation highlights the significance of considering the urban-rural divide in assessing data quality, with urban areas generally providing more accurate age-related information. However, a considerable difference is observed between the non-educated women's age misreporting compared with at least primary educated, ever-married women in the study sample (Table 4). Age misreporting was revealed to be the highest (120) among non-educated survey respondents in Armenia. From Table 4, uneducated respondents from Armenia (120), Azerbaijan (27.51), India (27.46) and Afghanistan (39.72) exhibit a significant degree of age misreporting, indicating that the reported ages may not accurately reflect the actual ages of individuals in these populations. In contrast, uneducated respondents from Bangladesh (5.40), Cambodia (5.97), Nepal (9.15), Sri Lanka (10.59) and Thailand (9.47) show lower levels of age misreporting. This shows a relatively more accurate reporting of ages among uneducated populations compared to previously mentioned countries. The observation highlights the impact of education on data quality, with uneducated populations in some countries providing data of rough quality. Education plays an essential role in determining data quality with the literate population providing approximately accurate data in selected Asian countries except Afghanistan (31.27). Note that the values for Myers' original values for educated and uneducated in Bangladesh and Nepal is having a different pattern. Surprisingly, no information on the educational status of women is available in the latest wave of Yemen DHS. Figure 2 shows that the variation of index values that takes the alternative method is distant from the original line in the graph, while the remaining versions are closer to Myers' line. Figure 1 shows age distribution in some Asian countries, where there are reported age anomalies even if the population is grouped in one year. These figures represent the distortion in age distribution.

FINAL REMARKS

The present study used standard and modified versions of Myers' index to explore the degree and pattern of age

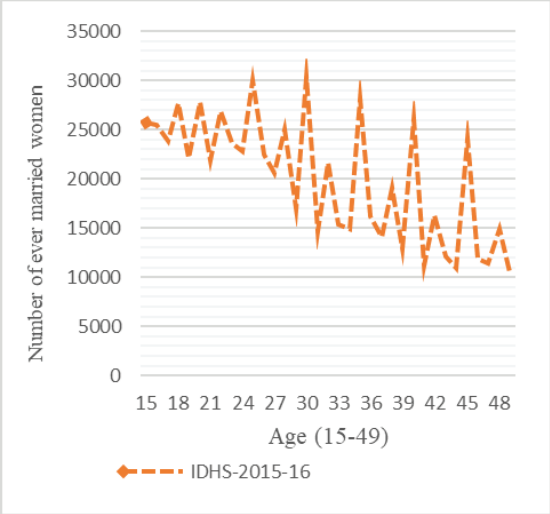

Figure 1.a : A single-year age distribution for total ever-married women in India based on sample of the DHS

Source: India Demographic and Health Survey 2015-16

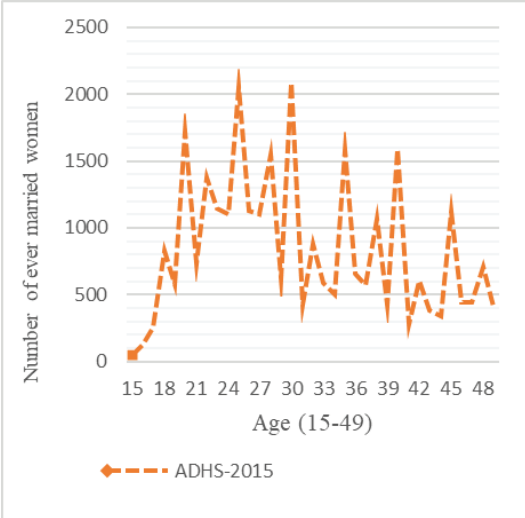

Figure 1.b : A single-year age distribution for total ever-married women in Afghanistan based on sample of the DHS

Source: Afghanistan Demographic and Health Survey 2015

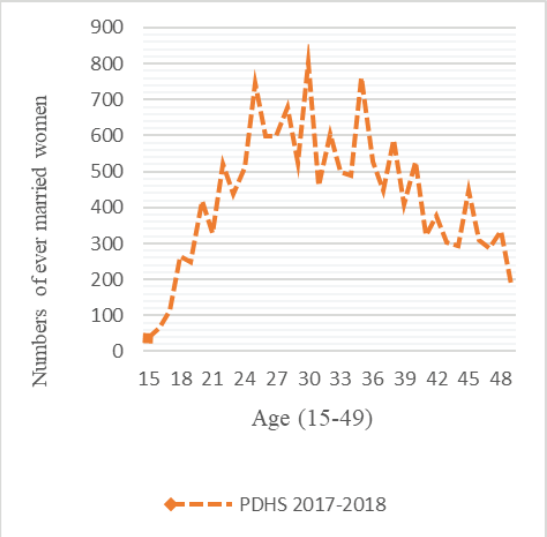

Figure 1.c : A single-year age distribution for total ever-married women in Pakistan based on sample of the DHS

Source: PDHS: Pakistan Demographic and Health Survey 2017-18

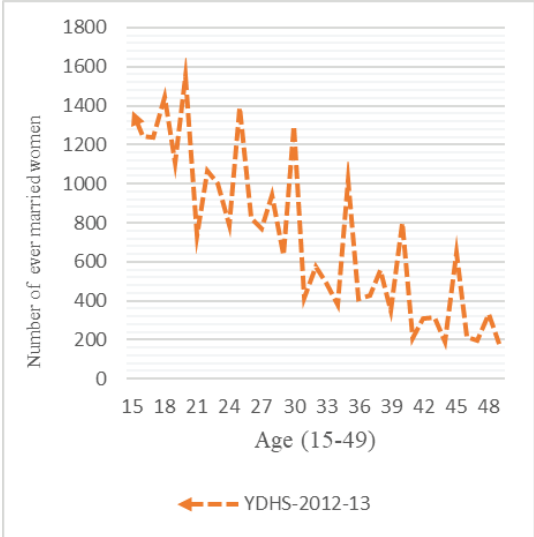

Figure 1.d : A single-year age distribution for total ever-married women in Yamen based on sample of the DHS

Source: YDHS: Yamen Demographic and Health Survey 2012-13

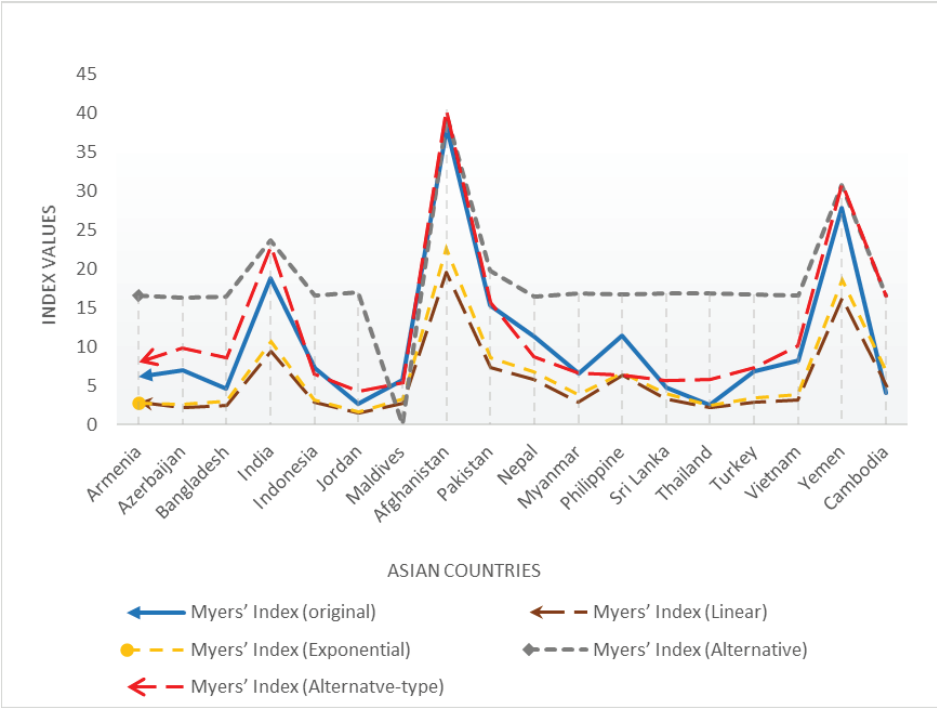

Figure 2: A single-year age distribution of Myers' index values for different Asian countries

heaping in different Asian countries using the most recent round of Demographic and Health Surveys conducted in different periods. This investigation was restricted to reproductive age limit of women and the degree to which Asian women preferred or stayed away from their survey replies for the age finishing off with specific digits. The analysis was conducted at three levels of 18 different countries: national or overall data, place of residence (urban versus rural) and education status (no education versus at least primary education). As expected, index results show a greater age misreporting among women with no education compared with those having at least a primary education. To check the applicability and legitimacy, the extended versions of Myers' index are used to measure the degree of age misreporting. Results are compared with the original Myers' blended index and the extensions of the Myers' index with similar material.

The concluded results are based on the new strategy that represents the accuracy of the index values, as there is the least distance between the values of the original and proposed versions of the Myers' index. However, the alternative Myers' index seems overestimated and distant away from the original values. Modified versions are valuable for the minimization of age heaping. Its startling advantage lies in the use of the person-year approach, because the assumption for an even distribution of persons of the terminal digits seems unrealistic. The person-year formula is used to overcome the assumptions of the rectangular distribution that is used to calculate the blended index. Further details of the advantages of person-year approach can be seen in the literature (Hinde, 2014; Shryock & Siegel, 1980). In addition, the proposed methods are also based on one of the key assumptions of linearity which is used in the estimation of the Myers' index in terms of numerical structure. Notably, our suggested index gives the findings and error directions that are nearly identical to the original Myers' index.

These findings are understandable, while extensions of Myers' index are more likely to be better than the alternative index. The extensions of Myers' index offer a basic proposed method that completely represents the changes in all age digits. The proposed indices are close to Myers' blended method. The survey, conducted on the age parameter of married women to elaborate on comparative patterns of age misreporting. In Afghanistan, India and Yemen show higher preference by age 15-49 when compared to other Asian countries. Significant evidence arises that there exist huge distinctions in the age reporting quality among Asian countries. However, by following the figures, the majority of irregularities are

observed in the graph of India, Afghanistan and Yemen. The graph of Pakistan also shows how anomalies that represent the quality of data reporting in these countries are not reasonable. In age reporting data for women, high anomalies might be the result of proxy reporting of age information. This implies that age awareness in these nations is very low and many have just an unclear thought regarding their age. The impact of such misrepresentation can lead to misclassification and miscalculation of population rates. Through this study, it is suggested to select a specialized enumerator for capturing age-related data from women.

REFERENCES

Bachi, R. (1951) The Tendency to Round Off Age Returns: Measurement and Correction, *Bulletin of the International Statistical Institute,* 33(4), pp:195-222.

Bailey, M. & Makannah, T. J. (1993) Patterns of Digit Preference and Avoidance in the Age Statistics of Some Recent African Censuses: 1970-1986, *Journal of Official Statistics*, 9(3), pp: 705-715.

Bekele, S. (2006) Analysis on the Quality of Age and Sex Data Collected in the Two Population and Housing Censuses of Ethiopia, *SINET: Ethiopian Journal of Science*, 29(2), pp: 123-132.

Bello, Y. (2012) Error Detection in Outpatients' Age Data Using Demographic Techniques, *International Journal of Pure and Applied Sciences and Technology,* 10(1), pp: 27-36.

Carrier, N. H. (1959) A Note on the Measurement of Digital Preference in Age Recordings, *Journal of the Institute of Actuaries,* 85(1), pp: 71-85.

Central Statistics Organization (CSO), Ministry of Public Health (MoPH) & ICF (2017) *Afghanistan Demographic and Health Survey 2015*, Kabul: Central Statistics Organization. [Online] Available from: Https://www.rhsupplies.org/uploads/tx_rhscpublications/Afghanistan_-_2017.pdf [Accessed : 15th August 2023]

Dahiru, T. & Dikko, H. G. (2013) Digit Preference in Nigerian Censuses Data of 1991 and 2006, *Epidemiology, Biostatistics and Public Health,* 10(2).

Department of Census and Statistics (DCS) & Institute for Resource Development (1988) *Sri Lanka Demographic and Health Survey 1987*, Colombo: Department of Census and Statistics. [Online] Available from: Https://dhsprogram.com/pubs/pdf/FR35/FR35.pdf [Accessed :15th August 2023]

Department of Statistics (DOS) & The DHS Program, ICF (2019) *Jordan Population and Family Health Survey 2017-18*. Amman, Jordan and Rockville, Maryland, USA: DOS & ICF. [Online] Available from: Https://dhsprogram.com/pubs/pdf/FR346/FR346.pdf [Accessed : 15th August 2023]

Fayehun, O., Ajayi, A. I., Onuegbu, C. & Egerson, D. (2020) Age Heaping among Adults in Nigeria: Evidence from the Nigeria Demographic and Health Surveys 2003-2013, *Journal of Biosocial Science*, 52(1), pp: 132–139.

Francis, E., Senyefia, B. & Sena, B. B. (2019) Statistical Analysis of Age Reporting Errors by Insured and Uninsured Patients in Cape Coast Teaching Hospital of Ghana. *Biomedical Statistics and Informatics*, 4(2), pp: 15-21.

General Statistical Office (GSO), National Institute of Hygiene and Epidemiology (NIHE) & ORC Macro (2006) *Vietnam Population and AIDS Indicator Survey 2005*. Calverton, Maryland, USA: GSO, NIHE & ORC Macro. [Online] Available from: Https://dhsprogram.com/pubs/pdf/AIS3/AIS3.pdf [Accessed: 15 August 2023]

Hacettepe University Institute of Population Studies (2014) 2013 *Turkey Demographic and Health Survey*. Ankara, Turkey: Hacettepe University Institute of Population Studies, T.R. Ministry of Development & TÜBİTAK. [Online] Available from: Https://dhsprogram.com/pubs/pdf/FR352/FR352.pdf [Accessed: 15th August 2023]

Hinde, A. (2014) *Demographic Methods*. Oxford: Routledge.

Institute of Population Studies, Chulalongkorn University & Institute for Resource Development/Westinghouse (1988) *Thailand Demographic and Health Survey 1987.* Bangkok, Thailand and Columbia, Maryland, USA: Institute of Population Studies, Chulalongkorn University & Institute for Resource Development/Westinghouse. [Online] Available from: Https://dhsprogram.com/pubs/pdf/FR37/FR37.pdf [Accessed: 15th August 2023]

International Institute for Population Sciences (IIPS) & ICF (2017) *National Family Health Survey (NFHS-4)*, *2015-16: India*. Mumbai: IIPS. [Online] Available from: Https://dhsprogram.com/pubs/pdf/FR339/FR339.pdf [Accessed: 15th August 2023]

Kpedekpo, G. M. K. (1982) *Essentials of Demographic Analysis for Africa*. London: Heinemann.

Ministry of Health (MOH) & ICF (2018) *Maldives Demographic and Health Survey 2016-17*. Malé, Maldives & Rockville, Maryland, USA: MOH & ICF. [Online] Available from: https://dhsprogram.com/pubs/pdf/FR349/FR349.pdf [Accessed: 15th August 2023]

Ministry of Health and Sports (MoHS) & ICF (2017) *Myanmar Demographic and Health Survey 2015-16*. Nay Pyi Taw, Myanmar & Rockville, Maryland, USA: MoHS & ICF. [Online] Available from: https://dhsprogram.com/pubs/pdf/FR324/FR324.pdf [Accessed: 15th August 2023]

Ministry of Health, New ERA & ICF (2017) *Nepal Demographic and Health Survey 2016*. Kathmandu, Nepal: Ministry of Health, Nepal. [Online] Available from: https://dhsprogram.com/pubs/pdf/FR336/FR336.pdf[Accessed: 15th August 2023]

Ministry of Public Health and Population (MOPHP), Central Statistical Organization (CSO), Pan Arab Program for Family Health (PAPFAM) & ICF International (2015) *Yemen National Health and Demographic Survey 2013*. Rockville, Maryland, USA: MOPHP, CSO, PAPFAM & ICF International. [Online] Available from: https://dhsprogram.com/pubs/pdf/FR296/FR296.pdf [Accessed: 15th August 2023]

Mwambene, E., Appunni, S. S., Hamisi, H. F., Lougue, S., Regassa, N., & Ogujiuba, K. (2012). An assessment of the age reporting in Tanzania population census.

Myers, R. J. (1940) Errors and Bias in the Reporting of Ages in Census Data, *Transactions of the Actuarial Society of America,* 41(2), pp: 395-415.

Myers, R. J. (1954) The Effect of Age of Mother and Birth Order on Sex Ratio at Birth, *The Milbank Memorial Fund Quarterly,* 32(3), pp: 275-281.

Nasir, J. A. & Hinde, A. (2014) An Extension of Modified Whipple Index-Further Modified Whipple Index, *Pakistan Journal of Statistics,* 30(2), pp: 265-272.

National Institute of Population Research and Training (NIPORT), Mitra and Associates & ICF International (2016) *Bangladesh Demographic and Health Survey 2014*. Dhaka, Bangladesh & Rockville, Maryland, USA: NIPORT, Mitra and Associates & ICF International. [Online] Available from: https://dhsprogram.com/pubs/pdf/FR311/FR311.pdf [Accessed: 15th August 2023]

National Institute of Population Studies (NIPS) & ICF (2019) *Pakistan Demographic and Health Survey 2017-18*. Islamabad, Pakistan & Rockville, Maryland, USA: NIPS & ICF. [Online] Available from: https://dhsprogram.com/pubs/pdf/FR354/FR354.pdf [Accessed: 15th August 2023]

National Institute of Statistics, Directorate General for Health & ICF International (2015) *Cambodia Demographic and Health Survey 2014*. Phnom Penh, Cambodia & Rockville, Maryland, USA: National Institute of Statistics, Directorate General for Health & ICF International. [Online] Available from:https://dhsprogram.com/pubs/pdf/FR312/FR312.pdf [Accessed: 15th August 2023]

National Population and Family Planning Board (BKKBN), Statistics Indonesia (BPS), Ministry of Health (Kemenkes) & ICF (2018) *Indonesia Demographic and Health Survey 2017*. Jakarta, Indonesia: BKKBN, BPS, Kemenkes & ICF. [Online] Available from: https://dhsprogram.com/pubs/pdf/FR342/FR342.pdf [Accessed: 15th August 2023]

National Statistical Service, Ministry of Health & ICF (2017) *Armenia Demographic and Health Survey 2015-16*. Rockville, Maryland, USA: National Statistical Service, Ministry of Health & ICF. [Online] Available from: https://dhsprogram.com/pubs/pdf/FR325/FR325.pdf [Accessed: 15 August 2023]

Noumbissi, A. (1992) L'indice de Whipple Modifié: Une Application Aux Données Du Cameroun, de La Suède et de La Belgique [The modified Whipple index: an application to data from Cameroon, Sweden and Belgium], *Population (french edition),* 47(4), pp: 1038-1041.

Pal, J. K., Mukhopadhyay, B. K. & Gupta, S. K. (2014) Myers' Blended Method: An Alternative Approach, *Journal of Scientific Research and Reports,* 3(18), pp: 2459-2465.

Philippine Statistics Authority (PSA) & ICF (2018) *Philippines National Demographic and Health Survey 2017*. Quezon City, Philippines & Rockville, Maryland, USA: PSA & ICF. [Online] Available from: https://dhsprogram.com/pubs/pdf/FR347/FR347.pdf [Accessed: 15th August 2023]

Ramachandran, K. V. (1967) An Index to Measure Digit Preference Error in Age Data. *World Population Conference, Belgrade*, *1965, Vol. III,* pp: 202–203, New York: United Nations.

Shryock, H. S. & Siegel, J. S. (1980) *The Methods and Materials of Demography.* Volume 2, Washington, DC: Department of Commerce, Bureau of the Census.

Singh, M., Kashyap, G. C. & Bango, M. (2022) Age Heaping among Individuals in Selected South Asian Countries: Evidence from Demographic and Health Surveys, *Journal of Biosocial Science,* 54(4), pp: 725–734.

Srinivasan, K. (1998) *Basic demographic techniques and applications*. London: SAGE.

Spoorenberg, T. & Dutreuilh, C. (2007) Quality of Age Reporting: Extension and Application of the Modified Whipple's Index, *Population,* 62(4), pp: 729-741.

State Statistical Committee (SSC) & Macro International Inc. (2008) *Azerbaijan Demographic and Health Survey 2006*. Calverton, Maryland, USA: SSC & Macro International Inc. [Online] Available from: https://dhsprogram.com/pubs/pdf/FR195/FR195.pdf [Accessed: 15th August 2023]

Whipple, G. C. (1919) *Vital Statistics; an Introduction to the Science of Demography*. New York: Wiley.

Susuman, A. S., Hamisi, H. F., Lougue, S., Regassa, N. A., Ogujiuba, K. & Mwambene, E. (2015) An Assessment of the Age Reporting in Tanzania Population Census 2012, *The Journal of Social Sciences Research,* 8(1), pp: 1553–1563.

Yusuf, F. (1967) On the Extent of Digital Preference in Reporting of Ages in Pakistan, *The Pakistan Development Review,* 7(4), pp: 519-532.

List of Referees - Volume 47 (2024)

Asha Abeyasekera
Centre for Women Studies,
University of York, UK.

N. K. Abeysekera
Department of Language Studies,
Faculty of Humanities and Social Sciences, The Open University of Sri Lanka.

Mayuri Atapattu
Department of Human Resources Management, Faculty of Management & Finance, University of Colombo, Sri Lanka.

K. A. C. Alwis
Department of Special Needs Education, The Open University of Sri Lanka.

A. U. Attanayake Barborich
University of Colombo

Kanchana Sujananie Bulumulle
Department of Social Studies,
Faculty of Humanities & Social Sciences, The Open University of Sri Lanka.

C. M. K. N. K. Chandrasekara
Department of Geography, Faculty of Arts, University of Colombo, Sri Lanka.

Viruli De Silva
Postgraduate Institute of Management,
Sri Lanka.

Dinali Enoka Devendra
Department of Language Studies,
Faculty of Humanities and Social Sciences, The Open University of Sri Lanka.

P. S. S. Dias
Sri Lanka Association for the Advancement of Quality & Productivity (SLAAQP)

Nishantha Gunasekara
Emsolv Consultants,
Sri Lanka.

R. D. Guneratne
SLINTEC Academy,
Sri Lanka.

Dinesh Hamangoda
Faculty of Commerce and Management Studies,
University of Kelaniya,
Sri Lanka.

Saman Handaragama Department of Social Sciences, Faculty of Social Sciences & Languages,
Sabaragamuwa University of Sri Lanka.

C. V. Imbulgoda
Deputy Registrar, University of the Visual and Performing Arts,
Sri Lanka.

Ayomi Irugalbandara Department of Secondary and Tertiary Education, Faculty of Education,
The Open University of Sri Lanka.

K. G. C.Jayasekara
Sustainable Energy Authority,
Sri Lanka.

H. G. Kanthilatha
Department of Psychology, Faculty of Arts, University of Peradeniya,
Sri Lanka.

Ananda Y. Karunarathne
Department of Geography,
Faculty of Arts, University of Colombo,
Sri Lanka.

Malraj B. Kiriella
South Asia Multidisciplinary Advisory Services,
Sri Lanka.

P. H. T. Kumara
Department of Public Administration,
Faculty of Management,
Uva Wellassa University,
Sri Lanka.

H. D. D. C. Liyanagamage
Department of Accounting and Finance,
Faculty of Management Studies,
The Open University of Sri Lanka.

V. V. Medawattegedera
Department of Language Studies,
Faculty of Humanities and Social Sciences,
The Open University of Sri Lanka.

Dushyanthi Mendis
Department of English,
Faculty of Arts, University of Colombo,
Sri Lanka.

C. Pathirawasam
Department of Commerce & Financial Management,
Faculty of Commerce & Management Studies, University of Kelaniya,
Sri Lanka.

K. D. R. L. J. Perera
Department of Secondary and Tertiary Education, Faculty of Education,
The Open University of Sri Lanka.

U. T. G. Perera
Department of Geography,
Faculty of Arts, University of Colombo, Sri Lanka.

Anton Piyarathne
Department of Social Studies,
Faculty of Humanities & Social Sciences,
The Open University of Sri Lanka.

Mahinda Pushpakumara
Department of Economics, Faculty of Arts, University of Colombo, Sri Lanka.

Edirisooriya Mudiyanselage Savithri Ranasinghe Department of Geography, Faculty of Arts, University of Colombo, Sri Lanka.

H. U. W.Rathnayake
Department of Electrical and Computer Engineering,
Faculty of Engineering Technology,
The Open University of Sri Lanka.

Herath Mudiyanselage Renuka
Department of Information Management, SLIIT Business School, SLIIT, Sri Lanka.

Unnathi Samaraweera
Department of Sociology, Faculty of Arts, University of Colombo, Sri Lanka.

W. A. S. M. A. I. Senevirathna
Department of Strategic Studies, General Sir John Kotelawala Defence University, Sri Lanka.

D. J. T. Siyambalapitiya
Ceylon Electricity Board, Sri Lanka.

Suchira Suranga
Family Planning Association, Sri Lanka.

W. M. S. M. K. Thoradeniya
Department of Sociology, Faculty of Arts, University of Peradeniya, Sri Lanka

A. Tilakaratne Buddhist Studies Program Unit, University of Colombo, Sri Lanka.

Edirisooriya Mudiyanselage Savithri Ranasinghe
Department of Geography, Faculty of Arts,
University of Colombo,
Sri Lanka.

H. U. W. Rathnayake Department of Electrical and Computer Engineering,
Faculty of Engineering Technology,
The Open University of Sri Lanka.

Herath Mudiyanselage Renuka
Department of Information Management, SLIIT Business School, SLIIT, Sri Lanka.

Unnathi Samaraweera
Department of Sociology,
Faculty of Arts,
University of Colombo,
Sri Lanka.

W. A. S. M. A. I. Senevirathna
Department of Strategic Studies,
General Sir John Kotelawala
Defence University,
Sri Lanka.

D. J. T. Siyambalapitiya
Ceylon Electricity Board,
Sri Lanka.

Suchira Suranga
Family Planning Association,
Sri Lanka.

W. M. S. M. K. Thoradeniya
Department of Sociology,
Faculty of Arts,
University of Peradeniya,
Sri Lanka

A. Tilakaratne
Buddhist Studies Program Unit,
University of Colombo, Sri Lanka.

AUTHOR INDEX - VOL. 47 – 2024

SUBJECT INDEX - VOL. 47- 2024

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SRI LANKA JOURNAL
OF
SOCIAL SCIENCES

Volume 47 Number 2 December 2024

CONTENTS

REVIEW ARTICLES

RESEARCH ARTICLES

Guide to preparation of manuscripts