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MESSAGE FROM THE VICE CHANCELLOR

I extend my warmest greetings to all participants of the International Conference on Science and Technology (ICST 2023) organised by the Faculty of Technology, SEUSL. It is indeed an honor for me to send the message to the book of abstract of ICST 2023.

The Annual International Conference on Science and Technology has become a hallmark of academic excellence, providing a platform for scholars to showcase their innovative research and contribute to the collective advancement of knowledge.

The abstracts reflect a wide spectrum of disciplines, and it is evident that the researchers have delved into cutting-edge topics that have the potential to make substantial contributions to their respective fields. The commitment to excellence in research demonstrated by the contributors is commendable, and I believe that the knowledge disseminated through these proceedings will undoubtedly have a positive impact on our academic community and beyond.

I would like to express my sincere appreciation to the Organizing Committee for their tireless efforts in coordinating this event. Your dedication to fostering a culture of research and academic inquiry is a testament to the commitment of the South Eastern University of Sri Lanka to advancing knowledge and promoting scholarly endeavors.

To the researchers, I extend my heartfelt congratulations on your achievements and the valuable contributions you have made to the scientific community. Your dedication to pushing the boundaries of knowledge is inspiring, and I am confident that your work will pave the way for further advancements in your respective fields.

As we navigate the challenges of our rapidly evolving world, it is through events like ICST that we strengthen the foundations of our academic community and forge new paths of discovery. I encourage all participants to engage in fruitful discussions, exchange ideas, and establish connections that will foster collaborative efforts in the pursuit of knowledge.

Once again, congratulations to everyone involved in the success of International Conference on Science and Technology-2023 including Chairman, Coordinator and Secretary of the Conference . I look forward to witnessing the impact of the research presented and to the continued success of the academic community at the South Eastern University of Sri Lanka.

Best regards,

Professor A. Rameez, PhD (NUS)
Vice Chancellor
South Eastern University of Sri Lanka

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MESSAGE FROM THE CHAIRMAN

I am much delighted to write this message to the third International Conference on Science and Technology-ICST 2023, proudly organised by the Faculty of Technology. This conference has been themed "Sustainable Economic Development through Empowering Research on Science and Technology." The theme is timely and need of the hour as far as Sri Lanka is concerned. Sri Lanka is gradually reviving from the impact of unprecedented scenarios like Easter Sunday attack, Global Pandemic of Covid 19 and economic bankruptcy. The country has to find its own pathways to rebuild the already fallen socio-economic development amidst the challenges that are interlocked globally.

Science, technology and research are the three pillars for a country to move towards the sustainable socio-economic development in the competitive world. In achieving the sustainability, a holistic approach has to be used to critically examine the inter-relationship between the natural, the governmental, the economic and the social dimensions of our world, and how science, technology and research can contribute to solutions. Technological development through research has a profound and long-term impact on income distribution, economic growth, employment, trade, environment, industrial structure and defence and security matters.

The scientific and technological community can make a leading contribution for tackling major problems, such as fighting disease; overpopulation and urbanisation; the digital/information divide and the impacts of information technology systems on world financial markets; coping with climate change; confronting the water crisis; defending the soil; preserving forests, fisheries and biodiversity; trade in biotechnological products and building a new ethic of global stewardship.

Moreover, I strongly believe that technological conferences like ICST 2023 provide a common platform for research scientists, academicians, professionals and students to share their experiences. I hope the ICST 2023 would be a great success.

I am deeply honoured and pleased to welcome all the participants and presenters to this conference. I would like to extend my sincere gratitude to all who are party to this conference.

Dr. U. L. Abdul Majeed
Dean
Faculty of Technology
South Eastern University of Sri Lanka.

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MESSAGE FROM THE COORDINATOR

I extend a warm welcome to you as the coordinator of the 3rd International Conference on Science and Technology 2023 (ICST2023), adding your esteemed company to our distinguished Conference Organizing Committee. This flagship international event, graciously hosted by the Faculty of Technology at the South Eastern University of Sri Lanka, stands as a testament to the unwavering commitment and collaborative spirit that defines our academic community.

The conference theme, "Sustainable Economic Development Through Empowering Research on Science and Technology," is designed to foster meaningful interactions among researchers from both academia and industries. It provides a robust platform for the exchange of groundbreaking innovations and inventions that align with this year's central theme.

The global challenges compounded by the recent pandemic have undeniably left a profound impact on economies worldwide. Developing nations, including Sri Lanka, have faced unique economic crises, necessitating sustainable solutions. ICST2023 aligns its focus with this theme, underscoring the pivotal role of science and technology research in constructing a resilient and sustainable economy.

With a notable submission of 76 full papers spanning eight distinct tracks, each subjected to a rigorous double-blind review process, we are delighted to inform you that initially 51 papers have been accepted with some comments in ICST2023, among these, 35 papers have been incorporated into the book of abstracts publication, and presentation following revisions accommodated by the authors, aligning with the reviewers' suggestion.

The compiled abstracts will be available in both hardcopy and electronic format through the university e-repository and conference site. Furthermore, all presented papers will be published in full papers, with outstanding contributions featured in the esteemed journals—Sri Lankan Journal of Technology and the Journal of Information and Communication Technology, both open-access publications of the Faculty of Technology, SEUSL. The remaining papers will be published as an ebook hosted on our repository.

The success of this conference owes much to the unwavering support and collaboration of numerous individuals. My heartfelt gratitude goes to the Vice Chancellor, Dean, Registrar, and Bursar of the South Eastern University of Sri Lanka for their invaluable support in organizing this event. Special appreciation is extended to our distinguished Keynote speakers, Senior Professor Gamini Senanayake, and Professor Gihan Dias for their enlightening addresses.

I would also like to express my sincere appreciation to Chairman Dr UL Abdul Majeed for his energetic support in organizing every activity relevant to this conference. Next, my gratitude goes to Dr ANM Mubarak, our dedicated Secretary, who played a pivotal role in communication and coordination with authors and track coordinators. Treasurer Dr G Nishanthan for his financial coordination, & budget preparation, etc for the conferences.

The efforts of the track coordinators and valuable reviewers across the eight tracks deserve commendation for their exceptional task of ensuring a meticulous paper selection process, I also express my thanks to the Editorial Team for their timely support in editing the conference books.

A special acknowledgement is extended to all the Conference Committee members, the academic and non-academic staff of the Faculty of Technology, South Eastern University of Sri Lanka, Also, I would like to express immense gratitude to our sponsors, Suganth Sea Farm Pvt Ltd, Hemsions International, and MicroTech Biological, for their generous financial support.

In conclusion, I extend my best wishes to all presenters and participants for a successful, dynamic, and memorable experience at the 03rd International Conference on Science and Technology, hosted by the Faculty of Technology, South Eastern University of Sri Lanka.

Mr. S.L. Abdul Haleem
Coordinator
International Conference on Science and Technology
Faculty of Technology
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ABSTRACT OF KEYNOTE SPEECH

Can ChatGPT do your Research?

Gihan Dias

Dept. of Computer Science and Engineering, University of Moratuwa

Abstract

ChatGPT, and other AI systems have become incredibly powerful. You can ask them any question, and they will answer. For example, if you ask "Write a paper on soil erosion in Ampara District", it replies, "Absolutely! Here's an outline for a paper on soil erosion in the Ampara District:" and gives a reasonable outline.
So can we just get them to do all our work for us?

No, not yet, though we don't know what the future holds.

ChatGPT is an example of *Generative Artificial Intelligence.* Given a request – called a prompt – it produces an output.

How does it work? It uses *Machine Learning* (ML). A system is *trained* with a *large* number (trillions) of examples. It learns patterns in them and uses them to produce output. For example, a machine translation system will see that in the input, the word "*මගේ*", may be translated *"vdJ"* or *"vd;Dila"* but "*මගේ නම*" is always *"vdJ ngau;"*. Therefore, when given a new text to translate, it will choose an appropriate output.

Machine learning is used for other tasks as well. It can recognise faces in images, detect fraud, predict future outcomes, etc.

How has ML become so powerful?

Current machine learning is based on *Large Models*. These models are *pre-trained* using huge amounts of data, from vast and diverse datasets. We can then fine-tune a model using a smaller amount of data, so the model becomes more of an expert in a particular area. For example, a model containing geological and rainfall data can be fine-tuned with rainfall and landslides in a particular area to allow it to predict landslides.

Machine learning is becoming common in research. An ML model can contain the results of past work. We then enhance it using data generated by us, and use it to generate predictions. ML models are not omniscient – they "know" many things, but are also often wrong. While they are good for a broad overview, details must be carefully verified.

Machine learning has become an essential part of research. If you write a paper, you should use an AI tool to improve the grammar and readability of your paper, and identify points you may have missed. However, it cannot – yet – write an entire paper for you.

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ABSTRACT OF KEYNOTE SPEECH

Importance of Investing on Research and Development to Achieve Sustainable Bio-Economic Development in Sri Lanka

Gamini Senanayake

University of Ruhuna

I. Introduction

Innovations through research and development (R&D) enable a country to achieve its economic development through improving the competitiveness and productivity. Technological innovations lead to use limited natural resources and bio-wastes in more productive and efficient manner. This will help to achieve a higher standard of living and a better quality of life. Therefore, budget allocation of a country on research and development is considered as an indicator of the country's innovative efforts in research. It also describes a country's efforts towards science and technology. Not only can investments in science and technology increase the competitiveness of an economy, but it can also provide positive spillover effects on the overall economy, such as increasing the standard of living. Many economists, including Romer (1990) and Solow (1957) argue that technological progress enhances economic growth. Therefore, it is proved that research and development have a positive relationship with GDP. After studying the economies in 87 countries, Sana Surani *et al* (2017) have reported that a one percent increase in research and development expenditure increases GDP per capita by 5 percent (with an r-squared of 0.874).

The Republic of Korea and Japan spend 4.5% and 3% of their GDP on research and development respectively. In contrast, Sri Lanka's contribution to research and development is very low and it was only 0.12% of the GDP of the country in 2020 (CBSL, 2020). In Sri Lanka the highest gross expenditure on Research and Development (GERD) was incurred by Business Enterprises (37.94%) followed by Government Research Institutes (34.12%), Higher Education Sector (26.7%), and Private Non-Profit Organizations (1.25%). The highest proportion of funds for R&D was devoted for Applied Research 47.45% of GERD while Basic and Experimental Developments accounted 29.30% and 23.25% of GERD respectively. The top three fields of Science which have the highest GERD are Engineering and Technology (27.65%), Agricultural sciences (24.20%) and Natural sciences (22.46%).

II. Technology and the Knowledge Based Bio-economy

The concept of a knowledge-based bio-economy (KBBE) has been introduced by the European Commission in 2004 (Albrecht *et al*., 2010). It is estimated that the European bio-economy currently has an approximate market size of over 2 trillion Euro, employing around 21.5 million people, with prospects for further growth looking more than promising. The increasing demand for a sustainable supply of food, raw materials and fuels, together with recent scientific progress, is the major economic driving force behind growth of the KBBE. The bio-economy – the sustainable production and conversion of biomass, for a range of food, health, fiber and industrial products and energy, where renewable biomass encompasses any biological material to be used as raw material - can play an important role in both creating economic growth, and in formulating effective responses to pressing global challenges. In this way it contributes to a smarter, more sustainable and inclusive economy. Therefore, to create a KBBE, technology can play a significant role. With technological advances, biological raw materials can be converted to more value added ready to consume products which will lead to earn more forex to the country. However unfortunately, Sri Lanka still export only raw biomass

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with very little value addition. This is mainly because Sri Lanka has not converted its economy to a KBBE using bio-system technological advances. In this context, Departments of Bio-system Technology in Sri Lankan Universities have a major role to play in converting Sri Lankan economy into a more sustainable KBBE.

III. Impact of Bio-system research on Sri Lankan Economy

The share of the agricultural sector's contribution to global GDP has declined from 4.3% to 3.3% for the period 1970 to 2013 (FAO, 2015). According to the Central Bank of Sri Lanka, there was a noticeable decline in the contribution of the agricultural sector to GDP, which has fallen from 47% to 7% between 1950 and 2019 in Sri Lanka (CBSL, 2020). If so, should we reduce or stop the investment on agricultural research? If we cut down the investment on Agricultural R&D, how we feed the growing population with limited resources such as land and water? Is it possible to feed the growing population only with already available Science and Technology? What are the alternative solutions? Can we import R&D findings carried out elsewhere and apply to our country? Only way to find appropriate solutions to our local issues is investing continuously on R&D activities. We have significantly increased our yields of main crops through agricultural research. However, postharvest technologies and value additions have not developed to the level of expectations. This is mainly because our conventional Faculties of Agriculture have mainly concentrated on agronomic practices which increase the biomass production. Therefore, investing specially on bio-system research in agriculture is a must to ensure food safety and sustainable economic development.

IV. The reason for underinvestment on research in Sri Lanka

The underinvestment in research in Sri Lanka continues because the political economy of public expenditure decisions tends to emphasize short-term payoffs and subsidies that are "politically visible," whereas investments in agricultural R&D are long-term (10 years or more) and risky. (World Bank. 2007) Trade subsidies and inconsistent national policies are other reasons for low investment in R&D. Low productivity, lack of accountability and irresponsibility of some of the researchers and conducting research for personal interest are the other contributing factors for underinvestment in research. Therefore, understating the "Valley of Death in R&D process" is important in investing in research. Thorough knowledge on this concept is important for all actors in the process of R&D, including researchers, financial managers, policy makers, politicians etc.

V. The way forward

According to the statistics, there is a huge potential for the government as well as for the private sector to expand their R&D in the country. Improving R&D could be the turning point to improve Sri Lanka's global competitive ranking in order to be successful. At a time when the country is suffering from lack of foreign reserves it needs to look beyond traditional export income sources. As a country we have a long way to go even when compared with our neighboring countries. Our investment on R&D is the lowest in the Asia and Pacific region and it is even lower than Tajikistan and Kyrgyzstan. Therefore, the government budget allocation for technological innovations should be immediately increased to direct the country toward a technology driven bio-economy. At the same time, all researchers and academics should carry out their research to find out practical solutions instead of conducting research on their personal interest.

VI. How to create a successful R&D eco-system?

When the European Union developed the concept of the KBBE, they developed a technology platform including academics, researchers and industry to deliver innovation, world leadership in food

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technologies and products and animal breeding technologies. Through this platform they developed a chemical and manufacturing industry base to process biomass into value added products.

Similarly, the Sri Lankan Government should take an urgent initiative to formulate a policy for a vibrant R&D culture. Policies, regulations, and incentives have to be in place to promote and develop the R&D eco-system. Investment in human capital and capacity building should be a top priority. R&D is mostly science and technology driven. Therefore, technically sound, postgraduate qualified human capital is a must to achieve economic sustainability through empowering research on Science and Technology.

Collaborating universities and research institutes with entrepreneurship is very essential as commercializing of new technological findings is critical to succeed in R&D. There is no point in creating a new product or a service if it cannot be commercialized. Therefore, it is important that a mechanism to be developed to closely work with private sector to commercialize the research findings of the universities.

Traditionally private sector has been termed as the 'Engine of Economic Growth'. In this scenario private sector could be the catalyst of changing the ecosystem to obtain economic sustainability of the country. They can contribute more towards R&D. According to the statistics private sector contribution to R&D is round 30%. Availability of treasury funds for R&D is always the issue. Therefore, there must be multiple sources of funding for research. As a solution to this funding issue, commercially focused equity investment platform (Something similar to European Technology Platforms (ETP)) should be created with the co-funding from treasury and private sector to provide funding for outcome based research.

VII. References

Albrecht, J., D. Carrez and P. Cunningham (2010) The Knowledge Based Bio-Economy (KBBE) in Europe: Achievements and Challenges. Clever Consult BVBA (Belgium) - www.cleverconsult.eu

CBSL (2020) Economic and Social Statistics of Sri Lanka, Central Bank of Sri Lanka, 197p.

FAO (2015), Eradication of Hunger and Improving Food and Nutrition Security FAO Annual Summary Report 2015

Romer, P. (1990). Endogenous Technological Change. Journal of Political Economy, 98(5), S71-S102.

Solow, R.M. (1957). Technical Change and the Aggregate Production Function. The Review of Economics and Statistics, 39(3) 312-320.

Surani S., W. Gendron, S. Maredia (2017). The Economic Impact of Research and Development. Econometrics 3161, 1-20.

World Bank (2007). World Development Report 2008: Agriculture for Development. Washington, DC. http://hdl.handle.net/10986/5990

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