SLINTEC
SRI LANKA INSTITUTE OF NANOTECHNOLOGY (PVT) LTD.

NASTEC

Performance Review of Sri Lanka Institute of Nanotechnology (SLINTEC)

Review Panel

Prof. R.M.G. Rajapakse, University of Peradeniya (Chair)

Prof. P.G.R. Dharmaratne, University of Moratuwa

Dr. Athula Senaratne, Institute of Policy Studies

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Executive Summary

The performance review of the Sri Lanka Institute of Nanotechnology (SLINTEC) for the period covering 2017-2019 is presented in this report. The review was conducted by the three-member panel appointed by the National Science and Technology Commission (NASTEC) of Sri Lanka. The report comprised of five sections. The Section 1 gives a brief introduction to SLINTEC together with objectives of the assessment. In the Section 2, the procedure followed in the performance review is described. In the Section 3, an assessment of management practices is presented according to the specific formats prepared by the NASTEC for the purpose. This is followed by an output assessment presented in the Section 4. In the final section, the Panel's views on overall performance of the institute and suggestions to improve the situation are discussed.

The NASTEC appointed review panel visited the NASTEC and discussed with the acting director and other representatives of the NASTEC on the purpose of review, procedure to be adopted in conducting the review and any other information pertinent to the review process. The review panel together with the NASTEC representatives then visited the SLINTEC and had meetings with various parties who gave presentations on the self-assessment of the institution. The review team had discussions with managerial staff, scientists, technical staff and others to gain knowledge on the SLINTEC activities of the aforementioned period. Due to the current pandemic situation, it was not possible to hold in-person discussions with the stakeholders but a one-day zoom meeting covered it, based on three categories of stakeholders. The report was prepared based on mutual agreement between the members of the review panel. In addition to the knowledge gained through various discussions with relevant parties, the review team considered the self-assessment report, the annual administration report (2017 to 2019) and the strategy at a glance 2020-2030 (Cooperate plan) in preparing this report. In the conclusion section (Section 5), an overview of institution's performance and contribution to national development and an overall judgment on different aspects described in this report are presented. This involves a SWOT analysis and recommendations to improve weaknesses. The review panel have made 11 recommendations to improve quality and services of the SLINTEC and to make sure the sustainability of the institution and addresses the lapses in the current operational model of the SLINTEC and proposes an implementable model for its sustainability.

Although the review period is 2017-2019, the NASTEC requested the review panel to consider any developments after 2019 also due to the prevailing pandemic situation. As such, we have included some selected data pertinent to developments in the years 2020 and 2021 also.

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1. Introduction

1.1. SLINTEC

1.1.1. History

Sri Lanka Institute of Nanotechnology (Pvt) Ltd (SLINTEC), came into existence on 31st March 2011, by the amalgamation of the Sri Lanka Institute of Nanotechnology (Pvt.) Ltd. with Nanco (Pvt.) Ltd. The amalgamated entity adopted the name Nanco (Pvt.) Ltd. Pursuant to Section 244 (1) (a) of the Companies Act No. 07 of 2007, the Registrar General of Companies issued a Certificate of Amalgamation to Nanco (Pvt.) Ltd. as a new company. Thereafter, on 30th November 2011, the amalgamated company, Nanco (Pvt.) Ltd. was renamed as SLINTEC. The SLINTEC is situated at the Nanotechnology and Science Park, Mahenwatte, Pitipana, Homagama, Sri Lanka.

The company is engaged in scientific research and development and private sector partnership projects in the fields of nano and advanced technologies. It aims to develop products and services, which benefit the economy while optimizing the use of natural and human resources available in the country. It works in close collaboration with both the local and foreign scientific community in furtherance of its objectives.

1.1.2. Vision of the SLINTEC

The vision of the SLINTEC is:

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"We want to play our part in the advancement of nanotechnology research and development. We hope to bring great minds and great technologies together in our pursuit to discover and develop products that change the way we live."

1.1.3. Mission of the SLINTEC

The following mission statements have been identified.

- ¶ Build a world-class research and development centre specialising in nanotechnology and advanced technology.
- ¶ Make products more competitive using nano and advanced technologies.

- Add value to Sri Lanka's mineral resources by showcasing the benefits of coupling minerals with nanotechnology.
- Build a nanotechnology and science park for research, development, and commercialization.

1.1.4. Governing Ministry

SLINTEC functions under the purview of the State Ministry of Digital Technology and Entrepreneur Development.

1.1.5. Source of funding

SLINTEC has three major sources of funding: State-sector contributions, private-sector contributions, and earned money as shown in Table 1 below.

Table 1: Source of funding as reported by the SLINTEC self-assessment report.

Source of funds	Amount (Rs)		
	2017	2018	2019
Equity	150,000,000	110,000,000	136,000,000
Government Grant	232,000,000	1,240,000,000	609,000,000
Income	205,000,000	143,000,000	90,000,000
Total	587,000,000	1,493,000,000	835,000,000

Table 1 shows that government grants were the major source of funding to SLINTEC during the evaluation period. The government has provided over LKR 2 billion compared with LKR 396 million equity capital provided by private sector which amounted to one-fifth of the state sector contribution. According to Table 2, SLINTEC income (LKR 438 million) has slightly exceeded the private sector funding. However, income figures given in self-assessment report have significant deviations from figures reported in Annual Reports for the period concerned, which have been analyzed in final concluding section.

1.1.6. Organizational Structure

The organizational structure of the SLINTEC is described in Figures 1 (a) and 1(b), as provided bythe SLINTEC in their response to the preliminary draft report submitted by the NASTEC. Their response indicates that some changes in the organizational structure has taken place during 2018-

2019 which the SLINTEC was not revealed to the panel during the discussion.

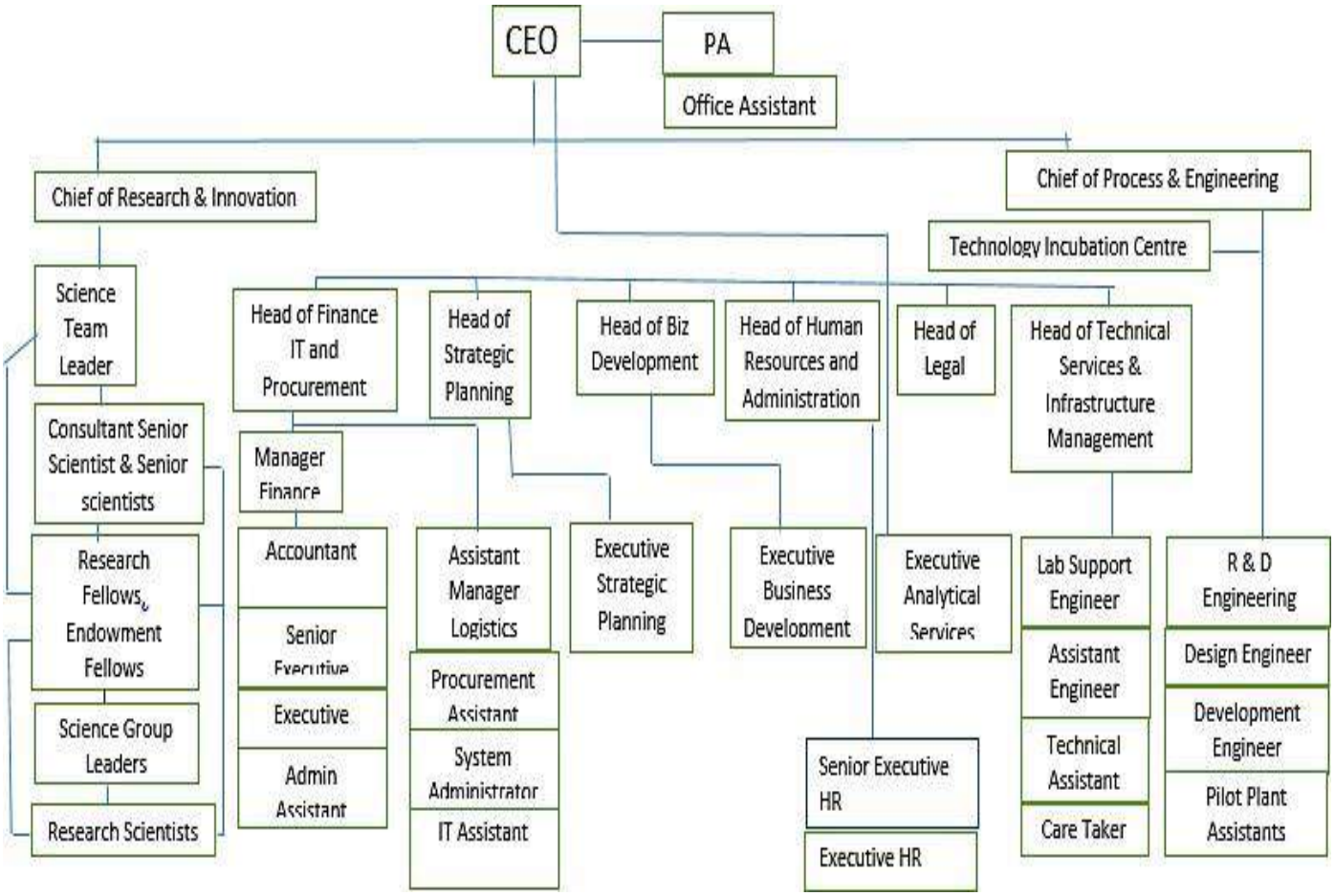


Figure 1 (a): Organizational Structure of SLINTEC (2017/2018)

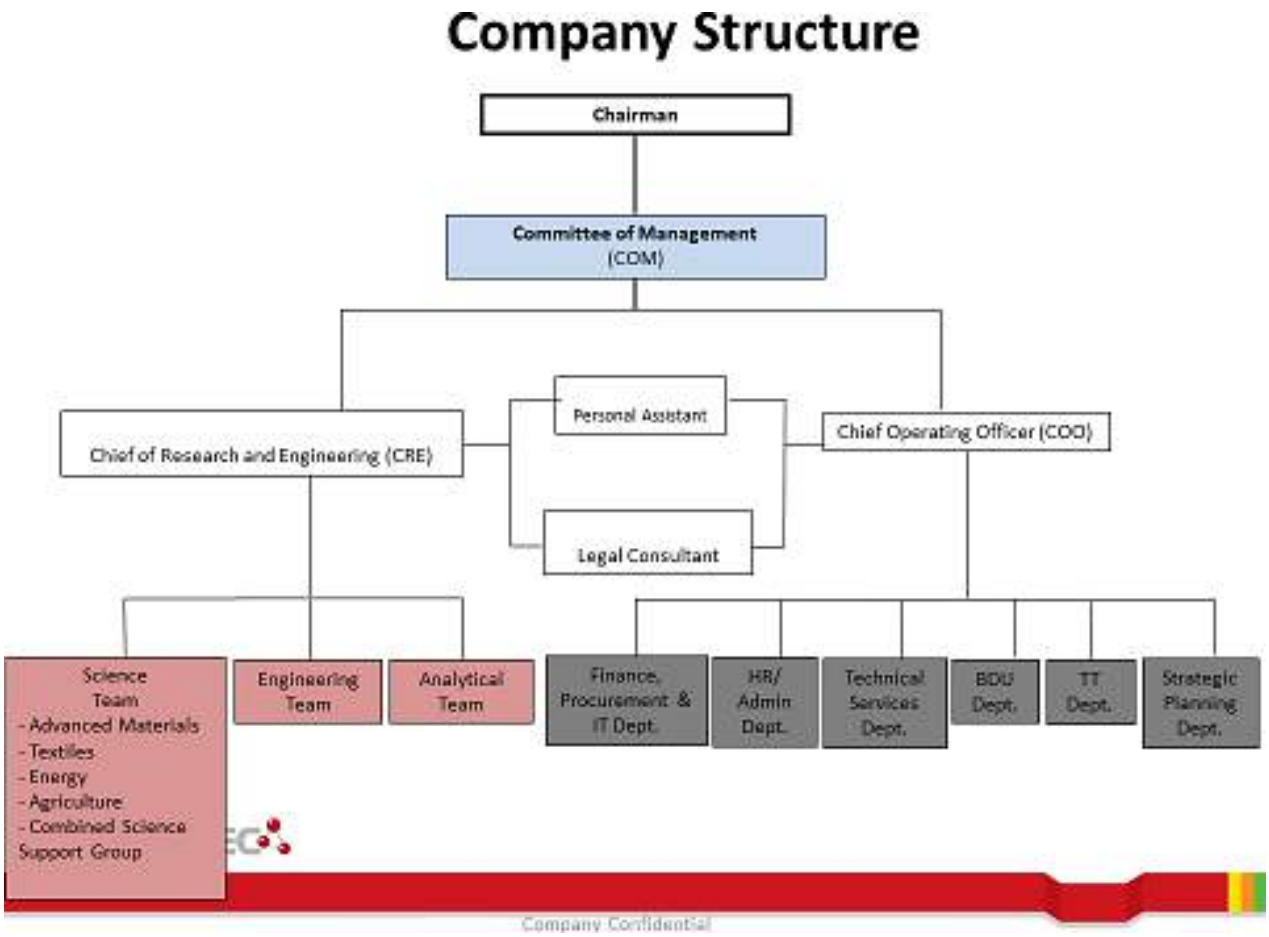


Figure 1(b): Organizational structure of the SLINTEC 2019 /2020

The organizational structure of the SLINTEC, during the period of evaluation, is composed of the Board of Directors, Chief Operating Officer (COO) and Committee of Management. The Committee of Management includes the COO, Head of Business Development Unit, Head of Infrastructure Management Unit, Head of Technology Transfer Unit, Head Finance, Procurements and IT, Head of Engineering, Head of Human Resources and Senior Scientists as from the information provided by the SLINTEC in its self-assessment report. However, in response to the draft report SLINTEC has indicated a major organizational change during 2018/2019 and hence the organizational structure (2018/2019) and that 2019/2020 are given in Figures 1(a) and 1(b), respectively.

The official website of the SLINTEC on its team https://www.slintec.lk/our-team/#com (accessed 25th June, 2021) gives the following information. The Science and Engineering Team is composed of six Senior Research Scientists and five Research Fellows. There are fifteen scientists present in the science and engineering team with nine Ph.D. In addition to the Head of Business Development there are two Senior Executives for Business Development. In addition to the Head of Technology Transfer there is one Executive for Technology Transfer. There is only one Senior Executive for Analytical Services. There is also a Legal Consultant attached to the SLINTEC.

1.2. Objectives of the assessment

The reasons for conducting the review according to the Review Manual prepared by NASTEC are:

- To obtain information on how to improve the activities of the institution.
- To induce a self-reflection by the scientists on the results and outcomes of S&T activities, the way they are performed leads to strategic orientation towards the desired goals.
- To assess effectiveness of the activities.
- To encourage good management of S&T institutes.
- To improve internal and external transparency.
- To recommend future resource commitments.
- To gather information for policy change.
- To inform the stakeholders about the institutional competencies.

1.3. Organization of the report

The report is comprised of five sections.

- Section 1 : Introduction to SLINTEC togetherwith objectives of the assessment.
- Section 2 : Procedure followed in the performance review.
- Section 3 : Assessment of management practices is presented according to the specific formats prepared by the NASTEC for the purpose.
- Section 4 : Output Assessment
- Section 5 : The Panel's views on overall performance of the institute and suggestions to improve the situation are discussed.

2. Procedure Adopted for Performance Review

A review team of three members were appointed by the NASTEC in consultation with the SLINTEC.

The review process had five distinctive steps.

1. Preparation for review.

   The NASTEC has forwarded a copy of the self-assessment report to the COO of the SLINTEC. The SLINTEC has submitted the completed self-assessment report to the NASTEC within four weeks. The NASTEC and the SLINTEC have formally agreed upon the members of the review team. The review team studied the self-assessment report. The Director/NASTEC met the review team and the COO of the SLINTEC prior to the visit to the SLINTEC and identified the lines of inquiry, further information and documentation required.

2. Visits of the review team to the SLINTEC.
3. Stakeholders' meeting
4. Preparation of the draft report by the review team. Based on the inputs collected from the review visits, reviewing official documents and stakeholder consultations, the review panel drafted the assessment report
5. Preparation and submission of the final review report by the review team to the NASTEC

2.1. Review of technical and administration reports/documents

The team reviewed the following documents submitted by the SLINTEC through the NASTEC as main sources of official information.

- Self-assessment report
- Annual administration report (2015 to 2018)
- Strategy at a glance 2020-2030 (Cooperate plan)

2.2. Fact finding visit to the SLINTEC

The review team together with the NASTEC officials visited the SLINTEC, at 9.00 am, on the 26th August, 2020, and met groups and individuals and discussed and obtained required information. The review team also participated in a laboratory and instrument facility visits. Mrs. Nazeema Ahamed, Acting Director/NASTEC made the introductory speech where she highlighted the aims and objectives of the review process. She explained that the NASTEC has the mandate to review Science and Technology institutions under the Science and Technology Act No. 11 of 1994. Although there is a provision to submit the review report to the parliament it has never happened. Additionally, she explained the purpose of the performance review. These include the following:

- To assess the performance of the institute over the past three years and to assess its output andactivities in line with the national development and natural practices.
- To conduct the institute's SWOTs in performing the activities and make recommendations for better performance.
- To include a self-reflection by the scientists on the results and outcomes of the Science andTechnology institutes.
    - Good management practices.
    - Inputs and effectiveness of the activities/infrastructure.
- To improve internal and external transparency.
- To recommend future goals.

The Chief Operating Officer (COO) of the SLINTEC presented the self-assessment report. He responded toquestions asked by the panel members on different aspects of SLINTEC operations. After completing initialsession with the senior management of the Institute, the review panel was invited to join an observationvisit to labs and other facilities of the Institute. Engineer Sunanda Gunasekara, Head of Technical and Infrastructure Management led the lab visit.

After concluding the observation visit to facilities, the Review Panel met Mr. Anil Fernando, the Head Finance presented the financial report. Internal auditing (BDO Audit Firm) in the afternoon. He explained the process involved in preparing monthly accounts, presenting and evaluating monthly progress, monitoring project-wise progress.

2.3. Stakeholder consultation meeting

The review team has met a group of SLINTEC stakeholders via an online meeting which was arranged by the NASTEC using the ZOOM conference platform due to restrictions imposed by thehealth authorities considering the pandemic situation prevailed. The list of stakeholders was provided by the SINTEC to the NASTEC (The list is given in Annexure 1). The stakeholders were categorized into three groups and three members of the review team chaired individual sessionsas given below. Three sessions were:

- ¶ Universities and Research Organizations: 07 stakeholders participated. The session waschaired by the Prof. Rajapakse
- ¶ Private Sector Companies: 15 stakeholders participated. The session was chaired by Dr.Senaratne
- ¶ State Sector Institutes: 05 stakeholders participated. The session was chaired by Prof.Dharmaratne

Stakeholders generally expressed their satisfaction towards the services rendered by the SLINTEC. However, they have highlighted some constraints and problems also. These will be discussed in relevant sections appropriately.

3. Management Assessment

This section presents the evaluation of review team regarding the management practices adopted by the SLINTEC. The evaluation was undertaken according to the guidelines provided by Review Manual prepared by the NASTEC with prescribed formats for specific aspects of evaluation. The Review Team has provided unanimous rankings for different management practices for which they identified sufficient evidence is available. For practices that the Review Team found no sufficient information available, no rankings were given and the NASTEC and SLINTEC are requested to provide further evidence.

3.1. Institutional response to external and internal environment in planning organizational strategy

Table 2 provides review team's assessment on institutional response to external and internal environment in planning organizational strategy. The Review Manual has specifically defined the external environment of S&T institutions broadly to guide the assessment[1].

[1] The Manual defined external environment to cover consumer/industry needs, government policies, market conditions, partners and competitors. The external environment is subject to constant change and S&T institutions are intended to periodically review and adjust its directions and goals to meet these changes.

Table 2: Evaluation on institutional response to external and internal environment in planningorganizational strategy

Management practice	Level of Practice (Performance Indicators)	Comments / Evidence
Government policies and development goals are used/ considered to establish goals and plan organizational strategy for the institution	Strong	Selected priority areas of research relevant to national development activities.
The organizational mandate (as specified by the relevant Act) is considered in strategic planning	Strong	Considered in the corporate plan.
The institution is responsive to changes in Government policies and strategies	Moderate	Research programmes have not evolved to reflect the changes in government policies and strategies.
Factors such as strengths, weaknesses, threats and opportunities are considered in strategic planning	Weak	SWOT analysis has not been provided in the corporate plan. However, a SWOT analysis was given in the Self-Assessment Questionnaire to NASTEC but it is not satisfactory since it does not provide an objective assessment of the strategic situation.
Stakeholders' needs are taken into consideration in strategic planning	Moderate	In response to the draft report, the SLINTEC described the details about the stakeholder consultations.
The Board of Governors is involved in strategic planning	Weak	In response to the draft report. SLINTEC indicated that Board Directors are not directly involved in strategic planning.
The extent to which staff members are involved in strategic planning	Weak	As per response to the draft report, all staff members are not directly involved in the planning process, their inputs are obtained through the COM members.
Government allocations and alternative funding opportunities (donor funding) are considered in strategic planning	Moderate	Although government grants were requested not all applications were approved. No mention about donor funding in the corporate plan.
The extent to which policies and plans of the organization are reviewed and updated	Moderate	As per response to the draft report, periodic reviews are carried out by the Committee of Management.

The overall performance of management assessment is only moderately satisfactory. It appears that the SLNTEC has selected priority areas of research relevant to national development activities, particularly for the value-addition to minerals, slow and controlled release fertilizer formulations, projects related to textile and garment industries etc. Therefore, the SLINTEC is strong in terms of cooperating with priority areas of the government. The SLINTEC is also strong in considering the organizational mandate for strategic planning. The strengths, and weaknesses should be considered in improving services rendered by an institution. However, it is not satisfactory in incorporating SWOT analysis data to their strategic planning. There is no trend in changing strategies to meet with current demands of the industry.

3.2. Planning S & T programs and priorities

Table 3 provides Review Team's assessment on planning science and technology programs and priorities. Under this topic, it is expected to cover research programs [2]of SLINTEC. SLINTEC's mandate is to build a world-class research and development center specialized in Nanotechnology and advanced technology and attract both local and international clients to locate their research facilities at the Nanotechnology and Science Park for furtherance of science and technology knowledge in Sri Lanka and contribute to the development of Sri Lanka. With the above concept in mind priority is given to the sustainability of research in the thrust areas of water, environment and food security. Widely accepted project management practices have been introduced to fast-track projects and to generate expected results at the end of the research projects. Also, SLINTEC has a Committee of Management comprised of COO, Chief of Research and Innovations, Head of Finance, Procurement and IT, Head of Technical Services and Infrastructure Management, Head of Business Development, Head of Technology Transfer, and two Research Scientists

[2] According the Manual a programme is "an organized set of research projects, activities or experiments that are oriented towards the attainment of specific objectives". Programmes are higher in research hierarchy than projects. Programme objectives should be consistent with organizational strategies and reflect user needs and development goals.

Table 3: Evaluation on planning S&T programs and priorities

Management practice	Level of Practice (Performance Indicators)	Comments/ Evidence
National development goals are considered in planning programs & setting priorities	Strong	Projects are compiled on thrust areas of water, environment and food security
Board of Governors participate in planning and priority setting of programs	Weak	Management committee involves in planning and priority setting
The extent to which the staff of the institution participate in programme planning and priority setting	strong	Management committee consists of staff too.
Stakeholder interests are considered in programme planning	Moderate	No proper mechanism to obtain stakeholder interests
The extent to which programmes are planned and approved through appropriate procedures	Strong	Management committee evaluates projects and ensures the compliance with board policies
The extent to which the availability of funds (government allocations and other funds) generating funds are taken into consideration in planning programmes	Moderate	Government does not allocate sufficient funds and institute depends on generated funds.
The obtaining of necessary equipment is considered in planning programmes	Strong	Programmes are planned based on the availability of equipment and assessing further requirement
Stakeholders are represented in the institution's planning and review committees.	Weak	No evidence of stakeholders is represented in planning or review
The extent to which socio economic and commercialization of aspects are considered in programme planning.	Strong	Programs are planned with the prospects of commercialization.
Effectiveness and efficiency of institutional procedures in approving new S& T programmes.	Moderate	Approvals depends on the availability of funds which is notreadily available

The overall performance of planning S&T programmes and setting priorities is satisfactory. The SLINTEC can be ranked strong in terms of taking National development goals are considered in planning programs & setting priorities, extent to which the staff of the institution participate in programme planning and priority setting, extent to which programmes are planned and approved through appropriate procedures, and for obtaining of necessary equipment is considered in planning programmes. However, the SLINTEC is moderately satisfactory in extent to which the availability of funds (government allocations and other funds) generating funds are taken into consideration in planning programmes because as of the evaluation period, there are no fund allocations from the state-sector. SLINTEC is considering socio-economic and

commercialization aspects to the good satisfaction. The involvement of stakeholders in planning projects and activities of the institute is weak. This is a very import ant issue that should get prime consideration in future endavours. The funding situation should be improved for tackling new S&T programmes and this aspect seems only moderately satisfactory.

3.3. Planning S & T/ R & D projects

Assessment on planning S&T/R&D projects[3] is given in Table 4. Evidence suggests that SLINTEC has relatively strong project planning capacities.

A committee consisting of senior scientists, head of finance, chief of research, HR consultant, engineers and chief of SLINTEC evaluate all the projects and research as indicated in the page number 7 of the self-assessment report. However, in response to draft report SLINTEC indicates that this committee cannot be considered as a research planning committee. All staff work is under a line manager who acts as the project manager who is under the preview of the committee of management.

Budget is prepared in accordance with the board of management's advice under the purview of the line ministry. The audit committee meets as required to review the operations of management and to ensure compliance with Board polices. The Committee reviews the quarterly compliance reports prepared by the management which details the action by management to ensure compliance with Board polices. It also reviews the quarterly internal audit report prepared by an independent auditor to ensure that management complies with specified procedures and that any shortcomings are addressed and corrected on a timely basis.

[3] A project is a set of activities designed to achieve specific objectives within a specified period of time. A project includes interrelated research activities or experiments, schedule of activities to be completed within a specific time period, budget, inputs and outputs, focused towards intended beneficiaries. Projects are the buildings blocks of programs. For an institution to achieve its objectives, it is necessary for projects to be well planned in terms of their expected outputs, activities, and input requirements.

SLINTEC has reached out to several international organizations and is developing project collaboration;

- Signed MOU with Fraunhofer Institute in Germany in 2019
- Signed MOU with MagGenome, an Indian life science company in 2019 to co-develop a nanotechnology-based test kit
- Appointed two members as the resource persons to promote SLINTEC and the technologies created by SLINTEC at a global level.
- SLINTEC is also connected with IPI, a Singaporean technology transfer platform to promote SLINTEC licensing opportunities in a global online platform.

SLINTEC has private equity partners and they are in the board of management. Commercial research is done for the private sector. Private citizens are encouraged to join SLINTEC Startup engine program as entrepreneurs. Facilities at the technology incubator center is geared to any outside party seeking to set up their incubator.

Consultants are hired when and if needed for their input when a project is given the go ahead by the management committee. Scientists who are line mangers act as the project manager involved with budgeting.

Table 4: Evaluation on planning S&T/R&D projects

Management practice	Level of Practice (Performance Indicators)	Comments/ Evidence
The staff is provided with guidance for project planning.	Moderate	In response to the draft report, the SLINTEC has provided details about how the staff is guided on project planning.
Previous research results/data are used for planning projects	Moderate	In response to the draft report, the SLINTEC has provided details about how data is used for planning projects.
The extent to which the institution follows a formal process for preparation, review and approval of projects	Moderate	A management committee involves in planning, evaluation and monitoring of projects
The extent to which organizational plans (e.g. medium-term plan, corporate plan, strategy etc.) are used to guide project selection and planning	Moderate	Project identification and implementation are partly based on the corporate plan
Multidisciplinary projects/ activities are encouraged by the institutions	Strong	Projects cover wide range of minerals, rubber, textile etc
Foreign collaborations are encouraged and incorporated in planning.	Moderate	Several MOU's have been signed for foreign collaborations but no evidence for proceeding beyond the signing of MoUs.
Partnership with private sector is encouraged by the institution	Strong	It has private equity partners and they are in the board of management. Commercial research is done for the private sector. Private citizens are encouraged to join SLINTEC Startup engine program as entrepreneurs.
The extent to which development research/activities are considered in planning projects	Strong	Research activities are focused on applied research.
The extent to which basic research are considered when planning projects	Inapplicable	As per mandate research should be results oriented toward meeting national goals
The degree to which adverse effects on environment are considered in planning projects	Strong	the sustainability of research in the thrust areas of water, environment and food security.

The overall performance in planning S&T/T&D projects is moderately satisfactory. SLINTEC is good in concentrating on applied research as per its mandate and that parameter is strong. SLINTEC is not meant for carrying out basic research. If however basic research is done, there should be foreseeable applications of their outcomes in the near future. The projects handled by SLINTEC considers the environmental aspects and sustainability of research in the thrust areas of water, environment and food are within their scopes.

3.4. Project management and maintenance of quality

Table 5 presents the assessment on project management and maintenance of quality. Proper management and quality assurance are necessary for ensuring the achievement of desired objectives and quality outputs.

Table 5: Evaluation on project management maintenance of quality

Management Practice	Level of Practice (Performance Indicators)	Comments/ Evidence
The effectiveness of the procedures for resource allocation at different levels (organization, departments, program etc.)	Strong	Resources are allocated on a fair basis between different groups.
Ensuring that instruments, equipment and infrastructure facilities are sufficient for implementation of projects	Strong	Facilities are available and properly maintained.
The effectiveness of administrative procedures and support for project implementation (procurement and distribution of equipment and materials, transport arrangements, etc.)	Strong	Effective procedures are in place.
Formal monitoring and review processes are used to direct projects towards achievement of objectives	Moderate	Procedures are available but no evidence given in the corporate plan.
The extent to which the researchers are supported by the required technical / field staff.	Strong	Supporting technical and field staff are available.
Ensuring that established field / lab methods, and appropriate protocols are used	Strong	Proper protocols are used.
Research projects/ S& T activities are completed within the planned time frame.	Strong	In response to the draft report, SLINTEC indicates that all projects are commenced with a planned time frame. Any delays in completing the activities have to be justified.
Ensuring that scientists / researchers have access to adequate scientific information (scientific journals, internet, international databases, advanced research institutes, universities etc.) that strengthens the quality of research.	Moderate	In response to the draft report, SLINTEC indicates that staff is provided with internet/intranet facilities and access to Elsevier database.
The extent to which quality assurance practices are followed by the institutions	Moderate	In response to the draft report, SLINTEC indicates that it is first institute to get GLP status from SLAB for the API synthesis laboratory.
Ensuring that researchers/ scientists have access to computers and necessary software	Strong	In response to the draft report, SLINTEC indicates that all scientists are provided with a laptop and a dongle with internet connection. Software such as Autocad, Solidworks, MS Project, MS NAV etc. are used by scientists and engineers.
Formal monitoring and review processes are used to direct projects towards achievement of objectives	Moderate	Procedures are available but no evidence given in the corporate plan. However, SLINTEC indicates that the Business Development Unit has records of such processes.

The level of project management and quality assurance based on the above ranking is generally satisfactory for the performance indicators for which evidence given. However, information is missing for several performance indicators. As most of the parameters have scored strong status, SLINTEC's strategies in project management and maintenance of quality is generally satisfactory.

3.1. Human resources management

An assessment on the situation of human resource management in SLINTEC is given in Table 6. Availability of an adequate number of qualified staff and effective management of human resources are key determinants of organizational performance. Establishing a cadre of qualified staff takes many years. To keep pace with new developments in science, technology and management, it is also essential to upgrade staff regularly. Staff planning, selection, recruitment, evaluation and training are key components of human resource management that need to be in place for effective performance of an institution.

Table 6: Evaluation on human resources management

Management Practice	Level of Practice (Performance Indicators)	Comments/ Evidence
The institution maintains and updates staff information in a database (including bio data, disciplines, experience, publications, projects)	Strong	Data given in the website.
The institution, plans and updates its staff recruitments based on programme and project needs	Strong	Recruitments are done based on requirements of the projects.
The effectiveness of the selection procedures and the schemes of recruitment	Weak	The recruitment scheme practiced by the SLINTEC does not encourage the selected staff to stay with the organization.
Training is based on institution and program objectives and on merit,	Moderate	In response to the draft report, SLINTEC indicates that no training opportunities are available for SLINTEC staff except day training programs.
The effectiveness of the procedures in promoting a good working environment and maintaining high staff morale.	Weak	There is a tendency for the researchers to leave the organization.
The effectiveness of staff performance appraisals	Moderate	In response to the draft report, the SLINTEC has provided Staff review and performance appraisal form.
The effectiveness of rewards and incentive schemes in motivating the staff	Weak	In response to the draft report, the SLINTEC indicates that salaries of the staff are less than those of other parallel organizations. Only a limited reward schemes are available. As such, there is a tendency for the researchers to leave the organization.
The effectiveness of managing staff turnover, absenteeism and work interruptions.		No evidence provided.

The overall assessment based on the above ranking is unsatisfactory since there are only two strong performance indicators with several moderate and a few weak indicators as appearing in the above table. Most of the scientists of the SLINTEC have left for permanent positions in the universities and other research institutes due to job insecurity, relatively lower salaries and other benefits. This leaves the organization weaker in terms of qualified human resources and continuously struggling to maintain the key positions occupied.

3.2. Management of organizational assets

Table 7 presents the Review Team's assessment on management of organizational assets in SLINTEC. According to the Review Manual, Organizational assets include not only staff building, equipment and finances, but also includes assets such as knowledge, technologies developed, intellectual property, and even credibility and reputation. A continuous effort is needed to protect all these assets, because they are the basis for the sustainability of the institution and allow it to continue delivering quality research and service outputs.

Table 7: Evaluation on management of organizational assets

Management Practice	Level of Practice (Performance Indicators)	Comments/ Evidence
The ability of the institution to carry out its mandate and the assigned statutory powers	Weak	Faced with problems with funding and resource mobilization.
Infrastructure (buildings, stations, fields, roads) is satisfactorily maintained.	Strong	Well maintained.
Vehicles and equipment (lab, field, office) are properly managed and maintained.	Strong	Equipment is well maintained as demonstrated by the Head of Technical and Infrastructure Manager. However, in response to draft report, the SLINTEC indicates that there are no funds to repair non-functioning instruments. Official vehicles are not available.
The effectiveness of procedures to ensure that equipment are in working order	Strong	Central equipment facility is available and is manned by a manager.
The effectiveness of the institution's overall strategy in generation and proper utilization of funds	Weak	Faced with problems with funding and resource mobilization.
The extent to which the institution identifies opportunities for income generation and cost recovery	Weak	Faced with problems with funding and resource mobilization.
The extent to which the intellectual property rights of the institute are protected	Strong	Procedures for protecting IP rights followed.

The overall assessment on management of organizational assets is only moderately satisfactory because the institution is strong in managing physical assets and intellectual property rights. However, the institute is weak in terms of the status of managing finances and human resources. As of SLINTEC's mandate it was supposed to be financed by both the state and private sector for five years until the institute reaches the status of self-sustenance in terms of finance. However, the SLINTEC has not achieved this status even after 17 years.

3.3. Coordinating and integrating the internal functions/units/activities

The coordination of units (departments, divisions, committees, research stations, etc.,) and level of integration among them are important for the overall performance of an institution. The organization of these units and the overall structure need to be reviewed from time to time to ensure smooth and effective operations. The planning and coordination of unit's logistics, resources, and information flows are necessary to achieve integration and smooth functioning. The level of coordination and integration in internal functions/unit/activities is evaluated in Table 8.

Table 8: Evaluation on level of coordination and integration in internal functions/unit/activities

Management Practice	Level of Practice (Performance indicators)	Comments/ Evidence
The extent to which institution is evaluated internally and restructured based on current needs	Moderate	In response to the draft report, the SLINTEC has indicated that internal M&E mechanism is available to evaluate its own activities.
The effectiveness of internal communication and coordination mechanisms	Strong	In response to the draft report, the SLINTEC has indicated that there are strong communication systems such as intranet, group emails and WhatsApp groups within the institution.
Institution's overall direction and coordination are provided by a central planning committee / unit.	Moderate	Management committee is in place but evidence for effectiveness is not provided.
The extent to which different units are assigned clearly defined functions	Strong	Well defined mandates for different units are in place.
Responsibilities of research / management staff are clearly identified	Moderate	In response to the draft report, the SLINTEC has indicated that detailed job description is given to all staff including to the Managerial staff.
Effectiveness of using appropriate reporting procedures and feedback in management at different levels	Moderate	Reporting procedures are in place but evidence for effectiveness is not provided.

The overall performance is satisfactory.

3.4. Managing information dissemination and partnerships

Dissemination of technology and information to users is an important requirement of all S&T/Research Development institutions. The partnership/linking up with other sectors in science and technology and information system (including universities, industries, private sector, international research organizations, extension, farmers, etc.) promotes information exchange, collaboration and cost sharing, and ultimately improves quality and relevance of research. The Review Team's assessment on management of information dissemination and partnerships are given in Table 9.

Table 9: Evaluation on managing information dissemination and partnerships

Management Practice	Level of Practice (Performance Indicators)	Comments/ Evidence
The institution systematically plans and performs dissemination of information	Strong	Evidence for research publications and patents are given.
The extent to which the institution plans and maintains linkages with key partners for sharing and dissemination of information	Moderate	In response to the draft report, the SLINTEC has indicated that social media presence; Website is up to date; Frequently featured in digital media. However, linkages with key partners in disseminating information is not clear.
The effectiveness of institutional procedures for technology transfer	Weak	Overall, nanotechnology has not become a strong industrial usage in the country.
The effectiveness of the system to obtain feedback from different types of stakeholders	Weak	No evidence according to the stakeholder consultations.

Overall, the partnership in managing information dissemination is only moderately satisfactory since only one performance indicator out of four scores at the strong status. It appears that the contributions to the advancement of scientific knowledge in terms of nanotechnology and its industrial application have not reached to a satisfactory level. However, the SLINTEC has achieved a significant progress after 2020 and over six nanotechnology-based products are currently in both local and international markets.

3.5. Monitoring, evaluation and reporting

Table 10 presents the assessment on monitoring, evaluation and reporting. Monitoring (assessing ongoing S&T/research activities) are key management processes of public S&T institutions. Monitoring and evaluation are also important for determining whether the institution is learning from its earlier achievements and failures. Monitoring, evaluation, and reporting procedures need to be properly designed (i.e., integrated into project planning and implementation) and periodically reviewed, in order to provide useful information for decision making and accountability.

Table 10: Evaluation on monitoring, evaluation and reporting

Management Practice	Level of Practice (Performance Indicators)	Comments/ Evidence
The institution monitors and evaluates (M&E) its own activities periodically.	Strong	In response to the draft report, the SLINTEC has indicated that has an M&E system.
M&E is supported by an adequate management information system (MIS), which includes information on projects (e.g., costs, staff, progress, and Results).	Strong	In response to the draft report, the SLINTEC has indicated that SLINTEC has a proper MIS system.
The extent to which S& T results and other outputs are adequately reported internally (e.g. through reports, internal program reviews, seminars).	Moderate	In response to the draft report, the SLINTEC has indicated that respective line managers evaluate project progress and then by CRI, Business Development Unit and Technology Transfer Unit. However, there is no evidence on reporting.
External stakeholders contribute to the M & E process in the institution.	Weak	In response to the draft report, the SLINTEC has indicated that the involvement of stakeholders in the M&E process is not possible.
The extent to which the results of M&E are used for project/ research planning and decision-making.	Moderate	In response to the draft report, the SLINTEC has indicated that M&E results are discussed in the CoM and passed on to the research planning committee for appropriate action.

Overall, the monitoring, evaluation and reporting is satisfactory.

4. Output Assessment

This section presents the output assessment of the evaluation.

4.1. Types of Outputs

There are four major types of outputs considered in the assessment. They are:

- Technologies developed
- New products developed
- Accepted recommended practices
- Number of patents obtained

4.1.1. Technologies developed

A summary of technologies developed by the SLINTEC is given below.

- Conversion of Sri Lankan Graphite to Highest Value-added Form
- Nano-fertilizer (Slow-release Urea) Technology
- Smart-release Fertilizer
- Micronutrient induced Seed Pot
- Fabric Softener
- Hydrophobic Coatings for Textiles, Glass and Paints

The conversion of graphite to expanded graphite and graphene products is an important technology developed to add value to Sri Lankan Graphite. The SLINTEC in collaboration with LOLC has developed a pilot plant for commercial production of these value-added forms of graphite. Due to this development, several new projects on exploration of Sri Lankan graphite have been initiated and several new graphite mines have been opened. Although Sri Lanka produces high quality graphite for over a century, no attempt has been made to add value to raw graphite. This technology can be adopted to export highly value-added forms of graphite to improve National Economy. However, nanotechnology can be adapted in converting almost all other minerals to highly value-added products and devices. Although, research publications and patents are available for the conversion of other minerals to value-added products such as thorium and titanium from mineral sands there are no evidence on commercialization or even pilot plant studies.

The novel fertilizer technologies developed could have potential answers to the fertilizer-related issues currently being considered in Sri Lanka. The slow-release and smart release formulations and micronutrient induced seed pots would make sure the minimization of the wastages of fertilizer and nutrients thereby reducing the environmental burden since the exact quantities of fertilizers/nutrients are supplied to the plants if and when required. However, the policy makers of the country appear to be unaware or ignorant of these important developments. The SLINTEC could take initiatives to popularize these developments and educate policy makers and farming community, in particular, and the general public, in general, of their achievements and their potential benefits.

The other developments are also of high importance to Sri Lankan industries and consumers. According to the SLINTEC mandate, its role is to carry out applied research in nanotechnology and integrate technologies with local industries for the betterment of the National Economy. It appears, therefore, that the extent of developments in nanotechnology and their integration with industrial products is not up to the expectations during the evaluation period. In response this statement, SLINTEC has indicated that they have initiated a Technology Transfer Unit in mid-2018. Currently over 6 nanotechnology-based products are in the local and international market (implemented in 2019-2021 period after establishing the Tech Transfer Unit).

Additionally, reviewers were made aware of the following developments that have been speedily carried out after the review period, in response to the COVID-19 pandemic situation prevailing in the country. SLINTEC's involvement in responding to such situations is commendable and satisfactory.

- SLINTEC SWABS for COVID-19 Testing (Since 2020)
- SLINTEC RT Lamp for COVID-19 Testing (Since 2020)
- Antimicrobial Exercise Book Covers (Since 2020)

4.1.2. Technologies transferred to industry/entrepreneurs

The project involved in converting Sri Lankan graphite to graphene products has the capacity of 1.8 MT per year with an expected income of USD 7 million to the country per annum. However, this is still under pilot plant scale and evidence for commercialization not provided. In response to this statement, SLINTEC has indicated that the technology has been transferred to a Joint Venture Company but commercialization has not begun.

Even though SLINTEC has mentioned that the smart-release fertilizer formulations developed has a potential to save up to 30% cost of imports of fertilizer to Sri Lanka, this has not been materialized. Furthermore, they have informed that three US patents obtained for slow-release fertilizer formulation has been sold to Nargarjuna Corporation Limited in India for USD 1.0 million. In response to this statement, SLINTEC has indicated that Nagarjuna has decided not to commercialize the technology for a variety of reasons and SLINTEC is not responsible for Nagarjuna's decisions.

The rights for application of fabric softener developed have been given to Textured Jerseys Lanka Ltd. with a Royalty of Rs. 7.8 million incomes generated to the SLINTEC with a client benefit of in excess of Rs. 40 million. The US patent for moisture managing fabric has been sold to MAS Holdings for Rs. 52.7 million.

A US patent comprising knowhow of hydrophobic coatings for textiles, glasses and paint products was transferred to Lankem PLC for Rs. 25 million.

There are a few other projects currently being carried out that have not been brought up to the stage of commercialization. These include packaging alternatives to Styrofoam, antimicrobial book covers.

Over 200,000 swabs have been manufactured and handed over to the health ministry saving at least Rs. 100 million. It is expected that the SLINTEC RT-LAMP for COVID-19 testing would reduce the cost of testing by 50% with an expected saving of Rs. 500 million per month.

4.1.3. Information dissemination/extension

The research community and the industries are well aware of the facilities available at SLINTEC for advanced research and in fact some equipment are only available at SLINTEC for high end research in Sri Lanka. It seems however that the number of publications in local and international journals are not adequate to publicize the activities. This however may be due to time taken for obtaining patents for some of the innovations which prevents publications beforehand. However, it is appropriate to issue a quarterly journal or a news bulletin depicting the work done, facilities available etc. The website of the Institute is another instrument that can be used for wide information dissemination and corporate communications. Delay in the issue of patents prevents implementations of successful research findings. The review team is of the view that the SLINTEC lacks a formal process for collecting and evaluating feedback from clients and researchers on a regular basis. This is something stakeholders are expecting.

4.1.4. Research publications

The researchers in the institute have published 33 of their research findings in international journals until 2018, but there are publications in 2019 and also no publications in local journals or conferences (Table 11). In response, SLINTEC maintains that publishing research work is not their main mandate.

4.1.5. Patents

SLINTEC has obtained 4 patents for research work done by R& T and such patents for the R& D work, means the recognition of original work done by the Institute and it upgrades the status of the institute (Table 12).

4.1.6. Services (Testing, calibrations, consultations, advisory etc.)

SLINTEC laboratories are well equipped with modern instruments needed for high end research and in fact some of the equipment are only available in Sri Lanka in their laboratories. FTIR, Raman Spectroscope, NIR Spectroscope, Florescence Spectroscope. XRD, NMR, LC-MS, GC-MS TEM, SEM, XPS and SPM, ICPMS, AAS, XRF, CHNS, EDX are some of them. They provide services for individual researchers, industries and government institutes. Sri Lankan researchers have the benefit of having this equipment under one roof, so that research can be conducted without delay. SLINTEC provides testing services, calibrations, consultancies to the industries and other institutes. However, SLINTEC has no accreditation and hence the reports are not qualified for obtaining necessary certificates for commercial partners to market their products. Although the SLINTEC is not mandated to carry out testing and calibration services, such services are currently under operation.

4.1.7. Training

SLINTEC provides training programs for its employees within Sri Lanka and overseas. However, SLINTEC does not provide training for others. The details of training programs conducted by the SLINTEC are given in Table 11. In response to this statement, SLINTEC indicates that during the period under review, SLINTEC provided PG degrees to SLINTEC scientists and others via SLINTEC Academy.

Table 11: Training given to staff

	2017		2018		2019	
	S&T staff	**other**	**S&T staff**	**other**	**S&T staff**	**other**
Post graduate level	A total of 16 students have been registered for PhDs and Masters. However, due to funding limitations, SLINTEC Academy programme has been discontinued and all those students who are enrolled at SLINTEC Academy will be registered at UoSJP to continue their PG studies.					
Diploma						
Short term training	**29**	**30**	**26**	**36**	**12**	**40**
Study tours/conferences	**32**		**25**	**10**	**25**	**10**

SLINTEC also facilitated visits by students and teachers (Table 12).

Table 12: Visitors to SLLINTEC

YEAR	VISITORS							Total
	School students	University students	Teachers	Foreign visitors	Navy students	Govt. visitors	Special visitors	
2017	519	640	946	70	36	184	151	**2546**
	7 schools	13 uni's						
2018	1054	568	236	82	0	103	88	**2131**
	12 schools	13 uni's						
2019	1686	288	263	71	80	103	108	**2599**
	19 schools	4 uni's						

4.1.8. Others

SLINTEC has received two presidential awards during the period of evaluation.

4.2. Output Measurements

Table 13 provides details of outputs during the period of 2017-2019. Descriptions on these output measurements were given sections 4.1.1 – 4.1.7.

Table 13: Output measurements

Category	Number			
	2017	2018	2019	
4.2.1.Technolgies Developed				
• New products/technologies	01	-	03	**Please see section 4.1.1 for additional remarks.**
• Improved products/technologies/laboratory methods	01	-	03	
• New planting materials/seed varieties	-	-	-	
• No. of projects completed	11	03	30	
4.2.2. Technologies transferred to industry/ entrepreneurs				
• Technologies developed locally	01	-	03	**Please see section 4.1.2 for additional remarks.**
• Foreign technologies adapted and transferred	-	-	-	
4.2.3. Information Dissemination/Extension				
4.2.3.1 Related Publications				**Please see section 4.1.3 for additional remarks.**
S &T Institutional Review reports				
Training Manuals				
Advisory leaflets				
Maps				
Posters				
4.2.3.2 Dissemination events				
Workshops and Seminars	-	-	-	
Conferences	7	10	10	
Exhibitions (participated)	-	-	-	
Media events	-	-	-	
Open days	-	-	-	
Demonstrations/Awareness programs	-	-	-	
4.2.4. Publications				
Research Papers in ISI Journals				**Please see section 4.1.4 for additional remarks.**
Research papers in international refereed journals	8	15	-	
Other Research Papers	-	-	-	
Conference Proceedings	-	-	-	
Books and Monographs	-	-	-	
Technical Reports	-	-	-	
Research Reports	-	-	-	

4.2.5. Patents				
4.2.5.1. Individual				**Please see section 4.1.5 for additional remarks.**
● Local patents	-	-	-	
● Foreign patents	-	-	-	
4.2.5.2. Institutional	1	2	1	
● Local patents	-	-	-	
● Foreign patents	-	-	-	
4.2.6. Services (Services (Testing, Calibration, Consultancies, Advisory etc)				
● Policies developed	-	-	-	**Please see section 4.1.6 for additional remarks.**
● Reviews of S&T institutes	-	-	-	
● Research grants awarded and administered	11	03	30	
● Funding for training programmes and other S&T activities	-	-	-	
● Monitoring of research projects	-	-	-	
● Data bases developed	-	-	-	
● S&T surveys and maps	-	-	-	
● Science popularization activities	-	-	-	
● Environmental impact assessments	-	-	-	
● Instrument calibrations	-	-	-	
● Consultancy services	-	-	-	
● Testing and analytical services	-	-	-	
● Vaccines/ seed production and distribution	-	-	-	
● Germ-plasm conservation	-	-	-	
● Recommendations in S&T matters	-	-	-	
4.2.7.Training				
4.2.7.1 Staff training programs				**Please see section 4.1.7 for additional remarks.**
● Local : no. trained	61	51	37	
● Foreign				
4.2.7.2. Training programs for stakeholders : no trained	30	36	40	
4.2.8. Awards			2	
4.2.8.1. Institutional				**Please see section 4.1.8 for additional remarks.**
Presidential award	**-**	-	2	
4.2.8.2 Individual	**-**	-	-	

5. Conclusions

5.1. Overview of institution's performance and contribution to National development

SLINTEC is expected to develop nanotechnology-based products and services to benefit the national economy. However, no evidence is available to suggest that strong development of nanotechnology-based industries in the country. There are few evidences provided in SLINTEC documents to the fact that local industries are using technologies developed by the SLINTEC R&D activities. For example, the technologies related to dyeing that was developed for textile and apparel industries have been commercialized. Operation of a pilot plant for graphene production has begun. A sum of USD 1 million was earned from selling patents to India. The SLINTEC has also earned LKR 85.5 million as royalty payments from Sri Lankan industries. Other achievements include 15 Patents (13 US Patents and 2 SL Patents), research papers, partnerships signed with several big companies and attracted 22 PhD holders. In spite of these achievements, however, given the level of investment made by the government and the number of years of institution's operation, the overall achievements related to national development is not satisfactory. In response to this statement, SLINTEC highlights that one of the key factors for the low success rate in technology transfer is due to the lack of technologically oriented industries and businesses in the country. However, they maintain that their performance is satisfactory considering the limited recurrent budget allocated by the government which is not acceptable since the SLINTEC is not expected to depend entirely on the state-sector funding.

Evidence from multiple sources indicates that SLINTEC is faced with following challenges.

- Economic viability of the company is threatened
- SLINTEC has failed to achieve the self-sustenance
- Key staff in science and technology is leaving the company

Economic viability of the company is threatened

According to the Annual Reports of SLINTEC, during the period of evaluation (2017- 2019), the institute has experienced annual losses in the range of LKR 140-160 million continuously. In all years, company's annual expenditure is higher than the annual income (Figure 2). The main component of annual expenditure that amounted for 60-65% of total cost was staff costs. Figure

2 shows that in all years, the total income remained lower than the total cost and the gap has increased sharply during the recent period. From 2014 onward, the total income has failed to cover at least the staff cost. This implies that the company is facing the problem of economic viability.

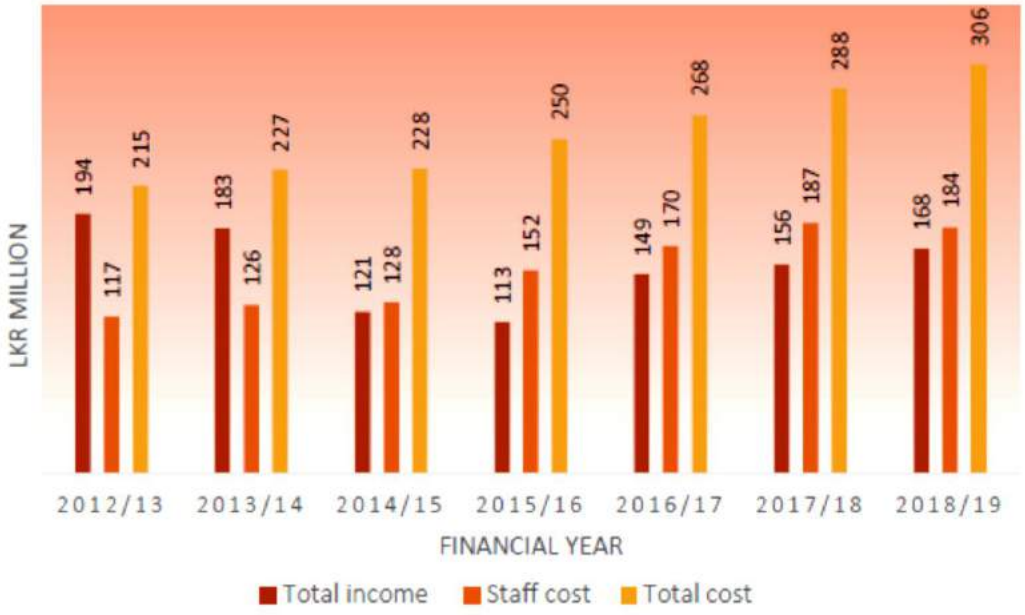


Figure 2: Total income,total cost and staff cost

SLINTEC has failed to achieve the self-sustenance

SLINTEC has faced problems in self-sustenance. According to information collected in the assessment, it is apparent that SLINTEC has been expected to become a self-sustained organization, gradually reducing its dependence on public funds by increasing the flow of income from multiple sources generated from institution's contribution to private sector industries. However, information from Annual Reports shows that SLINTEC has failed to achieve sustained growth of income even after 12 years and the company is actually experiencing a decline in income compared with early years of operation (Figure 3).

Figure 3 shows that the annual income of the company has fluctuated continuously and the contract income has decreased during the evaluation period from LKR 88 million in 2017 to LKR 39 million in 2019, which can be considered as a drastic drop. This is somewhat compensated by patent income in 2019 which shows a high level of fluctuation over years. The only source of income that has shown some stability and continuous growth is income from analytical services and others. However, this remains still at a relatively lower level of LKR 46 million in 2019.

It seems the most important source that can bring the stability to earnings of the company is income form contract research with the private sector. Even though some growth was reported in income from contract research until 2016, a drastic decline has taken place in last three years. This situation has seriously threatened the stability of institute's income and the potential for achieving self-sustenance.

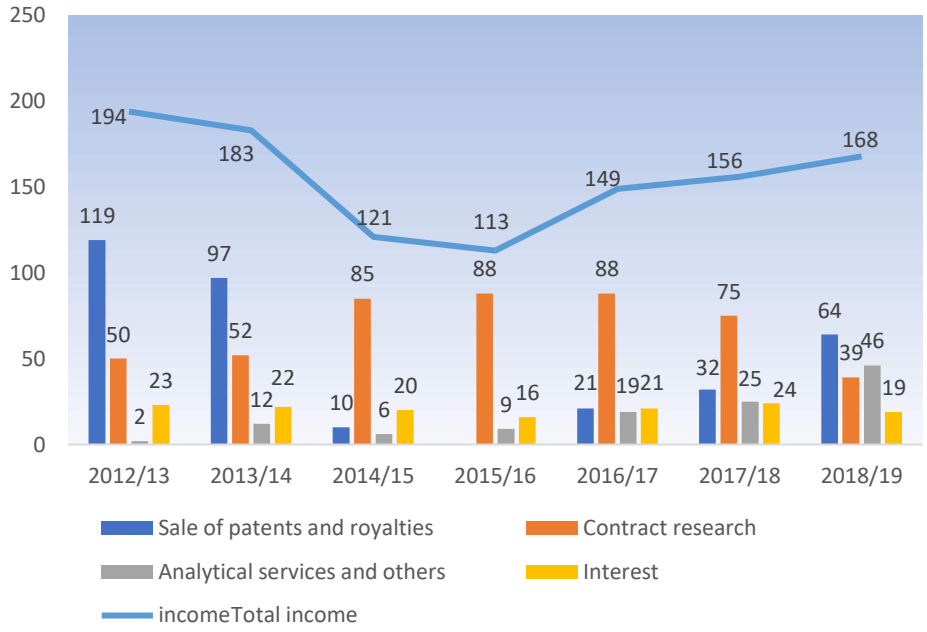


Figure 3: Trends and composition of total income

Although previously, the salaries of the employees were paid by the state sector contribution, the current situation is such that contribution from the state sector cannot be guaranteed continuously. Therefore, salaries of the staff should be paid from generated funds. As such, there is a 20% salary reduction during the period of the COVID-19 pandemic.

Key staff in science and technology is leaving the company

There are problems for retaining the skilled staff. Figure 4 shows that during the 2017-2019 period, the total number of permanent staff has decreased from 91 to 77. More critical issue is that science and technology staff has decreased from 75 to 60 which amounts to about 20% decrease. Number of scientists in the permanent cadre has nearly halved from 53 to 29. This implies that human resource capacity of the institute in core fields of science and technology has depleted rapidly. Meanwhile, the non-science and technology staff has remained stable at 16-17. In addition, the institute had Academy students and Graduate Interns carrying out research projects that can also be considered as a group contributing to the S & T capacity of the institute.

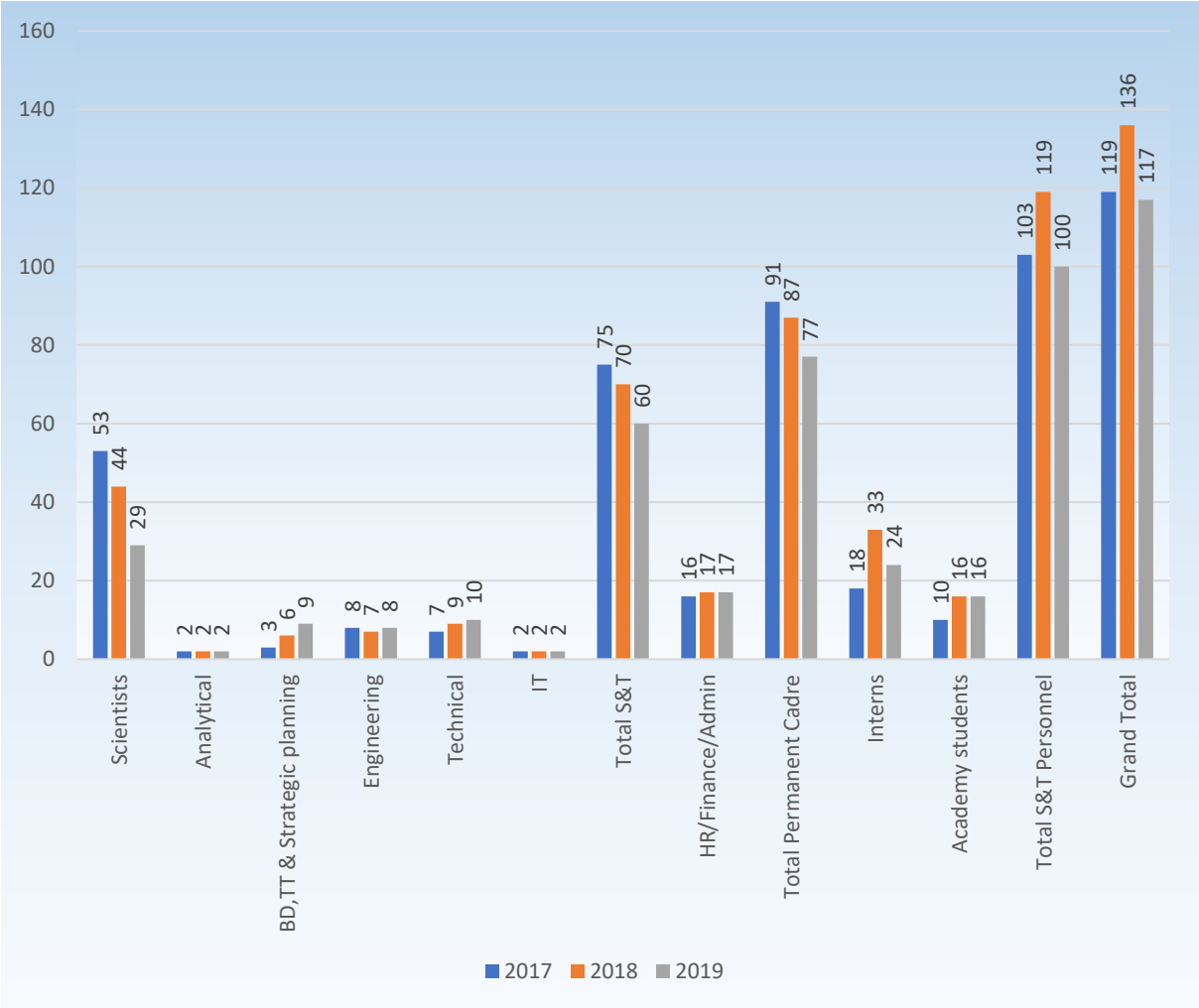


Figure 4: Depletion of human resource capacity

The major reason for skilled staff leaving the institute is comparatively low salaries and job insecurity associated with short-term employment contracts. Due to low income and uncertainty in contributions from the Government and private sector equity partners, there is a difficulty in maintaining a salary structure comparable to the relevant scales of university academic/non-academic sector salaries. As such, SLINTEC employees tend to leave SLINTEC for university appointments. As explained above, earnings from contract research have become minimal. The problem is further aggravated due to the fact that the appointments of the SLINTEC are of contract-basis whereas those of the universities are permanent. As such, the latter has more job security compared with SLINTEC that encourage staff to leaving for university positions.

5.2. Overall judgment on the different aspects and recommendations

Overall, it can conclude that SLINTEC's contribution to the national economy by way of developing nanotechnology-based business opportunities for private and public sector organizations have been below the expectations. The SLINTEC defends this statement saying that one of the key factors for the low success rate in technology transfer is due to the lack of technologically oriented industries in the country. We agree with their statements.

Strong private sector-based technology development activities have not emerged around facilities made available in the National Centre of Excellence or the Nanotechnology and Science Park. The failure to achieve intended objectives of the organization has placed SLINTEC in a difficult position in terms of maintaining economic viability of the institute, achieving the status of self-sustenance and retaining the strength of key science and technology staff. In essence, the institute has come to an uncertain position of its future sustainability unless continuously supported by public sector funding despite persistence losses. This cannot be considered as a healthy situation and it is unrealistic to expect that the Government can carry on the burden forever. Hence, some remedial actions are necessary to rectify the situation.

Some recommendations are made here to overcome this situation. Recommendations arepresented under two broad categories.

- ¶ Recommendations for necessary changes that can be implemented under existing institutional arrangement
- ¶ Suggestions to restructure the current model of operation to enhance the sustainabilityof the institute

Recommendations for necessary changes that can be implemented under existing institutional Arrangement

1) It appears that the self-sustenance of the institute only in terms of generated funds is not realistic under the prevailing adverse economic conditions. As such, state sector and private sector partnership in funding should be restructured. Some suggestions towards restructuring the current model of operation are given in the next section of recommendations.
2) The retention of human resources in the higher levels of research staff has become an

issue due to job insecurity and relatively lower salaries. It is recommended that measures to be taken to improve job security and salaries and other benefits in order to retain qualified personnel.

a. In order to increase job security and to decrease brain drain, it is recommended to include permanent cadre positions for at least few senior positions in research staff. There should be salary and promotional schemes in parallel to those of relevant posts of the Sri Lankan university and other research institute sectors.

b. Short term contracts such as 2-year contracts reduce the job security and the motivation of qualified staff to stay. The time scale of 2 years is hardly sufficient to carry out a proper research project that can be extended for commercial application. It is, therefore, recommended to increase the length of contracts of at least core staff members.

c. Since the SLINTEC has hybrid policies of the state and private sectors, the benefits should be given to the staff. It is recommended to initiate a bonus scheme based on commercialized research output in parallel with that prevailing in the private sector. In response to this statement, SLINTEC has indicated that it has an incentive scheme, but very limited in number.

3) The reinstating of the Chief Executive Officer (CEO) post is recommended. A suitable local scientist with proven record in research in fundamental and applied sciences, new inventions, scaling up research, and commercializing research outputs as consumer products, contacts with local industries with a proven record in collaborating with local industries, recognition in the global scientific arena and collaborations with foreign universities should be appointed as the CEO. The criterion for selection to this post should not be based on mere administrative experience but academic and research excellence pertinent to nanotechnology would be the best criterion. Rather than internal administration, the CEO should be able to attract industrial projects and to help improve income generated.

4) The lapse in efficient utilization of the human resources appear to be a major constraint and measures have to be taken to improve it.

a. The key scientific positions that are vacant should be filled with individuals with adequate knowledge, experience, interest and proven research record pertinent to industrial applications of research outputs in nanotechnology research and development.

b. It is not clear the function of the Chief of Research and Innovations and the accountability of the post. There is no information on activities carried out by this position. In response to this statement, SLINTEC indicates the following as job activities of the CRI.

- ¶ To coordinate and direct the strategic research programs to be implemented at SLINTEC.
- ¶ To ensure that staff is provided the necessary guidance to ensure overallcontract research programs with third party clients are fulfilled.
- ¶ To ensure that appropriate science staff recruitment process and needsare addressed in a timely manner.
- ¶ To play an active role in the management of SLINTEC.

The review panel is of the opinion that the above job description cannot be considered as a well-defined description for a such a high position of the organization and a report of the activities not submitted.

c. There are no records on the outputs generated from the Business Development Team although there is one Ph.D. holder and two other senior executives involved in this section. Preparation of a sound and realistic Corporate Plan with the consultation of scientific and administration staff and external stakeholders should be an essential role of this team, which is lacking at the moment. Even though SLINTEC has now provided a detailed description of the functions of this unit the above observations of the review panel are not denied by that description.

d. Performance of the Technology Transfer Division is not up to the expected standard. Only few patents were obtained during the period and there is no significant number of technology transfers to justify its role. In response to this statement, SLINTEC has indicated that a Technology Transfer Unit (TTU) was established in mid-2018 to accelerate commercialization activities. The improvements claimed are after the review period.

e. The analytical services section is composed of only one personnel but it is the section that generates funds every day. In response to this statement, SLINTEC indicates that the money earned by the analytical services is insufficient to cover even the direct cost of the services provided mainly due the big subsidy

offered to the university researchers. The review panel is of the opinion that analytical services is a potential area that SLINTEC can make significant earnings considering the high-tech equipment facilities available and therefore it is not necessary to provide services at a loss.

5) It is also recommended to improve connections between all Sri Lankan industries, both state-sector and private sector industries, and cater for their needs by marketing available services. Number of awareness programmes conducted appear to be limited. It is recommended to include proper awareness programmes to make the local industries aware of services that could be rendered by the SLINTEC to improve quality of products manufactured by the respective industries. It is also recommended to recruit a public relations officer to facilitate communications with local and foreign industries and to make them aware of services that could be rendered. The business development plan sent in response to this recommendation does not address the issues.

6) It is important to globalize R&D activities, scaling up research and commercial applications. As such, both local and foreign investors should be attracted to initiate new projects to help improve the national economy. In comparison to Sri Lanka, the number and scale of industries other regional countries such as India, Pakistan, Bangladesh are very high. Therefore, a higher demand for SLINTEC services can be expected if the service base can be extended beyond Sri Lanka at least to the South Asian region to attract income from foreign industries.

7) Improving the trust of stakeholders is recommended. To do so, the stakeholders should be called for project design and management meetings and their inputs should be considered. Also, the analytical services should be expedited and results should be given to stakeholders without unnecessary and unacceptable delays.

8) The research output in nanotechnology from Sri Lankan universities seems to be substantial. It is recommended to get services of the relevant experts in the university sector and other local research institutions subject to confidentiality agreements.

9) Regular assessment of output in relation to expenditure is recommended. The income should be higher than expenditures in order to make profits. All private sector organizations consider profit and cost calculations prior to initiating a new project. Such assessments are recommended and made transparent for the public since the SLINTECdepends also on public funds. The response given to this recommendation by the SLINTEC reflects that their self-perception about the organization is modelled as a service-oriented state-

sector agency rather a profit-oriented state-private hybrid organization.

10) A reasonable timeframe should be allocated for researchers to carry out scaling up studies and the expected output should be obtained within this timeframe. Reasons for any failures should be addressed and proper measures should be taken to avoid such incidents.

11) A proper mechanism to monitor progress of projects and performance of researchers should be introduced. This should be done by an independent panel of experts. Although SLINTEC indicates that most of the projects carried out are for clients which cannot be evaluated by independent panels due to confidentiality clauses this cannot be considered as an acceptable argument.

Suggestions to restructure the current model of operation to enhance the sustainability of the Institute

The above-mentioned recommendations can be initiated under the current operational model within the existing institutional structure. However, it is apparent that current operational model has severe limitations that prevented it from delivering expected results. Therefore restructuring the existing model can also be considered as an essential pre-requisite to ensure the long-term sustainability of the institute. Some suggestions to introduce a new operational model are given below.

¶ The state-sector funding has so far mainly been allocated for capital investments such as development of infrastructure, setting up laboratory facilities and installing modern equipment. As a result, a significant asset base with some state-of-the-art science facilities has been developed within the institute, which has been valued at LKR 3.4 billion at 2019. Given the current challenges faced by the institute, this model of building infrastructure using public funds should be revisited. If the current state of affairs continues, getting the returns of these investments may not be possible and these assets would become 'stranded assets'4.

¶ Hence, a new operational model that focusses on ensuring the sustainability of institute in short- to medium-term should be formulated. Given the global recession COVID-19 and economic downturn experienced by the national economy, it is hard to expect that SLINTEC can achieve self-sustenance by own income earned from contract research, patent income, analytical services and other incomes such as rentals.

- Therefore, investing further on development of infrastructure and scientific facilities should be brought to a halt at least temporarily. Instead, an operational model that aimed at efficient utilization of the existing infrastructure and scientific facilities should be set in force. The aim of the new model should be optimal utilization of existing facilities to maximize the returns from them in the short- to medium-term rather than further expanding the capital assets.

- The main challenge to be faced at present is retaining the human resources base of the institute by stopping the brain drain. To achieve this, a mechanism for funding staff salaries and other benefits that can be matched with potential competitors for skilled human resources such as universities and research institutes with more secure employment contracts should be in place. Hence, government should support a transitionary arrangement by diverting all funds from capital investments, helping to build an 'Endowment Fund[5]' that can support the staff salaries and other staff costs.

- While these transitory arrangements are in place, the management of SLINTEC can focused on developing a sound 'Corporate Plan' that can capitalize on the existing facilities in short- to medium-term with long-term strategy to achieving self-sustenance and income growth.

- Given the existing skills in corporate management and business strategies are limited within the institute, the preparation of 'Corporate Plan' may be outsourced to a reputed professional management company preferably with international experience. The same company can be given the task of providing some training to key staff that is required to successful implementation of the Corporate Plan.

[4] Stranded assets are investments that are not able to meet a viable economic return and which are likely to seetheir economic life curtailed due to a combination of technology, regulatory and/or market changes. Source: https://www.marketforces.org.au/info/key-issues/stranded-assets/

[5] Documents indicate that SLINTEC already has an endowment fund of which purpose is not very clear.

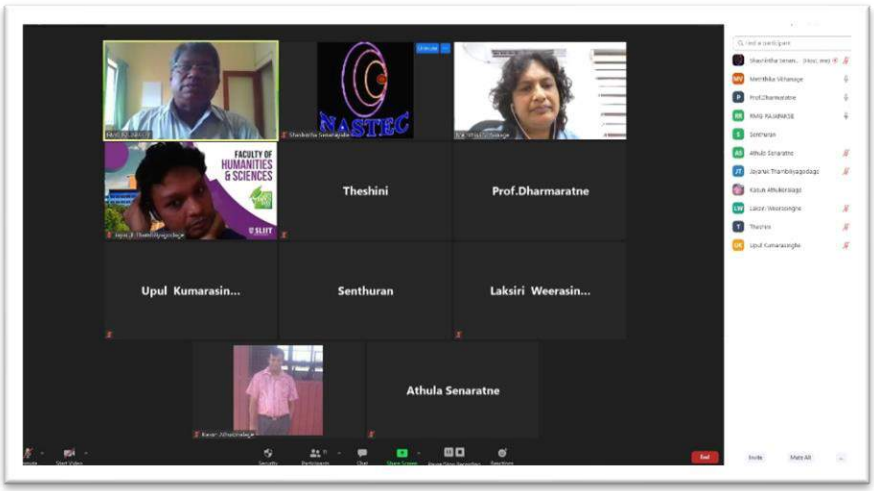
Annexure 01

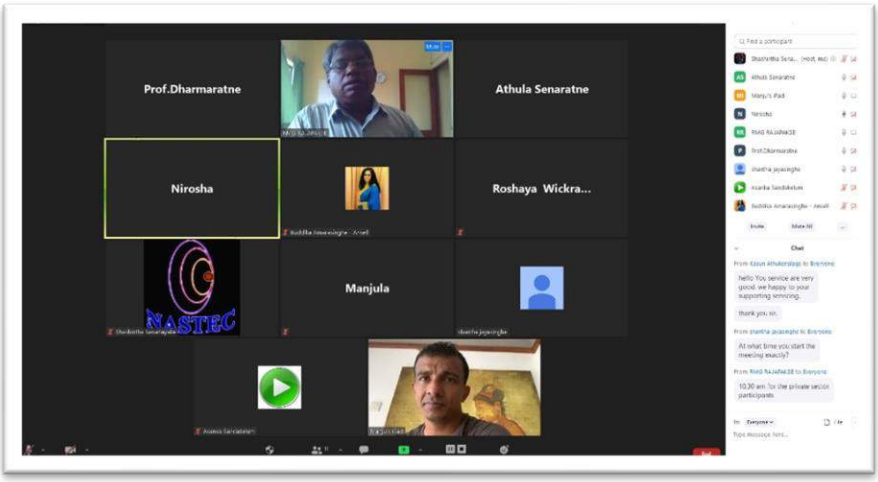
Performance Review of SLINTEC
Stakeholders Meeting on 15th January 2021
Participation list

Name	Address
Session 01 : Universities	
Dr. Laksiri Weerasinghe	Senior Lecturer, Department of Chemistry,University of Sri Jayewardenepura
Prof. Meththika Vithanage	Faculty of Applied Sciences, University of Sri Jayewardenepura
Mr. S. Senthuran	Lecturer, Department of Physics, University of Jaffna
Mr. Kasun Athukoralage	National Water Supply and Drainage Board Central Workshop, Maligawa road, Rathmalana
Dr. T. C Jayaruk	Senior Lecturer Sri Lanka Institute of Information Technology
Session 02 : Private Sector	
Mr. Eranda Jayasuriya	Process Engineer, Ansell Lanka (Pvt), Biyagama EPZ, Malwana
Mr. Asanka Sandakelum	Associate Manager- Engineering , Ansell Lanka (Pvt), Biyagama EPZ, Malwana
Dileepa Premathunga	Associate Director (R&D) , Ansell Lanka (Pvt), Biyagama EPZ, Malwana
Mr. Nuwan Mediriyawaththa	Executive R&D, Dipped Products, Brahmanagama, Pannipitiya, Kottawa
Mr. Manjula Jayawardane	Deputy Director General Manager, Innovation, Noyon Lanka Pvt Ltd, Biyagama EPZ, Walgama, Malwana
Ms. Nayuji Udugama	Excutive Officer, North Manufacturing Pvt Ltd Lot 37, BEPZ, Walgama, Malwana
Ms. Asanka Sahabandu	Assistant Manager, CIC Holdings Pvt Ltd 268 A/1,Lenagala Estate, Panagoda, Homagama
Mr. Tharindu Koralage	Excutive - Material Quality Assurance, Sillueta, Silueta Pvt Ltd. Lot 14, BEPZ, Walgama, Malwana
Ms. Nadeesha Gunasekara	Information Scientist, Link Natural Products

Mr. Shahid Sangani , Represented by Ms. Roshaya	Managing Director, Dynawash
Ms. Nirosha Jagodaarachchi	CEO , British Cosmetics
Mr. Manju Gunawardena,	CGTL/ LOLC Adv. Technologies
Mr. Prasanjith Wijayatilake,	Executive Director, BOI
Dr. Janaka Wickramasinghe	Director, EDB
Eng A A S P Jayasinghe	DDG (services), NERDC
Session 03 : Government Sector	
Mr. Prasanjith Wijayatilake,	Executive Director, BOI
Dr. Janaka Wickramasinghe	Director, EDB
Eng A A S P Jayasinghe	DDG (services), NERDC
Dr.(Ms) J.K.R.Radhika Samarasekera	DG , ITI

Annexure 02 – Photograph Evidence


NASTEC
FACULTY OF HUMANITIES & SCIENCES
Theshini
Prof.Dharmaratne
Upul Kumarasin...
Senthuran
Laksiri Weerasin...
Athula Senaratne


Prof.Dharmaratne
Athula Senaratne
Nirosha
Roshaya Wickra...
NASTEC
Manjula