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# **INSTITUTION REVIEW**

**National Engineering Research and Development Centre (NERDC)**

Prepared by

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## **Executive Summary**

The National Engineering Research and Development Centre (NERDC) was established under the State Industrial Corporations Act No 49 of 1957, on 14<sup>th</sup> August 1974 with the primary purpose of “developing, acquiring, adapting and transferring engineering technologies that would help in the production and sustainable utilization of human and material resources by engaging in Research and Development (R&D) activities that would have a direct impact on the economic development of Sri Lanka and on the improvement of the living standards of the people”.

Today, NERDC has earned reputation as one of the most prominent engineering research centers in the country possessing some of the best engineering research facilities in Sri Lanka in the fields such as cost-effective building construction, renewable energy, energy management, precision designing, manufacturing, electrical and electronics, post-harvest technologies and designing and fabrication of equipment and tools for Small and Medium Entrepreneurs (SMEs). Despite the presence of some well experienced and trained staff, remuneration levels, unfilled cadre, and several other constraining factors, some of which are beyond the control of the NERDC, have adversely affected attraction and retention of talented staff, and performance of the institution under all its mandates resulting in not realizing its full potential.

This institutional review was carried out by an independent panel of three members appointed by the National Science and Technology Commission (NASTEC) in consultation with the NERDC during the period from August 2020 to March 2021. The general objective of the review was to assess how effectively the NERDC has acquired and utilized the resources to generate programmes and activities consistent with the mandate and produce outputs that are relevant to its stakeholders and contributed to the national development efforts. The review was carried out in accordance with the procedure described in the NASTEC Review Manual.

A comprehensive review of management aspects and a review of institution outputs are given in Sections 3 and 4. Section 5 provides comments on the productivity of the NERDC based on outputs and staff strength while Section 6 provides an overview of the NERDC performance and contribution to national development. Section 7 provides overall judgement on the performance of the institution specifically with a brief situational review and possible action for consideration.

While the reader is requested to go through the entire report for a comprehensive understanding, the contents of the report are summarized below. However, the reader is cautioned to consider them with the serious constraints encountered by government institutions, solutions to some of which are outside the control of the institution.

### **Corporate Planning and Annual Planning**

NERDC prepares a rolling 5-year Corporate Plan, and the current applicable plan is for the period 2018-2022. It attempts to include the entire scope of the mandates within its 9 goals albeit with different emphasis. The plan itself seems very ambitious in certain strategies and actions but observed no initiatives for significant number of them indicating that they are either not realistic or lack of commitment in implementation, perhaps due to resource constraints. Similarly, very ambitious Key Performance Indicators (KPIs) have been identified to measure the degree of achievement, but they do not have an institutionalized mechanism to measure them. It may be required to use a few robust KPIs which can be measured for performance monitoring.

Some goals have narrow focus. For example, Goal 2 - To promote inventions and innovations as an essential aspect of economic development has one strategy. Goal 7 - To ensure Science & Technology (S&T) contribution in addressing the national issues of the country has only one strategy and two actions. Such goals lack real commitment for achievement. There is also a need to specifically mention the expectation to be aligned with the government priorities and policies with meaningful actions.

Discussions with the stakeholders indicated that there is a lack of stakeholder consultation during the preparation of the plan including, the Board of Management (BoM), all groups and levels of internal staff and external stakeholders. It was also observed that there is a lack of alignment between the Corporate Plan and Annual Plans indicating that the entire strategic planning process needs a better alignment to the organizational mandates, government priorities, stakeholder needs finally aiming for socio-economic development.

Annual Plans are abstract plans with no provision for clear identification of projects or emphasis but only the target numbers to achieve for most programmes. It would be more useful to have an Annual Plan prepared with clear project identification including new programmes and projects for effective project monitoring.

### **Planning of S&T Programmes and Projects**

Some of the research programmes conducted by the NERDC are thematic meeting a broader need. Projects initiated under such themes contribute to overall objective of the theme aiming to address a national issue or contribute to socio-economic development. Programmes such as sustainable building construction, sustainable energy can be considered as themes or programmes. However, even within these research programmes, there is a tendency to identify individual projects with no proper alignment to the final goal of the overall research programmes. Such alignment needs to be ensured during project approvals.

It was also identified that most projects conducted by the NERDC are standalone projects identified at department level by individual staff with own interest rather than arising out of a thematic research programme addressing a broader issue. Impact of R&D projects would be much more, if nationally relevant theme or a burning need with high socio-economic impact is first identified and then formulate multi-disciplinary research projects within those broader themes. This shortcoming mainly happens with lack of involvement of stakeholders in programme planning and prioritizing including BoM members, strategic stakeholders with multi-disciplinary expertise.

International collaboration is hardly considered. Industry collaboration and multi-disciplinary and inter-disciplinary focus is emphasized in the selection criteria, but implementation is rather weak. Techno Marketing Department (TMD) which is the interface between the stakeholders and the NERDC is expected to have a clear idea of industry needs. However, it is found that the involvement of TMD in project planning is also weak. Such involvement from planning through execution to marketing is helpful to ensure that the projects are designed to meet specific stakeholder needs and to help identify the viability of the proposed products.

The quality of project proposals submitted to Research Planning Committee (RPC) needs improvement and the research staff need to be trained and guided to develop good proposals. Collaborative research projects with universities and industry need to be emphasized and seriously taken consideration during project approval. There should also be opportunities for other stakeholders to be formally involved adequately in project identification/planning. The process adopted by the RPC does not indicate rigorous

project scrutiny considering the national needs, socio-economic impact, and market potential. Project approval process therefore needs to be strengthened.

### **Managing Projects Including Quality Management**

A considerable number of projects were found to be having time and cost overruns. Despite that there can be some valid reasons for some projects, the progress monitoring mechanism can be significantly improved to arrest such issues. Key performance data should be captured at frequent intervals and thorough scrutiny should take place preferably with external reviewers to ensure fulfilment of anticipated project objectives.

NERDC is generally sufficiently equipped in terms of infrastructure and equipment. New equipment is recently added to meet new demand driven testing and consultancy services. However, there are delays in providing industry services according to stakeholders indicating a need for more effective project management.

There are no established procedures for quality controlling of research work and other services rendered by the Centre except for some aspects of testing services indicating a need to establish a Quality Assurance Unit (QAU) with necessary controlling and compliance measures to ensure trust and confidence of the clients and quality delivery of research projects. Such quality control procedure should also be applied to the quality of documents such as project proposals, project completion reports, approval forms and assessment reports prepared by the NERDC.

### **Human Resource Management and Staff Performance**

Staff position in the NERDC has improved over the years. However, still one of the major issues faced by NERDC is attraction, recruitment and retention of research engineers/scientists and other technical staff due to low salaries, lack of conducive working environment and low staff morale due to several constraints. Most of these issues are beyond the control of the NERDC and government intervention is needed to solve such issues.

Staff training has been given increased emphasis at all levels with international training for senior researchers and higher management, skills and attitude training for others and orientation for new staff. However, there seems to be no dedicated Staff Development Unit (SDU) to identify and facilitate more need-based training to all levels of staff. Such a system would enhance staff motivation, satisfaction, and performance. Furthermore, the possibilities of trained staff to be used as trainers for the others and ensure such training is effectively used for performance improvement should be given further attention.

System in maintaining computerized staff details has improved to some extent over the years albeit there is no frequent updating to use such details for effective decision making. Maintenance of complete staff profiles including their track record of training would facilitate further training needs and more effective use of staff capabilities. Systems are available for staff appraisal of various staff categories. However, they are often carried out with no direct staff discussion and not based on actual performance which can have room for lack of transparency and consistency and lack of impact on enhancing staff performance.

Some reward systems and staff incentive schemes are in place and are effective in enhancing staff motivation and performance. However, their link to performance needs to be strengthened to make incentive schemes more effective and implemented in a fair manner to all categories of staff.

### **Organizational Assets Management**

NERDC is equipped with sufficient infrastructure in terms of buildings, equipment, and other capital assets for the current scope of activities. Buildings, roads, equipment are generally well maintained with the available resources and expertise of the NERDC. However, further improvements in terms of better landscaping the premises and more systematic regular maintenance can further improve work environment and customer satisfaction. Compliance requirements are generally well met having Asset Register with no concerned audit queries in procurement, use or any other aspect.

Some of the modern lab equipment and facilities can be shared with other R&D institutions and universities in carrying out their R&D and hence a suitable collaborative arrangement for such use is recommended.

Policies and procedures are in place for protection of IP rights. However, there is still a lack of emphasis and attention to this and that the number of patents obtained is an embarrassment to a national R&D organization such as NERDC. However, an increased attention is now given for IP securing and exploitation.

### **Coordination and Integration of Institution Functions and Entities**

Linkages between various S&T Departments of NERDC are mainly met by the departmental meetings with the Director General (DG) and Heads of Departments (HoDs). However, this has not fulfilled the need for strong collaboration between the departments in organizational decision making, development of plans or more effective implementation of projects and activities. There is no central planning committee as such except the meetings with DG and HoDs. There is a need to improve this process with better stakeholder involvement.

Expertise of research management staff is not always efficiently used as they also carry out other tasks resulting in lower outputs and a lack of impact of their efforts. Discussions with the Unions indicate that there is no opportunity for minor staff to share their feedback and that the human expertise and equipment resources available at NERDC are not effectively used indicating that integrating and communication between departments and between various layers of staff need to be improved.

### **Information Dissemination, Marketing and Partnerships**

Organization of Annual Research Symposium is a good initiative for dissemination of NERDC research findings but only NERDC staff participate at this event. Dissemination of research findings through conference presentations and journal publications is not a mandatory requirement of NERDC albeit cash reward is given for journal publications. Statistics indicate that publications by NERDC scientists is poor. A concerted effort is needed to increase this performance.

NERDC has established several external partnerships with local institutions, engineering faculties and even a few international partners. However, there are no indications of active collaborative research efforts with these institutions. More attention to such partnerships is warranted considering many benefits.

Technology Marketing Department is making increased attention to market technologies and products through exhibitions, displays, training, marketing literature and awareness programmes. However, the marketing expertise in the TMD should be further enhanced to ensure that effective marketing and information dissemination to industry, SMEs or to other potential users.

### **Organization Outputs and Outcomes**

NERDC has been carrying out vast number of projects and activities under its mandates for the intended objectives. However, outputs and outcomes indicate that the impact of such projects is below the expectations needing a concerted review as to how they can be improved. The outputs in terms of number of research publications, number of technologies developed, number of technologies transferred or diffused, number of patents obtained, extent to which such technologies are effectively used indicate somewhat embarrassing situation. These need to be looked at individually to identify strategies to improve performance.

It was also found that the NERDC is engaged in commercial construction, commercial fabrication etc. Despite that these may generate much needed income, those actions keep NERDC scarce resources out of their focused work. NERDC should be mindful in such engagement to ensure effective fulfilment of its mandates.

### **Organization Commitment to Address Previous Reviews**

NERDC has undergone a similar review process by NASTEC in 2013 and has received a comprehensive report with recommendations. However, there was no indication that these recommendations were seriously considered during corporate planning, annual planning, at strategic institution and stakeholder meetings for appropriate corrective action.

It may be more effective if the NASTEC can obtain periodic reports from the institution reviewed to ensure, appropriate actions are taken, and the recommendations are considered towards the improvement of the institution performance. It may also be appropriate if such monitoring is included in the institution auditing process, so that such actions are not neglected.

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The Review Panel wishes to extend their appreciation to the NASTEC for the confidence placed on them to carry out this review and for the guidance provided during the review process in accordance with the Review Manual Guidelines.

The support given by the NASTEC staff, Prof. Kshanika Hirimburegama the Chairperson, Ms Nazeema Ahamed Acting Director and Ms Rasitha Perera, Scientist, who coordinated this review in numerous ways are gratefully acknowledged.

The Director General of the NERDC and their staff received us cordially and cooperated fully in carrying out this review providing all necessary information. Special appreciation goes to Mr. Ajith Jayasuriya for coordinating the onsite review process. The Board of Management spared their valuable time for a special zoom meeting with us to exchange views which enabled us to gain insights into the new strategic directions for NERDC and for providing an open review of NERDC as they see it highlighting the proposed interventions. We extend our great appreciation for this cooperation and input by the Board, the Director General and senior staff.

Finally, the Heads of Departments/Divisions, research staff, the union representatives and external stakeholders are greatly appreciated for their valuable inputs during the discussions, which were very helpful in successfully carrying out our review.

## Abbreviations

BoM	-	Board of Management
CPD	-	Continuing Professional Development
DG	-	Director General
HoDs	-	Heads of Department
HR	-	Human Resources
IOT	-	Internet of Things
IT	-	Information Technology
KPIs	-	Key Performance Indicators
M&E	-	Monitoring and Evaluation
MIS	-	Management Information System
NASTEC	-	National Science and Technology Commission
NERDC	-	National Engineering Research and Development Centre
NRDF	-	National Research Development Framework
NSF	-	National Science Foundation
PMU	-	Project Management Unit
QAU	-	Quality Assurance Unit
R&D	-	Research and Development
RPC	-	Research and Planning Committee
S&T	-	Science and Technology
SDU	-	Staff Development Unit
SER	-	Self Evaluation Report
SLSI	-	Sri Lanka Standards Institution
SMEs	-	Small and Medium Enterprises
TMD	-	Technology Marketing Department
ToR	-	Terms of Reference

# 1. Introduction to the National Engineering Research & Development Centre

The NERDC was established by special gazette notification (No 124/6) published under the State Industrial Corporations Act No 49 of 1957, on 14<sup>th</sup> August 1974 with the primary purpose of “developing, acquiring, adapting and transferring engineering technologies that would help in the production and sustainable utilization of human and material resources by engaging in R&D activities that would have a direct impact on the economic development of Sri Lanka and on the improvement of the living standards of the people”.

Founded at the Industrial Development Board Complex at Katubedda, Moratuwa in 1974, subsequently operated at Kollupitiya, NERDC was shifted to the current more spacious location at the Ekala Industrial Estate in 1978 to accommodate its expanding activities.

Today, NERDC has earned reputation as one of the most prominent engineering research centers in the country possessing some of the best engineering research facilities in Sri Lanka in the fields such as cost-effective building construction, renewable energy, energy management, precision designing, manufacturing, electrical and electronics, post-harvest technologies and designing and fabrication of equipment and tools for SMEs. Despite the presence of some well experienced and trained staff, remuneration levels, unfilled cadre, and several other constraining factors, some of which are beyond the control of the NERDC, have adversely affected attraction and retention of talented staff, and performance of the institution under its all mandates resulting in not realizing its full potential.

## 1.1 The Mandate of the NERDC

The mandate of the Centre, as derived from the Act and the Annual Report 2019 are as follows:

- To provide for an institutional mechanism needed for the progressive development of indigenous technology by encouraging, recognizing and developing innovative and creative talent in Sri Lanka;
- To provide facilities to co-ordinate the technological, engineering and research capabilities of various public and private sector industries and institutions in a productive manner through co-operative endeavour;
- To ensure by adoption and adaptation the choice of technologies that would be consistent with the country's resource endowments and national planning objectives;
- To examine direct and indirect mechanism of technology transfer and offer counsel to appropriate government and private institutions in Sri Lanka, when required to do so;
- To promote the optimal exploitation of the country's human and material resources, particularly labour, raw material resources by promoting the growth of suitable technology;
- To design, manufacture, and test prototype machinery, pilot plants as demanded by industrial, commercial and other end-users in an economical manner;
- To provide for continuous monitoring of technological data and documentation relating to engineering designs and research through the co-operation of international and national agencies;
- To offer sustained consultancy services to public and private sector enterprises and undertake research and promote training activities to broaden the base of the country's engineering and industrial

design and research capabilities; and

- To make provision for purpose connected with engineering, research and development related to matters aforesaid.

## 1.2 The Vision and Mission

The Vision of the NERDC as identified in the Corporate Plan 2018-2022 is:

"To be the Centre of Excellence in Engineering Research and Development in South Asian Region"

The Mission of the NERDC is:

"Engage in Research and Development activities to develop, acquire, adapt and transfer Engineering Technologies that would have a direct impact on the Socio-Economic Development of Sri Lanka, while creating a culture within the organization to harness innovation and creativity of employees and stakeholders".

## 1.3 Governing Ministry and Source of Funding

The NERDC functions under the purview of the State Ministry of Skill Development, Vocational Education, Research and Innovation at present and formerly Ministry of Science, Technology and Research.

About 90% of NERDC funding is sourced from the Government; with about 10% met from internally generated funds, earned through engineering services to industries, consultancy and construction, technology transfer activities and professional testing services. The government recurrent allocation was only marginally increased during the last three years with Rs. 241Mn in 2017, Rs. 255Mn in 2018 and Rs. 268Mn in 2019. Capital grant has fluctuated with Rs. 38Mn in 2017, 57Mn in 2018 reducing again to Rs. 44.7Mn in 2019.

## 2. The Review Procedure

This performance review was carried out by the following three-member independent panel appointed by the NASTEC in consultation with the NERDC.

Prof. Ananda Jayawardane (Chairman)	Senior Professor in Civil Engineering, University of Moratuwa and Commission Member, University Grants Commission; former Vice Chancellor of University of Moratuwa and former Director General of the National Science Foundation (NSF).
Eng. Shiromal Fernando	Managing Director, Civil & Structural Engineering Consultants (Pvt) Ltd.
Prof. Buddhika Jayasekera	Professor, Department of Electrical Engineering, University of Moratuwa.

## **2.1 Scope of Review**

As mandated by the Science and Technology Development Act No 11 of 1994, NASTEC is required to review the progress of Science and Technology Institutions in achieving their mandated objects. Accordingly, this review was carried out with the general objective of determining the progress of the NERDC in achieving its objects as are relevant to it, to assess the quality, cost effectiveness, relevance and impact of the scientific programmes conducted at the Institute, and to ensure that the needs and expectations of the government and other stakeholders are being met to the fullest extent possible.

The members of the panel were quite conscious of the fact that while the review report must address the needs of all concerned parties, such as policy makers, the relevant line Ministry, and the Treasury, its most important function is to guide the NERDC towards self-improvement, at the institutional, programme, project, and individual levels. The panel ensured, as far as possible, that the analysis, findings, and the recommendations are evidence based and carried out in unbiased manner and presented constructively.

The professional opinion of the panel was developed based on the general guidelines in the 'Review Manual – Procedure for Performance Review of S&T Institutions' developed by NASTEC. This required an assessment of the management process of the institution as well as its outputs.

## **2.2 Pre-Assessment**

The first meeting of the panel and the NASTEC Chairperson, Acting Director General and the Coordinating Scientist took place on 20<sup>th</sup> August 2020 at the NASTEC Office where the panel was given a briefing of the objectives of the review and the review process. The following documents were also made available to the review panel. A preliminary discussion was also held to clearly understand the scope of the review, the process to be adopted, the programme of the visit and the required information and data to be collected.

- Self-Assessment Report (SER) submitted by NERDC
- NASTEC Review Manual – Procedure for Performance Review of S&T Institutions
- The Terms of Reference (ToR) of the Review (Appendix A)

After a desk study of these documents, the panel requested additional documents and the following were made available before the visit which were further studied by the panel to prepare for the onsite review process.

- Annual Reports – 2018
- Activity Plan – 2020
- KOICA proposal – Rural transport infrastructure development
- KOICA proposal – smoked fish technology dissemination
- NERD Review Report 2013 by NASTEC
- Corporate Plan 2018 – 2022

## **2.3 Detailed Assessment**

The following actions were done, and steps were taken in carrying out the complete review process.

- Visit to the NERDC by the panel on 8<sup>th</sup> Sep 2020. The visit commenced with an introductory speech and overview of performance review by Acting Director of NASTEC to the Senior Officials

of NERDC. This was followed by a presentation on general overview of NERDC by the Director General of the NERDC and a discussion with the senior officials.

- Several Technical Departments were visited, looked at the facilities, discussed about the projects and recorded relevant information. This was followed by visits to Human Resource (HR) and Finance Divisions.
- The day ended with a private discussion among panel members to consolidate observations.
- Second day visit to NERDC on 9<sup>th</sup> Sep 2020. The panel visited the Technology Park and Science Museum first, observed the exhibits, activities, facilities, programmes, and technology displays and had discussions with staff.
- This was followed by further visits to Technical Departments to obtain a comprehensive information of their facilities, processes, and activities.
- Discussions with the representatives of the Engineers' Association, Executive Union and the Technical Assistants' Union were separately held to obtain their views on the activities of NERDC.
- The second day visit ended with another private discussion among the members of the panel.
- On request of the panel further additional reports, namely, Annual Report 2019, performance report 2009-2015, performance report 2015-2017, list of projects carried out were also obtained for further information and validation.
- A meeting with the other stakeholders consisting of NERDC license holders of cost-effective building construction, crematorium technology, vegetable dryer, biogas technology, suppliers to NERDC, clients of department projects and clients of energy and environment projects took place on 11<sup>th</sup> Dec 2020 on zoom technology due to pandemic situation.
- A meeting with the members of the NERDC BoM took place on 29<sup>th</sup> March 2021 on zoom technology.
- Draft report was prepared by consensus with the agreement of all panel members. The opinions expressed and the recommendations made are therefore collectively decided by the panel.
- The draft report was sent to NERDC through the NASTEC in April 2021 to seek views and factual verification from the DG, NERDC.
- The review report was revised incorporating the factual corrections indicated by the NERDC.
- The final review report was submitted to NASTEC after appropriately incorporating feedback from NERDC and with collective agreement of all panel members.

### **3. Commentary on Management Assessment**

The NASTEC Review Manual specifies nine management aspects with their salient features as applicable to S&T institutions in general. The management review was carried out based on these aspects and are summarized under the following subheadings. However, there may be some overlaps as some of the management aspects have overlapping scope. The relevant analysis tables of the management processes are given in Appendix B.

- Institutional response to external and internal environment in planning and organizational strategy
- Planning S&T programmes and priorities
- Planning S&T and R&D projects
- Project management and maintenance of quality
- Human resource management
- Management of organizational assets
- Coordinating and integrating the internal functions/units/activities
- Managing information dissemination and partnership
- Monitoring, evaluation and reporting

#### **3.1 Assessment of Institutional Response to External and Internal Environment in Planning Organizational Strategy**

External environment of an institution consisting of factors such as consumer/industry needs, government policies, market conditions, partners, and competitors critically affects its performance. It is important for an institution to periodically review and adjust its directions and goals, to meet these changes. These adjustments in turn may require significant actions, such as changes in focus and programmes, organizational structure, and management strategies.

Annual Plans prepared by the NERDC indicate that efforts are made to align to government policies and goals appropriate to the time such as Blue Green Era, “Saubhagyaye Dhakma” and National Research and Development Framework (NRDF) prepared by NASTEC. However, they seem to be more cosmetic for seeking funds without a significant change in the strategic direction, actual projects, and institutional actions.

Perhaps due to limitations of resources and expertise, there is a significant variation on the emphasis given to address various mandates of NERDC resulting in insufficient attention to some of the key mandates such as strategic technology acquisition and transfer, more productive collaborative R&D with public and private organizations aiming for economic development, and shallow focus in some strategic technology areas, for example high-tech product research.

External stakeholder consultation is hardly evident in strategic planning or even annual planning except perhaps incorporation of feedback obtained during other occasions. Similarly, there is no evidence to indicate that the members of the BoM are involved in the strategic planning from the beginning except in the latter stages when plans are reviewed and approved by the Board. Preparation of the Corporate Plan is mainly done with the involvement of the top management, but other staff are not consulted directly. Similar situation has been observed during the 2013 review too. However, discussions with the members of the current BoM revealed that there is now a concerted effort for more productive

engagement of the Board for strategic planning, formulation of R&D projects to meet national needs with higher impact.

Even though some external funding has been obtained from sources such as KOICA for meaningful projects, there is plenty of potential to source further funding for NERDC R&D and technology transfer activities and international collaboration. Detailed analysis matrix is provided in Appendix B.1.

### **3.2 Planning S & T Programmes and Setting Priorities**

A programme in this context is considered as an organized set of research projects, activities or experiments that are oriented towards the attainment of specific objectives. Programmes are therefore higher in research hierarchy than projects. Programme objectives should be consistent with organizational strategies and reflect user needs and development goals.

Corporate Plan 2018-2022 of NERDC has been prepared to address almost all institutional mandates, albeit not every mandate is addressed with equal emphasis. However, this plan does not identify specific national S&T programmes or set priorities. It is observed that Annual Plans are prepared not in adequate alignment with the Corporate Plan and the national development goals are only cosmetically connected to activities with no appropriate prioritizing.

It was also identified that most projects conducted by the NERDC are standalone projects identified by individual staff with own interest rather than arising out of a thematic research programme addressing broader issues. Impact of R&D projects would be much more if a nationally relevant theme or a burning need with high socio-economic impact is first identified such as sustainable energy, smart agriculture, sustainable building construction, value addition to natural resources or even burning issue like human-elephant conflict and identify multi-disciplinary research projects within those broader themes. This mainly happens with lack of involvement of BoM members, strategic stakeholders with multi-disciplinary expertise in planning and prioritizing S&T projects.

Such broader themes will invariably have multi-disciplinary and inter-disciplinary teams working together for a solution with wider acceptance enhancing inter-departmental collaboration, ensuring staff satisfaction and motivation and continuity of projects even when one or two staff members leave the team. Programme planning is done collectively by DG, DDGs, Directors and Sectional Heads and related staff members. Staff members as a team does not participate. For example, it was pointed out by one of the Board members that the cost-effective housing project was designed by only engineers and there was no input from an architect. If such developments were carried out with input from other relevant expertise, the output would be better marketable.

NERDC indicates that sufficient funds are available for R&D. Only the Government allocation is considered with occasional external funds. There is potential for increase scope with additional external funding. With well-equipped but under-utilized laboratories, qualified and experience but under-tapped staff, the NERDC has great potential to significantly enhance its socio-economic impact. Detailed analysis matrix is provided in Appendix B.2.

### **3.3 Planning Science & Technology / Research & Development Projects**

A project is a set of activities designed to achieve specific objectives within a specified time period. A project includes interrelated research activities or experiments, schedule of activities to be completed within a specific time, budget, inputs and outputs, focused towards intended beneficiaries.

Current system of project initiation at NERDC is mainly at the department/individual level and are primarily due to personal interest of individual researchers and/or ad-hoc requests by individual stakeholders. Despite these projects can be linked to a national importance, their connection to the Corporate Plan or Annual Plan is weak. International collaboration is hardly considered. Industry collaboration and multi-disciplinary and inter-disciplinary focus too is weak despite they have been identified as important in project selection.

Techno Marketing Department is the interface between the stakeholders and the NERDC and is expected to have a clear idea of the technology transfer success of the past research projects and their shortcomings if any, and future needs. However, it is found that the involvement of TMD in project planning is weak. Such involvement from planning through execution to marketing is helpful to ensure that the projects are designed to meet specific stakeholder needs and to help identify the viability of the proposed product. The current practice is mainly seeking TMD assistance for marketing and licensing, but any feedback obtained during that time for modifications would be too late, resulting in poor technology transfer or technology does not fully meet the needs of the licensees. It is observed that, even the deficiencies of the newly developed products are reported to the relevant Department by the TMD; there was no evidence to show any collaborative efforts to incorporate such feedback to the best extent possible through joint review meetings between the Departments and the TMD.

There is a formal procedure for project proposal submission and evaluation through RPC, however, the quality of project proposals needs improvement indicating that the research staff need to be trained and guided to develop good proposals. Collaborative research projects with universities and industry need to be emphasized and seriously taken consideration during project approval. The current practice does not adequately offer opportunities for collective contribution by staff members. Furthermore, there are no opportunities for other Stakeholders to be formally involved adequately in project identification/planning.

Furthermore, it is doubtful that RPC being an internal team perhaps with inadequate multi-disciplinary expertise in all aspects, would carry out rigorous project scrutiny considering the national needs, socio-economic impact, and market potential. It was also noted that such project scrutiny is done openly, which may prevent close scrutiny and critical questioning. Detailed analysis matrix is provided in Appendix B.3.

### **3.4 Project Management and Maintenance of Quality**

NERDC is generally sufficiently equipped in terms of infrastructure and equipment. New workshop building for Mechatronics, new laboratory for refrigerator testing, a technology incubator etc. have been recently added and new demand driven testing and consultancy services have been introduced. However, there are delays in providing industry services according to stakeholders indicating a need for more effective project management.

Progress of research projects are monitored through regular meetings by DDG(R&D) with senior staff of each department. In addition, progress is reviewed by the Chairman, DG, DDGs with presence of Directors and Project Engineers. However, it is noted that a critical review of the projects is not possible at this meeting due to the large number of projects being reviewed within a limited time. About 1/5<sup>th</sup> of the projects are also abandoned (2009-2015 progress review report) due to poor planning and due to various other reasons. Monthly meeting with the DG and HoDs too is used to review project progress with other institutional activities. Despite project timelines are prepared during planning stage, they are

not effectively used during project implementation and monitoring resulting in time and cost overruns indicating the need for a more professional approach for project management.

Procurement procedures are generally effective albeit there are some delays. There are no complaints from the research staff for lack of support by technical staff. However, there seems to be no systemic procedure to obtain such support in a coordinated way. The library provides access to a few scientific databases and some literature sources. However, collaborations with universities, National Science Foundation (NSF) and other library sources are weak preventing the researchers to access all up-to-date literature.

There are no established procedures for quality controlling of research work and other services rendered by the Centre except for some aspects of testing services indicating a need to establish a QAU with necessary controlling and compliance measures to ensure trust and confidence of the clients and quality delivery of research projects. Furthermore, quality control procedure should also be applied to the quality of documents such as project proposals, project completion reports, approval forms and assessment reports prepared by the NERDC. Detailed analysis matrix is provided in Appendix B.4.

### **3.5 Human Resource Management**

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 can take 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 therefore key components of human resources management that need to be in place for effective performance of an institution.

One of the major issues faced by NERDEC is attraction, recruitment and retention of research engineers/scientists and other technical staff due to low salaries, lack of conducive working environment and low staff morale due to several constraints. Overall unfilled staff ratio in 2019 was 14% and for S&T personnel it was 15% which is a significant improvement compared to previous year where vacancies of S&T personnel was 30%. Number of Scientists with PhD was 5 in 2019 from only 1 in 2018 which is still very low (7% of S&T staff) for a knowledge intensive organization such as NERDC.

Systems in maintaining computerized staff details has improved to some extent over the years albeit there is no frequent updating to use such details for effective decision making. According to 2019 statistics almost 49% of all staff and 58% S&T staff are provided with short-term training or opportunities for Continuing Professional Development (CPD) courses. Orientation programmes for newly recruited staff and initiatives to provide outbound training are commendable. However, attention to real need based is not always the case. It was also found that there is still lack of staff orientation, misguidance by unsatisfied senior staff and complaints by primary level staff indicating that morale building activities can be improved including appreciating all levels of staff for a project completion/success. Annual staff appraisal of Junior Manager (JM) and above categories is performed by a committee and other categories simply by the supervisor with no direct staff discussion and not based on actual performance which can have room for lack of transparency and consistency.

International training opportunities are also given to senior research personnel on strategic areas such as technopreneurship in developing countries, managing research technology organisations, Internet of

Things (IOT) applications for smart farming, solar thermal technologies etc. However, these trainings can be better leveraged and shared with others for more impactful research.

Some rewards systems are in place including cash rewards for publications. Staff incentive scheme too is in place based on income generation activities. However, their link to performance needs to be strengthened to make incentive schemes more effective. Detailed analysis matrix is provided in Appendix B.5.

### **3.6 Management of Organizational Assets**

Under this scope, organizational assets include not only staff, buildings, equipment, and finances, but also include assets such as knowledge, technologies developed, intellectual property, and even credibility and reputation. A continuous effort is needed to protect all of these assets, because they are the basis for the sustainability of the institution and allow it to continue delivering quality research and service outputs.

NERDC is equipped with sufficient infrastructure in terms of buildings, equipment, and other capital assets for the current scope of activities. However, inadequate, qualified and competent human resources has significantly limited fulfilment of all the mandated activities of the institution. Infrastructure such as buildings, roads, equipment are generally well maintained with the available resources and expertise of the NERDC, and demand driven new equipment is acquired. However, further improvements in terms of good landscaping the premises and even better regular maintenance can further improve work environment and customer satisfaction.

Recurrent and capital grants secured from consolidated funds are generally fully utilized. About 10% of recurrent funds is generated through engineering services to industries, consultancy & construction, technology transfer activities and professional testing services. However, these funds can be better directed for higher impact projects, thereby earn more from enhanced technology transfer and licensing. It should be noted that the current 10% of capital income generation is a reduction over the years. However, it should be promoted only through mandated activities to prevent any negative impact on the expected mandates.

Policies and procedures are in place for protection of IP rights with increasing attention. However, there is still lack of emphasis and attention to this and that the number of patents obtained is an embarrassment for development and knowledge centric R&D organization such as NERDC. Detailed analysis matrix is provided in Appendix B.6.

### **3.7 Coordinating and Integrating the Internal Functions/ Units/Activities**

The planning and coordination of units (departments, divisions, committees, research stations, etc.) and interaction among them significantly contribute to the overall performance of the institution. The organization of these units and the overall structure need to be reviewed from time to time to ensure smooth and efficient operations. The planning and coordination of units, logistics, resources, and information flows are necessary to achieve integration and smooth functioning.

Tendency to work in isolation and no effective collaboration between various S&T Departments of NERDC is an inherent weakness identified earlier too. The Corporate Plan 2018-2022 has clearly identified the need for such collaborative research, multi-disciplinary approach, more effective involvement of TMD with S&T departments to develop technologies and products meeting actual industry needs etc. Linkages between various S&T Departments are still weak either formally or informally albeit they are somewhat

bridged by the departmental meetings with the DG and HoDs. However, there is no effective coordination and communication between departments, between various levels of staff either to inform or to take feedback from all levels of staff to support organizational decision making or development of plans.

There is no central planning committee in the Centre except meetings with DG and HoDs. There is a need to improve this process with better stakeholder involvement. Departments are aligned to specific technical areas and have broadly defined scope. However, due to poor coordination and collaboration, there is a tendency to unnecessarily duplicate resources and actions.

Expertise of research management staff is not always efficiently used as they also carry out other tasks resulting in lower outputs and lack of impact of their efforts. Discussions with the Unions indicate that there is no review/evaluation of research reports, no opportunity for minor staff to share their feedback and that the human expertise and equipment resources available at NERDC are not effectively used indicating that integrating and communication between departments and between various layers of staff need to be improved. Detailed analysis matrix is provided in Appendix B.7.

### **3.8 Partnership in Managing Information Dissemination**

An important requirement of all R&D institutions is management of dissemination of technology and information to users. The partnerships / linking up with other actors in S&T and information system including, universities, industries, private sector, international research organizations etc. promote information exchange, collaboration, and cost sharing, and ultimately improves the quality and relevance, and impact of research.

Dissemination of research findings through conference presentations and publications is not a compulsory requirement of NERDC albeit cash reward is given for journal publications. Statistics indicate that such publications in 2019 is 5 which is a reduction from 8 in the year before indicating poor performance by 61 S&T personnel in NERDC during that year. Despite the NERDC focus is on applied or development research, possibilities of dissemination of such developments in a more effective way should be promoted.

Self-evaluation report indicates that NERDC works closely with Sustainable Energy Authority (SEA), (Central Environmental Authority (CEA), NSF, Inventors' Commission (IC) and Industrial Technology Institute (ITI). However, there are no indications for serious collaborative research dissemination efforts with these institutions. It is commendable that NERDC has entered into several MOUs with engineering faculties for collaboration but there is no evidence to conclude effective collaboration either for project execution or dissemination of information.

Technology transfer is facilitated by TMD established for that specific process. This department is making increased attention to market technologies and products through exhibitions, displays, training, marketing literature and awareness programmes. However, the marketing expertise in the TMD is inadequate to ensure that effective information dissemination to industry, SMEs or to other potential users. Detailed analysis matrix is provided in Appendix B.8.

### **3.9 Monitoring, Evaluation and Reporting Procedures**

Monitoring and evaluation of research and development activities are key management processes of public S&T institutions. They are also important for determining whether the institution is learning from

its earlier achievements and failures and to provide useful information for decision-making and accountability.

Medium to long term objective review of direction and activities takes place during the preparation of the Corporate Plan. Annual report provides a fairly comprehensive report of activities prepared in an attractive way which has also won awards during several years becoming the winner in 2016, 1<sup>st</sup> runner up in 2017 in the category of R&D sector. Occasional review reports for reviewing activities for a longer period such as Performance Report 2015 – 2018, 2009-2018 are prepared. However, how such reporting is considered for decision making is not apparent.

Activity Monitoring and Evaluation (M&E) usually happens during the departmental review meetings and progress meeting with HoDs and DG. Monthly progress reports of individual projects need to be submitted in the specified format. However, close scrutiny of this format indicates that some pertinent information on project tracking such as original planned date, extended date, original budget, any revisions, reasons of any time and cost overruns, barriers for smooth project execution are not captured. Individual project-based expenditure and information about budgeting etc. are available centrally. However, there is no comprehensive Management Information System (MIS) for staff, progress and documenting results in a systematic way. Every project has a final report at completion. However, the quality of these reports needs improvement to be professional and comprehensive with achievement of objectives, potential for TT, lessons learnt and further R&D proposed.

Except in collaborative projects and projects funded externally, external stakeholders are not involved with the M&E process. This is significant in ensuring clear need-based research focus. There is no formal way of incorporating results of M&E in future projects albeit this happens through sharing experiences during discussions. Detailed analysis matrix is provided in Appendix B.9.

## 4. Commentary on Output Assessment

The NASTEC Review Manual specifies eight types of outputs as applicable to S&T institutions in general. The output assessment was carried out based on these types and are summarized under the following subheadings.

- Technologies developed
- Technologies transferred to industry/entrepreneurs
- Information dissemination/extension
- Research publications
- Patents
- Services (Testing, calibrations consultancies, advisory etc.)
- Trainings
- Others

The Corporate Plan 2018-2022, SER, Annual Reports published in 2018 and 2019 and Annual Activity Plans provided by NERDC were referred. The assessment was backed by the visit to the NERDC, discussion with all the HoDs, other staff, opinions of the BoM and the stakeholder meeting outcomes. The main focus of the panel was a detailed review of the activity plans and progress achieved throughout the years specifically considering the completed activities.

### Activity Plans

Review of the Corporate Plan 2018-2022 and Annual Plans indicate that the goals are generally aligned but the strategies and activities implemented are not effectively aligned indicating that the Corporate Plan is not seriously considered for direction and action. Annual Plan 2019 indicate that a target of 25 research projects was set for 2019 with 20 completed projects. The achievements for the years 2013 to 2018 based on the Annual Reports published show that the annual achievement is nearly 10 with new technologies and improvements. It was also noticed that most of the projects continued for 2-3 years. The panel therefore believes that the targets set by the NERDC are not achievable fully and the activity plans are to be prepared more realistically considering the available resources. The Centre employed 61 Engineers & Scientists in 2019 (see Table 1 below), and all the research work and services were initiated by them. Providing services to the industry with repair and improvements of plants, laboratory tests, energy and environmental product improvements, NERDC has achieved more than 70% of their targets.

**Table 1 Staff Availability**

Staff availability	2013	2014	2015	2016	2017	2018	2019
Staff	277	272	268	290	280	275	294
Engineers/scientists	42	43	46	50	45	47	61

### Overview of Output Assessment

The output over the years after the first institutional review in 2013, is summarized in Table 2 according to the output assessment matrix provided by the NASTEC.

**Table 2 Output Assessment Summary**

OUTPUT CATEGORY		2013	2014	2015	2016	2017	2018	2019
Products & Technologies Developed	New	7	5	7	7	7	4	6
	Improvements	3	3	3	4	2	3	4
Technologies Transferred	Locally Developed	2	2	1	3	4	1	1
	License Issued	11	21	17	17	23	23	28
Information Dissemination								
Publications	Training Manuals	0	0	0	1	0	0	0
	Leaflets/Articles	8	0	10	15	14	14	6
Event	Workshops & awareness events	18	19	34	27	40	37	39
	Conferences	0	0	1	1	1	1	1
	Exhibitions	18	15	12	12	12	8	10
	Media Events	8	12	5	4	12	12	5
	Open Days	0	0	1	1	1	0	2
Research Publications		0	0	11	6	7	0	5
Patents received		2	1	0	0	1	1	0
Services		Highly active on different service providing and difficult to quantify						
Trainings	Inhouse	2	1	1	7	8	5	2
	Local Opportunities	121	165	440	563	456	430	177
	Staff Training Foreign	3	8	3	8	10	3	7
	Stakeholder	17	5	4	27	16	8	NA

#### 4.1 Products & Technologies Developed

A list of typical technologies developed and ongoing during 2018 and 2019 are as follows. This is not an exhaustive list.

- Design and fabrication a Hyperbaric Oxygen Chamber for Hyperbaric Oxygen Therapy
- Development of machinery and equipment for coconut industry
- Development of small-scale machinery for Ayurvedic purposes-pilot operations of developed ayurvedic machineries (Guli making machine, polishing machine, and paste making machine)
- Smart parking monitoring system
- Power line carrier sensed street light control system
- Application of fly ash in construction industry
- Product development and commercialization of automated hopper machine
- Development of grocery bag production machine
- Device for measuring moisture content of fresh tea leaves
- Improvements for cremator technology
- Aquatic weeding machine

- Sample and report delivery system for hospitals
- 50Kg capacity vegetable dryer
- Livable houses at affordable cost
- Industrial coconut dehusker machine

While some technology projects are aimed for significant contribution to industry, services, and SMEs, and originated with a demand or request, most projects are basically individual projects generally resulting small-scale outcomes. NERDC should give a serious consideration as to how these R&D projects should be chosen considering the maximum possible social, economic, or even scientific impact. What combination of technologies should be developed for SMEs and large-scale manufacturers? On average NERDC produces around 5-7 technologies per year only some of which will have potential for technology transfer. This development output is marginal for a national engineering R&D institute such as NERDC.

It was identified that the technologies available on display at the Techno Park are mostly “old” technologies and most visitors used to tell “they are the same things that we saw many years ago” indicating that new useful technologies are hard to come by. Furthermore, very slow progress and incompleteness of technology projects is another issue specifically for individually commenced projects with no target for completion.

An increased impact may be possible if NERDC focusses on large scale programmes in areas of agriculture and fishing, material research, waste recycling, reuse, reduce and sustainable construction, indigenous manufacturing etc. In addition, it should show more interest in introducing foreign technologies and assimilate to suit local needs, introduce new trends to Sri Lankan construction industry targeting fast construction such as modular systems and 3D printed housing etc. Products by NERDC should improve the look and feel of the items to broaden its marketability locally and internationally. Focusing on government policy, ‘Subhagya Dakma’, “research is to be conducted to bring awareness on technology-based products, value addition to readily available resources in the country”.

A critical shortcoming of this technology development process is the lack of stakeholder consultation including potential end user during planning and execution of research projects and even sometimes incorporating feedback after technology transfer. There have been many situations where the technologies developed by NERDC do not really “fit” to the end user needs. However, it is commendable that Low-Cost Construction Technologies, cremator technology etc. have become successful and are comparatively popular in the industry. However, NERDC should work on developing such technologies in compliance to standards and in situations such standards do not exist, then to develop them together with Sri Lanka Standard Institute (SLSI).

NERDC has also taken initiatives recently to address hi-technology for enhanced value addition and to provide some advanced services such as refrigerator testing which are commendable moves. However, no useful technology projects have been completed or ongoing in the hi-tech space.

## **4.2 Technologies Transferred to Industry/ Entrepreneurs**

In general, average of 20-30 new licenses per year are issued for industry and entrepreneurs on NERDC Technologies (28 in 2019) and 60-70 technology licenses are renewed (69 in 2019). Technologies that were transferred in 2017 and 2018 are provided in Table 3. However, the license issuing process needs to be validated by issuing a license document for proof. Stakeholders suggested that the NERDC Technology for cost effective construction is misused by unregistered contractors and that eventually leads to loss of quality assurance to the end user. Thus, the market for NERDC Technology is depreciating from where it was. Similar importance should be given for adopting of foreign technologies. More products can be

developed at the Centre at a low cost (currently being imported by the government) by appropriately adapting and transferring such technologies. There were no records of such foreign technology transfers.

It was identified that the TMD should be significantly strengthened to be a strong bridge between NERDC and tech transferees. Its role should cover the entire spectrum of the projects, from planning through guiding during the development, transfer, after sale service to providing vital feedback to the developers.

**Table 3 Licenses issued in 2017 & 2018**

<b>2017</b>	<b>2018</b>
Cost Effective Building Technology	Bottom Ash Mixed Cement blocks and paving block
Cement Stabilized Compressed Soil Blocks Manufacturing	Cinnamon Oil Distillation Unit
Construction of Pre-stressed Foot-bridges	Crematorium Technology
Construction of Ferro Cement Foot Bridges	Cost effective building technology
Vegetable Dryer	Vegetable Dryer
Yoghurt Incubator	Bakery Oven
Foot Operated Water Valve	Solar Water Heater Technology
Manioc Slicer	Bottom Ash Technology
Manufacturing of Bottom Ash Mixed Cement Blocks	Manufacturing of Pre-stressed Precast Concrete Wall Panel for Retaining Wall

### **4.3 Information Dissemination/ Extension**

Information dissemination has been improved over the past years through conducting more workshops and media events. NERDC has participated in more than 70 exhibitions over 6 years (10 in 2019). TMD is now active in its presence in the market despite low impact. It actively participates at exhibitions, provides technology training, conducts awareness programmes, TV/Radio shows, publishes newspaper/magazine articles but the issue for low success is more on the readiness or fitness of the technologies.

NERDC should further improve their marketing strategies in order to effectively reach rural communities and all technology end users. They may collaborate with Provincial Secretariats, Grama Niladhari Divisions and other government institutions with the aim of transferring technologies specifically to SMEs and even other manufacturers. In order to market the low-cost construction technologies, the Centre may collaborate with the Architects and Quantity Surveyors in the industry to improve the technology and market it through them to clients, adding value to NERD Technology. Securing Sri Lanka Standards Institution (SLSI) standards for products and technologies, developing such standards with SLSI when no such standards exist, and obtain authorization for technology from the Construction Industry Development Authority (CIDA) when applicable, so the end users will be assured of the quality and compliance of such technologies.

### **4.4 Publications**

NREDC initiated their Research symposium and Open Day in 2015 and held it continuously which is a commendable initiative to disseminate NERD findings in terms of symposium proceedings. Thirty-four research papers have been published over the past 6 years which however is, marginal for a R&D organization with over 60 research engineers. Increased attention with a reward scheme is now in place to enhance publication output. As informed earlier, one serious constraint for this is the non-availability of sufficient senior researchers with PhD qualifications.

#### **4.5 Patents**

A significant KPI for a S&T and R&D institution is the number of patents. On average only about 3 applications per year are made for patents by the NERDC and number secured on average is one. This figure is embarrassing to a national R&D organization. However, now there is increased attention to this since 2018, providing several training opportunities and establishing Technology Information Service Centre (TISC) at NERDC and TMD given the dedicated responsibility to support for patents. However, the success depends on the development of more patentable innovations for which further interventions are needed.

#### **4.6 Services (Testing, Calibrations, Consultancy, Advisory and Education)**

NERDC is more focused on supplying a range of services to the industry and others. Typical ones include repairing and modification of crematoriums, environmental laboratory testing, boiler performance analysis, waste water testing, noise and air quality monitoring, lamp tests, manufacturing pre cast concrete building components, calibration services, electrical installations, energy auditing, cost-effective building construction etc. Of these services, ISO accreditation was obtained for “Wastewater testing”, “Noise level measurement”, “Refrigerator testing laboratory” and “Lamp testing” laboratory” in recent years improving the quality of services and customer confidence.

Further initiatives taken to enhance the services such as Mechatronics Enabled Economic Development Initiative (MEDI), standard prototyping testing facility for entrepreneurs, Technology Incubator are commendable albeit the vigour and impact of these services are yet to be seen.

Science and technology popularization services such as conducting awareness programmes for the school children and public, provision of facilities for budding inventors, management of Techno-Park and Museum for education are good initiatives. Extension of NERDC support for fabrication of machinery and construction of buildings and other structure too are services appreciated by the recipients, however, NERDC should be mindful about utilizing scarce resources for non R&D activities.

Overall, the stakeholders were satisfied about the quality of the services and laboratory facilities at the NERDC and the charges applied although some delays in providing services were reported mainly attributable to resource constraints. One suggestion forwarded by the stakeholders was having available spare machines to be used in case of repair work taking time, in order to avoid delays.

## **4.7 Training**

In terms of training, the centre has increased opportunities for the staff to improve their skills and knowledge by funding training courses organized outside the NERDC as well as organizing courses by the NERDC. Initiatives such as provision of 2-day residential outbound training programme for new employees in 2019, international short-term opportunities for senior research engineers on strategic areas, and other ad-hoc training opportunities are made available for staff. However, these training should be more need based and the recipients, specifically international training recipients, should be used as trainers to train other staff. Training of minor level staff should also be considered as a need to satisfy this level of staff and to enhance their productivity and improve positive attitude.

NERDC is also active in providing training to technology transferees. The transfer of this knowledge to the community was appreciated by the stakeholders in their remarks as well, while it was suggested for the construction sector to have training sessions for unregistered members and issue the license to avoid misuse of technology in the industry. The Scientists & Engineers are well recognized for their contributions through their work. However, recognition of the skilled workers who have contributed to develop products would also enhance their moral which was a concern of such staff.

NERDC also facilitates the apprentices and undergraduates in fulfilling their industrial training requirements. In 2019, 61 opportunities have been given for such training which too is commendable.

## **5. Productivity of the Institution based on Output and S&T Staff**

In general, from 2013 onwards, the NERDC has employed around 280-296 staff and among them 50-60 Engineers and Scientists. According to the NASTEC Review Report 2013, only one M.Phil. qualified engineer remained at NERDC with no PhD holders in the year 2012. Situation has now somewhat improved with 5 PhD holders with 61 research staff out of 72 in the cadre. As found in the annual reports, NERDC was concerned about the retainment of the qualified staff and several steps have been taken to incentivize staff with funding for postgraduate studies, providing opportunities for skills development and several measures to improve working environment. Through such measures the staff composition is now comparatively more qualified with several members having their charter qualifications and completed/ongoing master studies. Although the situation is still not fully satisfactory with over 15% vacancies, any further improvement in staff numbers and more qualified staff will also need government intervention to provide better remuneration. However, for the current scope of activities, NERDC is comprised of adequately knowledgeable staff and an adequate number of supporting staff as disclosed at the stakeholder discussions.

The productivity of the NERDC based on output, however, needs considerable improvement as highlighted in the previous sections. As also identified in the Corporate Plan 2018-2022, KPIs for productivity and output would include factors such as the number of technologies developed, technologies transferred or diffused, performance of such technologies/products in the market, number of patents obtained, number of publications in high impact journals and several others. Closer scrutiny of these KPIs indicate that NERDC's productivity and outputs in several aspects fall short and can be significantly improved.

Considering the productivity of the Center, more output is expected from large scale research programmes. This should be done commencing at the planning stage by identifying and allocating available staff more effectively, forming multi-disciplinary teams, selecting high impact research programmes with productive collaborations and with more effective project management.

The committee also believes that more staff is involved on the services and consultancy rather than innovation, research and development work – which needs a better balance.

## **6. Overview of Institution’s Performance and Contribution to National Development**

NERDC, over the years, has played a huge role in fulfilling its mandates albeit some mandates had received better attention than the others. Successful and demanding technologies have been transferred to the industry and to end users such as sustainable building construction and cremator technology. However, closer scrutiny indicates that most research, developments, technologies transferred have not resulted in anticipated social, scientific, or economic impact. Several major reasons have been identified and detailed in the report ranging from identifying research programmes, projects, resource allocation, progress monitoring, stakeholder/end user consultation, lack of collaborative multi-disciplinary/inter-disciplinary approach, technology marketing and effective technology transfer and several others.

The NERDC is operating with functioning departments related to different aspects of research, development, and technology transfer. However, the technology transfers are limited to a few areas like civil engineering technology. Other technological areas are not developed up to the same level in the research, development, and technology transfer. Furthermore, designing, manufacturing, and testing prototype machinery and pilot plants are limited to a few, such as biogas plants. There is a big vacuum in other technological areas related to the industrial, commercial, and other end-users. In addition, the NERDC offers a range of consultancy services such as testing facilities, fabricating, calibrations which indirectly support for industry development.

The following areas in the mandate are inadequately covered in the current focus of the Center and the Corporate Plan is not seriously followed in the operation of the Center:

- develop suitable technology for optimal exploitation of the country’s human and material resources,
- undertake research and promote indigenous technology,
- develop a critical mass of talented human resource base,
- promote grassroots innovations and bring them into the mainstream of National Innovation System,
- keep pace with global trends in advancement of engineering knowledge relating to research, design & development.

The contribution in broadening the base of the country’s engineering and industrial design and research capabilities towards the country’s development goals needs significant attention.

As stated in the vision, mission, and mandate of NERDC, the output of the organization should directly impact the sustainable economic and social development of the country which is not achieved as

expected at present. The committee therefore believes that output of each individual on cost basis be evaluated and monitored where the NERDC management could clearly identify whether the investments made are worthwhile and productive, and whether it has the expected impact on the country's economy, and thereafter align the projects accordingly. At the same time this can be used as a tool to remunerate better performers.

## **7. Overall Judgements on Different Aspects**

NERDC has earned reputation as one of the most prominent engineering research centers in the country possessing some of the best engineering research facilities in Sri Lanka. Over the years, it has played a huge role in carrying out research and development work in Energy and Environmental Engineering; Civil Engineering; Agriculture and Post-Harvest Engineering; Electrical and Electronic Engineering; and Mechatronic Engineering. It has also been providing a range of technical services to the industry and S&T awareness and education programmes to school children and general public through its Technology Park, Engineering Museum and several other ways. Overall, the NERDC functions include development of technologies; technology transfer, diffusion and dissemination; providing technical services to industry, supporting inventions and popularization of S&T.

Despite the presence of some well experienced and trained staff, remuneration levels, unfilled cadre, and several other constraining factors, some of which are beyond the control of the NERDC, have adversely affected attraction and retention of talented staff, and performance of the institution under all its mandates resulting in poorly realizing its potential.

This section attempts to collate the findings of our review and provide possible recommendations for consideration with the objective of providing constructive suggestions for improvement. Hence, the NERDC and the other readers should take the observations and recommendations given in the following sections in that context. The sections are structured by appropriately combining the review criteria provided in the NASTEC manual avoiding overlaps under following subheadings:

- Corporate planning and annual planning
- Planning of S&T programmes and projects
- Managing projects including quality management
- Human resource management and staff performance
- Organizational assets management
- Coordination and integration of institution functions and entities
- Information dissemination, marketing, and partnerships
- Organization outputs and outcomes
- Organization commitment to address previous reviews.

### **7.1 Corporate Planning and Annual Planning**

- NERDC prepares a rolling 5-year Corporate Plan, and the current applicable plan is for the period 2018-2022. It attempts to include the entire scope of the mandates within its 9 goals albeit with different emphasis. The plan itself seems very ambitious in certain strategies and actions but with no initiatives for significant number of strategies and actions indicating that it is not realistic in certain proposals or lack of commitment in implementation, perhaps due to resource constraints.

- Some goals have narrow focus. For example, Goal 2 - To promote inventions and innovations as an essential aspect of economic development has one strategy. Goal 7 - To ensure S&T contribution in addressing the national issues of the country has only one strategy and two actions. No strategies identified to promote this aspect within NERDC community.
- There are many KPIs identified in the Corporate Plan but many of them are not used as KPIs and no institutionalized mechanism to measure several of those. It may be required to use a few robust KPIs which can be measured for performance monitoring.
- The Corporate Plan has its first strategy in Goal 1 – To conduct R&D projects based on National Policies and Priorities but the proposed actions do not identify that it would focus to government priorities which might result in lack of focus towards them.
- Discussions with the stakeholders indicated that there is lack of stakeholder consultation during the preparation of the plan including, the BoM, all groups and levels of internal staff and external stakeholders.
- Preparation of Annual Plans need to be aligned to the Corporate Plan. However, there is lack of alignment between them indicating that the entire strategic planning process needs a better alignment to the organizational mandates, government priorities, stakeholder needs finally aiming for socio-economic development.
- Annual Plans are abstract plans with no provision for clear identification of projects but only provide the target numbers to achieve for most programmes. It would be more useful to have an Annual Plan prepared for clear project identification including new programmes and projects at least for internal use.

## **7.2 Planning of S&T Programmes and Projects**

- Some of the research programmes conducted by the NERDC are thematic meeting a broader need. Projects initiated under such themes contribute to overall objective of the theme aiming to address a national issue or contribute to socio-economic development. However, even within these research programmes, there is a tendency to identify individual projects with no proper alignment to the final goal of the research programme. Such alignment needs to be checked in project approvals.
- It was also identified that most projects conducted by the NERDC are standalone projects identified by individual staff with own interest rather than arising out of a thematic research programme addressing broader issues. Impact of R&D projects would be much more if a nationally relevant theme or a burning need with high socio-economic impact is first identified and then formulate multi-disciplinary research projects within those broader themes.
- Such broader themes will invariably have multi-disciplinary and inter-disciplinary teams working together for a solution with wider acceptance enhancing inter-departmental collaboration, ensuring staff satisfaction and motivation and continuity of projects even when one or two staff members leave the team.
- This shortcoming mainly happens with lack of involvement of stakeholders in programme planning and prioritizing including BoM members, strategic stakeholders with multi-disciplinary expertise in planning and prioritizing S&T projects.
- Current system of project initiation at NERDC is mainly at the department/individual level and are primarily due to personal interest of individual researchers and/or ad-hoc requests by individual

stakeholders. Despite these projects can be linked to a national importance, their connection to the Corporate Plan or Annual Plan is weak. International collaboration is hardly considered. Industry collaboration and multi-disciplinary and inter-disciplinary focus too is weak despite they have been identified as important in project selection.

- Techno Marketing Department is the interface between the stakeholders and the NERDC and is expected to have a clear idea of industry needs. However, it is found that the involvement of TMD in project planning is weak. Such involvement from planning through execution to marketing is helpful to ensure that the projects are designed to meet specific stakeholder needs and to help identify the viability of the proposed product. Similarly, any feedback given by the TMD to relevant divisions at any stage of technology/product development has be given due consideration.
- The quality of project proposals submitted to RPC needs improvement and the research staff need to be trained and guided to develop good proposals. Collaborative research projects with universities and industry need to be emphasized and seriously taken consideration during project approval. There should also be opportunities for other Stakeholders to be formally involved adequately in project identification/planning.
- The process adopted by the RPC which is an internal team does not indicate rigorous project scrutiny considering the national needs, socio-economic impact, and market potential. It was also noted that such project scrutiny is done openly, which may prevent close scrutiny and critical questioning needing strengthening of project approval process.

### **7.3 Managing Projects Including Quality Management**

- A considerable number of projects were found to be having time and cost overruns. Despite that there can be some valid reasons for some projects, the progress monitoring mechanism can be significantly improved. Key performance data should be captured at frequent internals and thorough scrutiny should take place preferably with external reviewers to ensure fulfilment of anticipated project objectives.
- There are no established procedures for quality controlling of research work and other services rendered by the Centre except for some aspects of testing services indicating a need to establish a QAU with necessary controlling and compliance measures to ensure trust and confidence of the clients and quality delivery of research projects.
- Such quality control procedure should also be applied to the quality of documents such as project proposals, project completion reports, approval forms and assessment reports prepared by the NERDC.
- NERDC is generally sufficiently equipped in terms of infrastructure and equipment. New equipment is recently added to meet new demand driven testing and consultancy services. However, there are delays in providing industry services according to stakeholders indicating a need for more effective project management.

### **7.4 Human Resource Management and Staff Performance**

- One of the major issues faced by NERDEC is attraction, recruitment and retention of research engineers/scientists and other technical staff due to low salaries, lack of conducive working

environment and low staff morale due to several constraints. Most of these issues are beyond the control of the NERDC and government intervention is needed to solve such issues.

- Staff training has been given increased emphasis at all levels with international training for senior researchers and higher management, skills and attitude training for others and staff orientation for new staff. However, there seems to be no dedicated SDU to identify and facilitate more need-based training to all levels of staff. Such a system would enhance staff motivation, satisfaction and performance. Furthermore, the possibilities of trained staff to be used as trainers for the others and ensure such training is effectively used for performance improvement should be given further attention.
- System in maintaining computerized staff details has improved to some extent over the years albeit there is no frequent updating to use such details for effective decision making. Maintenance of complete staff profiles including their track record of training would facilitate further training needs and more effective use of staff capabilities.
- Systems are available for staff appraisal of various staff categories. However, they are often carried out with no direct staff discussion and not based on actual performance which can have room for lack of transparency and consistency and also lack of impact on enhancing staff performance.
- Some rewards systems and staff incentive schemes are in place and are effective in enhancing staff motivation and performance. However, their link to performance is to be strengthened to make incentive schemes more effective and fairly given to all categories of staff.

## **7.5 Organizational Assets Management**

- NERDC is equipped with sufficient infrastructure in terms of buildings, equipment, and other capital assets for the current scope of activities. Buildings, roads, equipment are generally well maintained with the available resources and expertise of the NERDC, and demand driven new equipment has been acquired. However, further improvements in terms of better landscaping the premises and more systematic regular maintenance can further improve work environment and customer satisfaction.
- Compliance requirements are generally well met having Asset registers with no concerned audit queries in procurement, use or any other aspect.
- Some of the modern lab equipment and facilities can be shared with other R&D institutions and universities in carrying out their R&D activities and hence a suitable collaborative arrangement for such use is recommended.
- Policies and procedures are in place for protection of IP rights. However, there is lack of emphasis and attention to this and that the number of patents obtained is an embarrassment for development and knowledge centric R&D organization such as NERDC. However, an increased attention is now given for IP securing and exploitation.

## **7.6 Coordination and Integration of Institution Functions and Entities**

- Tendency to work in isolation and with insufficient collaboration between various S&T Departments of NERDC is an inherent weakness also identified in Corporate Plan. Linkages between various S&T Departments are mainly bridged by the departmental meetings with the DG and HoDs. This has not

fulfilled the need for strong collaboration between the departments in organizational decision making, development of plans or more effective implementation of projects and activities.

- There is no central planning committee as such except meetings with DG and HoDs. There is a need to improve this process with better stakeholder involvement. Departments are aligned to specific technical areas and have broadly defined scope. However, due to poor coordination and collaboration, there is a tendency to unnecessarily duplicate resources and actions.
- Expertise of research management staff is not always efficiently used as they also carry out other tasks resulting in lower outputs and lack of impact of their efforts. Discussions with the Unions indicate that there is no opportunity for minor staff to share their feedback and that the human expertise and equipment resources available at NERDC are not effectively used indicating that integrating and communication between departments and between various layers of staff need to be improved.

### **7.7 Information Dissemination, Marketing and Partnerships**

- Dissemination of research findings through conference presentations and publications is not a compulsory need of NERDC albeit cash reward is given for journal publications. Organization of annual Research Symposium is a good initiative but only NERDC staff participates at this event. Statistics indicates that publications by NERDC scientists are poor. A concerted effort is needed to increase this performance.
- NERDC has established several external partnerships with local institutions, engineering faculties and even a few international partners. However, there are no indications for active collaborative research dissemination efforts with these institutions. More attention to such partnerships is warranted considering many benefits of such partnerships.
- Technology Marketing Department is making increased attention to market technologies and products through exhibitions, displays, training, marketing literature and awareness programmes. However, the marketing expertise in the TMD should be further enhanced to ensure that effective information dissemination to industry, SMEs or to other potential users.

### **7.8 Organization Outputs and Outcomes**

- NERDC has been carrying out vast number of projects and activities under its mandates for the intended objectives. However, outputs and outcomes indicate that the impact of such projects is below the expectations needing a concerted review as to how they can be improved.
- The outputs in terms of number of research publications, number of technologies developed, number of technologies transferred, number of patents obtained, extent to which such technologies are effectively used indicates somewhat embarrassing situation. These need to be looked at individually to identify strategies to avoid such performance.
- It was also found that the NERDC is engaged in commercial construction, commercial fabrication etc. despite that these might generate much needed income, those actions keep NERDC scarce resources out of their focused work. NERDC should be mindful in such engagement if they do not fulfil NERDC mandates.

## **7.9 Organization Commitment to Address Previous Reviews**

- NERDC has undergone a similar review process by NASTEC in 2013 and has received a comprehensive report with recommendations. However, there was no indication that these recommendations were seriously considered during corporate planning, annual planning, at strategic institution and stakeholder meetings for appropriate corrective action.
- It may be more effective if the NASTEC can obtain periodic reports from the institution reviewed to ensure, appropriate actions are taken, and the recommendations are considered towards the improvement of the institution performance.
- It may also be appropriate if such monitoring is included in the institution auditing process, so that such actions are not neglected.

## **Appendix A – Terms of Reference of the Review Panel**

### **National Science and Technology Commission**

#### **External Review of the National Engineering Research and Development Centre**

##### **Objectives**

The Science and Technology Development Act No. 11 of 1994 mandates the National Science and Technology Commission, *inter alia*, to review the progress of Science and Technology institutions in relation to the Objects set out in section 2 of the Act (see Appendix)

Accordingly, this review is carried out with the Objective of determining the progress of the National Engineering Research and Development Centre (NERDC) in achieving such of these Objects as are relevant to it, to assess the quality, cost effectiveness, relevance, and impact, of the scientific programmes conducted at the Institute, and to ensure that the needs and expectations of the government and other stakeholders are being met to the fullest extent possible.

*The review may also serve:*

- To obtain information on how to improve the activities of the Institution
- To induce self-reflection by the scientists at the Institution on the results and outcomes of S&T activities
- To encourage good management of the Institution
- To improve internal and external transparency
- To recommend future resource commitments
- To gather information for policy change
- To inform stakeholders about the Institute's competencies.

##### **Duties of members of the Review Team**

Members of the review team are expected to follow the procedures described in the Review Manual prepared by NASTEC. This includes:

1. Study of the self-assessment report submitted by the National Engineering Research and Development Centre. NASTEC will provide you with a copy of this report. While the review is based on the information contained in this report, it need not be confined to the report.
2. Site visit to the Institute after preliminary discussions with the Director of National Engineering Research and Development Centre. You may have to examine previously requested documents, and interview relevant officers, in order to gather information necessary to evaluate the institution. The expenses for the transport, accommodation & meals will be reimbursed based on the NASTEC approved rates – Commission paper No 195-03 (Annexure 01).
3. Meeting with stakeholders of the Institute, in order to determine whether their expectations are being reasonably met by the Institution. The meeting will be set up by NASTEC in consultation with the NERDC.

4. Preparation of the draft report and submission of the same to the Director NASTEC, who will forward it to Director, National Engineering Research and Development Centre, for his verifications.
5. Preparation of the final report and submission of the same to NASTEC. After the comments of the Director, National Engineering Research and Development Centre, on factual matters of the draft report have been received and given due consideration, the Chair of the Review Team will be responsible for finalizing the report, in consultation with the other members of the team. The final report will be circulated by NASTEC to Ministry of Higher Education, Technology and Innovation and other relevant parties, including Audit General's Department.

The draft and final reports should contain assessments of both the management and output of the Institute, covering all areas included in the Review Manual to the extent that they are applicable, and submitted in the format described in page 29 of the Review Manual. The team may use its discretion in dealing with any additional matters not covered by the Review Manual, which in their opinion are relevant and important for purposes of this review. This should be done with proper documentation and justifications.

The member of the team should always bear in mind that, while the review report must address the needs of all concerned parties, such as policy makers, the relevant line Ministry, and the Treasury, its most critical function is to guide the Institution being reviewed towards self-improvement, at the institutional, project, and individual levels. It should be based on the Institution's mandate, and contain constructive criticisms, an unbiased analysis of the findings, and recommendations for improvement.

## Appendix

- (a) to promote the use of science and technology as an integral part of the effort to achieve rapid economic development, and improved quality of life and to alleviate poverty, and to involve scientists and technologists in the formulation of policy and in decision making ;
- (b) to foster scientific and technological activity in all its aspects with a view to developing self reliance in scientific and technological capability and to ensure the allocation of a reasonable proportion of the gross national product for science and technology activities;
- (c) to support the development of indigenous technology wherever feasible whilst promoting the import, adaptation and assimilation of technology for rapid growth in industry agriculture and services;
- (d) to ensure that institutions of higher education and technical education and research institutions produce scientists, technologists and technicians of high caliber and competence and to secure the provision of incentives to them with a view to ensuring their retention in Sri Lanka;
- (e) to provide adequate opportunities for all persons to acquire a basic education in science and its practical applications:
- (f) to cultivate among the people, an appreciation of the value of science, scientific method and technology and of the integral role that science plays in modern society;
- (g) to disseminate the benefits of science and technology activity to all sectors of the people;
- (h) to encourage and strengthen cooperation in science and technology between scientists in Sri Lanka, and between scientists in Sri Lanka and scientists outside Sri Lanka, and to provide access to global scientific and technological knowledge and activity ;
- (i) to develop the capability to continuously plan, evaluate and review strategies, legislation: and the institutional framework for science and technology in Sri Lanka ;
- (j) to identify priority areas of science and technology likely to be of benefit to Sri Lanka and to promote research and development in such areas.

## Appendix B – Management Assessment Matrices

### B.1 Assessment of Institutional Response to External and Internal Environment in Planning Organizational Strategy

Management Practice	Level of Practice (Performance Indicators)			Comments / Evidence
	Strong	Moderate	Weak	
Government policies and development goals are used/ considered to establish goals and plan organizational strategy for the institution.		X		Efforts are made to align to government policies and goals appropriate to the time such as Blue Green Era, “Saubhagyaye Dhakma”, NRDF mainly in the Annual Plan rather than in the Corporate Plan.
The organizational mandate (as specified by the relevant Act) is considered in strategic planning.		X		There is a significant variation on the emphasis given to various mandates resulting in insufficient attention to some and shallow focus in others.
The institution is responsive to changes in Government policies and strategies.		X		Attempts are made to relate the activities carried out to the changes in government policies and strategies in the Annual Plans
Factors such as strengths, weaknesses, threats and opportunities are considered in strategic planning.			X	These are identified in the corporate plan. However, how they are more effectively and productively leveraged in strategies and actions is not evident.
Stakeholders’ needs are taken into consideration in strategic planning.			X	External stakeholder consultation is hardly evident in strategic planning or even annual planning. Feedback taken during other workshops and activities may be indirectly considered
The Board of Governors is involved in strategic planning.			X	No evidence to indicate that the Board is involved in the strategic planning from the beginning except in the latter stages when plans are reviewed and approved by the board.

The extent to which staff members are involved in strategic planning.		X		Corporate plan is prepared by the top management. Lower grades are not considered directly.
Government allocations and alternative funding opportunities (donor funding) are considered in strategic planning.		X		They are mainly considered in Annual Plans and there are instances where donor funding eg. KOICA has been used for meaningful projects. More opportunities can be exploited.
The extent to which policies and plans of the organization are reviewed and updated.			X	Corporate plan is not seriously considered but annual operational plan is considered for operational aspects. However, current Board of Management is keen to address this aspect.

## B.2 Planning S & T Programs and Setting Priorities

Management Practice	Level of Practice (Performance Indicators)			Comments/ Evidence
	Strong	Moderate	Weak	
National development goals are considered in planning programmes & setting priorities.		X		Corporate Plan 2018-2022 only addresses goals and strategies in general considering the mandates, albeit not every mandate is addressed with equal emphasis. Even in annual plans national development goals are only cosmetically connected to activities with no appropriate prioritizing.
Board of Governors participate in planning and priority setting of programmes.			X	Only the Chairman and the Director General represent the Board in planning and priority setting. Project list is forwarded for information of the others. However, there is increased attention by the BoM to participate in planning and priority setting.
The extent to which the staff of the institution participate in programme planning and priority setting.		X		Programme planning is done by DG in consultation with Heads. Staff members as a team does not participate. Projects are usually identified on personal interest justified linking to national goals but they may not fall into a cohesive research programme.
Stakeholder interests are considered in programme planning.			X	Stakeholder interests are not directly sought in programme planning. Feedback from license holders is considered for any improvement.
The extent to which programmes are planned and approved through appropriate procedures.		X		Individual project proposals submitted in a specified format are considered by the Research Planning Committee (RPC) for approval. Approval criteria include national importance, wide usage and partnership. However, evidence indicate that this process has shortcomings.
The extent to which the availability of funds (government allocations and other funds) generating funds		X		NERDC indicates that sufficient funds are available for R&D. Only the Government allocation is considered with occasional external funds. There is potential for

are taken into consideration in planning programmes.				increase scope.
The obtaining of necessary equipment is considered in planning programmes.		X		NERDC laboratories are generally well equipped and project proposals have provision to specify laboratory facilities needed. However, no coordinated effort to effectively use facilities available in other research centers and institutes.
Stakeholders are represented in the institution's planning and review committees.			X	There are no external stakeholder involvement in planning and review committees.
The extent to which socio economic and commercialization of aspects are considered in programme planning.			X	Project selection criteria include national importance, wide usage in the society and partnership so that there a client at the end. However, there is no programme level planning or thorough scrutiny to ensure socio-economic benefits.
Effectiveness and efficiency of institutional procedures in approving new S& T programmes.			X	With no direct involvement of the BoM, relevant stakeholders in the RPC and in the absence of thorough scrutiny, there is much room for improvement also looking at programme level rather than disconnected project level approval.

Clear identification of national priorities with funding opportunities, consideration of projects packaged into a programme leading to a implementable technology solution, thorough scrutiny of the proposals with a well constituted RPC with all relevant stakeholders will result in significant improvement in the planning of S&T programmes and setting priorities of the NERDC.

### B.3 Planning S& T / R& D Projects

Management practice	Level of Practice (Performance Indicators)			Comments/ Evidence
	Strong	Moderate	Weak	
The staff is provided with guidance for project planning.		X		Some members are trained for planning projects but mostly HoDs provide necessary guidance. However, there was no evidence to indicate that adequate project planning training is provided to all research engineers.
Previous research results/data are used for planning projects.		X		This does not happen in a formalized way. However, feedback given by service recipients and licensees are taken albeit their consideration for improvement was not clear.
The extent to which the institution follows a formal process for preparation, review and approval of projects.		X		Individual project proposals are submitted to RPC using a standard format for consideration. RPC being an open internal committee does not follow a rigorous scrutiny of projects and most projects are approved to proceed.
The extent to which organizational plans (e.g. medium-term plan, corporate plan, strategy etc.) are used to guide project selection and planning			X	No evidence to indicate that these plans are used to guide project selection, rather indications are that such plans incorporate ongoing projects or interests of the Research Engineers. Project selection is not guided by the plans.
Multidisciplinary projects/ activities are encouraged by the institution.		X		A few projects with multi departmental teams are ongoing and importance of this is highlighted. However, no concerted effort is taken to formulate multi-disciplinary or inter-disciplinary projects and often projects initiate from a single department.
Foreign collaborations are encouraged and incorporated in planning.			X	Occasional efforts are made, e.g. KOICA collaboration. NERDC is also the focal point for APCTT – Indo Lanka technical cooperation. However, no significant effort is made for any foreign collaboration.

Partnership with private sector is encouraged by the institution.		X		Departmental level collaborations with industry is attempted. However, except technology licensees, and consultancy service seekers, private sector participation in research is low albeit this is one criterion identified for project approval. The involvement of the TMD in mediating this partnership is not effective.
The extent to which development research/activities are considered in planning projects		X		National importance and wide usage in the industry are some factors considered by RPC in approving projects but results indicate poor overall commercialization.
The extent to which basic research are considered when planning projects.			X	Conducting applied research is the main concern and it can be estimated that about 90% of research is applied.
The degree to which adverse effects on environment are considered in planning projects.		X		No environment impact due to project execution is considered. However, projects are formulated to address protection of environment in sustainable building construction, sustainable energy, reduction of emission of GHG and in conduct of environmental related testing.

The socio-economic impact can be significantly improved by addressing the above shortcomings in the planning of S&T and R&D projects. These shortcomings have also been highlighted in the previous review. However, only a marginal improvement of the process can be seen and there is plenty of room for improvement.

## B.4 Project Management and Maintenance of Quality

Management Practice	Level of Practice (Performance Indicators)			Comments/ Evidence
	Strong	Moderate	Weak	
The effectiveness of the procedures for resource allocation at different levels (organization, departments, program etc.)		X		Staff is recruited/allocated to different departments considering relevant expertise albeit similar expertise are present in several departments. There are multi departmental projects but limitations are mentioned in sharing facilities.
Ensuring that instruments, equipment, and infrastructure facilities are sufficient for implementation of projects.		X		NERDC is generally sufficiently equipped in terms of infrastructure and equipment. New workshop building for Mechatronics, new lab for refrigerator testing, a technology incubator etc. have been recently added. However, there are delays in providing industry services according to stakeholders.
The effectiveness of administrative procedures and support for project implementation (procurement and distribution of equipment and materials, transport arrangements, etc.)		X		These procedures are generally effective. No significant delays were indicated under these aspects albeit some delays in procurement due to flexibility in project execution. However, this may not be the case when projects are deadline driven.
Formal monitoring and review processes are used to direct projects towards achievement of objectives.		X		Monthly progress reports, monthly meetings with DG, quarterly research forums are used for this. Despite project timelines are prepared during planning stage, they are not effectively used during project implementation.
The extent to which the researchers are supported by the required technical / field staff.		X		There are no complaints from the research staff for lack of support by technical staff. However, there seems to be no systemic procedure to obtain such support in a coordinated way.

Ensuring that established field / lab methods, and appropriate protocols are used.	X			Indications are that all these are followed and equipment are maintained properly. Furthermore, stakeholders indicated that they have trust and confidence on the NERD services. SLAB certification has been obtained for key testing equipment.
Research projects/ S& T activities are completed within the planned time frame.			X	There are delays in completing projects as flexibility in timing is generally accommodated. One third of the project period is approved as extensions almost always.
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.		X		The library provides access to a few scientific databases and relevant literature sources. No complaints about Internet connectivity. However, collaborations with universities, NSF and other library sources are weak preventing the researchers to access all needed literature.
The extent to which quality assurance practices are followed by the institutions.		X		No established quality assurance unit or procedures available formerly to ensure such compliance. However, NERDC has implemented Quality assurance system in a few Laboratories – Wastewater, Lighting, Refrigerators, Noise Measurements
Ensuring that researchers/ scientists have access to computers and necessary software.		X		Adequate computers and software are available to execute the current scope of activities. However, there is always room for improvement.

It is noted that most projects have time overruns due to absence of an effective project management system. Industry stakeholder too complain delays in obtaining some services from NERDC. Implementation of an institution wide R&D project management and time management of consultancy projects is needed. Similarly, there is a need to establish an internal quality assurance system to enhance the customer trust and confidence further.

## B.5 Human Resource Management

Management Practice	Level of Practice (Performance Indicators)			Comments/ Evidence
	Strong	Moderate	Weak	
The institution maintains and updates staff information in a database (including bio data, disciplines, experience, publications, projects).		X		HR department maintains personal details, educational & professional qualifications, experience, publications etc in a computerized database but not the projects. However, no frequent updating.
The institution, plans and updates its staff recruitments based on programme and project needs.		X		Manpower planning in terms of cadre review takes place with top management considering the needs. No contract staff in general. However, project based recruitments are considered if needed.
The effectiveness of the selection procedures and the schemes of recruitment		X		Selection procedures are based on SOR and are transparent despite a few issues in SOR. However, institution is not always successful in attracting, recruiting and retaining staff due to low salaries even compared to other similar institutes.
Training is based on institution and programme objectives and on merit.		X		Staff are given opportunities for CPD courses albeit attention to real need based is not always the case. Initiatives on new staff orientation, outbound training etc. is commendable. However, there is a severe shortage of post-graduate qualified staff with PhDs required for a knowledge intensive R&D institution. International training in key areas are also given higher level research engineers.
The effectiveness of the procedures in promoting a good working environment and maintaining high staff morale.		X		Actions such as provision of transport, improvement of systems with online actions, provision of laptops to staff above MA level, staff societies have positive contributions. However, there is still lack of staff orientation, misguidance by unsatisfied senior staff

				and complaints by primary level staff specially indicating lack of recognition and rewards.
The effectiveness of staff performance appraisals		X		JM and above categories are appraised annually by a committee and other categories simply by the supervisor with no direct staff discussion and not based on actual performance which can have room for lack of transparency and consistency.
The effectiveness of rewards and incentive schemes in motivating the staff.		X		Some rewards systems are in place including cash rewards for publications. Staff incentive scheme too is in place based on income generation activities. However, their link to performance need to be strengthened.
The effectiveness of managing staff turnover, absenteeism and work interruptions.		X		Staff turnover specifically scientific staff is a significant concern due to lack of remuneration and poor working environment. In 2019, about 15% scientific staff cadre is unfilled.

Despite the presence of talented staff in certain categories, Human Resource Management is one of the critical issues at NERDC in terms of attraction, recruitment and retention of skilled and qualified staff due to several reasons such as low remuneration, lack of conducive working environment, staff performance based rewards and even shortcomings in the SOR. A concerted attention to this is needed to overcome this long standing HR issues are NREDC.

## B.6 Management of Organizational Assets

Management Practice	Level of Practice (Performance Indicators)			Comments/ Evidence
	Strong	Moderate	Weak	
The ability of the institution to carry out its mandate and the assigned statutory powers.		X		NERDC is equipped with sufficient infrastructure in terms of buildings, equipment and other capital assets for the current scope. However, inadequate human resources has significantly limited fulfilment of the mandated activities of the institution.
Infrastructure (buildings, stations, fields, roads) is satisfactorily maintained.	X			With the available resources and expertise of the NERDC, these identified infrastructure is generally well maintained. However, further improvements in terms of good landscaping the premises and even better regular maintenance can further improve work environment and customer satisfaction.
Vehicles and equipment (lab, field, office) are properly managed and maintained.		X		Existing equipment and vehicles are properly managed by NERDC maintenance staff and new ones have also been acquired. However, some require upgrades and improve quality.
The effectiveness of procedures to ensure that equipment are in working order.	X			Effectiveness of the procedures can be considered as strong although there is always room for improvement.
The effectiveness of the institution's overall strategy in generation and proper utilization of funds.		X		Recurrent and capital grants secured from consolidated funds are generally fully now utilized. About 10% of recurrent funds is generated through consultancy. However, these funds can be better directed for higher impact projects, thereby earn more from enhanced technology licensing, other tech transfer activities and provision of consultancy services.

The extent to which the institution identifies opportunities for income generation and cost recovery.		X		Current 10% of recurrent income generation is a reduction over the years. However, income generation should be promoted through mandated activities in order to prevent any negative impact on those.
The extent to which the intellectual property rights of the institute are protected.			X	Policies and procedures are in place for protection of IP rights. However, there is lack of emphasis and attention to this and that the number of patents obtained is an embarrassment for such a R&D organization. There is also a need to improve policy and procedures

## B.7 Coordinating and Integrating the Internal Functions/ Units/Activities

Management Practice	Level of Practice (Performance indicators)			Comments/ Evidence
	Strong	Moderate	Weak	
The extent to which institution is evaluated internally and restructured based on current needs.			X	There was no evidence to indicate efforts of restructuring considering current needs or even evaluation of any restructuring during the development of the Corporate Plan.
The effectiveness of internal communication and coordination mechanisms.		X		This usually happens through departmental meetings, internal emails to MA level and above and public address system in special needs. However, coordination and communication between departments, between various levels of staff either to inform or to take feedback from lower level staff was found to be not effective.
Institution's overall direction and coordination are provided by a central planning committee / unit.		X		There is no central planning committee as such and this planning happens at meetings with DG and HODs. There is a need to improve this process with better stakeholder involvement.
The extent to which different units are assigned clearly defined functions.		X		Departments are aligned to specific technical areas and have broadly defined scope. However, due to poor coordination and collaboration, there is a tendency to unnecessarily duplicate resources.
Responsibilities of research / management staff are clearly identified.			X	Expertise of research management staff is not always efficiently used as they also carry out other tasks resulting in lower outputs and lack of impact of their efforts. Need to emphasize their ToR and responsibilities
Effectiveness of using appropriate reporting procedures and feedback in management at different levels.		X		Discussions with the Unions indicate that there is no review/evaluation of research reports, no opportunity for minor staff to share their feedback despite departmental meetings.

## B.8 Partnership in Managing Information Dissemination

Management Practice	Level of Practice (Performance Indicators)			Comments/ Evidence
	Strong	Moderate	Weak	
The institution systematically plans and performs dissemination of information.		X		An annual research seminar is held by the NERDC. However, the participants are almost internal staff. Dissemination outside NERDC is not a compulsory need albeit cash reward is given for journal publications. Such publications in 2019 is 5 which is a reduction from 8 in the year before. Effectiveness of other media such as, newspaper articles, TV/Radio programs, awareness programmes, exhibitions, technology park, leaflets, training programmes, newsletters and web site can be further improved
The extent to which the institution plans and maintains linkages with key partners for sharing and dissemination of information.			X	SER indicates that NERDC works closely with SEA, CEA, NSF, IC and ITI. Collaboration MOUs with Engineering Faculties have been signed. However, there are no indications for serious collaborative research either as contract research or joint research or joint dissemination.
The effectiveness of institutional procedures for technology transfer.		X		Technology transfer is facilitated by TMD established for that specific process. Exhibitions, marketing literature, awareness programmes are held to promote commercialization. However, the involvement of TMD is mainly limited to efforts after technology is developed and no effective involvement in connecting collaborators or identify needs during the project planning and lack of marketing expertise.
The effectiveness of the system to obtain feedback from different types of stakeholders.		X		There is no formal stakeholder consultation system in place at any stage of project planning, execution or tech transfer but informal feedback is considered.

## B.9 Monitoring, Evaluation and Reporting Procedures

Management Practice	Level of Practice (Performance Indicators)			Comments/ Evidence
	Strong	Moderate	Weak	
The institution monitors and evaluates (M&E) its own activities periodically.		X		Any effort in long term objective review is during the preparation of the Corporate Plan. Annual report provides and stock of activities. Activity M&E usually happens during the progress meeting with Heads and DGs, and departmental meetings. The effectiveness of such M&E needs improvement.
M&E is supported by an adequate management information system (MIS), which includes information on projects (e.g. costs, staff, progress, and Results).			X	There is a need to submit monthly progress report of projects. However, this format does not capture all the information needed for effective review of individual projects. Individual project based expenditure and information about budgeting etc. are available. However, there is no MIS system for staff, progress and documenting results in a systematic way.
The extent to which S& T results and other outputs are adequately reported internally (e.g. through reports, internal program reviews, seminars).		X		Every project has a final report at completion. However, the quality of these reports needs improvement to be professional and comprehensive with achievement of objectives, potential for TT, lessons learnt and further R&D proposed. Annual research symposium provides completed and ongoing research and included in the regularly published Newsletter.
External stakeholders contribute to the M & E process in the institution.			X	Except in collaborative projects and projects funded externally, external stakeholders are not involved with the M and E process.
The extent to which the results of M&E are used for project/ research planning and decision making.		X		There is no formal way of incorporating results of M&E in future projects albeit this happens through sharing experiences during discussions.

