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Popular Lectures
Theme Seminar Presentations

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Editors' Note

The Jaffna Science Association (JSA) was established in 1991 by late Professor Alagiah Thurairajah with the objectives of promoting science, scientific research, and advancement of science education and technology. In this regards, JSA has been carrying out various knowledge-sharing activities to inform the latest advancements in Science to the people in this region. It has been carrying out various activities including School science programme, guest lectures, workshops, annual session and publication of proceedings and newsletters.

Every year, the annual sessions of the JSA are conducted with the objective of disseminating the knowledge on latest advancements in science and to encourage the researchers to publish their research findings. Further a theme which is relevant to the region depending on the current situation or issue is identified each year. Popular talks and seminars are organized based on the theme throughout the year.

This Proceeding (Volume 30, No. 2) contains the Presidential address, Professor Kandiah Balasubramanium Gold medal lecture, Chairpersons' addresses, Popular lectures and Theme seminar presentations delivered at the 29th JSA annual sessions. The sessions were held on 29-31 March 2023 at the Library Auditorium, University of Jaffna. It is a privilege to be the editor for the proceedings of Jaffna Science Association and I wish to thank the distinguished speakers for their contributions to this volume.

Mrs. Viniththira Jegapragash,
Chief Editor/Jaffna Science Association

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Toxicogenomics: Applications in Ecotoxicology

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Ecotoxicology is the study of integrating the effects of stressors (toxicants) across all levels of biological organization from the molecular to whole community to ecosystems. It can also be described that the study of effects of environmental toxic substances on ecosystems and their components. Because growing number of toxicants in the environment from variety of sources cause adverse effects on ecosystem at various levels.

Toxicogenomics is the study of the response of a whole genome to toxicants or environmental stressors. Output of these studies lead to the discovery of molecular pathways of toxicants, their mode of action and the specific chemical and their drug targets. Figure 1 shows that a diagrammatic representation of molecular pathway of an environmental toxicant in a cell.

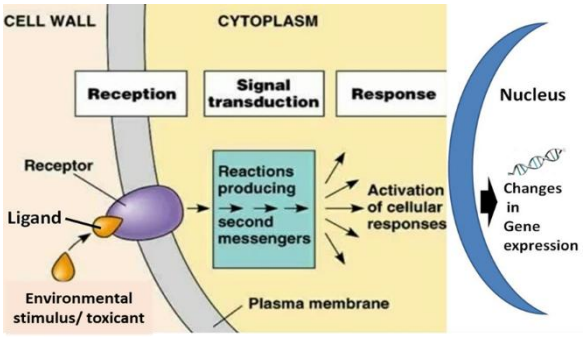

Figure 1. Molecular pathway of an environmental stimulus (toxicant) in a cell.

The toxicant (signal) enters into the cell via appropriate receptor and the signal transduction process will be initiated via second messengers; as a result, cellular response(s) will be activated in a form of gene expression. As per the toxicant type and its nature (concentration, available form, etc.), the level of gene expression also will be changed. Therefore, Toxicogenomics approach can be used to detect the relationship between the changes in gene expression and toxicological end points. It gives us the clear idea of the effect of environmental toxicant at cellular and molecular level.

'*Omics*' in toxicology: Functional molecular profiling techniques such as transcriptomics, proteomics, and metabolomics are collectively called as '*omics*'. All these techniques in combination with bioinformatics tools will give us the clear idea on molecular pathways of particular environmental toxicants and the respective gene expressional profiles.

Transcriptomics techniques: It uses the gene expressional profile in terms of transcripts – mRNA expressional profiles. Gene micro arrays and quantitative real time polymerase chain reactions (qRT-PCR) are the most popular techniques used in ecotoxicology.

Proteomics techniques: It detects the relationship between the genes and proteins produced by an organism upon toxic exposure. The separation, display and identification of proteins that involve in the toxicological pathway of an organism can be identified. SDS PAGE and mass spectrometry,

Western Blot and Electrophoresis techniques are the most common proteomic techniques used in ecotoxicology.

Metabolomics techniques: These techniques are used to identify the metabolic pathway activated or classes of metabolic products produced in response to specific environmental toxicants. NMR spectroscopy, mass spectroscopy techniques can be used to detect the structure and molecular weight of specific compounds respectively.

Applications of Toxicogenomics in Ecotoxicology

Toxicogenomics approach in ecotoxicology can be used to screen the hazardous environmental toxicants and their action mechanism at molecular level. Also, comparative studies on model organisms and human, dose-response relationships and the adverse effect of toxicant at cellular and molecular level can be used to predict the cellular response at molecular level, detection and prediction of diseases and in drug discoveries. Moreover, the results can be used to detect/ predict the pollution level in the respective environment. Classical toxicology techniques mainly rely on population level effects, i.e, how much exposure and for how long a time does the 'population' need to be exposed to show toxicity. In classical toxicological approach several techniques such as histopathology, clinical chemistry, metabolism, physiology, enzymology and electron microscopy have been used individually or in combination.

Meanwhile, toxicogenomic approach is used to explain the effects of contaminants at individual/ molecular level. Therefore, comparatively this technique is more sensitive than the classical ways. This technique includes DNA microarrays, qRT-PCR, Northern Blotsequencing, protein expression, Western Blot, and gets electrophoresis.

Gene microarrays can be used to detect the genotoxicity of a suspected contaminant(s). Micro array chips are commercially available for several model organisms including human, murine/ mouse, rainbow trout and zebrafish. For example, micro array chips for fat head minnow (fresh water fish) was tested to confirm the presence of endocrine disruptive compounds (Zare et al., 2018); also, this technique was used to detect the endocrine disruptive chemicals and their targeted brain tissues in Wister rats (Lichensteiger et al., 2015).

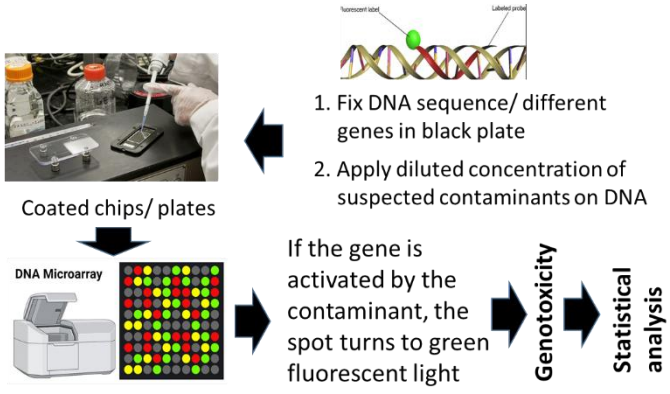

Figure 2. Gene microarray technique

Advantages are only small sample of DNA is enough, expression of several genes can be detected in a single assay and they are often sensitive to very little concentration of contaminants (pg/ L or ng/ L). But the *limitations* are: semi-quantitative method, cross hybridization & sequence specific binding anomalies are possible, and processing and scanning samples may take several days and generate large amount of information that can take considerable time to analyze.

Quantitative Real Time PCR (qRT-PCR) technique can be used to detect the presence and effect of environmental contaminants by detecting the gene expression at mRNA level (mRNA transcripts). In this technique also small quantity of DNA is enough to test the impact, sensitive to very low concentrations of contaminants (at pg/ L or ng/ L), it gives more quantitative measurements than the micro arrays. Further qRT-PCR technique can be used to detect the gene expressional profile and the relevant molecular pathway/ mechanism in response to the particular environmental contaminant. However, it is one of the expensive techniques.

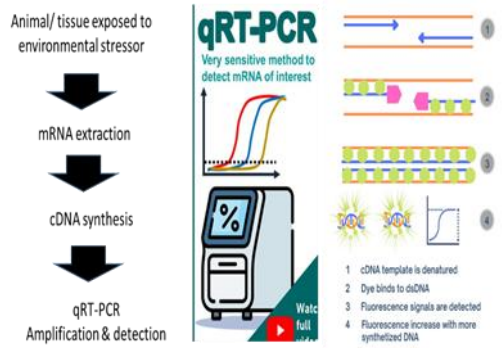

Figure 3. qRT-PCR technique

Therefore, among the different techniques, measuring the gene expression is one of the good methodology in ecotoxicology. Because it shows,

- Greater sensitivity:
    - This can detect changes in gene expression before gross changes such as: tissue damage, tumor formation, etc.
    - Earlier indication of a toxic response: this can be used to detect before tissue is altered/ tumors form
- Greater specificity:
    - Many different agents can cause liver tumor but they may do so through a number of different mechanisms;
    - many toxic agents have the same endpoint but get there by various pathways we may now identify;
    - It may provide a way to determine the mechanism of toxicity for a particular toxicant; possible to identify all possible toxicological endpoints in a single assay - DNA microarray.
    - Traditional/ classical methods requires separate assays to test, such as carcinogenicity, mutagenicity, reproductive toxicology, Immuno-toxicity, neurotoxicity, and endocrine toxicity.

- Relatively quick:
    - If a group of genes show characteristic similar pattern of gene expression, it may be possible to determine the toxic potential of that toxicant in a short time.
    - Reduce the number of animal toxicity testing
- Genetic variations & resultant effects:
    - Genetic makeup of metabolizing enzymes
    - Any alterations/ mutations/ polymorphism / expression due to environmental toxicants in metabolizing enzymes may lead to the differential activities.

Therefore, when a gene is expressed in-response to environmental contaminant (stimuli), the resultant gene expression(s) and the cellular response can be detected. As a result, potential impact at cellular/ molecular level can be detected even at very low concentration of (pg/ L or ng/ L) environmental toxicants.

For an example, Polycyclic Aromatic Hydrocarbons (PAHs) are a group of xenobiotic chemicals that cause adverse effects on organisms. This persistent organic pollutants are considered as ubiquitous contaminant in the environment (Abdel-Shafy & Mansour, 2016). This group of contaminants present in high proportion in oil and grease (Hylland, 2006), lubricating materials (Abdel-Shafy & Mansour, 2016), pharmaceuticals, agrochemicals particularly in pesticides, thermosetting plastics and flame retardants. Most of the PAHs are lipid soluble and thus readily absorbed from the gastrointestinal tract of mammals, rapidly distributed to variety of tissues and able to accumulate in body fat.

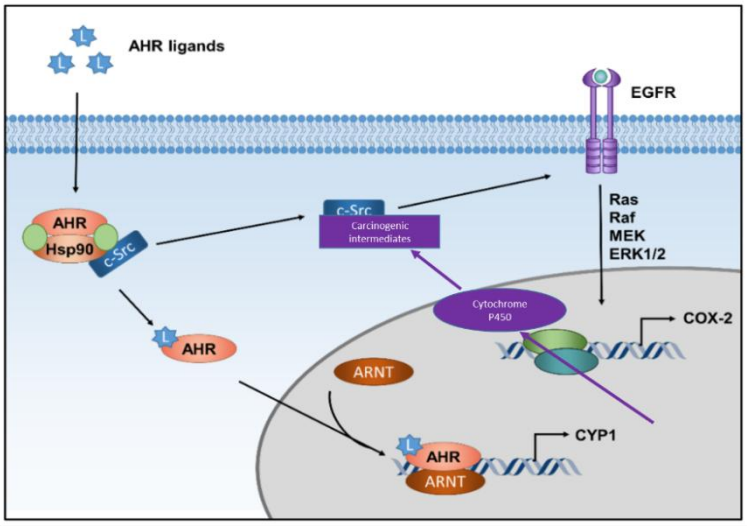

Figure 4. Aryl Hydrocarbon Receptor (AHR) molecular pathway (Vogeley et al., 2019)

PAHs and their metabolic intermediates can cause carcinogenic and mutagenic effects and are potent immune – suppressants (Stading *et al.*, 2021). The metabolism of PAHs occurs via the Cytochrome oxidase enzymes (Abdel-Shafy & Mansour, 2016). A gene called CYP1A1 (Cytochrome P450 Family 1 Subfamily A Member 1) encodes a member of the Cytochrome P450 super family of enzymes. The metabolism of PAHs results the formation of reactive oxygen species (ROS). Normally, the ROS level is maintained by the cellular mechanisms.

But, when the balanced is disrupted, cell experiences oxidative stress. PAHs disrupt this balance by binding with another ligand activated transcription factor proteins called Aryl Hydrocarbon Receptors (AHR). As a result, CYP1A1 gene and other genes in the AHR molecular pathway will be induced (Gastelum *et al.,* 2020). Thus, ROS production also will be increased. Increased ROS level cause DNA damage in various genes in the pathway and lead to mutagenesis, tumorgenesis, cell proliferation, loss of cell-adhesion which further result in cancer progression (Tsay *et al.,* 2013).It has been reported that dioxin and other poly-halogenated and polycyclic hydrocarbons cause altered gene expression and toxicity (Schmidt and Bradfield, 1996, Hankinson, 1995). Mixture of PAHs exposure on human granulosa and granulosa tumor cells induced the expression of AHR gene (Zajda *et al.,* 2017). Two different AHRs (AHR1 and AHR2) were reported from killifish (Karchner *et al.*, 1999) and in zebrafish (Dong *et al.*, 2004). Cardiovascular toxicity upon selected PAHs also reported from zebrafish(Billiard *et al.*, 2006).

In addition to these genes, another gene called multidrug resistance protein 2 (MRP2) or ATP-binding super family C member 2 (abcc2) is also identified as a potential genomic bio-marker for the detection of PAHs in *Drosophila melanogaster*(Vache *et al.*, 2007).

Therefore, identifying the gene expression/ over expression of genes upon the induction of known PAHs contaminants in animal models can be used as **biomarkers** to detect the potential environmental contaminants at very low concentrations. Also, potential effects of contaminants at cellular / molecular level can be detected.

This presentation is focused on the recent experimental evidences by the author and team. Oil and grease contamination in Chunnakam aquifers of Northern Province of Sri Lanka was reported since year 2015 and confirmed by several reports (Vigneswaran et al, 2015; Vijakanth et al, 2017; Wijeyaratne and Subanky, 2017; Velauthamurty *et al.,* 2021). Among the different PAHs from oil and grease, Naphthalene (Gesto et al., 2006) and phenenthrene (Sun et al., 2006, Barron et al., 2004) are one of the major PAHs present in marine and freshwater environments. Therefore, the present study was carried out to identify the toxicity of two selected PAHs (naphthalene and phenanthrene) in the early life stages of zebrafish *Danio rerio*.

Gene expressional analysis using qRT-PCR assay on early developmental stages of zebrafish when treated with both naphthalene and phenanthrene shows that mRNA expression of AHR2 was up-regulated when treated with naphthalene and down- regulated when treated with phenanthrene; while abcc2 significantly up-regulated at 72 hours of post fertilization when treated with both contaminants (Thulasitha et al., in press). In addition, toxicity assays confirmed that the concentration at 50 % mortality (LC_{50}) for naphthalene and phenanthrene at 96 hours of post fertilization were 19.1 mg/L and 2.14 mg/ L respectively (Vithushi and Thulasitha, 2021; Vithushi

and Thulasitha, 2020). Both naphthalene and phenanthrene exposure caused developmental deformities even at very low concentrations such as swallowed yolk sac, pericardial edema, irregular heartbeat, tissue degenerations, bent vertebral column, etc. Results from this study also indicate that hydrocarbon responsive genes are very sensitive to environmental toxicants. Therefore, they can be used as biomarkers in environmental applications.

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Sectional chairperson's address/ Section B

Tamil Language Computing: the Present and the Future

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Abstract

This paper delves into the text processing aspects of Language Computing, which enables computers to understand, interpret, and generate human language. Focusing on tasks such as speech recognition, machine translation, sentiment analysis, text summarization, and language modelling, language computing integrates disciplines including linguistics, computer science, and cognitive psychology to create meaningful human-computer interactions. Recent advancements in deep learning have made computers more accessible and capable of independent learning and adaptation. In examining the landscape of language computing, the paper emphasises foundational work like encoding, where Tamil transitioned from ASCII to Unicode, enhancing digital communication. It discusses the development of computational resources, including raw data, dictionaries, glossaries, annotated data, and computational grammars, necessary for effective language processing. The challenges of linguistic annotation, the creation of treebanks, and the training of large language models are also covered, emphasising the need for high-quality, annotated data and advanced language models. The paper underscores the importance of building practical applications for languages like Tamil to address everyday communication needs, highlighting gaps in current technology. It calls for increased research collaboration, digitization of historical texts, and fostering digital usage to ensure the comprehensive development of Tamil language processing, ultimately enhancing global communication and access to digital services.[1]

1.0 Introduction

Language computing, also known as Natural Language Processing (NLP), is a field of Artificial Intelligence that focuses on the interaction between computers and human languages, primarily in the form of speech and text. It involves developing algorithms and systems that enable computers to understand, interpret, and generate human language in a way that is both meaningful and useful. This encompasses a wide range of tasks, including speech recognition, machine translation, sentiment analysis, text summarisation, and language modelling.

Although nowadays mostly computer scientists and computational linguists are working on language computing, Language computing is an interdisciplinary area which combines elements of linguistics, computer science, cognitive psychology, and many more disciplines to create tools,

[1]This is the write-up of the address delivered at the 29th Annual Sessions of the Jaffna Science Association, held from March 29-31, 2023, at the University of Jaffna. The slides from this talk can be found: https://www.slideshare.net/slideshow/tamil-language-computing-the-present-and-the-future/269413540

applications, and services that can be useful for humans in various ways, including tools and services like virtual assistants, automated customer service, information retrieval, and language education.

The goal of language computing is to make computers or machines to process, and understand human languages and make meaningful inferences in order to make computers more accessible for human needs.

1.1 Why Language Computing

Language computing has become an integral part of our daily lives, simplifying various aspects of communication and information processing. From virtual assistants[2] to machine translation services[3] and aiding differently abled people[4], language computing is everywhere, breaking down language and communication barriers that once challenged global communication. By understanding and producing human language, these technologies make processes more efficient and faster, allowing real-time communication and access to information in different languages and cultures. Language computing not only improves personal and professional interactions but also democratises access to knowledge and digital services.

The business opportunities of language computing are enormous, driving innovation in a variety of industries. Companies use these technologies to analyse large amounts of text data, creating knowledge and insights and obtaining information to inform decision-making. Automated customer service, sentiment analysis, and marketing are just a few examples of how language computing is changing industries. By making business processes more efficient, language computing helps companies save time and resources, ulimately leading to greater productivity and profitability.[5]

Beyond its commercial applications, language computing supports research and scholarship in the fields of language, linguistics, and the humanities. Researchers around the world use natural language processing tools to study linguistic patterns, compare linguistic structures, explore the evolution of languages, and understand cultural nuances. This technological support is invaluable for academic research, allowing scholars to analyse large data sets that would otherwise be unmanageable.

1.2 Human ↔ Machine communication

Until very recently, computers needed to be trained in specific ways using structured information and precise instructions. This meant that humans had to communicate with computers in a highly

[2] https://assistant.google.com/

[3] https://translate.google.com

[4] https://www.seeingai.com/

[5] https://mck.co/3sED0NU

structured manner, adhering to strict syntax and formats (Programming languages) to ensure that the machines could understand and execute the commands, but computers could generate languages that humans could understand (shown in Figure 01). However, today, instructions for computers can be fed using natural language, making interactions more intuitive and accessible, and making computers accessible by everyone.

In the recent deep learning era, computers have gained the capability to learn independently. By utilising vast amounts of data from various sources of human input, they can construct their own knowledge maps and improve their understanding and performance over time (Figure 02). This self-learning ability allows computers to adapt to new information, refine their algorithms, and enhance their functionality without needing explicit programming for every new task. Consequently, this shift not only simplifies human-computer interaction but also opens up new possibilities for automation and innovation across numerous fields.

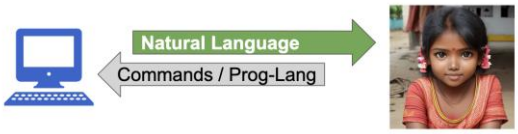

Figure 01: Traditional Computer-Human communication method

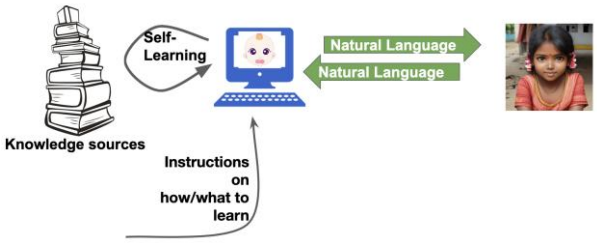

Figure 02: Present Computer-Human communication method

2.0 Language computing landscape

The language computing landscape can be visualised as shown in Figure 03. The foundational work of language computing enables the processing of any language. Building computational resources provides the necessary power for machines to process languages effectively. Based on these two components, language applications can then be developed. This section will examine the current status of each of these aspects in detail. Most of these computational resources are primarily built by computational linguists who have expertise in both Linguistics and Computer Science.

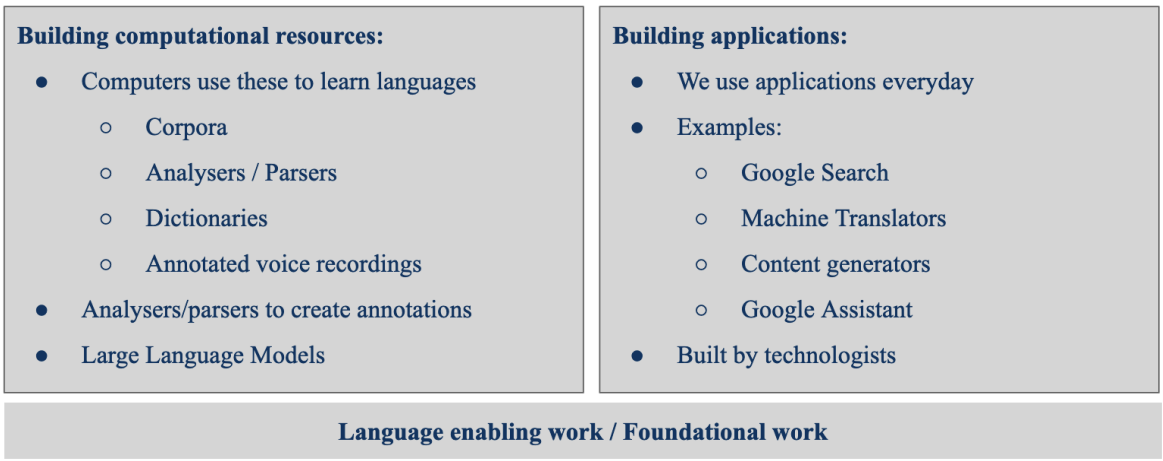

Figure 03: Language computing landscape

2.1 Language enabling/foundational work

Encoding refers to the mapping in which the characters we write are stored in a computer in the form of numbers. In the early days, Tamil was written using American Standard Code for Information Interchange (ASCII) encoding. However, various individuals modified the font rules to create numerous fonts that could display Tamil letters using ASCII encoding. The problem with this approach was that the exact font used for typing had to be applied to view the text correctly. Otherwise, the characters would not be displayed properly because the letters were actually stored as Latin characters. They appeared in Tamil only when the correct font rules were used.

This approach presented a huge problem. Since computers natively do not understand Tamil, it was challenging to develop applications for Tamil as we do for English. For instance, tasks such as sorting text, publishing content on the internet, or sending emails in Tamil were either impossible or very cumbersome. The lack of a standardised encoding system meant that Tamil text could not be easily shared or processed, significantly limiting its use in digital communication and content creation.

Later, in 1993, Tamil was included in Unicode version 1.1 encoding. Unicode aims to encode all the living scripts in the world so that computers can understand each script natively. Initially, a 128 code-block was allocated for Tamil, and Tamil characters were encoded within this space.[6] Instead of encoding each character individually, Tamil vowels, consonants (consonants with a modifier), vowel modifiers, numbers, and some symbols were encoded. These were initially sufficient to write basic Tamil characters using Unicode. However, since the standardisation was done following other Indo-Aryan scripts, specifically the Devanagari script, issues like sorting exist (ல, வ, ழ, ள, ற, ன are not encoded in the correct order as used in Tamil) in the current code chart.

[6] https://www.unicode.org/charts/PDF/U0B80.pdf

However, Unicode has enabled computers to understand Tamil characters natively. In addition to regular Tamil letters, special characters like numbers and symbols were also included in Unicode. Recently, Tamil fractions have been added to Unicode, which will help computers understand classical texts in the future.

Several fonts have been created using Tamil Unicode, allowing old character styles to be easily reproduced using Unicode font rules. Despite these advancements, the printing sector still struggles to adapt to Unicode, as some applications do not support Tamil well and sometimes break Tamil characters.

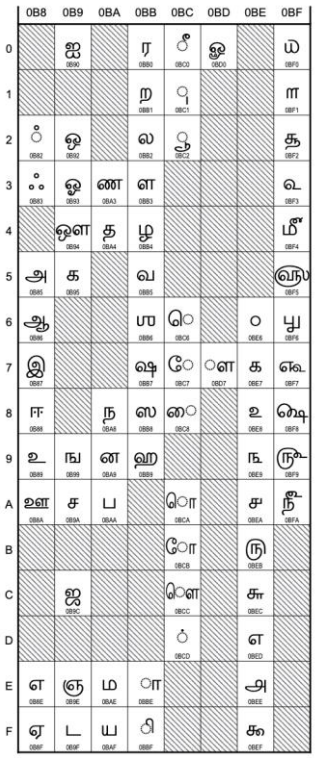

Figure 04: Tamil Unicode Chart

Moreover, awareness about Unicode is lacking. Although many people write in Unicode using mobile keyboards, some still use the old ASCII-based approach to type in Tamil. Additionally, some institutions and universities require their members to write articles in the ASCII-based approach. There are several scripts available to convert text from ASCII to Unicode. However, without knowing the correct font used for typing, it would be difficult to convert the text to Unicode accurately. While the foundational support for Tamil exists, there is still a long way to go to fully implement and practise Unicode standards.

2.2 Building computational resources

As shown in Figure 03, there are several computational resources available to feed language and linguistic knowledge to computers. This section will discuss some of the key resources used in language computing.

2.2.1 Raw data

There is a large amount of raw Tamil data available from various sources, including Wikipedia, news websites, and reports published by institutions. Recently, there have been efforts to compile these resources for training computers in natural language processing. For instance, Common Crawl[7] is a popular resource widely used for training machine learning models. This compilation of web data provides a vast dataset that can be leveraged to improve the capabilities of language models in understanding and generating Tamil text.

[7] https://commoncrawl.org/

However, existing efforts do not adequately catalogue these data sources in a meaningful way. Tamil varies significantly among regions, including differences in dialects and glossaries. When building an application or system for a particular region, it is essential to use data specific to that region. Currently, we lack properly compiled data sources that reflect these regional variations. Therefore, more work is needed to organise and catalogue Tamil data sources to ensure they are useful for region-specific applications and systems.

2.2.2 Dictionaries, Glossaries, Word Lists, and Gazetteers

We also lack comprehensive online dictionaries. While there are sources like Wikidata, the University of Madras lexicon,[8] and various glossaries available online,[9] these resources are not sufficient for capturing contemporary language. More importantly, glossaries need to be regularly updated to accommodate new terms and evolving language usage. This ongoing updating process is crucial to ensure that the resources remain relevant and useful for modern applications.

Given that Tamils are now living all over the world, it is also important to create and maintain up-to-date gazetteers. Gazetteers provide valuable geographic information, and having an updated gazetteer will support a wide range of applications, from academic research to practical tools for navigation and location-based services. Maintaining current and accurate geographic data is essential for effectively serving the global Tamil community and addressing their specific needs.

2.2.3 Annotated data

Annotations enrich data by adding additional layers of information, making it more valuable for analysis and processing. There are several levels of annotations that can be added. Annotations can be applied at the document level, and then further detailed at the content level, such as the paragraph level, sentence level, word level, morpheme level, and phoneme level. Annotations done at the document level are widely referred to as metadata annotations. The other annotations, which include those at the paragraph, sentence, word, morpheme, and phoneme levels, are mostly considered linguistic annotations. These linguistic annotations provide detailed information on the structure and meaning of the text, aiding in various applications such as natural language processing, linguistic research, and machine learning.

Understanding linguistic structure involves multiple layers of analysis. Phonology studies how phonemes make up sounds. Morphology examines how morphemes form words. Syntax explores how words combine to form sentences. Semantics investigates how language conveys meaning, while pragmatics looks at how language is used in context. By incorporating these aspects into

[8] https://dsal.uchicago.edu/dictionaries/tamil-lex/

[9] https://www.language.lk/en/resources/terminology/

annotations, data becomes richer and more useful for comprehensive linguistic analysis and advanced computational applications.

வந்தான் வா|+verb|+fin|+sim|+strong|+past=(ந்)த்|+3sgm=ஆன்

Figure 05: Morphological analysis of the Tamil verb "□□□□□□□" translates to "Came.he"

Although some linguistic annotations have been made at the levels of part of speech, morphology, and syntax, there is still a long way to go. Figure 05 shows an example for inflectional morphological analysis. Even in morphology, only inflectional morphology is handled in Tamil, where the analysis is limited to given words of the same part of speech. This means that while basic morphological analysis can be performed, more complex aspects of morphology, such as derivational processes, remain underdeveloped.

The biggest challenge we face in linguistic annotation is the lack of skilled annotators. These annotations cannot be done by native speakers alone; they require special training to understand linguistic structures. Furthermore, the process is extremely time-consuming and tedious. This combination of limited expertise and the labour-intensive nature of the task significantly hampers progress of the linguistic annotation process.

2.2.4 Computational Grammars

Computational grammars are essential resources that enable computers to understand language structure. These grammars can be written using linguistic formalisms such as Lexical Functional Grammar (LFG) and Head-driven Phrase Structure Grammar (HPSG). Writing computational grammars requires deep linguistic knowledge and an understanding of these formalisms. Additionally, expertise in modelling them using computers is crucial. There have been attempts to build computational grammars for Tamil using LFG. An analysis is shown in Figure 06. As illustrated in the figure, the analysis provides two types of structures: constituency structures and dependency structures. So far, these grammars handle simple sentences, and the work is ongoing.

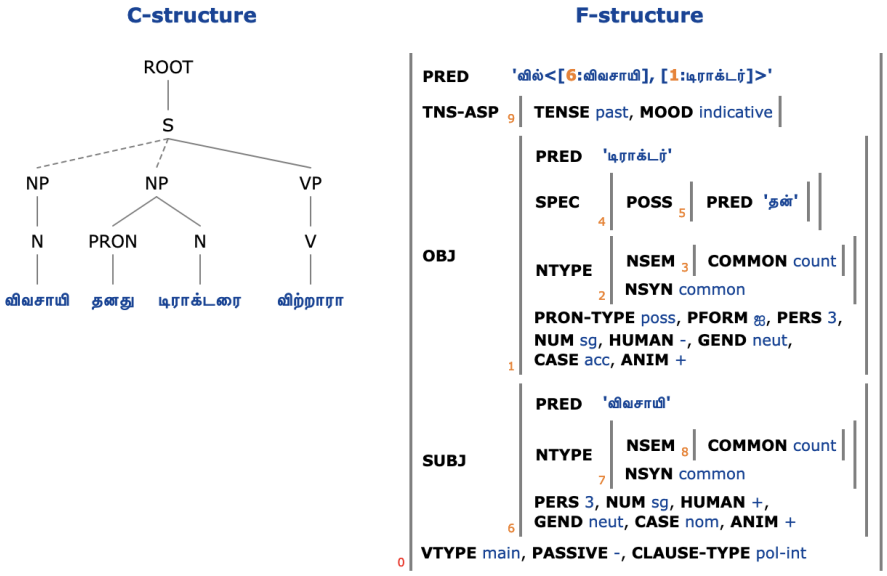

Figure 06: An analysis of a Tamil sentence using the LFG Formalism

2.2.5 Treebanks

Treebanks are valuable linguistic resources for training machines with rich linguistic information. They typically include annotations such as lemmas, parts of speech, morphology, and syntax. Dependency treebanks are particularly suitable for languages like Tamil, which have a free word order. Universal Dependencies (UD)[10] is a widely used formalism for building treebanks, covering over 160 languages to date. Since UD was developed with cross-lingual analysis in mind, treebanks created using this formalism can easily be compared with those of other languages, facilitating comparative studies.

There have also been efforts to develop treebanks using computational grammars. To date, two Tamil treebanks have been published in the Universal Dependencies repository. These are relatively small treebanks, but there are ongoing efforts to build a larger treebank with 100,000 tokens, which may soon be available in the repository.

2.2.6 Language models

Another key computational resource in natural language processing is the Large Language Model (LLM),[11] which is based on deep learning and neural networks. These models are trained on extensive datasets that include nearly everything written on the internet or available in digital form. Large language models, such as GPT and BERT, are capable of recognising, summarising, translating, predicting, and generating text and other content. Some of these models are multilingual, allowing them to handle multiple languages and facilitate cross-linguistic tasks. The

[10] https://universaldependencies.org/

[11] https://developers.google.com/machine-learning/resources

vast amounts of data they are trained on enable them to understand and produce human-like text with remarkable accuracy.

Training these models involves various algorithms and different types of neural network architectures. For example, encoder models convert given text to numerical representations that machines can understand, encoder-decoder models transform text from one form to another, and decoder models convert numerical representations back into text. These models can be customised for a variety of tasks, such as translation, summarisation, and text generation. For instance, Fairseq can be customised to perform translation tasks. The flexibility and adaptability of these models, combined with their deep learning foundations, make them invaluable tools for a wide range of applications in natural language processing and beyond.

Building advanced language models such as GPT-3 presents several significant challenges. These models require an enormous amount of high-quality data for effective training. Additionally, the computational resources needed are substantial; for instance, training GPT-3 reportedly costs around $4 million, and running ChatGPT costs approximately $100,000 per day.[12] The training processes for these models are often not transparent, making it difficult for external parties to understand or replicate the methods used. Due to these factors, developing and maintaining such models is typically beyond the reach of small organisations and educational institutions, particularly in parts of the world with limited resources.

2.3 Building applications

There are many applications being created for Tamil, including spell checkers, grammar checkers, text-to-speech applications, and machine translation applications. Some notable examples include Tamil spell checkers like Vaani,[13] and Tamil text-to-speech[14] applications such as Google Text-to-Speech. However, unlike the broad spectrum of applications available for other resource-rich languages like English, there are not as many applications addressing all the problems faced by Tamil speakers.

Most of these applications currently solve high-level problems, such as aiding in academic research and professional settings, but there are few, if any, applications that can be used by grassroots people to address their everyday issues. For example, while there are advanced tools for machine translation and educational purposes, there is a lack of practical, user-friendly applications for everyday tasks like casual communication, local business transactions, and accessibility tools for

[12] https://www.cnbc.com/2023/03/13/chatgpt-and-generative-ai-are-booming-but-at-a-very-expensive-price.html

[13] http://vaani.neechalkaran.com/

[14] https://ttsfree.com/text-to-speech/tamil-india

the elderly. This gap highlights the need for more development in this area to make technology more accessible and useful for Tamil speakers in their daily lives.

3.0 Future of Tamil Language Processing

The future of Tamil language processing appears to be centred on Large Language Models (LLMs), which are revolutionising the way we work and retrieve knowledge. Globally, there is significant investment in LLMs, leading to the development of applications like ChatGPT. Therefore, it is crucial that we also focus on leveraging these models for the Tamil language to ensure quality service and beneficial outcomes. While this is a primary focus, we must not neglect the study of the Tamil language itself, necessitating substantial investment in Tamil linguistic studies.

3.1 Focus on Quality Data

Although a significant amount of Tamil data exists, it is not as extensive as for some other languages and is often poorly organised and annotated. For example, resources like Common Crawl and corpora from AiPharat contain valuable data but suffer from duplication and lack of structure. Given Tamil's linguistic diversity, including regional dialects and the distinction between spoken and written forms, it is essential to organise existing data and annotate it with metadata indicating type and dialect. Additionally, we must continue collecting more information to build a comprehensive, high-quality dataset.

3.2 Focus on Digitising More Tamil Data

Tamil boasts a continuous literary tradition spanning millennia, with much of its old literature still on ola leafs and in printed books that have yet to be digitised. This vast body of knowledge remains untapped by current models. Developing technologies to digitise these texts is crucial. Furthermore, since the language has evolved over time, the structure and vocabulary of older texts differ from contemporary usage. We need strategies to ensure that models do not get confused by these variations.

3.3 Focus on Annotated Data

We also need more annotated data to evaluate and fine-tune large language models accurately. Detailed annotations capturing the nuances of the Tamil language are necessary to assess model performance and ensure context-appropriate output. Additionally, annotating data to capture cultural specificities is essential to prevent models from generating inappropriate content. Tamil's rich and diverse culture must be reflected in these annotations. Investing in computational linguistics studies and expanding related courses will cultivate a future generation of trained computational linguists capable of fine-tuning, evaluating, and building applications.

3.4 Focus on Research Collaboration

Enhancing research collaboration is vital. While there are global efforts related to Tamil technology, institutional collaboration is often weak, possibly due to funding constraints. Few institutions and grant organisations are willing to invest in Tamil-specific research, making it difficult for funded projects to involve more collaborators. Securing more funding and encouraging collaborative projects can address this issue. For instance, partnering with others to apply for substantial grants from various global organisations could be a viable strategy.

3.5 Focus on Increased Tamil Usage

Increasing the usage of Tamil in daily tasks and across devices will encourage major corporations like Google and Facebook to develop resources for the language. Writing more in Tamil, building content, and engaging with Tamil websites and ads can drive this initiative. It is also crucial to motivate the Tamil diaspora to use the language more frequently. Evidence from Latin America shows that local language usage can significantly boost sales, suggesting similar potential for Tamil.

4.0 Conclusion

Language computing is a rapidly evolving interdisciplinary field that integrates disciplines including linguistics, computer science, and cognitive psychology to enable computers to process and understand human languages. Language computing has transformed daily life by facilitating real-time communication, breaking down language barriers, and democratising access to digital services across different languages and cultures. Despite significant progress, challenges remain in developing resources for low resource languages like Tamil. While the transition from ASCII to Unicode has improved digital communication, further efforts are needed to standardise and raise awareness of Unicode. Comprehensive computational resources, including updated dictionaries, glossaries, and annotated data, are essential to support advanced NLP applications.

The advancement of Tamil language processing is at a critical juncture, driven by the emergence of large language models (LLMs). Although these technologies have revolutionised communication and information access, Tamil language computing still faces challenges related to data quality, linguistic diversity, and digital representation. To fully harness the potential of NLP for Tamil, future efforts should focus on collecting and curating high-quality data, digitising historical texts, and providing detailed linguistic annotations. Research collaboration and increased digital usage of Tamil are crucial. By leveraging LLM capabilities and fostering a collaborative environment, Tamil language computing can keep pace with global advancements while preserving and promoting Tamil's linguistic and cultural heritage, ultimately enriching the lives of Tamil speakers worldwide and driving innovation in various fields.

Sectional chairperson's address/ Section B

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Sectional chairperson's address/ Section C

In Vitro Litholytic Activity of Selected Siddha Drugs with and without Different Adjuvants on Urinary Stones

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Urinary stones are one of the complex, common and most painful medical problem encountered all over the world. Urinary stones are referred to as urinary calculi (Papadakis and McPhee, 2015) or urolithiasis (Mohan, 2015). These are polycrystalline aggregates composed of varying amounts of crystalloid and a small amount of organic matrix (Papadakis and McPhee, 2015) and it forms in any part of the urinary tract (Mohan, 2015). In Siddha medical literature, urinary stones are synonymously referred to as *Kalladaippu noi* (*Kalladaippu* means stone blocking and *noi* means disease) (Kannusamipillai, 1927; Kantnhasami Muthaliyar, 1952; Kupusamimuthaliyar, 2004; Yuhimamunivar, 2005; Sanmugavelu, 2010 and Uthamarayan, 2013) or *Asmari rogam* (*Asmari* means stones and roga means disease) (Saamy, 1973; Subramaniya Pandithar, 1934 and Vengadarajan, 1884). Urolithiasis is one of the most prevalent urologic diseases in Asia ranging from 1-5% (Ramello, *et al*., 2000 and Sorokin, *et al*., 2017).

If the stone disease is not treated it will be lead to impaired renal function or permanent damage of the kidney. In Western Medicine, the present management of urolithiasis is to relive pain during colics and perform surgery when indicated. Attention has not been given for dissolution or to prophylactic aspects. And also there are no effective drugs to be used, especially for the prevention or the recurrence of calculi. In this regard, many alternative medicines have been used to treat urinary calculi and have been shown to be effective (Butterweck and Khan, 2009). In Siddha Medicine, different combinations of drugs and adjuvants (அனுபானம் - *Anupaanam*) are used to treat dissolution of stones and first resorted by Ayurveda/ Siddha Physicians. In Siddha Medicine traditionally the Siddha drugs are administrated along with the adjuvants as vehicle and the adjuvants are considered to be having the pharmacological action similar to the drugs (Subramanian and Madhavan, 1983).

For this study the stones were collected from 100 patients who underwent surgical interventions for urinary stones at Genitourinary Surgical Unit of Teaching Hospital, Jaffna. The collected stones were analysed by wet chemical methods and analyzed stones were categorized (Abdel-Halim, *et al*., 1993). Among the analyzed stones, 51 were classified based on the amount of characterizing ions as previously published and 49 stones were based on the ratios between the characterizing ions and the second highest anions present in the stones. In the present study, based on these two methods

of classifications, highest number of patients had oxalate type of stones (54 nos.) followed by uric acid stones (25 nos.). Only 16 non-infectious phosphate stone (If the Phosphate component is greater than or equal to 10% with Uric acid less than 20% and Oxalate less than 40%) and 05 infectious stones (If the Magnesium ion is greater than or equal to 3%) were obtained.

The antiurolithic activity of selected Siddha drugs with and without different adjuvants (*Anupaanam*) was performed on surgically incised urinary calculi in an *in vitro* model. This study was carried out on urate stones because the highest numbers of stones were categorized definitely as urate type stones. Siddha drugs; *Nandukal Pashpam, Silajat Pashpam* and *Venkaara Pashpam* were selected for this study. *Musa sapientum* kuntze inner stem extract (Banana stem extract; *Monthan Vaalai Thandu* extract), *Cocos nucifera* Linn water (Coconut water; *Sevlaneer*), *Raphanus sativus* Linn. tuberous root extract (Radish extract; *Mullangi* extract), *Aerva lanata* Linn whole plant extract (*Sirupeelai* extract) and *Tribulus terrestris* Linn whole plant extract (*Siru Nerinjil* extract) were selected as the adjuvants.

Cumulative amount of urate released (10 days) with *Silajat Paspam* was the highest [2.82 (±0.01) mg]. It has better *in vitro* antiurolithic effect on urate stones than *Nandukal Paspam* [0.70 (±0.01) mg] or *Venkaara Pashpam* [1.55 (±0.11) mg]. Cumulative amount of urate released (10 days) with *Sirupeelai* extract (*Aerva lanata* Linn.) was the highest [11.24 (±0.22) mg] than the other adjuvants. *Nandukal paspam* with *Sirupeelai* extract [10.69 (±0.11) mg] had better *in vitro* antiurolithic effect on urate stone than the other drugs with different adjuvants. The urate stone treated with *Sirupeelai* extract or *Nandukal paspam* with *Sirupeelai* extract had highly significant antiurolithic effect than with *Nadukal paspam* alone ($p<0.001$).

The tradition of treating the urinary stone disease patients with drug and adjuvant has been in practice in Siddha Medicine System expecting the adjuvant as a vehicle for the drug and to have pharmacological effect similar to the selected Siddha drug. The present *in vitro* antiurolithic study findings supported that the urinary stone patients treated with drug and adjuvant or adjuvants alone had better *in vitro* antiurolithic effect than the drug alone. In this study *Silajat paspam* with radish extract or *Sirunerinjil* extract were the exception. Further studies should be carried out to estimate the inhibitors and promoters in the selected Siddha drugs, adjuvants and their mixtures and further *in vitro* antiurolithic study should be carried out with other types of stones. In addition to this clinical study should be carried out with selected Siddha drugs, adjuvants and their mixtures on urinary stone disease patients to validate the pharmacological effects.

Enhancing the healthy lifestyle during the economic crisis: How? and why?

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Now we are facing a dire economic crisis and it affects our lives in all domains. We have to change our life style according to this crisis situation and it affects our health, education, nutrition and transport. The question is "How we could enhance our life style healthy during this economic crisis? And why it is important". If we follow healthy life style, we would be healthy. Staying healthy is important in this economic crisis to reduce our medical expenses.

Health is defined by WHO as "Health is a state of complete physical, mental, social and spiritual wellbeing and not merely the absence of disease or infirmity. "Economic crisis affects peoples' health in many ways. It affects all different domains of health. It affects physical health in following ways, complications of chronic diseases like diabetes, high blood pressure will be increased. More infectious diseases can occur due to decreased immunity and food insecurity. Children and mothers could not to access nutritious food.

Economic crisis affects mental health. It causes depression, stress, anxiety and increased suicidal rates. Economic crisis affects social health. It causes more crime in the society, problems in the relationships among people, disruption in the social fabric and chaos in the society. It causes negative information in every news portal, sense of hopelessness and uncertain future.

Social determinants of health are the conditions in which people are born, grow, live, work and age. They include factors like socioeconomic status, education, neighborhood and physical environment, employment, and social support networks, as well as access to healthcare.

How health system is affected in economic crisis?

Inadequate drugs & surgical equipment due to problems in import. - "Essential medicines policy"

More people seek treatment from government sector. – Earlier upper middle-class people got treatment from private sector. Now due to financial hardship and inadequate medicines in the private sector they seek treatment in the government sector. It makes government health sector over crowded.

Increased communicable & non – communicable diseases among public due to consequences of economic crisis.

Inadequate human resources to serve the people. – migration of doctors, nurses and other health staff.

How individuals affected in economic crisis?

Availability of medicines is a problem. – shortage of medicines in hospitals & pharmacies.

Accessibility to health services or hospitals is a problem – transport cost. – Patients skip the clinics, delay the treatment seeking.

Affordability of medicines is a problem - Reduced income and increased prices of the medicines. – Patients change the drug regime by themselves, not taking some drugs by themselves.

People delay care and end up requiring more expensive treatment.

In this juncture we have to increase the "Health literacy "of the people. Health literacy is the degree to which individuals have the ability to find, understand, and use information and services to inform health related decisions and actions for themselves and others.

Being Healthy During the Crisis:

- Manage Stress - Use coping behaviours.
- Prioritize your health.
- The importance of good health literacy.
- Focus on solutions - Things that you can control
- Seek help, don't delay for treatment.

Ionic Liquids: New Materials for Diverse Applications

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Ionic Liquids:

Ionic liquids (ILs) are arbitrarily defined as ionic compounds with a melting point below 100 °C.[1] They typically contain an organic cation and an organic or inorganic anion. ILs which are liquid at or near room temperature are called room temperature ILs (RTIL). A wide range of possible combinations of cations and anions facilitate the designability of ILs. Low melting point, wide liquid range, negligible vapour pressure, nonflammability, wide electrochemical window, and excellent thermal and chemical stabilities are the key properties of ILs that make them important materials from an industrial application point of view.[2-3] The low melting point of ILs compared to classical ionic compounds is associated with the large size and low symmetry of the ions and also the delocalization of charge. The hybrid organic–ionic nature of ILs and the resulting intermolecular interactions give rise to a complex set of phenomena, creating an area of study that is both fascinating and challenging.

The evolution of ionic liquids (ILs) stemmed from the discovery of $[EtNH_3][NO_3]$, the first IL, which has a melting point of 12 °C, by Paul Walden in 1914.[4] Although few ILs were reported after that, the synthesis of various classes of ILs and the exploration of their applications became prominent after the synthesis of air and water-stable imidazolium-based ILs by Wilkes in 1992.[5] The number of papers on ILs has grown exponentially over the past two decades. A huge number of ILs have now been reported with different combinations of cations and anions.

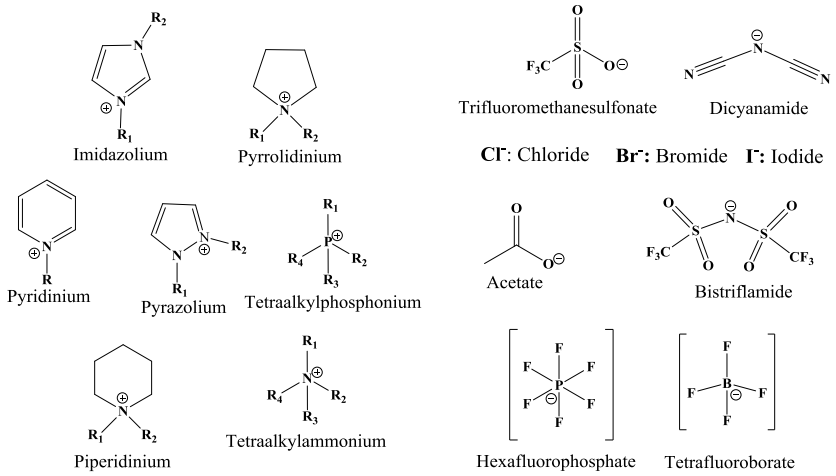
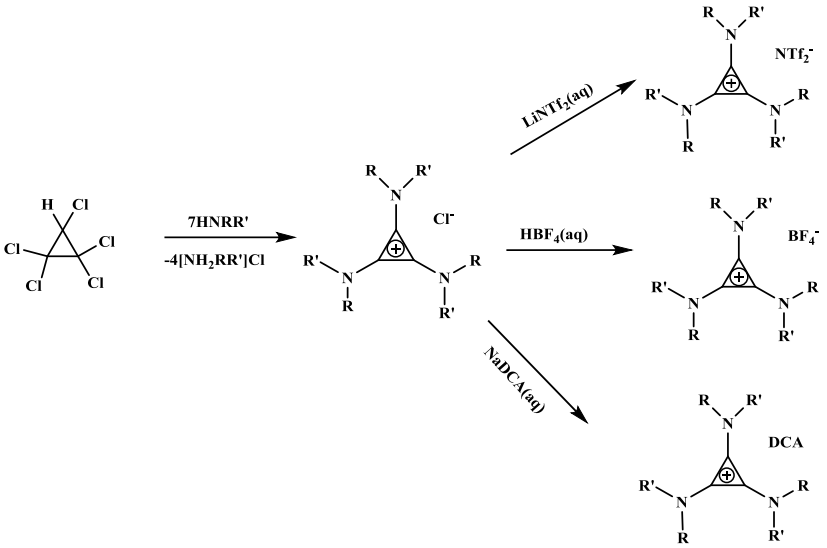


Figure 1: Commonly used cations and anions in the synthesis of ILs.

Synthesis of ionic liquids:

General synthesis of ILs is a two-step process. In the first step, the cation is synthesized by quartenization of an amine or phosphane to form the cation which is followed by an anion exchange reaction.

The cyclopropenium cation is another class of cations that can form ILs. The cyclopropenium cation is the smallest non-benzenoid aromatic system with two delocalized π electrons. The cyclopropenium ILs can be synthesized using pentachlorocyclopropane (PCCP) as shown in Scheme 1.[6]



Scheme 1: Synthesis triaminocyclopropenium ILs.

Applications of ILs:

The unique physicochemical properties of ILs have prompted searches for their applications in various fields. ILs can be used: as solvent; in catalysis; in lubrication; in electrochemistry; gas capture and storage and in analysis.[7]

ILs are attractive as potential solvents for several reasons:

- They are generally colorless liquids.
- They exhibit very low vapor pressures under ambient conditions and thus are effectively non-volatile.
- ILs can dissolve a broad range of inorganic, organic and polymeric materials.
- Synthetic flexibility that is not available for single component molecular solvents.

ILs are a good choice for the replacement of conventional molecular solvents in industries. Advantages of ILs over molecular organic solvents are their extremely low vapor pressure, less volatile and non-flammable, wide liquid range, high thermal stability, high ionic conductivity and good solvent for many organic and inorganic compounds. Due to the tunable solvent properties of

ILs, they are well suited for applications related to the selective dissolution of materials that are insoluble in water or in other common laboratory solvents.[8]

Another interesting application of ILs is their use as lubricants and lubricant additives. Lubricants are important materials for the service life of almost all machinery as they minimise friction and wear by acting as a barrier between the sliding parts. Properties of ILs such as high thermal stability, non-volatility and tuneable solubility make them interesting species for lubrication.[9-10]

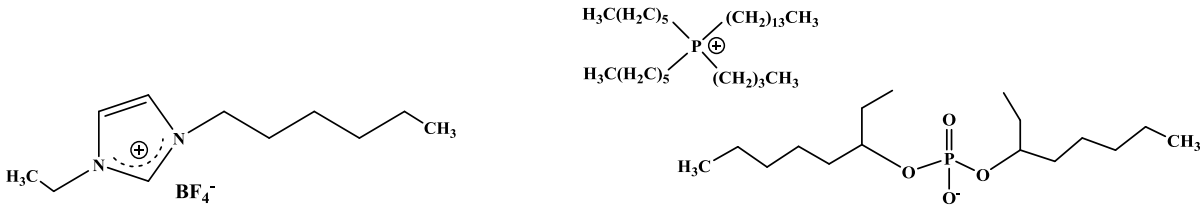


Figure 2: ILs reported for their lubrication properties (a) 1-ethyl-3-hexylimidazolium tetrafluoroborate (b) Trihexyltetradecylphosphonium bis(2-ethylhexyl)phosphate

High conductivity of ILs is an important transport property in terms of electrochemical applications. Although aqueous electrolytes exhibit high ionic conductivities, the main drawback with aqueous electrolyte is their limited electrochemical window and not suitable for wide temperature range. Large electrochemical window and the wide liquid range of ILs make them good electrolytes in electrochemistry.[11] ILs can be used as solvent free electrolytes to overcome the electrochemical window problem.

The combination of high conductivity, high thermal stability and non-volatile nature is necessary for applications like dye sensitized solar cells.[12]

ILs are useful in catalysis. Catalysis is a process in which the rate and/or the outcome of the reaction is influenced by the presence of a substance, catalyst. ILs are immiscible with numerous organic solvents and form biphasic systems with those organic solvents. Thus, ILs can be used in heterogenous catalysis.[13] For instance, Fang Dong et al. reported the use of acyclic SO_3H-functionalized ionic liquids as catalysts for Pechmann condensation reaction. N, N, N-trimethyl-N-propanesulfonic acid ammonium hydrogen sulfate [TMPSA][HSO4] has been proved to be the most active catalyst. Furthermore, their study shows that the coumarins products could simply be separated from the catalyst by filtration and the catalyst could be recycled and reused for several times without noticeably decreasing the catalytic activity.[14]

Industrial manufacture of ILs:

ILs have already moved from laboratories to industries and have been manufactured in large quantities.[15] Many companies now offer ILs as part of their existing chemical portfolio. For

instance, Io-li-tec company produces ammonium, imidazolium, phosphonium, piperidinium, pyridinium, pyrrolidinium, sulfonium based ILs. And these ILs have applications in synthesis, catalysis, and electrochemistry. Proionic company produces imidazolium and pyrrolidinium based ILs. Scionix company produces ammonium based ionic liquids. Solvionic company produces Ammonium, imidazolium, phosphonium, piperidinium, pyrrolidinium based ILs**.**

The increasing number of areas in which ILs are being employed can be demonstrated through academic publications, giving some direction as to the future of commercialized IL applications. This suggests that ILs are being used more as specialty chemicals where cost is not a prohibiting factor, rather than bulk solvents or electrolytes where they have to compete with the lower price of organic solvents.

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Anticancer peptides from medicinal plants: isolation, characterization, and *in vitro* cytotoxicity evaluation

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Introduction

Cancer, otherwise known as malignancy, is a deadly disease characterized by abnormal cell proliferation that invades and spreads to other organs or tissues through metastasis (Brown *et al*., 2023). The International Agency for Research on Cancer (IARC) reported in 2024 that 20 million new cases of cancer were diagnosed worldwide in 2022; by 2050, the figure is expected to rise by an additional 10 million. Additionally, 9.7 million cases of cancer-related mortality were reported globally, with the majority of these deaths occurring in Asian countries (International Agency for Research on Cancer, 2024). In Sri Lanka, there were 37,753 new cancer cases diagnosed in 2021, with an approximate rate of 103 new cases per day. It is noteworthy that breast cancer is the most common cancer among women in Sri Lanka, while lip, tongue, and mouth cancer are more prevalent in men (Figure 1) (National Cancer Control Program, Sri Lanka, 2023).

Figure 1: Crude incidence rate of leading cancers in males (A) and females (B) in Sri Lanka, 2021(National Cancer Control Program, Sri Lanka, 2023).

A balance between cellular proliferation and apoptosis typically maintains the body's homeostasis. Uncontrolled cell proliferation can result from flaws in cellular signaling that either promote or inhibit cell death. Genetic abnormalities in the genes governing cell division and apoptosis can modify the balance of cellular growth and apoptosis, which is the underlying cause of cancer (Hanahan and Weinberg, 2011; Evan and Vousden, 2001). Proto-oncogenes, tumor suppressor genes and DNA repair genes are the fundamental genes impacted by these mutations. These genetic mutations may be inherited from one's parents, resulting from environmental damage

to DNA or mistakes made during cell division. Cancerous cells can result from mutations in these genes that cause further mutations and chromosomal abnormalities (Bray *et al*., 2024; Lee and Muller, 2010). While the precise origins of cancer are still unknown, several risk factors have been linked to the disease, such as genetic mutations, environmental exposure to carcinogens, lifestyle factors, infections, hormonal changes, immune system dysfunction and family history (Weeden *et al*., 2023; Byrne *et al*., 2023; Hu *et al*., 2021).

A group of characteristics that differentiate cancer cells from healthy cells are known as the hallmarks of cancer. There are six hallmarks of cancer: sustaining proliferative signaling, evading growth suppressors, resisting cell death, enabling replicative immortality, inducing angiogenesis and activating invasion and metastasis. Moreover, two emerging hallmarks of cancer such as reprogramming of energy metabolism and evading immune destruction were also proposed (Hanahan and Weinberg, 2011). As illustrated in Figure 2, the basic concept behind developing cancer therapeutics is to target these hallmarks, even though these characteristics are the strength of cancer cells (Medina *et al*., 2020).

Over the last two decades, substantial advancements in cancer medicines have produced more precise and potent treatments. Surgery, radiation therapy, chemotherapy, immunotherapy, targeted therapy, hormone therapy and stem cell transplantation are some of the fundamental therapeutic options for cancer treatments (Krzyszczyk *et al*., 2018). Chemotherapy is often the initial treatment for many cancer types, followed by radiation therapy to destroy or reduce tumors. But in general, treatment regimens are tailored to the cancer's type, stage and genetic composition for better results. Nonetheless, these existing therapeutic options are reported to be attributed to several side effects such as nausea, vomiting, hair loss, subfertility, infection, bleeding, neurological syndrome, secondary cancers and relapse (Anand *et al*., 2023; Krzyszczyk *et al*., 2018). Consequently, identifying and characterizing innovative therapeutics with minimum side effects is still crucial for providing patients with comprehensive cancer treatment.

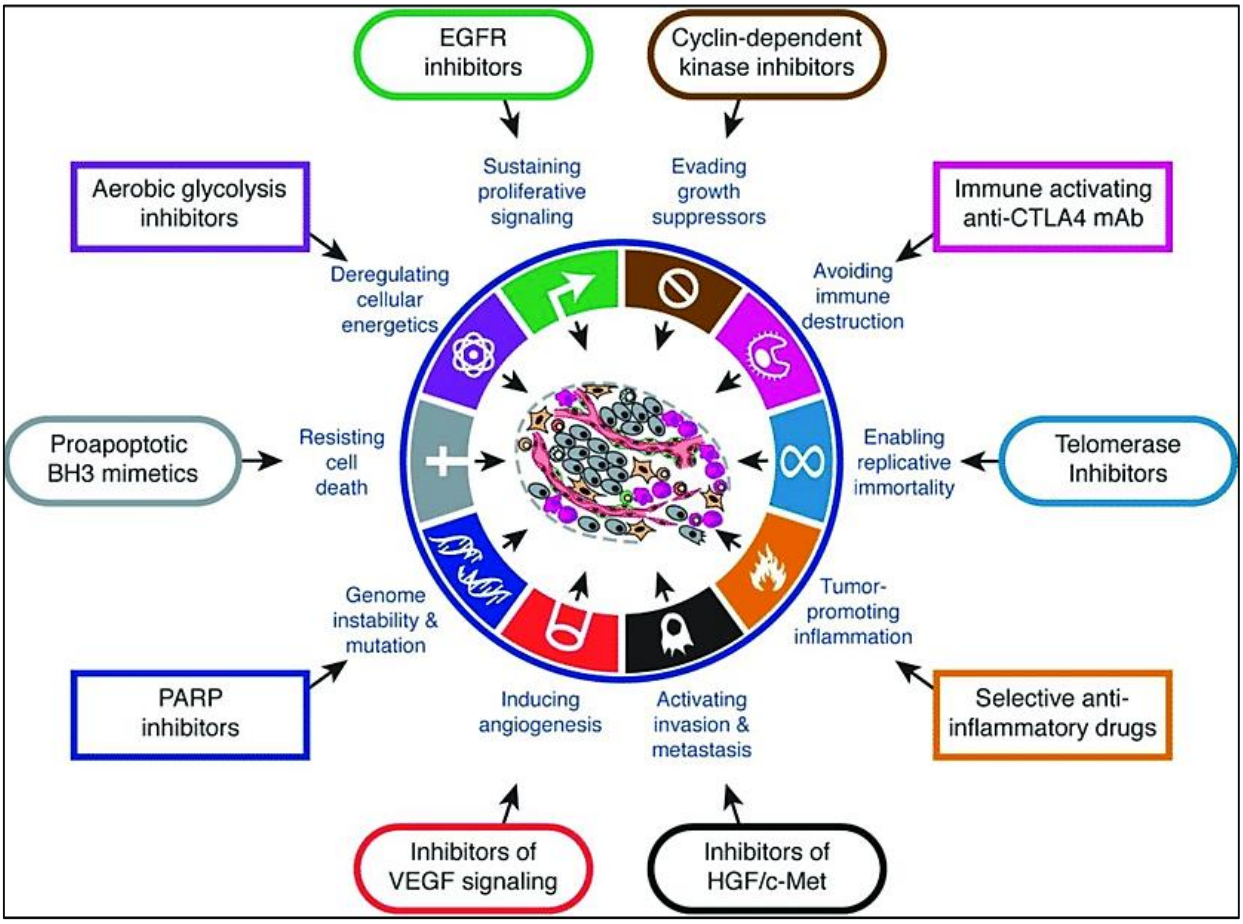

Figure 2: Therapeutic targeting of the hallmarks of cancer (Medina *et al*., 2020).

Anticancer peptides

Peptides are short, linear amino acid chains with unique biochemical and therapeutic properties. They can be designed with high specificity to bind and modulate protein interactions. Peptides have advantages like small size, easy synthesis, penetration, high activity, minimal drug-drug interaction, no accumulation and fewer toxic side effects (Rossino *et al*., 2023; Hashemi *et al*., 2021). Anticancer peptides have the potential for cancer prevention and treatment by targeting various molecular pathways involved in carcinogenesis. Anticancer peptides are classified into three groups: antimicrobial/pore-forming, cell-penetration and tumour-targeting (Boohaker *et al*., 2012). Antimicrobial peptides are crucial in the human immune system, binding to cancer cell membranes and disrupting them through folding-dependent mechanisms (Roudi *et al*., 2017). Cell penetration peptides are small peptides that transport molecules like DNA and proteins through the plasma membrane, making them ideal for peptide-based drug delivery and improving cancer treatment efficacy (Zhou *et al*., 2022). Tumor-targeting peptides target tumor cell receptors, making them useful for drug delivery, such as NGR and RGD, which bind with aminopeptidase N in endothelial tumors (Kebebe *et al*., 2018).

Anticancer peptides can be generated in three basic ways: synthetic or recombinant libraries, natural or bioactive peptides obtained from natural sources, and chemical libraries. Compared to peptides derived from random peptide libraries, bioactive peptides have numerous benefits, such as natural selection for stable fold, high *in vivo* stability against proteases and essential contact residues for transfer function (Purohit *et al*., 2024).

Discovery of anticancer bioactive peptides

Bioactive peptides can be identified using three main approaches: empirical, bioinformatic and integrated methods. Empirical methods identify novel bioactive peptides from protein sources, while bioinformatics identifies known peptides from unknown ones. However, these two approaches have several limitations, such as being expensive, time-consuming and unreliable in predicting peptide activity. Thus, researchers have combined the strengths of both approaches to create an integrated approach to bioactive peptide discovery (Figure 3) (Daliri *et al*., 2018).

Anticancer peptides from medicinal plants

Medicinal plants, rich in bioactive compounds including peptides, alkaloids, flavonoids and terpenoids have been used for centuries to treat various ailments, including cancer. Recent research has focused particularly on bioactive peptides derived from dietary proteins as potential alternative anticancer agents because of their low side effects (Ghadiri *et al*., 2024; Morales *et al*., 2017). The empirical approach is commonly used for discovering bioactive peptides from medicinal plants, which involves isolation, characterization and *in vitro* cytotoxicity evaluation.

Isolation of anticancer peptides from medicinal plants

Isolating bioactive peptides from medicinal plants involves several steps, including protein extraction, hydrolysis and purification. Initially, proteins are extracted from plant tissues using solvents such as water, ethanol, or buffer solutions, often with mechanical disruption like grinding or homogenization to release cellular contents (Hewage *et al*., 2022). Extracted proteins are then subjected to hydrolysis using enzymes such as trypsin, pepsin and alcalase, or chemical methods like acid or alkaline hydrolysis to release peptides. Subsequently, the purification of peptides is performed by sequential purification techniques, including ultrafiltration and different chromatographic methods (Shaik and Sarbon, 2022; Cruz-Casas *et al*., 2021). A model example of how garlic protein hydrolysate has been obtained for anticancer evaluation is shown in Figure 4.

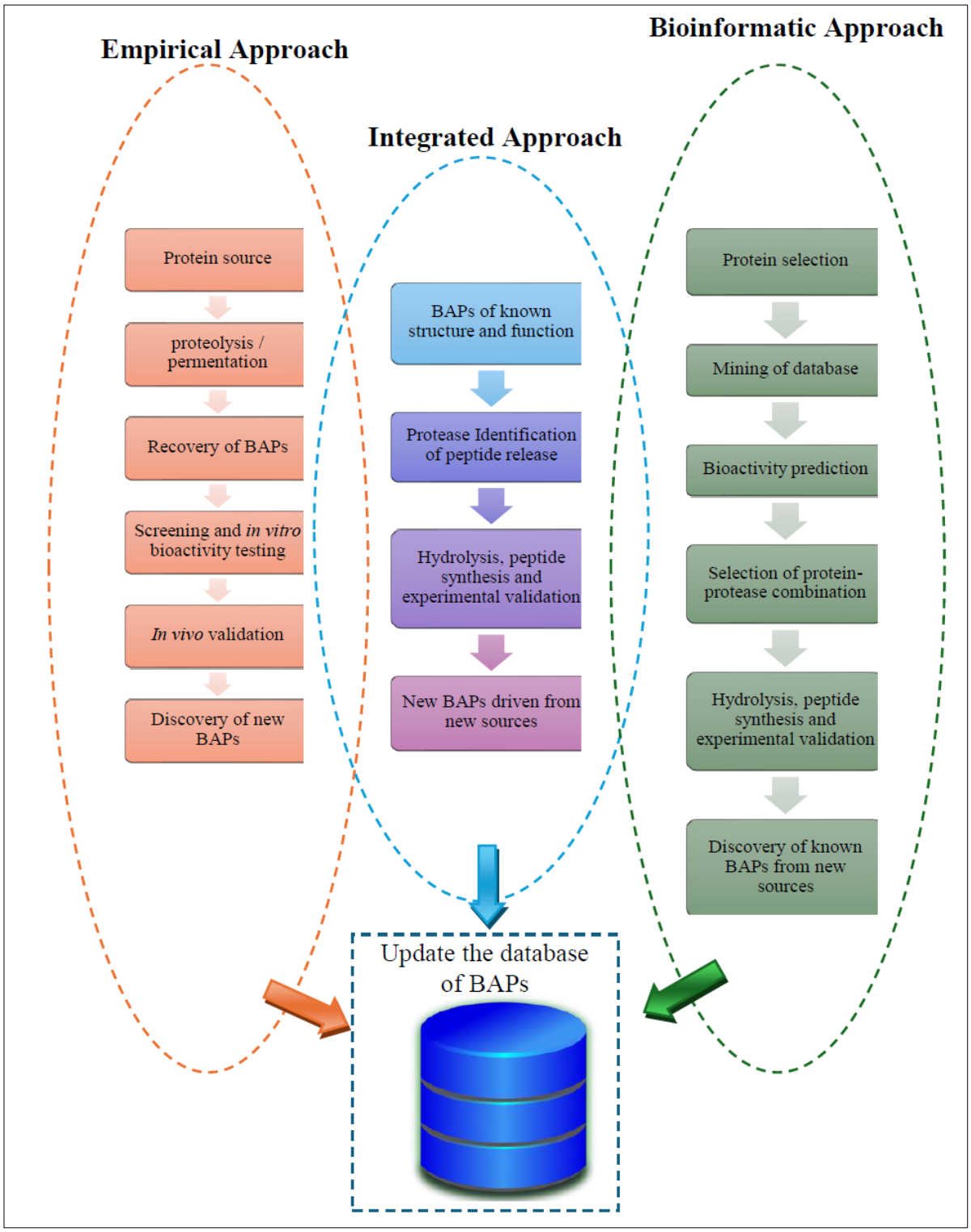

Figure 3: Means of discovering bioactive peptides (BAPs) (Daliri *et al*., 2018).

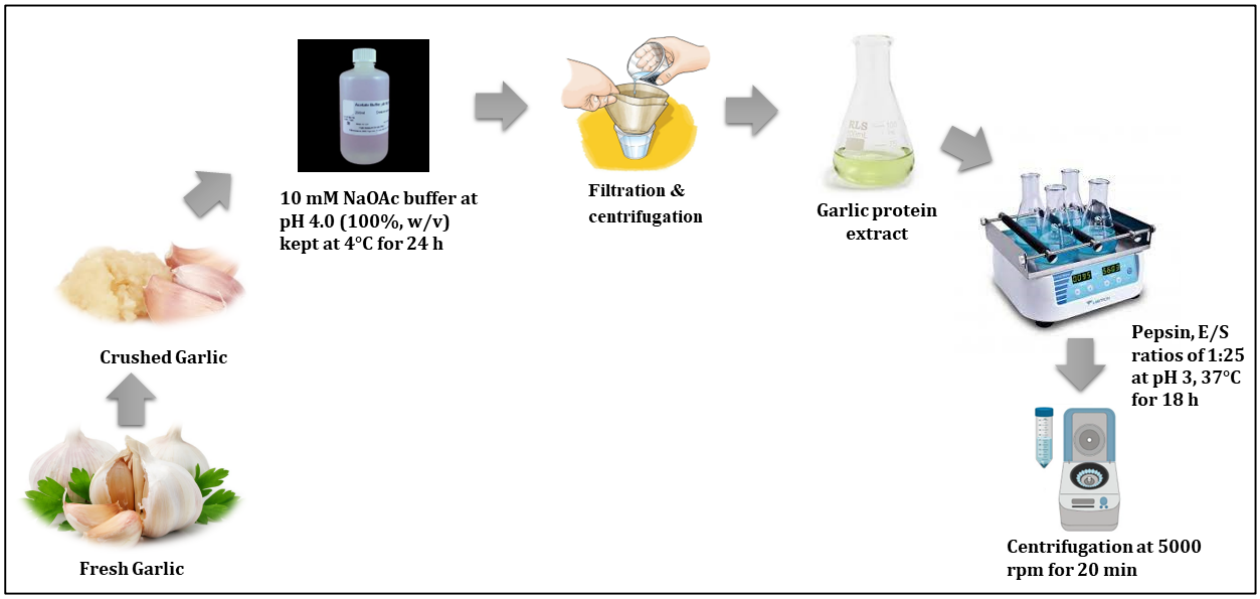

Figure 4: Preparation of garlic protein hydrolysate (Rasaratnam *et al*., 2021).

Characterization and *in vitro* cytotoxicity evaluation of peptides

Peptide characterization uses various analytical techniques: Mass Spectrometry (MS), Nuclear Magnetic Resonance (NMR) spectroscopy, Amino Acid Sequencing, High-Performance Liquid Chromatography (HPLC), Circular Dichroism (CD) spectroscopy and Fourier Transform Infrared (FTIR) spectroscopy. MS is generally used to determine the molecular weight and sequence of peptides, while NMR spectroscopy provides information about the three-dimensional structure of peptides (Galiakhmetov *et al*., 2022; Abril *et al*., 2022). Amino Acid Sequencing techniques like Edman degradation or tandem mass spectrometry play a vital role in identifying the specific sequence of peptide residues, albeit HPLC is used for purification and analysis (Miyashita *et al*., 2001). Furthermore, CD spectroscopy and FTIR are used to study the secondary structure of peptides (Keiderling and Lakhani, 2012; Fabian and Schultz, 2006).

The *in vitro* cytotoxicity of peptides is crucial for determining their potential as therapeutic agents, especially in cancer research. Microscopic analysis observes cell morphological changes after peptide treatment, calculates IC_{50} values, and understands dose-response relationships, providing a comprehensive approach to evaluate peptide *in vitro* cytotoxicity. To assess this, standard cell culture techniques are used, and peptide treatments are administered in varying concentrations to assess their dose-dependent effects. Cytotoxicity assays such as MTT, LDH and Annexin V/PI staining are used to measure cell metabolic activity, LDH release and cell membrane integrity, respectively (Sanjai *et al*., 2024). Furthermore, flow cytometry is used to analyze cell death pathways, including apoptosis and necrosis (Kari *et al*., 2022). Table 1 illustrates examples of

anticancer peptides successfully isolated and characterized from medicinal plants on different cancer cell lines.

Table 1: Anticancer peptides isolated and characterized from medicinal plants.

Sources	Peptide sequence or name	Cancer cell lines	Mechanism of actions	Reference
Garlic	VKLRSLLCS	MOLT-4 and K562	Induction of apoptosis via Bcl-2 proteins	(Rasaratnam *et al*., 2021)
Ginger	RALGWSCL	NB4, MOLT-4 and Raji	Modulation of apoptosis via p53, Bax, and Bcl-2	(Chatupheeraphat *et al*., 2021)
Black sesame	IGTLILM	MOLT-4 and NB4	Induction of apoptosis and autophagy via upregulating CASP3, ULK1 and BECN1	(Deesrisak *et al*., 2021)
Bitter gourd	BG-4	HCT-116 and HT-29	Modulation of apoptotic proteins Bcl-2, Bax, and caspase 3	(Dia and Krishnan, 2016)
Walnut	CTLEW	MCF-7	Induction of apoptosis and autophagy	(Ma *et al*., 2015)
Rice bran	EQRPR	Caco-2 and HCT-116	Inhibition of cell proliferation	(Kannan *et al*., 2010)

Summary

Cancer is a deadly disease caused by abnormal cell proliferation that invades and spreads through metastasis. Genetic abnormalities in genes can alter the balance of cellular growth and apoptosis leading to cancer. Although advancements in cancer treatments have produced more precise and potent treatments, the existing therapeutic strategies are associated with severe adverse effects. Natural resources-derived peptides are being explored as alternative chemotherapeutic agents due to their minimal side effects, gaining significant attention in recent years. Therefore, identifying and characterizing novel anticancer peptides from medicinal plants potentially may lead to the discovery of a cancer therapeutic with fewer side effects.

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நிலைமாறுகால நீதி மற்றும் இடைக்கால நீதியில் சமூக நிறுவனங்களின் பொறுப்புடைமை

கலாநிதி. ஜெகநாதன் தற்பரன்
சட்டத்தரணி

அறிமுகம்:-

இலங்கையில் போர் முடிந்து அல்லது யுத்தம் முடிந்ததாக அறிவித்து 14 வருடங்கள் கடந்து விட்டன. கடந்த 40 வருட காலச்சக்கரத்தின் தடங்கள் போரின் தாக்கங்களினாலும், ஆயுத நெருக்கடிகளின் பாதகமான சூழ்நிலைகளினாலும், அதிகம் காவு கொள்ளப்பட்டே இருந்திருக்கின்றது. 1991ல் இந்திய அமைதி காக்கும் படையின் இறுதி இராணுவம் இன்று போன்றதொரு தினத்தில் தான் இலங்கையிலிருந்து வெளியேறி இருந்தது. இருப்பினும் பொருளாதார ரீதியில் இன்னமும் தேசிய அரசுகளில், அண்டைநாடுகளில், அன்னிய தேசங்களில் தங்கி வாழவேண்டிய நிலையில் சமகால மக்கள் வாழுகின்றனர். இத்தகைய பின்னணியில் நிலைமாறுகால நீதி அல்லது இடைக்கால நீதி அன்றேல் இடர்கால மாற்றீட்டு நீதி தொடர்பில் சமூக நிறுவனங்களின் பொறுப்புடைமை குறித்து நிகழ்கால இருப்பையும், யதார்த்தத்தினையும் உணரவைக்கச் செய்யும் பொருட்டு சமகாலத்தே அனைவரும் கண்ணோட்டம் செலுத்துவது அவசியமாகிறது.

சமூக நிறுவனங்கள் என்பன யாவை?

முறைசார்ந்த, முறைசாரா அல்லது கட்டமைக்கப்பட்ட, கட்டமைக்கப்படாது தாமாகவே தொண்டு அடிப்படையில் கூடிக் கலைந்து செல்லும் குழுமங்கள், குழுக்கள், வலைப்பின்னல்கள், சமூக நிறுவனங்கள், சமூகத்தின் நிலைகள் என சமூக நிறுவனங்கள் தனியன்களின் தொகுதியையும்; சமூகத்தின் பிரஞ்ஞையினையும் "சமூக நிறுவனம்" என வரைவிலக்கணப்படுத்தலாம். குறிப்பிட்ட "சமூக நிறுவனத்தின்" நோக்கு தனியன்களின் தொகுப்பாகவும், பன்னோக்குக் கொண்டதாகவும், சமூக பிரஞ்ஞைக்கான வெளிப்பாடாகவும் அமைந்து காணப்படலாம். யுத்தத்தின் பின்பு சமூக நிறுவனங்கள் என்பதற்குள் அரசசார்பற்ற தொண்டு அமைப்புக்களும், கம்பனிகளும், வலிந்து உதவும் தொண்டர் அமைப்புக்களும் உள்வாங்கப்பட்டு இருந்தமையும் நோக்கத்தக்கது.

பலநோக்குக் கூட்டுறவுச் சங்கங்கள், மாதர் அபிவிருத்திச் சங்கங்கள், கிராமிய மேம்பாட்டுச் சங்கங்கள் என சிறப்பாக இன்னமும் ஏதோ ஒரு வகையில் செயற்பட்டு வரும் அமைப்புக்களும் சமூக நிறுவனங்களுக்கான சிறந்த உதாரணங்களே ஆகும்.

கணக்கு ஒப்புவிப்புப் பொறுப்புடைமை சார்நீதி :

போர் அல்லது ஆயுத நெருக்கீடுகளுடன் "சமூகம்" என்பது குறித்ததொரு நிறுவனம் சார்ந்திருந்த போர்க்காலங்களில், நிகழ்ந்த அநீதிகள், போர்க்கால விதிமுறைகள் பின்பற்றப்படாமை குறித்த குற்றச் சாட்டுதல்கள் கணக்கில் எடுத்துக் கொளளப்பட்டு, கணக்கு ஒப்புவிப்பு (Accoutability) பொறுப்புடைமை (Liabilities) என்பிக்கப்படுவதற்கு உலகில் பல்வேறு முறைமைகள் (Means and Methods) அணுகும் விதங்கள் பின்பற்றப்பட்டிருந்தன.

இத்தகு நிலைகள் மாறுகின்ற போதான காலப்பகுதிகளில் நீதி நிலைநாட்டப்படுவதற்கு நிலைமாறுகால நீதி (Transformative justice) முன்னர் இருந்த நிலைமைகளுக்கு மீளவும் எடுத்துச் செல்வதற்கு மீள் உருவாக்க நீதி (Restorative Justice), இடைக்காலத்திற்குப் பொருத்தமான ஒரு நீதியை சமூக நல்லிணக்கத்துடன் நடைமுறைப்படுத்துவதற்கு இடைக்கால நீதி (Transitional

Justice), பாதிப்புக்கு உள்ளாக்கியவர்களைப் பழிவாங்கல் என்பதனை வலியுறுத்தும் சட்டவாட்சிக்கான நீதி (Retributive Justice)என கணக்கு ஒப்புவிப்பு பொறுப்புடைமைசார் நீதி மற்றும் சட்டவாட்சி (Justice and Rule of Law) சார்ந்த விடயப்பரப்புக்கள் யாவும் பரந்த விடயப்பரப்புக்களைக் கொண்டவை.

இத்தகு பின்னணியில் சமூக நிறுவனங்கள் மக்களின் எதிர்பார்ப்புக்களையும், சிறப்பான எதிர்கால வாழ்வையும், கட்டியெழுப்ப வல்லதான நிகழ்ச்சி நிரல்களினை செயற்படுத்துகின்றனவா? அவ்வாறாகச் செய்தால் அத்தகு செயற்பாடுகள் மக்களின் மத்தியில் சாதகமான விளைவுகளைக் கொண்டு வரக்கூடிய ஏது நிலைகளைக் கொண்டுள்ளனவா? எதிர்மறை அல்லது பாதகமான விளைவுகளினை இல்லாது, நீர்த்துப் போகக்கூடியதான அன்றேல், அத்தகு நிலைமைகளினை நலிவடையச் செய்யத்தக்கனவாகக் காணப்படுகின்றனவா? என்கின்ற கேள்விகளை முதன்மைப்படுத்தி சமூக நிறுவனங்களின் பங்கும் செயற்பாடும் நான்கு முக்கியமான விடயப் பரப்புகளில் இக்கட்டுரையில் அணுகப்படுகின்றன.

(1) நேரிய தொலைதூர இலக்குக்கு சரியான பாதை எது?
(2) எமது கோரிக்கை என்ன?
(3) சட்டவாட்சி முறைமை எது?
(4) எமது சமூகத்தின் அர்ப்பணிப்புடனான ஈடுபாடு?

1. நேரிய தொலைதூர இலக்கும் சரியான பாதையும் :

1983 ஆண்டுக் காலப்பகுதியில் இருந்து அல்லது அதற்கும் முன்பு 1956ல் இருந்து தமிழ் பேசும் மக்கள் 1956 தொடக்கம் 1983 வரை; 1983 தொடக்கம் 1987 (இந்தியாவுடனான - ஒப்பந்த காலம்) வரை; 1987 தொடக்கம் 1991 வரை(இறுதி இந்திய இராணுவம் வெளியேறும் வரை); 1992 தொடக்கம்1995 வரை (இலங்கை இராணுவத்தால் யாழ்குடாநாடு கைப்பற்றப்படும் வரை) ; 1995 தொடக்கம் 2001 வரை(சமாதான ஒப்பந்தம் மேற்கொள்ளப்படும் வரை) ; 2006 தொடக்கம் 2009 வரை எனப் பல்வேறு காலகட்டங்களைக் கடந்து வந்துள்ளனர். அரசாங்கங்கள், மற்றும் அரசின் மூன்று அலகுகளும் (நிர்வாகம், சட்டம், சட்டவாக்கம்) சமூக நிறுவனங்களினை நல்லிணக்கம் சார்ந்த நடபடிமுறைமைகளினை சரிவர நாட்டின் அனைத்துப்பகுதிகளிலும் ஒருமித்து அமுலாக்குவதற்கு அனுமதிக்காத காலப்பகுதியாகக் காணப்பட்ட காலமது.

அதிகாரப்பரவலாக்கம், சட்டவாட்சியின் குறைபாடுகள், மனித உரிமைகள் மீறப்படுதலினைக் கண்டித்தல் எனப் பல கோரிக்கைகள் சமூக நிறுவனங்களினால் முன்வைக்கப்பட்டிருந்த போதும், அரசியல் சார் குடியியல் உரிமைகளினை மட்டும் நோக்கியதாக முதன்மைப் படுத்துவனவாக சமூக நிறுவனங்களின் செயற்பாடுகள் அமைந்து காணப்பட்டன. அரச சார்பற்ற நிறுவனங்கள், அரசினால் முதன்மைப்படுத்தப்படாத அல்லது கவனிக்கப்படாத விடயப் பரப்புக்களுக்கு முதன்மை கொடுக்கத் தலைப்பட்ட போது ஜனாதிபதியினால் உருவாக்கப்பட்ட குழுவும் (Presidential Task Force-PTF), அரசசார்பற்ற அமைப்புக்களின் செயலகமும் (NGOs Secretariate), அரசுசாரா சமூக நிறுவனங்களைக் கட்டுப்படுத்த முயற்சித்தன.

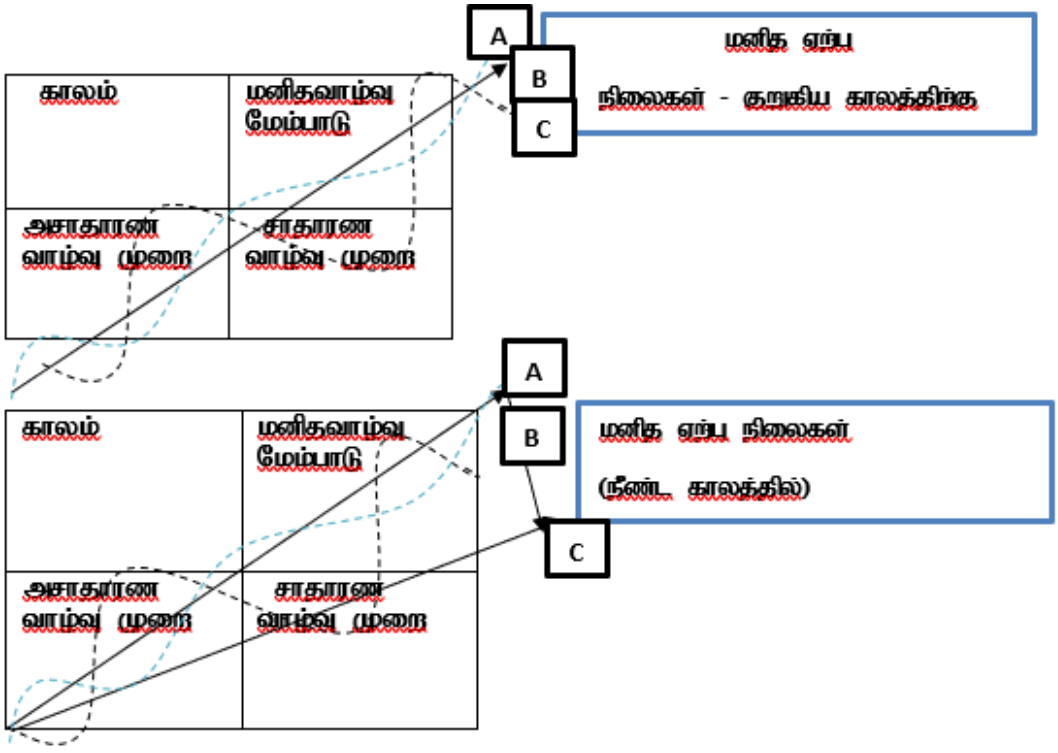
அரசியல் சார், தேர்தல் பரப்புரைகளில், நிதி வளங்களினைக் கையாள்வதில் சமூக நிறுவனங்கள், அரசின் கடும் போக்குக்கு ஆளாகின. 2009ம் ஆண்டின் பின்பு நிலைமைகள் சீராகக்

காணப்படுவதாகக் கருதப்படினும் சமூக நிறுவனங்கள் மீதான சட்ட வரையறைகள் இவ்வருடத்தில் வெளியிடப்பட்ட வர்த்தமானி வெளியீடு மூலம் மீளவும் கட்டுப்படுத்தப் பட்டுள்ளமையினை அவதானிக்க முடிகின்றது.

கூட்டுறவு, நல்லிணக்கம் போன்ற சமூக அமைப்புக்களின் தாரக மந்திரங்கள் இந்நிலைமை காரணமாக மேலும் நலிவுற்ற நிலைக்கு மக்களினையும், சமூக நிறுவனங்களினையும் எடுத்துச் செல்கின்றன. இது அபாயகரமான, அனர்த்த நிலைக்கு ஏதுவான அடிப்படையினைத் தோற்றுவிப்பதான அரச ஆக்கிரமிப்பு நிலைக்கு தள்ளிச்செல்லும் ஏதுநிலைகளே சமகாலத்தில் காணப்படுகின்றன.

சீரியவாழ்வும், ஜனநாயகப் பண்பும், வளச்சுரண்டலும், பொருளாதாரம் சார் நன்மைகள் ஊக்குவிப்பு செய்யப்படல், எனத் திட்டமிடப்பட்ட ஏகாதிபத்தியம் அரசினாலும், அரசு உந்துதல் செய்யும் சமூகக் கட்டமைப்புக்களினாலும் நடைமுறைப்படுத்தப்பட்டு வருகின்றன. மனித உரிமைகள் மீறப்பட்டாலும் பொருளாதாரம் மேலோங்கினால் நாடு வளம் பெறும் என்கின்ற அபரிமிதமான எண்ணம் (சீனாவின் மகுட வாக்கியம்) நடைமுறைக்கு வந்துவிட்ட நிலைகளே சமகாலத்தில் காணப்படுகின்றன. இதன் மூலம் அசாதாரண வாழ்வு நிலையைக் கூட மக்கள் சாதாரண வாழ்வு நிலையாக ஏற்றுக் கொள்ளப் பழக்கப்பட்டிருப்பர்.

ஆதலினால், சமூக நிறுவனங்கள் ஏற்புடைத்தான சாதாரண வாழ்வு, ஏற்றுக்கொள்ளக் கூடிய வாழ்வு முறைமை, அசாதாரண வாழ்வு முறைமைகளினை நிலைபேறானதாக வைத்திருக்கவும், அதற்கு அமைவாக அரசாங்கத்தினை தேர்வு செய்யவும் மக்களை விழிப்பு நிலையில் வைத்திருத்தல் அவசியம். இதனைப் பின்வரும் வரைபு மூலம் விளங்கிக் கொள்ளலாம்.



(A) இவ் வரைபுகளில், காலத்திற்குக் காலம் முன்னேற்றமான பரிணாம வளர்ச்சிப் போக்கினைக் கொண்டிருக்கும் மனித வாழ்வு சமூகத்துடன் நல்லிணக்கத்தினை, உலக அமைதியினை நோக்கி நகரும். பொருளாதார சமூக உரிமைகள் சீரிய முறையில் வளர்ச்சிப் போக்கினைக்

கொண்டிருக்கும். மனித உரிமைகள் யதார்த்தமாகும். மனிதம் மேம்படும். என்கின்ற கருத்தினை (A) பிரதிபலிக்கின்றது.

(B) மேற்படி (A) யினை அண்மித்ததாக சிறு அசைவுகள்,மாற்றங்கள், ஏற்படக்கூடிய ஏதுநிலைகள் காணப்படலாம். உள்ளூர் வெளியுலக தொடர்பு , பணவீக்கம், உள்ளூர்ப்போர் எனப் பல நிலைமைகள் காரணமாக (B) என்கின்ற இந்நிலை ஏற்படலாம். (A) யுடன் ஒன்றிச்செல்லல் என்கின்ற கருத்தினை (A) பிரதிபலிக்கின்றது.

(C) (A) யிலிருந்து முற்றிலும் விலகி (B) அல்லாத புதிய ஒரு வாழ்வு முறைக்கு இட்டுச் செல்லல். என்கின்ற கருத்தினை (C) பிரதிபலிக்கின்றது.

இங்கு (A) உம், (B) உம் மக்களினால் ஏற்றுக் கொள்ளப்படுகின்ற போது **புதிய ஒரு வாழ்வு முறையாகிய** (C) என்னும் நிலைமை கூட சாதாரணமாகி விடுன்றது. சிறந்த உதாரணம் அண்மையில் (2023), இலங்கையில் மேற்கொள்ளப்பட்ட பொருட்களின் விலை உயர்வும், பொருளாதார மீட்சிக்கான ஜனாதிபதியின் யுக்தியும் நோக்கப்படலாம்.

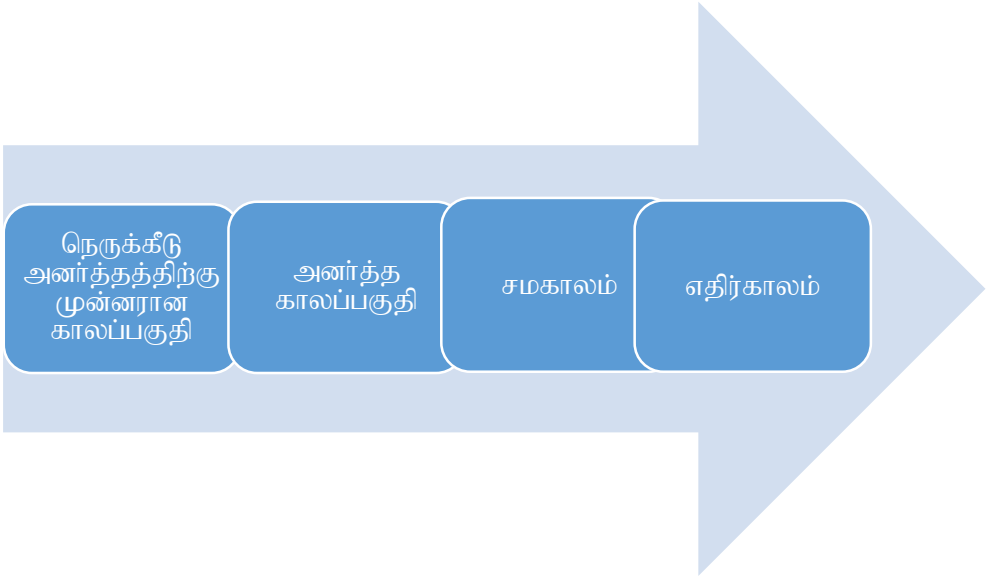
இதே நிலைமை முற்றிலுமாக விலத்திச் செல்கின்ற போதும், அசாதாரணமான சூழ்நிலையை ஏற்படுத்துகின்ற போதும் (C) யினை மக்கள் ஏற்றுக் கொள்கின்ற போது (C) எனும் அசாதாரண நிலை (A) எனும் சாதாரண நிலையாக மாற்றமடையும். இதுவே வாழ்வு என மக்கள் பழகிக்கொள்வர். இலங்கையின் வடபுலத்தே இராணுவத்தின் ஆட்சியினை மக்கள் 1995 ற்குப் பின்பும், 2009ற்குப் பின்பும் ஏற்றுக் கொள்ளப் பழகிவிட்டனர் என்பது இதற்குரிய சிறந்த எடுத்துக்காட்டு.

இவ்வாறாக சீரிய வாழ்வு குறித்த எண்ணக்கருக்கள் துலாம்பரமாக சமூக நிறுவனங்கள் மூலம் மக்களுக்குத் தெளிவுற, நயம்பட எடுத்துச் செல்ல வேண்டிய பாரிய பொறுப்பு சமூகத்திற்கு உண்டு. செயற்படாமல் உள்ள கூட்டுறவுச் சங்கங்களும், சனசமூக நிலையங்களும் குறிப்பிட்ட வரையறைக்குள் தம்மைக் மட்டுப்படுத்தாது விரைவாக செயற்பட திடசங்கற்பம் பூண வேண்டும்.

2. கூட்டான எமது கோரிக்கை என்ன?

கணக்கு ஒப்புவிப்பு பொறுப்புடைமை சார் நீதியில் முன்வைக்கப்படுகின்ற, முதன்மை பெறும் முறைமைகளில் நான்கின் விபரிப்புக்கள் பின்வருமாறு :

I. மீள்கட்டுமானம் செய்யப்படலுக்கான நீதி - Restorative Justice

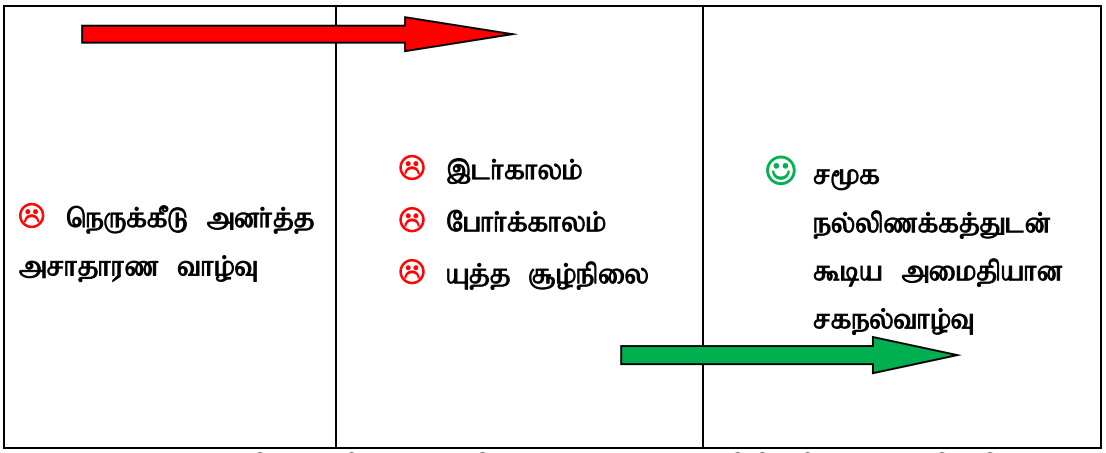


நெருக்கீட்டுக்கான எதிர்காலம் முன்வைப்புக்கள்

- **பாதிப்புக்குள்ளானவர்களுக்கான நிவாரணம்/இழப்பீடு.**
- **சமூக நல்லிணக்கம்**
- **குற்றப்பொறுப்புடைமை**

இவற்றின் மூலமாக முன்னர் காணப்பட்ட நிலைமைக்கு சமூகத்தினை மீளிணைவு செய்தல். உதாரணமாக, இலங்கை மக்கள் இயல்பாகவே நல்லிணக்கத்துடன் முன்பு வாழ்ந்தவர்கள் எனக் கருதினால் சமகால எத்தனிப்புகள் மூலம் அதே நிலைமைக்கு மீளக்கொணர்தல். சிங்கள, முஸ்லீம், தமிழ் என்ற பேதம் இன்றி அனைவரும் ஒன்றாக வாழத் தலைப்படல் என்பதான நிலைமை.

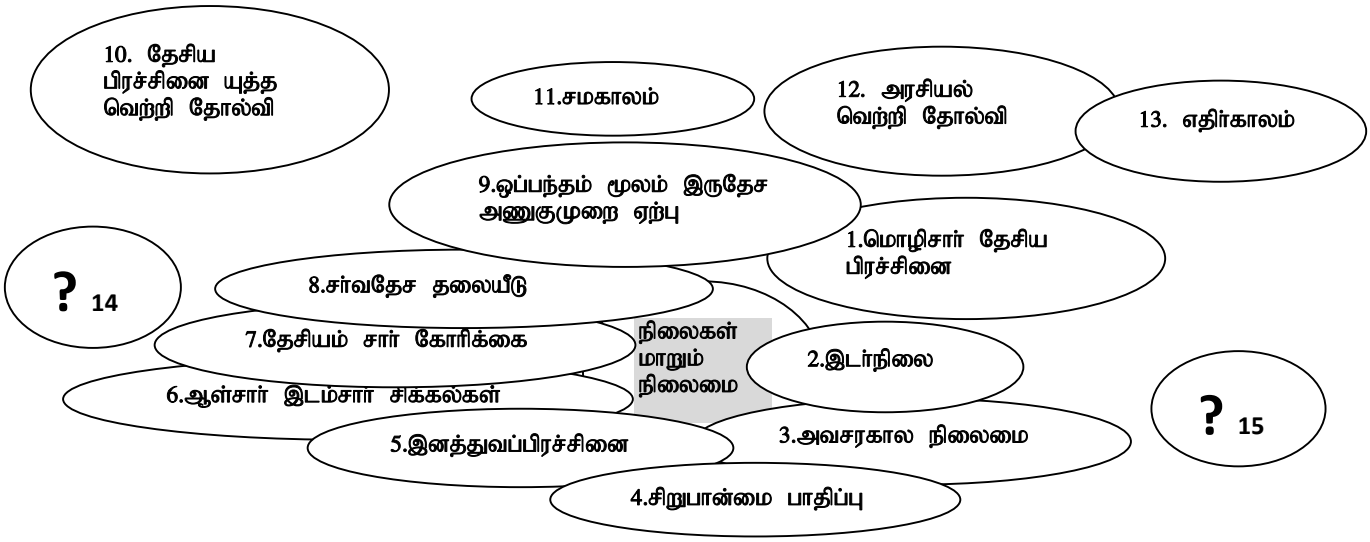
II. இடைக்கால நீதி - Transitional Justice



நிகழ்ந்ததாகக் கருதப்படும் உரிமை மீறல்கள், போர்க்கால யுத்தவிதி மீறல்கள் விசாரிக்கப்பட்டு, சர்வதேச /உள்ளூர் விசாரணைகள் முன்னெடுக்கப்பட்டு , உண்மைகள் இனங்காணப்பட்டு, வெளிப்படுத்தப்பட்டு, மன்னிப்புக் கோரி அவை வழங்கப்பட்டு சமூக நல்வாழ்வுக்கு வித்திடுதல்

என்பதான முறைமை. இங்கு எக்காலம் என்பதுவும், விசாரணை முறைமை என்பதுவும் , அடையவிரும்பும் இலக்கு என்பதுவும் அணுகப்பட வேண்டிய முக்கிய அம்சங்களாகின்றன. இதற்கு சிறந்த உதாரணமாக தென்னாபிரிக்காவின் உண்மையைக் கண்டறியும் ஆணைக்குழுப் பொறிமுறையைக் கருதலாம்.

III. நிலைமாறுகால நீதி – Transformative Justice



நிலைமாறுகால நீதி - இங்கு காலங்கள் மாறுகின்ற பொழுது இயைபான நீதி என்பது சுதந்திரமானதும் நியாயமானதுமான சட்டத்துறை மூலமும் (Independence of Judiciary and Judiciary Independence) சட்ட மீளாய்வு முறை மூலமும் (Judicial Review) சாத்தியமாதல் வேண்டும். அத்தகு ஆட்சி முறை (Rule of Law) நடைமுறைப்படுத்தப்பட நல்அரசும் (Good State) , நல்ல சட்டமும் (Good Law) அவசியமாகின்றது. அத்துடன் மக்களின் நம்பகத்தன்மையான சட்டங்கள் பாராளுமன்றத்தினால் சமகாலத்திற்கு ஏதுவாக இயற்றப்படல் வேண்டும். இத்தகு பாரிய மாற்றங்களும், அர்ப்பணிப்புக்களும் அவசியமானது.

IV. பழிவாங்கல் அல்லது தண்டனை முதன்மைப்படுத்தும் நீதி – Retributive Justice

பழிவாங்கல் அல்லது தண்டனை முதன்மைப்படுத்தும் நீதி என்பது முன்பு கூறப்பட்ட இடர்கால, போர்க்கால அனர்த்த கால நிலைமைகளுக்கு சற்று வேறுபாடானது. காரணகர்த்தாக்கள், பிரகிருதிகள், பாதிப்புக்குள்ளானவர்களை, மீள்பாதிப்புக்கு உள்ளாக்கியவர்களைக் காலக் கண்ணோட்டத்தில் அவதானிப்பு செலுத்தி சம்பந்தப்பட்ட திறத்தவர்களைத் தண்டித்தல், புனர்வாழ்வு அளித்தல், மீள் சமூகமயப்படுத்தல், தகவுநிலையை இல்லாது செய்தல், நிறுவனங்களினை மாற்றம் செய்தல், என சமூகத்தின் விருப்புக்கு ஏற்ப தண்டனை முறைமையினை ஏற்று நடைமுறைப்படுத்தல். இம்முறைமை மனித உரிமைக்கு முரணானதாக இருக்கலாம் என்பதனால் இம்முறைமை அண்மைக் காலங்களில் பின்பற்றப்படுவதில்லை. ஆனாலும் "ருவண்டாவில்" இம்முறைமை பின்பற்றப்பட்டு இருந்தமையைக் காணலாம்.

தொகுப்பு:

ஆதலினால், விபரிக்கப்பட்டவற்றில், உண்மைகளைக் கண்டறிதல், பொறுப்புக்கு உள்ளாக்குதல், இழப்பீடு அல்லது தண்டனையுடன் நஷ்டஈடு கோரிக்கை முன்வைப்பு, நல்லிணக்கம், (ஒருமித்த)

இலங்கைக்குள் அமைதி என, எந்த முறைமையினை நாம் வரவேற்கிறோம். ஏற்பு செய்யப் போகின்றோம். எமது நேரிய, சீரான, ஒருமித்த பாதை எது? தெற்கு சூடான், தென்னாபிரிக்கா, ருவண்டா, குர்திஸ்தான், கென்யா என பல நாடுகள் இம்மாதிரிகளைப் புலமையாகக் கையாண்டுள்ளன. புலமைத்துவமும், சர்வதேச பட்டறிவும் இதற்கு முதன்மையானது. எனவே, சமூக நிறுவனங்கள் செய்ய வேண்டிய முதன்மையான பணிகளில் எது சிறந்தது?. என்பதனை ஆய்ந்தறியவும், மேலே விபரிக்கப்பட்டவற்றில் ஒன்றா அல்லது புதியபாதையா என்பதனை உய்த்தறியவும் தலைப்படவேண்டும்.

3. அடுத்து சட்டவாட்சி முறைமை மற்றும் எமது பங்கும் செயற்பாடும் தொடர்பான தொடர்புறு விடயப்பரப்புக்கள் இரண்டினை ஒருமித்து நோக்குவோம்.

இருதேசம் ஒருநாடு, ஒற்றையாட்சிக்குள் சுயாட்சி முறைமை, தனிநாடு என எமது தமிழ்த்தரப்புக் கோரிக்கைகள் கூட்டு உடன்படு நிலையுடனான ஏற்பு (Collective agreement and Acceptance) என்பதனைப் பிரதிபலிப்பதாக இல்லை. சட்டவாட்சிப் பண்பு இயல்புக்கும் கோரிக்கைக்கும் அமைய வேறுபட்ட பரிணாமங்களைத் தோற்றுவிக்கும். சமூக நெருக்கடி காலத்திற்குக் காலம் பல்வேறு நெருக்குதல்களினை சமூகத்திற்குப் பரிசாகக் கொடுத்துள்ளது.

மாறாக, அமைதியான வாழ்வு முறையில் சமூக ஒப்பந்தக் கோட்பாட்டின் மூலமான ஒரு உடன்படு நிலையை ஒருமித்துக் கொண்டுவர இயலவில்லை. உரியமுறைத் தீர்வுகள் முன்வைக்கப்படக்கூடிய ஏது நிலைகள் சமகாலத்தில் உள்ளதாகவே கருதப்படுகின்றது. இளைஞர்கள், சிரேஷ்ட புலமையாளர்கள், சிறுவர் என மக்கள் பங்களிப்புடன் மக்களின் விருப்புக்கள், வேண்டுதல்கள் அல்லது தேவைகள் இனங்காணப்படல் வேண்டும். சமூக நிலைப்பாடும் சட்டவாட்சியும், சமூகக் கோரிக்கைகளும் தொடர்புற்றுக் காணப்படல் வேண்டும்.

உதாரணமாக, தமிழ்க்கட்சிகள் கோரிக்கை விடுக்கின்ற விடயப்பரப்புகளும் மக்களினால் முன் வைக்கப்படுகின்ற ஆர்ப்பாட்டப் பேரணிகளும், இரு வேறு நிலைப்பாட்டினை முதன்மைப்படுத்துகின்றன.

நிலைமாறுகால நீதியினை ஏற்பதாகவும், பழிவாங்கல் மற்றும் தண்டனையினை ஆதரிப்பதாகவும், பொதுமக்கள் கோரிக்கை விடுகின்ற போதும்; மீள்கட்டமைப்பு அல்லது நிலைமாறுகால நீதியினை தமிழ்த்தரப்புக் கட்சிகள் கோருவதாகவும் ; இவற்றுக்கும் அப்பால் கலப்பு பொறிமுறை அல்லது புதிய பொறிமுறையின் முக்கியத்துவத்தினை புலம்பெயர் அமைப்புக்கள் வலியுறுத்துவதும் அவதானிக்கத்தக்கது.

அத்துடன், பல்வேறு முறைமைகள் காணப்படுகின்ற போது தென்னாபிரிக்கா முறைமையின் ஏற்பானது, அதன் சாத்தியப்பாடுகள் ஆராயப்படாது ; அவசரமாக அந்நிலை மட்டும் பின்பற்றப்பட அரசாங்கம் தலைப்படுவது ஏன்? அத்தகு முறைமைகள் தமிழ்த்தரப்புக்குப் பொருத்தமானதா? இத்தகு நிலைமைகள் மட்டும் தீர்வைக் கொண்டு வருமா? எவரும் ஆய்வு செய்ததாக தெரிய அல்லது அறியக் கிடைக்கவில்லை.

அரசியற்கட்சிகள் முன்வைப்புக்களினை முன் நிறுத்துவதும், மக்கள் தமது பேரணிகளில், ஆர்ப்பாட்ங்களில் பலதரப்பட்ட முறைமைகளினை முன்வைப்பதும், இவற்றைக் கட்டுப்படுத்தக் கூடிய நடபடி முறைமைகளினை அரசாங்கம் கட்டவிழ்த்து விடுவதும் ; இவை அனைத்தையும் பார்த்தும் சமூக நிறுவனங்கள் நிவாரணங்கள் வழங்குதலை மட்டும் செய்து வருகின்றமையும், சமகாலத்தே

இலங்கையில் நோக்கத்தக்க துரதிஷ்ட சம்பவங்கள ஆகும். இந்நிலைமைகள் மாற்றம் பெறல் வேண்டும். உரியமுறைத் தீர்வுகள் எட்டப்படுதல் வேண்டும். இதற்கு சர்வதேசத்தின் உதவுகைகள், புலம்பெயர் தனியன்களின் அமைப்புக்களின் புலமைத்துவம் உதவியாக இருக்கலாம். இவை யாவுமே சமூக நிறுவனங்களின் பொறுப்புடைமையாகக் காணப்படுகின்றன.

அமெரிக்காவில் நிறவெறிக்காகப் போராடிய தத்துவஞானி மாட்டின் லூதர் கிங் இவற்றினையே "வன்முறைகளற்ற அமைதி முறைமை" மூலம் பின்பற்றினார். சமூக நிறுவனங்களின் வன்முறைகளற்ற ஒவ்வொரு அசைவும் சமூகத்தின் நிலைப்பாடுகளுக்கான அரசின் இருப்பினைக் கேள்விக்கு உட்படுத்தும் ஒரு நிலைப் புள்ளியாகக் (entry point) கருதினார். அத்தகைய புள்ளி பல விடயங்களுக்கு நுழைவாகவும், திறவுகோலாகவும் அமையலாம். அதனை, இனங்காணவும், பயன்படுத்தவும் சமூகம் பழகிக் கொள்ளுமாயின் எமது தரப்புக்கள் கொல்லப்படுவது என்பது தடுக்கப்படுவதற்கும், பலவீனமான தங்கிவாழும் சமூகம் உருவாகாமல் இருப்பதற்கும், எதிர்காலம் பாதிப்புறாத நிலையில் பேணிப் பாதுகாப்பதற்கும் உதவிசெய்யும். எதிர்காலமானது எம்மால் விட்டுச் செல்லப்படும் கடன்களுக்கும், செலுத்தப்படாத கொடுப்பனவுகளுக்கும் (unsettled dues) பொறுப்புக்கு உள்ளாக்கப்படாது, சுதந்திர ஜனநாயகத்தினை புதிய கோணத்தில் அணுகுவார்கள் என தத்துவஞானி மாட்டின் லூதர் கிங் கருதினார்.

ஆதலினால், புதிய ஜனநாயகத்திற்கு சிறந்த அடித்தளத்தினை அமைப்பதற்கும், கூட்டு ஒப்பந்த நிலைக்கும், சிறப்பான அணுகுமுறை குறித்த ஒருமித்த நிலைப்பாட்டிற்கும், அதன்வழி எமது நீண்ட கனவை நிலைநாட்டவும் சமூக நிறுவனங்களாவன சிறந்ததும், ஏற்புடைத்தானதுமான நீதியை நிலைநாட்டவல்ல ஏதுநிலைகளுக்கு அமைவான பொறுப்புடைமைகளை யதார்த்தமாக்கவல்ல செயற்பாடுகளை, அமுல்படுத்த வேண்டும். அதுவே, சமகாலத்தின் இன்றியமையாத தேவைப்பாடும் ஆகும்.

Eco-innovation for Plastic Alternative

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Plastics have become ubiquitous in contemporary society, seamlessly integrated into every aspect of daily life. Their journey began in 1862 when Alexander Parkes unveiled "Parkesine," the first synthetic plastic. This early iteration, made from cellulose nitrate, found utility in everyday objects such as buttons and combs. Breakthroughs in plastic technology occurred during the interwar period. Cellophane arrived in 1913, followed by polyvinyl chloride (PVC) in 1927, and then polystyrene and nylon in 1938. Finally, polyethylene, a cornerstone plastic material, was discovered in 1942. However, large-scale production and widespread use of plastic truly took root in the 1950s, witnessing a surge in consumer goods manufactured from this versatile material. The key advantage of plastics lies in their inherent moldability, enabling them to be shaped into a vast array of configurations. This characteristic, coupled with properties like lightweight construction, durability, flexibility, and affordability, fuelled their immense popularity.

The Power of Polymers and Side Chains

Most plastics are constructed from organic polymers, long chains of carbon atoms often linked with other elements like oxygen or nitrogen. These chains consist of repeating units called monomers, with each polymer containing thousands. The "backbone" of the chain acts as the central structure, holding these repeating units together. Side chains that significantly influence the plastic's properties are branching off from this backbone. By customizing these side chains, scientists can tailor the plastic's behaviour – from flexibility and durability to heat resistance. For instance, bulkier side chains can hinder the movement of the polymer chains, making the plastic more rigid. Conversely, smaller side chains allow for greater chain movement, resulting in more flexible plastic. Plastics can be derived from both natural and synthetic sources. Natural sources include rubber, plant cellulose derivatives, and limestone. Synthetic sources rely on byproducts from coal and petroleum. Regardless of the origin, various additives are incorporated during plastic production to enhance specific properties or simplify processing. These additives can modify characteristics like durability, flexibility, or heat resistance, while also influencing colour, texture, and appearance for specific applications. Fillers are another type of additive, reducing production costs while improving properties like strength, heat resistance, and colour clarity. Finally, stabilizers are employed to prevent degradation during processing and use, ensuring the plastic's longevity.

Types of Plastics

Today, seven major plastic types dominate the global landscape, each catering to specific needs. High-density polyethylene (HDPE) is widely used for milk containers, shampoo bottles, and cleaning agents due to its chemical resistance and durability. Low-density polyethylene (LDPE) finds its application in plastic bags and food wrappings, appreciated for its flexibility and low cost. Polypropylene (PP) is utilized in making bottle lids, food tubs, furniture, and car parts, valued for its versatility, strength, and heat resistance. Polystyrene (PS), often used for cutlery and food containers, is known for being affordable and lightweight, although it can be brittle. Polyvinyl chloride (PVC) is commonly used in pipes, vinyl flooring, cable insulation, and roofing because of its durability and resistance to chemicals and moisture. Polyethylene terephthalate (PET) is preferred for water and soda bottles due to its clarity and recyclability. Additionally, polyurethane (PUR) resins, along with polyester, polyamide, and acrylic (PP&A) fibers, are used across various sectors, offering a wide range of properties depending on the specific polymer.

The upward trajectory of plastic production

Plastics have become indispensable in modern life, and cost-effectiveness. However, this success presents a significant challenge: the exponential growth of global plastic production (GPP) since the mid-20th century. By 2020, GPP had reached a staggering 367 million metric tons, reflecting an average annual growth rate of 8.5% since 1950. If this trajectory remains unchecked, plastic production could potentially double by 2025 and triple by 2050, raising significant environmental concerns.

Lifecycle Assessment of Plastic

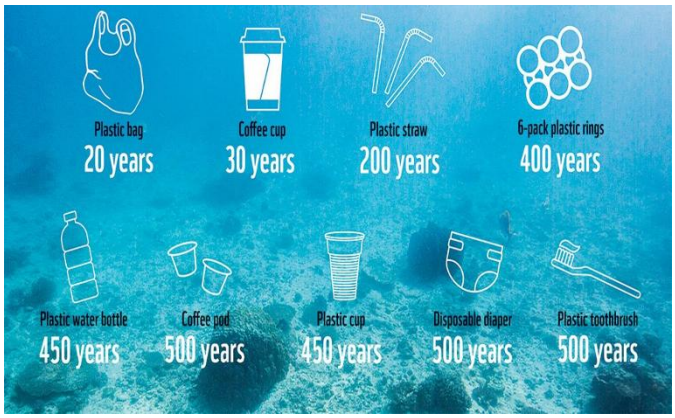

Figure 1: The lifetime of various types of Plastics

The ideal plastic lifecycle follows a linear progression: raw material extraction, design and production, packaging and distribution, use and maintenance, culminating in recycling, reuse, or recovery. However, a substantial portion of plastic waste deviates from this ideal path. Improper disposal practices, including incineration, open burning, landfilling, and environmental leakage, result in plastic pollution. These discarded plastics degrade at an excruciatingly slow pace, varying by polymer type (see Figure 1), and persist in the environment for centuries as contaminants.

The Multifaceted Impacts of Plastic Pollution

The qualities that have made plastic ubiquitous—durability and resistance to degradation—also present significant environmental challenges. Unlike natural materials that biodegrade, most plastics persist in the environment for centuries, accumulating in landfills and ecosystems. This plastic pollution disrupts wildlife habitats, endangers marine life through entanglement and ingestion, and even microplastics enter the human food chain. The extensive deployment of single-use plastics presents a unique environmental challenge due to their limited-service life and complex end-of-life management.

Figure 2. Plastic pollution in aquatic environments and impacts on food chains

The consequences of plastic pollution extend far beyond visual blight. It acts as a potent driver of biodiversity loss and ecosystem degradation, disrupting the delicate ecological balance. Plastic pollution harms human health by compromising food and water safety (see Figure 2). The economic burden is equally concerning, impacting sectors like tourism, fisheries, and agriculture. The global trade of plastic products and waste exacerbates the issue, disproportionately affecting developing nations, island communities, and marginalized groups lacking proper waste management infrastructure.

The environmental impact of plastic extends beyond its physical presence. The plastic lifecycle is intricately linked to climate change. Fossil fuel extraction for plastic production and greenhouse gas emissions released during plastic incineration significantly contribute to global warming. This creates a vicious cycle, as climate change can exacerbate plastic pollution by accelerating plastic degradation and releasing microplastics into the environment.

A Call for Collaborative Action

The narrative surrounding plastic demands a paradigm shift. Transitioning to sustainable alternatives, investing in responsible waste management infrastructure, and fostering a culture of responsible consumption are crucial steps towards mitigating plastic pollution. Concerted efforts by policymakers, industry leaders, and consumers are vital to safeguard our planet's health and well-being for future generations.

The global challenge of plastic pollution necessitates urgent and innovative solutions. The prevalence of plastic in our daily lives has led to significant environmental problems. However, eco-innovation is paving the way for sustainable alternatives that can mitigate these issues.

Holistic Approach to Sustainable Plastic Alternatives

The discourse surrounding plastic pollution mitigation often prioritizes carbon footprint reduction. However, a more comprehensive evaluation is essential. The Life Cycle Assessment (LCA) provides a comprehensive framework for evaluating plastic alternatives, encompassing not only greenhouse gas emissions but also a wider range of environmental impact categories

Beyond Carbon Footprint: Simply substituting disposable plastic with alternative materials is an inadequate solution. While curbing carbon emissions remains a crucial objective, a holistic evaluation is necessary. Comprehensive environmental evaluation is essential for informed material selection. The LCA of the petroleum-based plastic is depicted in Figure 3. The LCA should encompass resource extraction, water, and land use, potential releases of hazardous chemicals, and end-of-life considerations. Only through such a comprehensive approach can we identify and implement truly sustainable alternatives.

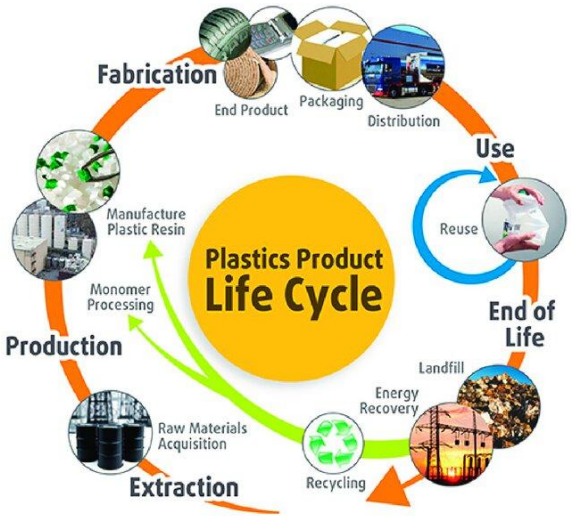

Figure 3. The life cycle assessment (LCA) of the petroleum-based plastic

The Power of Reusables: The most environmentally sound approach prioritizes reusable and refillable packaging systems. Shifting consumer behaviour patterns is key to achieving this objective. By promoting the use of unpackaged goods at local markets, farm shops, and zero-waste stores, or by facilitating the refilling of containers at participating supermarkets, we can significantly decrease reliance on single-use plastics. Fortunately, these solutions are often readily available from local markets, farm shops, zero-waste stores, and even some supermarkets. This shift towards reusable and unpackaged products necessitates minimal adjustments in consumer behaviour.

While reusable options offer significant environmental benefits, there will inevitably be instances where alternative materials are indispensable. Fortunately, a diverse range of options exists to address specific requirements. The critical aspect lies in selecting materials with minimal environmental impact throughout their life cycle.

To ensure the long-term sustainability of plastic alternatives, material selection should be guided by the following principles:

- **Resource Extraction**: Prioritize materials derived from renewable resources or recycled content to minimize environmental burden at the outset of the material lifecycle.
- **Water and Land Use**: Select materials with minimal water requirements and a low land footprint during production, thereby promoting resource conservation.
- **Chemical Release**: Avoid materials that leach harmful chemicals during their use or disposal, safeguarding human health and environmental quality.
- **End-of-Life Impact**: Prioritize biodegradable or easily recyclable materials to minimize environmental burden at the end of their useful life, promoting circularity within the material life cycle.

Sustainable Alternatives to Everyday Plastic Products

Although eliminating plastic may not always be feasible, several eco-friendly alternatives offer comparable functionality with a significantly reduced environmental impact.

Food Storage

- **Silicone Food Covers and Lids**: Although the sustainability of silicone is debated, it's a clear improvement over single-use plastic wrap.
- **Glass or Metal Containers**: These durable options are ideal for storing leftovers and dry goods, minimizing waste.

Personal Care

- **Boxed Washing Powder**: Choosing powdered detergents in cardboard packaging reduces plastic waste associated with liquid cleaning agents.
- **Refillable Glass Bottles**: Many stores offer refillable options for detergents, hand soaps, and sanitizers, promoting responsible consumption.
- **Glass or Metal Containers**: Repurpose glass jars or invest in metal containers to store toiletries and cosmetics, eliminating reliance on plastic packaging.
- **Natural Textiles**: Clothing made from cotton, wool, linen, or hemp offers a more sustainable alternative to synthetic fabrics that shed microplastics (note: be mindful of cotton's environmental impact).
- **Microfiber Cloths**: These reusable cloths effectively clean surfaces without harboring bacteria like traditional plastic sponges.
- **Toothpaste Tablets**: These compact, zero-waste tablets eliminate plastic toothpaste tubes and are made from natural ingredients.

- **Beeswax Wraps**: A reusable and biodegradable alternative to plastic wrap, these wraps keep food fresh using natural ingredients like beeswax and cotton.

Beverages

- **Reusable Drink Bottles**: Investing in a high-quality reusable bottle significantly reduces dependence on disposable plastic water bottles.
- **Glass Bottles or Aluminum Cans**: Opt for glass-bottled beverages or aluminum cans whenever possible, as these materials are more easily recycled than plastic.

Hygiene Products

- **Eco-Friendly Toilet Paper**: Look for toilet paper made from recycled content or bamboo, packaged in cardboard boxes instead of plastic.
- **Fabric Face Masks**: Reusable fabric masks are a more sustainable alternative to disposable masks, especially for non-essential workers.

Tableware

- **Recycled Paper or Bamboo Plates**: These biodegradable alternatives are a responsible choice for large gatherings or picnics.

Additional Considerations

- **Reusable Cups**: Using a reusable cup for your daily coffee or tea reduces single-use cup waste.
- **Unpackaged Goods**: Supporting stores that offer unpackaged goods like grains, produce, and cleaning products helps minimize reliance on plastic packaging.

By incorporating these alternatives into our routine, we can significantly reduce plastic pollution and foster a more sustainable lifestyle.

Eco-Innovation concept in the plastic alternatives

Eco-innovation is central to the global pursuit of sustainable development. It involves the strategic application of knowledge and technology to design and implement products and processes that minimize environmental impact. This encompasses a diverse array of advancements, from cutting-edge green technologies to socially responsible practices promoting environmental stewardship. Eco-innovation serves as a vital catalyst in the transition to a circular economy, where resource efficiency and waste minimization are paramount. The field of research dedicated to understanding the dissemination and adoption rates of these ecological innovations is termed eco-innovation diffusion.

Eco-innovation in plastic alternatives is a constantly evolving field. By encouraging ongoing research, targeted investments, and collaborative efforts, eco-innovation in plastic alternatives has an enormous opportunity to pave the path for a more sustainable future. The most promising ideas

will almost certainly integrate many ways to attain a truly sustainable future. We can all help to reduce plastic pollution, save precious resources, and protect our environment for future generations by developing and implementing demonstrably sustainable solutions. There are various eco-innovative techniques to developing plastic alternatives, which emphasize their potential for improving industries and reducing the impact on the environment.

Bioplastics

Bioplastics represent a burgeoning class of polymeric materials derived from renewable biomass sources. These materials include those directly processed from natural biopolymers (e.g., starch, cellulose, protein) and those synthesized from sugar derivatives and lipids (oils and fats) sourced from plants or animals. Bioplastics have garnered significant attention as a potential environmentally friendly alternative to traditional, fossil fuel-based plastics, particularly in food packaging applications.

While bioplastics offer a departure from dependence on finite fossil fuel reserves, a comprehensive evaluation of their environmental impact is critical. Production often necessitates the utilization of land and water resources for crop cultivation, raising concerns regarding potential land-use change and resource depletion. Additionally, the potential for improperly disposed bioplastics to negatively impact marine ecosystems warrants further investigation.

Advantages of Bioplastics

- **Reduced Reliance on Fossil Fuels**: Bioplastics leverage renewable resources, mitigating dependence on finite fossil fuel reserves.
- **Lower Carbon Footprint**: LCA suggest that some bioplastics boast a lower carbon footprint compared to conventional plastics.
- **Biodegradability**: Certain bioplastics are engineered to decompose naturally by microorganisms, potentially reducing waste accumulation in landfills.
- **Absence of Harmful Additives**: Some bioplastics are free of potentially harmful additives like phthalates and bisphenol A.
- **Preservation of Food Quality**: Bioplastic packaging may help preserve food flavor and aroma.

Bioplastics can be further classified as bio-based, biodegradable, and recyclable.

Bio-based Plastics

Bio-based plastics represent a diverse class of materials derived from renewable biomass sources such as vegetable oils, starches, and food waste. This category includes a significant variety of material properties and functionalities. The specific composition and design of each bio-based

plastic significantly influence its suitability for targeted applications and dictate appropriate end-of-life management strategies. Therefore, a nuanced understanding of the specific type of bio-based plastic is essential for maximizing its environmental benefits throughout its life cycle.

Biodegradable Plastics

Biodegradable plastics offer a promising solution to mitigate plastic pollution. These materials undergo a natural decomposition process mediated by microorganisms, ultimately breaking down into harmless byproducts like water, carbon dioxide, and biomass. However, understanding the environmental context of biodegradation is critical to maximize the benefits of these materials.

While biodegradation offers significant advantages, it is not synonymous with unrestricted disposal practices. The rate and efficacy of biodegradation are highly dependent on specific environmental conditions. Factors such as temperature, humidity, and the presence of requisite microbial communities significantly influence the decomposition process. A biodegradable plastic may not effectively degrade if discarded in an environment that does not meet these specific requirements. Therefore, robust waste management infrastructure and targeted consumer education regarding proper disposal are paramount for biodegradable plastics to realize their full environmental potential.

Two of the most prevalent biodegradable plastics include:

1. **Polylactic Acid (PLA):** Derived from starch sources such as corn, PLA exhibits versatility, mimicking the properties of common plastics like polyethylene and polypropylene used extensively in packaging and textiles.
2. **Polyhydroxyalkanoates (PHA):** Produced by microorganisms utilizing organic material, PHA finds applications in industrial settings, such as the injection molding of auto parts.

Oxo-biodegradable plastic is an exciting innovation in biodegradable polymers. It is made by blending a pro-degradant additive into the plastic during the extrusion process. The additive causes the molecular structure of plastic to break down when exposed to heat or sunlight. The plastic will eventually be in a state where it can be digested by microorganisms. At this point, the plastic will degrade at a faster rate until it has fully degraded into carbon dioxide, water, and biomass. Microorganisms will speed up the degradation process, but they're not required. This gives oxo-biodegradation a distinct advantage over prior methods for degrading plastic. The degradation time varies depending on the amount of exposure to degradation promoters (sunlight, heat, and microorganisms). In a landfill, oxo-biodegradable plastic will degrade quickly if oxygen is available to assist the degradation process. However, unlike other types of degradable plastic, oxo-biodegradable plastic will not release methane as it degrades.

Recycled Bioplastics

While the concept of "recycled bioplastics" holds significant promise for a closed-loop bioeconomy, current technological limitations often impede large-scale implementation. Ongoing research and development efforts are actively addressing these challenges, to unlock the full potential of bioplastic recyclability in the foreseeable future. Incorporating recycled bioplastics into manufacturing can achieve numerous environmental benefits:

- **Resource Conservation:** The use of recycled plastics mitigates dependence on virgin resources like petroleum, minimizing the environmental impact associated with resource extraction.
- **Waste Reduction:** By diverting plastic waste from landfills and the environment, recycled plastics contribute to a cleaner and healthier planet.
- **Greenhouse Gas Emission Reduction:** The production of virgin plastics generates significant greenhouse gas emissions. Utilizing recycled materials minimizes these emissions, fostering a more sustainable manufacturing landscape.

The Future of Bioplastics

Bioplastics hold considerable promise for fostering a more sustainable future. However, responsible production practices and proper waste management are crucial. Continued research and development efforts focused on optimizing the environmental profile of bioplastics can solidify their position as a viable alternative to traditional plastics.

Policy and Industry Initiatives

Governments worldwide are implementing policies to promote the use of eco-friendly materials and reduce plastic waste. Examples include bans on single-use plastics and incentives for businesses to adopt sustainable practices. Many companies are committing to sustainability by investing in research and development of plastic alternatives and adopting eco-friendly packaging. Increasing public awareness and demand for sustainable products are driving change in both policy and industry practices.

Summary

Mitigating the global plastic pollution crisis necessitates robust eco-innovations for plastic alternatives. While challenges persist, advancements in biodegradable polymers, bio-based materials, and enhanced recycling technologies offer promising solutions. Continued collaboration between governments, industries, and consumers is paramount to drive the adoption and development of these sustainable alternatives, ultimately fostering a healthier planet.

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Professor Kandiah Balasubramanium Gold Medal Lecture

Coping challenges of business enterprises in Jaffna

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Introduction

Throughout human civilisation, agricultural activities have been a vital part of society. As societies have evolved and become more complex, it has become increasingly difficult for individuals to produce all the goods and services necessary to meet their needs. Thus, specialisation in the production of goods and services relevant to specific sectors has emerged, with some individuals acting as producers and others as consumers. Business enterprises have become pivotal economic entities in this dynamic, playing a critical role in satisfying the needs and wants of consumers. Business which include trade and ancillary services (transportation, banking, and insurance) produce and provide a diverse range of goods and services that are essential to human society. In today's fast-paced, interconnected world, business organisations are central to the functioning of the global economy. Jaffna is a city located in the Northern Province of Sri Lanka, which has undergone significant economic and social changes in recent years following the end of the civil war. The Jaffna has a strong cultural heritage and is known for its agricultural produce, such as fruits, vegetables, and spices. The area is also home to a large fishing industry and has several tourism-related opportunities. However, the region still faces several challenges when it comes to doing business. Entrepreneurs and business leaders in the region must navigate the complexities of the marketplace with innovative strategies and creative problem-solving. By doing so, they can make significant contributions to the local economy while building successful businesses that have a positive impact on society.

Purpose of Business

The purpose of business extends beyond just generating profit. Although profit is undoubtedly a critical goal for most organisation, it is not the only one. There are other essential considerations that organisation must take into account to operate successfully in the business world. One of these considerations is the delivery of services that benefit society. While government organisations prioritise social services over profit, private sector organisation are also recognising the importance of social responsibility. By working to deliver services that benefit society, businesses can build a strong reputation in the market and contribute to the betterment of society as a whole. Another crucial purpose of business is to prioritise customer satisfaction. By providing high-quality products and services that meet the needs of their customers, organisation can foster customer loyalty and

build a positive brand reputation. This approach benefits not only to the company but also for the community and the environment as a whole. To survive in the market, businesses must diligently cater to customers' needs and wants by providing high-quality products and services at a reasonable price. Additionally, creating a diverse range of career opportunities and maintaining employee welfare are among the primary objectives of business organisations. These employee benefits extend beyond the provision of basic needs and include opportunities for social status and contribution. By investing in a business, individuals can aspire to excel in the industry and achieve the highest social standing through their efforts. This, in turn, can lead to increased revenue and market share. Creating employment opportunities is also a significant purpose of business. By providing jobs, organisation can contribute to the economic development of the communities in which they operate. In addition to social responsibility and customer satisfaction, organisation must also work towards the full utilisation of local resources to contribute to the sustainable development of their communities and minimise their environmental impact. In the realm of production, land, labour, and capital are the three essential factors. All available natural resources are considered as land. Example: Minerals, Forests,and Soils. The physical and mental contributions made by individuals to a business are referred to as labour, which encompasses various professions such as healthcare providers, porters,accountants, and managers. Capital is a human-made resource that supports the production process and includes buildings, machines, motor vehicles, and cash. Entrepreneurship, however, is recognised as a critical driving force behind businesses. Economists consider entrepreneurship to be the fourth factor of production that combines land, labour, and capital. As such, entrepreneurship is a multifaceted concept with economic, managerial, and sociological implications (Karunanayake and Senatheere, 2006). The purpose of business goes beyond just generating profits. Social responsibility, customer satisfaction, employment creation, and sustainable development are among the primary objectives of successful businesses. Entrepreneurs play a crucial role in driving businesses and must consider various factors, including the utilisation of local resources, to achieve long-term success.

Entrepreneurship and Entrepreneurs

Entrepreneurs play a significant role in mobilising resources, employees, capital, and technology to produce goods and services that meet human needs in both economics and management. From a psychological perspective, the behavior model posits that entrepreneurs are motivated by the forces observed in the experimenter. However, entrepreneurship is also a social process that is deeply embedded in society, with an emphasis on social behavior. Entrepreneurs are typically regarded as innovators who are at the forefront of economic development. They are skilled at identifying

intrinsically profitable opportunities, exploring them, and having a positive impact on the organization's effectiveness, as noted by Joseph Schumpeter (1934). In Sri Lanka, most entrepreneurs engage in self-employment and work hard to establish and maintain their businesses, enhancing their status in society. Risk-taking, innovation, and business decision-making are defining characteristics of entrepreneurs, especially in developing countries like Sri Lanka, according to Farook (1992).

Entrepreneurship in Jaffna has been gaining momentum in recent years. According to a report by the World Bank, Jaffna has the potential to become a regional hub for entrepreneurship, due to its strategic location and the availability of a skilled workforce. According to a report by Yarl IT Hub(2020), a non-profit organisation in Jaffna, the number of startups in the region has increased by more than 50% in the past five years. In 2020, the Jaffna District Chamber of Commerce estimated that more than 10,000 people were employed in the region's startup ecosystem. Despite the growth in entrepreneurship in Jaffna, there is still a gender gap. According to a survey conducted by the Jaffna Women's Chamber of Commerce, women entrepreneurs account for only 17% of the total entrepreneurs in the region.

Private sector business in Jaffna

Business organisations can be broadly classified into three types: government sector, private sector, and co-operative sector. While all three types are found in Sri Lanka, this discussion will focus solely on private sector businesses. The Northern Province of Sri Lanka comprises five administrative districts, 33 divisional secretariat divisions. Jaffna, one of these districts, covers an area of 1025 square meters and has 15 divisional secretariats and 435 Grama Niladhari units. According to the population assessment statistics of 2022, the population of the Northern Province is 626,000. Jaffna is a district in Sri Lanka where agriculture, small businesses, and retail and wholesale businesses are the main sources of income. The profession of educationist is also common in the region. However, despite the growing number of business ventures being established, entrepreneurship is not highly regarded as many young people aspire to become government employees. Nevertheless, Jaffna is slowly transforming into a commercial and industrial center, with a significant increase in small businesses, retail business, tourism, accommodation opportunities, and self-employment ventures. Many individuals are expanding their existing businesses or starting new ones, often with the assistance of leasing and financial organisation or banks.

Jaffna is attracting entrepreneurs from other parts of Sri Lanka who see the district's potential for growth and development. However, these business ventures face several challenges, such as limited

access to capital, lack of skilled labour, and inadequate infrastructure. Overcoming these obstacles will require collective efforts from both the private and public sectors. To gain insights into the activities and trends of commercial organisation in Jaffna, it is essential to examine the two distinct periods: pre-2009 and post-2009.

Examining the Pre-2009 Period: Jaffna's Commercial Landscape was under LTTE Control. Prior to 1995, the Sri Lankan government had no control over Jaffna, and the land route between the south and Jaffna was severed, making it difficult to transport goods between Colombo and Jaffna. However, experienced business influencers managed to operate by sea, resulting in a few traders monopolizing the market. Despite the high demand and rising prices, these traders were able to maintain profitability despite requiring significant investment. Post-War Development: Challenges and Opportunities for Business Ventures. Following the government's full control of Jaffna in 1995 and a peace agreement with the LTTE, some positive developments for businesses were observed. However, the period after 2009 marked a significant turning point, as the A-9 road between Colombo and Jaffna was reopened, leading to a surge in both new and existing business activities. Southern merchants also entered the market, while state-owned banks, leasing, and finance organisation emerged. Despite the potential for growth, this period also presented significant challenges for Jaffna's business ventures. Limited access to capital, lack of skilled labour, and inadequate infrastructure are some of the obstacles facing these ventures. Therefore, it is crucial to examine the challenges and opportunities for Jaffna's business ventures in the post-war period.

Need for the study

Compared to the pre-2009 era, there has been a substantial surge in the establishment of new businesses and expansion of existing ones in the Jaffna district. This trend can be attributed to a variety of factors that have emerged since 2009. According to recent discussions with the Chamber of Commerce in Jaffna, as of 2023, there are now over 10,000 retail and 500 wholesale businesses operating in the district. Notably, 20% of retail businesses and 50% of wholesale businesses are located within the Jaffna Municipality area. It is important to note that many of these businesses, which maintain high levels of inventory, are heavily reliant on debt capital. This reliance on debt financing has led to the failure of many such businesses, with a concerning number of business owners(5 - 10%) attempting suicide or fleeing with their families due to their inability to repay loans and credit. This is a sensitive social issue that has garnered attention from relevant officials and associations, such as the Chamber of Commerce, who have sought to identify the root causes of this phenomenon. Data of the study was collected through a range of methods, including

interviews and discussions with business owners and members of the Chamber of Commerce, as well as through observation.

Challenges for business in Jaffna

In today's competitive and challenging global environment, the development of multidimensional business ventures is crucial for the sustainable economic growth of developing countries like Sri Lanka. These ventures play a critical role in shaping and advancing societies. The question remains: can business organisation in Jaffna operate sustainably? Despite the potential for growth and development, these organisations face a range of issues, including business laws and regulations, financial and manpower capacity, and technology limitations. Prior to or during the war, only a limited number of individuals or experienced individuals from previous generations established and managed business enterprises in Jaffna. The end of the war, many individuals initiated and operated new business ventures. Due to the limited industrial opportunities, people displaced from their hometowns and settled in new locations. Assistance from relatives in local or relatives abroad was limited due to the global economic crisis. After the war, number of women headed families emerged and most people lost their job opportunities including daily wages.As a result, numerous new business ventures and organisation emerged in Jaffna as a result of the loss of relationships and possessions.

Additionally, many individuals from the south who possess financial resources and influence launched business activities in Jaffna. The government's new projects and the relocation of bank branches and financial firms to Jaffna fostered the emergence of numerous new business ventures. However, in this environment, business organisation confront many problems and challenges. Limited access to capital and financial services, the lack of skilled labour, and inadequate infrastructure are some of the significant challenges faced by Jaffna's business ventures. Moreover, the regulatory environment can be complex and challenging, particularly for small and medium-sized enterprises. However, with the right support and investment in capacity building, technology, and infrastructure, these challenges can be overcome, leading to the sustainable growth and development of businesses in Jaffna.

From the discussion with chamber of commerce, business community, and observations, the following problems faced by Jaffna business organisations are identified.

Remaining inactive in the market: Business ventures that continue to rely on traditional methods are at risk of losing customers and market share due to new competitors. On the other hand, many new business ventures are also operating without proper market research, a solid business plan, or a feasibility report, which puts them at risk of failure.

Lack of investment analysis: Expanding an existing business or starting a new one requires an investment analysis. Without proper analysis, investors are unable to recover their capital.

Inability to obtain adequate capital: Starting and running a small business requires significant capital, but many entrepreneurs begin with limited funds and struggle to obtain financing from individuals or financial institutions. Lenders often require the mortgage from the business or witness from government servants. As a result, small business owners may have limited access to credit.

At present, all special loan schemes are not operated due to the economic crisis of the country and the present interest rate is also very high. A small enterprises operating in rural areas has to compete with many small enterprises in urban areas. Thus, these small rural enterprises are not seen as important to the lending institutions. Effective rate of interest of micro level credits (micro - finance) is the major reason for the failure of small scale businesses.

Business-oriented activities of financial institutions: The contribution of banks and financial institutions is crucial in strengthening business ventures, particularly in developing regions.

Following the end of the civil war in 2009, a large number of government and private bank branches and financial institutions were established throughout the Jaffna district. It is essential to question whether these branches were established to meet the actual needs of the region or simply as a result of competitive pressures. These organisation provide large loans to entrepreneurs and are active in lending on a competitive basis. When customers apply for loans, financial institutions typically require a business plan, feasibility report, and past and projected financial statements. However, some financial institutions provided loans without proper evaluation or may provide loans that exceed what can be repaid. This can lead to a situation where borrowers are unable to pay back their loans, leading to the collapse of their businesses. In some cases, individuals have turned to high-interest loans or taken on additional debt, leading to severe financial hardship and even suicide.

Arrival and operations of leasing organisation: Since the opening of the A-9 road, several leasing companies have established their operations in Jaffna, and their extensive marketing campaigns and communication methods have attracted many traders and individuals. As a result, a large number of people have leased vehicles such as Autos, Motor bikes, Vans, tippers, and heavy vehicles without proper evaluation of their capacity to repay the lease amount and generate sufficient income. Consequently, many individuals are struggling to pay the lease amount, and when company representatives visit, they tend to away from them. This has resulted in these leasing organisations seizing their vehicles, further exacerbating the economic downturn for these individuals and traders. It is important to note that some business owners have also acquired vehicles beyond their actual needs and financial capacity.

Lack of proper capital structure: The interrelationship between equity capital and debt capital in a business venture is known as the capital structure. Many entrepreneurs tend to rely heavily on debt capital, particularly when starting a new business. However, this often results in a significant portion of their earnings being used to pay off interest and loan installments, leaving them struggling to cover basic expenses such as maintenance and salaries.

Lack of appropriate technology and modern machinaries: Despite the rapid pace of technological advancement and the availability of modern mechanaries, many small business entrepreneurs are unable to take full advantage of these resources due to their high cost. This puts them at a disadvantage in terms of competitiveness and can make it difficult for them to keep up with consumer preferences. In particular, consumers tend to favor machine-made products over hand-made ones, as they are often perceived to be of higher quality and more aesthetically pleasing.

Poor inventory management: Many businesses make the mistake of purchasing excessive quantities of raw materials or finished goods without proper evaluation of their production or sales requirements for a given period. This results in an excess of inventory that takes longer to sell, reduces in value over time, and poses potential financial difficulties. Additionally, some vendors fail to distinguish between fast-moving and slow-moving inventory, leading to a lack of efficiency in inventory management. It was observed this was the major reason for the failure.

Lack of Professional/Business uniqueness: Jaffna's businesses lack differentiation, leading to intense competition and oversupply, making it difficult for traders to market their products effectively. This is exemplified by the many unoccupied commercial buildings due to the proliferation of similar businesses.

Bad credit policies: Traders who prefer to buy goods on credit face the risk of not being able to pay back their debts within the specified period. This leads to a cycle of increasing debt, which can eventually lead to business closure. After opening of the A-9 road, it has resulted in traders from other parts of the country coming to Jaffna for the distribution of goods. These traders received post-dated checks from suppliers that typically last from one to three months, but traders may not be able to sell all of the products within this period, further increasing their financial risk.

Inadequate manpower and training: The lack of skilled personnel in Jaffna's businesses leads to low productivity and profitability. For instance, despite the opening of several theaters in Jaffna, business owners were struggle to find skilled workers to work in them.

Lack of marketing strategies: Jaffna's business people continue to carry out sales activities in the traditional way, posing a challenge as they fail to adopt new tactics that could improve their business and reach more customers. Southern traders are also concerned about the impact on their business

by operating in this region. However, they should adopt new marketing strategies and techniques to run their businesses successfully.

Unregistered businesses and inability to access financial assistance: Many small businesses in Jaffna are unregistered, which hinders their ability to access the benefits available to registered businesses. Additionally, traders lack the skills to prepare proposals for financial donations from government and non-governmental organizations, which may explain why many were unable to receive capital financial assistance from organisations like USAID.

Recommendations for problems

- In Jaffna, business organisations need to adapt their strategies to suit the current needs and times, as relying solely on the same business methods can hinder growth. According to the Central Bank of Sri Lanka, Jaffna recorded a Gross Domestic Product (GDP) growth rate of 5.6% in 2020, indicating the potential for business growth in the region. However, to ensure success, it is crucial to prepare a suitable business plan and feasibility report that analyses political, social, economic, and technical issues. Entrepreneurs lacking the knowledge and resources to do this can seek the help of academicians or business advisors to prepare comprehensive plans that consider the specific needs of the Jaffna region.
- Properly analysing investments is crucial for business ventures in Jaffna to perform as expected. Before starting or expanding a business venture or project, entrepreneurs need to evaluate the total capital required, machinery and equipment, employee allowances, operating expenses, and income available. Using appropriate methods, such as return on investment, paybackperiod , and net present value, entrepreneurs can assess relevant cash inflows and outflows to make informed decisions.
- Insufficient capital is a common problem for small business ventures in Jaffna. To address this issue, it is best to start with a small amount of capital first and gradually grow the business, gaining experience along the way. According to the Jaffna District Chamber of Commerce, the region has a vibrant small and medium enterprise sector, and entrepreneurs can take advantage of this by seeking mentorship and guidance from experienced business owners.
- Loans can be obtained from financial institutions like banks in Jaffna by submitting proper documents. Non-governmental organisations such as the Industrial Development Council/chamber of commerce can review project applications and recommend them to lending institutions, enabling entrepreneurs to raise capital. According to the Central Bank of Sri Lanka, Northern had a total of 11 licensed commercial banks and 2 licensed specialised banks in 2020, indicating the availability of financial resources for businesses in the region.

- Financial institutions in Jaffna need to act with economic development responsibility, not just for commercial purposes. According to the Central Bank of Sri Lanka, Northern had a total of 13 licensed financial institutions in 2020, including commercial banks, specialised banks, and finance organisations. Proper credit checks and evaluation of business plans and income statements are essential to ensure that loans are given according to the ability to repay. Monitoring after the disbursement of loans is also necessary to identify potential risks and address them promptly. Successful ventures can be rewarded through various means, such as reduced interest rates or extended loan terms.
- Leasing organisation in Jaffna should prioritise evaluating their needs of the customers and conducting a thorough assessment of vehicle performance before purchase to ensure that the leasing cost is reasonable and cost-effective from the customer's perspective. According to the Department of Motor Traffic, there were 42,874 registered vehicles in Jaffna as of 2020, indicating the potential for the leasing industry in the region. Hiring services rather than purchasing vehicles outright can also be a more cost-effective solution for leasing organisation.
- Organisation in Jaffna should maintain an appropriate capital mix and avoid relying heavily on debt capital to control high interest costs and ensure profitability. According to the Jaffna District Chamber of Commerce, the region has a diversified economy, with significant sectors including agriculture, fisheries, and tourism. By considering this rule and acting accordingly, businesses can maintain financial stability and pursue growth opportunities.
- Maintaining appropriate inventory levels is crucial to business success in Jaffna. Measuring daily sales and maintaining the required amount of stock for a month can help avoid financial stagnation and deficits. Stock levels should be adjusted based on whether items are fast or slow moving, and minimum, potential, and reorder levels should be determined and maintained. According to the Department of Agriculture, there were 5,020 registered farms in Jaffna as of 2020, indicating the potential for the agriculture sector in the region.
- It is important to avoid buying in excess or over the credit limit in Jaffna, as suppliers give goods on credit. Increasing sales and keeping the inventory turnover rate high can help to minimize this issue. Keeping the collection period to a minimum can also be beneficial, and offering incentives can encourage prompt payments. According to the Jaffna District Chamber of Commerce, the region has a growing retail sector, with various shops and stores catering to local demand.
- Adequate training can help to create efficient personnel in Jaffna, and forming an industrial organization or engaging existing industrial experts in the region can help to provide this

training. By developing the skills and knowledge of the workforce, businesses can improve their productivity and competitiveness, contributing to the economic growth of the region.

- In Jaffna, creating unique business ventures that cater to the needs and preferences of the local market can help businesses stand out from their competitors and succeed. Instead of replicating existing business models, entrepreneurs can explore new and innovative ideas that leverage the strengths of the region, such as its rich cultural heritage and natural resources. By doing so, they can tap into new markets and create value for their customers while contributing to the economic development of the region.

Conclusion

- The task of navigating the business landscape of Jaffna is undoubtedly challenging, and it requires businesses to adopt innovative strategies to overcome obstacles and drive sustainable growth.
- The challenges facing businesses in Jaffna are multifaceted, ranging from limited access to financing, inadequate infrastructure, and a lack of skilled personnel, among others.
- To address these issues, businesses must implement appropriate business methods, develop comprehensive business plans and feasibility reports, and perform thorough analyses of their investments.
- It is also crucial for businesses in Jaffna to explore alternative sources of financing, such as non-governmental organisations and regional development programs, and collaborate with financial institutions that prioritise economic development.
- Businesses must maintain an optimal capital mix and inventory levels to avoid excess or insufficient stock and create diversified business ventures rather than duplicating existing ones.
- Adequate training should also be provided to ensure the efficient utilisation of human resources. By adopting these innovative strategies, businesses in Jaffna can overcome their challenges and drive sustainable growth, ultimately contributing to the overall economic development of the region.
- To achieve this, it is essential for businesses to collaborate and work together, leveraging their strengths to navigate the business landscape and drive positive change.
- The key to success for businesses in Jaffna lies in their ability to adopt innovative strategies and collaborate ate effectively.
- By doing so, they can overcome the challenges they face and drive sustainable growth, making a positive impact not only on their businesses but also on the region as a whole.