CHAPTER 4

DEVELOPMENT OF A SURVEY INSTRUMENT

4.1 INTRODUCTION

Drivers of various vehicles while performing their work, expose them to a variety of risk factors that may cause musculoskeletal disorder of the spinal system. Apart from personal pain and annoyance, these symptoms and disorders result in the loss of very many working days, with consequent loss of industrial production and increased welfare payments by governments. Therefore, the design of an instrument for the assessment of potential environmental ergonomic risk factors and musculoskeletal disorders of spine is an essential requirement for conducting a cross-sectional study. Development of a LBD prevalence model for vehicle drivers requires thorough understanding of the workplaces under study and the LBD prevalence among those drivers. Single Decker bus drivers, Volvo AC bus drivers, Container lorry drivers, Lorry drivers and Tractor drivers are chosen for this research work in order to investigate the workplace environmental ergonomics. A thorough literature review helped us in identifying the relevant LBD variables. Using the variables, a LBD prevalence model is conceived. The details of the model, development of the instrument and validation through pilot study, are discussed in this chapter.

4.2 AN LBD ENVIRONMENTAL ERGONOMIC RISK FACTOR MODEL

Based on the thorough review of literature on LBD prevalence for vehicle drivers as presented in chapters 2 and 3, an LBD environmental
ergonomic risk factor model to investigate the LBD prevalence level among vehicle drivers has been developed and is given in Figure 4.1.

The constructs of the model are Intensity of WBV, Posture, Road Condition, Seat Condition, Discomfort, Drive Duration, Break Duration, Psychosocial Work Aspect and Psychosocial Personal Aspect. It is hypothesized that above factors contribute LBD among vehicle drivers. The level of LBD would be a raising slope. It is also hypothesized that prevention of Activities and Medical Intervention due to prevalence of LBD among employees is having positive association. These relationships are depicted in Figure 4.1.

Figure 4.1 Potential risk factor model for LBD prevalence level
4.3 KEY OPERATING ELEMENTS (ITEMS) OF LBD CONSTRUCTS FOR VEHICLE DRIVERS

The use of constructs in designing a survey instrument has played an important role in management research (Prajogo & Sohal 2003). Constructs are latent variables that must be measured indirectly through a set of observed indicators/variables. Constructs, rather than the individually observed indicators, enhance our conceptual understanding of the investigated phenomena (Kerlinger 1986).

The researcher after frequent interaction with the vehicle drivers to verify the critical reviews of the elements arrived after a thorough literature survey, decided to conceive this instruments. The researcher has come up with 33 operational items for LBD constructs. The operating elements included under each LBD constructs are discussed in the following section.

4.3.1 Intensity of Whole Body Vibration (IWBV)

IWBV1. Vibration perceived during driving

IWBV2. Vehicle jerking experienced during driving

IWBV3. Vehicle jolting experienced during driving

4.3.2 Posture (P)
4.3.3 Road Condition (RC)

RC1. Condition of the driving road surface
RC2. Type of the driving road surface
RC3. Speed of vehicle while driving

4.3.4 Seat Condition (SC)

SC1. Occurrence of seat bottom while driving
SC2. Opinion about the seat comfort
SC3. Mechanical seat suspension provided in the seat
SC4. Air seat suspension provided in the seat
SC5. No seat suspension
SC6. Seat has arm rest
SC7. Seat has adjustable lower back support

4.3.5 Discomfort (D)

D1. Vertical vibration experienced by mechanical vibration or shock in work
D2. Fore-aft vibration experienced by mechanical vibration or shock in work
D3. Side-to-side vibration experienced by mechanical vibration or shock in work

4.3.6 Drive Duration (DD)

DD1. Duration of travel everyday
DD2. Duration of drive everyday
DD3. Vibration affected duration in the work day

DD4. Duration of stationary time or crawling during driving

4.3.7 Break Duration (BD)

BD1. Break duration during the work day

BD2. Activities of Break duration

4.3.8 Psychosocial Work Aspect (PSWA)

PSWA1. Choice of deciding how to do the work

PSWA2. Choice of deciding what to do at work

PSWA3. Choice of deciding work timetable and breaks

4.3.9 Psychosocial Personal Aspect (PSPA)

PSPA1. Help and support from colleagues during difficulties in work

PSPA2. Help and support from supervisor during difficulties in work

PSPA3. Job satisfaction in the work

4.3.10 Indicators for Measuring Lower Back Disorder Symptoms (LBD Prevalence Level)

LBD1. Prevalence of low back trouble (ache, pain or discomfort)

LBD2. Duration of low back trouble in last 7 days

LBD3. Duration of low back trouble in last 12 months

LBD4. Extent of low back trouble in last 7 days

LBD5. Extent of low back trouble in last 12 months
4.3.11  **Indicators for Measuring Prevention of Activities (PA) due to LBD Prevalence**

**PA1.** Prevention of normal activities (job, house work, hobbies) due to trouble in lower back in last 7 days.

**PA2.** Prevention of normal activities (job, house work, hobbies) due to trouble in lower back in last 12 months

**PA3.** Change of job due to low back trouble

4.3.12  **Indicators for Measuring Medical Intervention (MI) due to LBD Prevalence**

**MI1.** Consultation with Doctor for the low back trouble in the last 12 months

**MI2.** Type of treatment prescribed by the doctor for the low back trouble

**MI3.** Hospitalization due to low back trouble

**MI4.** Hospitalization due to trauma in the back

4.4  **MEASURING INSTRUMENT**

Based on the literature survey, nine dimensions (sections 4.3.1 to 4.3.9) pertaining to LBD prevalence among vehicle drivers consisting of 33 items explaining the nine dimensions were included to design a questionnaire (Appendix 1 – English version, Appendix 3- Tamil version).

An instrument for assessing the low back pain prevalence level from vehicle operator’s perspective was designed. All the items were derived by the synthesis of indicators proposed in the environmental ergonomics
literature, combined with personal experiences and many hours of ponderous thinking by researchers.

The perception in combining a number of indicators was that this would provide a more comprehensive picture of environmental ergonomic practices by building upon the range of indicators proposed in literature. This in turn reflects the features of environmental ergonomics as a comprehensive approach. By a comprehensive review of literature and based on the brainstorming with experts in transport department, an attempt has been made and the instrument has been developed with 33 items in order to maximally address all the aspects of LBD with respect to various dimensions. A multi-dimensional scaling technique was used.

This study took cue from Pope et al (2002b), Magnusson et al (1998) and Mccalling et al (2010) and prepared comprehensive survey questionnaire with five-point Likert’s scale. (Questions on suspension type, availability of arm rest and back rest in the construct seat condition was framed as dichotomous questions (yes or no type) in items SC3. to SC7.)

The designed questionnaire consists of eight sections: A – Personal information, B – Occupational History (details of past and present job), C - Intensity of WBV, D – Posture, E – Work environment, F - Duration, G – Psychosocial Factors, H – Health information of lower back disorder.

The questions concerning personal information and occupational history sought details about physical characteristics, educational qualification, monthly income, exercise habit, smoking, Pan/tobacco chewing habit and alcohol consumption as factors that could confound the true effect of the nine variables selected for investigation.
The questions regarding intensity of WBV were in terms of jerk, jolt and intensity of vibration experienced during driving duration.

Those regarding the posture were in terms of five different possible configurations of torso (torso against backrest, torso straight, torso bent forward, torso twisted and torso bent and twisted) and five possible frequency of occurrence (never, seldom, occasionally, often, always). Figure 4.2 shows the various seating postures adopted by the drivers.

1. Torso Against Backrest  2. Torso straight  3. Torso Bent Forward
4. Torso Twisted  5. Torso bent & Twisted

Figure 4.2 Seating Postures
The questions regarding work environment were in terms of road condition (very good to very bad), type of road (National Highway to city road), style of driving (very even to very fast), discomfort from different modes of vibration (vertical, fore-aft and side to side vibration), seat details (suspension type, availability of arm rest, backrest and seat comfort ability). Figure 4.3 to 4.5 shows the various types of seat suspension.

Figure 4.3 Mechanical Suspension System
Figure 4.4 Air Suspension system

Figure 4.5 Seat Frame without suspension
Information about the duration of vibration gathered by asking details of duration of travel, driving, excess vibration affected period, stationary or crawling time and break period during working time.

Psychosocial factor was addressed by questions regarding job control, social support from colleagues/supervisors and job satisfaction (Always to Never).

The questions concerning lower back health sought details on presence of LBP (less than 8 hrs to always), severity of pain and prevention of activities (very mild to most severe) in past 7 days and past twelve months and consulting doctor for treatment (Never to Always).

4.5 FACE VALIDITY

The face validity is that on mere appearance, it can be seen that a measure is valid and reflects the constructs. As the constructs are identified from the literature, their selection is justified, thereby ensuring the face validity of the instrument.

4.6 CONTENT VALIDITY

A measure has content validity if there is a general consensus among researchers that the instrument includes items covering all aspects of the variables being measured. Since all the operating items under occupational history, low back pain prevalence level, intensity of whole body vibration and posture etc., were included through literature survey and subsequently approved qualitatively and objectively by experts in the relevant field (academic researchers, industrial engineering faculty and transport department faculties). These items are said to have strong content validity.
4.7 PRELIMINARY SURVEY

To validate the questionnaire, data were collected from 100 bus drivers in Tamilnadu through a preliminary survey. The questionnaire was given to 120 members but only 105 were collected. The non-response number was only 15. Out of questionnaires that were collected, 5 were not usable due to insufficient and/or incomplete data. As a result, 100 valid questionnaires were used for the analysis. Since the response rate was high (83%), the dismissal of rejects has no consequence. Statistical Package for Social Sciences (SPSS) version 17.0 was used for all statistical computations. Unidimensionality, reliability and discriminant analysis were conducted and questionnaire was validated.

4.8 SCALE REFINEMENT AND VALIDATION

Development of good measure to obtain valid and reliable estimates of the constructs of interest is important. Without establishing reliability and validity, it is difficult to standardize the measurement scales and find out whether they really measure what they are intended to measure. Therefore, the survey instrument developed by the researcher was assessed in terms of reliability and validity. Reliability refers to the instrument’s ability to provide consistent results in repeated cases, where as validity refers to the degree, the instruments measure the concept the researcher wants to measure. The validity of an instrument is commonly assessed using these characteristics: content, construct validity, reliability and discriminant validity.

4.8.1 Construct Validity

Unidimensionality was used to assess the construct validity. It is the extent to which observed indicators are strongly associated with each other and represent single concept. Principal component method was employed to
extract single component. The result of factor analysis is given in Table 4.1. All the loading values are in the range of 0.45 – 0.98, explaining 52% to 91% of total variance which is considered good for construct validity. Thus, out of 79 items included in the study, 60 items were retained in the instrument for further study.

Table 4.1 Unidimensionality Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>No. of items used</th>
<th>No. of items retained</th>
<th>Loading Range</th>
<th>Eigen value</th>
<th>% Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intensity of WBV</strong></td>
<td>3</td>
<td>3</td>
<td>0.780-0.840</td>
<td>1.412</td>
<td>70.62</td>
</tr>
<tr>
<td><strong>Posture</strong></td>
<td>5</td>
<td>3</td>
<td>0.643-0.844</td>
<td>1.570</td>
<td>52.34</td>
</tr>
<tr>
<td><strong>Work Environment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road condition</td>
<td>3</td>
<td>2</td>
<td>0.951</td>
<td>2.101</td>
<td>30.021</td>
</tr>
<tr>
<td>Seat condition</td>
<td>2</td>
<td>2</td>
<td>0.849-0.893</td>
<td>1.437</td>
<td>20.531</td>
</tr>
<tr>
<td>Discomfort</td>
<td>3</td>
<td>3</td>
<td>0.644-0.859</td>
<td>1.809</td>
<td>25.841</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Drive duration</strong></td>
<td>4</td>
<td>4</td>
<td>0.671-0.922</td>
<td>2.247</td>
<td>32.045</td>
</tr>
<tr>
<td><strong>Break duration</strong></td>
<td>2</td>
<td>2</td>
<td>0.643-0.844</td>
<td>1.318</td>
<td>28.172</td>
</tr>
<tr>
<td><strong>Psychosocial factors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSWA</td>
<td>3</td>
<td>3</td>
<td>0.628-0.822</td>
<td>2.399</td>
<td>39.98</td>
</tr>
<tr>
<td>PSPA</td>
<td>3</td>
<td>3</td>
<td>0.673-0.790</td>
<td>1.806</td>
<td>18.11</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>28</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
It can be seen from Table 4.1 that

- Out of 5 items of posture, 3 items are extracted to a single factor. The percentage of variance is 52.34. P1 (Torso against backrest posture adopted while driving) and P5 (Torso bent and twisted posture adopted while driving) are deleted due to poor loading.

- Out of 3 items in Road condition, 2 items are extracted to a single factor. The percentage of variance is 30.021. RC3 (Speed of vehicle while driving) is deleted due to poor loading.

- In other variables (Intensity of WBV, Seat Condition, Discomfort, Drive Duration, Break Duration, Psychosocial Work Aspect, Psychosocial Personal Aspect) all items are retained.

It can also be seen from the Table 4.1 that all the loading values are in the range of 0.628-0.951, explaining 52% to 76% of total variance which is considered good for construct validity. In all, out of 28 items included in the study, 25 items are retained in the instrument for further study and 3 items are deleted due to poor loading in the factor analysis.

4.8.2 Reliability Analysis

A cronbach’s alpha for the environmental ergonomic risk factors and rationale ratings were calculated using the ratings of the items to determine the internal consistency of those ratings (Portney & Walkins 2000). The result of reliability analysis is given in Table 4.2. An examination of the cronbach alpha for scales revealed that they were in the 0.714 to 0.972 ranges for nine dimensions. Reliability values of 0.70 and above are considered very
good (Nunnally 1970) for scale reliability. Thus all the scales developed in the study are reliable.

Table 4.2 Results of Reliability and Discriminant analysis

<table>
<thead>
<tr>
<th>Factor</th>
<th>No. of items</th>
<th>Alpha</th>
<th>Average Interscale Correlation (AVISC)</th>
<th>Discriminant Validity (Alpha-AVISC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensity of WBV</td>
<td>2</td>
<td>0.778</td>
<td>0.412</td>
<td>0.366</td>
</tr>
<tr>
<td>Posture</td>
<td>3</td>
<td>0.744</td>
<td>0.274</td>
<td>0.470</td>
</tr>
<tr>
<td>Road Condition</td>
<td>2</td>
<td>0.885</td>
<td>0.831</td>
<td>0.054</td>
</tr>
<tr>
<td>Seat Condition</td>
<td>2</td>
<td>0.723</td>
<td>0.571</td>
<td>0.152</td>
</tr>
<tr>
<td>Discomfort</td>
<td>3</td>
<td>0.774</td>
<td>0.403</td>
<td>0.371</td>
</tr>
<tr>
<td>Drive duration</td>
<td>4</td>
<td>0.723</td>
<td>0.495</td>
<td>0.228</td>
</tr>
<tr>
<td>Break duration</td>
<td>2</td>
<td>0.740</td>
<td>0.279</td>
<td>0.461</td>
</tr>
<tr>
<td>Psychosocial Work Aspect</td>
<td>3</td>
<td>0.780</td>
<td>0.414</td>
<td>0.366</td>
</tr>
<tr>
<td>Psychosocial Personal Aspect</td>
<td>3</td>
<td>0.714</td>
<td>0.232</td>
<td>0.482</td>
</tr>
</tbody>
</table>

4.8.3 Discriminant Validity

Discriminant validity refers to the degree to which a construct and its indicators differ from another construct and its indicators. The results of Discriminant validity is given in Table 4.2. Cronbach’s alpha versus average inter scale correlations with positive difference indicates the discriminant validity. On examination of the values it is found that the scales developed in the study exhibit strong discriminant validity.
VALIDATED INSTRUMENT AND ITS KEY OPERATING ELEMENTS

The instrument designed in the study, has been subjected to various validation tests (Items with 5 point Likert scale). Out of 28 items, 25 items are retained in the instrument. Apart from this, few items are modified and some items are removed. The details are given in Table 4.3 and questionnaire after these modifications is given in Appendix 3 (English version) and Appendix 4 (Tamil version). Thus, out of 79 items included in the study, 60 items are retained in the instrument for further study.

Table 4.3 Alterations in questionnaire item and description of alterations

<table>
<thead>
<tr>
<th>Items</th>
<th>Description of alterations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal and General information</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Do you exercise regularly?</td>
</tr>
<tr>
<td>2</td>
<td>How often each week do you engage in any vigorous exercise program or work out?</td>
</tr>
<tr>
<td></td>
<td>Since item 1 &amp; 2 are similar and intended towards habit of exercise. Only item 1 is retained and item 2 is deleted</td>
</tr>
<tr>
<td>1</td>
<td>Do you smoke?</td>
</tr>
<tr>
<td>2</td>
<td>When did you start smoking regularly?</td>
</tr>
<tr>
<td>3</td>
<td>Do you still smoke?</td>
</tr>
<tr>
<td>4</td>
<td>If no, when did you give up smoking regularly?</td>
</tr>
<tr>
<td></td>
<td>Since item 2, 3 &amp; 4 are intended towards habit of smoking Only item 1 is retained and items 2, 3 &amp; 4 are deleted</td>
</tr>
<tr>
<td>1</td>
<td>Do you chew Pan/Tobacco?</td>
</tr>
<tr>
<td>2</td>
<td>When did you start chewing Pan/Tobacco?</td>
</tr>
<tr>
<td>3</td>
<td>Do you still chew Pan/Tobacco?</td>
</tr>
<tr>
<td>4</td>
<td>If no, when did you give up chewing Pan/Tobacco?</td>
</tr>
<tr>
<td></td>
<td>Since item 2, 3 &amp; 4 are intended towards habit of chewing Pan/Tobacco Only item 1 is retained and items 2, 3, &amp; 4 are deleted</td>
</tr>
</tbody>
</table>
### Table 4.3 (Continued)

#### Occupational History - Previous Job(s)

<table>
<thead>
<tr>
<th></th>
<th>Question</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>What was/where your previous occupation(s)?</td>
<td>Item 1, 2 &amp; 3 are modified as single item, “Do you drive vehicles in previous occupation?”</td>
</tr>
<tr>
<td>2</td>
<td>Did you drive in your previous jobs on vehicle like trucks, buses, fork lifts, earth moving equipment etc?</td>
<td>For item 1.b, almost similar answer ‘No’ is obtained from pilot study, so only item 1.a is retained</td>
</tr>
</tbody>
</table>
| 3 | Yes….. No…..  
If Yes, Vehicle Name……..  
No of years………..                                                                                              | For item 1, almost similar answer ‘No’ is obtained from pilot study, so, item 1 is removed |

#### Occupational History - Present job

<table>
<thead>
<tr>
<th></th>
<th>Question</th>
<th>Notes</th>
</tr>
</thead>
</table>
| 1 | Do you drive any kind of vehicle in your present job? (ie car, bus, van, truck, train, tram, helicopter, other)  
Yes[ ] No[ ]                                                                 | Since, ‘No’ answer in item 1, itself indicate non-driving occupation  
Item 3 is deleted. Items 1 and 2 are retained. |
| 2 | If yes  
Type of vehicle……..                                                                                                                  |                                                                      |
| 3 | If no  
What is your current occupation……….                                                                                                   |                                                                      |

#### Personal Medical History

<table>
<thead>
<tr>
<th></th>
<th>Question</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Have you ever had to change jobs or duties because of low back trouble?</td>
<td>Almost similar answer ‘No’ is obtained in pilot study, hence, this item is dropped.</td>
</tr>
<tr>
<td>1</td>
<td>Have you ever had a trauma to you back that required a medical test?</td>
<td>Almost similar answer ‘No’ is obtained in pilot study, hence this items is dropped.</td>
</tr>
</tbody>
</table>
4.10 CONCLUSION

Based on the variables identified in the study, an LBD model has been developed. Using 28 operating elements, an instrument for eliciting data has been designed. Using the instrument a preliminary survey has been conducted and results are discussed in this chapter. Content validity, Construct validity, Reliability tests were conducted and the instrument designed for measuring LBD prevalence level amongst the vehicle drivers has been validated for final use. Out of 28 items, 25 items are retained. (for item with 5 point Likert scale). Based on the pilot study results, some modifications and deletion of items are carried out (on dichotomous or open ended items). Finally, out of 79 items included in the study, 60 items are retained in the instrument for further study. The results of the final survey are discussed in the next two chapters.