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AN OPERATIONS RESEARCH AND SYSTEMS ANALYSIS STUDY OF WEIGHING SCALES USED FOR GROWTH SURVEILLANCE

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ABSTRACT

Weight is the accepted indicator of growth in the growth monitoring system in the Philippines. The right choice and correct use of the appropriate weighing instrument or scale is of paramount importance for procuring accurate weight during weight surveillance (Operation Timbang). This operations research and systems study evaluates the different weighing scales used in the field, examines the different factors causing inaccuracies in weighing, investigates the feasibility of locally manufacturing the required weighing scales, and scrutinizes the calibration, maintenance and procedure needs of the recommended weighing scales. Seventy-eight (40 Rural Health Units and 38 Barangay Health Stations) health stations in Marikina, Quezon City, Pangasinan and Cavite were surveyed. The bar scale, the Salter spring-type weighing scale, the adult clinical scale and the bathroom scale were found to be the most commonly used weighing instruments. Calibration, maintenance and proper use were generally observed to be wanting and inadequate.

The study recommends the phase out of the bathroom scale; the use of the Salter spring type; the infant beam scale and the bar scale when weighing in the field; and the use of adult clinical scale or beam type clinical scale at health stations. It further recommends the standardized regular calibration and maintenance procedure for all scales used in growth monitoring. All procedures are recommended to be in

simple instructional form. For calibration, the use of standard test weights is recommended. The study finally recommends a modified weighing scale and crib design and the establishment of a regular replacement cycle for these weighing instruments. The local manufacture of weighing scale was found to be feasible.

INTRODUCTION

Operation Timbang (OPT) is the annual weighing of preschool children aged 0 to 83 months for the purpose of identifying and locating underweight children as well as determining the nutrition situation in the community. Information from OPT is used to establish priority in nutritional program interventions and for evaluating nutritional status. Weight is the accepted yardstick by which growth and nutritional status of preschool children is being determined. It is therefore very important to obtain accurate weights during the weight surveillance in order to ensure correctly the determination of the nutritional status of the targetted preschool children and to optimize the scarce nutritional program resources of the Department of Health.

The presence and use of defective weighing scales has been identified as one of the major causes of inaccurate weights obtained during the Operation Timbang of the Department of Health under the Philippine Food and Nutrition Program.

The Department of Health (DOH) Nutrition Service Nationwide Inventory of Weighing Scales conducted in 1987 indicated the lack and inadequacy of weighing scales for growth surveillance and monitoring [14]. Sixty-two percent (62%) of the total 11,379 weighing scales were found to be functional. The study recommended the procurement of eleven thousand additional weighing scales to be distributed to the different barangay health stations throughout the country.

The DOH Primary Health Operations Research (PRICOR) systems study conducted in the province of Bulacan in 1988 pointed to inaccuracies in weight due to elderly vintage and defective weighing scales [7]. There is likewise widespread perception that the classification and determination of nutritional status has been misleading due to the wide variation in the accuracy of weights obtained during Operation Timbang.

This operations research and systems study aims to primarily evaluate the effectiveness of the different weighing scales used in the field, examine the nature, type and extent of inaccuracies in weights attributable to the weighing instrument, investigate the current calibration, maintenance and use of the weighing instruments, determine the feasibility of locally manufacturing the desired weighing scale and finally recommend the most appropriate weighing scale to be used in Operation Timbang. Orientation on the effective use, calibration and maintenance of weighing scales is also part of the study to ensure that midwives and other health personnel are given immediate skills reinforcement on the importance of weighing instruments in Operation Timbang.

REVIEW OF RELEVANT LITERATURE AND EXPERIENCES

The Nationwide Inventory of Weighing Scales (1987) [14] indicated that most of the errors in weighing occurred due to the improper use of the weighing scale. The study also

indicated that there was lack or inadequate weighing scales which accounted for the wide variation in the coverage of the Operation Timbang from a low of 11% to a high of 70%. The study recommended the use of the beam type clinical model and bar scale and the spring type Salter scale for their apparent accuracy, sensitivity, portability and ease of use.

The Procedural Guidelines for Growth Monitoring of Preschool Children [13] recommended the use of the Infant Beam Scale, Beam Scale for Children, Clinical Model, the Bar Scale and the Salter Model of the Spring Scale. It likewise prescribed the proper use of weighing scale and correct procedures for weighing.

Several studies on the reliability and effectiveness of weighing scales were conducted. Florentino, et. al. (1975) [9] made a study on the field performance of the locally manufactured bar scale called "espada". Two hundred preschool children were weighed in Cabuyao, Laguna during the regular Operation Timbang. The results indicated that the bar scale was equally comparable in accuracy and reliability to the clinical scale under field conditions. Thusly, the b ar scale was recommended for use in screening children in levels of malnutrition provided the scale is well-taken cared of.

De Leon, et al. (1975) [6] conducted a comparative study on the accuracy and practicality of four weighing scales: lever type Krups (25 kg capacity with 50 gram sensitivity) Dial type (20 kg capacity with 100 gram sensitivity), bathroom (Berg lever type, 130 kg capacity with 500 grams sensitivity) and healthometer, clinical type scale (60 kg capacity with 20 gram sensitivity). Accuracy was tested using standard test weights while practically was evaluated by weighing 19 children under field conditions. The lever type clinical scale was found to be the most accurate and easy to use of the four scales tested.

Informal surveys from the field indicated some problems with the proper use of weighing scales. Among those problems mentioned were the difficulty in adjusting, inadequate calibration, lack of standardized procedure for calibration, use and maintenance, and it was also advanced that inaccurate weights were being obtained because of defective weighing scales.

METHODOLOGY

The study was conducted according to the six-step procedure of operations research. These steps are problem definition, data collection, analysis, evaluation of alternatives, recommendations and implementation. The procedure is summarized in Figure 1. The problem was defined as defective weighing scales used in growth monitoring. The primary manifestation of the use of defective weighing scales was the inaccurate weight readings obtained during growth surveillance. A simple cause diagram depicting the various causative factors of defective weighing scales is shown in Figure 2: Ishikawa Diagram of Defective Weighing Scales. As indicated in Figure 2, the primary sources of variation in weight readings are the type of weighing scales used, state the calibration and maintenance of the weighing scales, the weighing procedures employed, the level of the training and skills of the user and the environment of weighing. On the basis of this diagnosis, a structured data collection procedure was developed.

Data collection was done through a field survey of four major areas using a structured questionnaire and critical observations. These areas were Marikina, Quezon City, Cavite and

Pangasinan. Ten barangay health centers were surveyed in Marikina. These were Sto. Nino Health Center, the Concepcion Puericulture Center, the Bagong Lipunan (De La Pena) Health Center, the San Roque Puericulture Center, the Bagong Lipunan (Lakandula) Health Center, the Nangka Puericulture Center, the Marikina Heights Health Center, the Calumpang Health Center, the Tanong Health Center and the Barangka Health Center. In Quezon City, the health centers surveyed were the Kamuning Health Center, the Bago-Bantay Health Center, the Baesa Health Center, the Escopa Health Center, the Paltok Health Center, the Commonwealth Health Center, the Tandang Sora Health Center and the Krus Na Ligas Health Center.

In Cavite the health centers surveyed were the Dasmarinas Health Center; the Sabang Health Center; the San Agustin Health Center; the Bacoor 1 Health Center; the Mabolo Health Center; the Sineguelasan Health Center; the Malabag Health Center in Silang; the Binakayan and Kaingin Health Centers in Kawit; the Maitim II and Sungay Health Centers in Tagaytay; the Sinaliw Munti and Alfonso Health Centers; the Rosario, Tejeres and Ligtong I Health Centers; Caridad and San Roque Health Centers in Cavite City; the Naic, San Roque and Bancaan Health Centers ; the Imus, Palico and Bayan Luna Health Centers.

In Pangasinan, the health centers covered by the survey were: The Bonuan Gueset and Bonuan Boguig Health Centers in Dagupan City; the Lingayen I, Libong East and Matalava Health Center in Lingayen; the Enerangan, Cabatuan and the Alaminos Health Centers in Alaminos; the Bautista, Palisoc and Baluyot Health Centers in Bautista; the Aguilar, Ninoy and Bocacliw Health Centers in Aguilar; The Asingan I, Calepaan and the Tobay Health Centers in Asingan; the Sta. Maria, Paltan and Bantog Health Centers in Sta. Maria; the Urdaneta; the Manaoag, Member and Pao Health Centers in Manaoag; the Urbiztondo and Pisuac Health Centers in Urbiztondo.

During the survey, sample calibration tests were conducted on the various weighing scales in use. Standard test weights were utilized in the calibration.

The most commonly used weighing scales in the field were then brought to the National Standards Testing Laboratories of the Industrial Technology Development Institute for standardized calibration.

To gather data on local manufacturing of weighing scales and asses the feasibility of local manufacture, plant visits were conducted on two leading local manufacturers of infant weighing scales. These were the R.C. Rubber Manufacturing Company in Batangas City and the First Philippine Scales Industries in Malabon, Metro Manila.

The findings and observations obtained from the field survey and plant visits were analyzed. The focus of the analysis was on the causes of defective weighing scales.

To evaluate the performance and effectiveness of weighing scales, a multi-attribute analysis was performed. Important criteria were identified, specified and ranked according to importance. This was done by the members of the project team and some selected health personnel. The most commonly used weighing scales were then evaluated according to these established criteria.

After the analysis of the results of the survey, conclusions were made and recommendations generated. The recommendations were then evaluated on the basis of workability, operational acceptability and economy.

To validate the results and recommendations, the project team organized an orientation seminar for the different midwives of the survey sites. An equally important purpose of the seminar was to provide training on the proper use, maintenance and calibration of weighing scales used for growth monitoring. The seminar was further utilized to elicit additional information which would enhance the implementation of the different recommendations proposed by the project team.

Finally, the final recommendations were presented to the Department of Health Nutrition Service for disposition and implementation.

FINDINGS, OBSERVATIONS AND RESULTS

Distribution of Weighing Scales

Four types of weighing scales were found to be widely used in the four survey sites. These were the bar scale (espada type), the bathroom scale (different brands and make), Adult Clinical Scale (Detecto-type) and the Salter Spring Scale. The distribution of these most commonly used weighing scale is indicated below:

TABLE 1: Distribution of Most Commonly Used Weighing Scales

T Y P E	NO. OF UNITS	% BREAKDOWN
1. Bar Scale	66	29.46%
2. Bathroom Scale	59	26.34%
3. Adult Clinical Scale	47	20.98%
4. Salter Spring Scale	29	12.95%
5. Others	23	10.27%
TOTAL	224	100%

In Quezon City, the most commonly used weighing scales was the bar scale, and 75.6% of the weighing scales surveyed were bar scales of the espada type acquired through the National

Nutrition Council. In Marikina, the bathroom and the Salter spring type weighing scales were the most common, accounting for 50% of the total weighing scales surveyed (25% each). In Cavite and Pangasinan, the most commonly used weighing scales was the bathroom scale. Cavite had 29.7% bathroom scale while Pangasinan had 38.8%

Sixteen percent (16.1%) of the weighing scales were found to be non-functional. Most of them were in a state of disrepair. The breakdown of those weighing scales found nonfunctional is shown below:

TABLE 2: Breakdown of Non-Functional Weighing Scales

TYPE	NO. OF UNITS	% BREAKDOWN
1. Adult Clinical Scale	10	27.78%
2. Bathroom Scale	9	25.00%
3. Bar Scale	7	19.44%
4. Beam Type	3	8.33%
5. Salter Spring Scale	2	5.56%
6. Others	5	13.89%
TOTAL	36	100%

All of the adult clinical scales were found to be defective were at least ten years old. For the bathroom scales, bar scales and beam type, most of the defects were functional defects.

Defects in Weighing Scales

Two major types of defects were observed in the weighing scales. These were the functional defects and the cosmetic defects. Functional defects are those defects which impair the procurement of accurate weight. Cosmetic defects are physical defects which do not affect the taking of accurate weights.

The severity of defects can be categorized as critical, major or minor. Critical defects are defects which render the weighing scale non-functional, major defects are those which moderately affect the taking of accurate weight while the minor defects are those which do not affect the procurement of accurate weight.

Presented in the succeeding discussion are the detailed description of the different types of defects observed in the most commonly used weighing scales.

Bar Scale

This scale has a capacity of 25 kilograms with a graduation of 100 grams. All bar scales were acquired through the National Nutrition Council / Nutrition Center of the Philippines. They were manufactured by R.C. Rubber Company in Batangas City. The average cost per unit was P360. The average error obtained ranged from 50 to 250 grams. The most common defects observed in the bar scales were:

: Defective/missing bumper
: Corroded scale markings
: Slanted slider
: Missing/rusty steel counterpoise
: Counterweight not freely moving
: Difficulty in balancing
: Corrosion in some parts of the scale

Table 3 summarizes the most commonly observed defects found on bar scales.

The most common complaints with bar scale were:

: Heavy to carry
: Difficulty in weighing older preschoolers (5-6 years old)
: Difficulty in weighing and reading the weights when child is movable/restless or crying
: Mothers are hesitant to have their children weighed because of the danger of their children being hit by the heavy metal slider
: Difficulty in finding a convenient place to hang scale
: Will require at least two people in order to use adequately
: Tendency of infants to slip off the crib during weighing

Table 4 summarizes the most commonly cited experiences with the use of bar scales by midwives and barangay health workers

Most of the bar scales were observed to be hanged in wooden stand/beam, curtain rod, door beam and veranda using nylon rope, cable wiring, parachute rope and abaca rope. Some were hanged on branches of trees. Most bar scales were observed to be dusty and rusty.

The most common maintenance practices for bar scales were:

: Wiping with dry cloth
: Oiling the moving parts
: Washing crib linen
: Washing with soap and water
: Storing in a dry place

Calibration for bar scales were limited to putting slider to zero.

Salter Spring Type Scale

This scale is of the model 235 PBW weighing 1.2 kilograms with a single face of approximately 15 cm. It has a capacity of 25 kilograms with a graduation of 100 grams. It is imported from either Australia or England. The average cost is from P440 to P580. The average error obtained ranged from 50 grams to 150 grams. The most common defects observed in the Salter spring type scale were broken plastic cover and worn out crib linen. Some complaints with the Salter spring scale were the difficulty in finding a convenient place to hang the scale, and the difficulty in reading when the child being weighed is moving or restless. Many midwives preferred the Salter spring scale for its portability and handiness. The most common maintenance practices done on the scale are wiping/cleaning/dusting with dry cloth after use and storing in a box after use. Shown in Table 5 and 6 are the most commonly observed defects found in weighing scales and the most commonly cited experiences in the use of weighing scales.

Adult Clinical Scale

This Detecto Medical Scale has a capacity of 160 kg/350 1b with a graduation of 100 grams. These scales are usually placed against the wall on flat floor near the doctor's room or midwive's table. The most common defects observed in the adult clinical scale were:

: corrosion on slider and body
: counterweight not fully moving
: illegible scale markings
: poise not placed at zero when not in use
: scale cannot easily be balanced
: missing height readers
: easily goes off-balance
: no available screw driver to adjust counterweight

Table 7 capsulizes the most commonly observed defects found in adult clinical scales.

Most adult sales were likewise observed to be dusty and lacked adequate maintenance. For the functional adult scale, the average error obtained ranged from 50 to 150 grams.

Minimal maintenance was observed with the adult clinical scale. The most common were wiping and dusting with dry cloth, oiling and inspection of moving parts.

Table 3:

Most Commonly Observed Defects Found on Bar Scales

- Corroded scale markings
- Slanted slider
- Missing/rusty steel counterpoise
- Counterweight not freely moving
- Difficulty in balancing
- Corrosion in some parts of the scale
- Hang above eye level

Table 4:

Most Commonly Cited Experiences with the Use of Bar Scales by Midwives and Barangay Health Workers

- Heavy to carry
- Difficulty in reading weights for children who are movable/restless or crying
- Mothers are hesitant to have their children weighed because of the danger of hitting the child with the slider
- Difficulty in finding a convenient place for child hanging
- Children are afraid to be weighed (ayaw sumakay nang bata sa crib)
- Will require at least two people to operate

Table 5:

Most Commonly Observed Defects Found in Salter Spring-Type Weighing Scale

- Broken plastic cover
- Worn out crib

Table 6:

Most Commonly Cited Experiences with the Use of Salter Spring-Type Scale By Midwives and Barangay Health Workers

- Handy and easy to read weights
- Difficulty in reading weights especially when child is movable
- Difficulty in finding a convenient place for hanging

Table 7:

Most Commonly Observed Defects Found in Adult Clinical Scales

- Poise not placed at zero when not in use
- Corrosion on slider and body
- Tight counterweight
- Counterweight not fully moving
- Difficulty in balancing
- Illegible scale markings
- Missing height reader

Bathroom Scales

There were twelve brands of bathroom scales in use with varying capacities (120 kg to 140 kg) and sensitivities (0.5 kg to 1.5 kg). (Table 8). All of them have dual units (kg and lb). The average cost ranged from P270 to P570 per unit. The average error obtained using the standard weights ranged from 500 grams to 1,500 grams. These scales were located on flat floor beside the table of the midwife/nurse. The most common defects observed in the bathroom scale were:

: rusty/corroded
: illegible scale markings
: scratches
: tight adjustment
: easily goes off balance
: not easily balanced

Table 8:

BREAKDOWN OF BATHROOM SCALE BY CAPACITY AND GRADUATION					
Brand Name	Number	Capacity		Graduation	
		kg	lb	kg	lb
Kyungin Model	13	130	300	1	1
Counselor	12	140	305	1	1
Hanson	9	125	280	1	1
Fuji	7	130	300	0.5	1
Newport	3	130	300	1	1
Tanita	3	120	270	1	1
EKS Sweden	3	120	260	1	1
Kubota	1	130	300	1	1
Terralions	1	130	300	0.1	0.1
Yamato	1	130	300	0.5	0.5
Nutex Safan	1	120	260	0.5	0.5
Others	5	140	310	1	1
Total	59				

Table 9 summarizes the most commonly observed defects found in weighing scales.

The most common maintenance practices done on the bathroom scale were wiping with dry cloth, wrapping with plastic after use and keeping in box after use and storing in a dry place. Table 10 indicates the most commonly cited experiences with the use of bathroom scales.

Table 9:

Most Commonly Observed Defects Found In Bathroom Scale

- Inaccurate
- Rusty/corroded
- Illegible scale markings
- Scratches
- Tight adjustment
- Easely goes off-balance
- Difficulty in balancing

Table 10:

Most Commonly Cited Experiences with the Use With Bathroom Scales by Midwives and Barangay Health Workers

- Handy and easier to read weights
- Easily goes off-balance

Other Factors Contributing To Inaccurate Weights

These were causative factors of inaccurate weight which were not ascribable to the weighing instrument. These were noted down by the project team. Among the most notably observed were the following:

Most health personnel were not provided with instructions on how to use, calibrate and maintain weighing scales.

Most health personnel were not provided with handy tools like a screw driver to be used for adjusting or balancing of weighing scale.

Most health personnel assumed that the weighing scale they use provided them with accurate weight.

Most personnel regarded putting slider to zero as calibration.

There were misreading of weights due to wrong positioning of the user.

Scale was not balanced at zero reading

There was inadequate or lack of calibration.

There was apparent lack of knowledge in the use of the counterweight in balancing at zero reading.

MULTI-ATTRIBUTE ANALYSIS OF THE FOUR COMMONLY USED WEIGHING SCALES

The four most commonly used weighing scales were subjected to a multi-attribute analysis. Several important criteria were identified, specified and ranked according to importance by the project team using a simple ranking scheme. The general criteria for weighing scale evaluation promulgated by the Joint World Health Organization (WHO) and UNICEF Meeting 24-26 June 1985, was used as a basis. (see Table 11). Weights were not used. The criteria established ranked according to importance were:

1. Accuracy
2. Sensitivity
3. Ease of Use
4. Acceptability to the midwife, mother and child
5. Durability
6. Safety
7. maintenance
8. Portability
9. Universality
10. Parallax
11. Transportability
12. Cost
13. Feasibility of local manufacture

The four scales were then rated according to this ranked criteria. The Salter Spring scale, the Beam type scale and the Bar Scale were judged to be acceptable. The results of these comparisons are shown in Table 12.

Table 11:

GENERAL CRITERIA FOR WEIGHING SCALE EVALUATION
(JOINT WORLD HEALTH ORGANIZATION (WHO) AND UNICEF MEETING 24-26 JUNE 1985)

	Criteria	Weight
I.	FUNDAMENTAL DESIGN	70 pts.
	. Maintenance Points of wear, fulcrum, rack and pinion, ability to prevent wear other maintenance activities	15 pts.
	. Safety Scale hook strength, hanger hookstrength, materials provided with scales, rope, hook (training for securing scale) scale stability, vertical, scale stability, pivoting secured weights and counterweights, no sharp edges or roughness)	15 pts.
	. Durability Expected life, Impact resistance face material, body material, functional parts (Electronic only circuit integrity source of power, photovoltaic, lithium battery)	15 pts.
	. Portability Weight compactness, handling ease	10 pts.
	. Universality Babies 0 to 6 months, infants 6 to 24 months, toddlers 24 to 36 months, children 36 to 60 months, mothers	10 pts.
	. Tare Number of kg of tare (scope of tare)	5 pts.
II.	ACCEPTABILITY	50 pts.
	. Operator Ease of reading, ease of operating weighing time, ease of transporting perceived safety, time to tare, tools to tare	20 pts.

. Mother — 20 pts.
Non-threatening appearance, cultural acceptability of suspending a child perceived safety apprehension comprehension of weighing mechanism

. Child — 10 pts.
Apprehension, discomfort

III. POTENTIAL FOR SCALE ERROR — 40 pts.

. Accuracy — 10 pts.
Sine qua non plus or minus 100 gms Temperature compensation, hystenesis creep (a form of stretch with loading)

. Linearity — 10 pts.
The ability to measure with the same accuracy over a range of weights

. Precision — 10 pts.
Consistency of reading

. Sensitivity — 10 pts.
Least weight to cause movement

. Unobvious Damage — 5 pts.
Damage to rack and pinion, damage to springs, damage to weight

. Fatigue — 5 pts.
Spring fatigue, other fatigue fulcrum wear

IV. POTENTIAL FOR OPERATOR ERROR — 50 pts.

. Accuracy — 10 pts.
Clarity of markings/read out simplicity, no complicated calculators, errors of transportation (scale to chart) ability to specify language

. Tare — 5 pts.
(Sine qua non) Accuracy of taring, loss of tare during weighing

	. Parallax Classes of indicator to slide, closeness to needle to face	5 pts.
	. Complexity of use Number of hands needed to weigh, number of movements to weigh	15 pts.
	. Damping Accurately read with child in motion	10 pts.
	. Self-contained Number of detached parts of load hooks and weights	5 pts.
V.	GENERAL	40 pts.
	. Cost Real Cost, C/F vs. FOB, cost of packing shadow casting value of in-country production, additional cost for special training	30 pts
	. Packaging Unit packing, pack to specifications	5 pts.
	. Potential for Local Manufacture	5 pts.
	. Instructions	10 pts.
VI.	SLING/SUSPENSIONS (STAND-ON SCALE RECEIVES 30 POINTS AUTOMATICALLY)	30 pts.
	. Operator Ease of suspension, ease of putting child in sling, slinging time, ease of transporting, perceived safety cleanliness	10 pts.
	. Mother Non-threatening appearance, cultural acceptability, perceived safety, apprehension	10 pts.
	. Child Comfort of sling, non-conforming sling, size of leg holds (child), head rest grips dimensions, feel of material	10 pts.

Table 12:

COMPARATIVE EVALUATION OF THE COMMONLY USED WEIGHING SCALES

TYPE Criteria	Bar Scale (a)	Bathroom Scale (b)	Beam-Type Scale (c)	Spring-Dial Scale (d)	Remarks
Accuracy	50-150 grams	500-1500 grams	50-150 grams	50-150 grams	a,c,d
Sensitivity	100 grams	500 grams	100 grams	100 grams	a,c,d
Ease of Use	More pre-paration required	Easy	Easy	More pre-paration required	a,b
Acceptability: . Midwife or BNS . Mother . Child	 Slightly acceptable Slightly acceptable Slightly acceptable	 Moderately acceptable Highly acceptable Highly acceptable	 Slightly Moderately Highly acceptable Highly acceptable	 Lightly acceptable Moderately acceptable Slightly acceptable	 b b,c b,c
Durability	Greater than 5 yrs useful life	Greater than 5 yrs useful life	Greater than 5 yrs useful life	Greater than 5 yrs useful life	Assume same frequency of weighing a,b,c,d
Safety	Relatively Unsafe	Safe	Safe	Relatively Unsafe	b,c
Maintenance	Simple	Relatively Simple	Relatively Simple	Relatively Simple	a
Portability	3.0 kilos w/crib	1.5 - 2.0 kilos	5.4 kilos	1.35 kilos w/o crib	crib 0.95 kilos b,d
Universality	0-83 months	children & mothers	0-83 months	0-83 months	b
Parallax	High	High	Moderate	High	a,b,d
Transportability	Moderate	High	Low	High	b,d
Cost	P370	P270-P570	P4,400	P440-P577	a,b,d
Local Manufacture	Yes	Yes	Yes	Yes	a,b,c,d

RECOMMENDATIONS

Based upon the results of the study the following measures are recommended:

1. Phase out the bathroom scales in growth surveillance because of its unacceptable accuracy and sensitivity.

2. Use Adult clinical scale or beam type clinical scale when weighing at the health station.

3. Use the Salter Spring scale, beam type infantometer or bar scale when weighing in the field.

4. Establish a regular standardized calibration and maintenance procedure for the recommended weighing scale.

5. Provide simple instructional procedure for the operation, calibration and maintenance of weighing scale.

6. Establish the required specifications for weighing scales to be used for growth monitoring.

7. Conduct regular orientation on the proper use, care, maintenance and calibration of weighing scales to midwives and other health personnel.

8. Rehabilitate the non functional adult clinical scale.

9. Modify and redesign the weighing scale and the crib.

10. Locally source and manufacture the weighing scales.

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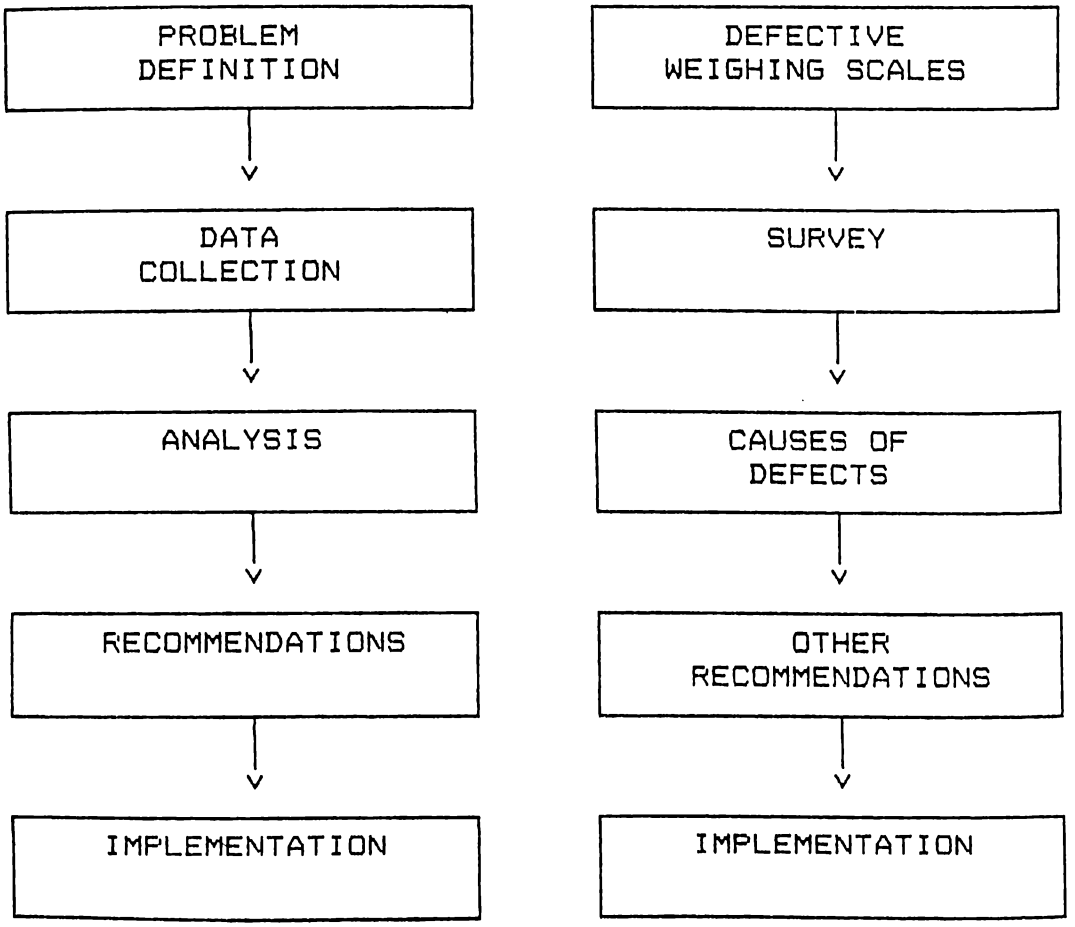

Figure 1
THE OPERATIONS RESEARCH PROCEDURE

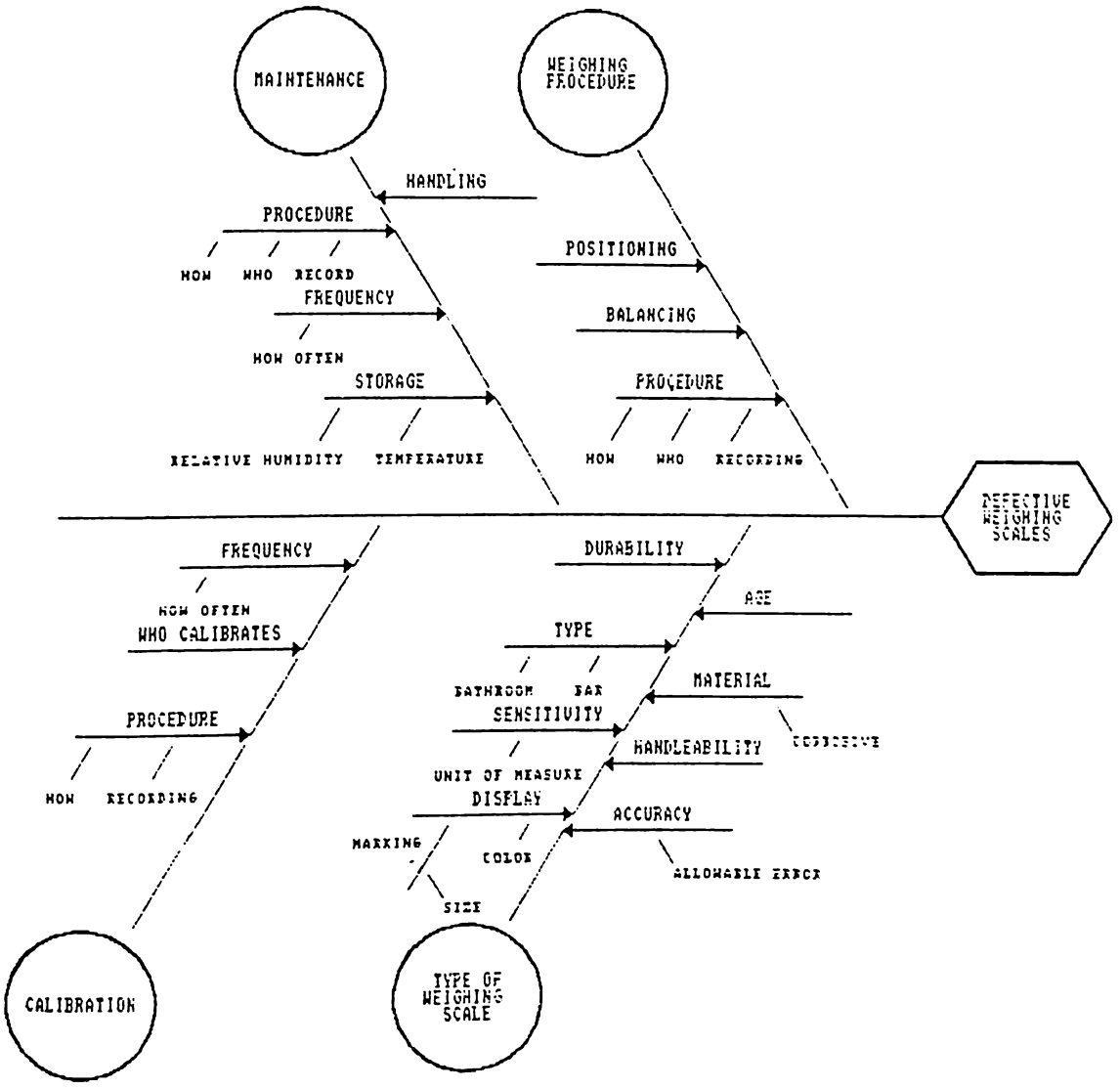

Figure 2
ISHIKAWA DIAGRAM OF DEFECTIVE WEIGHING SCALES