CHAPTER-3

METHODOLOGY AND INSTRUMENT DEVELOPMENT

This chapter details the various aspects of the research methodology used and the work done to develop the final instrument used for data collection. Section 3.1 presents the methodology aspects. The statement of the problem, objectives of the research, theoretical background of the study, hypothesis to be tested, variables in the study, scope of the study, research design, analysis design, sampling design and tools for data collection are discussed in this section. Section 3.2 looks at the instrument development process. The item generation process, validity analysis, reliability analysis, pilot test and structure of the final instrument are presented under this head. Section 3.3 gives the summary of the chapter.

3.1 Research Methodology

3.1.1 Statement of the problem

Coir and coir products have good prospects in the domestic as well as international market because of their unique quality of durability, bio-degradability and eco-friendliness. But India could tap only four percent of the world market potential for coir products. India and Sri Lanka are the two major producers and exporters of Coir products in the globe accounts for 88% of the world production. (Rajan A.C, Binil. M.T, 2004). Though it is viewed as the highly labour-intensive industry, the employee’s physical and psychological aspects of work are not addressed with⁶. The industry is characterized mainly with manual material handling tasks which may expose workers to physical risk factors. If these tasks are performed repeatedly or over long periods of time, they can lead to fatigue and injury. The main risk factors, or conditions, associated with the development of injuries in manual material handling tasks include:

⁶ Kerala Statistical Institute, 1997
- Awkward postures (e.g., bending, twisting)
- Repetitive motions (e.g., frequent reaching, lifting, carrying)
- Forceful exertions (e.g., carrying or lifting heavy loads)
- Pressure points (e.g., leaning against parts or surfaces that are hard or have sharp edges)
- Static postures (e.g., maintaining fixed positions for a long time)

Human Engineering (HE) is a multidisciplinary area having untapped potential in industrial context. Human performance is inextricably linked with performance characteristics of equipment, facility or environment in which the human is operating. (Wang Hong-bin, Liu Yu-hua, 2008; Banerjee, 1962)

HE applies anatomical, physiological and psychological knowledge to work and work environments in order to reduce or eliminate factors that cause pain or discomfort. It emphasis on avoiding unsafe, unhealthy, uncomfortable and unscientific body movements at work by taking account of the physical and psychological capabilities and limitations of humans. To know the comfort level of employees with respect to HE, the factors discussed were anthropometric, work place layout, productivity related, psychological, physical stress related, leadership styles, training and work study. Each factor was comprised of a set of parameters which have a direct impact on addressing ergonomic issues.

Study conducted by Wang, J. C. Thornton et al indicate many of the reported occupational problems were caused or exacerbated by a work environment that did not fit its occupants to their from anthropometrics. It includes parameters such as body posture, body movements, physical strain etc. Optimizing the layout of a plant can improve productivity, safety and quality of Products (Hal Ettinger, 2007). It includes the parameters such as adaptability to environmental variables such as temperature comfort zone, safeguard against dehydration and heat stress etc. Empirical studies have demonstrated a positive relationship between productivity and job satisfaction of employees. (Raymond A. Katzell, Daniel Yankelovich, 1975). It
includes the parameters such as energy consumption resulting in fatigue, causes of absenteeism, healthy body healthy mind etc. Psychological factors include the parameters such as manageable work content, job rotation, formation of autonomous working groups etc. A variety of human illnesses are due to the factors related to physical stress. (George P. Chrousos, MD; Philip W. et al, 1992) It includes the parameters such as work stress, role ambiguity etc. Leadership styles and training results in man’s best performance and it is reported as the most stimulating and challenging factor leading to high degree of motivation. (Barbara B Brown, 1974.) Work study which is accepted as an international standard on the subject, work study consists of two complementary techniques: Method study and work measurement.

HE interventions adopted in various industries across the globe are administrative interventions, engineering interventions, behavioural interventions and workplace controls. Lack of comprehensive HE intervention mechanism and proper understanding on the same in small-sized firms might have denied safe human performance and the consequential productivity mileage which could have churned out of it. (Montakarn Chaikumarn, 2005; Roger C.Jensen, 2007; Shiv Pratap Singh, 2009).

Any industry is a complex human-machine-organisation system and this system consists of six major components, which are human operator, equipment, task, workplace, environment and management. Employee outcome can be measured from the efficient function of ergonomics in the system components (Shikdar et. al, 2002) The triple criteria approach of measuring employee outcome – productivity, safety and reduced musculoskeletal disorders (MSD)– have been widely used by researchers to analyze from an ergonomic perspective.(Dahalan et al, 2003.; Munck-Ulfsält et al, 2003; Joseph, 2003).

The research tries to demonstrate the linkage between HE across categories of employee and organizational characteristics. The former includes the age of the employees, biometric dimension, employment period whereas the latter covers nature of the organization and size of the firm. Though employee characteristics are inextricably linked with sound ergonomic practices yet it was not seen to be
influencing the HE scores in coir sector. These findings supplement many of the previous studies (Sen, 1984; Nancy A. Baker, 2009; Pennig S, 2010).

The specific problems of the study are as follows:

1) What are the HE factors present in the Coir industry of Kerala?

2) What are the HE interventions adopted in the Coir sector?

3) What is the independent and combined impact of HE factors and HE interventions on employee outcome?

4) What are the impact of size and sector on the HE adoption and intervention in the Coir sector?

5) What are the impacts of employee characteristics on the HE adoption and intervention in the Coir sector?

6) What are the problems in the adoption and intervention of HE in the Coir sector?

3.1.2 Objectives of the research

1) To study the extent and nature of HE factors in Coir industrial units in Kerala.

2) To study the HE intervention practices adopted in the Coir industry of Kerala and its influence on employee satisfaction at the work place.

3) To compare and contrast the human engineering measures adopted in the Coir industrial unit of the state in terms of size of units as well as in terms of the sector in which it operates (public, private sector and co-operative society)

4) To identify problems, if any, in the human engineering being adopted by coir industry in Kerala

5) To suggest a refined human machine interface model for the Coir industry in Kerala.
3.1.3 Theoretical background of the study

Review of literature in chapter 2 presents an exhaustive research on human engineering programs and their interventions in industries in and around the world.

Many researchers have explored and established a tentative negative link between workplace risk factor and employee outcome (Duffy et al., 2002; Ali Mohammad et. al., 2011). Garg and Owen (1992) demonstrated the efficacy of ergonomic intervention strategy in reducing the incidence rate of occupational injuries. Karsh et al (2006) linked a select set of measures of ergonomic factors and interventions to employee performance. Sen, 1984 developed a model looking at how the outcome of the employee is influenced by the fit between the HE factors and interventions. But these studies used a very limited set of HE factors on the employee outcome. Linkages among the workplace risk factors, organizational characteristics and the various dimensions of employee characteristics are generally overlooked in the literature.

The following conceptual model which is an adaptation of the model by Sen, 1984 at a cotton textile mill in west Bengal is hypothesized for the study with modifications to suit the inquiry. The model can show the relationships of the different constructs that the researcher wants to investigate.
3.1.4 Hypotheses

Based on the Sen Model, the researcher has formulated the following five (alternate) hypotheses on the anticipated relationship among the variables in the study.

**H1:** HE interventions have significant positive relationship with HE

**H2:** HE has significant positive relationship with employee outcome

**H3:** HE interventions have significant positive relationship with employee outcome

**H4:** HE factors varies according to employee characteristics

**H5:** HE factors varies according to organizational characteristics

3.1.5 Variables used in the study

The theoretical and operational definitions of the factors in the study are given below. It includes HE factors, indicators of employee outcome, employee characteristics and organizational characteristics. The scales used for measurement are either taken from published inventories or developed by the researcher. The scales are
tested for their validity and reliability. The scales development process and the associated statistics are described in the subsequent sections.

1. Human Engineering Factors

i. Anthropometric factors

Anthropometry is a branch of anthropology concerned with comparative measurements of the human body and its parts. The term anthropometry derives from two Greek words: anthropos meaning human, and metrikos, meaning measuring, to create a word which deals with the human body measurements that refer to body size, strength, shape, and work capacity. It refers to the measurement of the human individual capability for the purposes of understanding human physical variation. The studies indicate that not only total body fat, but also regional fat and skeletal muscle, can be predicted from anthropometrics. (Wang, J. C. Thornton, S. Kolesnik, R. N. Pierson Jr. 2006). Many of the reported occupational problems were caused or exacerbated by a work environment that did not fit its occupants (Botha and Bridger 1998). It includes the parameters such as

- Body Posture
- Body Movements
- Physical strain (such as backache, chest ache, shoulder pain)
- Rest pause
- Replenish the fluid loss

ii. Work place Layout

Plant Layout is the physical arrangement of equipment and facilities within a Plant. The Plant Layout can be indicated on a floor plan showing the distances between different features of the plant. Optimizing the Layout of a Plant can improve productivity, safety and quality of Products (Hal Ettinger 2007). It includes the parameters such as
Adaptability to environmental variables such as Temperature comfort zone.

Safeguard against dehydration and heat stress through

a) Appropriate clothing

b) Protective gear

Proper illumination which enhances the visual performance

Housekeeping areas such as

a) Ventilation

b) Odour

c) Dust and Furnes

Noise

Accessibility to the relevant parts of the workplace

Isolation

Physical safety concerns

iii. Productivity related factors

Productivity is a measure of output from a production process, per unit of input. Empirical studies have demonstrated a positive relationship between productivity and job satisfaction of employees (Raymond A. Katzell, Daniel Yankelovich 1975)

It includes the parameters such as

- Energy consumption resulting in fatigue

- Causes of absenteeism
Healthy body
Healthy mind
Skill
Effort

Nature of job (leads to monotony and fatigue due to respective task)

Fatigue which is a concern on human engineer might be caused by many factors such as overload or under load (both physiological and psychological), poor work space design, poor work method, mental worry and anxiety unhealthy and hazardous physical environment, insufficient sleep, poor posture and faulty body mechanics, etc. Rhythmic work is less time consuming than static work (S. Ganguli, 1977).

iv. Psychological factors

It includes the parameters such as

- Work content is manageable
- Job rotation exists
- Formation of autonomous working groups are supportive
- There is Scope for group work
- Satisfied with Job security
- Salary provided is adequate
- Pay increments are satisfactory
- Job enrichment is more
- There exist an efficient system of grievance redress
- Morale level is high
- Punishment in the form of Wage cut and Suspension does not exist
- Loyalty towards the firm is high
- Pride in the organization is high
- Discipline is commendable
- Employee Turnover is less

v. Physical Stress

Stress is derived from the work of Hans Selye in his book (“The Stress of life” 1956). A variety of human illnesses are due to the factors related to physical stress. (George P. Chrousos, MD; Philip W. Gold, MD 1992)

It includes the parameters such as

- Work stress is less
- Role ambiguity does not arise
- Responsibility without authority is high
- Poor relationship with others
- Participation in decision making is encouraged

vi. Leadership Styles

Leadership means making positive changes happen. Specifically, ergonomic leadership entails both maintaining those interventions that have worked in the past, while simultaneously trying new approaches that go beyond the strategic limitations of past methods (Robert F. Pater, M.A., Strategic Safety Associates 2006)
vii. Training

Training results in man’s best performance and it is reported as the most stimulating and challenging factor leading to high degree of motivation. (Barbara B Brown 1974). To prevent large variations in employee performance, effective methods of training should be adopted. Training of employees is regarded as one of the most important functions of efficient resources management (Prytherch1986). Adequate and frequent training increases individual capabilities (Dominiak 2006) Effective training in technical aspects, communication and other relevant areas can help newcomers become more effective (Deephouse et. al 2005)

viii. Work Study

According to ILO’s manual on Work study which is accepted as an international standard on the subject, work study consist of two complementary techniques: method or motion study and work measurement or time study.

Method study is the systematic recording and critical examination of prevalent and proposed ways of performing work, the objectives being development of easier and more effective methods and reduction of costs.

Work measurement is defined as the application of techniques designed to establish the time for a qualified worker to carry out a specified job at an optimum level of performance.

While method study is concerned more with the job and reduction of the work content of job or operation, work measurement addresses itself to the investigation and reduction of any ineffective time associated with it. In other words, the focus of attention of work measurement is on the worker- on his motions, and on the time taken by him in performing the various elements of his work. Therefore, work measurement and its associated techniques could draw heavily on the knowledge available in the inter-disciplinary field of human engineering.

Two bifurcations of work study are time study and motion study.
(a) Time Study

Time study is a work measurement technique for recording the times and rates of working for the elements of specified job carried out under specified conditions, and for analyzing the data so as to obtain the time necessary for carrying out the job at a pre-determined or defined level of performance. It measures how long it takes an average worker to complete a task at a normal pace. (Frederick W. Taylor 1881)

(b) Motion study

Motion Study is designed to determine the best way to complete a repetitive job (Frank B. Gilberth, Lillian M.Gilberth 1916). It can be effectively used for performance evaluations and for planning purposes in order to predict the level of output that may be achieved.

2. Human engineering interventions

Human engineering interventions involve managing and designing the work and the work environment properly through ergonomics so as to prevent work-related musculoskeletal disorders, or at least reduce their incidence and severity (Karsh B.T et al 2006). Garg and Owen (1992) defines HE interventions as an emerging discipline whose objectives are to identify, analyze and prioritize the workplace risk factors that are likely to adversely affect an employee.

HE factors and HE interventions are two important constructs for both researchers and practitioners in the area of working life of an employee. The researcher has developed a valid and reliable measure of HE factors and interventions drawing from the works of various researchers in this domain. The instrument has 39 parameters measuring HE under the following factors: anthropometry, workplace layout, productivity, psychological, physical stress, leadership styles, training, work study. Similarly there are 23 parameters measuring HE interventions under the following sub dimensions: administrative, engineering, behavioural and workplace controls. The respondent has to indicate the level of presence of each HE factors and interventions on the five point Likert scale.
3. Employee outcome

Any industry is a complex human-machine-organisation system and this system consists of six major components, which are human operator, equipment, task, workplace, environment and management. Employee outcome can be measured from the efficient function of ergonomics in the system components Shikdaret. al, (2002)The triple criteria approach of measuring employee outcome – productivity, safety and reduced musculoskeletal disorders (MSD)– have been widely used by researchers to analyze from an ergonomic perspective.(Dahalan et al, 2003.;Munck-Ulfsält et al, 2003; Joseph,2003).

The study also adopted the triple criteria approach of measuring the employee outcome in terms of productivity, health and safety and MSD. They are operationally defined as below:

a) MSD

MSD is a disorder caused (or aggravated) by either the work environment or performance of the work. It is an indicator of incompatibility in the work system. It represents a main cause for absence from occupational work.

MSD is assessed through the following formula

\[ \text{MSD} = \frac{(\text{No. of absentees} - \text{allowable limit}) \times 100}{\text{allowable limit}}. \]

In this study, the respondent is asked to report MSD as a percentage. The data on allowable limit and actual no. of absentees are also collected from the employer so that the researcher can compute and confirm the percentage value. This is done to improve the accuracy and consistency of the measurement.

b) Health and Safety

Health and safety form an integral part of work environment. It is an indicator of workplace performance. It indicates how much the physical well-being of an employee is protected. It is reported as a percentage.
Health and Safety is assessed through the following formula

\[
\text{Health and Safety} = \frac{(\text{No. of workers suffered from illness} - \text{allowable limit}) \times 100}{\text{allowable limit}}.
\]

In this study, the respondent is asked to report health and safety as a percentage. The data on allowable limit and actual no. of workers suffered from illness are also collected from the employer so that the researcher can compute and confirm the percentage value. This is done to improve the accuracy and consistency of the measurement.

c) Productivity

Productivity from an ergonomics perspective is defined as compliance of physiological and psychological factors that are expected from the workplace. (Raymond A. Katzell, Daniel Yankelovich 1975)

Operationally it is defined as how the employee is rated on the following parameters. It includes the parameters of workplace viz, Energy consumption, causes of absenteeism, healthy body, healthy mind, skill, effort, nature of job. The respondents are asked to rate the parameters on a five point Likert scale. The average score on these parameters is taken as a measure of the productivity of the employee from the workplace.

4. Employee characteristics

a) Age factor

The Age factor of the employee is measured by determining whether the employee belongs to any of the following categories, namely less aged (less than 20 years), middle aged (up to 40 years) and more aged (40 years and more).

b) Biometric dimension

Biometrics measures the physical characteristics of employees. It indicates how much the work performance is influenced by height and weight of an employee.
It is measured as one of the following: (a) low (150 cm and 50 kg) (b) medium (150-170 cm and 70 kg) (c) high (above 170 cm and 70 kg)

c) Employment period

Employment period is defined in terms of the number of years involved in the industry as a worker. It is measured as one of the following: short (less than 10 years), medium (up to 20 years) and long (20 years and more).

5. Organizational characteristics

a. Nature of the organization

The nature of the organization is measured by determining which of the following sector it belongs to: public sector, private sector, and co-operative society

b. Size of the firm

The size of the firms is measured in terms of the initial investment viz, upper, middle and lower level.

3.1.6 Nature of the study

The study describes more precisely the people at work and work methods in Coir industry in Kerala. It tries to explain how HE interfaces are linked to the productivity and safety concerns of the employees. So the research design is exploratory in nature.

3.1.7 Data required

The total number of coir units in Kerala is 7105 as on 31st March 2010 (Kerala Economic Review, 2010). The researcher had conducted interviews with the top level management professionals, Secretaries of co-operative societies and employees, who have working experiences over 5 years. The pilot study data which had representation from locations like Allapuzha, Kollam, etc also supported the view that within the industry there exist work related health hazards. Hence it was decided to assume
homogeneity across the state belonging to the industry operating under various sectors. Determinations of sample frame and sample size are explained in detail in the subsequent section.

### 3.1.8 Sample Frame and sample size

Data were collected from the three sectors in the coir industry, public sector, private sector and co-operative societies. Each sector is trifurcated into three categories, upper, middle and lower based on their initial investments. Firms with investment above 25 lakhs brought under the purview of upper level followed by middle level with investment ranges from 15-25 lakhs and lower level ranges from 5-15 lakhs.

The Kerala State Coir Corporation (KSCC) list of sector-wise distribution of Coir Industry obtained through RI Act was used for deriving the sample frame with the criteria that those units which undertakes both production and processing activities (Public, Private and Co-operative Society separately) will come under the purview of the study. Sample frame is given in table 3.1(b). The sector wise distribution of the firms is shown below in table 3.1(a).

**Table 3.1(a) Sector wise distribution of firms**

<table>
<thead>
<tr>
<th>Sector</th>
<th>Number of firms in KSCC list</th>
<th>Number of firms involved in both production and processing activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co-operative society</td>
<td>479</td>
<td>257</td>
</tr>
<tr>
<td>Sector</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public Sector</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Private Sector</td>
<td>105</td>
<td>62</td>
</tr>
<tr>
<td>Total</td>
<td>587</td>
<td>322</td>
</tr>
</tbody>
</table>

Source: KSCC list obtained through RI Act
Sample frame at three levels is derived at each sector based on proportionate sampling. Details are shown in table 3.1(b)

<table>
<thead>
<tr>
<th></th>
<th>UPPER</th>
<th>MIDDLE</th>
<th>LOWER</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Society</td>
<td>9</td>
<td>23</td>
<td>18</td>
<td>50</td>
</tr>
<tr>
<td>Public</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Private</td>
<td>1</td>
<td>3</td>
<td>21</td>
<td>25</td>
</tr>
</tbody>
</table>

From the sample frame, the researcher had set a target of 450 as sample size based on purposive sampling. Sample size larger than 30 and less than 500 are appropriate for most research is one of the rules of thumb given by Roscoe, (1975).

### 3.1.9 Data Sources

The major source of data was primary data collected from the employees of coir industrial sectors namely public sector, private sector and co-operative societies. The sectors are further trifurcated into upper, middle and lower based on their initial investments. The organization details of the respondents were collected through the secondary sources like Company manuals, Coir News and published documents in the company’s websites. To support and enrich the primary data, secondary data were also collected from published and unpublished data related to the coir industry and HE. Secondary data collected from Centre for Development Studies, Central Public Library, Institute of Management in Kerala, Department of Commerce, University of Kerala, and Directorate of Coir Development.

### 3.1.10 Data analysis

Correlation (Pearson correlation and canonical correlation) techniques are used for testing hypothesis H1 to H3 which are about relationship among metric variables. ANOVA is used for testing hypothesis H4 and H5 which check for variation of the metric dependent variable namely HE across the variables such as employee characteristics and organizational characteristics. Mean, percentage,
ranking tables, Spearman’s correlation analysis are also used for analyzing the data. Multiple regression analysis was used to develop human machine interface model for Coir industry.

### 3.1.11 Tools of the data collection

Questionnaire method was used for data collection. The form was handed over to the respondent with a covering note. Necessary instructions were also mentioned. Figure 3.1 shows the instrument development process. The details are described in the next section.
Fig. 3.1 Development and validation of the instrument

1. Explore the factors and parameters used for assessing Human engineering in industries across the globe through review of literature

2. Design of survey instrument by careful selection of the representative items

3. Modification and refinement of the instrument based on the review by experts (face validity)

4. Check for the reliability of the final instrument using SPSS
   - Cronbach alpha

5. Pilot testing of the instrument is to be carried out among three sectors to improve the instrument further

6. Modification, refinement and finalization of the instrument based on the above analysis

7. Final data collection (through field survey)
3.2 INSTRUMENT DEVELOPMENT

3.2.1. Item Generation

The focus in this phase was to develop a comprehensive instrument to measure how far HE aspects address the employee satisfaction level. This was done based on the exhaustive survey of literature described in chapter 2. As mentioned in the literature review, Sen, (1984) had developed a valid and reliable measure of ergonomics risk factors to ensure the health and safety of the workers from a manufacturing industry perspective. Following established practices of instrument development, his study developed and empirically tested a model to ensure appropriate use of human resources in the workplace. His final instrument had 44 items in the present study, Sen’s instrument was taken as the base for measuring, identify and evaluate jobs. It was appended with parameters from Joseph (2003), mentioned in chapter 2.

This resulted in a draft questionnaire with 49 parameters for HE factors and 23 parameters for HE interventions. The employee outcome was measured with 9 questions on the productivity and three questions each on safety and MSD. The respondent had to indicate each item in on a five point Likert scale (strongly disagree; disagree; neither agree nor disagree; agree and strongly agree). There were also questions covering the organizational details of the respondent.

3.2.2 VALIDITY ANALYSIS

Validity is defined as the extent to which any measuring instrument measures what it is intended to measure (Carmines and Zeller, 1990). Different validity terms are used to illustrate the various aspects of validity. Any research instrument proposed should be tested for validity, so that it could be used for meaningful analysis. The initial validity tests, namely content validity and face validity was tested for the draft questionnaire as explained below.
Content validity

Content validity of an instrument refers to the degree to which it provides an adequate depiction of the conceptual domain that it is designed to cover (Hair et al., 1998). In the case of content validity, the evidence is subjective and logical, rather than statistical. Content validity can be ensured if the items representing the various constructs of an instrument are substantiated by a comprehensive review of the relevant literature (Bohrnstedt, 1983).

The present instrument has been developed on the basis of a detailed review and analysis of the prescriptive, conceptual, practitioner and empirical literature, so as to ensure the content validity.

Face validity

Generally, a measure is considered to have ‘face validity’ if the items are reasonably related to the perceived purpose of the measure (Kaplan and Scauzzo, 1993). Face validity is the subjective assessment of the correspondence between the individual items and the concept through rating by expert judges (Hair et al., 1998). In face validity, one looks at the measure and judges whether it seems a good translation of the construct under study. Face validity is also a subjective and logical measure, similar to content validity.

The face validity can also be established through review of the instrument by experts in the field (Hair et al., 1998). The present draft questionnaire has been given to five senior professionals from the industry and five senior professors in HRM. They have been briefed about the purpose of the study and its scope. The experts have been requested to scrutinize the questionnaire and to give their impressions regarding the relevance and contents of the questionnaire. They were requested to critically examine the questionnaire, and to give objective feedback and suggestions with regard to the comprehensiveness/coverage, redundancy level, consistency and number of parameters under each factor. They were requested to make necessary changes by simplifying, rewording, removing, replacing and supplementing the items. The feedbacks from the experts lead to some modifications in terms of content, wording
and structure of some of the questions. This resulted in a questionnaire, referred to as ‘pilot questionnaire’, containing 39 parameters spanning around 8 factors representing the HE aspect of employees and 23 parameters under HE interventions. The employee outcome is now measured with nine questions on productivity and three questions each for safety and MSD.

### 3.2.3 RELIABILITY ANALYSIS

Reliability of an instrument is defined as the extent to which any measuring instrument yields the same result on repeated trials (Carmines and Zeller, 1990). It is the degree to which the instrument yields a true score of the variable (factor) under consideration. The instrument is not considered as reliable to the extent to which it contains measurement error (Neale and Liebert, 1986).

There are several methods to establish the reliability of a measuring instrument. These include test-retest method, equivalent forms, split-halves method and internal consistency method. Of all these methods, the internal consistency method is considered to be the most effective method, especially in field studies. The advantage of this method is that it requires only one administration, and consequently this method is considered to be the most general form of reliability estimation (Sureshchandar et al., 2001). In this method, reliability is operationalized as ‘internal consistency’, which is the degree of inter-correlation among the items that constitute the scale (Nunnally, 1978). The internal consistency can be estimated using a reliability coefficient called Cronbach’s alpha (α) (Cronbach, 1951). The rule of thumb for acceptable α applied in most situations should be 0.70 or higher (Cronbach, 1990).

Based on literature support, a five factor structure was accepted as the best solution. The reliability of the scale developed in the current study is tested by computing Cronbach alpha (α) value for each of the five HE factors as well as for the entire set.
The final values of Cronbach alpha for the HE are presented in Table 3.2. It can be seen from the table that all the factors have Cronbach alpha value above 0.7, which testifies the reliability of the instrument.

**Table 3.2 Results of Reliability Analysis for HE factors**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Factors of HE</th>
<th>No. of items</th>
<th>Cronbach’s Alpha (α)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ANTHROPOMETRY</td>
<td>6</td>
<td>0.7001</td>
</tr>
<tr>
<td>2</td>
<td>WORKPLACE LAYOUT</td>
<td>8</td>
<td>0.9196</td>
</tr>
<tr>
<td>3</td>
<td>PRODUCTIVITY</td>
<td>7</td>
<td>0.8466</td>
</tr>
<tr>
<td>4</td>
<td>PSYCHOLOGICAL</td>
<td>15</td>
<td>0.9196</td>
</tr>
<tr>
<td>5</td>
<td>PHYSICAL STRESS</td>
<td>5</td>
<td>0.8466</td>
</tr>
<tr>
<td><strong>Overall fit</strong></td>
<td></td>
<td><strong>41</strong></td>
<td><strong>0.9536</strong></td>
</tr>
</tbody>
</table>

Source: Computed

Cronbach alpha (α) values are computed for the HE interventions. Table 3.3 shows the final reliability scores obtained for HE interventions which comprises of four factors. As seen, all factors as well as the overall scale have Cronbach alpha above the acceptable threshold of 0.7.

**Table 3.3 Results of Reliability Analysis for HE interventions**

<table>
<thead>
<tr>
<th>Sl No</th>
<th>HE interventions</th>
<th>No. of Items</th>
<th>Cronbach’s Alpha (α)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ADMINISTRATIVE INTERVENTIONS</td>
<td>8</td>
<td>0.8630</td>
</tr>
<tr>
<td>2</td>
<td>ENGINEERING INTERVENTIONS</td>
<td>6</td>
<td>0.8309</td>
</tr>
<tr>
<td>3</td>
<td>BEHAVIOURAL INTERVENTIONS</td>
<td>4</td>
<td>0.7663</td>
</tr>
<tr>
<td>4</td>
<td>WORK PRACTICE CONTROLS</td>
<td>5</td>
<td>0.6742</td>
</tr>
<tr>
<td><strong>Overall fit</strong></td>
<td></td>
<td><strong>23</strong></td>
<td><strong>0.9765</strong></td>
</tr>
</tbody>
</table>

Source: Computed
3.2.4 Pilot Test

In the light of the data collected and the insight gained from the pilot study carried out among DC Mills from private sector, Foam Mattings India Ltd from public sector and The New Model Coir Mats and Matting Co-operative Society Ltd No.524 from the co-operative sector, necessary changes were made in the interview schedule initially developed for the study.

The interview schedule was divided into two sections.

Section I was meant for collecting data about various company details such as Date of commencement, Nature of business, Nature of Products /Services, Total employment. Initial investment, Operating results for the last 5 years.

Section II was devised for collecting the views of employees about the different levels in respect of variables in Human Engineering.

Initially respondents were highly hesitant, suspicious about the nature of interview, totally reluctant to give adequate information for the specific questions and sometimes showing a negative attitude. Stiff competitions from the rival companies were cited as one of the reasons for not revealing the data. The data collected from the pilot groups was first scrutinized to identify the no response questions and if more than 80% of the respondents did not respond to a question, it was identified as a candidate to be removed or reworded.

3.2.5 Instrument for final survey

The final instrument was developed from the pilot study questionnaire, after all the modifications and corrections. The final instrument had 39 parameters spanning around 8 factors representing the HE aspect of employees and 23 parameters under HE interventions. The respondents were asked to indicate to what extent these parameters fit to their work environment. The respondent had to indicate the presence of each factors and its corresponding parameters on a five point Likert scale (strongly disagree, disagree, agree, strongly agree and no opinion).
The instrument was organized in three parts. Part A had 7 questions related to the details of coir units functioning in Kerala. Part B had 39 parameters presented in the order of importance. This part also contains 7 questions on HE interfaces to know the preferences among employees. Part C had the 23 HE intervention variables again presented in the order of importance. The instrument is shown in Annexure 1.

3.3 SUMMARY OF THE CHAPTER

The chapter presented various aspects of research methodology used in the study. It also explained the questionnaire development process. The draft questionnaire prepared based on literature review was edited by experts to improve its content and face validity. This tool was used for the pilot study carried out among private sector, cooperative sector and public sector firms. The pilot questionnaire was further scrutinised based on the non-response data. After the initial validity tests, namely content validity and face validity and reliability tests by computing Cronbach alpha (\(\alpha\)), the final instrument to be used for the final survey was developed. The instrument was scheduled to administer to a target sample size of 450 employees from among three sectors of coir industry.