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DEVELOPMENT OF STANDARDIZATION

AND QUALITY CONTROL

(DP/SRL/82/003)

SRI LANKA

Report on Application of Statistical Methods in

Standardization and Industry

Prepared for the Government of Sri Lanka

by the United Nations Industrial Development Organisation,

acting as executing agency for the United Nations Development Programme

Based on the work of G.W. DAFEY

Expert on Industrial Statistics

(DP/SRL/82/003/11 - 05/313.Z)

United Nations Industrial Development Organisation

Vienna

O. INTRODUCTION

0.1 The duration of the above project was 60 days and the work started on 26 March, 1986. The first four days were spent on discussions with various senior officers of Sri Lanka Standards Institution (SLSI) and finalization of the programme of work giving due weightage to the terms of reference as given below:

(a) To study the nature of work carried out by Statistical Unit of SLSI at present and to suggest modifications and improvements.

(b) To investigate the possibility of introducing modern data processing systems to the work carried out by this unit, in order to improve the quality and the quantity of work.

(c) Look into the areas of assistance to industrial sector particularly on sampling inspection schemes.

(d) To recommend the man-power and other facilities required to carry out functions in (a), (b) and (c).

0.2 As a part of the Expert assistance, thrust was given for the job description listed at (a), (c), and (d) of 0.1. However, with respect to terms of reference of the job description (b), discussions with senior officials of SLSI brought out the following:

"SLSI is actively considering setting up of a Computer Centre for development of its technical information system as well as extending the facilities of this centre to other functional areas of SLSI. They are in the process of selecting a computer for this purpose"

0.2.1 Since the same computer can be readily put to use
by the Statistical unit through a terminal, it is proposed
that the unit can do the statistical analysis of data by
developing suitable packages on statistical methods. It is
also recommended that a data base on the test reports from
SLSI laboratory be developed so that the data can be readily
used for preparation/revision of the standard.

1. PROGRAMME OF WORK

1.1 The main activities can be broadly divided into 3 different
categories, namely, guidance to officers of SLSI - particularly
of Statistical Unit, Industrial Visits and conduct of SQC
Training Programmes. The detailed programme is enclosed as
Annexure I.

1.2 The brief report of activities carried out under the
3 categories is given in clauses 2, 3 and 4.

2. GUIDANCE TO OFFICERS

2.1 This activity was broadly divided into two parts as
follows:

(a) Discussions with officers of Statistical Unit
regarding preparation of standards on Quality Assurance
and basic statistical concepts and methods useful
for industry.

(b) Discussions with officers of Statistical Unit and
other departments of SLSI for introduction of
statistical concepts in preparation of standards.

2.2 It was explained to the officers of Statistical Unit
that for preparation of standards on Statistical Methods
and Quality Assurance, they can take guidance from the
standards and documents prepared by International Organization
for Standardization and Indian Standards Institution. However,
they should include illustrative examples on the basis of data
collected from local industry.

2.3.....

2.3 A brief report on discussions held under item 2.1(b) is given below:

(a) <u>Sensory Evaluation of Mango Juice Cordial</u> - An experiment was conducted on samples from three different manufacturers to assess the differences between their products as also to determine the most desirable dilution ratio. No discussions were held with the officers of the Statistical Unit prior to planning and conduct of the experiments. Hence, it was not possible to directly draw the inferences on the above two hypothesis. The amount of data collected would have been much more useful if the experiment would have been planned in advance.

(b) <u>Drained Weight of Canned Fig</u> - This data pertains to the import inspection. At present, the minimum limit of drained weight is specified as 70 percent. It was not very clear whether this limit should be made applicable for the average of the lot or the individual container. The analysis showed that for certain sources, the specification requirements interpreted in either of the way, will not be met by the test results. However, it is in general, easier to meet the specification requirement if it is interpreted as average for the lot. It was explained to them that in India, the latest standard on sampling of fish products recommend that the minimum limit for drained weight should be made applicable for average of 5 tins.

(c) <u>Data on Microbiological Tests on Lobster</u> - It was noticed that some of the units were unable to meet the present microbiological requirements which is equivalent to those in the international standard. The data was essentially quite small and it was explained how the limits can be calculated on the basis of the present data and revised when more and more data get accumulated.

(d).....

(d) <u>Sampling Plan in Standard on Lobster</u> - The present.
standard on Lobster which is drawn on the basis of the
international document has given provisions for sampling
inspection and also the criteria for conformity based
on certain demerit scores procedure. It was felt by the
SLSI officers that the present procedure will need some
changes so that it is understood easily by the people
in the industry and the inspection staff. It was explained
to them how the same procedure can be re-worded to make it
more clearer to the people using it.

(e) <u>Anthropometric Data for Standardization of Garment Sizes</u> - The
analysis of the data from the survey conducted by one of the
agencies was available with them and they wanted to know
whether it can be used for the problems stated above. Since
the analysis had not given co-relations among various
measurements, it was explained to them that the data would not
be useful. However, if the original data is made available
to them, it can be made use of. The method of making use of
the data was also explained to the officer of the Statistical
Unit.

(f) <u>Data on the Samples of Fabric from Market</u> - A large number of
samples were collected and results were available on various
characteristics of the fabric. The analysis showed a very
high variability. It was explained to them that this is
presumably because of the differences in the varieties of the
samples purchased by them. As a matter of fact, unless it 's
known that the product is manufactured to the given specificati
requirement, collection of such a data would not be useful
for setting up the specification limits.

(g) <u>Dry Cell Batteries</u> - The revision of the standard was
pending with the Division Council because of lack of
understanding on the part of the members regarding the
sampling provisions included in the document. The explanation
given by the Expert enabled them to finalize the standard
for printing. The analysis of the data collected earlier
also indicated that there was no need to change the sampling an
conformity provisions included in the international document.

(h) ...

(h) <u>PVC Insulated Cables</u> - The analysis of the data
from manufacturers holding certification marks permit,
confirmed the existing specification limits, Since the
process capability was adequate.

3. INDUSTRIAL VISITS

3.1 The industrial visits were mainly carried out to impart
training to the officers of the Statistical Unit of SLSI for
undertaking the SQC consultancy in the industry. The occasion
was also utilised to assess the existing system of quality control
prevalent in various industrial units. The visits covered the
following five industrial units:

(a) Asian Cotton Mills Ltd.

(b) Pure Beverages Company

(c) Ceylong Bulbs and Electricals Ltd.

(d) Kelani Cables Ltd.

(e) B.C.C.

All these units have some inspection and quality control
activities being carried out by them. However, in no unit, the
"feed-back" and "corrective action" procedures are being followed on
regular basis.

3.1.1 Asian Cotton Mills is engaged in production of cotton and
blended yarns. The firm is having an elaborate system wherein
the working standards at various stages in production and for the
procurement of cotton are laid down. However, there seems to be
no "periodic reporting" and "corrective action" procedures. As a
matter of fact, the analysis of the recent data (2 - weeks duration)
on a particular count of yarn revealed that the average level was much
lower than the nominal count. There was no evidence of such an
analysis being carried out by the quality control department in the
factory resulting into corrective action to improve the quality.

3.1.2   The Pure Beverages Company is engaged in production
of various soft drinks, fruit juices, cordials, marmaleds, and
jams. Three of the soft drinks are produced under licence from
a reputed foreign collaborator. For these three products, a
system of quality assurance as given by the collaborator is being
strictly adhered to. For other products, they are only complying
with the inspection of the final product as laid down by the
procedure under SLSI certification marks permit. There is so far
no attempt to prepare a formal system of quality assurance for these
products.

3.1.3   The Ceylon Bulbs and Electricals are mainly engaged
in the production of tungsten filament general service electric
lamps. A quick study of the inspection data during production
and final testing of bulbs showed that there is as much as
12 to 15 percent loss of material due to various defects arising
during production. Besides, for several batches, the bulbs tested,
fail to meet the requirements for initial lumen and life test.
They are aware of these problems and are keen to initiate action
for the solution. However, they are looking out for consultancy
assistance from outside agency for tackling their problems.

3.1.4   Kelani Cables are manufacturing stranded aluminium
conductors, PVC insulated cables and enamalled winding wires.
For the first two products they are holding SLSI certification
marks permit. Recently, they have carried out analysis of the
data to ascertain the present status of quality and devicing the
steps to improve it. During the discussions on the analysis,
a number of suggestions were made for taking steps to improve
the quality of their product. This was their first attempt and
they are very enthusiastic in persuing the same if some expert
advice is available to them.

3.1.5 B.C.C. is manufacturing coconut oil (edible),
washing and toilet soaps and animals feeds. The latter
two products are covered under SLSI certification marks
permit. The quality control laboratory draws samples at
various stages and there is a system of bringing out the
non-conformities to the notice of production people. However,
there is no indication of any action being taken on these
reports. Thus, it was noted that a large percentage of soap
cakes have to be reprocessed due to various types of defects
on the cakes. At present, they are following an adhoc system
of sampling for determination of moisture content in the coconut
kernels purchased by them. They had shown interest in the
development of a more objective system for this purpose.

3.2 The above 5 companies belong to the top echelon of the
SRI LANKAN Industry. The systems followed by them are far from
satisfactory and show some gaps and drawbacks. The overall
industrial scene from the "Quality Assurance" point of view would
definitely be much worse.

3.3 A detailed report on each visit was prepared by the
officers of Statistical Unit.

4. TRAINING PROGRAMMES

4.1 Four training programmes were conducted to acquaint the
officers of SLSI and production and quality control personnel
in industry with the use of statistical methods. About fifty five
officers in SLSI and twenty three from industry participated
in these programmes.

4.2 The Course consisted of lectures on topics listed in
Annexure II.

4.2.1 The various statistical techniques were discussed
with the help of case studies from Indian and SRI LANKAN
industries.

4.3 A seminar for 3 hours duration was organised to discuss with
SLSI Standards Committee member on 'Application of Statistical
Methods in Standardization'. A large number of committee members
(over eighty) participated in the seminar.

5. ...

5. OBSERVATIONS AND RECOMMENDATIONS

5.1 At present, the committee secretary approaches the Statistical Unit for analysis of data for working out specification limits and provisions for sampling inspection, if necessary. It is recommended that all the preliminary draft standards when first prepared, may be referred to the Statistical Unit for their suggestions so that choice of subjects can be made at an earlier stage and collection of data can be planned in advance.

5.1.1 For preparation of the standard, on many occasions, the product is purchased from the market and the specification requirements are based on the data obtained from testing of these samples. It is recommended that this practice be discontinued and replaced by collection of data from the industry from their day-to-day operations. In case, the industry is not maintaining suitable records, they may be approached and requested to collect the data in a suitable proforma for a period of 2 weeks to one month. The analysis of this data would reflect the process capabilities of the industry and thus, the specifications would be more pragmatic. Ten standards may be chosen in a year for this purpose

5.2 In order to propogate the principles and concepts of quality assurance as also the use of statistical methods in industry, it is necessary to prepare a large number of standards within a period of 2 - 3 years. At present, there are only four standards published on the subject. A list of 24 subjects for preparation of the standard in order of their priority is enclosed as Annexure III. This list has been compiled by taking into consideration the work carried out and under progress with some of the national standards bodies and the relevant committees on International Standards Organiza·

5.2.1 It would be necessary to strengthen the technical committee for undertaking this work. Since at present there are not many personnel with statistical qualifications working in the quality control field in the industry, it would be better if some expert assistance is obtained to develop this work.

5.3 The Consultancy and Training department at present is offering training programmes containing very little course content on statistical methods. It is recommended that the present programme may be offered only at the level of workers and first level supervisors in the industry.

5.3.1 For the middle management level working in production and quality control department in industry, a new programme has to be developed and offered. The programme conducted by this expert may be taken as a guideline for this purpose. Subsequently, an advance programme may also be offered with the course content including design of experimentation, analysis of variance and some advance techniques for process control and sampling inspection.

5.3.1.1 Development of these two programmes would be possible only if the officers of the Statistical Unit are entrusted with the responsibility of conducting these programmes. Alternatively, the programme can be conducted by the 'Consultancy and Training Department' taking the officers of the Statistical Unit on the faculty.

5.3.2 It is also necessary to propogate quality assurance concepts at the top management level. For this purpose, it is recommended that seminars of half a day duration may be organized.

5.3.3 Initially, it is recommended that at least 2 such seminars per year for top management and 4 training programmes for middle management level may be organized. To begin with, it is necessary that the officers of the Statistical Unit deliver the lectures in the middle management seminar under the guidance of an expert so that they gain experience and confidence.

5.4 At present, the Consultancy department is giving emphasis on technical aspects and development of quality control system in the industry. It is recommended that the consultancy service to the industry should lay emphasis on application of statistical methods for identification and solution of quality problems. Through this activity, the industry gets easily convinced about the cost effectiveness of quality control programme and hence introduction of a QA system is facilitated. This type of work of consultancy can be carried out only if the officers of the Statistical unit are involved in this activity. However, in the initial stages, the officers may require some guidance and training under an expert.

5.5   In view of the quantum of work involved in various
activities listed under 5.1 to 5.4, the strength of the Statistical
Unit may be increased to 4 from the present strength of 2. It is
also recommended that the status of the Statistical Unit may be
raised to that of an independent department.

5.6   Since the activities mentioned under 5.1 to 5.4 are of
highly specialised nature, it would be necessary to give some
training to the newly recruited statistical officers. 'On the
job training'of' approximately 6 weeks duration, is recommended.
The facilities for such trainings are available with some of the
national standards bodies like Indian Standards Institution.

5.7   As indicated under 5.2, 5.3 and 5.4, it is desirable to seek
the services of an expert so that these activities can be
expeditiously undertaken and put on the proper footing. The
period of expert assistance may be approximately one year.
The terms of reference of the expert may be defined as follows:

   (a)   To revamp the committee set-up for preparation
         of standards on Quality Assurance and Statistical
         Methods and expand the scope and activity of the
         committee.

   (b)   To organize top management seminars and SQC
         training programmes for middle management level
         in the industry.

   (c)   To commence the activity of SQC Consultancy service, and

   (d)   To train the officers of the Statistical Unit for
         undertaking the activities under (a), (b), and (o).

ANNEXURE I

SRI LANKA STANDARDS INSTITUTION

UNIDO PROJECT DP/SRL/82/003/ 11 - 05

PROGRAMME FOR EXPERT ON INDUSTRIAL STATISTICS

Sl.No.	Activity	March				April																				May										
		26	27	28	31	1	2	3	4	7	8	9	10	11	16	17	18	21	22	23	25	28	29	30	2	5	6	7	8	9	12	13	14	15	16	19
1.	Discussions with Senior Officers of SLSI (DDG, Directors)	◄———►																																		
2.	Guidance to Officers in Statistical Unit on																																			
	(a) Preparation of SLC Standards					◄————————————————►																														
	(b) Use of Statistical Methods in Standards preparation; SLSI Certification & Pre-export & Import Inspection					◄————►				◄————►																										
3.	SLC Training Programmes																																			
	(a) Technical Officers (SO/TO/AD) — Forenoon 0930 to 1230						◄————►									◄————►				◄——►																
	(b) Directors — Forenoon 0930 to 1230																															◄►				
	(c) Committee Members — Forenoon 0930 to 1230																															◄►				
	(d) Industry — Full day																										◄————►									
4.	Visits to Industry — Full day													◄————►								◄——►														
5.	Report Writing — Full day																																			◄

TOPICS FOR TRAINING PROGRAMMES

		SISI Officers		Industr
		Standards & Implementation	Lab.	
1)	Principles and concepts QA System	✓	✓	✓
2)	Quality Cost	✓		✓
3)	Summarisation of data	✓	✓	✓
4)	Concept of Statistical distributions - Normal, Binomial and Poisson Dist.	✓	✓	✓
5)	Specifications and Tolerances - statistical concepts	✓	✓	✓
6)	Process Control Concepts, $\bar{x}$, median and R Chart, Interpretation of Control Charts	✓		✓
7)	p, c, demerit score, Individual charts, Modified Charts, Group Control Charts	✓		✓
8)	Sampling inspection Preliminaries and Basic concepts	✓		✓
9)	Sampling Inspection Tables	✓	✓	✓
10)	Statistical Concepts for preparation of SI	✓		
11)	Sensory Evaluation	✓	✓	
12)	Precision of test methods	✓	✓	✓
13)	Process Capability Studies	✓		
14)	Vendor Relations, Vendor Evaluation			✓
15)	Some useful Tools - Pareto Analysis, Cause and effect diagram, scatter diagram			✓

ANNEXURE III

Subjects for Preparation of Standards on Statistical Methods & Quality Assurance

1) Presentation of Statistical Data

2) Quality Assurance

3) Analysis of Quality Costs

4) Control Charts for Variables

5) Control Charts for Attributes

6) Sampling Inspection by Variables for percent defectives

7) Statistical Models for Industrial Applications - Continuous Distributions

8) Statistical Models for Industrial Applications - Discrete Models

9) Statistical Test of Significance

10) Precision of Test Methods

11) Criteria for Rejection of Outlying Observations

12) Statistical Vocabulary

13) Design of Industrial Experimentation

14) Analysis of Variance

15) Design of Industrial Experimentation - Orthogonal Arrays

16) Guidelines for development of Vendor Rating Systems

17) Regression and Correlation

18) Sampling plan indexed by Limiting Quality Level

19) Guide for Sampling Selection Methods

20) Special Control Charts - Modified Group, Cusum

21) Sequential Sampling Plans for Variables

22) Sequential Sampling Plans by Attributes

23) Chain Sampling Plan

24) Continuous Sampling Plan