Scientific data management strategies of Sri Lanka with special reference to government institutions*

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ABSTRACT

The purpose of this article is to explain and analysis the strategies of the scientific data management effort of government intuitions of Sri Lanka. Applied web-site based investigation into the data collection from the 11 government science and technology institutions under the ministry of technology and research of Sri Lanka. The paper begins with a review of the related literature and then takes to approach to discuss elaborates on how much of the selected institutions carried out for the processes of scientific data management, such as data acquisition, organization, storage/processing, retrieval, and dissemination. Study found that concept of scientific data management has been increasingly spreading among the government and private sector institutions with the help and positive participation of ministry of technology and research of Sri Lanka. Although, still there is no significant well developed data management system could be identified, attempts have been undertaken for scientific data collection, management, storage, methods of service delivery and the activities on the research promotion has remained on the considerable status. This paper provides basic understanding of the scientific data management of Sri Lanka and it proves the importance of better development of the data management sector in the country. This study explores current status and nature of scientific data management strategies of Sri Lanka. This study could be very useful for the policy makers for better revision of the introduced policies and for institution leaders to identify their strength and weakness within the institutions.

Keywords – Scientific data management, Sri Lanka, Ministry of technology and research

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1. INTRODUCTION

Scientific data has made significant impacts on our society today. A data is classified as scientific if the cultivation came from a scientific process and research. This means the conclusion of every scientific experiment is beneficial to the any country to improve competitiveness and productivity giving the means to achieve a higher standard of living and a better quality of life. They offer solutions to many of the important global and national issues, providing the knowledge and the means to generate economic activity, to improve health and living standards, to alleviate poverty, to enhance public safety and security, to preserve the quality of the environment, and manage the natural resources. In that sense most of the countries manage their scientific data onto enhancing the quality of life. Ministry of technology and research undertakes the responsibilities for the government scientific data management process of Sri Lanka. Vision of the ministry is to Sri Lanka becomes a scientifically and technologically advanced country by the year 2020. It formulates of policies, programmes and projects with regard to technology and research and for the direction of the implementation of such policies, programes and projects. The primary focus of the ministry is to ensure an alignment of the activities of all the Institutions under it with national objectives and to strengthen research-industry tie ups so that industry is benefitted from research findings to add value to products. This paper mainly discusses the process and contribution of 11 government bodies under the ministry of technology and research for scientific data management.

2. RELATED RESEARCH

Although, many researchers in different countries have focused on the scientific data management process of the world, this concept has not yet well documented in Sri Lanka. In this section, we referred articles and the journals on the topic of “Scientific data” “Scientific data management” “Science data Sri Lanka” “Scientific data management in Sri Lanka” by the Emerald Insight, JSTOR, Taylor & Francis Online, EBSCO HOST and by Google scholar as well. No article found in the topic “Scientific data management in Sri Lanka” in any journal. But few articles fond of the topic of “Science data Sri Lanka” especially on the field of medical. Therefore in this section we tried to collect articles in other countries than Sri Lanka.

Scientists normally limit the meaning of data management to the mere physical data storage and access layer. But the scope of scientific data management is much boarder: it is about meaning and content. Data, in the scientific method, means a record of the progress of your experiment. Data is whatever scientist observes about their experiment that may or may not change during the time of the experiment. McDonald (2010) stated records management and data management quite literally mean the same thing and gaps that exist are in the perceptions of what each concept means and the functions and status of the information jurisdictions that have claimed each for their own. Record management is quite old concept in the world then it has modified with the science and technology innovations. Scientific data means a data is classified as scientific if the cultivation came from a scientific process and research (Li and *others*, 2015).

In the past, when the number of scientists and researchers was relatively limited, much of the scientific communication took place through personal contact in disorganized, informal ways. Such a manner of communication is no longer efficient and it seems that more organized systems of communication are required. Hanson attributes the need for more organized scientific communication and development of sophisticated systems of communication to the following factors (Hanson, 1973): increased number of scientists and technologists and thereby increased amount of knowledge output; development of science, technology, and industry in less developed countries in Asia, Africa, and south America; increased number of scientific specialization, and at the same time, interrelatedness and overlap between many disciplines; development of science, technology, and industry into group activities which involves people who neither worked nor even knew each other previously; and increased speeds or shift of the present into the past and therefore increased knowledge restore which is belonged to the past. Scientists communicate to brainstorm ideas, be creative, formulate research questions, solve experimental or theoretical problems, disseminate results, and get feedbacks. The peer-reviewed journal article – polished, archived, and accessible – is only one facet of the scholarly communication process. Science is inherently social and informal, scholarly and scientific communication forms the backbone that connects scientists and enables scientific progress (Khosrowjerdi and Alidousti, 2010).

Scientists report data in many different forms and media. The following is a common subset of material that can be strictly factual

1. Text (including interspersed numeric values, names, organisms, chemical formula etc.

2. Mathematical equations
3. Tables
4. Images (cells, stars, animals, etc.)
5. Drawings of experimental procedures (equipment, workflows)
6. Graphs (relating variables, eg. X-Y, scatterplot, histograms, etc.)
7. Audio recordings
8. Video recordings

None of these should be copyrightable as "creative works" and all should be made open. Debarring any section of the world community from open availability of these sections is a direct detriment to science (Perrerson, 2009).

According to Rao (2001) there are many groups involved in the scientific data management process that has directly or indirectly shaped the past and are going to witness a major paradigm shift in the light of the electronic revolution. The main groups are: creators (authors), publishers(commercial and non-commercial), libraries(facilitators of information), institutions (academic and research and readers society at large).

Scientific data management concept came to Sri Lankan scenario of the establishment of the National Science Council (NSC) in 1968. Services and the concept developed gradually with the help of technological innovations and by the inventions of the scientists of Sri Lanka. The mandate to collect science and technological statistics was provided to the NSC of Sri Lanka the predecessor of NSF. The earliest study on S&T indicators was carried out in 1970 to assess the scientific resources in Sri Lanka in term of public expenditure on Research and Development by the Ceylon Institute of scientific & industrial Research (CISIR) predecessor of Industrial Technology Institute (ITI). The first systematically designed survey on scientific and technical manpower potential in the country was carried out in 1974 by the National Science Council (NSC). Establishment of science and technology policy research division at the NSF the regular survey commenced in 2006 covering all science and technology sectors (Handunnetti, 2009).

According to the World Bank report, progress of scientific and technical journal articles in Sri Lanka was last measured at 134.90 in 2009. As an example contribution to the medical

sector reports according to the Sri Lanka's cumulative medical publications output between years 2000-2009 was 1,740 articles published in 160 different journals. The average annual publication growth rate was 9.1%. Majority of the articles were published in 'International' (54.6%) journals. Most articles were descriptive studies (35.1%), letters (19.8%) and case reports (17.9%). The articles were authored by 148 different Sri Lankan authors of146 different institutions. The three most prolific local institutions were universities of; Colombo (547), Kelaniya (246) and Peradeniya (222) (Ranasinghe, Jayawardena and Katulanda, 2012).

A WHO study that blames arsenic for rising levels of chronic kidney disease in 2012 and they repot that there was a scientific data gaps between Sri Lanka further they figure out some scientific data was wrong and there were several mismatches. As an example, while WHO placed the figure the kidney disease affected by CKD at 400,000 people, the CSE said the figure was closer to 15,000. Therefore, WHO emphasizes the importance of systematic report and management of scientific data.

Although, scientific research is an essential component in guiding improvements in health systems the Sri Lankan medical research output during the last decade is only a small fraction of the global research output. There it is a necessity to setup an enabling environment for research, with a proper vision, support, funds and training. In addition, collaborations across the region need to be strengthened to face common regional health challenges (Ranasinghe, Jayawardena and Katulanda,2012).

Other researchers have paid attention to other aspects of scientific data aspects; e.g. communication in science and technology data (Fjallbrant, 2006), social and economic factors (Wilson, 1995), electronic digests (Ng, 1998), developments in scientific management (Kemp, 2013), scientific and technical information development changing contributions to the overall pattern of information flow changes (Vickery, 1999) and evolutions of scientific data (Case, 2002), institutional repositories (Johnson, 2002; Lynch, 2003), informal aspects of scholarly communication (Rowlands et al., 2004), and scholarly communication in east and southeast Asia (Xia, 2006).

Managing scientific data has been identified with one of the most important emerging needs by the scientific community because of the sheer volume and increasing complexity of data being collected. Effectively generating, managing, and analyzing this information requires a comprehensive, end-to-end approach to data management that encompasses all of the stages from the initial data acquisition to the final analysis of the data. The above literature survey

indicates that the existing scientific data management process does not well organized and further development and improvement of subject might be useful. Therefore, this paper has bridged the literature gap in Sri Lanka of the scientific data management.

3. OBJECTIVES

Main objective

- Identify the scientific data management mechanism of Sri Lanka.

Other objectives

- identify the scientific data types,
- examine the acquisition methods,
- identify provision of data storage process and privacy
- examine the dissemination of scientific data among the community

4. RESEARCH DESIGN

Web site-based investigation

By conducting the web site-based investigation, we examined the government and non-government sector has taken significant steps for the scientific data management in Sri Lanka. But that investigation proved that government sector has played the quite important role than non-government sector for promoting scientific data management in the country. The government first recognized the need for the development of electronic environment in the government data through the National Computer Policy (COMPOL) of 1983 (ICTA, 1983). This first attempt was taken by the Natural Resources, Energy and Science Authority of Sri Lanka (NARESA). Afterward, in 2010 ministry of technology and research appointed as operational management focal point for empowerment of science and technology industry in the country. Under the ministry 11 institutions have undertaken the science and technology data management of the country. Although, the concept “scientific data managements” is new to my country the sampled institutions have worked on the data and data management process formally or informally through their web portal and intuition libraries. Furthermore, workshops, seminar, exhibitions, and social media also enforce it more.

The survey carried to examine the web pages under the sub topics listed below to the collect data for true mechanism of the scientific data managements in the country; basic information, specified discipline and objectives of the institutions, data acquisition policies, data storage, backups and security, provision of data privacy, method of service delivery and data promotions, human capacity relating to scientific data management of the county.

5. RESULTS AND DISCUSSION

(I) Introduction

As pointed out earlier, ministry of technology and research is a government authority engaging the scientific data management in Sri Lanka. Main duties and functions of the ministry have published in Gazette Extraordinary No. 1681/3 dated 22.11.2010 as amended by Notifications published in Gazette Extraordinary No. 1736/23 of 14.12.2011 and Gazette Extraordinary No. 1796/10 of 06.02.3013. According to that act ministry is responsible for 11 duties and functions of field of S&T as listed below;

1. Formulation of Policies, programmers and projects in regards to the subjects of technology and science
2. Direction of the implementation of such policies, programmes and projects within the time line
3. Reforming of all systems & procedures to ensure the conduct of business in an efficient manner deploying modern management techniques & technology where applicable while eliminating corruption & waste
4. Provision of all public services that come under the purview of the Ministry in an efficient and people friendly manner
5. Scientific and Industrial research.
6. Establishment & control of Standards
7. Socio-economic research.
8. Planning & conducting research by providing required facilities to research & & research institutions

9. Researches in specific areas of basic science & promotion of fundamental studies
10. All other subjects that come under the 13 organizations under the ministry
11. Supervision of the Organizations

Ministry of technology and research governed as other government bodies and under this authority there are 11 sub institutions for the full fill the scientific data collection, organization, research, and for service delivery.

(I) Brief introduction of sampled institutions

1. ACCIMT

Arthur C. Clarke Institute for Modern Technology (ACCIMT) established in its present corporate form of a statutory board by the science and technology development Act No. 11 of 1994. Institute specializes in the disciplines of Electronics, Micro-electronics, Telecommunications, Information Technology, Space Technologies, Robotics and other related fields of modern technologies. Vision of the ACCIMT is to be a leading innovation center for modern technologies in the region. Under this vision institution work together with seven departments such as; communication, electronic, industrial services, information technology, space application, robotics and library service.

Web: http://www.accimt.ac.lk/

2. AEB

The Atomic Energy Board (AEB) of Sri Lanka is a statutory body functioning under the ministry of technology and research which was established by the Sri Lanka Atomic Energy Act No.40 of 2014.Radiation and radioisotope Technology has a wide range of applications in many fields that can make a significant contribution to the development of medical, agricultural, industrial, energy and environmental sectors in Sri Lanka. The Atomic Energy Board (AEB) has the responsibility of facilitating the utilization of this technology in the above-mentioned sectors in Sri Lanka. Vision of the AEB is to be a center of excellence, with

emphasis on national relevance and international recognition, for activities related to peaceful applications of nuclear technology with due consideration to safety.

Web: http://aeb.gov.lk/

3. ITI

The Industrial Technology Institute (ITI) is a wholly owned institute of the Government of Sri Lanka and functions under the jurisdiction of the Ministry of Technology & Research. A statutory board incorporated into the 1st April 1998, under the Science and Technology Development Act No. 11 of 1994, the Industrial Technology Institute (ITI) is the successor to the Ceylon Institute of Scientific and Industrial Research (CISIR). Vision of the ITI is to be a regional center of excellent in scientific industrial research for national development.

Web: http://iti.lk/

4. IFS

The Institute of Fundamental Studies (IFS) is in the forefront of scientific research in Sri Lanka established in 1981 by fundamental studies act of Sri Lanka. Even though the IFS is the only research institute which, by its Act, has the main objective of engaging in basic research , a recent policy change has placed greater emphasis on "basic research for national development". Further, to motivate students and younger scientists to engage in advanced competitive research and to promote international cooperation in research also its objectives.

Web: http://www.ifs.ac.lk/

5. NERD

National engineering research and development institute of Sri Lanka (NERD) established in 1974 as a result of the a request by planning ministry representative of the Industrial Development Board to Mr. Hector Abayawardana to plan out an Institution to bridge the gap between an Industrial extension service organization as IDB and scientific research institute as the CISIR. Thus the NERDC was in acted by an act of parliament under Special gazette Notification (No 124/6) was published under the Industrial Corporation Act No. 49 of 1957, on 14 August 1974. NERDC became operational during the latter part of 1974 , with as its first chairman. Main target of the institution is to engage in research and development

activities that would have a direct bearing on the industrial development of Sri Lanka and on the improvement of the living standards of the people, and thereby develop technologies that would help in the sustainable utilization of her human and material resources towards the economic development of the country.

Web: http://nerdc.lk/

6. NRC

National research council (NRC) is a plan and co-ordinate the research institution effort of researchers and facilitates their research in Public Sector Scientific Research and Development Organizations in Sri Lanka so as to build, strengthen and derive the maximum benefit of the country from a vibrant research community. NRC is to promote, direct and evaluate research of scientists in scientific R & D organizations, to direct the Science and Technology research effort of the country within a well-planned S & T Research Policy and Action plan which is closely linked to the national development framework already laid down. Further, to encourage and strengthen co-operation among researchers in science and technology in Sri Lanka on the one hand and between them and the international research community on the other.

Web: http://www.nrc.gov.lk/

7. NASTEC

The National Science and Technology Commission (NASTEC) is the Apex Policy Formulating and Advisory body of the Government of Sri Lanka on Science and Technology matters. It was created by an Act of Parliament, and came into operation in August 1998. NASTEC fulfills a need that has been highlighted for a long time for the scientific community, the establishment of a policy making apex body of scientists. The act states: ".... in formulating policies relating to science and technology, and in implementing such policies, the Minister shall have regard to the objects (set out in the Act), and shall consult the National Science and Technology Commission...". Main objectives of the NASTEC is to advise the government on policies and plans for the development of S&T including policies and plans and to submit a report annually, to the government, reviewing the S&T activities in Sri Lanka in the preceding year, and on the effectiveness of measures for the development of

human resources, the performance of S&T institutions, the effectiveness of public spending on Science & Technology and the use of Science & Technology by public sector undertakings.

Web: http://www.nastec.lk/

8. NSF

The National Science Foundation (NSF) is a state funded institution under the Ministry of Technology & Research. The NSF established in 1998 by the Science and Technology Act No.11 of 1994, Is the successor to the Natural Resources, Energy and Science Authority of Sri Lanka (NARESA). NARESA itself succeeded the National Science Council (NSC) established in 1968. Motto of the NSF is “Research is the foundation of knowledge". The motto of the NSF and its predecessors, NARESA and the NSC is also the main function of the NSF. The NSF is committed to generate knowledge, dissemination and transfer of knowledge and, more importantly, to ensure the effective utilization of knowledge, for the greater benefit of the people of Sri Lanka. The foundation supports, and embraces, research in all fields of fundamental and applied sciences as well as in the social sciences.

Web: http://www.nsf.ac.lk/

9. SLP

Sri Lanka planetarium (SLP) is a pioneer institution work for astronomy, space science and about the night sky. The theatre built primarily for presenting educational and entertaining shows about sky or for training in celestial navigation. SLP established in 1965 by the State Engineering Corporation and declared opens on 1st of February, 1965 for Ceylon Industrial Exhibition to introduce the latest technologies specially to show the capability of creating a night sky. Astro IT Labc of SLP is an educational facility located at the Sri Lanka Planetarium premises where astronomy and space science is demonstrated using information technology.

Web: http://www.planetarium.gov.lk/

10. SLINTEC

Sri Lanka institute of nanotechnology (SLINTEC) is a semi-government company formed through a Public-Private Partnership between the Government of Sri Lanka and five leading private sector companies. Even though, SLINTEC is semi-government company it is directly work with the ministry of technology and research and contribute for promotion of scientific data management of the country. The main targets of the SLINTEC are to build a national innovation platform for technology based economic development and to help increase Sri Lanka's high tech value added exports from 1.5% to 10% by 2015 through commercialization of nanotechnology and collaborate with research institutes and universities to develop Sri Lanka's technology and research capability to a world class standard and contribute towards setting up a knowledge based economy in Sri Lanka.

Web: http://slintec.lk/

11. SLIC

Sri Lanka Inventors Commission (SLIC) has been set up by parliament act no. 53 of 1979 to facilitate Sri Lanakns to be creative by providing assistance within appropriate legal, financial and technical framework. The official work of the SLIC was started in the year 1992. Main objective of the SLIC is to give technical and financial assistance to inventors enabling them to make available their innovative products in domestic or international market. The SLIC closely works with young investors in the schools and youth centers as well as promote and provide financial assistants for them.

Web: http://slic.gov.lk/

(II) Specialized disciplines

Taking the 11 government bodies as a sample we collected the data about 11 themes for analytically investigates the scientific data management strategy in Sri Lanka. Online survey data reveled that ten main subject areas have been covered by the 11 organizations under the ministry of technology and research and they formulated 10 x 10 Investment frameworks for research and development for 2015-2020. This initiative was undertaken on the premise that the achievement of the ambitious expectations from the Science, Technology and Innovation sector must be preceded by a focused Plan that targets national needs. Accordingly, the

Framework identifies ten national priority areas and ten intervention methodologies – hence the title 10 x 10 Investment Framework for research and development. The ten focus areas are 1.Water, 2.Food, Nutrition and Agriculture, 3.Health, 4.Shelter, 5.Energy, 6.Textile Industry, 7.Environment, 8.Mineral Resources, 9.Information Communication Technology and Knowledge Services, 10.Basic Sciences, Emerging Technologies and Indigenous Knowledge. All the institutions under the ministry covered subject areas given below. Table 1 displays subject coverage of institutions selected for the study.

Table 1: Specialize disciplines

Institution	**Specialize discipline**	**Keywords**
Arthur C. Clarke Institute for Modern Technology (ACCIMT)	S&T	electronics, micro-electronics, Telecommunications, Information Technology, Space Technologies, Robotics and other related fields of modern technologies
Atomic Energy Authority (AEA)	S&T	medical, agricultural, industrial, energy and environmental
Industrial Technology Institute (ITI)	S&T	plant, water, noise, alcohol based, oil, herbal product, cement, metals, wood, milk, cosmetics
Institute of Fundamental Studies (IFS)	S&T	renewable energy, artificial intelligence, environment and earth science, food science, microbial biotechnology, molecular biology and genetics, natural products
National Engineering Research and Development Centre (NERD)	S&T	agriculture, post-harvest technology, civil engineering, design fabrication, electrical, electronic, energy and environment, renewable energy, techno marketing

National Research Council (NRC)	S&T	medical, science and technology
National Science and Technology Commission (NASTEC)	S&T	Science & Technology
National Science Foundation (NSF)	S&T	Science , natural resources, energy
Sri Lanka Planetarium (SLP)	S&T	aerial surveying , science, Astronomy
Sri Lanka Institute of Nanotechnology (SLINTEC)	S&T	Nano aspects, agricultural, smart apparel, health care, water purification
Sri Lanka Inventors' Commission (SLIC)	S&T	Investigations

* S&T – Science and Technology

(III) Objectives of the institutions

Thoroughly examined the objectives, vision and mission statements for identified the main task of the sampled institutions. Data revealed that 100% of institutions indicated their main objective as "research and development" while 90.9% of institutions indicated "promotion S&T culture" in the country. 72.73% institutions actively participated in "national development", "provide scientific services" and promoted the S&T invention respectively. Especially SLIC promoted the investigations into the grassroots level to national level. Technology transformation also one of the objectives of the sampled institutions (27.27%). Ensuring quality of living is essential for any nation. Therefore, 18.18% institutions work on the S&T standardization. 18.18% of institutions mentioned one of the objectives of them as maintaining the e-repository.

Table 2: Objectives

Objectives	%	Keywords
Active participation for national development	72.73	better future, human development, economic growth , wellbeing, creation of national science platform
Research and development	100	new area of research, Socio-economic research, promoting future research
S&T promotion	90.9	science for all, invention, better science usage
Introducing new technologies	27.27	innovation, effective use of S&T
Scientific service	72.73	standard, software recovering
Invention	72.73	invention promotion
Establishment & control of Standard	18.18	standardization
Data archives	18.18	e-repository

(IV) Scientific data

Scientific data refers to the raw and basic data acquired in scientific activities (such as experiment, observation, detection, survey) or in other ways as well as the datasets processed and organized systematically according to different scientific activities' needs (Li and others, 2015).

The data can come from two main sources:

- Observation and measurement: In some domains observation (e.g. field studies) is still the only method, and in others measurements are carried out by scientists and recorded in note books, but increasingly the measurement of data ("raw data") is though instruments and sensors.
- Calculation: In many cases physical laws allow direct calculation of observables quantities and computers have sufficient power. Computer programs in quantum

mechanics, thermodynamics, classical mechanics and many other fields are often capable of showing excellent agreement with experiment and are much cheaper or can simulate unobservable situations (e.g. inside planets or stars).

Scientists report data in many different forms and media. All the institutions(100%) acquired and maintained text, tables and drawings of experimental procedure data. 90.9% of institutions collected images while 54.54% obtained graphs on the subject fields they are responsible for. Lesser than one second of institutions are acquired video and audio recordings.

Table 3: Data types

Data type	**%**
Text (including interspersed numeric values, names, organisms, chemical formula etc.	100
Tables	100
Drawings of experimental procedures (equipment, workflows)	100
Images (cells, stars, animals, etc.)	90.91
Graphs (relating variables, ex. X-Y, scatterplot, histograms, etc.)	54.54
Video recordings	45.45
Audio recordings	36.36

(V) Data acquisition

The online survey identified that, five main scientific data collection methods in sampled intuitions. 100% of institutions collected data through their research and experiments done by the scientists of their own institutions. There is a trend (63.64%) that obtained government data onto the directly related government ministries and government bodies. 54.54% of institutions acquired international organizations data while 36.36% of institutions obtained national university produced scientific data. Few institutions (27.27%) collaborated with local private organizations.

Table 4: Data acquisition

Affiliation	Frequency	%	Key institutions
institutional data	11	100	institute itself
Government data	7	63.64	National library of Sri Lanka, Dept. of technical cooperation, Ministry of power and energy, Dept. of education, Ministry of higher education, national health research council, Sri Lanka association for the advancement of science, institute of chemistry, institute of physics, institute of engineering, institute of biology
International organizations	6	54.54	International Atomic Agency, World Health Organization, UNESCO, Korea International Cooperation Agency, Japan International Agency , NORAD, USAID, INBAR, Asian and Pacific Center for Transfer Technology, Indian Ocean Rim citation for regional cooperation, Blue Ocean Ventures
National universities	4	36.36	University of Peredeniya, University of Colombo, University of Moratuwa
Private organizations/ NGOs	3	27.27	Brandex, Dialog, Heyles, MAS,

(VI) Data storage, backup and security

What is the storage, backup and security procedure of the scientific data in Sri Lanka has examined by the online survey. Data revealed that 100% of institutions stored data as institutional data sets and as digital copies. 90.9% institutions actively transfer data to national data e-repository established in the NSF of Sri Lanka. NSF has a data link with

national library of Sri Lanka for data security procedure. Out of 11 institutions 54.54% of them storage data onto library records while 36.36I% use virtual research center of data storage and maintained backups. Study data did not show the proper mechanism for maintaining backups through the cloud storage. Only 4 intuitions have actively participated in kept backups on the virtual research center using Dspace.

Table 5: Data Storage and security

Method	**Frequency**	**%**
Institutional data set	11	100
Digital copy	11	100
National e-repository	10	90.9
Library records	6	54.54
Virtual research Centre	4	36.36

(VII) Provision of data privacy

Collected data were process and stored in the institutions for the re-use and for data sharing with national and international organizations. Institutions provided data privacy with a relation to national e-repository. This e-repository has been established to create global visibility and accessibility to the collective output of scholarly research of Sri Lanka. The repository maintained by the NSF and it archives, preserves and offers access to the full text of scholarly literature of Sri Lankan origin. The repository reported daily date mechanism. It has six research communities as;

1.NSF funded research

2.NSF publications

3.Conferences and workshops of Sri Lanka

4.Journals published in Sri Lanka

5.New submissions

6. Chronic kidney disease (CKDu)

The e-repository provided facility for scientist to upload their research findings easily to this web portal.

(VIII) Service delivery

Online survey examined method of service delivery of the sampled institutions. Data revealed that all the institutions (100%) used web portal as a main service delivery method while, 90.9% of institutions published research publications annual reports and conducted lectures for the school and university students and for general public. One of the main targets of the ministry of technology and research was "science for all". Therefore, institutions such as NSF and NASTEC provided more and more training workshops, exhibitions and distributed the booklets among the people. But only one second of institutions had formal libraries for service delivery. Most of those libraries had OPACs (45.45%) and common trend in the institutions were provide data and other services through the web portal. Each of these institutions kept updating and maintaining web portal frequently. People can prefer 3 official languages (Sinhala, Tamil, and English) for data searching.

Table 6: Service delivery

Method of Service delivery	**Frequency**	**%**
Web portal	11	100
Annual reports	10	90.9
Research publications	10	90.9
Lecturers	10	90.9
News bulleting	9	81.82
Training workshops	9	81.82
Exhibition	8	72.73
Booklets	8	72.73
E-Journals	7	63.64
Library	6	54.55
OPAC	5	45.45

(IX) S*ervices*

All of the institutions provided information services and consulting services as an example ACCIMT provided technical services such as CCTV security surveillance system, hardware recovery and high-end electronic equipment recovery. Majority of institutions responsible for the subject field for the government and provided endless consulting and training services for the national development. On the other hand 90.9% institutions provided various types of professional development services as well.

Table 7: Services

Services	**Frequency**	**%**
Information	11	100
Consulting	11	100
Training	10	90.9
Professional development	10	90.9

(X) Service promotion

Scientific data promotion is the one of the main activities of the institutions of the sample. Except one, other institutions regularly work with newspapers to promote their services. 63.63% of institutions provided school level promotions while 45.45% of them engaged in youth society and TV programs. As a developing county, researches in the Sri Lanka do not have enough financial facilities to do good researches. Therefore 36.36% institutions provided research grants for the researchers of the field of science and technology. Further, researchers who have done remarkable investigations in the field have awarded by the 36.36% institutions. As an example NSF had five research award schemes as listed below;

- National Awards for Science & Technology Achievements (NASTA Awards)
- NSF Research Awards
- NSF Technology Awards
- TWAS/NSF Young Scientists Award
- Support Scheme for Supervision of Research Degrees

These award schemes are initiated in order to bestow on NSF grant recipients that have attained a high level of excellence in their research work. They deserve and to recognize their contribution to the advancement of science. At present NSF Research Awards are given annually for projects completed during the previous year. Recommendations are made by National/Research Committees based on final reports submitted by grantees. The NSF initiated the support scheme for supervision of research degrees (SUSRED) to motivate, support and recognize scientists/engineers engaged in supervising students conducting research in the areas of Science and Technology, leading to postgraduate degrees (MPhils and PhDs) as well.

Table 8: Service promotion

Promotion methods	**Frequency**	**%**
Newspaper articles	10	90.9
School level promotions	7	63.63
Youth society	5	45.45
TV programs	5	45.45
Research awards	4	36.36
Research grants	4	36.36

(XI) Human resource for scientific data management

Online survey examined about the availability of data scientist of the sampled institutions for identifying human capability of field of science and technology of Sri Lanka. Job titles available in the sampled institution were categories in to 7 titles according to their relativeness of duties. The data shown in the table below there were no job title enacted "data scientist" in any institution. The post named "research scientist" (90.9%) and research engineers (27.27%) also responsible for the job duties of data scientist. The data predicted that process of scientific data management has accelerated by these two categories of staff personals. Other staff titles directly related with the management role of the sampled institutions.

Table 9: Science and Technology Personnel

Job Titles	Frequency	%	Keywords
Research scientist	10	90.9	Nano scientists
Research engineer	3	27.27	Software engineer
System analysis	11	100	
Director	11	100	Assistant director
Librarians	6	54.54	Assistant librarian, information officer,
Technical officer	11	100	technical assistant
Other staff categories	11	100	Management Assistant, Laboratory attendant, administrative assistants , sectary, lab attendant

(XII) Qualifications

Data scientist's formal training is similar, with a solid foundation typically in computer science and applications, modeling, statistics, analytics and mathematics. What sets the data scientist apart is strong business acumen, coupled with the ability to communicate findings to both business and IT leaders in a way that can influence how an organization approaches a business challenge. Good data scientists will not just address business problems; they will pick the right problems that have the most value to the organization. Therefore, highest qualifications of research scientist and the research engineers were examined by the online survey by their online academic profiles. If qualification was not available with the web page I have done a people search to fulfill the study requirement. Data revealed that 25% of them were completed their PhD degrees while more than one second of them qualified Master of Science (MSc) (41%),Master of Philosophy (MPhil)(10%), Master of Engineering (MEge.) (5%) or Master of Business Administration (MBA) (8%) degrees as their highest qualifications. Even exceptions of Bachelor Science/Engineering (BSc/BE) or other degrees staff members of the intuitions has gained enough qualification for the scientific data management.

Table 10: Qualifications

Qualification	%
PhD	25
MSc	41
MPhil	10
MEng.	5
MBA	8
BSc/BE	6
Other degrees	5
Total	100

6. CONCLUSION

The study has shown the variety of contribution for scientific data management process by the government intuitions in the field of science and technology in Sri Lanka. The subject coverage of the institutions under the ministry could be categorized into 10 main areas mentioned in Table 1. Nevertheless, S&T institutions tried to gain expertise in services related to new technology and e-science especially services providing a publication environment to researchers because they were still in their primary clientele. Key objectives of the institutions were introduction of new area of research, socio-economic research, promoting future research and the science and technology promotion of the country. All the institutions (100%) acquired and maintained text, tables and drawings of experimental procedure data of their own institution than other national and international institutions. Online survey data shown that usage of system such as cloud storage (Some examples of privet sector storage resources include: Amazon S3, Elephant Drive, Mosy, Carbonite) was lacking of the sampled intuitions. Majority of intuitions have carried out traditional services and services delivery methods. Nevertheless, study revealed that institutions have employed enough qualified staff members for the scientific data data management. However, the absence of a broad based scientific literacy with an integrated approach to Science, Technology and the Arts, has restrained the growth of an innovation culture in Sri Lanka.

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