KJMS

ISSN 2579-2229

KDU Journal of Multidisciplinary Studies

Volume-5 Issue-01 July 2023

KDU Journal of Multidisciplinary Studies Volume-5 Issue-01 July 2023

General Sir John Kotelawala Defence University
Sri Lanka.

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KDU JOURNAL OF MULTIDISCIPLINARY STUDIES

Volume 05 Issue 1

July 2023

General Sir John Kotelawala Defence University

Sri Lanka

ISSN 2579-2229 (Online)

ISSN 2579-2245 (Printed)

Published by Faculty oF Graduate Studies, General Sir John Kotelawala Defence University, Ratmalana, 10390, Sri Lanka.

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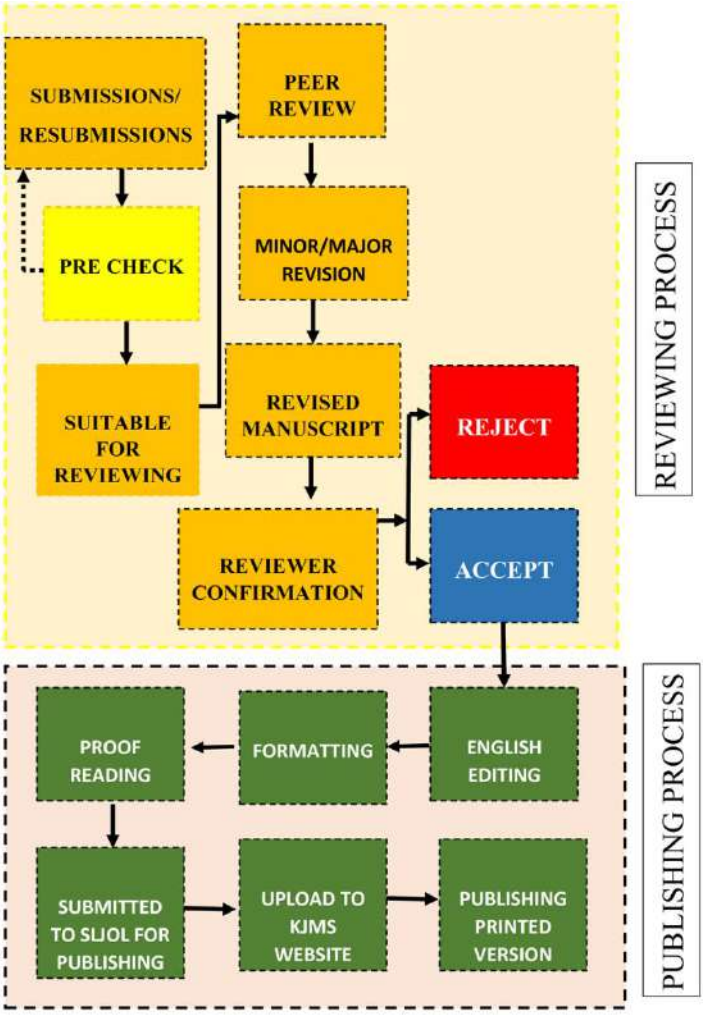

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https://doi.org/10.4038/kjms.v5i1.58

EXPLORING THE FUSION OF MAGIC AND REALISM IN HARRIS'S *CHOCOLAT:* A BEACON OF HOPE FOR LIBERATION

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ABSTRACT

With an emphasis on the novel's description of magical realism and social reformation, this research paper seeks to study Joanne Harris's Chocolat and its depiction of a society in which the residents strongly regard the so-called Christian orthodoxy. The researcher used a qualitative research method, such as literary analysis, to analyze the novel and explore its themes and motifs. For this, the novel is examined in detail, themes and motifs are identified, and the characters and their interactions are analyzed in detail. The researcher used quotes from the novel to support his claim. The female protagonist, Vianne, challenges this orthodoxy through her chocolate boutique in front of the church and initiates social reformation. The novel explores the negative portrayal of Vianne by the townspeople as a witch, outsider, and atheist, but she overcomes these issues by exposing the hypocrisy of the Christian orthodoxy and advocating for humanity, freedom, and social change through her chocolate shop. The author strikes a balance between magical and realist explanations in her writing. At the same time, the main character possesses a magical ability to intuit her customers' preferences and artfully win their affections. The novel encourages readers to accept the mystical elements of everyday life and scientific rationality. The findings and conclusion of this research is that Harris's Chocolat is a unique blend of magical realism and social reformation, challenging traditional Christian orthodoxy and advocating for a more humane, free, and accepting society.

KEYWORDS*: Christian Orthodoxy, Chocolat, Magic Realism, Hypocrisy, Freedom, Social Reformation*

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1. INTRODUCTION

This research focuses on the novel *Chocolat* (1999) by Joanne Harris, which is a mystical and sensuous novel that blends fantasy and realism to uncover the mystery of life and the Church in rural France. Harris examines the emptiness of rigid Christian masculinity and social reform through the positive depiction of female characters who lure blind adherents of the Church with her chocolate boutique. Additionally, the author portrays the anger of male characters in chocolate shops who also blindly support Christianity. The novel demonstrates how a 'strange' individual can transform the internal mechanisms of a society that has maintained the status quo for centuries, despite the antagonistic behaviour of the townspeople, through its characters.

The protagonist, Vianne, succeeds in winning the hearts of her customers very skillfully, almost magically. Harris exposes the inner psyche of Vianne and Reynoud that reject Christian orthodoxy and those that blindly follow it, using strong metaphors like Church and *Chocolat* and creating dualistic characters like Vianne and Francis Reynoud. In *Chocolat*, by Harris, Vianne and Reynaud have a complex and evolving relationship. The protagonist of the book, Vianne, is described as a free-spirited and self-reliant lady who establishes a chocolate store in a traditional French village. Reynaud, the mayor of the town and a devoted Christian, disagrees with Vianne's liberal viewpoints and sees her as a danger to the moral standards of the neighborhood. Their relationships are tense and contentious because they represent different worldviews. However, as the narrative goes on, their connection develops in complexity as they get to know one another's viewpoints and intentions. The novel's fundamental topic, the development of their dynamic connection, emphasizes the transformational power of empathy and understanding.

The focus of this study is on the protagonist's ability to forge her magical identity and establish herself in the cultural extraterrestrial hub while having to navigate a stereotypically imposed historical maze. This book's main goal is to explain humanity and freedom via Vianne, the protagonist.

Particularly with reference to women, *Chocolat* is recognized for its magical and realistic features. The wonderful depictions of the physical joys of chocolate in the novel might be misleading when viewed through the lens of the pagan versus Christian paradigm. It also tells the tale of how foreigners come to live in a tiny town. In a tiny society, the arrival of one person can change the balance of power. This book blends magic and realism, as it is a literary style or genre that blurs the line between reality and fantasy by fusing aspects of the ordinary or realistic with the extraordinary or fantastic. Franz Roh, a German art critic, coined the phrase in the 1920s to describe a movement in German art; however, it later came to be associated with the mid-20th century literary boom in Latin America, particularly with the works of authors like Gabriel Garca Márquez, Isabel Allende, and Jorge Luis Borges.

Love and forgiveness are presented as redemptive characteristics in this book, despite accusations from some critics that it is anti-religious. Cooking, a free spirit, love, and acceptance of others are all aspects of Vianne that make her special. The sole instance of magic that is clearly discernible is when Vianne and Armande are able to see Pantoufle, the made-up bunny that Vianne's daughter kept as a pet. One element of the book that contributes to its magic realism is the way Harris purposefully chooses not to set it in a specific period or place, giving it a fairytale-like character and a universal topic.

In *Chocolat*, Harris explores themes that are present in her earlier works, such as the role of magic in contemporary life, the harm caused by prejudice, particularly religious intolerance towards those who deviate from established norms, and the dangers of uncritically accepting what is often mistaken as progress and success. These themes are integral to Harris' literary oeuvre. The novel chronicles the story of a woman who seeks to revitalize a struggling business through her confectionery skills, only to be met with opposition from the local church pastor,

who portrays her as a malevolent influence on the community. Despite this, she manages to demonstrate her benevolent intentions and bring happiness to the townspeople, while also protecting her friend Josephine from her abusive husband and finding love herself.

Talking about ‘witches’ in western society requires addressing the conflict between women and the Judo-Christian faith. It would appear that while discussing ‘the famine condition,’ women's views on religion should be taken into serious consideration. Religious doctrine and teachings continue to have an impact on history, politics, and culture today, in varying degrees of clarity. Addressing the varied consequences of religion on society is vital, but perhaps these underlying effects are more crucial.

The book utilizes the perspectives of both Vianne and Reynaud, the local priest. Each chapter features a shift in point of view, with Vianne being the primary narrator. This approach lends to a more captivating story than if it had solely been from Reynaud's perspective. Reynaud is depicted as a young, embittered, and austere priest who frequently advocates for penitence and fasting, which would have a negative impact on the prosperity of Vianne's Chocolaterie. He actively avoids Vianne, a vivacious, kind-hearted, and amusing woman who forms a close bond with the gypsies residing in the region.

This novel explores various themes that Harris frequently revisits in her work, including issues of identity, maternal relationships, the allure and terror of mundane objects, the outsider's place in society, and the dichotomy between faith and superstition. Moreover, the book highlights the delight of finding pleasure in small things within the literary world. Harris has also elucidated her approach to incorporating critiques of realistic viewpoints into her fictional narratives, proposing the possibility that such perspectives may be reflective of the antichrist and contemporary reality.

The female protagonists in Harris's stories are strong, competent women. They have an innate loyalty to the natural world and are unwaveringly aware of their own innate abilities. These skills are demonstrated in a number of contexts throughout Harris's writing; her female characters are claimed to be talented in the culinary arts, horticulture, performing arts, and physical dexterity. But underneath these personality features, the protagonists also contain traits that distinguish them as ‘magic ladies’. The abilities perfected by Harris' ‘magic women’ are also saturated with the social, historical, and psychological connotations of witchcraft, evil, and magic.

In fact, Harris provides her characters a stage from which to freely reveal their truths rather than initially examining their acts, convictions, and moral standards. For instance, Vianne has the opportunity to let the reader piece together the specifics of her mother's death on their own by progressively revealing them throughout the novel. Harris, on the other hand, likewise exhorts her reader to contest the tales that her characters tell; she refutes their exaggerated tales as fabrications created to reinforce the strange concept that is given to them. Harris keeps delving deeper into the realm of magical realism.

Objectives of the Study

- To analyze and interpret Joanne Harris's novel, *Chocolat*, through the lens of magic realism and social reformation.
- To understand how the protagonist, Vianne, challenges the Christian orthodoxy through her chocolate boutique and initiates social reformation.
- To understand how the novel balances between magical and realist explanations and encourages readers to accept the mystical elements of everyday life and scientific rationality.

Review of Literature

Joanne Harris's novel *Chocolat* has been widely recognized for its portrayal of the fusion of magic and realism. Through the character, Vianne, Harris challenges the traditional Christian orthodoxy and

advocates for social reformation. This literature review aims to explore the critical reception of the novel and the ways in which it has been analyzed and interpreted in relation to its themes and motifs.

Joanne Harris's novel Chocolat has been noted for its exploration of magical realism and social reformation. Harris' modern reader is well aware of what makes a witch because they have grown up with fairy tales and folklore stories that depict witches as child murders, social outcasts, and sexual predators. In *Chocolat*, Harris draws direct allusions to the canon of childhood stories and makes it plain to the reader the importance and power of those stories to her female heroes. It is obvious that the morality and societal values portrayed in the 'Hansel and Gretel' story are directly impacting Father Reynaud's opinions of Vianne and her chocolaterie when he describes his young terror of that narrative thus:

> When I was a child I used to listen in terror to the story of the gingerbread house, of the witch who tempted little children in and ate them. "Look at the shop, all wrapped in shining papers like a present waiting to be unwrapped and I wonder how many people, how many souls, she has already tempted beyond redemption.

By rejecting these widespread assumptions, Harris is making it obvious to current readers that she wishes to confront not only the tropes associated with the traditional literary image of a witch but also the traditional representations of women in general.

The way she portrays women, especially Vianne, demonstrates that these historically and socially constructed standards of motherhood are frequently attained by women themselves. Vianne is attempting to make up for the 'motherly failings' demonstrated by her own mother. About *Chocolat*, Shila North has the following views:

> The many descriptions of chocolate alone will make your mouth water. Vianne and her daughter move to a little village where she decides to open a chocolate shop during Lent. This leads to a bitter contrast with the priest, who sees her as an evil influence who's trying to lead his parishioners to temptation and sin.

The investigation of the binary oppositions of pleasure and denial is essential to Harris's story about food. Food is a symbol of passion, and eating it denotes the satisfaction of that emotion. Descriptions of many chocolate varieties and opulent foods are fuelled by undertones that analyze great longing and vigour. It is fascinating that Armande in *Chocolat* decides to celebrate her last birthday with food; this gives her chance to narrow valley in the company of her friends and family while indulging in rich, cheery, and overdone delicacies as a way to exhibit her unyielding desire for life.

This study provides a way through the complex critical terrain surrounding the terms as they relate to the arts—art, literature, and film. It traces their development from the 1920s to the present, paying particular attention to the transition from early 20th-century German art criticism to worldwide modern critique. The term 'magic realism' first introduced by German art critic Franz Roh in his book *Nach-Expressionismus (MagischerRealismus)*: *problem der neuestert Europaischen Malerei*, published in 1925 to describe a school of painting, which is post expressionist artist in the mid-1920s (Suma, 2018). Later, Latin-American writer Alejo Carpentier classic 1949 essay that introduce the concept of *loreal maravilloso*to the America, who built on the idea of *magischerrealismus* and added elements of surrealism.

Since 1950s and 1960s, the concept of magical realism has increasingly been associated with Latin-American fiction. Then, the term used to refer to all narrative fiction that includes magical happenings in a realist matter of fact. They used to co-exist with the normal, plausible, everyday events on the same level as supernatural, extraordinary and even fantastic events, whose authenticity is never questioned (Gracia, 1995).

In other words, magic realism is not a fiction about magic or the supernatural. The history of magic(al) realism, or the related phrases magic realism, magical

realism, and magnificent realism, is a complicated saga spanning eight decades with three major turning points and many characters, according to Maggie Bowers' 2013 book Magic(al) Realism. Three time periods can be identified based on the topography of these eight decades of magic realism. The first era takes place in the 1920s in Germany, the second in the 1940s in Central America, and the third in Latin America starting in 1955. (7).

Painting done in a manner that deviates from everyday reality by combining genuine shapes was known as magical realism. It was a method for expressing and responding to reality as well as for visually illuminating its mysteries. However, during the 1960s and 1970s, the concept of magic realism had a significant rise. In the 1940s, magical realism served as a vehicle for the realistic American attitude while also establishing a distinct literary genre in Latin America.

Magical realism was utilized in surrealistic and expressionistic art during the 1920s, not just in expressionistic. The surrealist movement focuses on a deeper intellectual and psychological reality by challenging the physical object and actual existence of things. The innovative studies of the human mind by Sigmund Freud and Carl Gustav Jung, or psychological examination of the human mind, had a significant impact on the surrealism. The surrealists' theories of the subconscious and unconscious mind, which are based on people's behaviors, ideas, and dreams, aid them in rendering the physical and intangible world authentically. Due to the fact that magic realism and surrealism existed at the same time, there is a lot of uncertainty around it.

The word ‘magic’ itself alludes to the idea that humans are capable of influencing the natural world through esoteric, mystical, or paranormal ways. Magical beliefs are seen to be in opposition to religious and scientific beliefs. Regarding magic, the *Encyclopedia Britannica* states:

> Magic essentially refers to a ritual performance or activity apart from other religious phenomena and superstition that is thought to lead to the influencing of human or natural events by an external and impersonal mystical force beyond the ordinary human sphere and realism views on cultural and historical evolution. (298)

All magic is superstition, according to the dominant religious and particularly scientific belief systems in the Western world. Among other things, magical realism has been described as a literary movement, trend, or form. In her primary book on the subject, Amaryll Chanady states that she views magical realism as "a literary mode rather than a specific, historically identifiable genre" (16). A literary style is more broadly defined than, say, a genre, which conforms more rigidly to form and traditions. I'll also use the term "literary mode" for this study to refer to the idea. The appearance of the supernatural or anything that goes against our preconceived notion of reality is a necessary component.

Tindal (2007) contends that food plays a significant role in Harris's writing, acting as a vehicle to highlight important ideological issues while also offering readers an escape and idealized experience. As seen through the eyes of *Chocolat*, food takes on a dual character as a means of enjoyment and fulfillment as well as being entwined with religious iconography that supports Catholic doctrine. According to Tindal, food has a special place in the Catholic Church's eucharistic celebrations because it represents the body of Christ and shows a person's adherence to congruent theological principles when it is consumed.

Vaishnavi and Suganya (2021) explore the relationship between food and emotions in the novel *Chocolat* by Joanne Harris, highlighting how food fills the emptiness of the soul and helps the characters overcome their trauma. The authors emphasize that food is associated with emotions and expressions are evident whenever food is mentioned in the novel. Additionally, Joanne Harris's emphasis on a balanced way of life is also discussed, and the authors argue that the usage of food in the novel promotes the idea that balance should exist in both an individual's behaviour and way of life.

As the afro-mentioned reviewers have analyzed Joanne Harris' novel *Chocolat* from a variety of angles, the focus of this study is on how the text's magical and realistic parts interact. This study is a thorough textual analysis designed to show the value of this theoretical framework.

2. METHODOLOGY

The research methodology for exploring the fusion of magic and realism in Harris's *Chocolat* and its role as a beacon of hope for liberation involves a combination of qualitative and literary analysis methods.

Zamora & Farsi (1995) defines "Magical realism refers to literature in which elements of the marvelous, mythical, or dreamlike are injected into an otherwise realistic story without breaking the narrative flow". It refers to a mode of writing that can be characterized as an amalgamation of realism and fantasy.

Sources of Data

The primary source of data for this research would be the novel *Chocolat* by Joanne Harris. Other potential sources of data could include interviews with readers or scholars familiar with the novel, and relevant secondary sources such as critical essays, reviews, and interviews with the author.

Methods of Data Collection

1. Close reading: A close reading of the novel was made to identify and analyze the magical elements, characters, themes, and plot developments relevant to the research questions.

2. Content analysis: The novel was analyzed using a content analysis approach to identify and categorize key themes and elements relevant to the research questions.

Data Analysis

1. Thematic analysis: Thematic analysis was made to identify key themes that emerge from the data, such as the role of magic as a liberating force, the intersection of magic and realism, and the ways in which the novel challenges traditional gender roles.

2. Discourse analysis: Discourse analysis was conducted to explore the ways in which the fusion of magic and realism in *Chocolat* reflects broader cultural and historical tensions.

3. Content analysis: Content analysis was carried out to identify and categorize key elements in the novel, such as magical elements, characters, and plot developments, to help answer the research questions.

3. DISCUSSION

This research examines the work by Joanne Harris's major subject of fantasy and realism, concentrating on the rural protagonist who must deal with a variety of internal and external forces. Harris investigates the concepts of humanity, freedom, and societal reformation via the figure of Vianne, who runs a chocolate store in front of a church. The book combines natural and magical themes as well as urban and rural traits, emphasizing the tension between the townspeople's fantasies and realities. Harris skillfully combines these components to distinguish herself as a magical realist. This research makes the case that as all fictional works is the results of imagination and creativity; they all contain elements of magical realism, whether intentionally or unintentionally.

In *Chocolat*, the mysterious Vianne personifies spiritual development by fusing imagination and reality and frequently employing magic realism. A small-town priest who views Vianne and her daughter as a wicked influence objects to their migration there and their opening of a chocolate business during Lent. Despite the novel's glib depiction of Catholicism, it has intriguing issues and is well-written. Through her chocolate business, Vianne establishes a loyal client base and swiftly develops customer service skills, which enable her to

achieve both financial success and personal pleasure.

With the aid of the environment, the comparison of chocolate and the church, the description of food, the character who participates in the community's temptation in front of the church, and dream imagination, Joanne Harris employs the magic and realism techniques in her novel *Chocolat.* It teaches important life lessons by aiming to bring societal transformation and human life back into balance. The protagonist, Vinnea, Reynaud, is at the centre of the narrative, both in his dreams and in real life. The novel also has a magical component to it. The reader begins to suspect that Vianne may not be totally human when they see that she always leaves a town when the wind shifts, has an intuitive knowledge of how others are feeling, and reads tarot cards frequently. Although there does not seem to be anything supernatural about Vianne, we cannot help but wonder throughout the novel if she is a witch or some other creature with a unique power. She is just an extremely intelligent woman who has chosen a very unique path in life. As a result, the main character Vianne is in a position where she can successfully merge magic and reality.

Despite having certain magical talents, Vianne does not adhere to her mother's beliefs. The divergent worldviews of Vianne and her mother might be interpreted as a reflection of the interaction between magical realism and fantasy. In a fantasy world, practically everything is conceivable, but in a magical realism world, the proverbial other foot must always be on the ground. Therefore, it is intriguing to consider why Harris chose to maintain her fiction rooted in reality, especially when viewing her writings from a feminist viewpoint. When Vianne talks about the relatively common activity of cooking in Chocolat, something similar may be observed: Vianne transforms her mother's more unusual practices into something more commonplace while yet maintaining that both are magical in their own unique ways.

Vianne Rocher and her daughter Anouk, two wanderers who have spent their lives roaming from place to place, arrive in Lansquenet-sous-Tannes, a small French village. They enjoy the festival and decide to stay, so Vianne rents a house and opens a chocolate shop just in front of the church. This decision does not go down well with the village priest, Father Reynaud, who thinks that opening such a shop at Lent, a time of fasting, is an insult, and a menace, to religion. He also doesnot approve of Vianne because of her refusal to attend church or confession, and convinces some of his parishioners to stay away from the 'evil' chocolate shop. Despite this, the shop attracts a few customers from the very start. Not only has Vianne a knack for figuring out what each client's favourite type of chocolate is, but she is also a good listener who makes everyone feel welcome (Barale, 2000).

She has, in a Foucauldian sense, assimilated what people are expected to be under social pressure, leading her to start seeing herself. For example, Vianne tells her daughter, "If we are to stay, we must be as much like them as possible" (49). They must initially conceal and deny who they truly are on the outside until it becomes so ingrained that even they start to forget who they truly are underneath the surface. This is necessary for them to function in society. Thus, the central protagonist is aware of their position as an outsider. She fights against it and tries to blend in with the neighborhood and society. In *Chocolat*, Vianne is aware of the negative effects of being an outsider and has taught her daughter the same thing:

> I taught her all of this long ago; the hypocrisy of the Church, the witch-hunts, the persecution of travelers and people of other faiths. She understands. But the knowledge does not transpose well to everyday life, to the reality of loneliness to the loss of a friend. It's not fair. Her voice was still rebellious, the hostility subdued but not entirely. (59)

Furthermore, the influence of the Church is a powerful representation of society's homogenizing effects in the novel. Unsurprisingly, Vianne and the local Church delegate end themselves in an unofficial power struggle. The female population in the hamlet is therefore fearful and dispersed throughout the

book, and Vianne, a strong lady and an outsider, must work hard to alter things. The narrative centres a mother and adaughter and serves as the foundation for Vanne's efforts to establish a female community in the chocolate industry. She is therefore unwelcome in each of their groups.

In the book, Vianne is essentially free to walk around and run anywhere she wants, but it turns out that this is not the type of freedom they actually require. The real objective would be to accept oneself for who one is, and possibly to influence the neighbuorhood to do the same. In the novel, Vianne and Anouk's past has been a constant source of travelling. By taking a position towards the conclusion, Vianne thinks they will finally be able to establish roots in the neighborhood.

Vianne wants to make changes in her life, not just for herself but also for her child. She agrees that she does not want her child to have a childhood similar to her own. She and Anouk have stayed in the same country for the previous five years in an effort to lessen the disruption brought on by their move and potentially establish themselves more permanently. The masculine characters in Harris' works also fit into this sectarian category. In Harris's writing, men tend to appear less frequently than women, but when they do, they frequently represent extreme manifestations of magical or religious belief. Father Reynaud represents the severe presence of religious self-control as a devoted follower of Catholic Church dogma and as he who converts anyone who chooses to violate such rules. Father Reynaud is introduced in *Chocolat* as Vianne's enemy, and the book's conclusion, in which he gives in to his sensual desires for pleasure, satisfaction, and chocolate, demonstrates Harris' preference for the moral dilemma of her magical characters over that of her religious ones.

Reynaud's thoughts and experiences are described in *Chocolat* in a chapter that is written from his point of view. This allows readers to understand his perspectives on Vianne, the peasants, and various religions. He describes how he finds her shop's brightness disconcerting. Reynaud objects to her giggling and gestures, saying that they are "accustomed to a greater restraint" (25). Although he claims to be an unkind man, he does mention at the chapter's end that losing all contact with other people is akin to going to hell. He claims that he wants to develop his communication skills and, maybe more crucially, his ability to hope.

Yet in the next chapter, Reynaud asserts that he has changed his mind and now sees Vianne as a foe. In the beginning of Lent, she opened a chocolate shop, and she now gets to hear his parishioners in the confessional recount their broken fasting promises. He becomes aware of the appeal of stronger regulations and laws: "The strict, structured society of the Old Testament appeals to me. We understood our situation at that time. Despite our adoration for God, we feared Him more (34).

It occasionally happens in a place like Lansquenet that one person—a teacher, a café owner, or a priest—becomes the focal point of the community. This one individual is the essential hub of the machinery that spins lives, causing wheels to whirl, hammers to strike, and needles to point the hour, just like the critical pin of a clock mechanism. Rounaud's role and responsibilities are known to Vianne. It is not yet obvious if she plans to assume the role of the community's 'lynchpin' but it is evident that a significant portion of her trips have been devoted to finding other towns in a similar state and restarting the "clock" in them. This implies that, as opposed to the church, who is seeking evil, she is the one pursuing the forces of good.

Vianne was not raised in a highly Christian environment. In fact, she has come to distrust everyone connected to organized religion because a priest attempted to separate her from her mother. Her religious education included a variety of tales and doctrines. This is in keeping with the New Age movement, which encourages people to mix their particular set of beliefs from many sources. Without a doubt, Vinne's mother concurred with this:

> And I her daughter, listening wide-eyed to her charming apocrypha, with tales of Mithras and

> Baldur the Beautiful and Osiris and Quetzalcoatl all interwoven with stories of flying chocolates and flying chocolates and flying chocolates and flying carpets and the Triple Goddess and Aladdin's crystal cave of wonders and the cave from which Jesus rose after three days, amen abracadabra, amen. (114)

In this belief system, Christianity and its myths are demoted from their position of hegemonic dominance and reduced to one of many different mythical belief systems. However, Vianne does believe in herself as a magician, that bad magic and the unexplained exist, and that she tends to approach these tales with a certain amount of skepticism, indicating that she no longer believes in them. In her reality, Harris seems to distinguish between actual knowledge and other mystical traits. Harris makes use of irony to illustrate how fundamentally similar to other old tales Christian myths are. Harris makes use of an everyday object to simultaneously remind the reader of another thing.

Yet, the 'church not chocolate' campaign is highly valued in Harris' examination of religious belief in *Chocolat*. Food is a major motif in Harris's work. Food takes on a dual character as seen through *Chocolat's* eyes: it is both a source of pleasure and satisfaction and is also shrouded with religious symbolism that is utilized to further Catholic doctrine. At the Catholic Church's celebration of the Eucharist, food represents Christ's body and shows a person's fidelity to the related theological principles. By placing Vianne's chocolate festival within Easter festivities, which are generally planned to renew religious faith and promote the ideals of sacrifice, constraint, and control, Harris accentuates this symbolic contradiction. People frequently view food as a sign of sensory pleasure or as an expression of desire. Easter Sunday marks the end of the community's 40-day fast and the religious celebrations in Lansquenet.

Vianne is an archetype, not just a character. She embodies a primal feminine nature that Harris associates with being paganic, worldly, and sensually affirming of life. Her male counterpart is a stereotype as well. The parish priest is Reynaud, whose name means 'fox' in French. He embodies a certain kind of masculinity that Harris associates with Christianity's patriarchal, ethereal, and life-denying mindset.

Nathanson's objection has some merit because Raynauld is a man known as 'The Black Man,' Vianne's adversary, and Raynauld is a man. In addition to Reynauld, Monsieur Muscat, a local café owner and Josephine's abusive husband, is also introduced in the story. Yet, Nathanson makes no mention of the fact that *Chocolat* also features 'decent' male characters, such as Roux and Guillaume. Roux serves as the narrative's primary love interest for the most part. He doesnot have a significant impact on the story, but he does symbolize Vianne's 'ideal man' in certain aspects, which is possibly why he stays in the background since Vianne doesnot want a committed, relationship with a man.

According to Western culture's prevailing presumption, the majority of people do not believe that magic can actually change the natural world and lead it to behave in a particular manner. Today, magic is seen as both one of these things and a creation of the mind. Without realizing it, Athena was highlighting the much expanded cosmos that each of us has but has yet to recognize. The author refers to her as a lady from the twenty-second century who, as a result, is forthright about living in the twenty-first century. That was her main worry. Due to this, the novels discuss free love, which mostly entails the ideas that we often connect with love, such as desire, possession, reconciliation, and betrayal. Free love is like a river that overflows its banks. The most crucial aspect of social and terrestrial existence is reconciliation. In his study paper, Adhikary (2020) asserts that the intersection of trauma, memory, and fact characterizes postcolonial political challenges.

In the novel *Chocolat*, the seemingly incompatible concepts of reality and enchantment are simply harmonized. Both are essential to communicate Marquez's individual point of view. The reality presented in Marquez's book is not simply one observer's point of view; rather, it is a compilation of experiences from several people from various

backgrounds. In magic realism, he portrays a world in which magic, superstition, religion, and history all coexist.

4. CONCLUSION

In this research, the female heroine successfully negotiates the various challenges life throws at her. She has several challenges as an antichrist and a foreigner. Where she lives, She is known as a witch and a female atheist?

She experiences social transformation, though, and is successful in the area. Using a magical instrument, the book investigates other puzzles relating to Vianne's regular worlds. Given that Vianne's mother has always been an outsider, she could be more conscious of her paranormal talents. She decides to limit her potential and her skills as well. The book's major themes – which are crucial from a feminist perspective – include women's underestimate of their potential, suppression of their true selves, and attempts to conform to social conventions. In order to portray these concepts clearly and captivatingly, magical realism is used. Harris undoubtedly drew influence for her writing from a wide range of literary subgenres. She heavily draws inspiration from narrative akin to a carnival, the conventional aesthetics and worldviews propagated by ambient fairy tales, and magic realism for most of her own work. Traditional magic-inspired genres mix in Harris' work with more modern themes, such as an emphasis on food and worries about the status and future of single moms and women in a world dominated by men. Harris' greatest accomplishment, however, is employing magic realism to explain even the most fundamental everyday actions, like eating and caring for children.

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KJMS 2023 VOL.5 (1): 11-25

KDU Journal of Multidisciplinary Studies
(KJMS) Volume 5. Issue 1 July 2023
https://doi.org/10.4038/kjms.v5i1.59

MANIPULATION OF STEM CELL FATE IN VITRO USING PLASMID-BASED TRANSCRIPTION FACTOR OVER-EXPRESSION SYSTEMS

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ABSTRACT

Introduction: The ability to switch stem cell differentiation fate in-vitro, is a powerful tool that may allow the generation of large numbers of cells that may be required in order to develop biologically engineered tissues and cells required for therapeutic applications such as pharmacological testing of new medications. The transcription factor ("master switch") Olig2, alone or in conjunction with Nkx2.2, has been implicated as a key cell fate decider for emerging neuro-glial precursors derived from both embryonic stem (ES) cells and from foetal neural stem (FNS) cells.

Methods: The in-vitro system of stem cells devoid of exogenous signaling was developed. Stem cells were manipulated by pIRES plasmid vector driven, constitutively expressed Olig-2 or Olig-2/Nkx2.2 transcription factor system introduced into proliferating embryonic or foetal neural stem cells, following a similar embryological temporal patterning sequence seen in-vivo.

Findings: Successful stem cell fate modification could be achieved in-vitro using the transcription factor overexpression system. Substantially different cell fates were noted in the presence of Olig-2 alone and in combination with Nkx2.2, with the achievement of premature glial differentiation.

Conclusion: This method, therefore, may be useful to generate rare live human cells (such as Oligodendroglia or specialised myocardial cells) in-vitro.

KEYWORDS— *Stem cell re-programming, fate modulation, Transcription factors*

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1. INTRODUCTION

Provision of rare cells such as human cardiomyocytes, neural precursors and oligodendroglia, for in-vitro studies on effects of various drugs and for disease models is a much sought after goal of many research groups.

Stem cells that are thought to mediate the replacement of many cell types of the body following trauma or disease processes have been investigated for their regenerative potential. However, achieving the exact internal milieu required for this process is difficult to recreate in-vitro. Therefore, genetic manipulation such as selective, transcription factor modulation has been sought as an attractive method to achieve large numbers of desired cells in-vitro for experiments.

The process of neuroglial specification from multipotent stem cells provides valuable insight into the importance of transcriptional factors in regulating cell fate decisions during the process of embryological development. This presents an opportunity for us to develop tools and systems to gain in-vitro mimicry of this process using the over-expression of key transcription factors for stem cell fate modulation.

Olig2, described initially as a transcription factor important in the specification of oligodendrocytes (Zhou et al., 2000), (Lu et al., 2000) has since then been demonstrated to be linked to the specification of motoneurons and oligodendrocytes (Takebayashi et al., 2000), (Zhou and Anderson, 2002), (Lu et al., 2002) in the ventral spinal cord, as markers in neoplastic disease (Lu et al., 2001), in the early stages of specification of astroglia in the neural precursors in the subventricular zone (SVZ) (Marshall et al., 2005) and ependymal cells (Masahira et al., 2006).

Several groups have attempted the strategy of overexpression of Olig2 to specify oligodendroglia from stem cell populations such as olfactory ensheathing cells (Zhang et al., 2005), and mouse neural stem cells (Copray et al., 2006). Human foetal neural stem cells/precursors present an attractive prospect of a precursor cell type that has a better safety profile with their lineage restriction compared with ES cells, but have sufficient immaturity to attempt directed differentiation to generate human oligodendroglia. However, these stem cells/precursors have not been investigated for their full potential for the generation of oligodendroglia.

We have revisited the role of Olig2 in the specification of glia from neural stem cells, derived from embryonic stem cells from a system devoid of morphogens that could otherwise over or underestimate the perceived effect and also from cultures of human foetal neural stem cells, in order to understand some of the multitudinous roles for Olig2 in operation in such systems. We discuss the use of the gene over-expression strategies for generating human oligodendroglia, using a plasmid vector-driven, constitutionally expressed transcription factor system.

2. MATERIALS & METHODS

A. Cell Culture

Mouse ESCs were cultured as previously described and differentiated in COM (Wiles and Johansson, 1999), (Bouhon et al., 2005), (Bouhon et al., 2006). ESCs were maintained by routine feeder-free culture on 0.1% gelatin (Stem Cell Inc, Temecula) in lscove's Modified Dulbecco's Medium (IMOM)/ GlutaMax I (lnvitrogen, Carlsbad, CA, http://www.invitrogen.com) supplemented with 15% foetal calf serum (Bio Sera, Ringmer, East Sussex, U.K., http://www.biosera.com), penicillin/streptomycin, nonessential amino acids (lnvitrogen), 2-mercaptoethanol (Sigma-Aldrich, St. Louis, http://www.sigmaaldrich.com), and 10 ng/ml leukaemia inhibitory factor (Chemicon, Temecula, CA, http://www.chemicon.com). ESC lines E14, and W9.5 (with feeders for maintenance, followed by feeder free passaging) were used, and they showed similar differentiation properties. For terminal differentiation, enzymatically dissociated ESCs were resuspended in COM and plated at $4*10^6$ cells per 16 ml in 10-cm plastic culture dishes (Grainer Biochem). The technique for the successful culture of

embryonic stem cells in a morphogenic signal free environment in-vitro has been previously described by our group (Joannides et al, 2008) and (Athauda-arachchi, 2009).

Human foetal neural stem cells were cultured as previously described (Svendsen et al., 1998). Human foetal neural tissue was acquired, governed by local ethical guidelines, from terminated foetuses between 8 and 12 weeks in gestation. Automated tissue chopping with Mcllwain tissue chopper (Mickle Engineering, UK) was used for establishment of primary cultures and passaging. The cultures were established in T75 flasks (lwaki), with Dulbecco's Modified Eagles Medium (DMEM) and Ham's F-12 medium 2:1 with GlutaMax I, 2% B27 supplement and 1x penicillin/ streptomycin (all from Invitrogen). Growth factors were used as described previously. Cell cultures were fed every 3rd day and passaged between 3 and 6 passages before terminal differentiation. For terminal differentiation, single cell suspensions were made by enzymatic dissociation of neural precursors thus cultured and plated on poly-ornithine (POrn, Sigma) and laminin-1 (Sigma) at 10 µg/ml coated coverslips at 250,000 viable cells per coverslip and cultured in Dulbecco's modified Eagle's medium/2% B-27 (Invitrogen), 1% N2(Invitrogen). Following trophic factors were used (post nucleofection) to support terminally differentiating progeny: Glial Derived Neurotrophic Factor (GDNF) at 10ng/ml and Brain-Derived Neurotrophic Factor (BDNF) and recombinant Platelet Derived Growth Factor-a (PDGF- a) at 10ng/ml (all from R&D).

Human Embryonic Kidney (HEK) cells were cultured in T25 flasks (lwaki) in DMEM and 10% foetal Calf serum and passaged as per standard procedures.

B. Construction of a plasmid vector system with constitutive Olig2/Olig-Nkx2.2 or Nkx2.2 expression

plRES plasmid vector with cytomegalovirus promoter (pCMV) was used to construct a gene expression system. The following cDNA (original cDNA clones: gift from Dr. Toru Kondo) was used to construct two types of plasmid vectors: mouse Olig2 cDNA in multicloning site A alone or along with rat Nkx2.2 cDNA cloned into multicloning site B. A plasmid construct with only Nkx2.2 in multicloning site B was also constructed. Control vectors included pl RES vector with no cDNA inserts and those with enhanced green fluorescent protein (eGFP). Standard molecular biology procedures were followed and accuracy of cloned sequences and their up and downstream sites were checked by gene sequencing. Mass scale plasmid production was performed and plasmid DNA was purified using an endotoxin free preparation methods (Quiagen, Endofree Maxi kit).

C. Transfection of HEK cells, mouse ES and human foetal neural stem cells

Delivery of the plasmid vectors into cultured HEK cells, mES and hFNS cells were performed by nucleofection using standard procedures recommended by the manufacturer (Amaxa, GmBH). These cell lines were transfected with a variety of programmes and the presence of transgene expression was confirmed by immunohistochemistry and western blotting and the most efficient transfection parameters were deduced for mES and hFNS cells. In the case of mES cells, transfected cells were selected for G418 resistance for 2 weeks and cell lines with stable transgene expression were amplified prior to differentiation. They were also checked for continued expression of pluripotency markers prior to differentiation. In the case of human foetal neural stem cells, transient transfection followed by terminal differentiation was performed without the use of G418.

D. lmmuno-cytochemistry

lmmuno-cytochemistry was performed on either free-floating whole-sphere (whole-mount) cryostat sections or plated cells as described. Primary antibodies used were the following: Anti- Oct4(1: 100, Santa Cruz) Anti-Olig2 (1:20,000; gift of Dr.David Rowitch); anti-Nkx2.2(1:50 from Developmental Studies Hybridoma Bank, Iowa City, IA, http://www.uiowa.edu/_dshbwww); anti- Human nestin (1:400 Chemicon); anti- Rat nestin (1:400; BD Pharmingen, San Diego,

http://www.bdbiosciences.com/pharmingen); anti-Beta-Ill- tubulin (1:200; Sigma-Aldrich); anti- EGFR (1:50; Affinity Bioreagents, Golden, CO, http://www.bioreagents.com); anti-glial fibrillary acidic protein (anti-GFAP) (1:200; DAKO, Glostrup, Denmark,http://www.dako.com);Anti-04, anti-A2B5 and anti-GalC supernatants (1:5 live staining, (Sommer and Schachner, 1981));. Secondary antibodies (lnvitrogen) were used at concentrations of 1:1,000.

Glass coverslips thus prepared were mounted in Vectafluor mounting medium (Vector Laboratories; Burlingame, CA, USA) and viewed a Leitz microscope with appropriate filters for cell identification and counting. For each coverslip, three consecutive random fields were counted using a grid, and all cells on each cryostat tissue section were counted. The number of positive cells was expressed as a mean± S.E.M. from 3 slides in each experiment. Each experiment was repeated at least 3 times.

E. Western Blotting

Transfected HEK cells and mES cells after long term selection were grown to 70% confluency were used to prepare protein lysates by the following washing in PBS and suspension in RIPA buffer (PBS, SOS 1%, Triton-x100 1%, Na deoxycholate 0.5%) with Mini-complete protease inhibitor (Roche) and lysed using Lysing Matrix C Ribolyser beads and a Ribolyser. The lysate was then centrifuged at 14000 rpm for 20 minutes at 4°C and the supernatant was collected for freezing at -20^{o} C or for use in experiments.

Protein quantification was done by copper sulphate and bicinchonic acid method (SCA assay (Pierce Kit). Lysate containing 20 ug of protein was used for 15% Sodium Dodecyl Sulphate- Polyacrilamide gel electrophoresis (SDS-PAGE) with PVDL blot transfer and detection. SDS- PAGE was performed for approximately 3 hours using a constant voltage of 40V. The transfer was done at constant direct current at 300 mA for 1 hr. Primary antibodies used were Olig2 (1:40,000; gift of Dr. David Rowitch); anti-Nkx2.2 (1:100 from Developmental Studies Hybridoma Bank, Iowa City) and secondary antibodies used were Horseradish peroxidase conjugated secondary antibodies.

F. Co-immuno-precipitation

Co-immuno-precipitation was performed to demonstrate the presence of interaction between mouse Olig2 and rat Nkx2.2 in HEK cells using immunoprecipitation starter pack (GE Healthcare Inc), using Sepharose H beads soaked in RIPA lysis buffer to adsorb complexes saturated with Anti-Nkx2.2(DSHB 1:100) overnight and detecting the complexes with western blotting using Anti-Olig2(1:40,000 gift from Dr. D. Rowitch).

G. RT-PCR analysis of gene expression

Day 8 early neurospheres derived from the mES cells with transfected plRES-Control (referred to as the Ctrl) and plRES-Olig2 (referred to as the test) plasmids, were snap frozen in -80^{o}C or added with RNAse later (Quiagen) prior to storage in -80°C.These were then used for extraction of mRNA. This involved the use of RNAeasy RNA extraction kit (Quiagen), according to the manufacturer's instructions.

The mRNA thus obtained was assessed for quantity and purity, using a spectrophotometer (GeneQuant Pro). cDNA was synthesized using Superscript Ill (lnvitrogen) and random hexamers according to manufacturers' instructions. One microlitre each of cDNA was used to analyze for the presence of the transcripts.

3. RESULTS

We established the accuracy of the gene cloning by independent sequencing (Lark Technologies, Takerly, UK) and checked for expression of Olig2 at protein level in human & mouse cells by western blotting and demonstrated that the Olig2 and Nkx2.2 expressed by this system form a physical complex by PCR, co-immunoprecipitation and imunnohistochemical evidence of expression (Fig 1,2 ,3,4,5).

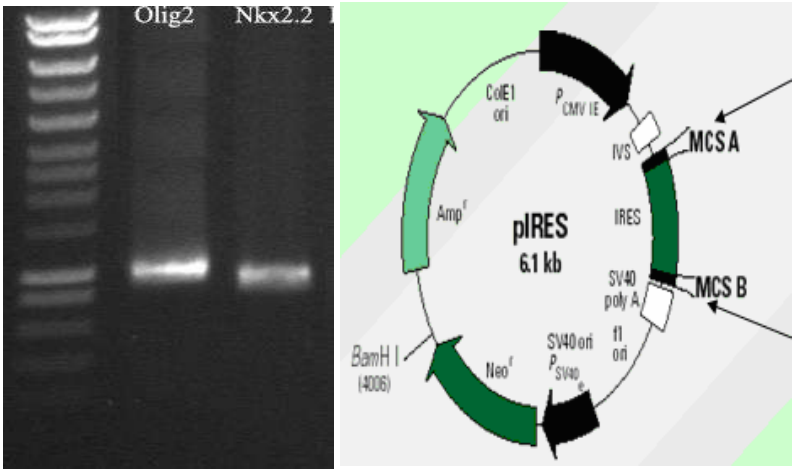


Figure 1: Cloned PCR amplicons Olig 2 and Nkx2.2, from cDNA library, and intended multicloning sites (MCS) A or B of plamid vector pIRES

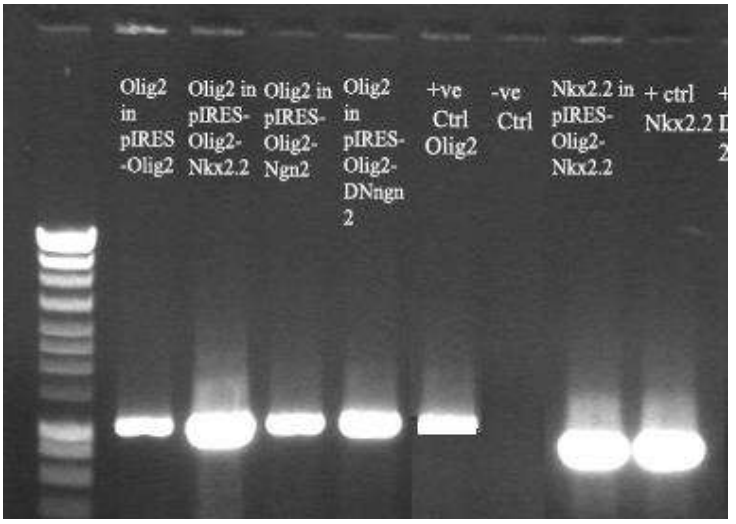


Figure 2: PCR detection of over expression of cDNA Amplicons at MCS A or MCS B in various plamid contructs tested in mouse ES cells

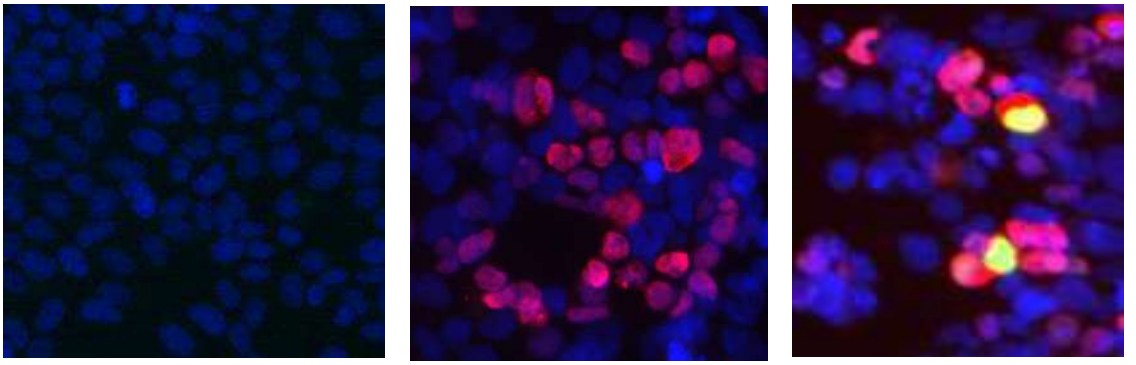


Figure3: Proof of Expression of plasmid based Olig2 and Nkx2.2 in tranfected HEK (Human Embryonic kidney cells) assessed by immuno-histochemistry.A-Control pIRES plasmid transfected cells-no expression of either Olig2 or Nkx2.2. B-Olig2 cDNA containing pIRES plasmid transfected cells-Olig2 expression.C-Olig2-Nkx2.2 double cDNA containing pIRES plasmid transfected cells- express both Olig2 & Nkx2.2

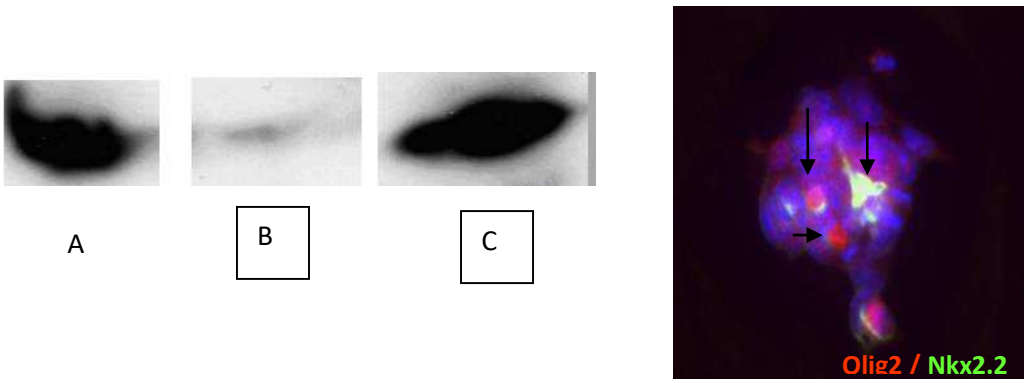


Fig 4: Immunoprecipitation using protein lysates from mouse embryonic Stem cells transfected with Olig2 and rat Nkx2.2 in pIRES-Olig2-Nkx2.2 transfected cell collections:
A- western blot confirmation of olig2 expression of 32 kDa protein band
B- control for non-specific binding: beads only
C- antigen pull-down from lysates with anti-rat Nkx2.2 and recognition of complex with anti-mouse-olig2 during co-immunoprecipitation

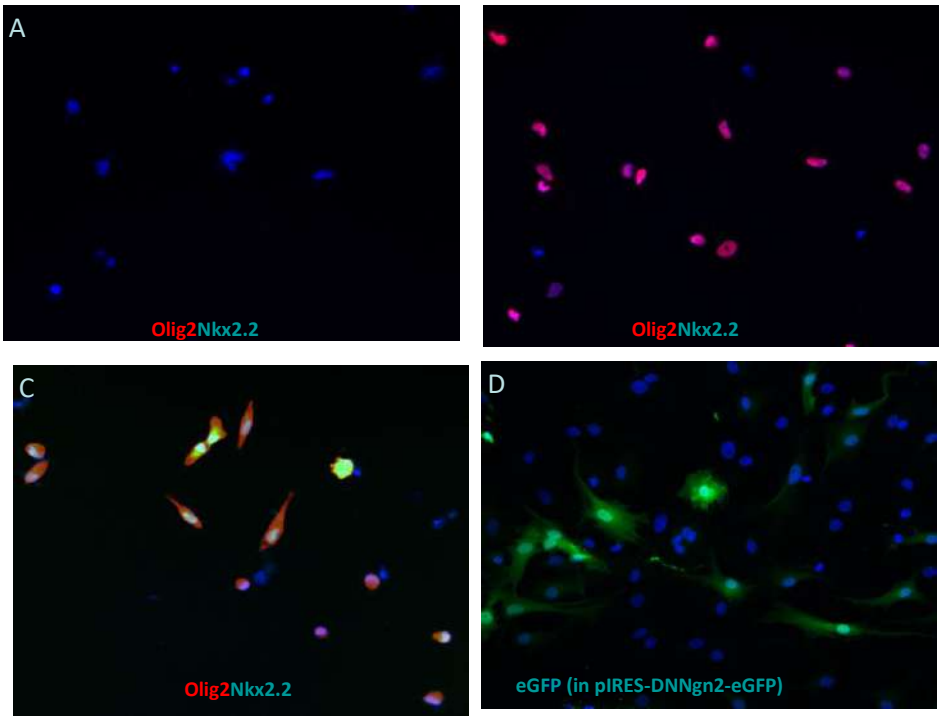


Figure 5: Expression of Olig2, Olig2 with Nkx2.2, GFP (in B locus of pIRES with dominant negative Ngn2 in A locus) in human foetal neural stem cells 48 hours post transfection with pIRES constructs:
A-pIRES control, B-pIRES-Olig2,C-pIRES-Olig2-Nkx2.2, D-pIRES-ΔNgn-GFP

A. Mouse ES cells fate regulation

At the commencement of the experiment, the cellular morphology and expression of pleuripotency marker Oct-4 were comparable in both the controls and Olig2 over-expressing mES lines. The only difference detected was the expression of Olig2.

Terminal differentiation of early (day8) neural precursors for 10 days demonstrates that in the presence of Olig2 over-expression, premature gliogenesis occurs when compared to the controls which generate a predominant neuronal phenotype (Fig 6). Quantification reveals that 10 days post-plating, GFAP positive cells arise (52.82% +/-1.75% n=3) with a reduction of ß -I11-tubulin positive cells (40.48%+/-2.89% n=3) in the presence of Olig2 misexpression, in sharp contrast to the controls where a predominance of ß -11I-tubulin positive cells (91.88%+/-2.01%, n=3) were present, without any cells expressing GFAP (0%, n=3) (Fig 7). The GFAP positive cells with Olig2 misexpression also co-stained for S100f3 but do not stain for nestin (figure 8). Olig2 over expression also leads to the presence of bipolar A2B5 positive, nestin negative cells at 5 days' post plating (Fig 9), but does not generate 04 positive cells at day 10 (0%, n=3) under these conditions.

In contrast to the above, terminal differentiation of early (day8) neural precursors for 10 days in the presence of over-expression of both Olig2 and Nkx2.2, 04 positive cells were also analysed (6.083%+-/0.57% n=3) (figure 11). Some of these 04 positive cells also stained for GalC (1.86%+/-0.15% (n=3)) and appeared morphologically larger and more arborised; whilst the remainder were only expressing 04 and were comparatively smaller, reminicient of early oligodendroglia (fig 10).

In the presence of Nkx2.2 and Olig2 expression, the total number of glial cells does not differ significantly from the situation when only Olig2 is over-expressed (48.68%+/- 4.34% n=3 and 52.82%+/-1.75% n =3 respectively, figure 10). Further, there is no significant difference in the beta-11I- tubulin positive cell numbers in the two situations above (39.45%+/-2.92% n=3 and 40.48%+/- 2.89% n=3 respectively). This implies that the presence of Nkx2.2 is immaterial to the neuronal-glial fate decision making which therefore is entirely dependent on the presence or absence of Olig2 misexpression in this system. In contrast, Nkx2.2 in the presence of Olig2 is likely to affect an oligodendroglial-astroglial fate decision after the neuronal-glial fate decision has occurred.

B. Human neural stem cells fate regulation & demonstration of specification of human oligodendroglia in-vitro

We examined the fate of human foetal neural stem cells subjected to transient over-expression of Olig2 with or without Nkx2.2(Fig 5). The transfection efficiencies for these cells were low (27.41%+/-1.36%) even under optimal conditions. However, this was still sufficient to specify 04 expressing cells after 14 days of terminal differentiation, when both Olig2 and Nkx2.2 were over-expressed (3.087%+/-0.49%, n=3). There were also 04 and GalC double positive arborized cells with typical human oligodendroglial morphology at day 14 (1.75%+/-0.226%, n=3), (figures 12,13). Olig2 alone was not sufficient to specify 04 positive cells, neither were the controls.

4. DISCUSSION

A. Premature acquisition of gliogenic competency during the generation of mouse ES derived early neural precursors an human neural precursors triggered by over-expression of key transcription factors

Directed differentiation of neuronal and glial precursors needs a thorough understanding of how cell fate decisions occur during development can be studied using ES neuralisation. The radial glial specification and their transition from an early neuronal to late glial competency in the context of ES differentiation is a much discussed phenomenon (Liour et al., 2006), (Pollard and Conti, 2007). Further, tissue derived neural precursors seem to exhibit a similar pattern in development through radial glial stages in-vivo (Gotz and Huttner, 2005; Misson et al., 1988). Transcription factors have been described to affect the progeny specified from radial glia in culture (Hack et al., 2004).

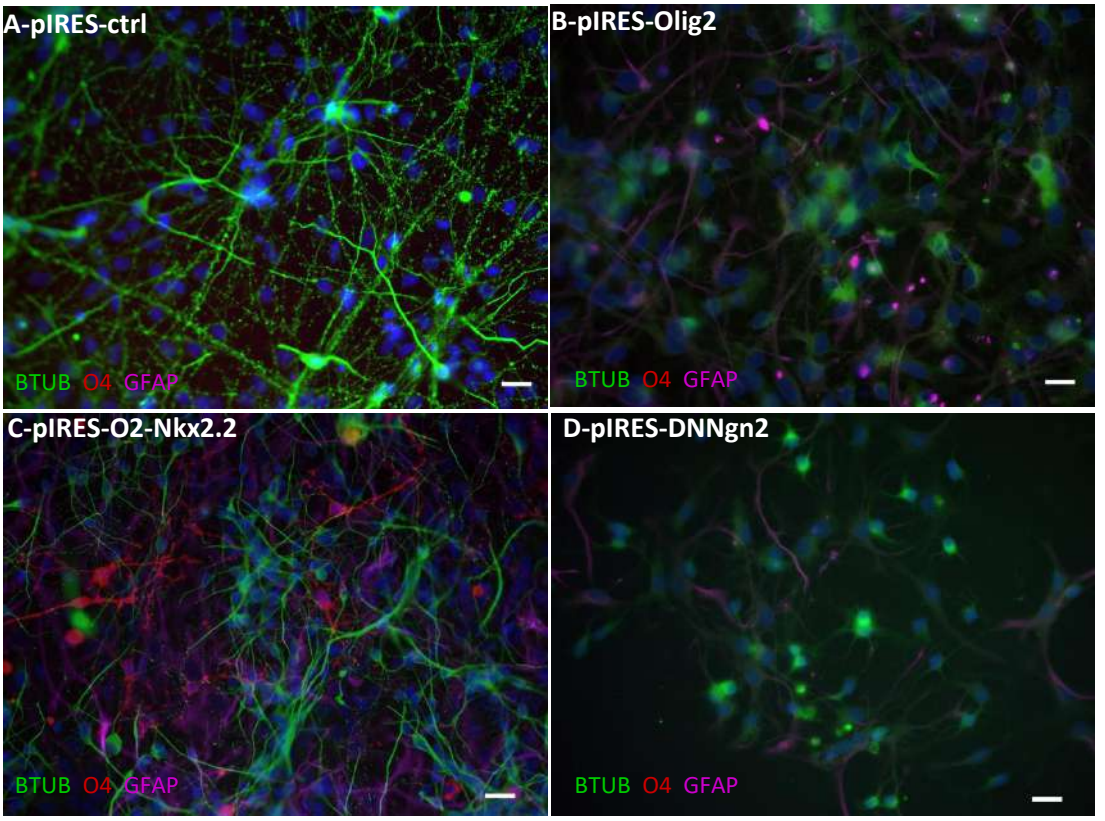


Figure 6: mES derived NPCs terminally differentiated and subjected to immuno-cytochemical analysis for lineage markers: GFAP (astroglial) ß-III-Tubulin (neural) lineages

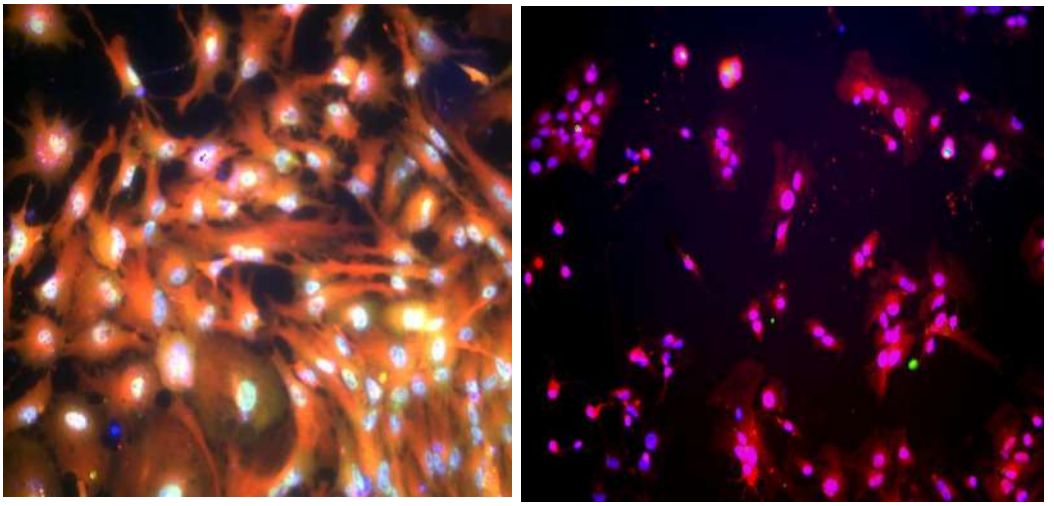
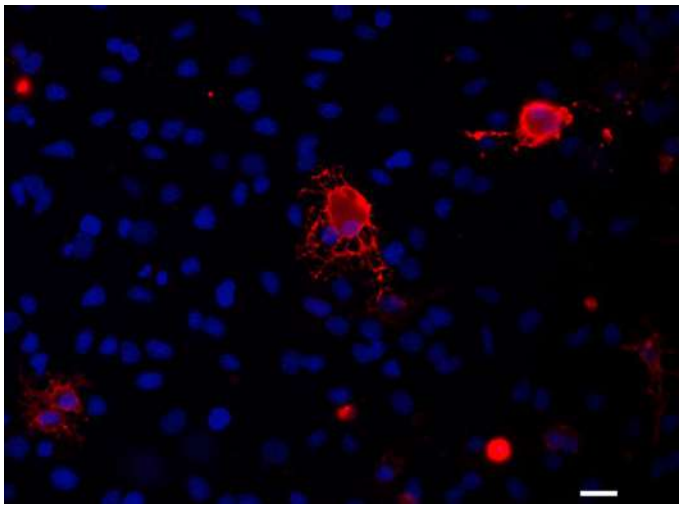
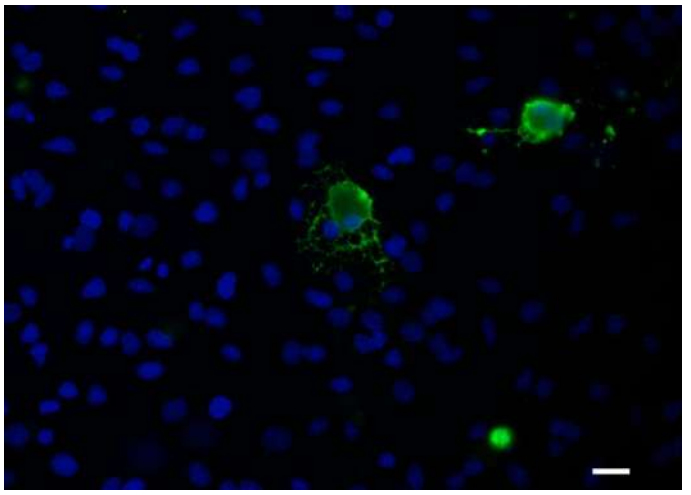


Figure 7: mES derived NPCs terminally differentiated and subjected to immuno-cytochemical analysis - additional immunocytochemical markers present in GFAP positive cells



Demonstration of the presence of oligodendroglial markers O4 and GalC amongst terminally differentiated progeny 10 days after plate down.



Note the presence of some O4 +ve cells with GalC (larger, more arborised cells) or without GalC (smaller cells) expression.

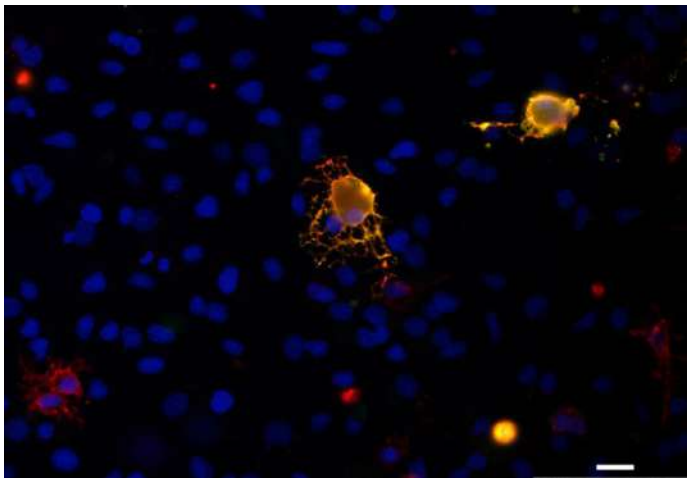


Figure 8: terminal differentiation of mouse ES cells, transfected with pIRES-Olig 2 and Nkx 2.2 constructs.

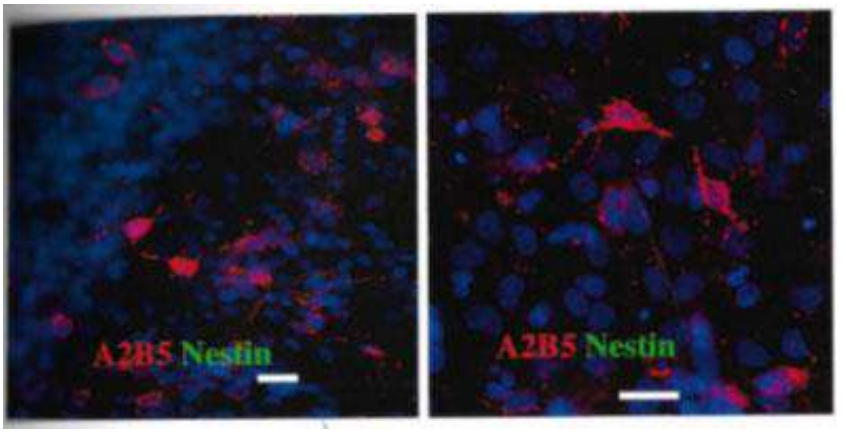
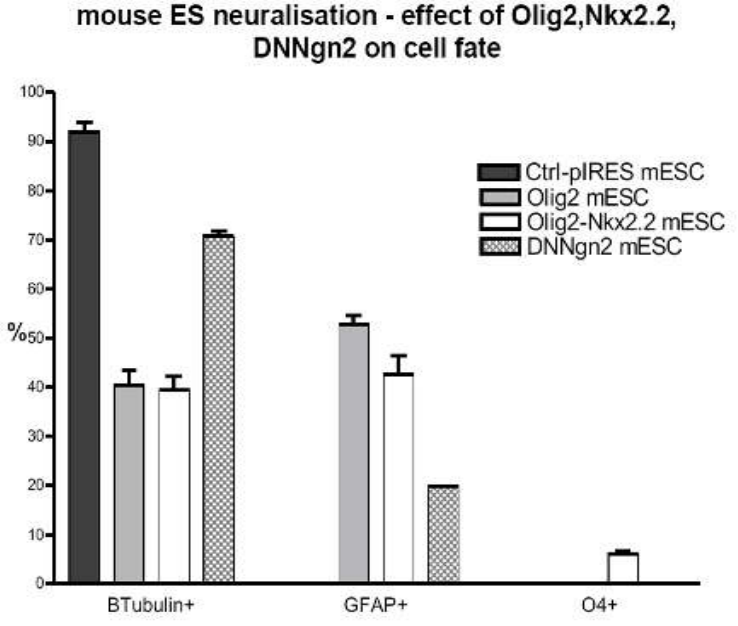


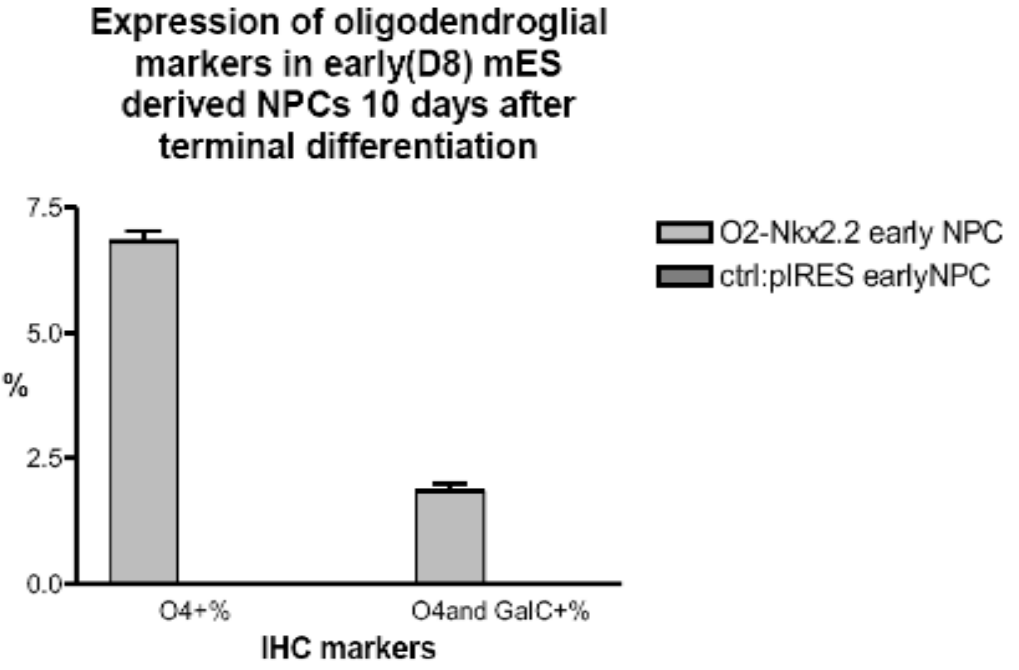
Figure 9: Further characterization of some progeny of pIRES-Olig2 transfected mES NPC (D8) terminally differentiated for 5 days after plate down. Immunohistochemical analysis with primary antibodies mouse lgM supernatants with antiA2B5 and mouse anti-rodent-Nestin. [Occasional A2B5 positive cells (which are mostly bipolar in morphology) and negative for nestin are seen, suggestive of a phenotype of late OPCs. (higher magnification on right-Scale bars 25 µm].



X Labels	Ctrl-pIRES mESC			Olig2 mESC			Olig2-Nkx2.2 mESC			DNNgn2 mESC		
	Y1	Y2	Y3	Y1	Y2	Y3	Y1	Y2	Y3	Y1	Y2	Y3
BTubulin+	93.92	93.87	87.86	41.44	44.94	36.06	42.51	42.22	33.61	71.29	68.85	72.03
GFAP+	0.00	0.00	0.00	50.36	51.90	56.21	45.17	47.48	35.17	19.91	19.86	19.60
O4+	0.00	0.00	0.00	0.00	0.00	0.00	6.17	7.03	5.05	0.00	0.00	0.00

Quantification of terminally differentiated mES derived from day 8 NPC, 10 days after plate down. Data for the final triplicates of experiments with fully dissociated precursors shown in table.

Figuree: 10- progeny emerging from differentiating mES neural precursors by Immuno-cytochemistry



IHC markers	O2-Nkx2.2 early NPC			ctrl:pIRES earlyNPC		
	Y1	Y2	Y3	Y1	Y2	Y3
O4+%	7.2100	6.4300	6.8200	0.0000	0.0000	0.0000
O4and GalC+%	1.6100	1.8400	2.1400	0.0000	0.0000	0.0000

Quantification of O4 alone or O4 and GalC positive cells amongst the terminally differentiated NPC (day8) derived from pIRES-O2-Nkx2.2 mES cells 10 days after plate down.
(Data for triplicates of experiments is shown in table.)

Figure: 11: Oligodendroglial markers expressed by differentiating mES neural precursosr transfected with constructs

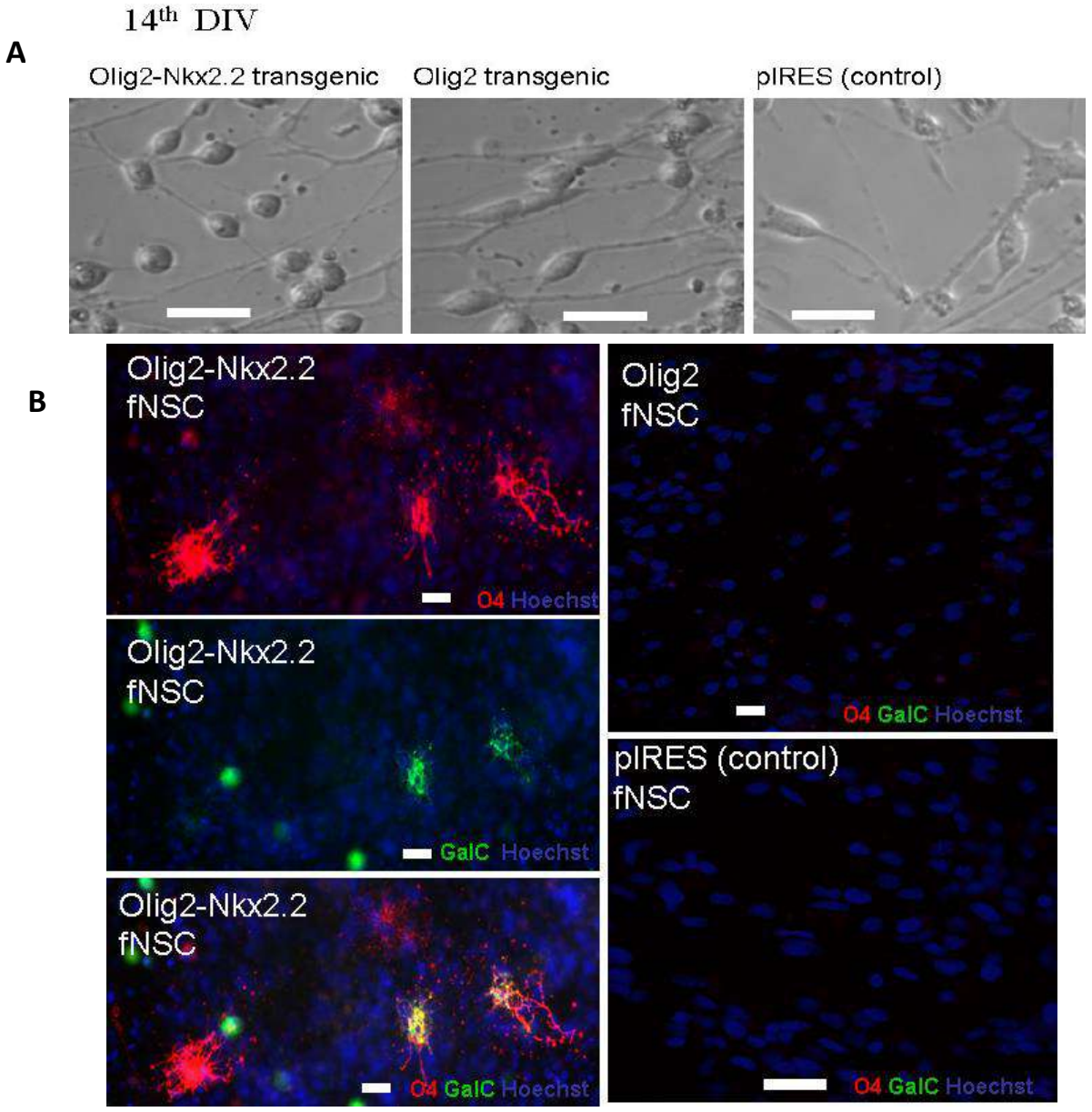


Fig: Appearance foetal NPC, after 14 days in vitro differentiation:
A-Live images.
B-Expression of oligodendroglial markers O4 and GalC, only in coverslips with the Olig2-Nkx2.2 transfected cells.
(Scalebars 25 um).

Figure: 12 : Terminal differentiation of human neural precursors transfected with transcription factor expressing plasmid constructs

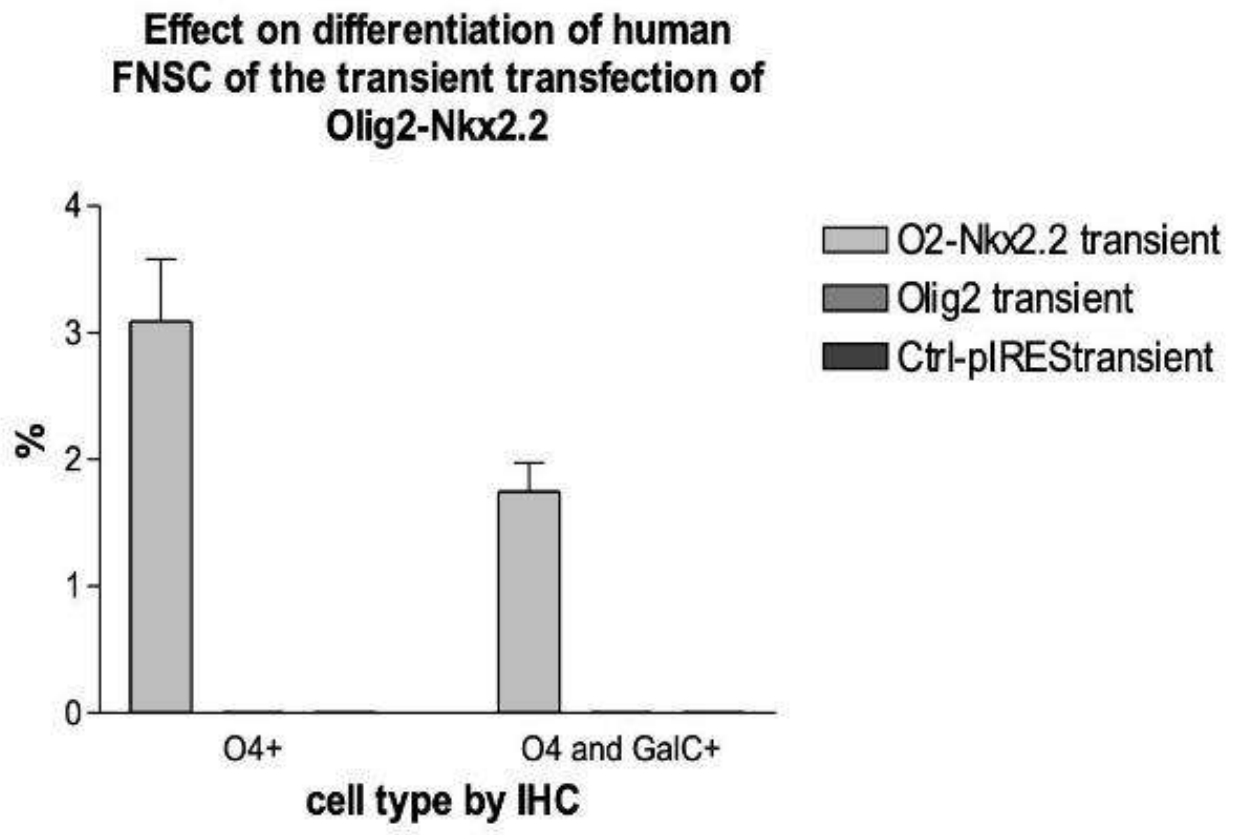


Figure: 13: Immuno-cytochemical analysis of terminal cell fate and specification of human oligodendrocytes in-vitro from human foetal neural stem cells transfected with Olig-2 & Nkx2.2 over-expression.

More recently, 3-D aggregate in-vitro culture techniques also suggested the association of high levels of these transcription factors during glial development. (Youn W. et al., 2020).

Therefore, along similar lines, we investigated whether Olig2 alone or in combination with its binding partners, can accelerate the process of acquisition of glial competency. A major practical problem in elucidating the true effect attributable to a transcription factor is the necessity in tissue culture for added morphogens, such as retinoids and sonic hedgehog, which could confound the perceived effect. Therefore, we chose to study the effect of Olig2 on neural precursors developing from embryonic stem cells in an in-vitro model of neuralisation, which does not employ the use of such morphogens. We also investigated the potential of utilising such a strategy for generating human oligodendroglia.

We have demonstrated that Olig2 can accelerate the process of achieving a premature glial competency. Given the similarity of sub-ventricular zone derived precursors/radial glia to ES derived neural precursors (Liour et al., 2006), our findings are in keeping with the observations made by two other groups for a proposed novel role for Olig2 in the process of differentiation of subventricular zonal precursors to astrocytes as well as oligodendrocytes (Marshall et al., 2005), (Masahira et al., 2006) and also indirectly supports the theory of glial restricted progenitors arising during neural development (Mayer-Proschel et al., 1997), (Rao and Mayer-Proschel, 1997). We

also demonstrate that the technique of transcriptional factor control can be applied to reveal the presence of a considerable oligodendroglial potential in human foetal neural stem cells, which have a much limited nascent potential to differentiate into many cell types, compared to ES cells. Therefore, this may be a safer and efficient method to attempt direction of differentiation to achieve human oligodendroglial cells for research.

B. Proof of concept of directed stem cell differentiation, using cDNA vectors in-vitro for diagnostic & therapeutic applications

Extrapolation of these results suggests that the co-operative action of Olig2 and Nkx2.2, which are highly conserved transcription factors in evolution, irrespective of the source of cDNA extraction, under optimal DNA transfection or transduction conditions, should be able to restore the oligodendroglial potential in a vast majority of cultured human foetal neural stem cells as well as embryonic stem cells, mirroring normal.

5. CONCLUSION

Whilst acknowledging this is a limited study of proof of concept, we conclude that directed differentiation of human foetal neural stem cells or embryonic stem cells, under relevant transcriptional regulation, may represent an attractive option for the generation of rare human cells such as oligodendroglia, illustrating potential for stem cell based diagnostic or therapeutic applications in many other fields such as neurology, cardiology or endocrinology.

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7. ACKNOWLEDGMENT

The University of Cambridge and Gates-Cambridge Trust is acknowledged for their support with International Gates Scholarship.

KJMS 2023 VOL.5 (1): 26-40

KDU Journal of Multidisciplinary Studies
(KJMS) Volume 5. Issue 1 July 2023
https://doi.org/10.4038/kjms.v5i1.60

INTELLIGENT VIDEO SURVEILLANCE MECHANISMS FOR ABNORMAL ACTIVITY RECOGNITION IN REAL-TIME: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Video surveillance plays a crucial role in securing indoor and outdoor locations in today's unreliable world, particularly in real-time applications for behaviour detection, comprehension, and labelling activities as normal or suspicious. For example, in the development of automated video surveillance systems, smart video reconnaissance systems based on picture recognition and activity recognition that detect violent behaviours is basic to forestalling wrongdoings and giving public security. According to the literature, Artificial Intelligent, Machine Learning, and deep portrayal-based approaches have been effectively utilized in image recognition and human activity observation tasks. In this literature review, a 3D convolution neural network based on deep learning is used as the proposed methodology. Thus, this article completed a Systematic Literature Review (SLR) in light of intelligent video surveillance to real-time identify abnormal activities from 2016 to 2021. In this current study, 50 research papers were considered and based on the screen filtering, the most suitable 16 papers were filtered based on intelligent video surveillance and real-time abnormal activities. Furthermore, this study identifies potential areas for improvement in intelligent video surveillance systems that can enhance public safety and security, underscoring the importance of ongoing research in this field.

KEYWORDS: *Abnormal, Activities, Machine Learning, Real-Time, Video Surveillance*

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1. INTRODUCTION

A form which differs from a bunch of typical forms is referred to as an abnormality. When it comes to abnormal activity detection, nowadays it is a significant issue in video surveillance. Abnormal event detection can be defined as the recognition of sporadic, unexpected, uncertain or uncommon occasions or things that are not deemed to be routinely happening occasions or consistent things in a form or things contained in a dataset that deviate from current forms (Franklin, Mohana and Dabbagol, 2020).

In the utilization of wellbeing or protection and defence for the administration of individual life and the general population, video surveillance performs effectively. When considering surveillance videos, the most common behaviour is to mark it as a regular activity that does not cause concern (Mansour *et al.*, 2021). Because of these requirements, in the modern world, different types of cameras have been installed at each side and video observation systems can comprehend the moment as well as anomalous actions with immediate detection. As well, it creates an automated observation system instead of human noticed focused services (Franklin, Mohana and Dabbagol, 2020).

Nowadays, video observation has been displayed as a desirable answer to address explicit requirements for safety and public peace. As a result, CCTV (Closed Circuit Television) camera modules enable the human administrator responsible for viewing the displays to manage as well to check what is happening at all of the monitored locations in real-time. Furthermore, the exploration and categorization of events in the compressed domain allow for improved data restoration and conservation for storage (Diop, 2020).

In the modern world, an AI (Artificial Intelligence) system has made it easier for people to deal much effectively by making easy on their tasks and providing much exact and precise outcomes. When considering AI for video surveillance, that has been useful for analyzing sound and pictures from video observation cameras to identify people, items, vehicles, attributes, and occasions perfectly.

Surveillance procedures based on Artificial Intelligence and intelligent video analytics compute and give safety efforts which consist a major influence on avoiding abnormalities; especially, to identify unusual occasions different creative thoughts in video analytics and AI-related observation has been utilized in regions, for example, temporal object tracking, human identification, traffic checking, and host identification (Balasundaram and Chellappan, 2020). Compared with normal surveillance cameras, the AI systems eliminate the total reliance on human checking and, on behalf of providing notices to the security group well in advance before the happening of an abnormal activity (Balasundaram and Chellappan, 2020).

Modelling of environments, motion detection, categorization of movement of things, tracking, reaction interpretation, expression, and combination of contribution from numerous cameras are all steps of computer vision technologies. As an initial step, to extract characteristics from distinct video sequences, this approach requires a lot of pre-processing. Two types of classification techniques are available in the literature namely supervised and unsupervised. Unsupervised classification can be considered as a computer-based system that does not need any human participation, while supervised classification utilizes manually labelled training data (Amrutha, Jyotsna and Amudha, 2020).

Furthermore, GMM (Gaussian Mixture Model) method, SVM (Support Vector Machine), Neural Networks, which are all Machine Learning techniques, have been used to identify abnormal activities (Luo *et al.*, 2017; Tariq *et al.*, 2020).

AI algorithms are rapidly improving in numerous areas. In pattern recognition and object detection, Machine Learning algorithms are the most frequently used algorithm (Liu *et al.*, 2019). Stacking provides a mix of Machine Learning models into a one large model. The stacked classifiers support to acquire huge outcomes from various Machine Learning models. Stacking is used in consolidating different Machine Learning trained models (Shahad *et al.*, 2016).

Machine Learning techniques are useful in video compression for a variety of tasks, including improving the codec, reducing complexity, and

recreating characteristics lost during compression. Post-processing is another area where Machine Learning can be applied to improve the quality of compressed video. Applying quantization to an auto-encoder bottleneck is another method for learning useful latent representations and obtaining compressed images. Networks with Deep Learning capabilities may learn unsupervised from unstructured data. Deep Learning is a subset of Machine Learning in AI. (Shankar *et al.*, 2020) Machine Learning techniques can be used to enhance object tracking and anomaly detection. Machine Learning has been used in the field of crowd surveillance for tasks such abnormal event detection, item tracking, and person tagging (Mohan, Choksi and Zaveri, 2019).

Background

According to the literature, some significant issues can be seen with conventional video surveillance approaches; particularly, standard video surveillance methods need a lot of time and do not offer real-time video processing. Additionally, human mistake resulted in false alarms, maintenance issues, and storage problems (Mohan, Choksi and Zaveri, 2019).

Deep Learning implementations as well as more conventional or hand-engineered features are being employed by a variety of researchers to identify the early efforts of violent behaviours (Ishikawa and Zin, 2019; Amrutha, Jyotsna and Amudha, 2020; Koppikar *et al.*, 2020; Janakiramaiah, Kalyani and Jayalakshmi, 2021; Pawar and Attar, 2021; Rezaee *et al.*, 2021). However, most of these works have only paid attention to accuracy, paying little attention to real-time operations. Therefore, those researches will highlight a gap related to real-time detection of abnormal activity using intelligent video surveillance.

Additionally, a competent video surveillance quickly identifies any suspicious activities. However, most of the surveillance systems in use today are operated by people. They need constant human attention as a result to detect any unusual activities. When humans are involved, the system's effectiveness gradually declines over time due to the human stress factor. Additionally, errors can result from manual intervention. However, video surveillance automation offers a solution to this issue. This is because the automated system's function is to alert when a predetermined abnormal activity is taking place in the form of an alarm or in any other way. The information needed for efficient and quick decision-making can be extracted and analyzed by an intelligent surveillance system (Mathur and Bundele, 2016; Bouindour, Hu and Snoussi, 2019; Amrutha, Jyotsna and Amudha, 2020). So, this research would fill that gap which involves human attention to detect abnormal activities.

Moving targets that are too close together and incredibly small objects were not validated by the vision-based cellular model method. In addition, no viable method has been found to compress all the information from various viewpoints of a single pedestrian into a single high-dimensional point for the purpose of detecting loiterers. (Mathur and Bundele, 2016) This proposed method can identify areas for improvement or gaps in research work that have already been completed.

Rezaee *et al.* (2021) have investigated various crowd anomaly detection techniques, and they have looked at numerous factors including single monitoring, classification based on manually collected features, categorization that uses Deep Learning, and hybrid models. Automated surveillance video analytics has emerged as a new technical trend in the security industry. An automated method of detecting any anomalous activity is human behaviour recognition in a video monitoring system. (Amrutha, Jyotsna and Amudha, 2020) In order to provide safety and security, video surveillance system is commonly used in all public spaces to keep track on what is happening nearby.

And also, it has widely been utilized for a variety of tasks (Ishikawa and Zin, 2019; Tariq *et al.*, 2020) such as monitoring military-reserved areas, illegally parked vehicles, smoke, fire, crime, vehicle, person tracking, unattended object surveillance, road monitoring, security surveillance, post-disaster management and so on (Kalaivani, Roomi and Jaishree, 2017; Mohan, Choksi and Zaveri, 2019; Pawar and Attar, 2021). Therefore, this research also would support this alarming situation.

When the typical Support Vector Machines method

for unusual events is used alone, it works poorly. However, it works well when used with classification once features that used a Deep Learning algorithm have been converted. Additionally, utilizing Machine Learning applications for video surveillance such as anomalous event detection produces improved outcomes. Even the three-dimensional video input data can be handled by standard techniques like CNN (Convolutional Neural Network). CNN may be used to identify an image's features, categorize photos, and more. Additionally, CNN can extract video characteristics and patterns more quickly than conventional image processing methods (Mohan, Choksi and Zaveri, 2019; Mansour *et al.*, 2021).

Anomaly patterns are those that emerge during testing because of several restoration faults. The greatest results for image classification came from Deep Learning. As a result, it is determined to be appropriate for video activity categorization. However, when tracing is done for recording, it is difficult and frustrating to find annotations. Encoders built on Deep Learning have been used to autonomously train the model for typical behaviour while utilizing restoration loss to identify anomalies (Singh, Singh and Gupta, 2020).

Nandyal and Angadi (2021) introduced an automatic and innovative algorithm for object detection for video monitoring and tracking in real-time security systems. An enhanced version of the Kanade-Locus-Thomsai extraction algorithm for object tracking functions is given by the system. However, this paper suggests a simplified algorithm that detects and monitors a small number of features, both continuous and discontinuous, instead of constantly detecting and tracking many feature points of an object. So, this research would fill that gap.

Most publications have used computer vision, using different algorithms or Neural Networks, to analyze human activity from videos. To determine trajectories or motion patterns, computer vision algorithms need a lot of pre-processing (Greco *et al.*, 2016).

In addition, background removal has been predicated on a static backgrounds premise that was usually inaccurate in real life scenarios. The methods described above are ineffective when dealing with crowds. Consequently, a deep architecture for the prediction of suspicious activity might be built using 2D CNN (two-dimensional Convolutional Neural Network) and LSTM (Long Short-Term Memory). As a result of that, the precision of the system can be improved. Most Deep Learning papers only identify suspect behaviour. As a consequence, a reliable way is required to alert security when there is any suspicious activity (Amrutha, Jyotsna and Amudha, 2020).

Therefore, to fill those gaps, this research would be a great support.

Table 1 below shows the motivation obtained through research questions and literature review. These research questions are a great help to complete this review and a systematic literature review can provide answers to these questions.

Table 1: Research Question and Literature Review

ID	Research Question	Motivation
RQ1	When and where were the studies published?	Identify the most significant publication in the video surveillance system field
RQ2	What types of research have been done?	Identify the most active and influential researchers that gave the most contribution to a research area of video surveillance system field
RQ3	What are the gaps identified related to intelligent video surveillance to real-time identify abnormal activities?	Identify gaps for application video surveillance
RQ4	What kind of topic is popular among the researchers in the intelligent video surveillance field?	Identify research topics and trends in video surveillance system field
RQ5	What kind of datasets are the most utilized for intelligent surveillance videos?	Identify datasets commonly used in intelligent video surveillance
RQ6	What are the technologies that used in intelligent video surveillance to real- time identify abnormal activities?	Identify the common Machine Learning methods for visual surveillance and object analysis on the video surveillance system

2. METHODOLOGY

In conducting our research, we adhered to the standards outlined by Kitchenham and Charters (Kitchenham, B, 2007).

A. Planning the review

By putting up research questions related to our study's goals, we designed this review. We established the inclusion/exclusion criteria, search strategy, and search string. Below, we go into greater detail about these.

B. Review objectives and research questions

Nowadays, in order to fight crime and avert undesired events that have a significant impact on society, security management professionals heavily rely on video surveillance. The use of surveillance cameras to monitor public actions has increased rapidly in both the private and public sectors. One of the most efficient strategies for ensuring security is video monitoring. The collected footage is readily transferred to the security staff after installing a surveillance camera. However, anomaly activity can only be identified by using an intelligence system to evaluate the video (Balasundaram and Chellappan, 2020).

RQ1: When and where were the studies published?

RQ2: What types of research have been done?

RQ3: What are the gaps identified related to intelligent video surveillance to identify abnormal activities real-time?

RQ4: What kind of topics is popular among the researchers in the intelligent video surveillance field?

RQ5: What kind of datasets are the most utilized for intelligent surveillance videos?

RQ6: What are the technologies that are used in intelligent video surveillance to identify abnormal activities real-time?

C. Search strategy

The investigation was conducted using the work of Kitchenham and Charters (Pawar and Attar, 2021). After defining our objectives and questions, we developed a systematic search approach to evaluate all relevant empirical resources that were readily available for the review's purpose.

The search space, that includes printed proceedings and electronic resources, was established as shown in Table 2. The papers were initially obtained from online databases, and after that they were examined using reference searches to discover further pertinent research (snowballing). Additionally, we searched the related publications in the DBLP (Digital Bibliographic Library Browser) database to find the authors of the papers. This additional method aimed to cover any potential work which had been missed.

Table 2: Search Sources

Areas	Search Source
Electronic databases	IEEE Explorer Science Direct Springer ACM Digital Library
Searched items	Papers from journals and conferences
Search applied on	Full text—to ensure that none of the papers that have our search terms in the titles or abstracts but are nonetheless related to the review object are missed
Language	English
Publication period	From January 2016 to June 2021

Then, as described in section E, the criteria for inclusion and exclusion were applied to the recovered studies in two separate rounds, each including a varied number of researchers.

D Search criteria

The search strategy specifies the search terms and search strings that will be utilized to find materials. By evaluating previous research papers, all of the studies relevant to "video surveillance to identify

abnormal activities real-time " were identified and classified. For this, key terms such as "Surveillance", "Abnormal", "Video", and "Real-Time" were utilized to search for research papers on the above topic. Tables 3, 4, 5, and 6 demonstrate how search strings are used in databases such as IEEE Xplore, Springer, ScienceDirect, and ACM Digital Library. Many papers, reports, and articles published in various journals and conferences were investigated.

Based on each database's search capabilities, we manually created the search term in each one. Each database search was regarded as a learning and testing session.

Table 3: Search Terms of the Study on Intelligent Video Surveillance Real-Time

Areas	Search Terms
Intelligent	intelligent
Video	video, moving picture
Surveillance	surveillance, monitoring, observation, supervision
Real-Time	real-time
Search string	"intelligent" AND ("video" OR "moving picture") AND ("surveillance" OR "monitoring" OR "observation" OR "supervision") AND "real-time"

Table 4: Search Terms of the Study on Video Surveillance Abnormal Activities

Areas	Search Terms
Video	video, moving picture
Surveillance	surveillance, monitoring, observation, supervision
Abnormal	abnormal, unusual, anomalous, violence, suspicious
Activities	activities, event, behaviour
Search string	("video" OR "moving picture ") AND ("surveillance" OR "monitoring" OR "observation" OR "supervision") AND ("abnormal" OR "unusual" OR "anomalous" OR "violence" OR "suspicious") AND ("activities" OR "event" OR "behaviour")

Table 5: Search Terms of the Study on Real-Time Identify Abnormal Activities

Areas	Search Terms
Real-Time	real-time
Identify	identify, detect, recognize, identification
Abnormal	abnormal, unusual, anomalous, violence, suspicious
Areas	**Search Terms**
Activities	activities, event, behaviour
Search string	"real-time" AND ("identify" OR "detect" OR "recognize" OR "identification") AND ("abnormal" OR "unusual" OR "anomalous" OR "violence" OR "suspicious") AND ("activities" OR "event" OR "behaviour")

Table 6: Search Terms of the Study on Video Surveillance Real-Time Identify Abnormal Activities

Areas	Search Terms
Video	video, moving picture
Surveillance	surveillance, monitoring, observation, supervision
Real-Time	real-time
Identify	identify, detect, recognize, identification
Abnormal	abnormal, unusual, anomalous, violence, suspicious
Activities	activities, event, behaviour
Search string	("video" OR "moving picture") AND ("surveillance" OR "monitoring" OR "observation" OR "supervision") AND "real-time" AND ("identify" OR "detect" OR "recognize" OR "identification") AND ("abnormal" OR "unusual" OR "anomalous" OR "violence" OR "suspicious") AND ("activities" OR "event" OR "behaviour")

E Inclusion and exclusion criteria

The following inclusion and exclusion criteria were used to evaluate if a study should be included:

Inclusion Criteria

IC1: The study includes information about intelligent video surveillance and real-time

identification of abnormal activities.

IC2: The studies are only from conferences and journals.

IC3: The studies that have been published from 2016 to 2021.

Exclusion Criteria

EC1: The studies do not have an abstract.

EC2: Selected studies do not contain any keywords.

EC3: The studies that are published before 2016.

EC4: Selected studies do not contain any keywords.

F Conducting the review

This part presents the findings of our information extraction and search from related sources and databases.

G Study search and selection

Utilizing the search technique, the studies were found utilizing the given electronic databases (already mentioned in section C), and only databases that disseminate peer-reviewed publications were incorporated (16). The inclusion criteria were used to conduct a thorough review of the study titles and abstracts (1st stage). Most of the papers found met the inclusion criteria IC1, IC2, and IC3. A large portion of the results were discarded as a result of the search engines' restrictions in mapping the search string to the entire body of content of the document. We ended up with 50 potential studies as a consequence of the first round of categorization. We also double-checked to ensure that the papers we found did not include debates, editorials, comments, tutorials, prefaces, or presentations. The pre-selected papers were then examined by titles, abstracts, and keywords in the 3rd stage in order to apply the exclusion criteria (EC1, EC2, EC3, and EC4). We read the complete paper for the publications where agreement was not obtained, and then we eliminated the research based on the established exclusion criteria. 8 papers were removed from the 48 that were pre-selected after the inclusion criteria were applied due to the fact that they did not focus on any subject directly related to the subject of our enquiry (EC1 to EC4). Consequently, 16 studies are included in our final stage (take a look at the two right-hand columns in Table 7).

H Data extraction and synthesis

A total of 50 were discovered as a consequence of the 1st stage of searching. There were 30 IEEE Explorer research papers, 12 Science Direct research papers, 5 Springer research papers and 3 ACM Digital Library research papers among them. The title, abstract, and keywords were evaluated in the first step of the selection process. The inclusion criteria (IC1, IC2, and IC3) were used to select research articles, whereas the exclusion criteria (EC1, EC2, EC3 and EC4) were used to reject research papers that met exclusion requirements. The duplicate publications were removed in the 2nd stage.

Table 7: Results from Selection Stages

Stage	Applied criteria	Analyzed content	The initial number of studies	The final number of studies	Reduction (%)
1st stage	IC1, IC2	Title, abstract, keywords	50	50	0%
2nd stage	Duplication removal	Title, abstract, keywords	50	48	4%
3rd stage (a)	EC1, EC2, EC3, EC4	Title, abstract, keywords	48	40	16.6%
3rd stage (b)	IC2, IC3	Title, abstract, keywords	40	32	20%
4th stage	IC1	Full text	32	16	50%
Final stage			50 (sources)	16 (sources)	68%

The 3rd stage included applying inclusion and exclusion selection criteria to the title, abstract and keywords, and eliminating papers. In the 4th stage, the selection process (inclusion and exclusion) was used for the entire stage. From a total of 50 papers,

16 are chosen at the conclusion of the procedure. Table 8 shows the results of the various stages of selection.

In the first step, the research title, abstract, and keywords were used as selection criteria. The first round of the selection process included 50 papers. The purpose of this research is to categorize the studies and select the most important ones by rejecting those that are irrelevant to the topic. As a consequence of this selection procedure, we have chosen 16 publications from different databases. 34 documents were discarded, while 16 were saved from a total of 50. There were 10 IEEE publications, 3 Science Direct publications, 2 Springer publication, and 1 ACM publications among the 16 articles chosen. Exclusion criteria EC1, EC2, EC3, and EC4 were used to eliminate publications. We chose key publications based on the IC1, IC2, and IC3 inclusion criteria. At the end of the process, we selected 16 publications that we believe are best acceptable for conducting a comprehensive literature review on intelligent video surveillance to real-time identify abnormal activities.

I Quality Assessment criteria and screening procedures

This criterion was used to ensure that the article is a relevant study for the chosen topic by evaluating the quality of the chosen work. The chosen articles were evaluated based on the following criteria which are research goal, contextualization, literature review, related work, methodology, result, and conclusion based on aims, and suggestion of future studies.

The following are the quality evaluation criteria that were utilized to evaluate the chosen papers.

- The number of citations used in existing research.
- At the conference that paper was published.
- Papers which have ethical standard likes reference format.
- Check answers are suitable for the research questions.
- The research question that they are focused.
- Latest research publications from 2016-2021.
- Papers that clearly clarify the results and discussion.

Figure 1 shows the proposed research method to continue this research. The final result is achieved through data collection, data pre-processing, frame extraction and separation, spatial autoencoder architecture and abnormal event prediction steps. That is to identify fighting abnormal behaviours in real-time. If an abnormal event occurs, it will be notified through an alert message.

J Proposed methodology

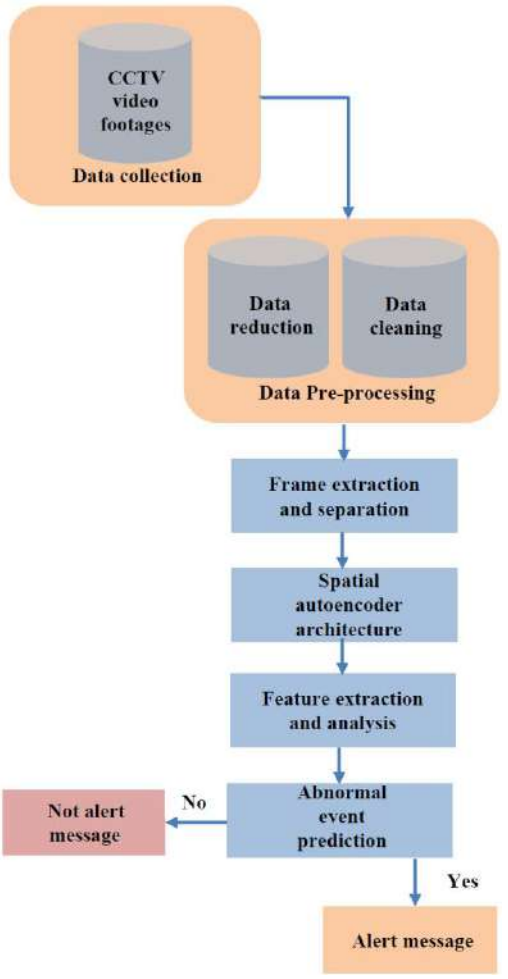

Figure 1: Proposed method for the research

3. RESULTS

We discuss the review's findings in this section in the context of the research problems.

A. Overview of studies

The chosen papers of this mapping study are shown in Figure 2. The table shows the publication year, title and other details of these publications. The research papers selected here will be carried out between 2016 and 2021.

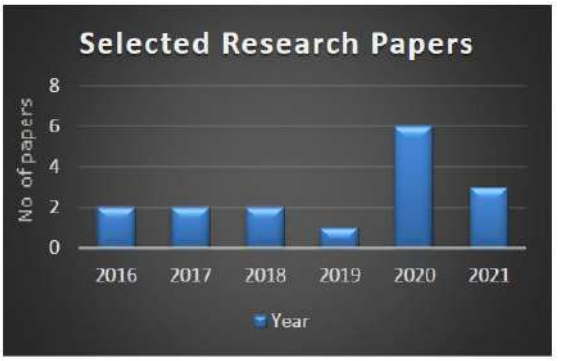

Figure 2: Selected research papers by year

B (RQ1) When and where have the studies been published?

For our research study, publications from 2016 to 2021 were gathered from a variety of reliable sources. A total of 50 research publications have been discovered. For this systematic literature review, 16 research publications were chosen from among them.

C (RQ2) What types of research have been done?

Many studies have been conducted to better understand the approaches for detecting suspicious activity, with a particular emphasis on violence detection for public settings, abnormal behaviour recognition, and anomalous event detection. Utilizing a super frame segmentation algorithm for tracking abandoned objects, identifying anomalous human behaviour, and unattended baggage, among other things, allowed for a thorough comparison of the many suggested solutions. Intelligent methods like Neural Systems, Fuzzy Logic, Support Vector Machines, Genetic Algorithms, etc. are the foundation of many technologies (Mathur and Bundele, 2016). (Diop, 2020) The suggested method for categorizing events in the compact domain in CCTV systems is related to the LDA model.

Table 8: Selected Studies

ID	Bibliographic Reference	Type	Year
#1	(Mathur & Bundele, 2016)	Conference	2016
#2	(Coming Lopez & Lien, 2020)	Conference	2020
#3	(Kamthe & Patil, 2018)	Conference	2018
#4	(Pramanik et al., 2021)	Journal	2021
#5	(Amrutha et al., 2020)	Conference	2020
#6	(Diop, 2020)	Conference	2020
#7	(Balasundaram & Chellappan, 2020)	Journal	2020
#8	(Rouhani, Mirhoseini and Koushanfar, 2017)	Journal	2017
#9	(Mohan et al., 2019)	Conference	2019
#10	(Franklin et al., 2020)	Conference	2020
ID	**Bibliographic Reference**	**Type**	**Year**
#11	(Li et al., 2020)	Journal	2020
#12	(Rasmi & Vinothini, 2015)	Conference	2016
#13	(Mansour et al., 2021)	Journal	2021
#14	(Phule & Sawant, 2017)	Conference	2017
#15	(Dong et al., 2020)	Conference	2020
#16	(Rezaee et al., 2021)	Journal	2021

D (RQ3) What are the gaps identified related to intelligent video surveillance to identify abnormal activities real-time?

This evaluation method can identify areas for

improvement or gaps in research work that have already been completed, as indicated below: Motion objects which are too close together and tiny objects are invalidated by the vision-based cellular model method. Sunlight causes the bounding box that represents a moving target to become too small in some frames, leading to inaccurate detection.

In addition to being outdoors, this also failed to recognize two moving things. Also, when many objects with the same color profile engage in an occlusion event, classification and tracking based on colour features may fail. In addition, no viable method of reducing all the information from several pedestrian perspectives to a single high-dimensional point in the event of loitering person detection has been found. Additionally, there is currently an inadequacy of demanding and professional high-quality data sets available for testing (Mathur and Bundele, 2016).

E (RQ4) What kind of topics is popular among the researchers in the intelligent video surveillance field?

The results of a few key studies indicate that the following subjects have received the most attention in recent research on video surveillance systems: the integration of various computer vision and image processing algorithms that analyze object, activity, and behaviour recognition. Aware of any unplanned event for a drone surveillance system, and visual monitoring that explains image processing or computer vision techniques which are recently being used for video surveillance. That describe how infrastructure, network design, and operational protocols are combined into a massive system to reflect the practical requirements for CCTV installations in the future.

F (RQ5) What kind of datasets are the most utilized for intelligent surveillance videos?

A dataset is a collection of data used in a particular quantity for applications of Machine Learning. It is difficult to gather a surveillance video dataset for a certain activity, like crowds, pedestrians, or cars. Newer versions of video datasets from a number of researchers and organizations enable other researchers to evaluate their approaches and make additional contributions to the field of video surveillance. Crowd, traffic, facial, pedestrian, and other forms of monitoring activities are some of the video results. Most of the videos can be used for motion segmentation, behaviour analysis, abnormal event detection, tracking objects, tracking moving objects, and density estimations. Public datasets include those from UMN, UCSD, ViSOR, UCF, AVSS, XJTU, and CAVIAR, to name a few.

G (RQ6) What are the technologies that used in intelligent video surveillance to real-time identify abnormal activities?

It has been attempted to conceptually explain the various solution methods employed by the various researchers. The TensorFlow Deep Learning framework, that is placed on a GPU system, and MATLAB R2014a are the tools (Mohan, Choksi and Zaveri, 2019) that have been utilized for the investigation. The approach has been assessed in terms of F1 score and correctness using three datasets. Additionally, they used three datasets - (i) the UMN, (ii) Avenue, and (iii) UCSD datasets - to assess anomaly detection and to compare them in respect of F1 score and accuracy. Subsets of the UCF-101 action recognition dataset make up the data set for activity recognition. (Phule and Sawant, 2017) has designed, when a crowd is identified, a message signal is instantly transmitted to the higher authority person via the GSM (Global System for Mobile Communication). In terms of computing complexity and threshold values, this strategy is safe and efficient (Wan *et al.*, 2021). The remaining lengthy video is split into many SOIs that include the video events that use a super frame segmentation technique based on feature fusion.

4. DISCUSSION

The root cause of the most common anti-corruption acts in the world today is the failure to prevent the root cause of those acts. Abnormal behaviours occur through a number of incidents such as robbery, fraud, corruption, murder, and threats. Proper solutions to these are implemented only after the occurrence of

the incidents. That person only gets justice in law. It does not re-correct the event. Therefore, in the world including Sri Lanka, a proper prevention practice has not been found in relation to these incidents so far.

Nowadays, there are many cameras, but they only record video. Only object detection can be done in some CCTV cameras, but nothing more than that. Also, when an abnormal event occurs, the videos recorded by the CCTV cameras should be monitored manually, and it is a tedious and time-consuming task. This is a very complex problem.

The main importance of this real time video surveillance is to prevent or minimize the impact of abnormal events happening to the person. That is, if a person is assaulted, it is identified by CCTV cameras to immediately identify what this event is and inform the respective authorized user. This will be notified to the respective user as an alert. Then, a quick action can be taken to prevent the incident.

In the past research findings, most of the researches are based only on the detection of abnormal activities related to abnormal behaviours such as Violence, Suspicious, Anomaly detection and Road Monitoring (Ha *et al.*, 2018; Koppikar *et al.*, 2020; Tariq *et al.*, 2020; Nandyal and Angadi, 2021). Relative to these abnormal behaviour detections, only a small amount of research has been done on real-time abnormal behaviour detection. They can be taken as traffic pre-events detection, crowd anomaly detection, Anomaly Detection in Elderly Behaviour, Anomaly Recognition, Human Violent Activity Recognition etc. (Luo *et al.*, 2017; Parvin *et al.*, 2018; Coming Lopez and Lien, 2020; Singh, Singh and Gupta, 2020; Pramanik, Sarkar and Maiti, 2021). Moreover, no proper method has been found yet to identify the fighting scene in real-time, which is taken under abnormal behaviours in places where people hang out more. And no research has been done in Sri Lanka to identify the fighting scene in real-time. For this reason, it is still traditionally used to start investigations by observing the relevant CCTV footage after an abnormal behaviour occurs. This is a time-consuming task and requires a lot of effort to catch the relevant people. However, researches have been done under various topics related to detecting this abnormal, unusual, suspicious activity around the world. (Luo *et al.*, 2017) carried out the research utilizing a real-time detection algorithm for atypical behaviour in crowds that is based on the Gaussian mixture model. In this research, they first used the GMM method to analyze the surveillance video and detected the location of the pixels that does not appear frequently. Then, they analyzed the temporal and spatial motion information of abnormal behaviour by modelling the abnormal behaviour. Eventually, they achieved real time abnormal behaviour detection. Pramanik, Sarkar, and Maiti (2021) have conducted research to develop a real-time video surveillance system capable of identifying traffic-related incidents before they occur. Here they have created a plan for a traffic monitoring system with the aim of enhancing road safety. To achieve this, they have employed spatio-temporal granules based on colour images for detecting moving objects. Singh, Singh and Gupta, 2020) proposed a real-time anomaly recognition through CCTV using Neural Networks. In this study, the anomaly recognition system consisted of a design that is composed of convolutional and recurrent Neural Networks. In this way, this research showed that real time abnormal behaviours are identified using Machine Learning and data mining techniques in many parts of the world. But this kind of research has not yet been done in Sri Lanka. Therefore, for filling those gaps in the literature, this research will be a great support.

The space-time-related properties are used to identify the observed items as normal or abnormal since the objects are moving. We have found various papers that are related to the intelligent video surveillance for real-time identification of abnormal activities. In this study, similar and related research papers were selected according to our research domain from 2016 to 2021. According to the literature, many models and studies are available for intelligent video surveillance. In this situation, we discovered some research pertaining to the design and implementation of a new intelligence video analytical solution as a human object recognition approach for surveillance footage (Balasundaram

and Chellappan, 2020). The results show that the IVA model works better than most existing approaches in terms of object recognition and classification with reduced error (Balasundaram and Chellappan, 2020). We might discover that their future work will involve using this technique to experiment with and validate the results with more benchmarked and bespoke datasets, as well as combining this and the model with a sophisticated framework that might be utilized for smart surveillance.

On the basis of complex activity recognition and deductive reasoning, Coming Lopez and Lien, (2020) also proposed a new approach for end-to-end adaptable real-time abnormal recognition with reaction localization. We discovered CSVD, a particular complex action dataset, which was developed for spotting violence in stationary security cameras. As demonstrated by their testing findings, their system has competing accuracy and speed, demonstrating its suitability for real-time applications. Additionally, they provided several recommendations for upcoming work, including the use of techniques like dynamic programming to better optimize feature extraction algorithms.

A novel IVADC-FDRL model has also been developed by Mansour *et al.*, 2021 for the recognition and categorization of anomalous in surveillance footage. The IVADC-FDRL model's categorization and anomaly detection phases are its two main components. The Faster R-CNN model is used to find anomalies in each frame once the input surveillance videos are first broken down into a collection of frames. A number of simulations were run using the benchmark UCSD anomaly dataset as their experimental results for the IVADC-FDRL model. They also indicated that in the future, the provided IVADC-FDRL model might be utilized to detect falls, find anomalies in pedestrian walkways, and other things.

When looking at Dong, Zhang and Du, 2020, they suggested an automatic object detection and tracking method that uses a cooperative working mechanism between a detector and a tracker. This approach initialized the position of the object automatically in the first frame and improves the detection accuracy. The method composed of three modules: detection, tracking, and decision-making. The detection module was designed to quickly extract specified categories of objects. The tracking module, the kernel correlation filters tracker (KCF) was used to perform data association and processing. To extract moving objects quickly and accurately, the detector employed a mixed Gaussian background modeling technique combined with HOG and SVM detection models. The suggested technique's detection and tracking modules collaborate with one another. As a result, the tracking and detection module is able to decide definitively on every frame and generate findings that are more reliable. It succeeds in improving detection precision and achieving the objective of autonomously implementing the object's placement in the first frame.

5. CONCLUSION

Based on the literature review of intelligent video surveillance for real-time abnormal activity detection, research has been done on many aspects such as road traffic, smart city using 3d road monitor and suspicious person detection, and all of them have proposed solutions to prevent abnormal behaviours. Here, 16 articles selected from 50 research papers were reviewed and several future research directions were identified. The studies conducted so far can be classified into real-time video surveillance, real-time abnormal activity detection, and intelligent video surveillance. For this review, research papers have been obtained from IEEE Explore, Science Direct, Springer and ACM digital libraries. The main research gap identified in this study is that CCTV video cameras still do not have a proper solution for identifying the location of fights in public suburbs. Therefore, a new method was proposed here. The research method proposed here is mainly expected to provide a real-time prediction to prevent fight scenes which is an abnormal activity and to present a warning to prevent the occurrence. And to achieve these goals there are many technologies like CNN architecture, Advance Motion Detection (AMD) algorithm and Support Vector Machine. Also, from

the limitations identified through this review, a new method is proposed. Therefore, this systematic literature review will be an excellent work for real-time identification of the locations of fighting scenes under real-time detection of abnormal behaviours, as well as for future research to identify the areas where these abnormal fighting behaviours are reported most and to develop a new model by focussing more attention on those locations. Also, new researchers will be able to get the basic foundation needed to start their research through this study.

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KJMS 2023 VOL.5 (1): 41-53

KDU Journal of Multidisciplinary Studies
(KJMS) Volume 5. Issue 1 July 2023
https://doi.org/10.4038/kjms.v5i1.61

CHALLENGES AND WAY-FORWARD OF NON-ORGANIC AGRICULTURE TO ORGANIC AGRICULTURE: A COMPARATIVE STUDY BETWEEN CHINA AND SRI LANKA

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ABSTRACT

The agriculture around the world is still heavily associated with chemical fertilisers, pesticides etc. and being inorganic. Although, a positive trend has been developing for organic agriculture around the world due to the benefits it delivers. Since the comparative studies related to organic agriculture on China and Sri Lanka are hardly found, the objectives of the study to perform a comparative analysis between China and Sri Lanka. Further, study examines benefits and challenges of both contexts. The research applies qualitative purposive sampling method and collect data using interview technique. Further study expects to use secondary data sources to achieve its objectives. The primary data is analysed using the thematic analysis. Moreover, the study focuses to examine the secondary sources related to China and Sri Lanka. The results of the study revealed that, although the China has remarkable progress in organic agriculture, there are deficiencies such excessive supply of organic products, disparities in organic production and consumption, Inadequacy of trust of consumers on organic foods, low educational status of organic farmers and deficiencies in technology used for organic agriculture and expensiveness in organic products compared with inorganic resulted in low demand. Also, results of the study further revealed that, the rapid transformation from inorganic agriculture to organic committed by the government of Sri Lanka created certain issues in the country resulting a threat to the food security of the country. Further, there are many deficiencies noted in the process such lack of proper mechanism to supply organic inputs to bridge the country's requirement, no proper mechanism in place to monitor the organic agriculture process, difficulties in obtaining of organic certification, lack of local certification bodies, deficiencies in alternatives to replace chemical inputs such pesticides, weedicides etc., lack of government support to farmers to bear the income loss incurring due to the loss of yield during the transition period etc. Further, results of the study highlight the comparative differences between two countries. Moreover, challenges, benefits, strengths, weaknesses, and threats in the organic agriculture of these countries are objectively evaluated.

KEYWORDS: Organic Agriculture, Chemical Fertilizer, Organic Products, Organic Inputs, Alternatives of Chemical Inputs

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1. INTRODUCTION

World's agricultural traditions have been significantly changed by technological advancements and introducing of chemicals as inputs such fertilizers and pesticides. These initiatives have introduced an era with high agricultural production and good quality products. However, it is a fact that, soil and water pollution have been increased by these residues generated by chemicals. Although, the agricultural productivity has been increased due to the application of chemicals, it has been caused for the contamination of soil and water resources. Due to the impacts of inorganic agriculture, consumers are making high preference on organically farmed products (Perera *et al.,* 2007). Organic farming is a production method that protects the quality of soils, ecosystems, and people (Siriwardana & Silva, 2013). Today, it is a big challenge to clients to find out quality organic foods. Organic farming encourages peoples' long existence through nutritious foods and environmentally friendly agriculture (Santhirakumar & Narmilan, 2019).

Therefore, importance of the organic agriculture has been increasing currently, as a global trend. In 2018, 186 countries are recorded with organic activities (Research Institute of Organic Agriculture (FiBL), Frick, and IFOAM – Organics International, Bonn., 2020). Many countries around the globe have been considering, establishing of required policies and legal frameworks to standardize the organic agriculture (Busacca *et al.,* 2020). The total farming lands dedicated for organic agriculture, around the globe is recorded as 71.5 million hectares in 2018, which is 60.5 million hectares increase compared to 1999 (Schlatter *et al.,* 2020). However, the organic share of total agriculture lands globally is still at 1.5 percent (Willer *et al.,* 2020).

Sri Lankan agricultural production system focuses export market through the plantation sector which yielding with perennial crops such coffee, tea, rubber, and coconut. Further, it aims to fulfil local requirements through small holder sector included small farmers who cultivates rice, vegetables, legumes, tubers, spices, and fruits (Agricultural Research Policy (SLCARP) Ministry of Agriculture, 2018; Sangakkara & Katupitiya, 2004). According to the statistics, Sri Lanka possesses organic agricultural land of 77,169 hectares in 2018 which is a decrease of 19,149 hectares compared to 2017. Sri Lanka is one of the leading countries in Asian region having highest organic share of total agricultural land of 2.8 percent in 2018. Sri Lanka has about 1,416 organic producers, 879 organic processors and 313 organic exporters in 2018 (Schlatter *et al.,* 2020).

Organic agriculture of Sri Lanka is still at its fundamental stage. The contribution of the organic agriculture is at 6 percent of the total agriculture in Sri Lanka. There are only few local and international certification bodies are available in the context. Organic producers who focus foreign market largely work with the Control Union and other organic producers work with certifying authorities such as Sri Cert and SLSI (Ecorys Nederland, 2020).

literature review

A. Global Status of Organic Agriculture

According to FiBL[1] survey 2020, world's entire organic areas is recorded as 107.3 million hectares in 2018. The distribution of the same is comprised in 67 percent of agricultural land and crops, 32 percent wild collection and 0.6 percent other. In 2018, there are 71.51 million hectares of lands deployed for organic agriculture, which is an increase of 2.02 million hectares with 2.90 percent compared to 2017. World's per capita organic food consumption is calculated as 12.9 euros in 2018 (Schlatter*et al.* 2020).

B. Organic Agriculture in China

China possessed the world's third largest organic agriculture land, which is 3.13 million hectares in

[1] Research Institute of Organic Agriculture, Switzerland.

2018. Moreover, China's organic share of total agricultural land was reported as 0.6 percent in 2018. Further, China operated the world fourth largest markets of 8.1 billion euros approximately for organic food in 2018 (Schlatter *et al.*, 2020). Furthermore, China is the largest organic agri-food supplier to European Union (EU) which represents 12.7 percent share of all organic imports to EU with 415,243 metric tons (Panichi, 2020).

C. Organic Agriculture in Sri Lanka

Sri Lanka has implemented a rapid transformation from inorganic agriculture to organic farming in 2021. Imposing a prohibition on agrochemicals is not adequate to achieve the success of the transformation. However, such transformation requires massive efforts, including rigorous practices and sharing of know-how. This process could take considerable time on developing countries. Organic farming does not mean the application of organic fertilizer alone, but to make it a success, it must be associated with unique regenerative techniques. Thus, rapid transformation may appear not to be practically a viable solution in the short run. However, Sri Lanka is a developing country that could implement such changes gradually with the support of regenerative permaculture experts (Sivaramanan & Kotagama, 2021).

2. METHODOLOGY

The research is designed as a qualitative research within the research paradigm of interpretivism/ Constructivism (Creswell, 2014). The research applies the qualitative purposive sampling method and collects data using interview technique (Sekaran, 2003; Sapsford and Jupp, 2006; Creswell, 2014). Further, the study expects to use secondary data sources to achieve its objectives. The primary data is analysed using thematic analysis. The primary data collection is comprised of six interviews obtained from professionals with hands on experience in the field of agriculture. These respondents were selected using published web sites of government and non-government agriculture-research-based institutions. Further, the respondents possess sound theoretical and applied knowledge in agriculture due to their academic engagements and post qualification working experience in the field and also as senior researchers in the field. The adequacy of primary data collection or the sample size is decided upon meeting the saturation point. In qualitative research studies, the primary data collected through the interviews are converted into interview transcripts and analysed using Thematic Analysis Technique which is heavily applied by the qualitative researchers to analyse the bulk interview data (Maguir & Delahunt, 2017; Jugder, 2006; Braun & Clarke, 2006 p.78). Further, the study refers to reputed secondary sources such The World of Organic Agriculture Statistics and Emerging Trends, Publications of China Beijing Organic and Beyond Corporation, Agriculture related research articles published in reputed local journals and research conference proceedings etc. for its analysis.

ANALYSIS

A. Comparison of Statistics

The study expects to perform a comparison of available statistics of China and Sri Lanka to create an understanding about the status of organic agriculture of these countries.

1. Organic Agriculture Land and Its Share

In agriculture, land is one of the most important production factors. In terms of organic agriculture, China possessed 3.14 million hectares of land on organic agriculture in 2018 while Sri Lanka deployed 0.08 million hectares for organic agriculture for the same period. Sri Lanka is one of the leading countries in the Asian region having a high organic share of total agricultural land, which was recorded as 2.80 percent in 2018. Further, China contributes for 0.60 percent organic share of total agricultural land for the same period (Refer Table. 1).

2. Organic Producers, Processors and Exporters

According to statistics published in 2020, China reported 6,308 Organic Producers, 3,865 Organic Processors and 1,198 Organic Exporters in 2018. In turn, Sri Lanka reported 1,416 Organic Producers, 879 Organic Processors and 313 Organic Exporters in the same period

(Refer Table. 2).

Table 1. Organic Agriculture Land and Its Share on Total Agricultural Land 2018

Theme	China	Sri Lanka
Organic Agricultural Land [million hectares] 2018	3.14	0.08
Organic Share of Total Agricultural Land 2018	0.60%	2.80%

Source: Schlatter *et al* (2020) based on FiBL survey (2020 p.39-40 & p.43-44)

Table 2. Organic Producers, Processors and Exporters 2018

Theme	China	Sri Lanka
No. of Organic Producers 2018	6,308[2]	1,416
No. of Organic Processors 2018	3,865	879
No. of Organic Exporters 2018	1,198	313

Source: Schlatter et al (2020) based on FiBL survey (2020 p.58-63)

Table 3. Organic Agriculture Exports 2018

Theme	China	Sri Lanka
Organic Agriculture related Exports (million euros) 2018	806	259
Organic Retail Sales (million euros) 2018	8,087	no data available

Source: Schlatter et al (2020) based on FiBL survey (2020 p.68-69)

3. Organic Agriculture Exports and Retail Sales

In 2018, China earned 806 million euros through their organic agriculture related exports while Sri Lanka reported 259 million euros on organic agriculture related exports in the same period. Further, China earns 8,087 million euros as its Organic Retail Sales in 2018 (Refer Table. 3).

4. Organic Imports of European Union (EU)

China was the world rank number one (01) organic supplier to European Union in 2018, having supplied 415,243 metric tonnes. China contributed with a 12.7 percent share of all organic imports of European Union during the same period. And also, Sri Lanka possesses 26th position (rank no.26) of the list of organic suppliers to European Union in 2018, while suppling 26,570 metric tonnes. Further, Sri Lanka contributed a 0.8 percent share of all organic imports of European Union pertaining to the same period (Refer Table. 4).

Table 4. Organic Imports of European Union 2018

Indicator	China	Sri Lanka
Metric Tonnes (MT)	415,243	26,570
Rank	1	26
Share of All Organic Imports to EU (percent)	12.7	0.8

Source: Panichi (2020) based on TRACES/European Commission (2019 p.146-147)

5. Land Use on Key Cultivations in Organic Agriculture

According to the Statistics of FiBL & IFOAM[3] – Organics International (2020), It is identified that China has diversified land use in organic agriculture among many cultivations (Refer Table. 5). Further, China has heavily deployed land for Cereals and Oilseeds. However, there is no such distributed diversification among crop types identified in Sri Lanka.

[2] According to the statistic of 2016, reported in 2018

[3] International Federation of Organic Agriculture Movements (IFOAM).

B. What does it mean as Organic Agriculture in Sri Lankan Context

According to the primary data analysis, respondents' views on the concept of organic agriculture are identified.

Table 5. Land Use and Key Cultivations in Organic Agriculture

Type of Commodity	China	Sri Lanka
Beehives (Beehives No.)	229,084	-
Aquaculture Production [metric tonnes]	71,667	-
Cereals Organic area [hectares]	968,000	-
Citrus fruit Organic area [hectares]	11,963	-
Dry pulses Organic area [hectares]	59,000	-
Temperate fruit Organic area [hectares]	51,022	-
Tropical and subtropical fruit Organic area [hectares]	-	591
Grapes Organic area [hectares]	19,888	-
Oilseeds Organic area [hectares]	478,000	-
Olives Organic area [hectares]	-	-
Vegetables Organic area [hectares]	43,602	129
Organic cotton/ Certified Organic Area [hectares] (2017/2018)	20,023	-

Respondent 1, 2 and 5 (R1, R2 & R5) stated that the recognition on the organic agriculture heavily depended on the certification as Organic by the world's recognized certification body. R1 and R5 further stated that the farmers have to spend at least three (03) years in preparation of the land with organic inputs such agro chemicals and fertilizer to be qualified in getting Organic Certification. According to R1, Organic Agriculture is free from agro chemicals and fertilizer (inorganic). Moreover, R5 revealed that there is a misconception in our context that producing agriculture products using Compost or Biodegradable material such Compost or Vermiwash, is Organic Agriculture. But, when it is made using compost or similar inputs, it should be classified under Natural Agriculture instead Organic Agriculture.

C. SWOT Analysis on Organic Agriculture of China and Sri Lanka

1. Strengths, Opportunities and Challenges in Organic Agriculture of China

1.1. Strengths and Opportunities of Organic Agriculture in China

Strengths and Opportunities in organic agriculture of China are identified as, having a certification system with high accuracy and consecutive improvement, having high contribution of the government towards the enhancement of organic agriculture, having simulation programmes on organic certification and nominated week for the promotion of organic theme in order to spread and create an impact, increasing the prices of traditional agricultural products due to the bad impacts of urbanization, increasing of usage and people's preference on organic foods in superior quality, spreading of organic restaurants and encouraging of organic farming through urban tourism agriculture and having chances to enter the high quality foreign organic products to the local market (Youting *et al*., 2020).

1.2. Challenges in Organic Agriculture in China

According to the report of Organic Agriculture in China 2020, published by China Beijing Organic and Beyond Corporation (OABC), challenges and opportunities of organic agriculture in China have been identified as follows.

1.2.1. Excessive Supply of Organic Products

China's total organic production and consumption in 2018 were recorded as 24.32 and 9.21 billion US dollars respectively with an oversupply by 62.1 percent as illustrated in Figure 1 below (Youting *et al.,* 2020).

Figure 1: Organic Products Output vs Consumption (USD).Source: Youting *et al* (2020; p.43)

1.2.2. Disparities in Organic Production and Consumption

The organic agriculture is mostly concentrated in remote area of China such Xinjiang, Heilongjiang, Inner Mongolia, Liaoning, and Guizhou, having small population, low industrial pollution and suitable climatic conditions. First-tier cities such Beijing, Shanghai, Shenzhen, Guangzhou, Chengdu, Hangzhou, Chongqing, Wuhan, Xi'an, Suzhou, Tianjin, Nanjing, Ningbo etc. which possess large populations, consume a huge quantity of organic foods. These cities are the primary contributors of the consumption of organic foods (Youting et al., 2020).

1.2.3. Consumers' Trust on Organic Foods Inadequate

Consumers face difficulty to trust organic food, due to the media publicity and the social reliability method. Further, the perception of urban generation believing that the chemical pesticides is the only the way to control pests in agriculture also limit the consumption of organic food (Youting *et al.,* 2020).

1.2.4. Low Educational Status of Organic Farmers and Deficiencies in Technology Used for Organic Agriculture

Because of the low educational level of organic farmers, they do not have a thorough insight into organic agriculture. Further, they do not have a comprehensive understanding about organic agriculture; therefore, they focus only on banning chemical inputs on pests and diseases (Youting *et al.,* 2020).

1.2.5. Expensiveness in Organic Products Compared to Inorganic products, which Resulted in Having the Low Demand

Prices of organic foods are five to ten times higher than those of inorganic foods. Therefore, people are not able to purchase such expensive products (Youting *et al.,* 2020; Scott & Si, 2020).

2. Strengths, Opportunities and Challenges in Organic Agriculture of Sri Lanka

2.1. Strengths, and Opportunities in Organic Farming of Sri Lanka

Organic agriculture is environmentally friendly. It conserves natural resources such as soil and water. Further, it promotes human health and long life. Benefits of the organic farming has been absorbed by many agricultural sectors. According to Santhirakumar and Narmilan (2019), Siriwardhane and Samaraweera (2017) and Malkanthi (2021), there is good demand for organic foods due to the health consciousness and environmental friendliness in nature. According to Malkanthi (2020), availability of indigenous knowledge and tactics on organic agriculture, diversified ecological status, and assistance of the government are the key capacities.

Ecorys Nederland (2020) identifies strengths related to Sri Lanka organic agriculture as having a wide range of hands-on exposure with the private sector and emphasizes the opportunities of Sri Lanka organic agriculture as having high demand for organic products in the international market, increasing the

local and regional demand for the organic products, priority of the new government over the organic farming and organic farming in conserved natural areas.

Through the interviews conducted by the researcher in the context, the opinions of professionals in agricultural field have been collected. The analysis of experts views, emphasizes strengths and opportunities in Organic Agriculture of Sri Lanka as follows.

Strengths

- Having traditional seed varieties with high adaptability due to the qualities they possess such as needing less fertilizer and water and high resistance for pest attacks E.g. Sri Lanka's traditional rice varieties.
- Indigenous and community knowledge in agriculture.
- Having trained human capital (officials) and physical resources such research centres, seed banks and training centres. E.g. Centres located in Pannala, Makandura, which train farmers to produce Compost Fertilizer.
- Natural environment conditions leading to less, or negligible pests, diseases and weeds compared to South Asian Countries (India, Myanmar, Vietnam etc.).
- Having rich soil condition in the country.
- Vast diversity due to the ecological zones and ability to proceed cultivation throughout the 365 days of the year.
- Low cost to maintain optimum levels compared to other countries even with the technology (greenhouses).
- Having developed standards for organic agriculture, organic fertilizer by the Sri Lanka Standards Institute and having optimum plant quarantine regulations.
- Having separate plans for organic agriculture by the Ministry of Agriculture.

Opportunities

- Having a good demand for organic products locally and internationally.
- Having premium price for organic products in the marketplace and the said premium price compensating the yield loss which occurs due to maintaining of organic cultivation.
- Suitability of organic cultivations in small land sizes and convenience to deploy resources/ materials E.g. For lands having 1/2 to 1 hectare.
- Having safety, quality, and health benefits in Organic Agriculture.
- Vulnerability in improving the traditional seed varieties E.g. Paddy.
- Attitude that consumption of organic products is health friendly.
- Ability in developing of indexes to measure and apply the optimum levels of agro organic fertilizer etc. to attain the efficiency of organic agriculture to retain the sustainability.
- Ability to maintain close supervision which is highly required over the organic agriculture as a result of development of semi urban sector and population aging. E.g. Elderly population who are living in small size land blocks (e.g.10 perches) due to the land fragmentation, has enough opportunity keep close supervision over the organic cultivation they maintain.
- Opportunity to developing of local certification body for organic products' certification purpose.
- Having niche marketplace for organic products and potentiality in expanding organic products in local Super Market chains focusing on potential customer segments.
- Opportunity to increase the yield in the long run due to the enrichment of the soil condition as a result of maintaining of Organic Status.

2.2. Challenges, Weaknesses, Threats, and Constraints for Organic Farming in Sri Lanka

Santhirakumar and Narmilan (2019) emphasized that

few farmers are converting into organic agriculture. Existing challenges such as deficiency in household income, low life standards, novel technical capabilities of the small-scale female farmers, issues encountered in marketing stage, required standards on organic food labelling, required quality standards of organic products additionally, losing the financial support through the Samurdy scheme adversely impact for the adaptation of organic agriculture, and further, according to Siriwardana and Silva (2013), having deficiencies in reaching of credit information, marketplaces, and prices for small-scale farmers. Also, lack of organisational support, including the assistance of the government, is in poor status on organic paddy sub-sector.

Moreover, challenges on organic farming are identified as low yield followed by the low income, market opportunities limited for organic products, knowledge gaps on the certification process and also, the certification process being costly and complicated (Malkanthi, 2020; Karalliyadda & Kazunari 2018). Further, Siriwardhane and Samaraweera (2017) and Malkanthi (2020) identified the availability of low organic inputs, deployment of high amount of labour and consuming of more time as constraints on organic agriculture.

Moreover, as Ecorys Nederland (2020) emphasized the weaknesses of the sustainable organic agriculture in Sri Lanka in their project report of Technical Assistance to the Modernisation of Agriculture Programme as lack of expertise in the public sector, less priority given by the Ministry of Agriculture on organic farming, lack of pre-discussion with stakeholders in the process of standards and legislation development and such standards and legislations depicting weaknesses in adapting into the local settings, the national standard being established focusing European Union are having extreme demands in the development of the domestic market and lack of membership in Asian Local Government for Organic Agriculture (ALGOA). Further, Ecorys Nederland (2020) emphasized that the threats for the organic agriculture in Sri Lanka as lack of supporting programmes in organic agriculture, continuing the supply of subsidies for chemical inputs and having biasedness by credit and research on conventional agriculture.

The interviews conducted with the agriculture field experts revealed certain deficiencies related to the Organic Agriculture in Sri Lanka as follows.

- The contribution of the organic agriculture being minimal on the agriculture exports.
- Unavailability of local body for Organic Certification.
- Establishing the National Organic Council Unit (NOCU) in the Export Development Board (EDB) rather than in the Ministry of Agriculture, which prevents successful coordination among all potential stakeholders such all processors, exporters etc. (NOCU is the unit where all the processors, exporters are to be registered).
- Organic Certification is currently issued only by the Control Union (International body) and third country registration facility which could be obtained through the NOCU to export Organic products to Europe or Japan, is currently in inoperative status.
- High cost to obtain Organic Certification from the Control Union.
- Lack of a monitoring mechanism by the government to screen and provide assurance as truly organic (like GAP certification).
- Importing of organic fertilizer in inferior quality due to inadequate quantities of organic fertilizer to meet the local demand.
- Inability to successfully control pests and diseases due to lack of alternatives for pesticide, fungicide, weedicide etc.
- Organic cultivation is not commercially viable compared to the growth of the population and the consumption pattern due to the low yield and it may lead to creating issues in the food security. Also, to meet the demand for growing population, high quantity organic fertilizer is needed, which is difficult to manage currently.
- Existing hybrid seed varieties (foreign) used in Organic Cultivation in our context are not

good fit. For instance, these hybrid seed varieties are developed to get high yields using high amounts of fertilizer and they are highly vulnerable for pest and disease attacks.

- Transition from inorganic agriculture to organic has a crop loss and it is difficult to implement in large scale.
- Farmers do not have adequate knowledge in organic agriculture.
- Lack of indexes for farmers to decide the adequate dosage of organic fertilizer based on the crop type, age etc.
- Even though organic products get premium price in the marketplace, the production cannot be increased accordingly due to the scarcity of resources such labour and lands.
- There is no mechanism established to compensate on the farmers over the losses incurred during the conversion period from inorganic to organic cultivation.

D. Is Organic Agriculture Successful in Sri Lanka

According to the analysis, it is revealed that organic agriculture in Sri Lanka is currently not in a successful status. According to all Respondents, the Government's decision in converting the total agriculture into organic status is a failure. Further, as revealed by the Respondents, there are no countries in the world that converted into 100 percent Organic.

According to R1, *'We failed in Organic Agriculture. Ex. I work mostly with Tea and Paddy, the existing seed varieties are developed using sophisticated methods for inorganic cultivation expecting high yield (provided high content of agro chemicals and fertilizer) these seeds are needed to apply fertilizer even before starting the cultivation, when it is converted to organic with the same seed types with no chemical fertilizer, since having existing level of pest, face for entire yield loss. In Sri Lanka, there is a 40 percent yield loss due to the fertilizer issue. Specially for vegetables (in Nuwara Eliya), suffered with pest attack than the fertilizer issue with high yield damage in organic agriculture. Converting 100 percent into Organic is not practical. The Government decision over the night to convert into the Organic cultivation is not farsighted decision, very incorrect decision.'.*

Further, according to R6, *'you have to identify a zone or such way to develop organic agriculture. There is no acceptance for organic products without a certification in the International Market. Government also thought that our cultivation could be exported (organic) immediately. We can't do that; we do not have even a local body for organic certification. There is no development over such areas. Sudden conversion total agriculture into organic is a big mistake that the government committed'.*

E. Success Stories in Organic Agriculture in the World

When considering the success stories in organic agriculture in the world, it is revealed that no country had implemented 100 percent organic. Bhutan and Sikkim state of India have achieved success in organic agriculture. Further, according to the Respondents, they do not have adequate knowledge in success stories of organic agriculture in the world.

3. DISCUSSION

During the past four decades, the world's per capita food production has grown by 17 percent. Chemical inputs have contributed to increase the agricultural yield considerably. The success experienced has increased the excessive use of agrochemicals. Consecutive improvements in chemical inputs have enhanced the powerfulness and become more hazardous and expensive. This has created an adverse impact on environment and human health conditions (Perera *et al.*, 2007).

According to the IFOAM survey on organic standards and legislation, 84 countries have established organic standards in 2019, and 17 countries have been drafting legislation which is in progress. The European Union (EU) has approved a basic act of its new organic regulation in 2018, which will be implemented in 2021. The secondary legislation (act) for production,

labelling, controls, and trade started to be drafted and adopted in 2018, which has been in progress. One important change has been in place on group certification (Group certification means that a certain number of small farmers are allowed to acquire the certification as a single entity), which is currently only allowed for small operators in developing countries. Applicability of the new regulation is enforced everywhere in the world, including the European Union (Busacca *et al.,* 2020; Willer *et al.,* 2020).

The national regulation on organic agriculture has not been still enforced in the Sri Lankan context. As a result, the domestic market also is not yet regulated. According to the national regulation, all organic products have to be certified by an accredited certification body registered under the National Organic Control Unit (NOCU). International certification bodies such SriCert, Biocert and Sri Lanka Standard Institute or Participatory Guarantee System certified bodies (PGS) are currently doing the certification for the domestic market. PGS is not mentioned in the national regulation and is based on group certification. Small farmers in organic spice farming are practicing the Group certification. The importance of such systems is applicable to other organic small farmers as well. Smallholder farmers with short and transparent channel partners are with a disadvantage due to non-inclusion of PGS in the national regulation (Ecorys Nederland, 2020).

According to Malkanthi (2021), policies on organic agriculture have to be developed covering all aspects such as production, handling, processing, certification, labelling and marketing for the benefits of farmers, marketers and consumers. Ecorys Nederland (2020) reported that there is no adequate support by the public sector over the organic extension services.

Considering the organic share of total agricultural land is at minimal status in China and Sri Lanka. However, Sri Lanka is one of the leading countries in the Asian region having high organic share of total agricultural land. China was the world's rank number one (01) organic supplier to European Union in 2018 and contributed a 12.7 percent share of all organic imports of European Union during the same period. And also, Sri Lanka possessed the 26th position in the list of organic suppliers to European Union in 2018, Further, it is revealed that China exports organic products fifteen times more than Sri Lanka. According to the Statistics of FiBL & IFOAM - Organics International (2020), It is identified that China has diversified land use in organic agriculture among many cultivations. Further, China has heavily deployed land for Cereals and Oilseeds. However, there is no such distributed diversification among crop types identified in Sri Lanka.

4. CONCLUSION

China is the world's third largest organic agricultural land-deployer and the leading country in many aspects of organic agriculture in the Asian Region. Further, China is the top supplier in organic agriculture products into the European Market. Organic production of China is mostly concentrated on remote areas and the heavy consumption of organic products are concentrated in eleven (11) first tire cities of China. Further, China possesses excessive supply of organic products compared to the demand. Moreover, prices of organic foods in China are between five to ten times greater than those of conventional foods. The regulations on organic agriculture in China are with fully implemented status. Sri Lanka is one of the leading countries of the Asian Region which is having a high organic share of total agricultural lands. Further, Sri Lanka has implemented the rapid transformation into organic agriculture from inorganic, but it is experiencing that such rapid transformation is not practically a viable solution in the short run. However, Sri Lanka being a developing country, it is advisable to implement such changes gradually with the support of regenerative permaculture experts. Moreover, strengthening of areas such as planning and supervision, institutional support system to adopt the organic agriculture, enhancing of farmers' capacity to promote organic agriculture and ensuring a healthy food security with no chemical inputs are noted as essential elements to achieve success in organic agriculture in Sri Lanka.

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KJMS 2023 VOL.5 (1): 54-65

KDU Journal of Multidisciplinary Studies (KJMS)
Volume 5. Issue 1 July 2023
https://doi.org/10.4038/kjms.v5i1.62

CROP YIELD FORECASTING USING MACHINE LEARNING TECHNIQUES - A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

The utilization of machine learning has become increasingly important in the prediction of crop yields for facilitating decisions regarding crop cultivation and management during the growing season. Numerous machine learning and data mining algorithms have been developed to support research in crop yield forecasting. In this study, a systematic literature review (SLR) was conducted on research published between 2016 and 2021 to investigate the use of machine learning in crop yield forecasting. A total of 261 relevant studies were identified from five electronic databases, out of which 15 studies were selected for further analysis based on inclusion and exclusion criteria. The selected studies were thoroughly examined, and their methods and features were analyzed, to provide suggestions for future research. The results showed that evapotranspiration, temperature, precipitation, and soil type were the most commonly used features in crop yield forecasting, while RMSE, MSE, MAE, and R2 were the most commonly used evaluation parameters. The challenges include selecting appropriate input variables, handling missing data and outliers, and capturing non-linear relationships between variables. The authors discuss various techniques such as feature selection, regularization, imputation, non-linear machine learning, data preprocessing, and data augmentation to address these challenges. The Support Vector Machine, Linear Regression, Artificial Neural Network (ANN), and Long-Short Term Memory (LSTM) were identified as the most commonly used algorithms in these models.

KEYWORDS*: Crop yield forecasting, Data mining, Deep learning, Systematic review*

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1. INTRODUCTION

The fast growing human population in the world has increased the need for food for human survival. Around 2000 years ago most of the Earth's population started to depend on agriculture (Rutledge et al., 2011). Meeting the limited food resources available on earth is a major challenge. It is primarily located in the poorest countries of the Third World and is currently growing as its population grows. More than a billion people are suffering from food shortages. This is because population growth is higher than the development of agricultural products and agricultural technology. Therefore, the agricultural sector should be made more productive and efficient than before. People want to get more out of their fields, and therefore new techniques should be used to improve the yield. Researchers are looking for new solutions to increase crop yields.

Machine learning (ML) and Data Mining approaches are used in many fields from Developing the Profiles of Supermarket Customers (Min, H., 2006), to Predicting customer's gender and age depending on mobile phone data (Al-Zuabi et al., 2019). Machine learning has also been used in agriculture for many years (Conway, J.A. et al., 1991). Crop yield forecasting is a challenging issue in precision agriculture, and many models have already been proposed and validated. Crop yields depend on various factors such as climate, weather, soil, fertilizer application and seed variety, so it is necessary to use several data sets for this problem. This suggests that crop yield forecasting is not a trivial task. Instead, it consists of several complex steps. At present, crop yield forecasting models can reasonably estimate the true yield, but a better performance of the yield forecast is still desirable (Shahrin, F. et al., 2020).

Machine learning is a practical approach within the field of artificial intelligence (AI) that focuses on learning and has the ability to predict yields based on several features. The process involves determining patterns and correlations within datasets, training models using the data, and representing results based on past experience. During the training phase, historical data is used to build a forecast model with various features, and the parameters of the models are determined. To evaluate the model's performance, part of the historical data not used for training is reserved for testing. To understand the application of machine learning in crop yield forecasting, we conducted a systematic literature review (SLR) that identifies potential gaps in research and helps professionals and researchers who are interested in conducting new studies in this area. The SLR study provides new perspectives and insights for new researchers in the field. In this paper, we present our empirical results and responses to the research questions defined as part of this review article. The article is structured as follows: Part 2 provides background information (Related work). Part 3 explains the methodology. Part 4 presents the results of the SLR. Part 5 discusses the findings of our review, and Part 6 concludes this paper.

Related work

The development of a precise crop harvest prediction model holds significant importance for farmers in making informed decisions regarding crop selection and planting schedules. Diverse methodologies are available for crop yield forecasting. This review critically analyzes the existing literature on the application of machine learning techniques in crop yield forecasting. Although a majority of the previous research studies have not conducted a comprehensive review of the available literature, several studies have examined specific aspects of crop yield forecasting. There are a few SLR examples of reviews on this, as (summarized in Table 1)

Gandhi and Armstrong published a review paper on the application of data mining in the field of agriculture in general. They concluded that further research was needed to see how the implementation of data mining into complex agricultural datasets could be achieved (Gandhi and Armstrong, 2016). Elavarasan et al. conducted a publication survey of machine learning models related to crop yield forecasting based on climatic parameters. The survey

advises looking broadly to find other parameters that contribute to crop yield (Elavarasan et al., 2018).

Beulah conducted a survey of various data mining techniques used to predict crop yields and concluded that crop yield forecasts could be solved using data mining methods (Beulah, 2019).

Table 1: Summary of selected literature

Reference	Goal	Research questions
Van Klompenburg, T. et al., 2020	Review of Crop yield prediction using machine learning to investigate to what extent deep learning algorithms were used for crop yield prediction.	RQ1- Which machine learning algorithms have been used in the literature for crop yield prediction? RQ2- Which features have been used in literature for crop yield prediction using machine learning? RQ3- Which evaluation parameters and evaluation approaches have been used in literature for crop yield prediction? RQ4- What are the challenges in the field of crop yield prediction using machine learning?
Naftali Slob. et al., 2020	Provide an overview of what has been done on the use of ML in the dairy sector.	RQ1 - What kind of problems are solved using ML and what ML tasks are these problems mapped into? RQ2 - What independent and dependent variables are used to build the ML models? RQ3 - What ML algorithms are applied for the models? RQ4 - Which evaluation parameters and which evaluation approaches are used? RQ5 - Which algorithm performs the best? RQ6 - What are the challenges reported in the identified articles?

Naftali Slob, Cagatay Catal and Ayalew Kassahun conducted a review and provided an overview of what has been done on the use of ML in the dairy sector. (Naftali Slob. et al., 2020).

Thomas van Klompenburg, Ayalew Kassahun and Cagatay Catal conducted a review of Crop yield prediction using machine learning to investigate to what extent deep learning algorithms were used for crop yield prediction. (Van Klompenburg, T. et al., 2020).

According to this SLR, the above are the important review articles presented in this section.

2. METHODOLOGY

In this research process, we followed the guidelines suggested by Kitchenham et al., (2007).

2.1. Planning the review

Initially, the research inquiries are delineated, and subsequently, relevant studies are chosen by utilizing databases. Specifically, the ACM Digital Library, IEEE Xplore, ResearchGate, SpringerLink, and ScienceDirect databases were employed for the present study. Once the pertinent research is identified, it undergoes a filtering process, and is assessed using quality standards. The pertinent data from the selected studies are then extracted and synthesized in accordance with the research questions.

2.1.1. Research questions

The objective of this systematic literature review is to obtain a comprehensive understanding of the published research on crop yield forecasting within the field of machine learning and data mining. To achieve this goal, various dimensions have been analyzed in the reviewed studies. The present study outlines five research questions (RQs) to guide the SLR analysis.

RQ1: When, where, and who have published studies?
RQ2: What are the algorithms that have been used so

far for prediction?

RQ3: What are the features/factors used in the literature to predict crop yields using machine learning?

RQ4: What are the evaluation parameters and evaluation approaches used in the literature to predict crop yields?

RQ5: What are the challenges in the field?

Table 2: Search sources

Electronic databases	ACM Digital library IEEE Xplore ResearchGate SpringerLink ScienceDirect
Searched items	Journal and conference papers
Search applied on	Full text—to avoid missing any of the papers that do not include our search keywords in titles or abstracts, but are relevant to the review object
Language	English
Publication period	From January 2016 to December 2021

Table 3: Search term of the tertiary study

Areas	Search Terms
Machine Learning	“machine learning”, “deep learning”, “data mining”
Crop Prediction	“crop yield prediction”, “crop yield forecasting”, “yield prediction”, “yield forecasting”
Review	“systematic literature review”, “systematic review”, “study”, “review”
Search string	(“machine learning” OR “deep learning” OR “data mining”) AND (“crop yield prediction” OR “crop yield forecasting” OR “yield prediction” OR “yield forecasting”) AND (“systematic literature review” OR “systematic review” OR “study” OR “review”)

2.1.2 Search strategy

After defining our research questions using the study by Kitchenham et al., (2007) as a guide to research, we began with the formulation of a formal search strategy for analyzing all existing empirical material specific to the purpose of this review.

A basic search is done by an automated search. The plan included defining the search space, including electronic databases and printed processes, as provided in Table 2. The studies were first taken from the above electronic databases and then analyzed to identify other meaningful studies through investigative search (snowballing).

The inclusion and exclusion criteria were then applied to studies obtained, involving a different number of research as described in section 2.1.4

2.1.3 Search Criteria

The search was conducted in five databases (Table 2). Search input was used to gain a broader perspective on "machine learning" and "yield forecasting" studies.

After applying the exclusion criteria and processing all the results, a more complex search sequence is built to avoid skipping relevant studies. Table 3 and Table 4 represent the search strings.

2.1.4 Inclusion and Exclusion Criteria

The following inclusion and exclusion criteria were used to determine whether a study should be included.

Table 4: Search term of the study

Areas	Search Terms
Machine Learning	“machine learning”, “deep learning”, “data mining”
Crop Prediction	“crop yield prediction” , “crop yield forecasting” , “yield prediction” , “yield forecasting”
Search string	(“machine learning” OR “deep learning” OR “data mining”) AND (“crop yield prediction” OR “crop yield forecasting” OR “yield prediction” OR “yield forecasting”)

Inclusion Criteria:

IC1: The publication is related to the agricultural sector and yield prediction combined with machine learning

IC2: It is relevant to the search terms defined in Section 2.1.3.

IC3: The study is published between January 2016

and December 2021.

Exclusion Criteria:

EC1: Publication is not written in English.
EC2: Publication that is a duplicate or already retrieved from another database.
EC3: Full text of the publication is not available.
EC4: Studies that do not meet inclusion criteria.
EC5: Publication is a review/survey paper.

2.2 Conducting the review

In this section, we obtain information from our search findings and related sources and databases.

2.2.1 Study Search and Selection

By following the search strategy (previously explained in Section 2.12), the selected electronic databases were searched and the studies were retrieved. In this original search, we retrieved 261 studies as shown in Table 5. After applying three Inclusion criteria, only 72 studies remained for further analysis, after which fourteen studies were selected for further analysis by applying all five criteria for exclusion. In Table 5, we show the number of papers obtained initially and the number of papers remaining after applying the selection criteria.

Table 5: Distribution of papers based on the databases

Database	# of initially retrieved papers	# of papers after inclusion and exclusion criteria	Percentage of Papers (%)
ACM Digital library	22	1	7
IEEE Xplore	88	4	29
ResearchGate	57	3	14
SpringerLink	54	4	29
ScienceDirect	40	3	21
Total	261	15	100

To answer the five research questions, data from the selected studies were extracted and synthesized. The selected studies that passed the inclusion and exclusion criteria are presented in Table 6. During the data synthesis, all the extracted data were consolidated and synthesized and the research questions were answered accordingly. The results are set out in Section 3.

Table 6: Selected publications

ID	Retrieved from	Reference	Title	Year
1	IEEE Xplore	#12	Rice crop yield prediction in India using support vector machines	2016
2	IEEE Xplore	#13	Rice crop yield prediction using artificial neural networks	2016
3	SpringerLink	#14	Predicting Early Crop Production by Analyzing Prior Environment Factors	2017
4	IEEE Xplore	#15	Rice yield prediction model using data mining	2017
5	IEEE Xplore	#16	Prediction of Crop Production in India Using Data Mining Techniques	2018
6	SpringerLink	#17	Yield Forecasting of Spring Maize Using Remote Sensing and Crop Modeling in Faisalabad-Punjab Pakistan	2018
7	ScienceDirect	#18	Artificial intelligence approach for the prediction of Robusta coffee yield using soil fertility properties	2018
8	SpringerLink	#19	Smart Farming System: Crop Yield Prediction Using Regression Techniques	2018
9	ScienceDirect	#20	Design of an integrated	2019

			climatic assessment indicator (ICAI) for wheat production: A case study in Jiangsu Province, China	
10	SpringerLink	#21	Sugarcane Yield Grade Prediction Using Random Forest with Forward Feature Selection and Hyper-parameter Tuning	2019
11	ResearchGate	#22	Prediction of Rice Yield via Stacked LSTM	2020
12	ACM Digital library	#23	Prediction of Soybean Yield using Self-normalizing Neural Networks	2020
13	ResearchGate	#24	Prediction of rice yield based on LSTM long Short and long memory network	2021
14	ScienceDirect	#25	Crop Yield Forecasting using Data Mining	2021
15	ResearchGate	#26	Review on Crop Prediction Using Deep Learning Techniques	2021

2.2.2. Data extraction and synthesis

Based on the guidelines provided by Kitchenham et al., (2007), we defined a data extraction process to identify relevant information from 15 included preliminary studies related to our research questions. Our data extraction process includes the following: First, we set up a form to report the ideas, concepts, contributions, and findings of each of the 15 studies.

The following data were extracted from each publication: (i) Research Topic; (ii) Database; (iii) Year of publication; (iv) DOI; (v) Keywords; (vi) Research Objectives Defined; (vii) Novelty of the study; (viii) Data Sample Details; (ix) Methodology; (x) Country/location of the analysis;

2.2.3. Quality Assessment Criteria and Screening Procedures

In order to assess the systematic review at hand, the following quality criteria were employed:

- Examination of the number of citations incorporated in each study sourced from existing research.
- Verification of publication venue, ensuring the inclusion of papers published in recognized conferences or journals.
- Analysis of the research inquiry that the authors have concentrated on.
- Analysis of the conclusions drawn by the researchers in response to the research questions.
- Scrutiny of adherence to standard reference formatting.
- Consideration of studies published between 2016 and 2021, prioritizing the most recent research.
- Prioritization of publications that possess well-defined discussions, results, and conclusions.

3. RESULTS

In this section, we describe the findings of our review of our research questions.

3.1. Overview of studies

Selected publications are shown in Table 6. The table shows the publication year, title, and other details of these publications.

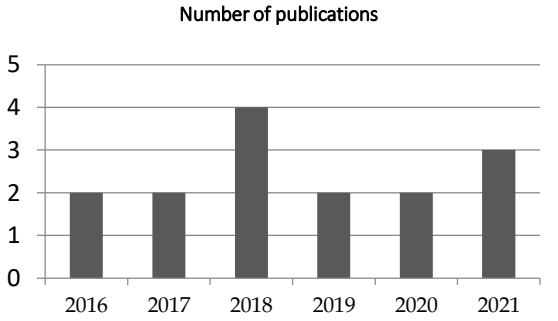

Figure 1: Distribution of the selected publications per year.

Figure 1 shows the number of publications that have

been published during the last six years from among the selected publications.

3.2. (RQ1) When, where, and who have published studies?

For this study, publications from the period 2016-2021 were extracted from various valid sources. 261 research papers were retrieved.

Out of these, 15 research papers have been selected for this systematic literature review (Table 6).

3.3. (RQ2) What are the algorithms that have been used so far for prediction?

Table 7: Most used algorithms for prediction.

Name of the algorithm	# of times used
Support Vector Machine	8
Long Short-Term Memory	3
Neural Networks	6
Linear Regression	7
Random Forest	4

To address the second research question (RQ2), machine learning algorithms were investigated and summarized. The algorithms used more than once are listed in Table 7.

3.4. (RQ3) What are the features/factors used in the literature to predict crop yields using machine learning?

Table 8: All features/factors used.

Feature/Factor	# of times used
Precipitation	10
Temperature	9
Evapotranspiration	4
Area	6
Nutrient	2
Sunshine duration	3

To address research question two (RQ3), features/factors used in the machine learning algorithms applied in the publications were investigated and summarized.

All features we were able to extract are shown in Table 8.

As shown in Table 8, The four most frequently utilized independent variables in crop yield analysis are precipitation, evapotranspiration, temperature, and area, while crop yield is considered as the dependent variable. These independent variables are part of a larger feature set that includes various other variables.

One of the feature sets is "Soil Information", which includes soil maps, soil type, pH, and product area. Another feature set is "Crop Information", which consists of variables related to crop weight, growth during the growth process, plant variety, and crop density. Additionally, there is a feature set called "Humidity", which comprises rainfall, humidity, predicted rainfall, and precipitation.

Moreover, the feature set,"Nutrients" encompasses the nutrients already present in the soil, as well as irrigation and fertilizer application. It is important to note that all of these features are used as independent variables in crop yield analysis.

3.5. (RQ4) What are the evaluation parameters and evaluation approaches used in the literature to predict crop yields?

Evaluation parameters were identified to solve the fourth research problem (RQ4). Table 9 shows all the evaluation parameters used and how they were used.

RMSE (Root mean square error), R2 (R-squared), MSE (Mean square error) and MAE (Mean absolute error) appear to be the most commonly used evaluation parameters.

Table 9: All evaluation parameters used.

Key	Evaluation parameter	# of times used
RMSE	Root mean square error	9
MSE	Mean square error	5
MAE	Mean absolute error	5
R^2	R-squared	4
WI	Willmott's Index	1
ENS	Nash-Sutcliffe efficiency coefficient	1

3.6. (RQ5) What are the challenges in the field?

To address the fifth research question (RQ5), publications were read to see if any issues or improvements were stated for future models. In several studies, data inadequacy (undersized data) has been cited as a problem. Data plays an important role in the machine learning process. One of the important issues faced here is the lack of good quality data. Dirty and useless data can make the whole process extremely tedious. A proposed improvement would be to integrate more data sources.

4. DISCUSSION

The analysis of our Selected 15 Studies underscores the significance of the authors' geographical location, as they represent various regions around the world. Despite our efforts to conduct an extensive search, it is possible that some valuable publications may have been missed, and the use of additional similar terms could have yielded new studies. Nonetheless, the search engine's ability to generate a considerable number of publications indicates a sufficiently comprehensive search.

In the context of our research question RQ1, which pertains to the temporal, geographical, and author-related aspects of the selected crop forecasting papers related to Machine Learning, we have chosen papers published between 2016 and 2021 from various reputable sources. Our systematic literature review (SLR) specifically focuses on the 15 selected papers, which we have found to be relevant and informative for our study.

In reference to RQ2, Table 7 demonstrates that a majority of experiments utilize a standard algorithm as a benchmark to evaluate the effectiveness of a proposed algorithm. Furthermore, recent studies have incorporated Deep Learning (DL) techniques, a subset of Machine Learning, for predicting crop yield. Long Short-Term Memory (LSTM) is one such DL technique that has shown promising results.

Regarding RQ3, the grouping of key features/factors can aid in visualization. The commonly employed factors for crop yield prediction include evapotranspiration, soil type, precipitation, and temperature, as shown in Table 8. Additionally, some studies have explored the use of trace elements such as magnesium, potassium, sulfur, and calcium as features. Notably, the types of features utilized in these studies differ, with temperature being measured as an average in some experiments and as maximum or minimum values in others.

In relation to RQ4, an investigation was conducted into the evaluation parameters utilized in several selected papers, as outlined in Table 9. The evaluation parameters included RMSE (Root Mean Square Error), R2 (R-squared), MAE (Mean Absolute Error), MSE (Mean Square Error), and MAE (Mean Absolute Error). The majority of the models achieved high accuracy values for their evaluation parameters, indicating that these models were capable of producing accurate predictions.

Regarding RQ5, the identified articles provided clear statements on the challenges encountered.

One of the studies focused on rice crop yield prediction in India using support vector machines (SVMs) (Gandhi et al., 2016). The study faced the challenge of selecting appropriate input variables for the SVM model. To overcome this challenge, the authors used a feature selection method to identify the most relevant input variables for the model.

Another study on rice crop yield prediction used artificial neural networks (ANNs) (Gandhi et al., 2016). The study encountered the challenge of over fitting, which occurs when the model performs well on the training data but poorly on the test data. To overcome this challenge, the authors used a regularization technique, which randomly drops out some neurons during training to prevent over fitting.

In the study on rice yield prediction using data mining (Dey et al., 2017), the authors faced the challenge of dealing with missing data. To overcome this challenge, they used the k-nearest neighbour (k-NN) imputation method to fill in the missing values.

Jambekar et al. aimed to predict crop production in India using data mining techniques. The authors

encountered the challenge of dealing with a large number of input variables, which can lead to poor model performance. To overcome this challenge, they used a wrapper feature selection method, which selects the best subset of input variables based on their performance on a validation dataset (Jambekar et al., 2018).

Kouadio et al. aimed to predict the yield of robusta coffee using soil fertility properties. The authors faced the challenge of dealing with non-linear relationships between the input variables and the target variable. To overcome this challenge, they used a non-linear machine learning technique called random forest, which can capture non-linear relationships between variables (Kouadio et al., 2018).

Shah et al. focused on crop yield prediction using regression techniques. The authors encountered the challenge of dealing with missing data and outliers in the dataset. To overcome this challenge, they used a data preprocessing method to fill in the missing values and remove the outliers from the dataset (Shah et al., 2018).

Xu et al. (2019) addressed the challenge "lack of accurate and reliable data on weather conditions, soil quality, and crop growth stages" by designing an integrated climatic assessment indicator (ICAI) that integrates various climatic factors, such as temperature, precipitation, and sunshine duration, to assess the impact of weather conditions on wheat production.

Another challenge is the complexity of crop growth processes, which require models that can capture the nonlinear relationships between input factors and crop yields. Meng et al. (2020) used stacked Long Short-Term Memory (LSTM) networks to predict rice yields. The stacked LSTM model was able to capture the nonlinear relationships between the weather factors and rice yield.

Furthermore, the performance of machine learning models depends on the quality and quantity of data available for training and testing. Mo et al. (2021) used LSTM networks to predict rice yields but faced the challenge of limited training data. To address this challenge, they applied data augmentation techniques to increase the size of the training dataset.

Kamath et al. (2021) used data mining techniques to predict crop yields, and their approach relied on the availability of historical data. They collected and processed data on weather conditions, soil quality, and crop yields to build decision trees that can be used to predict future yields.

However, it is possible that there may be additional challenges that were not mentioned in the literature.

5. CONCLUSIONS

This article presents a formal and original systematic review of the literature on crop yield forecasting using machine learning methods. The review followed established guidelines for conducting systematic literature reviews (Kitchenham et al., (2007)) to identify and categorize all relevant literature on the topic. After conducting a thorough search of a well-known electronic research database, a total of 261 original papers were identified. Through a rigorous filtration process, 15 relevant papers were selected for analysis and evaluation.

The selected papers were evaluated for their quality and analyzed based on the following research questions: (i) Who are the authors, when and where were the studies published? (ii) What are the algorithms that have been used for prediction? (iii) What are the features/factors used in the literature to predict crop yields using machine learning? (iv) What are the evaluation parameters and approaches used in the literature to predict crop yields? (v) What are the challenges in the field?

The findings of this research provide valuable insights and future directions for industry and research professionals in the field of crop yield forecasting using machine learning. The study reveals that various features are used in different research papers, depending on the scope and data availability of the selected publications. The choice of features is influenced by the availability of data and the purpose of the research. It was also observed

that models with more features do not necessarily provide better performance for yield forecasts. Several algorithms have been used in different studies, and while no definitive conclusion can be drawn as to the best model, some machine learning models have been found to perform better than others.

The results of this review indicate that neural networks and support vector machines are the most commonly applied algorithms in the existing literature. Therefore, the authors recommend that future studies explore the potential of deep learning algorithms, specifically LSTM-based models, for predicting crop yields. The study concludes by proposing further research on the development of the problem of crop yield forecasting.

In conclusion, our systematic literature review on crop forecasting papers related to Machine Learning has shed light on several key aspects, including the temporal, geographical, and author-related aspects of the selected papers. We have found that the use of Deep Learning techniques such as Long Short-Term Memory (LSTM) has shown promising results in predicting crop yield. Additionally, the commonly employed factors for crop yield prediction include evapotranspiration, soil type, precipitation, and temperature.

Evaluation parameters such as RMSE, R2, and MAE were used to assess the accuracy of the models, which produced high accuracy values. Despite the challenges encountered in crop forecasting, further data collection and exploration may lead to even better accuracy in predicting crop yield.

The article discusses various challenges and solutions encountered in crop yield prediction using machine learning techniques. Challenges include selecting appropriate input variables, dealing with missing data and outliers, and capturing non-linear relationships between variables. Solutions include using feature selection and regularization techniques, imputation methods, non-linear machine learning techniques, data preprocessing, and data augmentation. The article also emphasizes the importance of having accurate and reliable data for training and testing machine learning models, and the availability of historical data for data mining approaches. However, there may be additional challenges not covered in the literature.

The findings of this study provide valuable insights and future directions for industry and research professionals, and pave the way for further research in the field. The authors recommend the exploration of deep learning algorithms, specifically LSTM-based models, for improving crop yield forecasting.

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KJMS 2023 VOL.5 (1): 66-76

KDU Journal of Multidisciplinary Studies (KJMS)
Volume 5. Issue 1 July 2023
https://doi.org/10.4038/kjms.v5i1.63

CORPORATE GOVERNANCE ON FINANCIAL PERFORMANCE: EVIDENCE FROM LISTED COMMERCIAL BANKS IN SRI LANKA

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ABSTRACT

Corporate governance is a widely accepted governing mechanism that is followed by a majority of organizations believing that it would help to improve the financial performance of the organization. Based on this scenario, this study examines the impact of corporate governance on the financial performance of listed commercial banks in Sri Lanka. Financial performance has been considered as the dependent variable while return on assets and return on equity have been considered as the proxies for the dependent variable. Corporate governance has been considered as the independent variable while board size, board balance, female directors, board meetings, and board ownership have been considered as the proxies to measure the independent variable. A deductive approach has been employed using secondary data which is obtained from listed commercial banks in Sri Lanka. Descriptive and inferential statistics such as Pearson correlation and panel data regression have been used for the analysis purpose. The results of the Pearson correlation revealed that board size has a positive correlation with banks' financial performance while female directors show a negative relationship with banks' financial performance. Panel data analysis recommended the random effect model as the best-fitted model for ROA and ROE. The result of the Robust specification test at a 95% significant level confirmed that, in panel A for ROA, only the number of executive directors shows a significant relationship while in panel B for ROE, both independent variables of a number of executive directors and board ownership show a significant relationship. The empirical findings of this study are helpful for any individual, institutional decision-makers, managers, academics, and any other parties who are interested in corporate governance.

KEYWORDS: *Board balance, Corporate governance, Financial performance*

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1. INTRODUCTION

Corporate governance is about putting in place the structure, processes and mechanisms that ensure that the firm is being directed and managed in a way that enhances long term shareholder value through accountability of managers while enhancing firm performance. In other words, through such structure, processes and mechanisms, the well-known agency problem may be addressed such that the interest of managers can be associated with those of the shareholders.

There is no universally accepted definition for corporate governance. What is more representative of the concept is the statement that "corporate governance refers to a set of rules and incentives by which the management of a company is directed and controlled. Good corporate governance maximizes the profitability and long-term value of the firm for shareholders", which views corporate governance as a set of mechanisms through which outside investors protect themselves against expropriation by insiders. Then they give specific examples of the different forms of expropriation. The insiders may simply steal the profits; sell the output, the assets or securities of the firm they control to another firm they own at below-market prices; divert corporate opportunities from firms; put unqualified family members in managerial positions; or overpay managers. This expropriation is central to the agency problem described by Jensen and Meckling (1976) as cited by Shah and Hussain (2012).

Organizational performance changes reasonably, as the company changes the corporate governance process that influences the long-term decision and day-to-day activity. These corporate governance changes may influence the firm's performance level. When the corporate governance practices change, the companies change their performance in a favourable manner, while also changing financial leverage in a favourable manner for the shareholders.

In this case, the company should identify the main dimension to inflate the firm's performance. Further the financial manager or CFO should know how to maintain a proper performance level (ROE, ROA, P/E Ratio) by changing profit margin and share valuation. Therefore, the relationship between corporate governance system and the bank performance should be identified to make the appropriate financial decision. In order to become pioneer in the banking sector, it is vital to comply with corporate governance within organizations. Otherwise, company cannot manage their decision based on the performance when companies face bad conditions.

As per the compliances of the Sri Lankan Institute of Chartered Accountants (ICASL) and the Securities and Exchange Commission (SEC), code of best practices on corporate governance are mandatory requirements for the Sri Lankan banks. It revealed that corporate governance practices have an ability to influence on bank performance. Previous empirical studies such as Tandelilin, Kaaro and Mahadwartha (2007), Velnampy (2015), Anandasayanan and T. Velnampy (2018), Danoshana and Ravivathani (2019) stated the impact of corporate governance mechanism on financial performance of the corporations. Besides, Mohammed (2011) found that weak corporate governance practices and agency problems influence to reduce the bank performance in Nigeria. Although the scholars found a significant impact of corporate governance on financial performance, a divergence of the results can be identified related to the corporate governance practices which they employed. As examples, board gender diversity is an important factor to determine the firm performance (Boyle & Jane 2011; Bathula 2008). However, some scholars such as Rose (2007), BeleteZegeye (2015) identified gender diversity as an insignificant factor to determine the firm performance. A mixed result can be also identified related to the frequency of board meetings (Karamanou et al. 2005; Danoshana & Ravivathani 2013; Akpan 2015). Further, the same scenario can be also identified as related to the board ownership (Kibrysfaw Getahun 2013; Harun 2017). As existing knowledge generates puzzling results related to the areas of corporate governance and financial performance and moreover, as per the researchers' knowledge, in Sri Lankan context, few studies have

been conducted related to corporate governance and financial performance with reference on listed commercial banks in Sri Lanka, it is necessary to conduct research with further investigating the relationship between corporate governance and financial performance in listed commercial banks in Sri Lanka.

Based on relevant literature and empirical findings in other countries, this paper contributes to the bank performance literature in Sri Lanka by investigating the relationship between financial performance and corporate governance mechanism in the Sri Lankan banking industry. Thus, this study provides an opportunity to look at various parts of the bank governance framework and the financial incentives that influence managers and owners long term & short-term financial decisions. Further, the study can serve as a reference material for future researchers who need to make research on this area. Moreover, the empirical findings of this study would also be useful for regulators, policy makers, managers of the commercial banks for crafting policies.

Literature Review

Corporate governance is a relationship between shareholders (stockholders), board of directors and managers (top management) in shaping the direction of the company in order to achieve a sustainable performance. Corporate governance consists of external corporate governance and internal corporate governance. The principal objective of business enterprises is to enhance economic value for all shareholders by making the most efficient use of resources. A company that meets this shareholder value creation objective will have greater internally generated resources, improving its prospects for meeting its environmental, community, and social obligations, which is a lead indicator of corporate success of bank. As well as bank performance represented mainly through profitability. Profitability is measured by return on equity and return on assets.

Concerning the significance of the corporate governance and its nature, three dominant theories can be identified related to the corporate governance, namely, agency theory, stakeholder theory, and resource dependency theory. Agency theory is based on a principle-agent relationship. This theory identifies corporate governance as a controlling mechanism to control the agency cost and specially to resolve the conflict-of-interest issue between owners and managers. The stakeholder theory is an extension of the agency theory. Although the agency theory more focuses on the board of directors' accountability to the shareholders, stakeholder theory expanded this accountability not only to the shareholders but also in different sub-groups in the business environment such as suppliers, employees, business partners and so on (Freeman et al., 2004). As per resource dependency theory, board of directors are considered as a provider of the resources such as information, skills, business expertise, access to key constituents such as suppliers, buyers, public policymakers, and social groups as well as legitimacy to the business (Harun, 2017). According to the stakeholder theory, directors play an advisory and counseling role to the firm management. Thus, a dual role related to the board of directors can be identified as per the above-explained three theories. Finally, agency theory and stakeholder theory have seen corporate governance as a mechanism to minimize agency conflict while recourse dependency theory has seen corporate governance as a mechanism to interact the business organization with different resources (Harun, 2017).

Here onwards, scholars' special attention is adverted towards a variety of models, analytical tools and methodologies related to this studied area and key findings of the previous empirical studies.

Khatib and Nour (2021) have conducted a study to find out the impact of corporate governance on firm performance during Covid 19. The authors have collected secondary data from 188 non-financial firms in the Malaysian market for the period from 2019 to 2020. The results of the study have found that firm performance, governance structure, dividend, liquidity and leverage level do not have any significant change in pre and post crisis period. Furthermore, the results revealed that board size has a positive impact on firm performance and board

meetings while the audit committee has a significant negative impact on the firm performance.

Zukaa et al. (2018) have conducted a study to examine the effect of corporate governance on firm performance by collecting pieces of evidence from Syria. Data have been obtained from all firms listed at Damascus Securities Exchange (DSE) for the period between 2011 and 2015 and multiple linear regression has been used to analyze the collected data. Board of directors, audit, disclosure, and ownership structure have been used to measure corporate governance. The study's results revealed a significant impact of ownership structure on firm performance proxies.

Mashayekhi and Bazaz (2010) studied the relationship between certain corporate governance aspects such as board size, independence of the board, board leadership and institutional board investors on firm performance in Iranian economics. This research found that small boards are more efficient as the monitoring purpose, as well as a positive relationship, was identified between independent directors and the firm performances.

Further, Mohammed (2012) examined the impact of corporate governance on bank performance in the Nigerian context and results revealed that in any financial sector stability depends on the superiority of the code of corporate governance practices. Adegbemi, Ofoegbu and Fasanya (2011) studied the impact of corporate governance on bank performance in the same context and the results revealed that there is a negative impact on bank performance when there is a poor corporate governance practice. In the same context, Olayiwola (2018) examined the influence of corporate governance on the performance of ten listed companies over the period from 2010 to 2016 and panel data regression results revealed that corporate governance significantly influences on firm performance.

Ahmed et al. (2020) conducted a study to examine the importance of corporate governance on firm profitability by collecting cross-sectional data from 50 non-financial firms of OMAN. The secondary data have been collected from annual reports in the year 2018 and partial least squares have been used to analyze the collected data. The findings of the study revealed that there is a significant impact from board size, ownership, gender, and audit committee, and on firm profitability. Markonah and Prasetyo (2022) studied the effect of good corporate governance (GCG) on financial performance at banks in Indonesia over the period from 2011 to 2020 and the results indicates that GCG has a direct or indirect impact on banking financial performance.

In the Sri Lankan context, Guo and Kga (2012) examined the relationship between corporate governance and the financial performance of listed companies in CSE and the results revealed that there is a significant relationship between corporate governance and financial performance. Further, scholars found that the share of non-executive directors has negatively influenced on ROA. Anandasayanan and Velnampy (2018) also conducted a study in the Sri Lankan context based on diversified holding companies listed in CSE and the results confirmed that there is a significant impact of corporate governance on corporate profitability. Similar results to the previous findings were also confirmed by the scholars such as Siriwardhane (2008), Heenetigala (2011) as cited by Danoshana and Ravivathani (2019).

Danoshana and Ravivathani (2019) have conducted a study to examine the effect of corporate governance on firm performance by collecting secondary data from 25 listed financial institutions for the period 2008 to 2012. Return on Equity (ROE) and Return on Assets (ROA) have been used to measure the firm performance and board size, meeting frequency and audit committee of the company have been used to measure the corporate governance. The authors have used descriptive statistics, correlation and multiple regression to analyze the collected data and have found that corporate governance significantly impacts on firm's performance and board size while audit committee size has a positive impact on a firm's performance. Moreover, the authors have found that

meeting frequency has a negative impact on a firm's performance.

Velnampy (2015) conducted a study related to corporate governance and firm performance by using selected Sri Lankan banks. The results revealed that the board size, independence of boards, gender and education qualifications of directors are not significantly related to company performance.

However, Perera and Aruppala (2017) revealed that there is a positive relationship between financial performance and the number of board meetings and the education levels of the board of directors. Further, scholars found a negative relationship between financial performance and board size, the gender composition of the board of directors, outside directors, and CEO duality. Moreover, scholars conclude that there is no similarity in the disclosure of corporate governance practices of Sri Lankan banks.

2. METHODOLOGY

The hypothetical method is applied to understand the bank's financial performance response to corporate governance. Secondary data were gathered by following the convenience sampling technique and data were extracted from annual reports in ten listed commercial banks which are registered in CSE, Sri Lanka from 2007 to 2016. Organizational performance is a critical concept due to the existence of a large number of definitions for performance. However, performance may refer to the increase of the share price, profitability, or the present valuation of a company (Melvin & Hirt, 2005). In the Sri Lankan context, Corporate Governance practices (Independent Variable) are introduced by the Institute of Chartered Accountants of Sri Lanka and the Colombo Stock Exchange with the association of the Central Bank of Sri Lanka. Five corporate governance practices and two financial performance indicators are applied to achieve the objectives of the study. Figure 1 illustrates the conceptual framework of this study while Table 1 illustrates the operationalization of the variables.

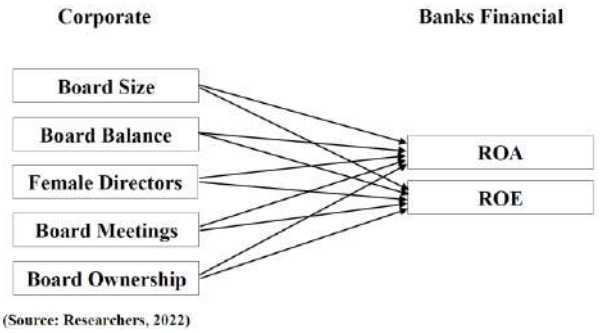

Figure 1: Conceptual Framework

Table 1: Measurement of the Variable

Independent Variable	**Measurement**	**Notation**
Board Size	Number of directors on board	BS
Board Balance	Number of executive directors	EX
	Number of non-executive director in the board	NEX
Female Directors	Number of female directors on board divided by total number of directors	FD
Board Meetings	Board meeting frequency is measured by the total number of meetings held per in a year	BM
Board Ownership	The percentage of the firm's outstanding shares owned by members of board of directors excluding the CEO	BO
Dependent Variable	**Measurement**	**Notation**
Return on Equity	Banks Net Income plus Depreciation divided by its book value of shareholder's Equity.	ROE
Return on Assets	Banks Net Income plus Depreciation divided by its book value of Total Assets	ROA

(Source: Researchers, 2022)

The Variance Inflation Factor (VIF) is used for identifying the multi-collinearity issue of the independent variables and it indicates a strong linear association among independent variables. According to Montgomery and Peck (1982), if the VIF value is greater than 5-10, then the regression coefficients are poorly estimated.

Correlation analysis and panel data regression analysis are used for identifying the relationships, model building and hypothesis testing. The entire analysis was done by using Stata software as it is the most appropriate software for panel data analysis. Panel data (also known as longitudinal or cross-sectional time-series data) is a dataset in which the behaviour of entities is observed across time. The following two models are built for measuring the impact of corporate governance on banks' financial performance.

$ROE_{it} = \beta0 + \beta1\ BS_{it} + \beta2\ EX_{it} + \beta3\ NEX_{it} + \beta4\ FD_{it} + \beta4\ BM_{it} + \beta4\ BO_{it} + e_{it}$ --------- (1)

$ROA_{it} = \beta0 + \beta1\ BS_{it} + \beta2\ EX_{it} + \beta3\ NEX_{it} + \beta4\ FD_{it} + \beta4\ BM_{it} + \beta4\ BO_{it} + e_{it}$--------- (2)

Where, β0, β1, β2, β3, β4, are the regression coefficient, "e" represents the error term, "*it*" represents the "i" company at time "t" and other notations are explained in Table 1.

The panel data regression analysis will suggest three types of models, namely, the random effect model, fixed effect model, and ordinary least squares model. Out of above-stated models, the best model will be selected by using the specimen tests of Breusch and Pagan Lagrangian multiplier test, Fisher (F) tes,t and Hausman Specification test.

3. RESULTS AND DISCUSSION

Descriptive Statistics

Table 2 comprises the descriptive statistics for the variables that investigate the effect of different corporate governance elements on a bank's financial performance.

Table 2: Descriptive Analysis

Variable	Obs	Mean	Std. Dev.	Min	Max
ROA	100	1.7	1.32	0.1	12.27
ROE	100	15.58	7.39	0.69	44.69
BS	100	11.1	1.74	6	18
EX	100	0.17	0.04	0.01	0.03
Nex	100	0.82	0.1	0.05	0.16
FD	100	0.14	0.11	0	0.04
BM	100	13.78	2.74	7	25
BO	100	0.02	0.032	0	0.22

(Source: Stata Output for Sample Data Set)

The maximum value of the ROA amount is 12.27 while the minimum amount is 0.1. As well as the maximum value of the ROE amount is 44.69 while the minimum amount is 0.69. The average value of ROA is 1.7 while ROE is 15.58. Average of 0.17 executive directors include in the board while representing a maximum of 3 and minimum of 1. Board has met average times of 13.78 and this ratio is also agreed with the guide line issued by CA Sri Lanka (minimum requirement is at less 12 time met the directors). Frequency of board meeting signifies minimum of 7 and maximum of 25 per one accounting period. Board ownership variable indicates 0.02 of average value in banking sector. According to above table, zero (0) minimum ownership and 0.22 maximum ownership represent the banking sector. When considering the board size, it will split within the 6 (minimum) to 18 (maximum). The variables of female directors and non-executive directors show 0 to 0.04 and 0.05 to 0.16 minimum and maximum values respectively.

Table 3: Correlation Analysis

Pearson's Correlation Matrix

	BS	EX	NEX	FD	BM	BO
ROA	-0.112	0.193	0.107	*-0.037	0.082	-0.087
ROE	*0.056	0.28	-0.109	0.123	0.205	-0.199

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

Source: Strata Output Sample Data set

As per Table .3 Pearson's correlation matrix, board size and female directors show a significant relationship between Return on assets and Return on Equity variables under the significant level at 0.05. Board size is positively correlated with ROE which means regularity of board meeting has higher performance and have an expansionary impact. However, the female director shows a negative association with bank performance.

Unit-Root Test

All the variables of corporate governance and financial performance are tested to check whether they are stationary or not stationary. Harris-Tzavalis unit-root test is conducted to test the stationarity of all variables. As per the results of Table 4, the alternative hypothesis is accepted which indicates that the panel is stationary. It means the null hypothesis of panels containing unit roots are rejected since the P value is significant.

Table 4: Harris-Tzavalis Unit-Root Test Results

Variable	Statistic	P - Value
ROA	0.1071	0.0000
ROE	0.1225	0.0000
BS	0.0791	0.0000
EX	0.1309	0.0000
NEX	0.1309	0.0000
FD	0.8024	0.0000
BM	0.1004	0.0000
BO	0.4637	0.0000
(Source: Stata Output for Sample Data Set)		

Collinearity Statistics

The multi-collinearity is an essential requirement to check in multiple regression analysis. In this study, VIF test is used to identify the multi-collinearity issue among independent variables. If the VIF value is more than 10, it indicates a collinearity problem (Myers & Myers 1990). As per the test results of Table 5, all independent variables' VIF values are below 10. Hence, it provides evidence that there is no possibility to have multi-collinearity issues in selected independent variables.

Table 5: Results of the Multi-Collinearity Test

Variable	**BS**	**EX**	**NEX**	**FD**	**BM**	**BO**
VIF value	2.85	2.23	1.46	1.28	1.26	1.18
Mean VIF Value	1.71					
(Source: Stata Output for Sample Data Set)						

Panel Data Analysis

There are three models tested in this study, namely Ordinary Least Squares (OLS), Fixed Effect Model (FEM), and Random Effect Model (REM). For the objective of finding out the most appropriate model to estimate and represent the results, F test, LM test and Hausman test are performed. All the models are conducted towards each data panel which represents the ROA and ROE. Panel A represents (Table 6) the models with ROA Panel B (table 7) represents the models with ROE.

Table 6: Results of Panel Data Analysis (Panel A)

Test	**Panel A – ROA**			
Specification Test	**Tested**	**Statistic**	**P-value**	**Model Selection**
F-test	OLS/Fixed	1.09	0.00	Fixed
LM test	OLS/Random	6.17	0.00	Random
Hausman	Random/Fixed	1.40	0.96	Random
(Source: Stata Output for Sample Data Set)				

Initially, F test is conducted to select the most suitable model between the Classical regression model and the Fixed effect model. Coming to a conclusion based on Table 5 and 6 results, the Fixed effect model is suggested rather than the Classical regression model (Pooled OLS) for both ROA and ROE because F statistics are significant at 0.05 levels. Subsequently, researchers try to identify either one way or two-way fixed model fitted for further consideration. At the significant level of 5%, a One-way fixed model is recommended for both panels. However, Fixed time effect models for both panels are not significant at this level. It means time impact is not significant for ROA and ROE, hence, researchers selected the One-way fixed model for future considerations.

Table 7: Results of Panel Data Analysis (Panel B)

Test	**Panel A – ROE**			
Specification Test	**Tested**	**Statistic**	**P-value**	**Model Selection**
F-test	OLS/Fixed	0.17	0.00	Fixed
LM test	OLS/Random	10.76	0.00	Random
Hausman	Random/Fixed	0.24	0.98	Random

(Source: Stata Output for Sample Data Set)

Table 8: Results of the One-way Random Effect Model

Panel A					Panel B			
Variable	**Coefficient**	**Robust Standard Error**	**Z –stat.**	**P-value**	**Coefficient**	**Robust Standard Error**	**Z-stat.**	**P-value**
BS	0.08	0.08	0.96	0.33	0.12	0.49	0.24	0.80
EX	6.51	2.52	2.58	0.01*	26.91	13.82	1.95	0.05**
NEX	-0.31	2.30	-0.14	0.89	-9.90	12.07	-0.82	0.41
FD	-2.04	1.85	-1.1	0.27	-2.14	6.12	-0.35	0.72
BM	0.05	0.05	1.01	0.31	0.48	0.43	1.1	0.27
BO	-3.11	2.52	-1.23	0.22	-32.64	6.84	-4.77	0.00*
Constant	-0.53	2.68	-0.2	0.84	12.06	13.54	0.89	0.373
P		0.00			P	0.00		
Sigma e		0.94			Sigma e	5.30		
Sigma u		1.14			Sigma u	5.66		
Rho		0.40			Rho	0.46		

(Source: Stata Output for Sample Data Set)

Second, Breusch and Pagan Lagrangian multiplier test is used to identify the best model between Classical regression model (Pooled OLS) and Random effect model. This test was also conducted for the dependent variables of ROA and ROE individually. As per the test results indicated in table 4.5 and 4.6, P values of the Breusch and Pagan Lagrangian multiplier tests' statistic for both panel A and panel B are significant at the level 5%. It implies that Random effect models for both panel A and panel B are suitable models than Classical regression model (Pooled OLS). However, the researchers cannot come to the final conclusion based on these results because, before that, it is necessary to verify whether the separate company specific characteristics follow the one-way time random effect model or not. The "rho" ratio indicated null value and time random effect model is not appropriate for both panels. Hence, One-way firm random effect model is suggested for panel A and B.

Finally, Hausman test is used for identifying whether the fixed effect model or the random effect model is more suitable to interpret the relationship between the firm performance and the corporate governance variables. As per the crosswise of the firm level, Hausman statistic is not significant at the significant level of 5%. Hence, the researchers can accept the null hypothesis that the difference in coefficients is not systematic. Thus, it can be concluded that the firm random effect model is the best fitted model for ROA and ROE.

Table 8 presents the results of the one-way random effect model analysis which covers the two dependent variables. (Panel A-ROA and Panel B-ROE). Return on assets and return on equity are dependent variables and Board Size, Executive Directors, Non-Executive Directors, Female Directors, Board Meetings, Board Ownership are taken as independent variables.

It is recommended to compute Robust standard error correcting for the possible occurrence of heteroscedasticity and hence, this study calculates robust standard errors to the ROA and ROE, random effects regression models to estimate the efficient regression coefficients. As per the results of Robust specification test at the 95% significant level, in panel A, only the number of executive directors shows a significant relationship with ROA. Simultaneously, in panel B, both of the independent variables of number of Executive directors and Board ownership shows a significant relationship with ROE. As per the agency theory, there exists a positive link between board independence and firm performance

(Krivogorsky, 2006). Hence, it can be explained that if the directors have shares, they are not independent. So, the negative relationship between Board ownership and ROE is acceptable based on the agency theory. However, board size, non-executive directors, female directors, and board meetings do not reveal any significant relationships with both ROA and ROE panels. These findings agree with the findings of scholars such as Rose (2007), Jenson (1976) as cited by Harun (2017), Effiok et al. (2012).

4. CONCLUSION

The authors have conducted the study to examine the impact of corporate governance on financial performance of Listed Commercial banks in Sri Lanka. Financial performance has been considered as the dependent variable while return on assets and return on equity have been considered as the proxies for the dependent variable. Corporate governance has been considered as the independent variable while board size, board balance, female directors, board meetings and board ownership have been considered as the proxies to measure the independent variable. Descriptive and inferential statistics such as Pearson correlation and panel data regression have been used for the analysis purpose. The results of the Pearson's correlation revealed that board size has a positive correlation with banks' financial performance while female directors show a negative relationship with banks' financial performance. The result of the Robust specification test revealed that, in panel A for ROA, only the number of executive directors shows a significant relationship while in panel B for ROE, both independent variables of the number of executive directors and Board Ownership shows a significant relationship. Ultimately, future researchers are suggested to identify if there is any divergence in corporate governance practices and financial performances between state-owned commercial banks and private commercial banks. Further, it is suggested to compare this relationship with international commercial banks and domestic commercial banks.

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KJMS 2023 VOL.5 (1): 77-85

KDU Journal of Multidisciplinary Studies
(KJMS) Volume 5. Issue 1 July 2023
https://doi.org/10.4038/kjms.v5i1.65

EVALUATION OF SCATTER DOSE RECEIVED BY THE THYROID REGION IN PATIENTS WITH BREAST CANCER RECEIVING ADJUVANT CHEST WALL IRRADIATION USING 2-D RADIOTHERAPY

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ABSTRACT

According to the Global Cancer Observatory 2020 report, breast cancer is the top most cancer among females in Sri Lanka. It has been reported that thyroid can receive a significant amount of radiation dose in breast cancer patients who received adjuvant two dimensional (2D) conventional therapy. The aim of this study was to evaluate the scatter dose received by thyroid region during chest wall radiation in conventional 2d-radiotherapy. 41 breast cancer patients who had adjuvant 2D-conventional radiotherapy were included in this study. All selected patients were treated by TheratronTM 780e cobalt teletherapy at Apeksha Hospital, Maharagama, Sri Lanka. Polimaster PM1610 dosimeter was used to measure the scatter dose. A statistical analysis was performed using IBM SPSS. The mean values for the total scatter dose from the glancing fields and the SCF (supraclavicular fossa) field were 112.33±5.50 mSv and 421.79±32.49 mSv respectively. The mean value of the total scatter dose was 534.10±34.11 mSv. Moreover, 78.97% of the scatter dose was received by the SCF field while 11.36% and 9.66% were received by medial and lateral glancing fields. A considerable amount of radiation has been received by the thyroid region among breast cancer patients who received chest wall irradiation with SCF irradiation. In order to reinforce the conclusion, further studies need to be performed with accurate dose measurement especially with Thermoluminescent dosimeter (TLD).

KEYWORDS: Breast cancer, Chest wall irradiation, Cobalt teletherapy, 2D-conventional radiotherapy, Scatter dose, Dosimeter

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1. INTRODUCTION

Cancer is one of the leading causes of death for both males and females worldwide. According to the Global Cancer Observatory 2020 report, about 10 million deaths and 19.3 million new cases have been reported globally (Sung et al., 2021). Surgery, chemotherapy and radiotherapy are three main pillars in cancer treatment. Due to the efficiency of treatment and low cost compared with other radiotherapy treatment options, about 50% of cancer patients receive radiation therapy during their course of treatment (Byron et al., (2013), Ramanathan et al., (2022)). At present, there are various types of treatment to explore radiation in radiotherapy such as 2D-coventional radiotherapy, three-dimensional conformal radiotherapy (3D-CRT), intensity modulated radiotherapy (IMRT), image guided radiotherapy, tomotherapy, stereotactic radiosurgery, particle therapy, etc. (Ramanathan, 2017). Even though, there are several advanced teletherapy treatment modalities currently available, still most of the developing countries use cobalt teletherapy due to its simplicity, relatively low initial cost and less workforce requirement (Ramanathan, 2021). Currently, 9 cobalt teletherapy machines are functioning in Sri Lanka (Ramanathan et.al 2022).

Breast cancer is the topmost cancer among women in Sri Lanka, and 3975 new cases were reported in 2022 (GLOBOCAN 2022). Approximately 3000 new cases of breast cancer are diagnosed every year (NCCP, 2023 and Balawardena et al., 2020). Breast cancer is formed in breast tissue. The most common type of breast cancer is ductal carcinoma which starts in the lining of the milk ducts. Another type of breast cancer is lobular carcinoma which starts in the lobules of the breast (NCI-USA, 2020). Appropriate use of adjuvant radiotherapy is necessary for better prognosis. Adjuvant radiotherapy is given in addition to breast surgery. It is used to destroy the remaining cancer cells in the breast or lymph nodes after surgery. Usually, adjuvant radiation therapy may last 3 to 7 weeks. Adjuvant radiotherapy is recommended in patients with a high risk of local or regional relapse. This includes patients with large primary tumours (> 5 cm) and with 4 or more involved lymph nodes (Chev, 2001).

Generally, 2D-conventional radiotherapy, 3D-CRT and IMRT treatments are practiced for breast cancer radiotherapy in Sri Lanka. 3D-CRT and IMRT are more conformal radiation therapy in which the tumour control probability is high comparing with 2D conventional radiotherapy. Adjuvant radiotherapy with 2D- conventional radiotherapy planning is not a computed tomography (CT) image-based procedure. It uses only a trans axial contour of breast for planning. The contour is taken at the middle level of the breast along the trans axial axis. The chest wall is irradiated by two parallel opposed tangential beams which are rectangular shaped and large enough to irradiate the interested area of the breast. The ipsilateral supraclavicular fossa is irradiated with a direct anterior beam which is almost square shaped and large enough to irradiate the interested area of supraclavicular fossa with lymph nodes. The 2D-conventional treatment planning is performed only in central or single transverse plan by considering the patient data contained that plane only. There is no knowledge of off axis dose distribution. This is the major disadvantage in 2D-conventional radiotherapy.

Scatter radiation received by the patient during radiotherapy is unavoidable. The patient can receive scattered radiation which comes outside the direct photon beam. The scattered radiation can be arising from different sources such as leakage radiation, scattered from the collimator, scattered radiation from floor, wall, and ceiling, radiation scattered from the patient, etc. The scattered radiation received by the patient is unwanted additional radiation dose to the patient. Akin et al., (2014) evaluated thyroid dose received by the patient who received postoperative chest wall/breast and regional nodal irradiation during 3D-conformal radiotherapy. The authors used thyroid gland contouring in treatment planning to evaluate thyroid dose. The mean dose received by thyroid gland was reported as 22.5 Gy. Similar studies were conducted by Akyurek (2014) and Kanyilmaz et al. (2017), and the reported mean thyroid doses were 31 Gy and 18.98 Gy respectively.

According to the World Health Organization (WHO) estimation, breast cancer is the most common cancer among women in Sri Lanka. Therefore, studying of benefits and risks of breast cancer radiotherapy is important. As the survival of breast cancer patients is increasing, incidence of radiation induced thyroid dysfunction was found to be relatively common late radiation toxicity. Adjuvant 2D conventional radiotherapy is still practiced for the breast cancer patient in Sri Lanka. But there is no evidence of estimating thyroid gland toxicity to radiation among the breast cancer patients in Sri Lanka. This study evaluates the scatter dose received by the thyroid region during the chest wall irradiation among breast cancer patients who received adjuvant 2D-conventional radiotherapy by using Polimaster1610 dosimeter.

2. MATERIALS AND METHODS

Descriptive cross-sectional prospective approach was used in this study. Patients who received radiation to chest wall and supraclavicular fossa (SCF) as adjuvant radiotherapy (2D conventional) for carcinoma of breast in TheratronTM 780E 60Co teletherapy machine at Apeksha Hospital, Maharagama from 02nd September 2020 to 15th February 2021 was the population of the study. Convenience sampling was used to select samples from the population. 41 patients were selected for this study.

Patients who had chest wall adjuvant radiotherapy with supraclavicular fossa treatment (2D conventional) for carcinoma of breast as primary cancer were included. Patients who were between the ages of 18 to 80 years were included in this study. Patients who underwent thyroid surgery, thyroid disorder patients, patients who underwent radioiodine treatment, patients who had previous treatment to ipsilateral supraclavicular fossa were excluded. Ethical approval was granted by the ethical review committee, Faculty of Medicine, General Sir John Kotelawala Defence University, Sri Lanka. In addition, the permission was obtained from the director of Apeksha Hospital, Maharagama to conduct this study.

The pamphlets were distributed among the patients who received radiation to chest wall as adjuvant radiotherapy (2D conventional) for carcinoma of breast at TheratronTM 780E 60Co teletherapy machine which was located at the department of radiotherapy, Apeksha Hospital, Maharagama. The purpose and the requirements for the research were explained to the participants by an investigator of the research team and each participant was given an information sheet. The written consent was obtained from the participants who were satisfied with the criteria of the research study.

An interview was held with participants by one of the investigators before data collection. The required data was collected from the treatment prescriptions of participants during the interview. Participants were needed to hold the dosimeter on their neck at the level of the thyroid gland during the treatment. The investigators were helped for placement and fixation of dosimeter with a specially made and pre-tested neck band as shown in figure 1.

Figure 1: Specifically made and pre-tested neck band to fix the dosimeter.

The selected participants for this study were positioned/aligned on the breast board which was laid on the treatment couch using the laser system. The correct placement of dosimeter and comfortability of the participants were ensured by the research team. Radiation treatments as prescribed by the consultant radiation oncologist was delivered by the radiation therapists. The gantry angles for medial glancing, lateral glancing, and for SCF treatment fields were accumulated from each patient. Moreover, body evaluation angle, field-size of glancing and the field size of SCF were gathered.

Finally, the dosimeter was detached from the

participants and participants were removed safely from the treatment couch, after the delivery of radiation treatments. Participants were educated in post treatments / procedures by the research team, and they were discharged from the treatment room. Dosimeter was connected to the computer and the readings were retrieved using dosimeter application software. The scatter dose received by the thyroid region by medial glancing, lateral glancing, and SCF irradiation were retrieved using Polimaster1610 dosimeter. The procedure was repeated for all participants and data was collected. Collected data was tabulated in a master chart using Statistical Package for the Social Science software provided by International Business Machines Corporation (IBM-SPSS 23). All the tabulated data were statistically analysed to achieve the objective of the study. Explanatory variables were evaluated and presented with frequency tables and scatter plots. Pearson correlation coefficient was also used to express both direction and degree of correlation

3. RESULTS

Adjuvant two-dimensional (2D) conventional radiotherapy is the most common in developing countries due to the lack of linear accelerators. Therefore, this study focused on evaluating scatter dose received by the thyroid region during 2D-conventional radiotherapy for breast cancer patients as all government radiotherapy centres in Sri Lanka use this kind of treatment. Furthermore, this study was to examine how the scatter dose correlates to the treatment parameters.

Table 1 shows the descriptive statistics of dose measurements. The mean scatter dose to the thyroid region by the medial glancing is 61.34 mSv. The mean scatter dose received to the thyroid region by the lateral glancing is 50.99 mSv. The mean scatter dose received to the thyroid region by SCF field is 421.79 mSv. The mean value of the sum of the scatter dose to the glancing fields is 112.33 mSv. The mean of total scatter dose received to the thyroid region by the glancing and SCF beam is 534.10 mSv. Other descriptive statistics of measured doses are shown in table 2.

Table 1 shows the descriptive statistics of measured dose. The notations are indicated as follows: MG-Medial Glancing, LG- Lateral Glancing, GD-Glancing dose, Min.- minimum, Max.- maximum, Var.- variance, SD-standard deviation, and Per.-percentile. All measured doses are in mSv.

	Dose by MG	**Dose by LG**	**Dose by SCF**	**Sum of GD**	**Total Dose**
Mean	61.34	50.99	421.79	112.33	534.10
Median	57.12	45.45	419.79	107.09	542.19
Min.	30.91	23.58	60.08	56.68	129.15
Max.	108.65	121.92	728.66	206.07	878.24
Range	77.74	98.33	668.58	149.39	749.09
SD	18.27	24.89	202.91	35.24	213.05
SD of mean	2.85	3.89	32.49	5.50	34.11
Per. 25	47.69	32.95	231.07	89.98	327.08
Per. 75	75.33	65.57	636.93	125.82	756.20

Table 2: Descriptive statistics of irradiated field variables. The notations are indicated as follows: Min.- minimum, Max.- maximum, Var.- variance, SD-standard deviation, and Per.-percentile.

	Glancing Height (cm)	**Glancing Width (cm)**	**Area (cm^2)**	**SCF Area (cm^2)**
Mean	17.82	11.07	197.32	51.90
Median	18.00	11.00	195.00	49.00
Min.	15.00	7.00	126.00	35.00
Max.	20.00	15.00	300.00	81.00
Var.	1.72	4.47	1682.3	100.3
SD	1.31	2.11	41.02	10.01
SD of Mean	0.20	0.33	6.41	1.60
Range	5.00	8.00	174.00	46.00
Per. 25	17.00	10.00	165.00	45.00
Per.75	18.00	13.00	220.00	60.00

The mean glancing height among 41 patients is 17.82 cm. The mean glancing width is 11.07 cm. The mean glancing area is 197.32cm^2. The mean SCF area is 51.90 cm^2.

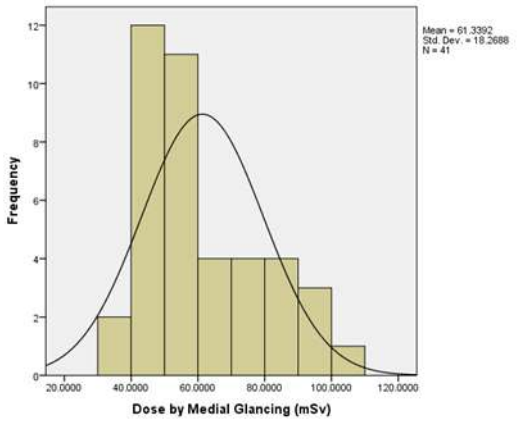

Figure 2: Distribution of scatter dose received by medial glancing.

The distribution of scatter dose received by the thyroid region from medial glancing is explained by histogram (figure 2). The mean scatter dose to the thyroid region by medial glancing is 61. 34 mSv. Most patients from the sample receive the scatter dose between 40 mSv and 60 mSv. About 12 patients received the high scatter dose of 50 mSv which is 29.26% of the sample population. The bell- shaped curve demonstrates the distribution as almost normal.

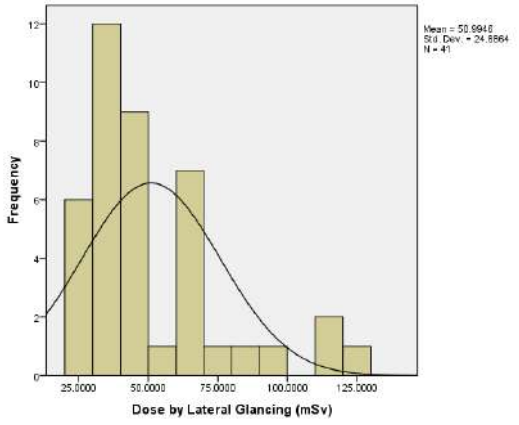

Figure 3: Distribution of scatter dose received by lateral glancing

The distribution of scatter dose received by the thyroid region from lateral glancing is explained by histogram (figure 3). The mean scatter dose to the thyroid region by lateral glancing is 50.99 mSv. 12 out of 41 patients get the scatter dose of 35 mSv which is the highest frequency in the histogram. The lowest scatter dose for thyroid region is 20 mSv and the highest scatter dose is 150 mSv. The curve is moderately skewed positively and has a platykurtic distribution.

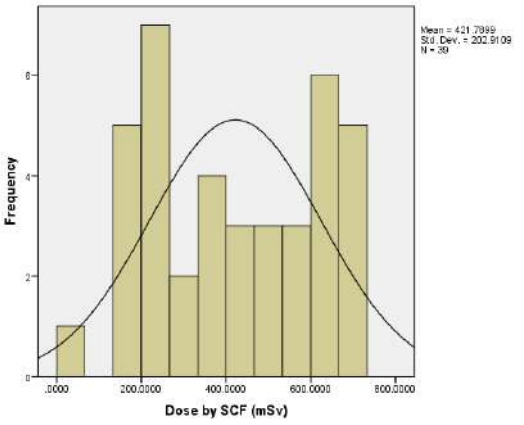

Figure 4: Distribution of scatter dose received by SCF.

The distribution of scatter dose received by the thyroid region from SCF is explained by histogram (figure 4). The mean scatter dose to the thyroid region by SCF exposure is 425. 99 mSv. Most patients have received a scatter dose of more than 200 mSv to the thyroid region, and the dose is distributed up to 720 mSv. The bell-shaped curve demonstrates the distribution as almost normal.

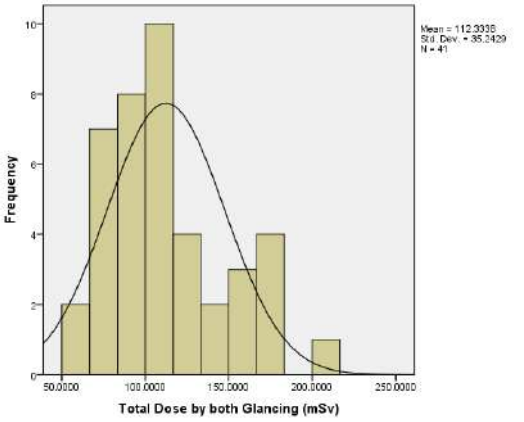

Figure 5: Distribution of scatter dose received by both glancing.

The distribution of sum of scatter dose by glancing is explained by the histogram of figure 5. The mean scatter dose to the thyroid region by both glancing fields is 1685.01 mSv. Most patients have received scatter doses between 1000 mSv and 2000 mSv. 10 out of 41 patients have received scatter doses of 1625 mSv as the highest frequency. Most of the patients have received scatter doses below 2000 mSv. The curve is bell shaped and displays a small degree of platykurtic distribution. The bell-shaped curve demonstrates the distribution as almost normal.

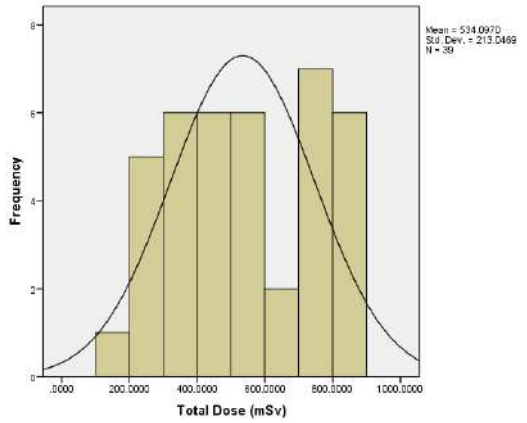

Figure 6: Distribution of total scatter dose per fraction.

The distribution of total scatter dose per fraction is explained by the histogram of Figure 6. The mean total scatter dose to the thyroid region by a fraction is 8074.98 mSv. Most patients have received scatter doses of more than 5000 mSv. The bell-shaped curve demonstrates the distribution as almost normal.

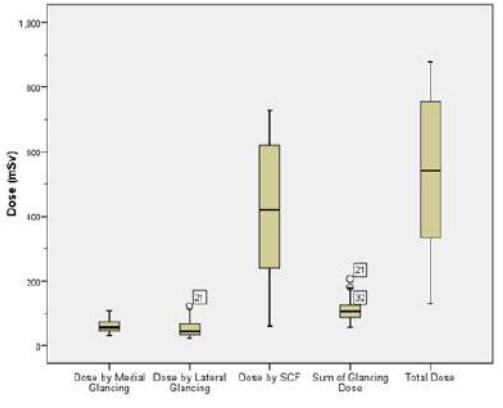

Figure 7: Dose contributions in box plot.

Dose contributions by beams for total scatter dose per fraction is explained by box plots of Figure 7. The box plot of scatter dose by medial glancing, scatter dose by lateral dose and sum of glancing scatter doses are comparatively short. The box plot of scatter dose by the SCF field is comparatively taller than glancing which suggests the SCF field's scatter dose is holds larger amount of scatter dose received by the thyroid region. The obvious difference between the box plots is worthy for further investigations.

The correlation between glancing width and the scatter dose by the medial glancing is significant at the 0.05 level with Pearson correlation coefficient of r=0.346. This indicates that there is a moderate positive relationship between the variables. The correlation between glancing height and the scatter dose by the lateral glancing is significant at the 0.05 level with Pearson correlation coefficient of r=0.308. This also indicates that there is moderate positive relationship between the variables. The correlation between glancing width and the thickness of irradiated tissue is significant at the 0.01 level with Pearson correlation coefficient of r=0.623. This indicates that there is a strongly positive relationship between the variables.

Further, the partial correlation of doses and radiation beam variables were performed by setting the thickness of irradiated tissue as control variable. It showed that there is a partial correlation between glancing height and the scatter dose by lateral glancing to the thyroid region.

4. DISCUSSION

While radiotherapy has many benefits and increases the survival in cancer therapy, some of the adverse events can occur due to the irradiation of other organs in and around the treatment field that may jeopardize the quality of life. Lungs, and contralateral breasts are considered as organs at risk during chest wall irradiation. But, the thyroid gland is not considered as an organ at risk during the chest wall irradiation even though there is probability of risk. Some studies have reported thyroid disorders that occurred due to scatter

dose received by thyroid gland during chest wall irradiation. There are limited numbers of studies about thyroid dose evaluation in breast patient radiotherapy. However, data availability regarding the dose of the beam delivered to thyroid region during radiotherapy to supraclavicular field is insufficient.

A previous study (Kanyilmaz et al., 2017) showed the mean dose received by thyroid gland during breast cancer treatment with 3D conformal Radiotherapy was 18.98 Gy, when all or part of the gland irradiated with conventional fractionation of 2 Gy per fractions with total 25 fractions. In our study we evaluated and measured the dose received by thyroid region of all 41 patients with breast cancer who were received 2D conventional radiotherapy for breast/chest wall and supraclavicular region, and the mean thyroid dose was 542.19 mSv, per 267 cGy fraction. According to the same previous literature the maximum dose received by thyroid gland was 46.9 Gy and minimum thyroid dose received was 2.25 Gy. In this study the maximum thyroid region dose was 878.24 mSv and the minimum dose was 129.15 mSv, per 267 cGy fraction and the total number of fractions was 15.

In our study, the median dose to thyroid region was 534.10 mSv per fraction, and the standard error was ±33.28 mSv per fraction. Wolny-Rokicka et al., 2016 have statistically proven in their study that the median dose received by thyroid of the SCRT group that underwent irradiation of the regional lymph nodes and scar or breast was 1957.5 cGy. In the results of our study, it is shown that the range of the total dose to thyroid region per 267 cGy fraction was 749.09 mSv, and the standard error of the mean was 34.11 mSv.

It was needed to find out the correlation between scatter dose to thyroid region and explanatory variables. The study results show that following correlations are significant at 0.05 level, dose by medial and glancing width, and dose by lateral glancing and glancing height. The correlation between glancing width and dose by medial glancing was significant at the 0.01 level with the Pearson correlation coefficient r = 0.623. It shows a strong degree of correlation.

Thyroid disorder is a well-known late effect in head and neck radiotherapy. Most studies focus on evaluating thyroid dose during head and neck radiotherapy but there are few studies related to chest wall irradiation. It is also important to reduce thyroid dose in chest wall irradiation. Only very few studies have been conducted to investigate radiation induced thyroid dysfunction in breast cancer patients receiving RT to the supraclavicular filed that involve the part of thyroid gland. There are three different types of radiation induced thyroid dysfunctions such as hypothyroidism (HT), subclinical HT and clinical HT. The previous study, Akyurek, 2014, reported that the overall incidence of hypothyroidism was 21% in patients with breast cancer who had supraclavicular radiotherapy. Also they reported that 2% cases had subclinical HT and 4% cases had clinical HT. Their results showed that the mean thyroid dose of ≥36 Gy produced a significant impact on the development of HT. Another study (Bruning et al., 1985) has mentioned that HT was significantly common in breast cancer radiotherapy patients who received radiation to SCF.

Wolny Rokicka et al., 2016 found that the incidence of RT-induced hypothyroidism was exposed after two years since the radiotherapy in 6% population in breast cancer patients receiving SC-RT. Similarly, Kikawa et al., 2017 have reported that the prevalence of HT in patients with breast cancer in their study after irradiation to the SC region was 2.4% which is less than the previously reported. In a previous study, Reinertsen et al. showed a marked increase in the development of hypothyroidism after multimodal treatment of breast cancer that received adjuvant radiotherapy.

Another study carried out by Tunio et al., 2015 among breast cancer patients receiving RT, 3 (15%) patients had hypothyroidism in SC-RT group and one (5%) patient had subclinical hypothyroidism. According to the literature, the previous study conducted by Kanyilmaz et al., 2017, 51 (21%) patients were diagnosed with HT, 22 (9.1%) patients

had clinical HT and 29 (11.9%) patients had subclinical HT. In that they revealed Dmean >21 Gy was the threshold value for the development of hypothyroidism.

5. CONCLUSION

The main aim of this study was to determine the scatter dose received by thyroid region during the chest wall irradiation among breast cancer patients who received adjuvant radiotherapy. Our results implied that the mean of the scatter dose received by thyroid region by medial glancing was 61.34 mSv per 267 cGy fraction and by lateral glancing it was 50.99 mSv. The mean scatter dose received by thyroid region was 421.79 mSv per fraction of 267 cGy. It will mainly affect the thyroid region. Further, the total dose received by thyroid region from three fields per fraction was 534.10 mSv. According to the results, we present the evidence that over 75% of the scatter dose is contributed by supraclavicular filed while only 21.02% of scatter dose is delivered by both medial glancing filed and lateral glancing filed. Further, it implied that medial glancing filed gives a higher impact on the dose received by thyroid region than the lateral glancing field.

However, according to the results there is a correlation between scatter dose by medial glancing and glancing width with the value of r = 0.346 and scatter dose by lateral glancing and glancing height with the value of r = 0.308. It shows that the radiation scattered dose to thyroid region by glancing fields significantly depends on the height and width of glancing fields.

According to our results, we suggest the use of imaged based treatment planning techniques to limit the required height and width of glancing beams like 3D CRT and IMRT. Therefore, further studies need to be conducted to estimate the scatter dose by 3D CRT and IMRT treatment plans. According to both literature and our findings, future research should consider the potential effects of radiation on development of hypothyroidism as late toxicity in breast cancer patients more carefully. Similarly, we recommend to avoid unnecessary thyroid gland radiation especially during irradiation of supraclavicular region, and routinely screening breast cancer patients for hypothyroidism on follow up, and at the same time, thyroid gland should be excluded from the treatment field whenever possible.

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KJMS 2023 VOL.5 (1):86-97

KDU Journal of Multidisciplinary Studies (KJMS)
Volume 5. Issue 1 July 2023
https://doi.org/10.4038/kjms.v5i1.66

OPTIMAL CUT ORDER PLANNING SOLUTIONS USING HEURISTIC AND META-HEURISTIC ALGORITHMS: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Cut order planning is a significant task in the apparel industry which determines the fabric spreading layout that can affect different aspects of the apparel industry including the cost of garments, the efficiency of the sewing line, etc. Due to the nature of the cut order problem, it is very hard to determine an optimal solution for the cut order plan although there are ready-made software and also industry experts working on this. Hence, various attempts have been made to optimize it by using machine learning algorithms in the modern world. This review aims at identifying how heuristic and meta-heuristic algorithms are used to optimize the cut-order planning solutions to obtain a near-optimal solution. Furthermore, the lack of research limits it down to 13 papers to be reviewed, and this paper discusses the methodologies and algorithms used, research parameters, issues, and future areas that need to be investigated for the cut order problem. The review shows that the genetic algorithm is widely used to optimize the cut-order plans by adopting the hybridization approaches along with some other meta-heuristic algorithms such as simulated annealing, tabu search, etc. Experimental results indicate that researchers were able to minimize fabric waste by optimizing the cut order plans.

KEYWORDS: *heuristic algorithms, cut order problem, cut plan, meta-heuristics, systematic review, apparel industry*

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1. INTRODUCTION

The apparel industry is one of the leading industries possessing trillions of dollars in market capitalization. In general, the garment manufacturing process has different stages (Fig. 1). Cutting is the most important process in apparel manufacturing because a significant amount of garment cost depends on the fabrics and is the most valuable material in the production process (Enes et al., 2020).

Cut order planning and spreading comes before the cutting. Spreading is where the fabrics are laid on the cutting table before assigning the markers to them. Cut order plans are there to determine proper fabric spreading layouts. It describes how the fabric is going to be laid on the cutting table hence orders require large quantities of pieces at once. The cut order problem (COP) with the cutting process in the apparel industry is known to be an NP-Hard (nonlinear polynomial-time) problem (Unal et al., 2020). Not being able to have an optimal solution on how the fabric and markers are to be laid down on the cutting table to complete the order quantity by minimizing the fabric wastage can be known as COP (Jacobs-Blecha et al., 1998). Cut order planning may differ according to the objective preferred such as fabric utilization, and time efficiency. Manual labour by industry experts and industrial software programmes specified to generate cut order plans are currently being used to find optimal solutions.

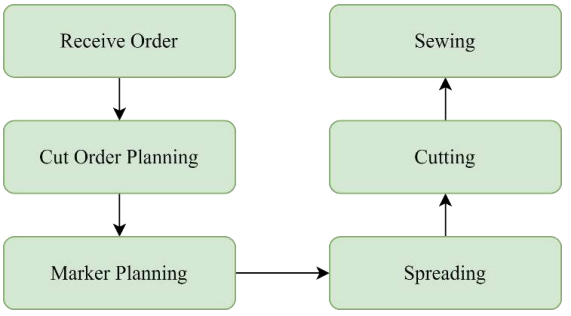


Figure 1: Garment manufacturing process

Statistics show that textiles waste will increase by 60% each year between 2015 and 2030, resulting additional 57 million tons of waste every year (Shirvanimoghaddam et al., 2020), (Niinimäki et al., 2020). So, the efficiency of traditional methods is questionable and hence, researchers attempted to try different approaches for the cut order problem using machine learning techniques that are more advanced than just a software programme (Schmidt et al., 2019). Lots of algorithms and methodologies can be found with machine learning. It seems that heuristic and meta-heuristic algorithms are more popular among researchers when it comes to problems like cut order planning that requires optimization (Poorzahedy et al., 2007).

This study aims at investigating how heuristic and meta-heuristic algorithms are used to optimize cut-order planning solutions. The review contains the following sections. Section 2 describes what motivated the authors to study this area. Section 3 investigates existing literature on COP. Section 4 describes the methodology used to conduct the review. Section 5 investigates the findings of the study. And finally, in section 6, research gaps in the current research are discussed, which will be useful for future researchers.

Objective of the study

As previously described, the objective of the cut order plan is to determine the fabric spreading layout on the cutting table when there is an order with a higher quantity and in different sizes, colours, etc. (Enes et al., 2020). In such a scenario, industry experts predetermine how the fabrics are spread over the cutting table to minimize the fabric amount required (Sarkar, 2007).

An optimistic cut order plan will reduce the single product cost by minimizing fabric wastage (Jana, 2007). Non-optimal cut order plan can lead to extra pieces of garments and the time required for the cutting process, labour cost, etc. depends on the cut order plan. Different types of automated software are available to generate cut order plans/solutions (Padhye, 2007) but their effectiveness is questionable.

Here is an example of an order that consists of 40 garments. Small 15 [Red 5, Blue 10], Medium 25 [Red 10, Blue 25]

Two possible COP solutions are given below for the particular order

So*lution 1*

Lay 1 – S:2M [5 Red, 5 Blue]
Lay 2 – S: M [5 Blue]

Solution 2

Lay 1 – S: M [5 Red, 10 Blue]
Lay 2 – M [5 Red, 5 Blue]

Each layer contains two lays and size combinations for each marker and supposed layers for each segment (lay). Figure 2 illustrates a single lay plan. Hence this is a simple example, it is possible to generate more suitable solutions that can reduce fabric wastage. With larger quantities of garments, it is difficult to have an optimal solution as a cut order plan.

Heuristic and meta-heuristic algorithms perform a significant role in these kinds of optimization problems (Rodríguez et al., 2018). Researchers tend to use both types of algorithms to address the cut-order planning problem by generating optimal cut-order planning solutions. But in the meantime, there is no critical understanding of them for the particular problem.

Different meta-heuristic algorithms were introduced over the decades (Hsieh, 2020) and many possible trends could be identified and could have developed for generating cut-order planning solutions.

There are some systematic reviews done but they mainly focus on strip packing problems and marker-making processes in the apparel industry. There is a lack of reviews focusing on the cut order planning process.

It will be more beneficial to have an understanding of how and what the meta-heuristics were used previously by the researchers to address the cut order problem. So, the objective of the study is to identify how researchers intended to use meta-heuristic algorithms to address the cut order planning problem.

Related Work

This section intends to discuss existing knowledge related to this area.

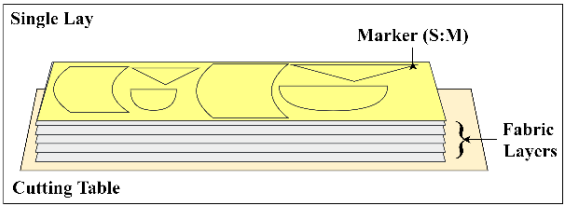


Figure 2: Fabric spreading layout

Guo et al. conducted a review to determine how artificial intelligence (AI) is applied to the apparel industry covering 4 areas which are design, manufacturing, retailing, and supply chain management (Guo et al., 2011). It covers most of the apparel manufacturing process. The authors determined that machine learning methodologies can improve the efficiency of the garment industry. Neural networks and genetic algorithms are the most popular among researchers according to the insights given. Cut order planning and marker making are considered a single problem that may not be the ideal situation within the apparel industry.

Jalil et al. conducted a systematic literature review to discuss the challenges facing the adoption of AI technologies in the garment industry (Jelil et al., 2018). The author classified the review into three categories to cover the areas: production planning, control, and scheduling. Cut order planning is discussed as an individual problem. It appears that genetic algorithms were used by the researchers to address the cut-order planning problem.

Table 1: Existing literature on cut order planning using heuristic and meta-heuristic algorithms

Title	Goal
Applications of artificial intelligence in the apparel industry: a review (Guo et al., 2011)	Analyze the limitation and research challenges of previous studies.
Review of Artificial Intelligence Applications in Garment Manufacturing (Jelil et al., 2020)	Investigate and exploit artificial intelligence techniques in a variety of industrial applications.
AI for Apparel Manufacturing in Big Data Era: A Focus on Cutting and Sewing (Xu et al., 2018)	Investigate how artificial intelligence is used in cutting, sewing, finishing, and packing processes.

Xu et al. investigated how artificial intelligence is being used in cutting and sewing processes in the apparel industry (Xu et al., 2018). Cut order planning is discussed as a separate task under the cutting process. It states that the thickness of the cloth and the depth of the cutting knife decide the maximum number of plies for the cut order plan. It further states that the time required for the cutting process can be affected by the cut order plan.

Findings show that there are no direct reviews done on

this particular area. Hence there is a need for a systematic literature review to have a comprehensive view of how meta heuristic algorithms are being used to address the cut orer planning problem.

2. METHODOLOGY

The review is done using guidelines provided for performing systematic literature reviews in software engineering (Kitchenham et al., 2007). Research questions and inclusion and exclusion criteria are defined first and then reliable sources are identified to find relevant research papers.

For the conducting phase, search strings are used with the relevant keywords to search through the databases and retrieved the papers. Inclusion and exclusion criteria were applied to determine the most effective research papers and then the review task was done. Finally, for the reporting, the findings on the research questions are discussed below.

Planning the Review

This section describes how the review was planned, research questions and the inclusion and exclusion criteria.

Research questions

To find how meta-heuristic and heuristic algorithms were used in optimizing the cut-order planning solutions these research questions are defined.

RQ1 – What is the research trend of using heuristic and meta-heuristic algorithms in recent years?

RQ2 – Which algorithms are popular when addressing the cut order problem?

RQ3 – How effective are the parameters used by the researchers on the cut order problem?

RQ4 – What are the existing research issues and future areas that can be investigated?

Search strategy

Terms mentioned in the search criteria are used to search through the selected databases to find relevant papers on the focused field of study. The search strings were varying because the filtering and searching facilities given by the selected databases are different from each other.

IEEE Xplore, ACM Digital Library, Science Direct, SpringerLink, and Google Scholar were the selected databases in which papers that are published in English from the year 2007 to 2022 were sought for.

Then the inclusion and exclusion criteria were applied to the selected papers to refine them furthermore.

Search criteria

Search strings used and generated for each database are as follows. The best possible strings were selected to achieve maximum accuracy while searching.

IEEE Xplore – "Full Text & Metadata":cut order AND "Full Text & Metadata":plan OR "Full Text & Metadata":problem OR "Full Text & Metadata":planning AND "Full Text & AND "Full Text & Metadata":apparel OR "Full Text & Metadata":apparel industry AND "Full Text & Metadata":fabric OR "Full Text & Metadata":fabric utilization

ACM Digital Library – [[Title: cut order plan] OR [Title: cut order planning] OR [Title: cut order problem]] AND [Title: meta heuristic algorithm] AND [Title: fabric utilization apparel industry] AND [Publication Date: (01/01/2007 TO 12/31/2022)].

SpringerLink – 'cut AND order AND problem AND plan AND planning AND apparel AND fabric AND meta AND heuristic'.

ScienceDirect - cut order plan planning problem apparel industry fabric utilization meta-heuristic, cut order planning problem solutions apparel industry heuristic algorithm.

Google Scholar - cut order problem plan planning apparel fabric utilization meta-heuristic algorithm.

Inclusion and exclusion criteria

To be effective these inclusion and exclusion criteria are used to determine whether the paper must be included or not. The papers that fulfill these criteria are included in this review. Table 2 describes the criteria in detail.

Table 2: Inclusion and exclusion criteria

Inclusion Criteria	Exclusion Criteria	Justification
IC1: Papers Published between 2007 - 2022		Significance improvement can be determined hence the development of the meta-heuristics trendier these years.
IC2: Papers published in English		Resources are not enough to translate the papers and translation can lead to misunderstanding of the content.
IC3: Papers that are related to the apparel industry.		The literature review is intended to review the cut order problem that occurs in the apparel industry.
IC4: Papers relevant to the cut order planning		The literature review is focused on the cut order problem.
	EC1: Papers that are an abstract or a review or a case study.	The full paper needs to be analyzed to understand how researchers address the cut order problem.
	EC2: Publications that do not represent any heuristic or meta-heuristic algorithms.	Identifying how meta-heuristics are used to address the cut order problem is the aim of the study.

Conducting the Review

This section aims to describe the selection and data synthesis phase in detail.

Study search and selection

Selected databases were searched to find the relevant research papers using search strings defined.

The selection was done according to the flow diagram guidelines provided by the PRISMA statement (Page et al., 2021). Figure 3 illustrates the selection process.

Synthesis and data extraction

According to the methodology, the next part was data extraction and synthesis.

Extraction and synthesis were done by using "Zotero" which is a software programme that aids researchers to collect, organize, cite, and share research. Selected papers were imported into the programme and managed through it. An excel sheet was used to extract data from the research papers including title, abstract, year, authors, parameters used, meta-heuristic algorithms used, difficulties, and suggested future works.

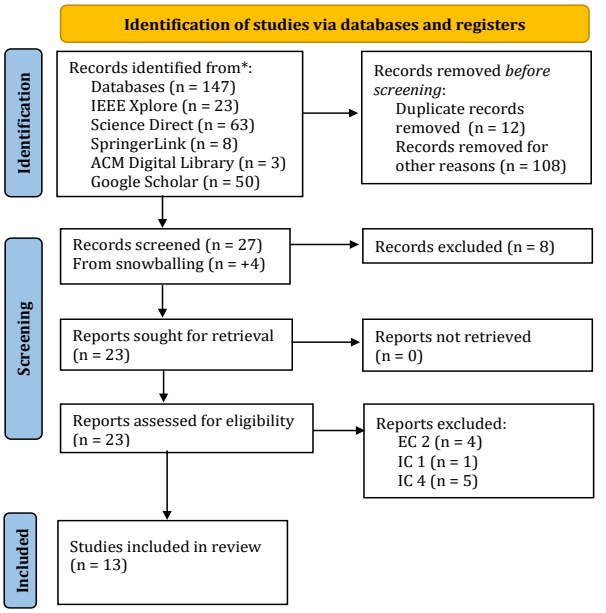


Figure 3: Selection of papers

3. RESULTS

This section contains the findings from the research by reviewing and previously defined research questions are answered here. A total of 13 research papers were identified that are relevant to the research topic satisfying the objective of this systematic literature review.

Research Trend (RQ1)

According to the conducted review, the information

about retrieved papers includes where they have been retrieved and when they have been published (Table 3). illustrates the distribution of research attempts taken over the years. The current trend lacks the interest of the researchers to optimize the cut order planning problem

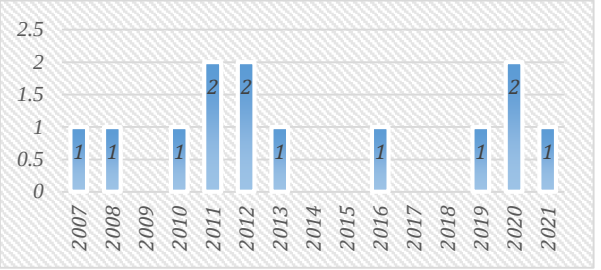
Table 3: Information on selected papers

ID	Venue	Title	Summary
#1	Springer-Verlag Berlin Heidelberg	A hybrid genetic algorithm for the cut order planning problem (Bouziri et al., 2007)	A hybrid approach to generate cut order plans using genetic algorithm, and simulated annealing
#2	International Journal of Production Economics	Genetic optimization of fabric utilization in apparel manufacturing (Wong et al., 2008)	A genetically optimized decision-making model
#3	International Journal of Production Economics	A state-space solution search method for apparel industry spreading and cutting (Nascimento et al., 2010)	Graph theory-based model with heuristic algorithms
#4	Springer-Verlag Berlin Heidelberg	Research on cut order planning for apparel mass customization (Yan-mei et al., 2011)	Mathematical model optimized by probability search algorithm and genetic algorithm.
#5	Production Planning & Control	Elucidating a layout problem in the fashion industry by using an ant optimisation approach (Yang et al., 2011)	Integer programming model using ant colony optimization algorithm.
#6	Journal of Emerging Trends in Computing and Information Sciences	Canonical genetic algorithm to optimize cut order plan solutions in apparel manufacturing (Abeysooriya et al., 2012)	A canonical genetic algorithm approach
#7	International Journal of Information and Communication Technology Research	Hybrid approach to optimize cut order plan solutions in apparel manufacturing (Abeysooriya et al., 2012)	A hybrid approach using the genetic algorithm
#8	Elsevier	Optimizing cut order planning in apparel production using evolutionary strategies (Wong et al., 2013)	Decision-making model optimized by genetic algorithm
#9	International Transactions In Operational Research	Heuristics for the combined cut order planning two-dimensional layout problem in the apparel industry (M'Hallah et al., 2016)	Comparative research based on simulated annealing, genetic algorithm, and hybridization of them
#10	IEEE/CAA Journal of Automatica Sinica	A heuristic algorithm for the fabric spreading and cutting problem in apparel factories (Shang et al., 2019)	An iterated greedy algorithm-based model using heuristic algorithms
#11	Computers & Industrial Engineering	Hybrid heuristics for the cut ordering planning problem in apparel industry (Xu et al., 2020)	An approach using integer programming, genetic algorithm, and enumerate algorithm.
#12	The Journal of The Textile Institute	Reducing waste in garment factories by intelligent planning of optimal cutting orders (Tsao et al., 2020)	A comparative approach based on genetic algorithm, simulated annealing, tabu search, and hybridization of them
#13	The International Journal of Advanced Manufacturing Technology	Optimization of garment sizing and cutting order planning in the context of mass customization (Alsamarah et al., 2021)	Genetic algorithm-based approach aligned with heuristic algorithms

According to what we have found, there are not many attempts to address the cut order planning problem using meta-heuristic algorithms and only a few researchers were interested in this particular problem.

Behalf of that marker planning optimization was considerably popular among the researchers. Fig. 4 (COP) using heuristic and meta-heuristic algorithms considering the number of research works done.

According to the review, researchers used several heuristics, metaheuristic algorithms, and hybridized versions of them to generate solutions to the cut order



. **Figure 4: Distribution of research works**

Methodology and Algorithms Used (RQ2)

planning problem.

Bouziri et al. proposed a hybrid approach to generate cut-order planning solutions by combining two-dimensional layout problems and cut-order problems (Bouziri et al., 2007). The resulting problem is modeled and solved using a hybrid heuristic that combines a genetic algorithm (GA) and simulated annealing (SA).

Wong et al. created a genetically optimized decision-making model using adaptive evolutionary strategies to address the cut-order planning process (Wong et al., 2008). Genetic algorithms are used to optimize the COP decision-making model and are further optimized using an evolutionary algorithm (EA) with the evolutionary trajectories.

Nascimento et al. researched to determine optimal fabric spreading and cutting schedules. A graph theory-based model was developed by ed applying heuristic rules to select the most promising colour combination (Nascimento et al., 2010). Further applied exhaustive search algorithms (ESA) and greedy search algorithms (GSA) to achieve suitable solutions in the hybrid phase.

Yan-mei et al. developed a mathematical model and optimized it by using a probability search algorithm (PSA) to obtain optimized size combination plans (Yan-mei et al., 2011).

Yang et al. proposed a model combining an integer programming model (IP) and ant colony optimization (ACO) to identify most economic cutting patterns to control cost and reduce production time (Yang et al., 2011).

Abesooriya et al. carried out research based on a pure genetic algorithm to optimize cut order problems to find the optimum size ratios for each cut template used (Abeysooriya et al., 2012). Methodology breaks down into 3 stages that are encoding chromosomes, selection, crossover, and mutation.

Abesooriya et al. used a hybrid approach to optimize cut-order plan solutions in apparel manufacturing. hybridization was done by combining the conventional heuristic of COP generation and genetic algorithm (GA) to optimize cut-order plan solutions targeting the reduction of the long execution time with the previous method (Abeysooriya et al., 2012). A mask encoding string was defined by them to improve the encoding mechanism of basic GA using the conventional heuristic method of COP generation in the process.

Wong et al. created a genetically optimized decision-making model using adaptive evolutionary strategies to optimize the cut order problem. model, then validated using 4 sets of real production data. Genetic algorithms are used to enhance the resulting cut-order plans (Wong et al., 2013).

M'Hallah et al. combined Cut order problem (COP) and two-dimensional layout (TDL) into a single problem CT (CT = COP + TDL) which objected to minimize fabric length and then it is solved using constructive heuristics, and three metaheuristics: simulated annealing, genetic algorithm, and hybrid approach (genetic annealing) (M'Hallah et al., 2016).

Shang et al. proposed an iterated greedy algorithm for solving the fabric spreading and cutting problem which contains a constructive procedure and an improving loop (Shang et al., 2019). With that, they create a set of lays in sequence first, and then the loop tries to pick each layer from the layer set and rearrange the remaining lays into a smaller lay set as much as possible.

Tsao et al. used a variety of hybrid heuristics with genetic algorithms to determine effective COP solutions (Tsao et al., 2020). They combined two heuristics in their study which are simulated annealing-based genetic algorithm (SA-GA) and tabu-search-based genetic algorithm (TS- GA) and compared three metaheuristics: simulated annealing, genetic algorithm, and tabu search

simulated annealing, genetic algorithm, and tabu search by formulating COP problem as a mixed-integer programming model.

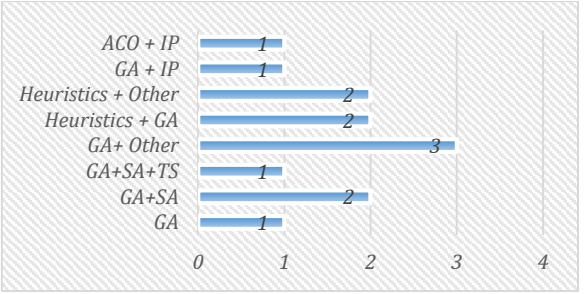


Figure 5: Algorithms used to optimize COP

Xu et al. presented a mass customization-oriented garment production planning system to generate more efficient size charts and cut order plans (Xu et al., 2020). A genetic algorithm and expanded integer programming model are developed to optimize the cut-order solutions.

Alsamarah et al. created a genetic algorithm-based approach to optimize the cut order planning which was designed depending on mathematical equations to get the correct distribution (Alsamarah et al., 2021).

Research Parameters Used to Optimize Cut Order Planning (RQ3)

In most cases, researchers focused on the fabric wastage factors to minimize the fabric wastage with the cut order planning. Minor of them considered other aspects as well.

The number of sizes, order quantities, fabric width, minimum and maximum ply height, the maximum length of the cutting table, and the shortest length layout of the pieces of particular sizes is taken into consideration by Bouziri et al. (Bouziri et al., 2007).

Wong et al. considered various factors affecting the cut order plan to conduct their research covering the fabric, fabric cost, labor cost, time constraints, and electricity requirements. (Wong et al., 2008). The same parameters were used again in the subsequent research of the authors (Wong et al., 2013).

Nascimento et al. used fabric utilization parameters such as Number of sizes, Number of colours, Maximum spreading length, etc., and cost factors including fabric cost, average sale price, etc. to maximize the efficiency of the output generated by the models (Nascimento et al., 2010).

Yan-mei et al. focused on the length of the cutter blade, the thickness of the fabric, the size of the clothes, and the cutting table to conduct their research (Yan-mei et al., 2011).

Yang et al. focused on fabric utilization factors such as a set of the patterns used, colours, demand for each size in a particular colour, etc., and cost factors such as stack cost of a layer of cloth, cutting pattern setup cost, etc. (Yang et al., 2011).

Abesooriya et al. in canonical genetic algorithm to optimize cut order plan solutions in apparel manufacturing considered the fabric measures such as the number of different fabric types, the number of sizes, the maximum number of garments in the cut template, the maximum number of plies in the lay (Abeysooriya et al., 2012).

Abesooriya et al., with their subsequent research considered fabric measures such as the number of garment sizes, the number of different fabric types, the maximum number of garments in the cut template, the maximum number of plies in the lay, and the number of times a particular size appeared in the cut template (Abeysooriya et al., 2012). The major goal was to reduce the execution time of the algorithm.

M'Hallah et al. considered the unique garment type and colour that is being laid on the table to determine the best possible option when cutting a huge number of quantities, number of occurrences of each size, the number of layers, and the length are some of the parameters mentioned (M'Hallah et al., 2016).

Shang et al. used parameters such as the maximum allowed fabric length, maximum allowed fabric layers, number of different garment figures, and number of different fabric types (Shang et al., 2019).

Tsao et al. objected to finding the optimal number of layers for the cut order plan by considering the number of ordered sizes and the demand for each size (Tsao et al., 2020). Here are the other parameters which they considered; Estimated length of fabric for size, cost of Setup a new section, cost of excess production, cost of using fabric, the maximum length of fabric, the

maximum number of layers in each section, and the minimum number of layers in each section.

Xu et al. used a set of sizes, order demand for size, set of markers, set of markers, etc. to improve the fabric utilization when generating the COP solutions (Xu et al., 2020).

Alsamarah et al. investigated fabric utilization with a fixed marker width and marker length which is defined while fabric consumption (Alsamarah et al., 2021). Along with that, they considered the number of different sizes, colours, and the number of layers in the process.

Research Issues and Future Works (RQ4)

According to the researchers, the most common difficulty was to generate the near-optimal solution for the cut order planning problem because of its NP-Hard nature.

Bouziri et al. used outdated hardware resources compared to currently available hardware, and they state that "GAn and the sequential TDL algorithm are coded in Fortran and run on a Pentium IV, 1.7 GHz and 256 Mb of RAM" which could affect the execution time of the algorithm (Bouziri et al., 2007).

Shang et al. also used slightly outdated hardware resources which is a server with Intel Core2 Duo Q9400 2.66 GHz and Microsoft Windows 7 Ultimate (Shang et al., 2019).

Nascimento et al. state that because of the complex and combinational nature of the problem its size grows exponentially with time and hence processing time takes too long (Nascimento et al., 2010).

Yan-mei et al. only focused on single fabrics with different sizes when optimizing the cut order plan (Yan-mei et al., 2011). Hence, they state that future research could focus on more customized apparel orders and other optimization methods can also be used.

Yang et al. used minimal hardware resources which can affect the efficiency of the model developed (Yang et al., 2011). They used a PC with a 1.66 GHz Intel Core Duo L2400 and 1 GB RAM. Also, they state that sometimes the hybrid model that they have developed was unable to result in a good solution in some cases.

Abesooriya et al. state the original form of the genetic algorithm is unable to solve more complex COP problems. For example, it cannot obtain quality solutions in small population sizes or smaller numbers of generations (Abeysooriya et al., 2012). Hence, they suggested a hybrid approach in which the properties of GA will be used to optimize the solution and conventional heuristic methods of solving COP reduce the population size and number of generations which enables higher efficiency and greater effectiveness.

In their subsequent research, Abesooriya et al. state that further investigation using optimization techniques such as simulated annealing, and tabu search can be done to achieve more effective and efficient solutions for the COP when combined with the genetic algorithm (Abeysooriya et al., 2012).

Wong et al. state that the evolutionary process of cut order planning can be improved further by focusing on the combination of evolution strategies and other heuristic search techniques such as particle swarm optimization, ant colony optimization, etc. (Wong et al., 2013). which will improve the convergence speed and global optimization ability.

M'Hallah et al. said that future research can adopt other types of costs, multiple garments, and patterned fabric, and improve the TDL packing approach (M'Hallah et al., 2016).

It says that among all the algorithms the high-level setting always yielded a better result for the minimum cost but the CPU time was long Tsao et al. in their research (Tsao et al., 2020).

Xu et al. state that the research work can be improved by adding fit related pricing system to the sizing system and as per the COP, it is important to apply artificial intelligence techniques to generate accurate data of markers due to their complexity with the size combinations (Xu et al., 2020).

Alsamarah et al. say that their study can be extended to several sectors in garment factories, with multiple objectives integrating production line efficiency, reliability, and the extension of further research (Alsamarah et al., 2021).

4. DISCUSSION

This section discusses the research gap and areas that can be investigated in future work. The study shows that the number of research done on cut order planning problems by using heuristic and meta-heuristic algorithms is considerably less compared to other investigative areas.

As per the related work, existing literature reviews barely contain the involvement of meta-heuristic algorithms in the context of cut order planning. Covering the whole production process of the apparel industry tightened the space to investigate the cut order planning problem specifically throughout the empirical literature. It has been determined that the cut order problem can be addressed by using meta-heuristic algorithms but it lacks a direct focus on the cut order planning problem.

Hybridization of meta-heuristics allowed researchers to achieve better solutions to solve optimization problems. According to the literature, genetic algorithm (GA), simulated annealing (SA), tabu search (TS), evolutionary strategy (ES), and some other heuristics are used to achieve better results.

According to the review, it has been determined that for 77% percent of reviewed papers, researchers used genetic algorithms as one of their algorithms to optimize the cut-order solutions. 92% of researchers used some sort of hybridization approach with their research.

In recent years, many meta-heuristic algorithms have been introduced such as galactic swarm optimization (2015), duelist algorithm (2016), mayfly optimization algorithm (2020), etc. New heuristics can also be derived from the industrial activities that are currently used for the COP. Researchers can attempt to investigate them.

Primarily the fabric utilization factors are widely used to optimize the COP such as fabric height, width, ply height, number of fabric layers, etc. Industrial application of cut order planning requires several facts to be considered such as the objective function of the cut order plan (ex-cost, time), labour cost, electricity cost, etc. introducing such parameters based on those factors may increase the effectiveness and efficiency of the solutions resulting maximum output from the cut order plan. A thorough investigation of such factors can be done in future works.

It has been discovered that existing research needs some enhancement with the hardware resources that were being used. Hardware resources are rapidly growing with size, performance, etc. The impact of the hardware resources when using heuristics and meta-heuristic algorithms to optimize COP can also be investigated.

Thus far, the genetic algorithm is popular among researchers. Study shows that hybridization of the genetic algorithm combining heuristics or other meta-heuristic algorithms were given better solutions. Combining new algorithms with genetic algorithms may result differently. Considering the NP-hard nature of the cut order planning to achieve a near-optimal solution is still questionable hence the solutions can be further optimized by improving the models proposed by the researchers.

5. CONCLUSION

Cut order planning creates a problem where fabric wastage can happen when the cut plan is not optimal. Using traditional methods such as manual labour and industrial software cannot ensure optimal solutions for cut order planning. In that case, researchers investigated meta-heuristic algorithms and whether they can achieve near-optimal solutions for the cut order problem and found that they are more accurate and efficient than the traditional methods.

The study aimed at finding how heuristic and meta-heuristic algorithms are used to optimize the cut order problem to achieve optimal solutions to identify recent research trends, use of heuristics and algorithms, parameters being used, and current research issues and future perspectives. A total of 13 papers were selected to be reviewed and further analyzed to answer the research questions.

Results indicate that genetic algorithms and simulated annealing are mostly used by the researcher to optimize the particular problem. Hybrid approaches combining heuristics and meta-heuristic algorithms, especially the genetic algorithm resulted in more promising solutions.

Researchers primarily focused on fabric utilization factors enabling gaps in the investigation of cost factors and time constraints. Further improvement of the models, adaptation of new heuristics, and meta-heuristic algorithms may result in more optimal solutions for the cut order planning problem.

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KJMS 2023 VOL.5 (1):98-105

KDU Journal of Multidisciplinary Studies (KJMS)
Volume 5. Issue 1 July 2023
https://doi.org/10.4038/kjms.v5i1.67

EMOTIONAL INTELLIGENCE, ACADEMIC PERFORMANCES AND ASSOCIATED FACTORS AMONG NURSING UNDERGRADUATES IN SELECTED GOVERNMENT UNIVERSITIES IN SRI LANKA

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ABSTRACT

Background: *Emotional intelligence (EI) is considered as a main aspect that impacts the academic performance of students, particularly in the health field. The aim of this study was to assess the impact of EI on the academic achievement of the students and the socio-demographic factors affecting it.*

Methods: *A cross-sectional study was conducted in four selected government universities. The systematic random sampling method was used to select/recruit participants. EI was assessed using a validated self-administered Genos EI scale (a concise version consisting of 7 domains; 31 questions equally weighted; total score of 155). Socio-demographic data were obtained using a self-administered questionnaire and the academic performance was assessed by the year GPA of the students who had completed the semester examinations. Ethical clearance was obtained from the Ethical Review Committee of KAATSU International University. Analysis was done by using the Spearman rank correlation, Mann-Whitney U test, and the Kruskal Wallis test employed since the data were not normally distributed.*

Results: *Of 200 students; 80.0% were females (mean age 24.2 ± 2.59 years). The median total EI score was 114.0 (females-113.0, males-125.0; p = 0.073). Median score was highest for Emotional reasoning (male-21.00, Female-19.0; p=0.04) and lowest for Emotional Self Control (male-15.0, Female-14.0; p=0.067). A majority of 53.5% obtained 96-126 of total EI score. Demographic variables – gender, having siblings, family type, loss of parents, participation in extracurricular activities or parental education were not associated with the total EI score (p>0.05) except socio economic status (p=0.028) and study year (p=0.022). Academic performances were assessed by the GPA, and there was a moderate positive correlation between GPA and Emotional Intelligence among all three batches, 2nd year (p=0.004; r=0.435), 3rd year (p =034, r =0.376), 4th year (p=0.000; r = 0.641).A significant weak positive correlation was found with family relationships (p=0.003; r=0.214) and satisfaction with study of nursing (p=0.000; r=0.316).*

Conclusions: *Emotional intelligence was associated with the factors such as study year, income level, self-satisfaction on the nursing programme whereas age, gender, education level, parental influence did not show any significant relationship. EI was shown to have a significant positive weak correlation with the GPA.*

KEYWORDS: *Emotional Intelligence, Academic Performance, Nursing Undergraduates, Sri Lanka*
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1. INTRODUCTION

Emotional Intelligence is (EI) described as non-cognitive intelligence on overall functioning and adaptive coping of the emotional aspects for cognitive abilities, introspection, emotional literacy, and self-awareness (Cherniss, 2010). EI is fundamental to the nursing profession since it facilitates the processing of emotional information for individuals and improves patient care through effective communication and therapeutic relationships (Dian & Sheron 2019).

Emotional intelligence among nursing students is crucial when they deal with clients in any setting. Nursing students who are studying in any particular year in diverse backgrounds are engaged in numerous emotionally charged experiences to learn how to develop a therapeutic relationship by monitoring their emotions and those of others (Horton-Deutsch and Sherwood, 2008). There are many studies related to EI conducted among nurses working in clinical settings, i.e. EI and its association to job performance (Vahidi et al., 2016), EI and its impact on occupational stress (Heenatigala et al., 2016), and EI and job satisfaction. Furthermore, EI is related to positive ways of dealing with work-related conflicts and coping styles (Ali, Morad and Sabri, 2020). EI of nursing undergraduates has not been discussed widely within the Sri Lankan context. Therefore, the findings of this study will be significant to reveal the EI status of nursing students. EI status of nurses and other areas are found in the literature, for instance, EI and job performance (Sewwandi & Thissera, 2015). According to the findings of the study, there is a significant impact of EI on job performance among nurses, and the researcher recommends organizing educational and training programmes regarding EI and job performance of nurses. A study conducted to assess the EI and Job satisfaction among nurses (Senanayake et al., 2020) has found a weak positive correlation between EI and job satisfaction among the nursing officers in General Hospital, Kalutara. Enhancement of job satisfaction through continuous evaluation and implementation of EI developing programmes in the hospital has been recommended by the researcher.

According to the evidence available, EI is fundamental to all basic nursing education programmes (Whitley-Hunter, 2014). Often, nursing students and patients experience emotions in response to precipitating conditions. When students recognize these emotions, they can adequately address patients' needs. Through EI, nursing students can learn to access their emotions and understand patients' emotions for assessing situations and facilitating healthy outcomes (Horton-Deutsch and Sherwood, 2008). Students may also continue to develop their EI throughout the nursing coursework in nursing education (Molina-mula and Gallo-estrada, 2020). In Sri Lanka there were studies conducted to assess EI among medical students (Edussuriya et al., 2018; Ranasinghe et al., 2017; Wijekoon et al., 2017). However, there are no published data on this area among nursing students in Sri Lanka.

Accordingly, this study aimed to assess the level of EI and academic performances and related factors among nursing undergraduate students in selected government universities in Sri Lanka. The findings of this study will be significant as this is a study that focuses on the student nurses' levels of EI, its relation to academic performances, and associated factors. In the literature, it is found out that based on the data gathered by assessment of EI, they have implemented programmes for improvement for their students (Polonio-López et al., 2019). Strengthening EI throughout nursing education is one positive response to increasing retention rates of nursing students and newly-licensed nursing professionals in the work environment (Bagheri et al., 2017). It is imperative for them to get ready by being emotionally prepared and to gain the ability to transit from the academic setting to work as a clinical nurse. Doing EI assessment will be an aid for identifying their levels in order to improve themselves for facilitating better patient care.

Besides, these results will be serving as baseline information for monitoring implemented or planned EI intervention programmes. In addition to that, these results are expected to encourage other

researchers to draw their attention more towards this area and conduct further research.

2. METHODS

A descriptive cross-sectional study was conducted during August-October 2021, involving 200 nursing undergraduates from four government universities in Sri Lanka. The systematic random sampling technique was used to select the students. The study instrument used to assess the EI was self-administered Genos emotional questionnaire (concise version), which is a widely used validated questionnaire (Palmer et al., 2014). For this study an EI questionnaire validated to the Sri Lankan context was used (Edussuriya et al., 2017).

The scale consists of 31 items, which are rated on a five-point Likert scale that ranges from 1 (almost never) to 5 (almost always). The scale includes seven dimensions (seven subscales). These subs scales are Emotional Self- Awareness (ESA), Emotional Expression (EE), Emotional Awareness of Others (EAO), Emotional Reasoning (ER), Emotional Self-Management (ESM), Emotional Management of Others (EMO), Emotional Self-Control (ESC). The items are scored on a five-point Likert scale, from "Almost Never" to "Almost Always".

A supplementary questionnaire was prepared to include demographic data (gender, family type, residential status and number of siblings in the family, monthly house hold income etc.). Furthermore, student perception of level of family support, self-motivation to study nursing, level of socialization within the faculty and religiosity were assessed by students response on a five point Likert scale to the following questions in the supplementary questionnaire; "I get good family support to carry out the academic work", "I am motivated by myself to study nursing and be a competent nursing professional in the future", "I think that I am well socialized within the faculty" and "I think I'm a religious person". Academic performances of the study participants were assessed by the Grade Point Average (GPA) which has been calculated for the students who have completed the examination with the respective years.

The total EI score was calculated by the sum of the sub categories. The Genos EI raw scores (subgroup scores and cumulative score) were correlated to demographic data. A pilot study with 11 randomly selected nursing students (10% of the study sample) was performed to ensure applicability, clarity and feasibility of the instruments. The students took around 15 - 20 minutes to complete the questionnaire. The mean age of the pilot study group was 25.27 ±2.97, the mean GPA was 2.97± 0.48, and the mean total EI score was 113.91 ±16.50.

Table 1: Sociodemographic characteristics of the participants

Demographic data:-		**Percentages and the number of participants**
University	USJP	18.5%(n=37)
	UOP	27.5%(n=55
	UOR	26%(n=52)
	KDU	28.0%(n=56)
Study year	2nd year	38.0%(n= 76)
	3rd year	33.5%(n=67)
	4th year	28.5%(n=57
Age	Mean	24.2
	Median	24
	Mode	24
	Std.Dev	2.59
Gender	Male	20.0%(40)
	Female	80.0%(160)
Nationality	Sinhala	92.5%(185)
	Tamil	5.5%(11)
	Muslim	2%(4)
Religion	Buddhist	89.0%(178)
	Hindu	4.5%(9)
	Catholic	4.5%(9)
	Islam	2%(4)

Table 2: EI scores for subscales and its association to gender

EI		ESA	EE	EAO	ER	ESM	EMO	ESC	Total
Theoretical range		6-20	8-25	8-20	7-25	9-25	9-20	4-20	31-155
Total score		3011.00	3628.00	3022.00	3727.00	3632.00	3099.00	2880.00	
Mean (% from max score)		15.06 (75.2)	18.14 (72.50)	15.11 (75.50)	18.64 (74.50)	18.16 (72.60)	15.49 (77.40)	14.40 (72.00)	115
Median		15.00	18.00	15.00	19.00	18.00	16.00	14.00	115
Median by sex	Male	16.00	19.50	16.0	21.00	19.50	16.00	15.00	123
	Female	15.00	18.00	15.00	19.00	18.00	16.00	14.00	115
P value		**.464**	**.154**	**.248**	**.040**	**.097**	**.427**	**.067**	
P values for the difference between gender >0.05 - Mann-Whitney U test									

Data Analysis

Data analysis was done by using the Statistical Software SPSS version 23. Descriptive statistics, associations and correlations were performed as the statistical procedures. All the data were not normally distributed. Shapiro Wilk test p value <0.05 and histograms showed non normal curves. Hence non parametric tests were employed. Correlation analysis was done by using Sperman rank correlation, two independent groups were compared by the Mann Whitney U test and more than two groups were compared by the Kruskal Wallis test. Significant p value was determined at the 0.05 levels.

Ethical Consideration

Ethical clearance was obtained from the Ethical Review Committee of Kaatsu International University. Permission was obtained from the selected universities prior to data collection. Informed consent was taken from the participants as stated earlier. The confidentiality of the participants was ensured at all stages of the study. Their participation in the study was entirely voluntary The total score was not significant among male and female groups p=0.073;>0.05 None of the demographic variables mentioned in the table 04 (Having siblings, Family type, Loss of parents, participation in extracurricular activities or selection of nursing degree programme as a self-motivated decision) were not associated with the total EI score of the participants (p>0.05).

according to the consent. They were allowed to withdraw from the study at any time despite consenting to take part earlier.

3. RESULTS

Table 1 contains demographic traits of the students, and it shows that most of the nursing students were at the age of 24, according to the mode of the data set. The mean age of the participants was 24.2±2.59. The majority of the participants were females 80.0% (n=160). According to the data, there were 38% (n=76) 2nd year participants, while 33.5% (n=67) were 3rd year and 28.5% (n=57) were 4th year participants.

Based on the total score categories, the highest score of 77.4% has been taken for Emotional management of others (EMO) and there were no any association to the EI subscales and gender except Emotional reasoning (ER) (p = 0.04;<0.05). (Table 02: EI scores for subscales and its association to gender)

Table 3: Association of emotional intelligence with the gender

Gender	N	Mean ranks	Median	P value
Male	40	115.15	125.0	0.073
Female	160	96.84	113.0	
Total	200			

The total score was not significant among male and female groups p=0.073;>0.05(Table 03). None of the demographic variables mentioned in the table 04 (Having siblings, Family type, Loss of parents, participation in extracurricular activities or selection of nursing degree programme as a self-motivated decision) were not associated with the total EI score of the participants (p>0.05).

Total EI score was significant among the study year. For the second year, the median score was 111.0 ± 13.85 and for the third year it was 114.0 ± 17.87. Considering the study years, the final year students had the maximum score of 116.00 ± 22 and the total EI score was significant among these three groups (p=0.022;p<0.05.)

The total EI score of the participants was not significant based on educational qualifications of the mother (p= 0.580) or educational qualifications of the father (p=0.529). Monthly income was categorized into four levels. Majority 36.5%(n=73) were in the 30000-60000 Rs. income category. According to the results given in the table, there was a significant difference of total EI score (mean rank and the median) among the income category groups p=0.028;p<0.05. the highest median (120.0) was reported by the higher income level of above 60,000 category and the lowest value (104.50) was reported by the lower income category. The results indicate a significant weak positive correlation (p=0.003; r=0.214) with the family relationship and the emotional intelligence among the study participants and the significant weak positive correlation (p=0.000; r=0.316) with satisfaction with the study of nursing and the emotional intelligence among the study participants

Table 4: Demographic variables and association with total EI score

Parameter	Status	No.	%	Mean Rank	P Value
Having siblings	Yes	185	92.5	100.31	.869
	No	15	7.5	102.87	
Family type	Nuclear	169	84.5	100.54	.982
	Extended	31	15.5	100.29	
Loss of parents	Yes	17	8.5	95.97	.736
	No	183	91.5	100.92	
Extra extracurricular activities	Yes	141	70.5	104.49	.131
	No	59	29.5	90.96	
Self-motivated decisions	Yes	98	49.7	100.35	.741
	No	99	50.3	97.67	

Table 5: Correlation between academic performances (GPA) and Emotional intelligence.

	Study year	r value	p value
Correlation between GPA and the emotional intelligence.	2nd year	0.435	0.004
	3rd year	0.376	0.034
	4th year	0.641	0.000

The Grade Point Average was calculated for the students who had completed the semesters without any repeat modules. Accordingly, only 116(58%) students have got their GPA due to incompletion of one or more modules. GPA ranges from 2.10 to 3.95 and the mean GPA was 3.30± 0.45.

Results indicate a moderate positive correlation between GPA and Emotional Intelligence among all three batches – 2nd year (p=0.004; r=0.435), 3rd year (p =034, r =0.376), 4th year (p=0.000; r = 0.641). This means there is a positive correlation between GPA and the Emotional intelligence among the nursing students. This indicates that students with higher GPA have high emotional intelligence levels.

4. DISCUSSION

The aim of the present study was to examine the association between emotional intelligence and academic performance in undergraduate nursing students in selected government universities in Sri Lanka. The results identified that there is no association between emotional intelligence and the demographic characteristics of participants that include having siblings, family type, loss of a parent, participation in extracurricular activities, self-motivated decision, educational qualification of the parents, and in contrast to that it was found out that family income was having a significant relationship with the EI. The results indicate a significant weak positive correlation between the family relationship and satisfaction with the study of nursing and the emotional intelligence among the study participants. Further, it was shown that there is a moderate positive correlation between GPA and emotional intelligence among all three batches and a positive correlation between GPA and the Emotional intelligence among the nursing students. This indicates students with higher GPA have high emotional intelligence levels.

The present study does not show a correlation between gender and the EI. However, a study conducted among nursing students in a public university in Oman has shown statistically significant higher scores among male nursing students in total and emotionality component scores (Deepa et al., 2021). Similar to the present finding, there were significant associations reported between the EI scores and the cumulative GPA and level of study. According to this study higher age category and being male predicted higher EI scores. Similar findings showed in the study conducted among the nursing students in college of nursing (Thamizhselvan and Vembu, 2019), and results revealed that the demographic variables such as age, gender, participation in extracurricular activities, domicile and family environment had not shown statistically significant association with level of emotional intelligence among nursing students. According to the present study, EI level of the nursing students was significant based on the socioeconomic status. EI level of the participants from high-income level families have shown a high score whereas EI level of participants from lower income level families have shown a low score. This has been proven by Brackett et al., (2012) in the study where it has stated that the income level of the families of nursing students have a significant impact on the EI level of the nursing students where the nursing students from high-income level families have the opportunities to have better education and improve EI whereas the nursing students from low-income families do not have opportunities to have a better education and improve EI.

Emotional Intelligence level of nursing students has a positive correlation with the family relationships in the present study. This has been proven by Berman and Radda (2012) where it has shown that good family relationships have a positive and significant relationship with the EI of nursing students. These findings suggest the important to improve the family relationships of nursing students in order to improve EI level. It should be taken into consideration by nursing students that development of strong family relationships will ultimately result in higher academic performances. EI level of the students from all three study years has shown a positive significant relationship with their academic performances. Students with higher EI levels have taken a high GPA value for their academic studies. This has been proven by Beauvais et al., (2011) in the study conducted to investigate the relationship between EI and the academic performances of nursing students, and it has shown that there is a positive significant relationship between the academic performances and EI of nursing students. Similarly, EI was also positively associated with academic achievement among nursing students in India (Kumar et al., 2016).

Moreover, EI score was significantly different among the study years. Median score values for EI have been increased from the first year to the third year showing a significant relationship between the study year and EI of the students. This has been proven by Deb (2013) where the study year of nursing students has a positive and significant relationship with the EI level. In contrast to the study findings, some studies showed that there was no

statistically significant difference between the freshmen's and senior students' scores (Barkhordari and Rostambeygi, 2019). Similarly, some studies revealed that undergraduate and graduate nursing students have high levels of EI and positively correlated with GPA in the graduate students, which show their academic performance, but it was not showed any correlation between EI and GPA among undergraduate students (Beauvais, et al., 2014). Some studies suggest in contrast to the present finding reveling that there is no correlation of academic success with overall emotional intelligence (Beauvais et al., 2014). Having a better EI level among nursing students is important to improve their performances in the academic work. Therefore, it is important to improve the EI level of students through the nursing programme.

5. CONCLUSION

Findings of the study show non-significance of the EI among male and female graduates. Further, it was able to investigate that demographic data such as age, family type, having siblings, loss of parents, involvement in extracurricular activities, educational qualification of the mother and father do not have a significant relationship with emotional intelligence. Further, it was identified that associated factors such as study year, income level of the families of nursing students, self-satisfaction on the nursing programme and future expectations have a significant relationship with EI.

Findings further indicated that a significant weak positive correlation exists between family relationships and emotional intelligence among the study participants. Similarly, a significant weak positive correlation was found between satisfaction with the study of nursing and emotional intelligence among nursing students. From the research study, it was possible to investigate whether higher EI of nursing students results in having higher academic performance levels.

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KJMS 2023 VOL.5 (1): 106-118

KDU Journal of Multidisciplinary Studies
(KJMS) Volume 5. Issue 1 July 2023
https://doi.org/10.4038/kjms.v5i1.68

AN INVESTIGATION INTO TEACHERS' UNDERSTANDING OF STUDENT DISCIPLINE IN PUBLIC SECONDARY SCHOOLS IN OYO STATE

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ABSTRACT

The study investigated teachers' understanding of student discipline in public secondary schools in Oyo State, Nigeria. It examined the public secondary school teachers' knowledge of student discipline in the 21st century. It further determined the appropriateness of strategies adopted by teachers in enforcing discipline in schools and as well examined the challenges facing the enforcement of discipline in public secondary schools.

The study adopted a survey design. The population of the study comprised all the public secondary school teachers in the Oyo central senatorial district of the state. The sample size comprised 200 senior secondary school teachers selected across public schools in the Oyo East Local Government Area of the state using a simple random sampling technique. A questionnaire titled Discipline Knowledge and Strategies Assessment Questionnaire (DKSAQ) was used to collect data for the study. Percentage, mean, standard deviation, and ranking were used to analyse the data.

The results showed that public secondary school teachers had incomplete knowledge about student discipline in the 21st century. The results showed that secondary school teachers adopted both appropriate and non-appropriate discipline strategies. Students' unfriendly home environments, parents' inability to provide basic needs, and fear of reprisal from students or their gangs were some of the identified factors militating against the enforcement of discipline in schools. The study, therefore, concludes that public secondary school teachers' knowledge of school discipline in the 21st century is inadequate and recommends that modalities through which teachers can have access to new knowledge and skills be put in place by their employers.

KEYWORDS: *Teachers, Knowledge, Student Discipline, Punishment, Strategies*

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1. INTRODUCTION

In any society, it is the responsibility of the adult members to properly guide the younger ones to absorb the virtues and other appropriate modes of conduct for adequate adjustment and functioning. The obligation of assisting children to acquire the appropriate behaviours and societal expectations is becoming a more arduous task than what can be left for parents to shoulder all alone in contemporary society. As a result, schools as an agent of socialization have been complementing the efforts of the parents to ensure the children grow up to become responsible adults. Though there seem to be several ways through which schools can affect desirable behaviour in children, discipline has been a significant strategy used by schools to control and modify children's behaviour.

It is however important to stress that while many individuals will acknowledge that discipline is an effective means of shaping children's behaviour, not many fully understand what discipline entails. Discipline as a term is often misused as many usually equate it with punishment (UNESCO, 2015). When it is said that a child needs disciplining, what easily comes to the minds of many people is that the child needs to be flogged or punished. In other words, for too many, discipline implies punishment. Discipline is, however, defined as the practice of teaching or training a person to obey rules or a code of behaviour in both the short and long terms.

Discipline is distinguished from punishment along with the intent. While punishment is meant to control a student's behaviour, discipline is meant to develop learners' behaviour, especially in matters of conduct. Discipline is also meant to help learners to learn what they are capable of learning and also it serves as the basis for guiding them on how to live in harmony among themselves and to get along with other people. The ultimate goal of discipline according to UNESCO (2015) is for students to understand their behaviour, take initiative, be responsible for their choices, and respect themselves and others. In other words, they internalize a positive process of thinking and behaving that can last a lifetime (UNESCO, 2015; Ajayi & Babatunde, 2017).

It is worthy of note that the task of building an effective and efficient society is a duty of all. Nevertheless, parents (homes) and teachers (schools) seem to be at the forefront of any other agents responsible for the socialization process of the individuals into a larger society. One of the professional roles of a teacher is to create a positive learning environment – a prerequisite for efficient learning, to minimize students' disruptive behaviour (Virtudazo & Guhao, 2020) and as well to assist them in inculcating desirable behaviour for effective functioning in the society at large. Also, in the Nigerian educational system, the legal doctrine of the in-loco-parentis bestowed on teachers authorized them to assume parental rights, duties and obligations expected of a parent to the child, and as a result, teachers are in a position to discipline the students as the situation may demand (Nakpodia, 2012). Lewis, Romi, Qui and Katz (2005) found teachers' disciplinary strategies as potent in school-related factors that shape learners' behaviour.

However, nowadays, teachers' rights to discipline learners' misbehaviour in the schools' settings are being challenged and becoming less effective in the system. The findings of Virtudazo and Guhao (2020) on lived experiences of public school teachers on student discipline in the classroom showed that teachers as a result of imposing discipline experienced harassment and intimidation, student defiance and disobedience, teachers' risk of litigation, etc. The incidence of parents and other family members hiring thugs to beat teachers at school over issues related to child discipline seems to be a recurring decimal in the Nigerian Secondary schools and reported by the daily newspapers (Oluwagbemi, 2017; Lambo, 2021; Olatunji, 2022). This ugly development tends to pose challenges and limitations to teachers' efforts at appropriately guiding learners. As opined by Ajibola and Ali (2014), many traditional approaches to discipline adopted by secondary school teachers are negative, punitive and reactive with a tendency to breed bad feelings for all parties involved. In other words, when

teachers lack a clear understanding of what discipline entails, there is the possibility of equating it with punishment. According to Ajibola and Ali (2014), a positive approach to discipline is based on the principle that when a student is inculcated with adult's skills to solve problems rather than taken as a child that must be punished, the tendency is high for such a student to respond positively and behave well.

Considering the importance of roles played by teachers in various secondary schools in Nigeria, there is a need for all segments of society to stand up in support of them. The forms of support expected from the entire society are not only to safeguard them against unlawful or unnecessary litigation and harassment from parents and wards but for government to create a conducive learning environment that permits modern-day teaching skills acquisition and professional development. As a legal rule called the 'Nemo dat rule' (One cannot give what one does not have) is still a truism, teachers' application of traditional approaches based on negative, punitive and reactive measures to discipline in contemporary society might create more problems than it solves with little or no positive outcomes in the behavioural change of students.

On empirical studies on teachers' knowledge and adoption of positive discipline, it seems that teachers are beginning to embrace the new development. In a study carried out by Chang, Juan and Chou (2014) where fuzzy measurement (logic) was applied to determine the appropriateness of disciplinary strategies among 400 teachers in Taiwan, the outcomes of the study revealed that in the positive discipline domain and the highly acceptable and effective strategies, teachers identified orally praising of students frequently, integration of life events in classroom management, granting awards, small merits, work incentives, and leading students to actively involved in volunteering activities. However, in the general discipline domain, it was found that teachers recognized notifying parents to associate in solving problems and adjusting students' seating as highly acceptable and effective strategies to deal with issues of students' misbehaviour. Kenely (2015) also reported that teachers mostly adopted disciplinary measures such as hinting techniques, discussion and effective teaching strategies to promote learning and learner responsibility. It was also reported in the findings that teachers rarely respond aggressively to learners' misbehaviour.

In a similar study conducted to explore the strategies employed by teachers to manage indiscipline in Effutu Municipality in Ghana, Amoah et al. (2015) found that teachers resort to an angry rebuke or reprimand as a disciplinary measure. The finding summarised teachers' disciplinary approaches as ranging from judgmental to subjective behaviours and teachers as well evaluate the disciplinary measures as appropriate or otherwise in managing misbehaviour. It was also found that teachers used verbal appreciation and shying away from their habit of de-motivating students and trying to encourage students not interested in classroom activities instead of punishment.

Despite the new trend of embracing a positive approach to discipline capable of developing learners' behaviour, evidence in the literature still suggests that researchers, teachers and parents alike are yet to fully comprehend what discipline entails. For instance, Ajibola and Ali (2014) were of the view that discipline was not necessarily connoted punishment but acknowledged as one of the disciplinary measures in schools. Omoteso and Semudara (2011) found that the majority (90.5%) of the teachers adopted giving advice as a measure for dealing with students' classroom misbehaviour; nevertheless, 57.6% and 59.6% of the teachers also adopted measures such as assigning of a portion of land for clearing and asking the misbehaved students to stand at the back of the classroom during the lesson as means of managing classroom misbehaviours in school. Olakitan (2014) reported that 84.7% and 83.7% of the parents and teachers respectively acknowledged the use of flogging while 79.4% and 78.9% of the parents and teachers also identified kneeling as corporal punishment measures in secondary schools. It was also found that 79.4% of the teachers perceived corporal punishment as the best measure to deal with students' misbehaviour in schools while the majority of the teachers (73.8%)

and parents (61.9%) exhibited a positive attitude towards the use of corporal punishment as disciplinary measures in schools.

In another related study carried out by Nkomo and Mayanchi (2016) to examine the most common measure of discipline employed by private and public teachers in Calabar municipality, the outcomes of the study showed that flogging, exercise or drills, and compelling students to maintain certain painful postures were in use to deal with students' misbehaviour. The outcomes of Odebode's (2020) study showed that teachers' knowledge of the discipline is inadequate as punishment was still regarded as one of the best strategies for dealing with students' misbehaviours in schools. Other strategies identified in the study include the use of reinforcement, modelling from school authorities, high parental supervision and professional referral while Aryati, Mauly and Muhammad (2021) found out that teachers adopted corrective discipline such as corporal punishment and rote learning; assertive discipline measures as well as preventive discipline to deal with students' disciplinary issues.

Statement of Problem

There seems to be a plethora of evidence on teachers' efforts to curb students' misbehaviour not only for effective and meaningful learning to take place in the classrooms but for the students to develop the desirable characters for effective transition into responsible adult life. However, the development in contemporary society about students' development of characters and virtues suggest that teachers' efforts had yielded little or no positive outcomes. This negative trend might be attributed to teachers' lack of clear understanding of what discipline entails as many still equate the term to mean punishment. Schools are regarded as one of the important agents of the children socialization process and teachers as major players play a significant role in the learning and character development of any child. This study, therefore, investigated teachers' understanding of the discipline in public secondary schools in Oyo State, Nigeria. Specifically, the study:

1. examined the public secondary school teachers' knowledge about discipline in the 21st century,
2. determined the appropriateness of strategies adopted by teachers in enforcing discipline in the public secondary schools, and
3. identified the challenges facing the enforcement of discipline in public secondary schools.

Research Questions

1. What is the public secondary school teachers' knowledge about discipline in the 21st century?
2. How appropriate are strategies adopted by teachers in enforcing discipline in public secondary schools?
3. What are the challenges facing the enforcement of discipline in public secondary schools?

2. METHODOLOGY

The study adopted a descriptive survey. A questionnaire titled Discipline Knowledge and Strategies Assessment Questionnaire (DKSAQ) was used to collect data for the study (Appendix 1). Percentage, mean, standard deviation, and ranking were used to analyse the data.

The population of the study comprised all the public secondary school teachers in the Oyo central senatorial district of the State. The total population of secondary school teachers in Oyo State is currently not available. However, the total number of teachers in senior secondary schools as at 2018/2019 was estimated to be 64,611 (Private senior secondary schools inclusive) (Statista, 2023) The sample size comprised 200 public secondary school teachers selected in Oyo East Local Government Area of Oyo State using a simple random sampling technique. The rationale for sample size selection is based on the principle of the Central Limit Theorem that with a sample size of 100 or more, a sampling distribution is assumed to be normal in shape (Healey, Prus, & Lieflander, 2019). The participants comprised 92 (45.5%) males and 106 (53.5%) females in which

Appendix 1: Research Instrument- Questionnaire Used in Methodology

DEPARTMENT OF EDUCATIONAL FOUNDATIONS, FACULTY OF EDUCATION
AJAYI CROWTHER UNIVERSITY, OYO, OYO STATE

DISCIPLINE KNOWLEDGE AND STRATEGIES ASSESSMENT QUESTIONNAIRE (DKSAQ)

Dear Respondent,
This questionnaire is designed to obtain information on your perspective to discipline as well as strategies you adopt in dealing with misbehaviours in the classroom. Your responses shall be treated with the utmost confidentiality and used solely for research purposes. I, therefore, urge you to attend to all the items as objectively as possible.
Thanks

SOCIO-DEMOGRAPHIC DATA
Name of School: ……
G**ender:** Male ( ) Female ( )
Age: Less than 25yrs ( ) 25-34yrs ( ) 35-44yrs ( ) 45years and above ( )
Educational Qualification: NCE ( ) B. Sc. /B. A ( ) B. Sc. Ed/B. A. Ed/ B. Ed ( )
Postgraduate ( ) Others (Please Specify): ……..
Years of Teaching Experience: Less than 5yrs ( ) 5-10yrs 11-15yrs ( ) 16yrs and Above ( )

SECTION B: KNOWLEDGE OF DISCIPLINE
Direction: Kindly read the statements in the table below and express your understanding about what discipline connotes as against the misused word known as punishment by ticking (√) the box that correspond to your opinion using: **True** or **False**.

S/N	Items	True	False
1	Discipline simply means punishment		
2	Punishment is an action (penalty) that is imposed on a person for breaking a rule or showing improper conduct		
3	Discipline is an action (penalty) that is imposed on a person for breaking a rule or showing improper conduct		
4	Punishment aims to control behaviour through negative means		
5	Discipline aims to control behaviour through negative means		
6	Discipline is the practice of teaching or training a person to obey rules or a code of behaviour in both the short and long terms		
7	Punishment is the practice of teaching or training a person to obey rules or a code of behaviour in both the short and long terms		
8	While punishment is meant to control a child's behaviour, discipline is meant to develop a child's behaviour, especially in matters of conduct		
9	While discipline is meant to control a child's behaviour, punishment is meant to develop a child's behaviour, especially in matters of conduct		
10	The ultimate goal of discipline is for children to understand their own behaviour, take initiative, be responsible for their choices, and respect themselves and others		
11	The ultimate goal of punishment is for children to understand their own behaviour, take initiative, be responsible for their choices, and respect themselves and others		
12	It is impossible to discipline students without punishing them		

SECTION C: STRATEGIES FOR MANAGING CLASSROOM BEHAVIOUR

Instruction: Kindly indicate how often you use the following techniques for managing your classroom. Tick (√) the option that best applies to you, taking into account that:

R= Rarely **S**= Sometimes **O**= Often **U**= Usually
Rarely: The technique is displayed almost never
Sometimes: The technique is displayed occasionally
Often: The technique is displayed regularly
Usually: The technique is displayed almost always

S/N	Strategies	R	S	O	U
1	I involve students in establishing rules and procedures				
2	I share with students the reasons behind the disciplinary approach(es) I use				
3	I provide positive reinforcement to students for appropriate behavior (e.g. tangible rewards)				
4	I make students aware of consequences for misbehaviour (e.g. loss of break time, extra classroom time)				
5	I use class time to reflect on appropriate behaviour with students as a group				
6	I redirect inappropriate behaviour on the spot, using loud voice				
7	I ignore misbehaviour that is non-disruptive to class				
8	I use short verbal cues to stop misbehaviour (e.g. say student's name aloud, use "shh" sound)				
9	I use nonverbal signals to stop misbehaviour (e.g. make eye contact, approach and touch disruptive students)				
10	I use self-assessment forms for students to evaluate their own behavior (e.g. checklists)				
11	I inform parents about classroom expectations				
12	I send for parents to report inappropriate behaviour.				
13	I send for parents to report good behaviour				
14	I collaborate with parents on a home-school behaviour plan				
15	I teach parents activities to do with students at home to reinforce good behaviour at school				
16	I inform parents about the policies regarding the use of mobile phones at school				
17	I inform parents about social networks and their correct use (e.g. "Facebook", "Twitter", "Instagram")				
18	I refer students to school guidance counsellor				
19	I send students home for aggressive or disruptive behaviour				
20	I send students to the Principal's office for misbehaviour				

SECTION D: CHALLENGES CONFRONTING TEACHERS IN ENFORCING DISCIPLINE

Kindly read the statements in the table below and respond appropriate by ticking (√) the box that correspond to your opinion on what you consider as challenges confronting teachers in enforcing discipline in schools using Strongly Agree (**SA**), Agree (**A**), Disagree (**D**) and Strongly Disagree (**SD**)

S/N	Challenges	SA	A	D	SD
1	Teachers' inadequate knowledge and skills in dealing with classroom misbehaviours				
2	Undue interference and harassment from the parents				
3	Indiscipline among the teachers themselves				
4	Uncooperative attitudes of school management				
5	Parents' inability to provide their wards with basic needs				
6	Students' unfriendly home environment				
7	Fear of reprisal from student or their gangs				
8	Lack of motivation on the part of the teachers.				
	Others(Please Specify):				

28(14.1%) were below the age of 25 years, 47(23.7%) were of age 25-34 years, were 35-44years, 81(40.9%) while 42(21.2%) were of age 45 years and above. In terms of their educational qualification, 20(10.1%) had NCE, 51(25.8%) had B.Sc. /B. A, 83(41.9%) had B.Sc. Ed/ B. A. Ed / B. Ed, 44(22.2%) had post-graduate degree. In addition, 54(2 7.3%) had teaching experience less than 5 years, 24(12.1%) had between 5-110 years of experience, 65(32.8%) had teaching experience between 11-15yeas while 55(27.8%) had above 16 years of teaching experience. A questionnaire titled Discipline Knowledge and Strategies Assessment Questionnaire (DKSAQ) was used to collect data for the study. DKSAQ consists of 40 items of which items 1-12 measured knowledge of the discipline, items 13-32 measured strategies for managing classroom behaviour (Adapted from Classroom Management Questionnaire, Diaz, Gonzalez, Jara-Ramirez, & Munoz-Parra, 2018) with a four-point Likert scale response **R**= Rarely **S**= Sometimes **O**= Often **U**= Usually, while items 33-40 measures how to curb corrupt practices with a four-point Likert scale response format of Strongly Agree, Agree, Disagree, and Strongly Agree. The instrument DKSAQ reported a moderate Cronbach's Alpha reliability coefficient of 0.78 when the instrument was pilot-tested with forty (40) respondents. Frequency, percentage, mean, standard deviation, and ranking were used to analyse the data collected for the study.

3. RESULTS

Research Question 1: What is the public secondary school teachers' knowledge about student discipline in the 21st century?

Table 1: Result table for Research Question 1: Secondary School Teachers' Knowledge about Student Discipline in the 21st Century

Knowledge of Student Discipline	Score Range	Frequency (f)	Percentage (%)
Low	0-4	6	3.0
Incomplete	5-8	153	77.3
Adequate	9-12	39	19.7
Total		198	100.0

In order to answer this research question, teachers' responses to 12 items on facts about a discipline that distinguished it from the most misinterpreted term as punishment were scored. Based on their respective scores, their knowledge is categorised and presented in Table 1.

Results in Table 1 showed that the majority (77.3%) of the teachers have partial knowledge of what discipline entails, 3.0% have low knowledge and 19.7% have adequate knowledge about the discipline. This shows that the knowledge of public secondary school teachers about discipline in the 21st century is partial. It is neither low nor high.

Research Question 2: How appropriate are teachers' adopted strategies in enforcing discipline in public secondary schools?

To answer this research question, teachers' responses to 20 items indicating 20 different strategies used in the school setting to enforce discipline are scored and subjected to a descriptive analysis of frequency and percentage. In addition, based on the mean value of each strategy, the appropriateness of the strategies is determined and the result is presented in Tables 2 and 3.

The result in Table 4 showed the appropriateness of strategies adopted by teachers in enforcing discipline in the public secondary schools in Oyo State. It is shown that three out of the listed appropriate strategies are used by the public secondary school teachers in Oyo State. They are: sharing with students the reasons behind the disciplinary approach(es), provision of positive reinforcement to students for appropriate behaviour, and making students aware of consequences for misbehaviour. These strategies are also often or regularly used. However, though, sometimes used by the teachers, some of the Non-appropriate discipline strategies are using class time to reflect on appropriate behaviour with students as a group; redirecting inappropriate behaviour on the spot, using a loud voice, ignoring misbehaviour that is non-disruptive to class, and sending students home for aggressive or disruptive behaviour.

Research Question 3: What are the challenges facing the enforcement of discipline in public secondary schools?

Table 2: Appropriateness of Teachers' adopted Strategies in Enforcing Student Discipline in the Schools?

S/N	Teachers' Student Discipline Strategies	Rarely		Sometimes		Often		Usually		$\overline{X}$	SD
		f	%	f	%	f	%	f	%		
1	I involve students in establishing rules and procedures	60	30.3	54	27.3	28	14.1	56	28.3	2.4	1.2
2	I share with students the reasons behind the disciplinary approach(es) I use	22	11.1	69	34.8	40	20.2	67	33.8	2.8	1.0
3	I provide positive reinforcement to students for appropriate behavior (e.g. tangible rewards)	40	20.2	26	13.1	70	35.4	62	31.3	2.8	1.1
4	I make students aware of consequences for misbehaviour (e.g. loss of break time, extra classroom time)	36	18.2	46	23.2	39	19.7	77	38.9	2.8	1.1
5	I use class time to reflect on appropriate behaviour with students as a group	56	28.3	52	26.3	50	25.3	40	20.2	2.4	1.1
6	I redirect inappropriate behaviour on the spot, using loud voice	49	24.7	81	40.9	52	26.3	16	8.1	2.2	0.9
7	I ignore misbehaviour that is non-disruptive to class	99	50.0	50	25.3	23	11.6	26	13.1	1.9	1.1
8	I use short verbal cues to stop misbehaviour (e.g. say student's name aloud, use "shh" sound)	28	14.1	71	35.9	68	34.3	31	15.7	2.5	0.9
9	I use nonverbal signals to stop misbehaviour (e.g. make eye contact, approach and touch disruptive students)	40	20.2	64	32.3	51	25.8	43	21.7	2.5	1.0
10	I use self-assessment forms for students to evaluate their own behavior (e.g. checklists)	64	32.3	64	32.3	34	17.2	36	18.2	2.2	1.1
11	I inform parents about classroom expectations	53	26.8	92	46.5	24	12.1	29	14.6	2.1	1.0
12	I send for parents to report inappropriate behaviour.	50	25.3	96	48.5	34	17.2	18	9.1	2.1	0.9
13	I send for parents to report good behaviour	76	38.4	64	32.3	35	17.7	23	11.6	2.0	1.0
14	I collaborate with parents on a home-school behaviour plan	65	32.8	67	33.8	41	20.7	25	12.6	2.1	1.0
15	I teach parents activities to do with students at home to reinforce good behaviour at school	54	27.3	59	29.8	42	21.2	43	21.7	2.4	1.1
16	I inform parents about the policies regarding the use of mobile phones at school	50	25.3	57	28.8	44	22.2	47	23.7	2.4	1.1
17	I inform parents about social networks and their correct use (e.g. "Facebook", "Twitter", "Instagram")	65	32.8	63	31.8	37	18.7	33	16.7	2.2	1.1
18	I refer students to school guidance counsellor	33	16.7	103	52.0	41	20.7	21	10.6	2.3	0.9
19	I send students home for aggressive or disruptive behaviour	80	40.4	60	30.3	23	11.6	35	17.7	2.1	1.1
20	I send students to the Principal's office for misbehaviour	46	23.2	97	49.0	38	19.2	17	8.6	2.1	0.9

Table 3: Appropriateness of Teachers' adopted Strategies in Enforcing Student Discipline in the Schools?

S/N	Teachers' Student Discipline Strategies	$\overline{X}$	SD	Frequency of Use	Appropriateness Status
1	I involve students in establishing rules and procedures	2.4	1.2	S	A
2	I share with students the reasons behind the disciplinary approach(es) I use	2.8	1.0	O	A
3	I provide positive reinforcement to students for appropriate behavior (e.g. tangible rewards)	2.8	1.1	O	A
4	I make students aware of consequences for misbehaviour (e.g. loss of break time, extra classroom time)	2.8	1.1	O	A
5	I use class time to reflect on appropriate behaviour with students as a group	2.4	1.1	S	NA
6	I redirect inappropriate behaviour on the spot, using loud voice	2.2	0.9	S	NA
7	I ignore misbehaviour that is non-disruptive to class	1.9	1.1	S	NA
8	I use short verbal cues to stop misbehaviour (e.g. say student's name aloud, use "shh" sound)	2.5	0.9	S	A
9	I use nonverbal signals to stop misbehaviour (e.g. make eye contact, approach and touch disruptive students)	2.5	1.0	S	A
10	I use self-assessment forms for students to evaluate their own behavior (e.g. checklists)	2.2	1.1	S	A
11	I inform parents about classroom expectations	2.1	1.0	S	A
12	I send for parents to report inappropriate behaviour.	2.1	0.9	S	A
13	I send for parents to report good behaviour	2.0	1.0	S	A
14	I collaborate with parents on a home-school behaviour plan	2.1	1.0	S	A
15	I teach parents activities to do with students at home to reinforce good behaviour at school	2.4	1.1	S	A
16	I inform parents about the policies regarding the use of mobile phones at school	2.4	1.1	S	A
17	I inform parents about social networks and their correct use (e.g. "Facebook", "Twitter", "Instagram")	2.2	1.1	S	A
18	I refer students to school guidance counsellor	2.3	0.9	S	A
19	I send students home for aggressive or disruptive behaviour	2.1	1.1	S	NA
20	I send students to the Principal's office for misbehaviour	2.1	0.9	S	A

***Frequency of Use**: Mean of 1.00-1.50=Rarely (R=Almost Never),1.60-2.50=Sometimes (S=Occasionally use), 2.60-3.50= Often (O=Regularly), and 3.60-4.00=Usually (U=Almost Always).*
***Appropriateness Status:** A= Appropriate, NA= Not Appropriate*

Table 4: Result Table for Research Question 3:
Challenges Confronting the Enforcement of Student Discipline in the Public Schools

S/N	Challenges	$\overline{X}$	SD	Rank
1	Teachers' inadequate knowledge and skills in dealing with classroom misbehaviours	2.4	1.0	8th
2	Undue interference and harassment from the parents	3.0	0.9	3rd
3	Indiscipline among the teachers themselves	2.6	0.8	6th
4	Uncooperative attitudes of school management	2.6	0.9	6th
5	Parents' inability to provide their wards with basic needs	3.1	0.9	1st
6	Students' unfriendly home environment	3.1	0.8	1st
7	Fear of reprisal from student or their gangs	3.0	0.8	3rd
8	Lack of motivation on the part of the teachers.	2.7	0.9	5th

Mean of < 2.5= No A Serious Challenge; 2.5 and above= A serious challenge

Result in Table 5 showed the challenges facing the enforcement of discipline in the public secondary schools in Oyo State from the perspective of classroom teachers. The result showed that teachers identified 'Students' unfriendly home environment', and 'Parents' inability to provide their wards with basic needs' as the foremost challenges with a mean of 3.1 each and a SD of 0.8 and 0.9 respectively. Also, ranked next are 'Fear of reprisal from students or their gangs' and 'Undue interference and harassment from the parents' with a mean of 3.0, a SD of 0.8 and 0.9. Fifth in rank is 'Lack of motivation on the part of the teachers' with a mean and a SD of 2.7 and 0.9 while Indiscipline among the teachers themselves and Uncooperative attitudes of school management occupied the sixth rank with a mean of 2.6 each and a SD of 0.8 and 0.9 respectively. Ranked the least among other challenges is 'Teachers' inadequate knowledge and skills in dealing with classroom misbehaviours' with a mean of 2.4 and a SD of 1.0. Therefore, teachers in public secondary schools in Oyo State identified students' unfriendly home environment, parents' inability to provide their wards with basic needs, fear of reprisal from student or their gangs, undue interference and harassment from the parents, lack of motivation on the part of the teachers, indiscipline among the teachers themselves, and uncooperative attitudes of school management as serious challenges confronting the enforcement of discipline in the public secondary schools in the state. (see Appendix 4).

4. DISCUSSIONS

The finding of the study showed that public secondary school teachers have partial knowledge about discipline in the 21st century. This is evident as the majority of the teachers exhibited a partial knowledge of what discipline entails in the 21st century. Many teachers tend to equate discipline to punishment and this lack of clear understanding of what discipline actually may hamper its effectiveness as a measure to develop students' capacity to embrace worthwhile behaviour. A lack of a clear understanding of the principles of discipline that distinguish them from punishment tends to result in mixing the use of punishment with some elements of discipline. This situation tends to result in counterproductive outcomes in teachers' aims and efforts towards developing and nurturing the desirable behaviour in students. The finding of the study corroborates the findings of Odebode (2020) and Aryati, et al. (2021) that suggest that teachers adopted some elements of punishment alongside discipline principles that primarily focus on developing students' behaviour rather than controlling such behaviour.

The findings of the study also revealed that both appropriate and inappropriate disciplinary strategies are used by the teachers that participated in the study. Out of the appropriate disciplinary measures considered in the study, only three are often or regularly used by the teachers while others are occasionally used. These include sharing with students the reasons behind the disciplinary approach(es) used; provision of positive reinforcement to students for appropriate behaviour, and making students aware of consequences for misbehaviour. Also, four disciplinary measures are considered inappropriate in the study and they are sometimes or occasionally used by the teachers. Among these inappropriate measures are teachers' use of class time to reflect on appropriate behaviour with students as a group; redirecting inappropriate behaviour on the spot, using a loud voice, ignoring misbehaviour that is non-disruptive to class, and sending students home for aggressive or disruptive behaviour. The findings of the study corroborate findings of Chang, et al. (2014) that reported some positive disciplinary measures as adopted by teachers in dealing with students' misbehaviours; Kenely (2015) found that teachers adopted measures such as hinting techniques, discussion and effective teaching strategies to promote learning and learner responsibility, and Odebode (2020) found that the use of reinforcement, modelling from school authorities, high parental supervision and professional referral as commonly used by teachers to deal with students' misbehaviour.

The findings of the study further revealed students' unfriendly home environment, parents' inability to provide their wards with basic needs, fear of reprisal from the student or their gangs, undue interference

and harassment from the parents, lack of motivation on the part of the teachers, indiscipline among the teachers themselves, and uncooperative attitudes of school management as serious challenges confronting the enforcement of discipline in the public secondary schools in the state. The outcome is consistent with the findings of Virtudazo and Guhao (2020) that as a result of imposing discipline, teachers experienced harassment and intimidation, student defiance and disobedience, teachers' risk of litigation. Also, the finding is consistent with reports of Oluwagbemi (2017), Lambo (2021) and Olatunji (2022) that teachers do experience harassment and assaults from students' parents or family members as a result of their attempt to curb students' misbehaviour using punitive measures in schools.

5. CONCLUSION

The study investigated teachers' understanding of the discipline in public secondary schools in Oyo State, Nigeria. From the outcomes of the findings, the study concludes that public secondary school teachers in Oyo State, Nigeria demonstrated a partial knowledge of school discipline in the 21st century. Many of the teachers still adopted both appropriate and non-appropriate strategies in enforcing discipline in the schools.

Implication for school counselling psychologists

The incidence of students' misbehaviour both within and outside the school settings is becoming a recurring issue with its attendant adverse effect both on learning and character development. When this ugly development is not nipped in the bud as early as possible, there is a possibility of the teachers and school administrators losing grip in their efforts to turn out learners with the requisite knowledge, skills, values and attitudes required for adult life in later life. As a result, there is a need for concerted efforts of all helping professionals within the educational settings to work hand in hand to assist the classroom teachers. There is a need for professionals like school counsellors and school psychologists to deploy their professional skills in developing the needed interventions either directly to assist in overcoming behavioural issues in schools or indirectly train the classroom teachers on positive disciplinary measures that work.

Classroom teachers already have many tasks to handle and as a result, they need the help of other helping professionals within the system. The schools' administrators should provide the needed logistics for the office of professionals like school counsellors and psychologists to be functioning. These professionals are expected to periodically engage the classrooms teachers and discuss the challenges related to students' misbehaviour and other personal mental health issues that can hinder their effectiveness in the school setting.

6. RECOMMENDATIONS

Based on the outcome of the findings, the following recommendations were made:

There is a need for employers of teachers (government) to put in place modalities through which teachers can have access to new knowledge and skills. This can be done through organizing seminars, workshops and other in-service training, skills acquisition and development. It is expected that teachers will have access to the best practices of handling students' behavioural challenges and as well to update their skills and knowledge about what positive disciplinary measures entail.

There is also a need for teacher training institutions to rejig and update the contents of their curriculum to meet the prevailing circumstances in society. These institutions should deliberately include in the course requirements for trainees, skills training programmes capable of equipping the trainees, with positive, effective and efficient classroom management and control strategies.

The school authorities need to put in place measures that can promote effective school-home partnerships. This partnership tends to promote cooperation and collaboration between the schools, parents and communities. Through such partnership, issues related to students' misbehaviour and other vital

issues will be discussed and deliberated upon for mutual understanding and benefits.

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KJMS 2023 VOL.5 (1): 119-131

KDU Journal of Multidisciplinary Studies (KJMS) Volume 5. Issue 1 July 2023

https://doi.org/10.4038/kjms.v5i1.69

INVESTIGATING THE CREATIVITY SKILLS OF UNIVERSITY STUDENTS WITH HEARING AND VISUAL IMPAIRMENTS IN KWARA STATE, NIGERIA

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ABSTRACT

Creativity skills are imperative for university students with hearing impairment and visual impairment for survival in the academic domain. Adopting the Five Creative Disposition Model, the study investigated the creativity skills of university students with hearing and visual impairment in Ilorin, Kwara State, Nigeria. The descriptive survey design was adopted and the study targeted university students with hearing impairment and visual impairment in Ilorin Kwara State, Nigeria. All 31 students with hearing impairment as well as all 13 students with visual impairment were selected for the study using a purposive sampling technique. The findings of the study revealed that students with visual impairment were high in all five creative dispositions, and also, students with hearing impairment were high in four creative dispositions except for inquisitive skills. The study recommends the use of assistive technology such as screen readers, magnification software, Braille displays, hearing aids, and cochlear implants, which could significantly enhance the learning experience of students with hearing and visual impairments. Providing access to these assistive technologies can help students participate fully in the classroom and achieve academic success.

KEYWORDS: *Creativity Skills, Hearing-Impaired Students, Visually-Impaired Students, Disability, Five Creative Disposition Model and Componential Theory*

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1. INTRODUCTION

Creativity can be seen as "a process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies; identifying the difficulty; searching for solutions, making guesses, or formulating hypotheses about the deficiencies; testing and retesting these hypotheses and possibly modifying and retesting them; and finally communicating the results" (Fields & Bisschoff, 2014). In this study, creativity is defined as a set of tactics used by students with special needs to thrive in the academic domain, particularly in a culture where prejudice and discrimination are prevalent. There have been a few theories on creativity developed throughout the years, but the componential theory of creativity was crucial in the study.

Componential Theory of Creativity

Teresa Amabile's componential theory of creativity was effectively stated in 1983. The hypothesis was carefully crafted to be applicable to both psychological and organizational creativity research (Amabile, 2012). It describes the creative process as well as the different aspects that influence both the process and the results. According to Amabile (1997), everyone has the ability to do at least rudimentary creative work; nevertheless, personality, environment, and time all have an impact on the amount of creativity and its frequency. Amabile enumerated two major suppositions. "There is a continuum from low, everyday levels of originality to the highest degrees of creativity found in historically significant inventions, performances, scientific breakthroughs, and works of art". Second, there are degrees of creativity in the behaviour of any single individual, even within a domain" (Amabile, 2012). Amabile further stated that the level of creativity that an individual produce at a particular point in time is a function of the creativity components operating within and around that individual at that time.

Amabile's idea is based on how individuals are/can be creative in a given setting at a specific moment. Students must optimize their creativity in order to excel academically; in general, students use a variety of creative tactics to achieve academic success. However, the various challenges university students face, such as academic stress (Reddy, Menon and Thattil, 2018), financial stress (Hicks, 2021), relationship problems (Nwosu, 2014) and career choice complexities (Nauman and Sarwat, 2014), are well documented in literature, especially for students with disabilities(Agyire-Tettey et al., 2017; Kapur, 2018). As a result, students acquire inventive techniques to deal with a variety of challenging situations at school.

The Five Creative Disposition Model

The five creative disposition model investigates the numerous creative dispositions that creative people use to keep afloat in life's complexity. According to Rabi and Masran (2016) a creative person(s) can develop novel ideas (originality), which are unusually relevant when considering several possibilities (fluency), are usually open-ended and can be thought of in a variety of ways (flexibility), and are rich in content, interest, and conclusion (elaboration). People that are creative go deeper into concepts, allowing them to comprehend, analyze, decide, assess, and develop promising options into artistically fruitful outcomes (Min-Ying, 2015). Furthermore, creative people have the ability to listen to their inner voice, they regard themselves as creative, they have a strong desire to express their ideas, and they are aware of their strengths, passions, and convictions (Treffinger *et al.*, 2002). Finally, creative individuals are inherently curious and eager to try new things. They are not afraid of the unknown and can tolerate uncertainty in order to achieve this goal, and they are committed to seeing their ideas through to completion.

In the study, these qualities were compressed and compacted into the "Five Creative Disposition Model," which comprises five creativity skills: inquisitive, persistent, imaginative, collaborative, and discipline (Foghlam, 2014; Collard & Looney, 2014; Spencer et al., 2014; Thompson, 2016). Curiosity or inquisitiveness demonstrates a student's ability to wonder and ask questions, explore and experiment in their environment, and study and

challenge topics. In psychology, inquisitiveness is classified as intrinsic motivation which is thought to be important for encouraging active learning and spontaneous exploration. According to Borowske (2005) there are two types of inquisitiveness that influence creativity. The first is an instinctive or emotional response, in which an individual's attention and concentration are stirred and awakened when confronted with a new problem. This means that curiosity might lead to exploration, which is frequently accompanied by anxiety. Second, "scientific curiosity or metaphysical wonder," in which the brain reacts to gaps or inconsistencies in its knowledge, prompting it to seek explanations.

Persistent ability demonstrates a student's ability to persevere in the face of adversity and uncertainty. When confronted with an unanticipated challenge, highly motivated pupils persist longer and continue to put in greater effort toward educational activities (Lens *et al.*, 2005). Students' perseverance may persist even after they have achieved their educational aim. It's referred to as effort management or effort regulation by Ampofo and Owusu (2015) and it refers to the ongoing expenditure of effort on a task, even when faced with impediments. Persistence may be necessary for students with special needs to achieve their educational goals.

According to Min-Ying (2015) imaginative skill is an ability and a thinking style that is beyond reality and pre-existing knowledge that plays a critical role in being creative. It entails the ability to generate a mental image of an image or thoughts, the mental flexibility to think in a certain way rather than just having a quasi-visual mental picture of concepts, and it is usually specific rather than abstract or generic. To be imaginative, according to Takaya (2004), is to think in alternate or various possible ways in order to break habitual or mechanical ways of thinking and to look beyond what is offered in order to avoid falling victim to only what is presented. Imaginative skill could help students with disability in developing alternative ways of solving emerging and pressing academic problems.

Collaborative skill refers to the capacity to work as part of a team and to collaborate with others to achieve a common goal. Summers et. al. (2005) and Zheng et. al. (2018) found a positive link between college students who participate actively in collaborative learning. Students with collaborative skills participate in group discussions, collaborative tasks, actively contribute to the achievement of a common learning goal, and share effort to achieve established objectives. Collaborative skill could be an effective method for encouraging academic creativity by assisting students in gaining needed support from their peers. According to Lew et. al. (2000) if there is a distinct academic group contingency and collaborative skill contingency reinforcing them to act, students will improve their performance. This capacity may be necessary for students with disabilities to engage in facilitative and interactive behaviors with their teachers and peers to attain their objectives.

The spectacle of creative effort, innovation, creativity, and a different approach to things are all indicators of creative abilities. Being creative, on the other hand, necessitates a high level of discipline. The ability to design realistic and reflective techniques for reaching defined goals is referred to as discipline (Simba et al., 2016). Discipline, for example, can help students perceive issues in new ways, recognize ideas worth pursuing, and persuade others of their ideas, all of which can encourage and strengthen creativity. Every human, according to Amabile (2012) possesses a certain level of creativity, and students with impairments are no exception.

Hearing Impaired and Visually Impaired Students

According to Deyglio (2009) every student should be able to express and demonstrate their talents and competences in the classroom, and neither disability nor a lack of topic knowledge should be a barrier. Mutumburanzou (2018) reiterated that creative skills can be learned through instruction and practice or are innate. Teachers and instructors, according to Obradović et. al. (2015) should focus on improving educational processes for visually and hearing challenged students through inclusivity, flexibility,

and recognizing students' attributes, aptitude, and skills, especially at the tertiary level. In order to maximize their potential in the school system, visually and hearing impaired students must use their creativity talents (Malik *et al.*, 2014). There is ability in every disability, and disability does not always imply incapability (Frieden, 2004). Inquisitive and inventive skills, for example, enable students with disabilities to engage their minds critically and effectively (Echezona, Osadebe and Asogwa, 2011).

Students with hearing impairment are classified as deaf or hard of hearing depending on the severity of their hearing loss, which can be permanent or temporary and range from mild to profound (Agyire-Tettey et al., 2017). Congenital deafness is a born deafness, whereas adventitious deafness is acquired deafness. According to research (Stinson, 1999) students with hearing impairments in traditional schools are frequently shunned by their hearing peers, even in the classroom. It is clear that self-concept and academic achievement of hearing impaired students have a significant relationship (Omotayo, 2011). Furthermore, negative attitudes of societies and students without disabilities toward hearing-impaired students have an impact on their academic and psychological well-being in school (Mwanyuma, 2016). In order for hearing-impaired students to be properly integrated into the schooling system, appropriate teaching aid should be inculcated (Mpofum & Chimhenga, 2013; Kun-man, 2017).

Visually challenged students have trouble seeing things up close or far away, have trouble seeing clearly, have a limited field of vision, are unable to distinguish colors, or have completely lost their sight. Binocular vision anomalies, poor optical correction, and prolonged use of vision in a stressful situation, among other things, might cause this (Kotingo et al., 2014). According to evidence (Stewart, 2014; Nasiforo, 2015) visual impairment has a negative impact on educational attainment; nevertheless, the introduction of inclusive education has aided visually impaired students in achieving their educational goals (Eguavoen, 2016). Similarly, Shahed et. al. (2016) asserted that providing active support from all stakeholders, particularly in the areas of technology and creativity, can dramatically improve the academic performance of visually impaired children.

Statement of the Problem

Creativity is essential for survival, particularly in the academic world. To maintain physical and psychological equilibrium, each person engages in some type of creative behavior. In the academic domain, however, creativity abilities are especially critical for students with hearing and visual impairments. Academic complexity and the stress that comes with them may be particularly harmful to these students in traditional universities where there is little or no help. Anecdotal data suggests that students with disabilities face the same difficulties, problems, and academic obstacles as those without disabilities. Students with visual impairment, for example, are required to enroll in an average of 13 courses per semester, move from one class to another in different locations, and follow up on test issues as other students, often without the assistance of a school guide and with the assistance of other students. During class hours, students with hearing impairments have been seen to have no translators and are frequently unable to articulate their thoughts and ideas because they are either dismissed by their peers or isolated during the academic discourse.

Furthermore, evidence has shown the challenges of students with visual impairment (Farrah et al., 2012; Agyire-Tettey et al., 2017; Otyola et al., 2017; Temesgen, 2018; Amin et al., 2021) and hearing impairment (Florence, 2008; Kapur, 2018; Wezzie Khomera et al., 2020) in their educational pursuits. However, to the best of the researcher's knowledge, no study has explored creativity skills, adopting the Five Creative Disposition Model, specifically to these categories of university students. Thus, this study assessed "Creativity Skills of University Students with Hearing and Visual Impairment in Kwara State: Adopting the Five Creative Disposition Model".

Research Question

What is the level of creativity skills (inquisitive,

persistent, imaginative, collaborative and disciplined) of university students with hearing impairment and visual impairment in Ilorin, Kwara State, Nigeria?

Research Hypotheses

Ho_1: there is no significant difference of the inquisitive skill of university students with hearing impairment and visual impairment in Ilorin, Kwara State, Nigeria.

Ho_2: there is no significant difference of the persistent skill of university students with hearing impairment and visual impairment in Ilorin, Kwara State, Nigeria.

Ho_3: there is no significant difference of the imaginative skill of university students with hearing impairment and visual impairment in Ilorin, Kwara State, Nigeria.

Table 1: Demographic Data of the Respondents

Variables	Frequency	(%)
a. Gender		
Male	21	47.7
Female	23	52.3
Total	**44**	**100.0**
b. Type of Impairment		
Hearing	31	70.5
Visual	13	29.5
Total	**44**	**100.0**

Ho_4: there is no significant difference of the collaborative skill of university students with hearing impairment and visual impairment in Ilorin, Kwara State, Nigeria.

Ho_5: there is no significant difference of the discipline skill of university students with hearing impairment and visual impairment in Ilorin, Kwara State, Nigeria.

2. METHODOLOGY

The study adopted descriptive survey research. A descriptive research design was considered appropriate for the study because it enabled the researcher to obtain information from a representative sample of the population to describe the research situation as it really exists.

The population of this study comprised all university students with hearing impairment and visual impairment in Kwara State. The target population includes all students with hearing impairment and visual impairment in a selected conventional university in Ilorin Metropolis. There are three universities in Ilorin Metropolis. A purposive sampling technique was used to select one university because it houses the largest number of students with hearing impairment and visual impairment. All 31 students with hearing impairment and all 13 students with visual impairment were purposively selected, which brings the sample size to 44.

An Adapted reconfigured questionnaire tagged "Creativity Skill Scale Questionnaire (CSSQ)", which captures the five creative disposition models, was used to collect the data for the study. The instrument comprised two sections coded A&B. Section A consists of the demographic information of the respondents including, gender and type of impairment. Section B Creativity Skills Scale (CSS) developed by Thompson (2016), "Targeting Creativity Skills for High School Students with Special Needs", was adapted under the supervision of experts to fit the context of the study. Four points Likert scale; "Not yet evident" (1), "Emerging" (2), "Expressing" (3) and "Excelling" (4) suggested by Treffinger et al., (2002) and used by Thompson (2016), was adopted as the scale of measurement. Mean scores below the cut-off Mean of 2.50 (i.e. 4+3+2+1/4 scale of measurement) was interpreted as a Low level while Mean score above the cut-off mean of 2.50 was interpreted as a High level of creative skills.

Face and criterion-related validity tests were conducted with the help of a disability specialist, to ensure the reliability of the instrument, and split-half procedure was conducted and the Correlation Coefficient of 0.73 was obtained for the instrument with the use of Cronbach alpha. The instrument was therefore adjudged to be very reliable.

The researcher personally administered the instrument to the students following all ethical processes. Approval was received from the centre for support service for the deaf from the selected institution and the consent of the students was sought before the instrument administration. For the visually impaired students, the items were read and their responses were collected after which the researcher personally collected copies of the completed questionnaire from the respondents for analysis.

The data were subjected to descriptive and inferential statistics. Percentage and frequency count was used to organize the demographic characteristics of the respondents. Descriptive analysis of Mean was used to answer the research question and Independent t-test was used to test research hypothesis one, two, three, four, and five all at 0.05 level of significance.

3. RESULTS

The "demographic description" of the respondents was described. The data presented in Table 1 shows the demographic characteristics of the respondents using percentages. Results in Table 1 show that out of the 44 university students with disabilities who participated in the study 21(47.7%) were male while 23(52.3%) were female. Also, 31(70.5%) students were with hearing impairment and 13(29.5%) where with visual impairment.

Research Question:

What is the level of creativity skills (inquisitive, persistent, imaginative, collaborative and discipline) of university students with hearing impairment and visual impairment in Ilorin Kwara State, Nigeria?

To answer the research question, descriptive analysis of mean was used to analyse the responses of the respondents on the five creativity skills based on the four-point Likert scale which was summed up to ascertain the cut-off Mean point of (4+3+2+1/4) 2.50. Also, the responses of each respondent were summed up to ascertain the average and then divided by the number of items in each category (inquisitive, persistent, imaginative, collaborative and disciplined) to determine the Mean of each skill.

A Mean greater than 2.50 was regarded as a high level and below 2.50 was regarded as a low level of creative skill. The result was presented in Table 2;

Table 2: Descriptive Analysis of Mean Showing the Creativity Skills of University Students with Hearing Impairment and Visual Impairment in Ilorin Kwara State, Nigeria

Skills	Hearing Impairment (N=31)			Visual Impairment (N=13)		
	Mean	**Std.**	**Level**	**Mean**	**Std.**	**Level**
Inquisitive	2.49	0.94	Low	2.56	0.47	High
Persistent	2.53	0.62	High	2.67	0.45	High
Imaginative	2.90	0.70	High	3.41	0.60	High
Collaborative	2.74	0.70	High	3.15	0.60	High
Discipline	2.83	0.53	High	3.00	0.55	High
Grand Mean	**2.70**			**2.96**		

Table 2 shows that university students both with hearing impairment and visual impairment in Ilorin, Kwara State scored above the cut of Mean point of 2.50 in all the components of creativity skills including persistent (2.53; 2.67) Imaginative (2.90; 3.41) collaborative (2.74; 3.15) and discipline skill (2.83; 3.15) respectively except for inquisitive skill (2.49; 2.56) where students with hearing impairment scored below 2.50 and students with visual impairment scored above 2.50. Also, the grand mean of 2.70 for students with hearing impairment and 2.96 for students with visual impairment indicates a high level of creativity skills for both categories.

Hypotheses Testing

Five research hypotheses were raised for this study and all were tested with the use of an Independent t-test all at 0.05 level of significance.

H_{01}: *There is no significant difference in the creativity skills of university students with hearing impairment and visual impairment in Ilorin Kwara State, Nigeria.*

Ho_2: *there is no significant difference in the persistent skill of university students with hearing impairment and visual impairment in Ilorin Kwara State, Nigeria.*

Ho_3: *there is no significant difference in the imaginative skill of university students with hearing impairment and visual impairment in Ilorin Kwara State, Nigeria.*

Ho_4: *there is no significant difference in the collaborative skill of university students with hearing impairment and visual impairment in Ilorin Kwara State, Nigeria.*

Ho_5: *there is no significant difference of the discipline skill of university students with hearing impairment and visual impairment in Ilorin Kwara State, Nigeria.*

To test all the hypotheses, responses on each creativity skill (inquisitive, persistent, imaginative, collaborative and discipline) of university students with hearing impairment and visual impairment in Ilorin, Kwara State were coded and analyzed using independent t-test statistical analysis individually in a single table. The result was compressed and reported in Table 2;

Results in Table 3 show the t-value of each of the five creativity skills i.e.-0.51, -0.78, -2.26, -1.86 & -0.92 and the p-value also, i.e. 0.616, 0.441, 0.029, 0.070 &0.365 respectively. The table indicates all the p-values were greater than 0.05 ((0.616, 0.441, 0.070 & 0.365) > 0.05) except for imaginative skill with a p-value of 0.029.

Since the p-value of inquisitive (0.616), persistent (0.441), collaborative (0.070) and discipline skills (0,365) are greater than 0.05 and imaginative skill (0.029) is less than 0.05 alpha level, it can thus be concluded that; The null hypotheses one, two, four and five are not rejected; meanwhile the null hypothesis three was rejected.

Hence, there is no significant difference in inquisitive, persistent, collaborative and discipline skills of university students with hearing impairment and visual impairment in Ilorin Kwara State, Nigeria; but there is a significant difference in imaginative skills of university students with hearing impairment and visual impairment in Ilorin Kwara State, Nigeria.

4. DISCUSSION

The finding of the study shows that the level of creativity skills of university students with hearing impairment and visual impairment in Ilorin Kwara State, Nigeria was relatively high. This finding agrees with the findings Stanzione et. al. (2013), Daramola et. al. (2019) and De Caroli et. al. (2020) submissions that both hearing-impaired and visually impaired students have a relatively high level of creativity and this has made them to adapt relatively well in a school environment at every level. Although, they pass through a lot, on and off campus, especially in a society with high prejudice, harnessing these creative skills and abilities are eminent both for their psychological and physical well-being including academic success. Echezona et. al. (2011) supported this, reiterating that there is ability in every disability; Hence students with hearing impairment and visual impairment scan very well and function in the academic environment if they can maximize these creative abilities.

The findings also revealed that university students with hearing impairment in Ilorin, Kwara State has low level of inquisitive skill; this could be because of the nature of the disability. This is evident because majority of students and staff on campus does not understand sign language (Antia et al., 2012; Antia & Kreimeyer, 2016) and this has impede interaction and discussion among students with hearing impairment, other students on campus and staff. However, since the advent of the internet interaction has drastically improved (Bodemann, 2012; Thorén et al., 2013; Egaga & Aderibigbe, 2015).

Table 3: Independent t-Test for each Creativity Skills of University Students with Hearing Impairment and Visual Impairment in Ilorin Kwara State, Nigeria.

Skills	Impairments	No	Mean	Std.	*df*	t-value	p-value	Remark
	Hearing	31	9.68	3.74				
Inquisitive					42	-0.51	0.616	NS
	Visual	13	10.23	1.88				
	Hearing	31	10.10	2.50				
Persistent					42	-0.78	0.441	NS
	Visual	13	10.69	1.80				
	Hearing	31	11.61	2.79				
Imaginative					42	-2.26	0.029	S
	Visual	13	13.62	2.40				
	Hearing	31	13.71	3.49				
Collaborative					42	-1.86	0.070	NS
	Visual	13	15.77	3.00				
	Hearing	31	11.35	2.19				
Discipline					42	-0.92	0.365	NS
	Visual	13	12.00	2.20				

Another finding of the study indicates that there is no significant difference in inquisitive, persistent, collaborative and discipline skill of university students with hearing impairment and visual impairment in Ilorin, Kwara State, Nigeria. Inquisitive, collaborative, persistent and discipline are crucial skills needed by students living with disability to thrive in the academic environment (Spencer, Lucas and Claxton, 2014). Although, the nature of hearing impairment and visual impairment may differ, however, students with hearing impairment and visual impairment require these skills to thrive in the university atmosphere (Thompson, 2016). The study also revealed a significant difference in Imaginative Skill of university students with hearing impairment and visual impairment in Ilorin, Kwara State, Nigeria. The nature of disability is of immense importance, and it may contribute to the difference in exploring their imagination (Newman, 2020).

Key Highlights

The inquisitive skill, persistent skill, imaginative skill, collaborative skill, and discipline skills are all crucial for the development of hearing-impaired and visually-impaired students; while these skills are interdependent, it is important to note that the development of each skill may be impacted differently by the disabilities of the student. For example, the inquisitive skill may be more difficult to develop for students who have difficulty processing auditory or visual information.

Similarly, the persistent skill may be more challenging for students who face additional barriers to learning, such as limited access to learning resources or limited support from educators and peers. It is also important to consider that the development of these skills may require accommodations and modifications to traditional teaching methods and materials to ensure that all students, including those with hearing and visual impairments, can fully participate in the learning process.

Collaborative skill is particularly important for hearing-impaired and visually impaired students as it enables them to work with others who may have different communication needs and to build a supportive and inclusive learning environment.

Finally, discipline skill is essential for hearing-impaired and visually impaired students as it enables them to stay organized, manage their time effectively, and remain focused on their learning goals despite potential challenges they may face due to their disabilities.

Alignment with UN's SGDs Goals

Developing the creativity skills of hearing-impaired and visually impaired students aligns with the fourth Sustainable Development Goal (SDG) of Quality Education in several ways:
Inclusive Education: By enhancing the creativity skills of hearing-impaired and visually impaired students, we can create an inclusive learning environment where these students can participate fully in classroom activities, express themselves creatively, and engage with the curriculum in meaningful ways. This aligns with SDG 4, which emphasizes the importance of ensuring that all learners have access to quality education.

Improved Learning Outcomes: Developing creativity skills can help special students to think alternatively, solve problems, and communicate effectively. By enhancing these skills, hearing-impaired and visually impaired students can improve their learning outcomes and achieve academic success. This aligns with SDG 4, which aims to ensure that all learners acquire the knowledge and skills needed to promote sustainable development.

Empowering Students: Developing creativity skills can also empower hearing-impaired and visually-impaired students to express themselves and share their perspectives with others. By giving these students the tools and skills to express themselves creatively, we can help them to build self-confidence, develop a sense of agency, and participate more fully in society. This aligns with SDG 4, which emphasizes the importance of empowering learners to become active agents of change in their communities.

Promoting Inclusive Societies: By promoting the creativity skills of hearing-impaired and visually impaired students, we can help to create a more inclusive society that values diversity and promotes equal opportunities for all. This aligns with SDG 4, which aims to ensure that education promotes social cohesion, tolerance, and respect for diversity.

In general, by encouraging the creativity skills of hearing-impaired and visually impaired students, we can promote quality education, empower learners, and build more inclusive societies that promote sustainable development.

5. CONCLUSIONS

University students with hearing impairment and visual impairment face a lot of challenges in school; ranging from social discrimination, academic difficulty and lack or little school support in all areas among others. However, despite all the challenges students with disability may face on campus, indications by the study were that students with hearing impairment and visual impairment possess relatively high creativity skills which might have sustained them on campus and in their academic pursuits thus far. Applying the five creative disposition models including inquisitive, persistent, imaginative, collaborative and discipline skills, the study reflects the usability of these skills and their differences between students with hearing impairment and visual impairment; indications were that no significant difference was found between students with hearing impairment and visual impairment on the four creative disposition except for imaginative skill. Thus, it can be inferred that creativity skills are highly adopted among students with disability and developing these creative skills are essential for university students with hearing impairment and visual impairment in Ilorin, Kwara State to thrive academically.

Since both university students with hearing impairment and visual impairment largely depend on the five creative dispositions to thrive in the academic domain as revealed in the findings of the study, the following practical approaches to support these students were recommended.

1. The use of assistive technology such as screen readers, magnification software, Braille displays, hearing aids, and cochlear implants could significantly enhance the learning experience of students with hearing and visual impairments. Providing access to these assistive technologies can help students participate fully in the classroom and achieve academic success.
2. University educators could make several accommodations to their teaching methods to support students with hearing and visual impairments, such as providing written copies of lectures, using visual aids, providing additional time for assignments, using inclusive language, and providing real-time captioning or sign language interpretation.
3. Collaborating with the student, their parents/guardians, and other professionals such as an audiologist or a vision specialist, an Individualized Education Plan could be developed and implemented to provide individualized support for each student with hearing and visual impairments to ensure academic success.

Therefore, future research should be conducted on creativity skills as a correlate of visually impaired and hearing-impaired students' academic identification. In addition, due to the small sample size – 44 respondents, which happens to be the total number of hearing-impaired and visually impaired students in the selected institution, research should be conducted on a broader scale involving high numbers of hearing and visually impaired students to buttress the generalization of the findings.

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KJMS 2023 VOL.5 (1): 132-144

KDU Journal of Multidisciplinary Studies (KJMS) Volume 5. Issue 1 July 2023

https://doi.org/10.4038/kjms.v5i1.70

INTEGRATING AIR ASSETS FOR AUGMENTING SURVEILLANCE CAPABILITIES OF THE SRI LANKA COAST GUARD

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ABSTRACT

Law enforcement at sea is of prime importance for an Island nation. At present Sri Lanka Coast Guard (SLCG) satisfies its aerial demands through Sri Lanka Air Force (SLAF) under various limitations causing a gap between the demand and supply of aerial surveillance requirements. Hence this exploratory qualitative study has followed a deductive approach, interpretivism philosophy, and grounded theory strategy to realize the objectives of determining the present status of the SLCG surveillance mechanism, determining how the air assets could be effectively integrated into the SLCG surveillance mechanism, and to study the impact of integrating air assets into the SLCG surveillance mechanism. A Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis resulted in strengths as already enacted act, experienced crew, and intention of authorities to integrate air assets into SLCG. Weaknesses were found to be a lack of naval assets, manpower, and the absence of air assets. Opportunities are the possible training opportunities, collaboration with the Sri Lanka Navy and SLAF, obtaining air assets through mutual cooperation, and leeway of integrating into a common maritime policy. Changing dynamics of non-traditional security threats, and geo-political implications due to inadequate presence and inadequate budget were identified as threats in SWOT analysis. Based on the outcome of the SWOT analysis, researchers came up with five recommendations such as formulating a framework for integrating air assets into SLCG, formulating a doctrine and Standard Operating Procedure for maritime-air operations of SLCG, developing a dialogue with SLAF for mutual cooperation and secondment of air and ground crew required for SLCG air operations, pursue diplomatic means for obtaining air assets and related training and finally conducting joint and multinational training and operations with local and international stakeholders. Therefore, strengthening SLCG capabilities and capacities by integrating air assets through a feasible framework in meeting its future operational demand is essential.

KEYWORDS: *Coast Guard, Air Force, SWOT, Law enforcement, Transnational Organized Crimes*

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1. INTRODUCTION

"Safety and security don't just happen; they are the result of collective consensus and public investment. We owe our children, the most vulnerable citizens in our society, a life free of violence and fear."
-Nelson Mandela- (Nelson Mandela Foundation, 2022)

Maritime security is an essential requirement for an island nation. Sri Lanka is straddling at the approximate center of the Indian Ocean, thus vulnerable to traditional and non-traditional security challenges arising from the region (Bueger, 2015), (Chatterjee, 2014). Hence, maintenance of law and order at sea is of prime importance, which is a responsibility shared by coast guards and the Navy through their constabulary roles. Sri Lanka Coast Guard (SLCG) is a government establishment for multi-mission services to ensure the security of coastal areas, maritime zones (Fig. 1), territorial waters, and high seas (Department of Coast Guard Act, 2009). It is the law enforcement authority at sea.

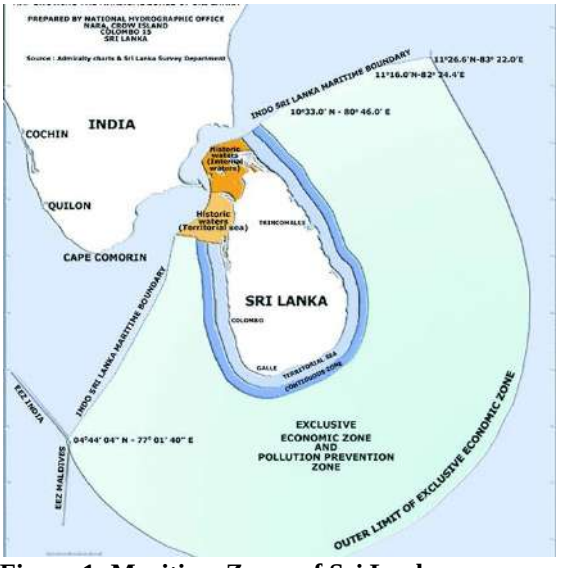

Figure 1: Maritime Zones of Sri Lanka
Source: (Giri, 2018)

The operational domain of the coast guard is not restricted to the maritime domain, but it expands across the aerial domain too (Gray, 2001). As an entity with numerous duties and functions pertinent to preventing the illegal activities defined by the government in Coast Guard Act, SLGC requires an effective mechanism to monitor the area of responsibility it is assigned with.

Territorial waters and Contiguous Zone (CZ) extend 12 nautical miles (NM) and 24 NM from baseline respectively. Exclusive Economic Zone (EEZ) expands up to 200 NM from the baseline of Sri Lanka except towards North, North West, and West. Further, there is a claim to expand Sri Lanka EEZ up to 350 NM (Wanasinghe and Wijethunga, 2021). Present EEZ accounts for approximately 6-7 times bigger than the land area. In addition, Sri Lanka is located at the center of the Indian Ocean Region (IOR), and one of the world's busiest Sea Lines of Communications (SLOC) lies 3-4 NM below Sri Lanka joining East and West. This area and beyond are to be covered by the SLCG to perform its duties effectively. The use of only surface vessels for surveillance of this area is not feasible due to the inherent technical limitations such as speed, range, and detection capabilities of naval vessels.

Coast Guards of regional and global counterparts have already established their aviation to supplement the naval fleet in enhancing their surveillance capabilities (Carlo and Paul, 2015). As the security dynamics at sea are becoming more complex, SLGC would require sound sensors to collect information from the area concerned, thus requiring aerial inputs for effective and efficient operations.

The problem identified is that the capacity of the SLCG is presently limited to surface operations as far as their assets are concerned. The area assigned to perform its duties overwhelms its present capacity, thus demanding more assets. The responsibility of assuring security, safety, and stewardship at sea demands the support of the air assets to supplement the output of surface assets (Brown, Potoski, and Slyke, 2008).

Therefore, without the inputs of air assets for surveillance of a vast sea area, there could be a gap between the expected outcome and the actual outcome, which is the gap identified by the researchers to motivate this study. This gap is evident in the reported crimes at sea despite the efforts by

SLCG. Hence, the paper focuses on identifying the present capabilities and capacities of SLCG for surveillance and studying how the integration of air assets could contribute to capacity building. The objectives of this paper are as follows.

- To determine the present status of the SLCG surveillance mechanism.
- To determine how the air assets could be effectively integrated into the SLCG surveillance mechanism.
- To study the impact of integrating air assets into the SLCG surveillance mechanism.

The research questions are such that how the present SLCG operates its surveillance mechanism, how the air assets could be integrated into the SLCG surveillance mechanism to enhance its effectiveness, and what would be the impact of integrating air assets into the SLCG surveillance mechanism. Since the literature regarding coast guard operations pertinent to Sri Lanka is limited, this research outcome would be significant for SLCG and SLAF in particular and to the government authorities seeking effective law and order implementation at sea in general.

2. METHODOLOGY

A deductive approach was espoused to find means to the observed phenomenon. During this exploratory qualitative study, researchers have employed interpretivism as the philosophy, whereas encompassing grounded theory strategy is the strategy. The time horizon was cross-sectional and the collection of primary data was conducted by interviewing nine respondents from SLCG and Sri Lanka Air Force (SLAF) selected through purposive sampling. Secondary data was collected through literature and government publications pertinent to coast guard operations. The technique was data collection and analysis. Further, a Strength, Weaknesses, Opportunities, and Threats (SWOT) analysis was conducted by translating the data collected from the respondents thematically, with a perspective of integrating air assets into SLCG.

The conceptual framework has been developed, based on the theoretical framework, and in line with the three research objectives.

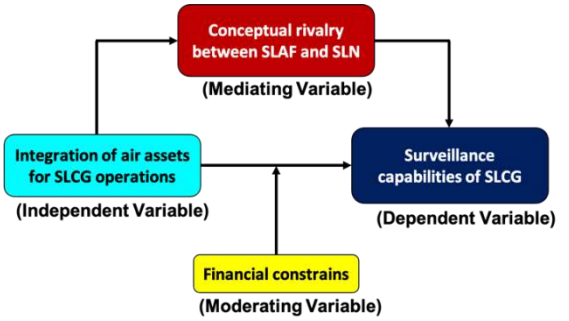

Figure 2: Conceptual Framework
Source: Authors (2022)

BACKGROUND

Contemporary situation

SLCG is a relatively young service with a service of approximately 12 years. Cabinet paper was approved for the establishment of SLCG on 07 March 2007 and Coast Guard Act No.41 of 2009 was enacted on 09 July 2009. SLCG commenced its duties on 04 March 2010 under the Ministry of Defence (SLCG, 2010). SLGC has a separate fleet of vessels, establishments for training and operations, specialized equipment…etc.

SLGC is headquartered in Mirissa and functions under four regions such as Southern, Eastern, Nothern, and Western. SLCG bases, stations, sub-stations, life-saving posts, fishing monitoring points, and special duty points are scattered along the entire coast of Sri Lanka (SLCG, 2010). However, the limited resources and personnel assigned to discharge the duties of SLCG have delimited the operations to the areas with high-intensity of marine activities. By referring to the distribution of SLCG establishments it is evident that the surveillance capability is highly limited. A number of security threats such as illegal immigration, Illegal unregulated and unreported (IUU) fishing, smuggling of drugs…etc. are emanating from North Western, Northern, and North Eastern waters (Wanasinghe, 2016). These areas are not sufficiently covered by SLCG establishments distributed as indicated in Figure 3.

Figure 3: SLCG Establishments
Source: (SLCG, 2010)

In addition, the fleet of SLCG is limited to four Offshore Patrol Vessels (OPV) and 27 Fast Attack Crafts.

Requirement of augmenting surveillance capability and capacity of SLCG

Considering the sea area of Sri Lankan waters, it is obvious that SLCG is nowhere near meeting the surveillance demand essential for law enforcement duties. Timely identification of crimes at sea is extremely important for preventing or mitigating the adverse outcome of it. Illegal activities such as oil spills, sea dumping, piracy, and maritime terrorism can cause out of proportion adverse impact on national security architecture if not detected and addressed on time (García Ruiz, South and Brisman, 2022). Naval disasters such as the New Diamond incident in 2020 and the X-press Pearl incident in 2021 are clear examples for out of proportion harm due to late detection and incapacitation in handling by local agencies (Wanasinghe and Wijethunga, 2021).

Since there are different security threats originating from different sea regions of Sri Lanka such as IUU fishing mainly from North Western and Northern seas, smuggling via Western, North Western, and Southern sea routes, oil spills from Eastern, Southern and Western seas…etc. (Bandaroff, 2021), (García Ruiz, South and Brisman, 2022), (Kulathunga, 2018), it is required to have all-around surveillance on a regular basis. For a developing country like Sri Lanka, it is difficult to employ a system covering all aspects of around-the-clock surveillance. On the other hand, failure to detect the illegal activities described above does incur serious damage in terms of security, socio-economic affairs and the environment. Air operations are costly affairs, which demand a substantial budget. It is not the capital cost that put the operators in trouble, but the operational (recurrent) cost (Lee *et al.*, 2001). Base maintenance facilities, specialised equipment, tools, highly specialized technical staff and a higher level of training are some basic prerequisites of safe and efficient air operations. Nevertheless, Sri Lanka can develop a framework to integrate air assets into SLCG, in the same manner, they have integrated naval assets. As the system has been functioning successfully so far it could be adapted for integrating air assets into SLCG. SLAF could facilitate the ground support and operate the air assets of the SLCG for air operations in a similar manner that SLN does for naval operations.

SWOT ANALYSIS ON INTEGRATING AIR ASSETS FOR AUGMENTING SURVEILLANCE CAPABILITIES OF SLGC

The scope of the SWOT analysis was limited to the discussion of facets pertinent to the integration of air assets. The interview data was thematically compiled to conduct the SWOT analysis.

Strengths

The SWOT analysis exposed the following strengths of SLCG for integrating air assets for its surveillance operations.

1) Already enacted act to provide the establishment of SLCG, to specify the functions, and to provide for matters connected therewith or incidental thereto: Act of SLCG is enacted on 09 July 2009. There are two closures covering the employment of air assets for discharging SLCG duties. The powers of the SLCG include;

> *'Stop, enter, board, inspect and search any place, structure, vessel or aircraft and to arrest and detain any vessel or aircraft '*

'Examine and seize or dispose of any fish or any article, device, goods, vessel, aircraft or any other item relating to any offence which has been committed or it has reasonable grounds to believe that such offence has been committed (Department of Coast Guard Act, 2009)

Enforce these two closures of the SLCG Act, it requires air assets. Further, a breach of law and order at sea by an aircraft could only be pursued by another appropriate aircraft. Apart from these specific closures other closures covering the duties of SLCG would be greatly supplemented by the employment of aerial capabilities due to the very characteristics of height, reach and speed of air assets.

2) Established organizational structure with a space for further expansion: SLGC has a well-systematized organizational structure to address its operational and functional scope. However, at present, there is no dedicated place in the organization structure for air operations. Nevertheless, it could accommodate air operations to present organizational structure. As the SLGC conducts naval operations in line with the SLN, air operations could be conducted in line with the SLAF modus operandi.

3) Interoperability with other stakeholders: The breakdown of SLGC naval assets is as follows.

Table 1: Naval assets of SLCG

Vessel Type	Quantity
OPVs	04
Fast Attack Craft	27

Source: SLCG (2022)

All these assets have interoperability with air, naval, and ground assets. At present SLCG closely operates with the following stakeholders for realizing its operational objectives:

- Lanka Police
- Sri Lanka Customs
- SLN
- Marine Environment Protection Authority (MEEPA)
- Coastal Conservation and Coastal Resource Management Department (CCCRMD)
- National Aquatic Resources Research and Development Agency (NARA)
- Department of Fisheries and Aquatic Resources (DFAR)

In addition, SLCG at times works with SLAF where air assistance is mission critical. It is known that SLCG has already implanted the required equipment for interoperability. Further, human capital also plays a key role in the joint operational environment. Effective integration is a result of continuous training and working with clear objectives and guidelines.

4) Experienced crew: SLGC has employed an experienced crew in naval affairs and operations. They are provided with specialized training locally and internationally for performing their duties in different situations. Controlling oil spillages, arresting armed violators such as pirates/terrorists, and comprehending unarmed violators such as illegal fishermen demand different specializations (Wang *et al.*, 2014). In addition, vessels such as SLCG Ship (SLCGS) Suraksha, SLCGS Samaraksha, SLCGS Smudraraksha etc., have limited firefighting capabilities. SLCG has training centres and qualified instructors for conducting this specialized training.

5) The intention of relevant authorities to integrate air assets into SLCG operations: Authorities of SLCG have identified the importance of inducting air assets into their operations, which could exponentially enhance their surveillance capabilities. SLN has shown an increasing determination for inducting an aviation arm for its operational requirements. Whenever operational

requirement demands air support, SLAF is usually called upon as of now.

Weaknesses

The SWOT analysis enunciated the following weaknesses of SLCG for the integration of air assets for its surveillance operations.

1) *Lack of adequate naval assets and equipment:* At present SLCG is allocated a very limited number of vessels for surveillance as listed in Table 1. Hence it has to seek support from stakeholders such as SLN and SLAF for fulfilling their surveillance demands. The absence of adequate coastal RADARs, the limited operational range of SLCG vessels and the limitations of shipborne RADARs had narrowed down the SLCG surveillance capability and capacity. The SLAF and SLN assets in such nature have certain limitations, which do not fully cater the expected input by SLCG, being designed to meet military operational demands rather than enforcing law and order.

2) *Lack of adequate manpower:* Lack of qualified manpower in highly specialized undertakings is not a novel notion for specialised organisations, which SLCG is not immune to. It takes time and effort in training personnel to undertake specialized tasks such as coast guard operations. The high-risk factor has become a key concern in the majority of SLCG operations.

3) *Absence of air assets:* For surveillance of large swaths or seas, aerial platforms are best suited considering the overall outcome of the effort. The primary air power characteristics of height, speed and reach of aircraft enable the operators to screen larger areas in a shorter period with a lesser effort. Modern technologies such as advanced RADARs, sophisticated sensor pods, and synthetic imaging systems have significantly enhanced surveillance capability and capacity. These systems undermine the limitations imposed by weather and lighting conditions. Further, the assets are to be dedicatedly available for the surveillance requirement of SLGC, to reduce delays. Hence, it is understood that without suitable air assets for surveillance, covering the sea area of responsibility that falls under SLCG seems to be way beyond its capacity.

4) *The conceptual rivalry between SLN and SLAF in maritime-air operations:* When it comes to maritime-air operations SLAF and SLN become the primary agencies in the Sri Lankan context. SLAF has been operating over Sri Lankan seas as the sole air operator to date. SLN used to seek the assistance of SLAF for satisfying its aerial requirements. Nevertheless, scarcity of air assets and exponential operational costs have created a condition where SLAF is obliged to give precedence to its independent maritime-air demands, over SLN requirements at times. Hence SLN has been contemplating on establishing a naval aviation to address their maritime-air operational demands to reduce dependence on SLAF.

Inducting air assets is a lengthy and complex process. It entails numerous prerequisites and operational support measures to commence air operations. Apart from the capital cost of aircraft, it requires proper base maintenance facilities, an effective forward logistical supply system, adequately trained and certified crew for maintenance and flying, various test equipment and workshop facilities, aerodrome facilities, and numerous correspondence for regularizing operations. Most importantly these measures decide the safety of flight operations. As SLAF has adequate supportive measures and expertise, forming up naval aviation for SLN would almost certainly duplicate efforts and cost at the national level, without yielding expected outcomes. Therefore, SLAF has been advocating otherwise to avoid operational complexities and the divide of budgets for a similar national purpose. Undoubtedly, the necessity of SLN and SLAF for tailoring the maritime security fabric is equally important as two blades of a pair of scissors for cutting (Lambeth, 2008). Nevertheless, obtaining aircraft for SLGC is a totally different discussion since law enforcement and defence are two distinctive functions of national security.

5) *Lack of mutual collaboration:* Irrespective of the resources, capabilities, and capacities, no

country is in a position to satisfy its law enforcement requirements at sea alone. Thus, multilateral collaborations are required. At present SLCG has bilateral/multilateral agreements with the United Nations Office of Drugs and Crime (UNODC), Japan, Australia, and Indian counterparts. Nevertheless, as far as IOR is concerned, many Transnational Organized Crimes (TOC) has links to Golden Crest and Golden Triangle, which utilize Sri Lanka as a transit hub. Thus, more strong relationships with regional and global counterparts are required. Preventing crimes across Indo-Lanka International Maritime Boundry Line (IMBL) requires strong mutual cooperation with India. Information and intelligence sharing is a much-needed activity for the effective mitigation of crimes emanating from IOR.

Opportunities

The SWOT analysis resulted following opportunities for SLCG to integrate air assets for its surveillance operations.

1) Increased training opportunities: Being a law enforcement agency SLCG receives a greater number of specialized training from foreign counterparts. Many crimes emanating from the marine domain undermine and threaten the realization of the United Nations (UN) Sustainable Development Goals (SDG). Therefore UNODC funds many such training programs across the globe (UNODC, 2022). The scope of these training programs spans almost all specializations required for SLCG duties. It is a matter of effective employment of diplomatic tools for obtaining adequate training opportunities for SLCG.

2) Collaboration with SLN and SLAF for capacity building: SLCG has a close collaboration with SLN. The situations at sea demanding more manpower, specialization, and naval assets are being addressed by the support of the SLN frequently. Almost all major maintenance of SLCG vessels, manpower, and technical and equipment support for SLCG operations are met by employing SLN assets and men. SLAF also could similarly facilitate SLCG as SLN provides its services to attain SLCG operational demands with proper collaboration, provided that the SLGC is equipped with air assets. Further, existing assets in SLN and SLAF could be utilised as practicable to meet the operational success of SLCG.

3) Possibility of obtaining air assets through mutual cooperation: Mutual cooperation between interested parties is commonplace in coast guard operations (Khurana, 2007). The mutual effort by Sri Lankan and Australian authorities for curtailing illegal migrants from former to latter is such a program, where the latter provided many assets and training to the former for conducting operations effectively (Jayasuriya, 2014). Furthermore, air diplomacy could be utilized for yielding better results. SLCG was donated with a number of ships such as SLCGS Suraksha from India, SLCGS Smaraksh, and Samudraraksha from Japan for coast guard duties as a result of an effective diplomatic projection of requirements of capacity/capability enhancement. In the same manner, SLCG can seek air assets through diplomatic means. For the operation of air assets, pilots and technical crew from SLAF could be seconded. Major maintenance requirements could be outsourced to SLAF workshops in the same manner SLCG operates and maintains its fleet of vessels.

4) Enable integration into a common maritime policy: The total sea area of 169,000 square miles of IOR is shared by 38 littoral states(Senaratne, 2016). Due to the enormity of IOR, all these littoral countries are tussling in realizing their national maritime interests alone. Hence, there are numerous bilateral and multilateral cooperations formulated to meet such objectives collaboratively (Bateman, 2005), (Wijetunge and Wanasinghe, 2021). As argued by Senarathne (2016), a common maritime policy would be a better option, consisting of all interested actors. Appropriate naval and air assets are essential in translating paperwork into action(Dabova, 2013). Hence, to contribute to a common framework and to negotiate through diplomatic means, Sri Lanka should be in a reasonable state of affairs in terms of

air and naval assets with interoperability (Wanasinghe and Wijethunga, 2021).

Threats

The SWOT analysis revealed the following threats to SLCG in the absence of air assets for its surveillance operations.

1) Changing dynamics of non-traditional security threats: There is a number of non-traditional security threats to the peace, law, and order of Sri Lanka springing from the marine environment (Wanasinghe and Abewardana, 2021). Most of these threats could be categorized as TOCs due to the collusion of multinational stakeholders. Some of the most prominent threats are as follows;

- Armed robbery at sea
- Piracy
- Maritime terrorism
- Smuggling of drugs, humans, contraband…etc
- Illegal immigration
- Marine pollution
- IUU fishing

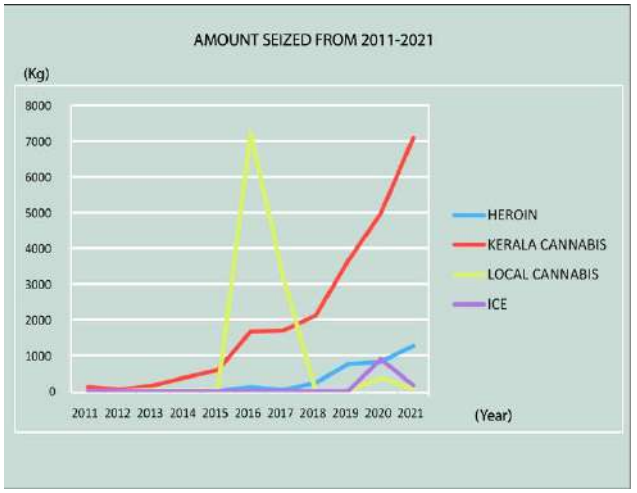

Figure 4: Seizure of drugs by SLN 2011-2021
Source: (SLN, 2022)

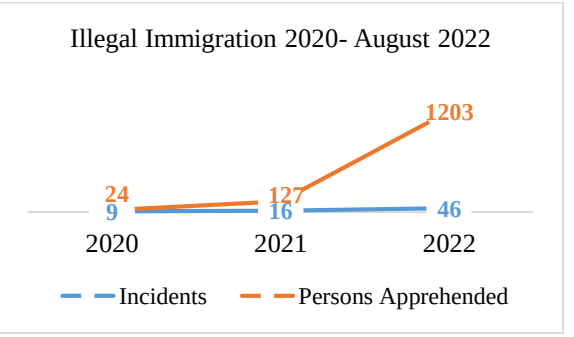

Figure 5: Illegal Immigration in Sri Lankan Waters 2020-August 2022
Source: (SLN, 2022)

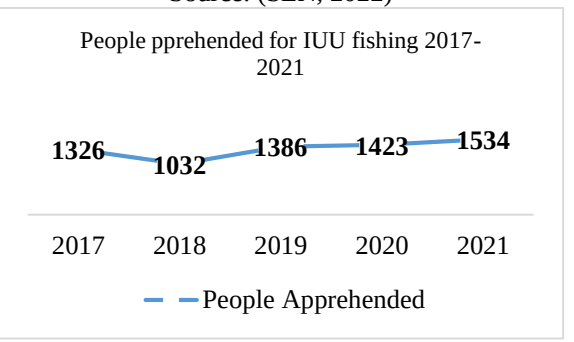

Figure 6: People apprehended for IUU fishing 2017-2021
Source: (SLN, 2022)

Out of these threats, armed robbery, piracy, and maritime terrorism threaten the peace and safe operation at sea, which has a very serious socio-economic and security impact on Sri Lanka. Smuggling and illegal immigration also cause complex social issues leading to economic consequences. IUU fishing and different ways of marine pollution such as sea dumping and oil spillages usually result in long-lasting environmental impacts on marine ecosystems in addition to the economic impact. Continuous monitoring of these crimes at sea is not an easy task. It needs more assets, more effort, and sophisticated technology (MDSL, 2020).

2) Geo-political implications due to inadequate presence: IOR is a region, which entails complex criminal activities due to various reasons such as heterogeneity of demographic variables in littoral countries, the vastness of the sea area, hub location between crime-prone regions, and lack of capabilities and capacities of regional states

(Wanasinghe, 2016). Only a few countries such as India, Pakistan, Indonesia, Australia…etc are having a strong fleet of naval and air assets for addressing crimes at sea. Nevertheless, some extra-regional actors such as the United States, China, and Japan are operating in the region to ensure their national interests pertinent to IOR (Wijetunge and Wanasinghe, 2021). If Sri Lanka cannot attend to the matters relating to security, law, and order at its seas, these players would be more than happy to intercede causing gratuitous geo-political implications for Sri Lanka. There is no guarantee that the only intention of these players is to enforce law and order for the regional betterment. Hence, the absence of adequate naval and air assets for surveillance, monitoring, and investigation could permit the meddling of foreign players.

3) Inadequacy of budget allocation: As a developing state, Sri Lanka is not in a position to spend a substantial amount of money on costly affairs such as naval and air operations of SLCG. Nonetheless, the security, socio-economic and geo-political concerns could be undermined due to unattended criminal matters in Sri Lankan waters. Today criminal organizations are more complex, strong, sophisticated, networked, and dynamic. Without a sufficient amount of assets, manpower, and suitable equipment, it is very difficult to counter them, which eventually incurs higher financial losses for the government. It should be understood that the financial commitment to security-related matters is not expenses but investments. An unsafe environment at sea could emasculate the entire security architecture of an island nation.

3. RECOMMENDATIONS

Based on the outcome of the SWOT analysis researchers deduced the following recommendations.

Formulating a framework for integrating air assets to SLCG.

A workable framework is required for integrating air assets for SLCG. Air operations cannot be done in isolation. All agencies operating in a particular air space are to abide by laws, regulations, and procedures enacted by state and non-state aviation organizations and cooperate for ensuring safe and efficient flying operations. Hence, SLCG should cooperate with other agencies conducting air operations in Sri Lankan skies such as SLAF, the Civil Aviation Authority of Sri Lanka (CAASL), and the International Civil Aviation Organization (ICAO). There would be a load of correspondence for obtaining the required certification and clearance for air operations, thus requiring a sound framework to fit its air operations under the present context. Further, SLCG is required to coordinate with agencies operating in the marine domain such as SLN, and Maritime Rescue Coordinating Center (MRCC) for effective collaboration. Collaboration with ground agencies could be done through SLCG headquarters. Considering the air, land, and marine domains researchers have developed a primary framework for SLCG air operations as follows.

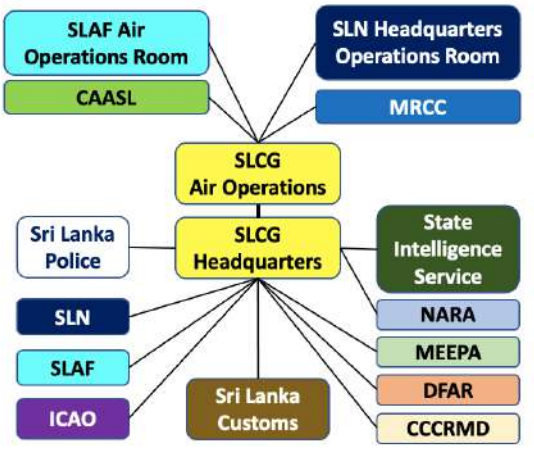

Figure 7: Primary Framework for SLCG air operations
Source: Authors (2022)

Formulate a doctrine and Standard Operating Procedure (SOP) for maritime-air operations of SLCG.

Maritime-air operations are complex and diversified in nature. Unlike under ordinary circumstances, time-bound situations such as armed robbery, piracy, terrorism, oil spillage, marine fire, etc. demand quick and accurate responses. Hence, a well-thought-out doctrine and relevant SOPs are to be in place. SLAF

and SLN are well conversant with operations of similar nature. Hence SLCG could exploit the experience and professional expertise of SLAF and SLN in developing a doctrine and SOPs for its maritime-air operations.

Develop a dialogue with SLAF for mutual cooperation and secondment of air and ground crew required for air operations.

In the same manner, the naval operational experience is obtained through SLN for SLCG naval operations, SLCG could make necessary arrangements through an all-encompassing dialogue with SLAF for its air operations. SLCG could form an agreement for the secondment of pilots, engineers, technical crew, logisticians, and other crew for the operation of its air fleet. Further, the agreement shall cover the required technical expertise and support from workshops, usage of aerodrome facilities, and base maintenance facilities of SLAF.

Pursue diplomatic means for obtaining air assets and related training.

Diplomatic means are to be employed for obtaining air assets for the air operations of SLCG. It could be obtained as donations, for a concessionary rate, or through credit lines. Obtaining aircraft is to be followed by obtaining the required training and competency to operate them in similar means. During this process, being a developing state with a small economy, Sri Lanka is finding difficulties to meet its law enforcement requirements. Nevertheless, the importance of the same could not be negated. Hence, maximum effort is to be put forward in establishing an air arm for SLCG through diplomatic means to manage the exponential cost factor.

Conducting joint and multinational training and operations with local and international stakeholders.

It is unlike to obtain all the required assets sufficient for satisfying SLCG air operations, thus requiring effective collaboration with local and international stakeholders for capacity building. Conducting operations in joint and multinational nature, demands a greater level of interoperability and training. Without frequent and task-oriented training it is not feasible to perform joint operations under difficult and dynamic conditions.

4. CONCLUSION

Law enforcement at sea is of prime importance for an island nation like Sri Lanka. Due to the vastness of Sri Lankan seas, it requires a strong and full-scale coast guard service around the island to realize the national security objectives pertinent to law and order at sea. Crimes emanating from the maritime domain are multifaceted. There is a high probability for such crimes to fall into the category of TOC due to the involvement of multinational stakeholders. Hence, it is comprehended that counter-crime tasks engulf the capacity of a single entity or a single state for that matter. Modern-day, access to technology is relatively easy and most criminals are well-geared for incorporating sophistication into their activities. SLCG is a very young organization, which is still in the developing stage. To mature, it requires a number of capabilities and capacities such as air constituent. At present, it patronizes SLAF assistance for its surveillance requirements. Nonetheless, SLAF has its role to play, thus giving primacy to its operational demands over the assistance of other agencies. Therefore, at times SLCG would not be able to enjoy SLAF aerial surveillance inputs, which could be a mission-critical facet. Hence, a long-term solution is required such as inducting air assets for SLCG in meeting its growing surveillance demands. Yet, it lacks adequate Professional expertise, tech-savvy manpower, and ground-based facilities, which are essential for safe and efficient air operations. Hence, SLCG could espouse a similar methodology for managing and operating its air assets through SLAF as it does with SLN. A primary framework is proposed by the researchers for incorporating air operations in collaboration with other local and foreign agencies. It is understood that states are best benefited by going into mutual cooperation than operating in isolation especially countering TOC in the maritime domain. Still, it requires a fair contribution from all stakeholders to make the

common endeavour a success. In absence of their own capabilities, other counterparts would have leeway for pursuing their veiled interests, without even getting noticed. Therefore, strengthening SLCG capabilities and capacities by integrating air assets in meeting its future operational demand is essential.

5. ACKNOWLEDGMENT

For the successful completion of the research followed by this article, the authors would like to offer their sincere gratitude to SLCG, SLAF, and SLN professionals engaged in maritime-air operations.

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KJMS 2023 VOL.5 (1): 145-151

KDU Journal of Multidisciplinary Studies
(KJMS) Volume 5. Issue 1 July 2023
https://doi.org/10.4038/kjms.v5i1.71

THE CROSS-CULTURAL ADAPTATION OF THE SCHUTTE SELF-REPORT EMOTIONAL INTELLIGENCE TEST (SSEIT) FOR USE AMONG NURSING STUDENTS IN A DEFENCE UNIVERSITY, SRI LANKA

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ABSTRACT

The ability to recognize, control, and evaluate emotions is defined as emotional intelligence (EI). EI is a vital part of ward management and patient care in nursing practice. When EI is assessed and instilled in nursing students regularly, it paves the way for a long-term career. Schutte Self-Report Emotional Intelligence Test (SSEIT) has been identified as a useful tool for assessing emotional intelligence in nursing students. The goal of this study was to translate and adapt the 33-item SSEIT to use in Sinhala. The developer granted permission to translate the SSEIT into Sinhala. The cross-cultural adaptation was completed in five stages: (I) initial translation, (II) translation synthesis, (III) back translation, (IV) Expert Committee Delphi review, and (V) pre-final version testing. The translated version's content and consensual validity were assessed using a two-round Delphi process with five experts. Items rated 0-3 range by 70% of the raters were removed or reworded. The process was repeated for the reworded items, and those with 70% or higher ratings in categories 4-6 and/or 7-9 were kept. Following that, the Content Validity Index (CVI) was evaluated using I-CVI, Universal Agreement (S-CVI/UA), and Average CVI (S-CVI/Ave). Finalized SSEIT was administered to 197 nursing undergraduates from Kotelawala Defence University in Sri Lanka. In the Sinhala version of the SSEIT, the maximum CVI of each individual item (I-CVI=1.0) and the maximum overall CVI (S-CVI/UA = 1.0; S-CVI/Ave = 1.0) were also displayed. Cronbach's alpha was 0.963 which indicates a very high internal consistency The Sinhalese version of the SSEIT is a robust and reliable tool that has been culturally adapted to test EI in nursing students.

KEYWORDS: *Emotional Intelligence, Schutte Self-Report Emotional Intelligence Test, nursing students, Sri Lanka*

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1. INTRODUCTION

Emotional intelligence (EI) is the ability to understand and reason with emotion, integrate emotion into intellect, identify and convey emotion, and control one's own and others' emotions (Salovey, Peter; Mayer, 2000). Goleman identifies four elements of EI: self-awareness, self-management, social awareness, and relationship management (Goleman et al., 2002). Self-awareness refers to a person's proclivity to be aware of his or her feelings, attitudes, and behaviour in response to specific circumstances (Benbassat and Baumal, 2005). Self-management is the capacity to direct one's thoughts, feelings, and behaviour in ways that are appropriate for achieving the intended objective (Ott, 1998). Social awareness means being able to precisely attention to the emotions of other individuals to considerably comprehend the scenario. Relationship management means being able to properly manage social interaction by controlling one's emotions, other people's emotions, and situations (Salovey, Peter; Mayer, 2000).

Nurses as highly involved healthcare workers are expected to possess high EI to provide patients with appropriate care (Drigas and Papoutsi, 2018). Even if some nurses are unaware of the various aspects of EI, they can unintentionally learn and use some of these skills through experience. These abilities must be organized and improved to be more successful and efficient. By enhancing one's decision-making, time management, stress tolerance, and communication abilities, one can increase the quality of care (Snowden et al., 2015). Existing research has demonstrated the significance of EI for the nursing profession, including the development of therapeutic nurse-patient interactions, the provision of high-quality care, and the efficient use of nurses' consultation responsibilities (Yildirim-Hamurcu and Terzioglu, 2021). Additionally, EI helps nurses manage the complexity of interpersonal ties while adjusting to environmental changes and stress overload, decreasing stress, and increasing work productivity (Garside and Nhemachena, 2013; Lewis et al., 2017).

Clinical ability, which includes clinical knowledge, attitude, and skills, is a requirement for all nurses (Garside and Nhemachena, 2013). The main goal of Clinical education is to improve nursing students' clinical competence and practical abilities (Kumara and Sudusinghe, 2021). In addition to improving patients' medical experiences, high clinical aptitude boosts nursing students' sense of professional identity and accomplishment (Yildirim-Hamurcu and Terzioglu, 2021). It has been demonstrated that emotional intelligence (EI) can predict nursing students' performance in the classroom and clinical settings (Choi et al., 2015; Sharon and Grinberg, 2018). To equip nursing students to become better nurses in the future, it is crucial to routinely evaluate their EI (Kumara and Sudusinghe, 2021).

The 33-item Schutte Self-Report Emotional Intelligence Test (SSEIT) is regarded as a reliable tool for measuring EI in nursing students. It was developed in 1998 by Dr Nicola Schutte and her colleagues and is based on the Salovey and Mayer emotional intelligence paradigm (1990) (Schutte et al., 1998). This test looked at four different aspects: emotion usage, self-relevant emotion management, emotion perception, and other emotion management. The responses were graded on a scale of 1 to 5 with 1 being strongly disagree, 2 being disagree, 3 being neither agree nor disagree, 4 being agree, and 5 being highly agree. Thirty items of the questionnaire are evaluated positively, while three of them (items 5, 28, and 33) are given a reverse score. Higher SSEIT scores indicate greater emotional intelligence (Schutte et al., 1998). The original SSEIT obtained internal consistency reliability of 0.90 (Schutte et al., 1998). Though this was a sound scale to measure EI, it had not been cross-culturally adapted to use with Sri Lankan nursing students. Hence, the primary goal of this study was to translate and culturally validate the Sinhala version of SSEIT.

2. METHODOLOGY

The translation process of the SSEIT to Sinhala

Permission to translate SSEIT was granted by the original authors then the proposal was submitted receiving ethical approval from the Ethics Review Committee, Faculty of Medicine, General Sir John Kotelawala Defence University, Sri Lanka. The cross-cultural adaptation was completed in five stages: (I) initial translation, (II) translation synthesis, (III) back translation, (IV) Expert Committee Delphi review, and (V) pre-final version testing (Beaton et al., 2000).

In stage, I, two local professional translators who are native and bilingual experts translated the English SSEIT scale into Sinhala. First, the two translators worked independently on the forward translation of the original items, instructions, and responses. Both translators and the local coordinator discussed the translations and agreed on a reconciled version during the second stage. The language was made conversational and simple to understand for the target audience, and measures were taken to ensure that the translated scale is conceptually equivalent to the original scale. In stage III, a local professional translator who is both an English native speaker and a Sinhala expert translated the first Sinhala version of the scale back into English. The translator did not have access to the original version of the scale at this point.

Evaluating the translated tool's content and consensus validity

Using the Modified Delphi Technique, a panel of experts comprised of a consultant psychiatrist, two clinical psychologists, a senior lecturer in sociology, a senior lecturer in nursing, and a nursing officer (Grade I) evaluated the translated scale for content validity and consensual validity (Hecht, 1979; Jones and Hunter, 1995). On a scale of 0 (complete disagreement) to 9 (complete agreement), each item was rated for consensual validity based on whether its conceptual meaning was retained after translation (ii) if it was appropriate for use with nursing students (iii) if it was culturally relevant to Sri Lanka. The content validity of each item was graded on a scale of 0 (complete disagreement) to 9, with consideration given to (i) whether each item was a relevant indication of its scale and (ii) whether the scale's overall set of items was adequate for evaluating EI. Items with ratings of 70% or higher in the 4-6 or 7-9 categories were retained, while items with ratings of 70% or higher in the 0-3 category went through a second round of the Delphi process.

The panel of experts' consensus was used to assess the content validity of individual items (I-CVI) and the overall scale (S-CVI). The average CVI (S-CVI/Ave) and the universal agreement (UA) among experts are the two methods for calculating S-CVI (Polit and Beck, 2010). The proportions of items on a scale that received a relevant rating of 4-6 or 7-9 categories from all experts were used to calculate S-CVI/UA, and the S-CVI/Ave value was calculated using the average of the I-CVIs for all items on the scale.

Pre-testing the validated scale

Thirty nursing graduates from the Faculty of Allied Health Sciences at General Sir John Kotelawala Defence University participated in a pre-test to assess the scale's level of difficulty, the simplicity of its concepts, any discomfort during the response, and the appropriateness of its length.

Assessing the reliability of the cross-culturally adapted scale

To determine the validity of the cross-culturally adapted scale, a descriptive cross-sectional study was conducted among nursing undergraduates at the Faculty of Allied Health Sciences, General Sir John Kotelawala Defence University in Sri Lanka. For an internal consistency reliability study, a sample size of five to ten times the number of items in the instrument should be used (Kyriazos, 2018). Therefore, a minimum sample size of 140 participants (28 items x 5) was required for the scale to be validated. The online version of the translated and cross-culturally

adapted SSEIT was distributed to all willing nursing undergraduates (n=197) at General Sir John Kotelawala Defence University in Sri Lanka. The Statistical Package for Social Sciences (SPSS) version 23.0 was used to explain the demographic traits of the participants using descriptive statistics. Cronbach's alpha was used to gauge the scale's internal consistency reliability. The minimum acceptable level of Cronbach's alpha internal coefficient of reliability is 0.7 (Furtado et al., 2022).

3. RESULTS

Content and consensual validity of cross-culturally adapted SSEIT

All the items for the Sinhala version of the SSEIT were kept because 70% or more of the ratings fell into groups 4-6 and 7-9 according to the Delphi procedure (summatively). To restore their proper cultural meaning, several words have been altered. Additionally, all the items underwent the Delphi procedure again in the second round, including re-ratings in categories 7-9. As a result, the cross-culturally adapted SSEIT showed the highest levels of content validity for each of the individual items (I-CVI=1.0) and the entire test (S-CVI/UA = 1.0; S-CVI/Ave = 1.0). The general agreement showed that the cross-culturally adjusted SSEIT is a reliable instrument for evaluating EI.

Table 1 Personal Characteristics

Characteristics	Status	Frequency (n)	Percentage (%)
Gender	**Female**	160	81.20
	Male	37	18.80
Nationality	**Sri Lankan**	197	100.0
Year of Study	**First-year**	86	43.70
	Second-year	41	20.80
	Third-year	38	19.30
	Fourth-year	32	16.20

Reliability of the cross-culturally adapted SSEIT

All the participants were Sri Lankan (100%, n=197) and the majority of them were females (81.20%, n=160). The sample included nursing undergraduates in their first (43.7%, n=86), second (20.8%, n= 41), third (19.3%, n=38) and fourth years (16.2%, n=32) (Table 1). Cronbach's alpha was 0.963, indicating that the validated scale had very high internal consistency.

4. DISCUSSION

Many studies have found that EI has a significant impact on the nurse-patient relationship and the job satisfaction of nurses (Codier, 2020; Senanayake et al., 2020). Furthermore, when healthcare professionals begin to express compassion, patient satisfaction and outcomes improve (Nightingale et al., 2018). Therefore, frequent assessment of EI is necessary among nursing students who are going to be future nurses (Kumara and Sudusinghe, 2021). This study aimed to translate and cross-culturally adapt SSEIT as a valid instrument to assess the EI of nursing students in Sri Lanka.

There are no strict rules and regulations for adapting a questionnaire for use in another cultural setting. However, everyone agrees that using a questionnaire in another linguistic context right after a translation is inappropriate (Beaton et al., 2000; Guillemin et al., 1993; Herdman et al., 1998; Reichenheim and Moraes, 2007; Wang et al., 2006). As a result, the cross-cultural adaptation of SSEIT has proceeded through five stages to achieve acceptable content and consensual validity (Beaton et al., 2000; Fink et al., 1984; Jones and Hunter, 1995) and excellent CVI values.

Internal consistency, stability, and equivalence are all part of reliability (Bannigan and Watson, 2009). Internal consistency, which specifies the extent to which each item in a test measures the same notion or construct, is frequently used to explain dependability testing (Tavakol and Dennick, 2011). Cronbach's alpha and composite reliability (CR) values should be greater than 0.70. Further, when Cronbach's alpha is greater than 0.9 it is exceptional (Lin et al., 2020). Cronbach's alpha for translated SSEIT' revealed

outstanding results (α= 0.963). In previous research, acceptable reliability levels (α = 0.87) on the SSEIT were reported (Birks et al., 2009). The use of a common validation process in cooperation with a diverse team and the complete sample response without attrition was the study's merits. The study's cross-sectional descriptive design, however, might have significant disadvantages.

5. CONCLUSION

The Sinhala version of the SSEIT has demonstrated strong content and consensual validity, making it a reliable tool for assessing EI in nursing students in Sri Lanka.

Funding statement

There was no specific grant for this research from any funding organization.

Conflict of interest

The authors affirm that they do not have any conflicts of interest.

6. ACKNOWLEDGEMENT

The translators and the panel of experts contributed to the Delphi process.

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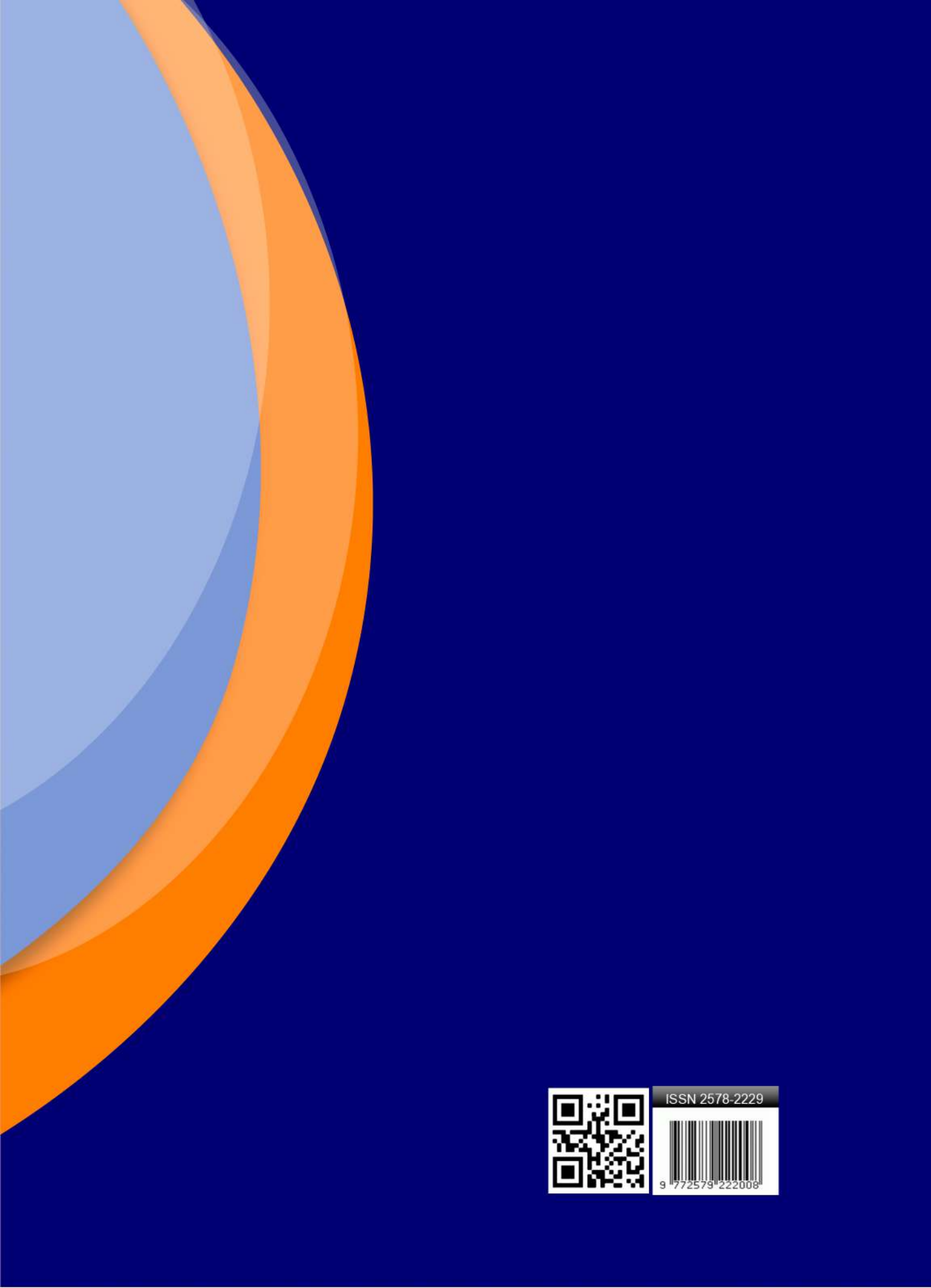
ISSN 2578-2229