Work-related Musculoskeletal Disorders in the Philippine Garments Industry

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CHAPTER 1: PROBLEM RATIONALE

➢ History of the Philippine Garments Industry
  ▪ Started in the 1950s
  ▪ Backyard Industry

➢ Multi-Fabric Agreement (MFA)
  ▪ In the 1970s, MFA between the Philippines and the USA, EU and Canada
  ▪ Preferential treatment to Philippine garments where a fixed quota was provided
  ▪ Export-Oriented
  ▪ Garments and Textile Export Board (GTEB)
CHAPTER 1: PROBLEM RATIONALE

- Competitiveness in the Post-Quota Regime
  - Phase out of MFA in 2005
  - Detrimental for the Industry.
Philippine Garments and Textile Exports
(Source: NSO)
- Labor Cost
Table 77 – Comparative Wages in Asian Countries: As of October 31, 2013

<table>
<thead>
<tr>
<th>Country</th>
<th>Daily Minimum Wages</th>
<th>Exchange Rate Per US$1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In Country Currency</td>
<td>In US$</td>
</tr>
<tr>
<td>Cambodia (Cambodian Riel)</td>
<td>8,496.41</td>
<td>2.03</td>
</tr>
<tr>
<td>China/Shenzhen (Yuan Renminbi)</td>
<td>29.00 - 50.00</td>
<td>4.73 - 8.16</td>
</tr>
<tr>
<td>Hong Kong (HK Dollar)</td>
<td>240.00</td>
<td>30.95</td>
</tr>
<tr>
<td>Indonesia/Jakarta (Rupiah)</td>
<td>27,683.33 - 73,333.33</td>
<td>2.47 - 6.55</td>
</tr>
<tr>
<td>Japan (Japan Yen)</td>
<td>5,160.00 - 6,696.00</td>
<td>52.52 - 68.15</td>
</tr>
<tr>
<td>Malaysia (Ringgit)</td>
<td>26.67 - 30.00</td>
<td>8.46 - 9.51</td>
</tr>
<tr>
<td>Myanmar</td>
<td>500.00</td>
<td>0.51</td>
</tr>
<tr>
<td>Philippines/Metro Manila (Peso)</td>
<td>429.00 - 466.00</td>
<td>9.93 - 10.79</td>
</tr>
<tr>
<td>Philippines/III (Peso)</td>
<td>285.00 - 336.00</td>
<td>6.60 - 7.78</td>
</tr>
<tr>
<td>Philippines/IV-A (Peso)</td>
<td>255.00 - 349.50</td>
<td>5.90 - 8.09</td>
</tr>
<tr>
<td>Philippines/VII (Peso)</td>
<td>282.00 - 327.00</td>
<td>6.53 - 7.57</td>
</tr>
<tr>
<td>South Korea (Won)</td>
<td>38,880.00</td>
<td>36.63</td>
</tr>
<tr>
<td>Taiwan (Taiwan Dollar)</td>
<td>634.90</td>
<td>21.58</td>
</tr>
<tr>
<td>Thailand/Bangkok (Baht)</td>
<td>222.00 - 300.00</td>
<td>7.13 - 9.64</td>
</tr>
<tr>
<td>Vietnam (Dong)</td>
<td>46,666.67 - 66,666.67</td>
<td>2.21 - 3.16</td>
</tr>
</tbody>
</table>

Source:  
CHAPTER 1: PROBLEM RATIONAI

- Technology
  - Automatic patter-maker software and hardware
  - Automated sewing process
  - Automated embroidery process
- Electricity Cost
  - The Philippine electricity rate is comparable to Japan
CHAPTER 1: PROBLEM RATIONAL

- ASEAN 2015 Integration
  - Garments Industry is one of the 9 industries to receive government support under the Manufacturing Industry Roadmap

How Can The Philippine Garments Industry become Competitive?
- Uncontrollables
- Controllable: Management of Operations
  - Inventory Management, MRP, ERP
  - Scheduling, Logistics
  - Work Design
    - Ergonomics
Work-related Musculoskeletal Disorders (WMSD)

- One of the areas in the industry where improvements could be carried out
- Definition: Musculoskeletal disorders are “injuries and disorders of the muscles, nerves, tendons, ligaments, joints, cartilage and spinal discs.”
CHAPTER 2: RESEARCH QUESTION

- Review of Related Literature
  - Competitiveness in the Industry
  - Cost of WMSD
    - Occupational Safety and Health Administration (USA)
      - Work-related musculoskeletal disorders (MSDs) are the most widespread occupational health hazard facing the USA.
      - Nearly two million workers suffer work-related musculoskeletal disorders every year.
• Median number of lost workdays associated with these incidents is **seven days**.
• The direct costs attributable to MSDs total **$15 to $18 billion per year**, with indirect costs (such as resulting management costs or the cost of production losses) increasing the costs to employers to more than **$45 billion** (an average of $135 million per day).

- **WMSD in Different Industries**
  - Construction Industry
  - Mining Industry
  - Health Care Industry
WMSD in the Garments Industry

- Awkward Postures
- Repetitiveness
- Long Working Hours

- Other Risk Factors Causing WMSD
  - Environmental Factors
    - Illumination
    - Heat
    - Sound Level
Conceptual Framework – Model 1

Variables which may cause WMSD's
- Psycho-social Factors
- Worker Factors
- Environmental Factors
- Physical Factors

Body parts which may be affected by WMSD's
- Neck,
- Shoulder, Upper/Lower Arm,
- Hand/Wrist, etc.

Response Variable: Pain from WMSD's
- Frequency Rate
- Severity Rate
- Combined Frequency and Severity Rates

Research Outputs
- Variables Causing Pain from WMSD
- Development of Models to Predict "Pain Level" from WMSDs
- Recommended Model to Predict "Pain Level" from WMSDs
Conceptual Framework – Model 2

**MODEL NO. 2**

- **Variable which may cause Loss Time**
- **Response Variable:** Breaktimes
- **Research Output**
  - Development of Model to Predict "Breaktimes" expended due to pain from WMSDs
  - Recommended Ergonomic Intervention

- **Pain Level from WMSD's**
- **Minutes per Hour**
Research Questions

What are the significant risk factors of WMSDs which cause pain among sewing machine operators in the garments industry

Model 1
Hypothesis Testing (Example)

$H_0$: $B_{X_1} = 0$; the variable “Demand” has no relationship with the “Pain Level” from WMSDs

$H_1$: $B_{X_1} \neq 0$; the variable “Demand” has a relationship with the “Pain Level” from WMSDs

Where $B_{X_1}$ is the coefficient of the variable $X_1$, “Demand”

Model 2
Hypothesis Testing

$H_0$: $B_{X_1} = 0$; the variable “Pain Level” has no relationship with the “Breaktimes”

$H_1$: $B_{X_1} \neq 0$; the variable “Pain Level” has a relationship with the “Breaktimes”

Where $B_{X_1}$ is the coefficient of the variable $X_1$, “Pain Level”
• What are the Ergonomic Interventions which could reduce or minimize “Pain Level” from WMSDs among sewing machine operators in the Garments Industry?
CHAPTER 3: RESEARCH METHODS

Research Design – Correlation-Prediction Type

Variables Under Consideration

- Independent Variables
  - Psychosocial Risk Factors
    - Demand
    - Control
    - Manager’s Support
    - Peers’ Support
    - Relationship
    - Change
- **Environmental Risk Factors**
  - Illumination Level
  - Heat Stress Index
  - Sound Level
- **Physical Risk Factors**
  - Awkward Postures
  - Duration of Awkward Posture
  - Repetition of Task
  - Force Exertion
  - Vibration
  - Personal Workplace Layout
  - Facility Layout
Worker Risk Factors

- Gender of the Operator
- Age of Operator
- Weight of the Operator
- Height of the Operator
- Average number of working hours per day
- Years of Work Experience
- Marital Status
- No. of Children
- Education Background
- Additional jobs
- Workplace Layout
- Facility Layout
- Type of Breaktime Preferred
- Degree of Difficulty of Sewing Task
- No. of Minutes of Breaktime per Day
- Salary per Month
• Dependent Variables
  • Model 1: “Pain Level”
    • “Pain Level” (combination of Severity and Frequency Rates)
    • Human Body Areas Involved
  • Model 2: “Breaktimes” or Work Interruption
Human Body Representation

A. NECK
B. SHOULDER
C. UPPER BACK
D. ELBOW
E. FOREARM
F. HAND
G. LOWER BACK
H. HIP
I. LEG
J. KNEE
K. LOWER LEG
L. ANKLES
M. FEET
Site Selection and Sample Size Determination

- Small and Medium Scale Garments Industry
  - Magna Carta: these firms should have assets (excluding land value where the facility is situated) not going beyond ₱20,000,000.
  - Industrial Sewing Machine Operators
  - Study is limited to Upper Garments: T-shirt, Polo Shirt and the like

- Sample Size
  - Formula (Source: ILO, Geneva, Switzerland)
Data Gathering, Measures and Instrumentations

- Survey Forms:
  - Screener Questionnaire
  - Survey Questionnaires

- Other Survey Tools
  - Work Sampling
  - Rapid Entire Body Assessment (REBA)

- Environment Measurement Tools
  - Sound Level Meter
  - Light Meter
  - Heat Stress Index Meter
Data Measurement and Instrumentation for Independent Variables
<table>
<thead>
<tr>
<th>RISK FACTOR</th>
<th>UNIT OF MEASUREMENT</th>
<th>INSTRUMENT USED FOR MEASUREMENT</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. Psychosocial Risk Factors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rating:</td>
<td>1-Strong Agree, 2-Agree, 3-Disagree 4-Strongly Disagree</td>
<td>Survey Questionnaire</td>
<td></td>
</tr>
<tr>
<td><strong>II. Environmental Risk Factors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Illumination</td>
<td>Lux or Foot-Candle</td>
<td>Lux Meter</td>
<td>Standards on Appendix V</td>
</tr>
<tr>
<td>b. Heat Stress Index</td>
<td>Celsius</td>
<td>WBGT Meter</td>
<td>Standards on Appendix VI.</td>
</tr>
<tr>
<td>c. Sound level</td>
<td>Decibel</td>
<td>Sound Level Meter</td>
<td>Standards on Appendix VII.</td>
</tr>
</tbody>
</table>
### III. Physical Risk Factors

<table>
<thead>
<tr>
<th>Physical Risk Factors</th>
<th>Measurement Details</th>
<th>Assessment Tool(s)</th>
<th>Referenced Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Posture and Force</td>
<td>Rapid Entire Body Assessment (REBA) Value</td>
<td>Work Sampling, REBA Employee Assessment Worksheet and REBA Tally Sheet per Operator</td>
<td>Worksheet on Appendix XII</td>
</tr>
<tr>
<td>b. Duration of Awkward Posture</td>
<td>Percentage</td>
<td>Work Sampling and REBA Tally Sheet per Operator</td>
<td></td>
</tr>
<tr>
<td>c. Repetition</td>
<td>Rating: 1-no repetition, 4-highly repetitive</td>
<td>Survey Questionnaire</td>
<td></td>
</tr>
<tr>
<td>e. Personal Workplace Layout</td>
<td>Rating: 1-Strongly Agree, 2-Agree, 3-Disagree, 4-Strongly Disagree</td>
<td>Survey Questionnaire</td>
<td></td>
</tr>
<tr>
<td>f. Facility Layout</td>
<td>Rating: 1-Strongly Agree, 2-Agree, 3-Disagree, 4-Strongly Disagree</td>
<td>Survey Questionnaire</td>
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</tr>
<tr>
<td>IV. Worker Risk Factors</td>
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<tr>
<td>------------------------------------------------</td>
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<td></td>
</tr>
<tr>
<td>a. Gender</td>
<td>Male or Female</td>
<td>Survey Questionnaire</td>
<td></td>
</tr>
<tr>
<td>b. Age</td>
<td>Years</td>
<td>Survey Questionnaire</td>
<td></td>
</tr>
<tr>
<td>c. Weight</td>
<td>Kilos</td>
<td>Weighing Scale</td>
<td></td>
</tr>
<tr>
<td>d. Height</td>
<td>Centimeters</td>
<td>Steel Tape Measure</td>
<td></td>
</tr>
<tr>
<td>e. Ave. No. of Working Hours</td>
<td>Hours</td>
<td>Survey Questionnaire</td>
<td></td>
</tr>
<tr>
<td>f. Years of Work Experience</td>
<td>Years</td>
<td>Survey Questionnaire</td>
<td></td>
</tr>
<tr>
<td>g. Educational Background</td>
<td>Choice:</td>
<td>Survey Questionnaire</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-Elementary Grad., 2-High School Grad., 3-Vocational Grad., 4-College Grad.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. Marital Status</td>
<td>Choice:</td>
<td>Survey Questionnaire</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-Single, 2-Married, 3-Divorced/Widowed,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. No. of Children and Dependents</td>
<td>Numerical Value</td>
<td>Survey Questionnaire</td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Type</td>
<td>Survey Questionnaire</td>
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<td>-------------------------------------------------------------------------</td>
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<td></td>
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<tr>
<td>j. No. of Other Jobs Providing Additional Income</td>
<td>Numerical Value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>k. No. of Minutes of Physical Exercises/wk.</td>
<td>Minutes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>l. No. of Minutes of Breaktime/day</td>
<td>Minutes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>m. Type of Breaktime Preferred</td>
<td>Choice: Choice:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-Short, frequent</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2-long, seldom breaktimes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n. Degree of Difficulty of Sewing Task</td>
<td>Rating: Rating:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-Very easy, 2-Easy,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3-Difficult, 4-Very</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Difficult</td>
<td></td>
<td></td>
</tr>
<tr>
<td>o. Monthly Salary</td>
<td>Peso Value</td>
<td></td>
<td></td>
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</tbody>
</table>
Data Measurement and Instrumentation for Dependent Variables
<table>
<thead>
<tr>
<th>RESPONSE VARIABLE</th>
<th>UNIT OF MEASUREMENT</th>
<th>INSTRUMENT</th>
<th>REMARK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Rate (FR)</td>
<td>Rating: 1-No incidence,</td>
<td>Survey Questionnaire</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4-High Frequency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severity Rate (SR)</td>
<td>Rating: 1-No pain,</td>
<td>Survey Questionnaire</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4 -Too painful</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combination of FR and SR</td>
<td>Rating: 1/13 – Min. 16/208</td>
<td>Survey Questionnaire</td>
<td>Each body part: 1-16; Whole body:</td>
</tr>
<tr>
<td>(CFRSR) or “Pain Level”*</td>
<td>- Maximum</td>
<td></td>
<td>13-208</td>
</tr>
<tr>
<td>“Breaktimes” **</td>
<td>Minutes/hour</td>
<td>Survey Questionnaire</td>
<td></td>
</tr>
</tbody>
</table>

* Dependent variable in the Model No. 1. Independent variable in the Model No. 2.
** Dependent variable in the Model No. 2
Ethical Considerations

- Permission from Companies
- Permission from Respondents
  - Survey Questionnaire
  - Observation
  - Measurement of Worker Factors
  - Environmental Data Gathering
- Confidentiality of Information from Respondents
  - Number system to identify operator, instead of the name of the same
Chapter 4: Data Analysis

• Cronbach’s alpha
  – For internal reliability of subjective questions under the Psycho-social Risk Factors
• Multiple Regression using SPSS
• Model 1
  – Model 1A
Model 1A

\[ \hat{y} = -31.681 + 10.236x_{30} + 15.467x_{15} + 13.788x_{31} + 5.619x_{6} - 6.722x_{23} \]

Where
\[ \hat{y} = \text{Estimate of Pain Level from WMSD} \]
\[ x_{30} = \text{Independent Variable, Type of Breaktime Preferred} \]
\[ x_{15} = \text{Independent Variable, Gender} \]
\[ x_{31} = \text{Independent Variable, Degree of Difficulty of Sewing Task} \]
\[ x_{6} = \text{Independent Variable, Empowerment} \]
\[ x_{23} = \text{Independent Variable, Company Policies} \]
Model 1A

• Model 1A Indicators
  – Individual Significance
  – Model Significance: Analysis of Variance (ANOVA)
  – R-Square: 30.20%
  – Root Mean Square Error: 16.46

• Further Improvement?
Model 1B

\[ \hat{y} = -34.059 + 10.335x_{30} + 15.263x_{15} + 13.689x_{31} + 1.304x_{6}^2 - 1.268x_{23}^2 \]

Where

\( \hat{y} \) = Estimate of “Pain Level” from WMSD

\( x_{30} \) = Independent Variable, “Type of Breaktime Preferred”

\( x_{15} \) = Independent Variable, Gender

\( x_{31} \) = Independent Variable, Degree of Difficulty of Sewing Task

\( x_{6} \) = Independent Variable, Empowerment

\( x_{23} \) = Independent Variable, Company Policies
Model 1B

• Model 1B Indicators
  – Individual Significance
  – Model Significance: Analysis of Variance (ANOVA)
  – R-Square: 32.20% (from 30.20%)
  – Root Mean Square Error: 16.37 (from 16.46)

• Further Improvement?
Model 1C

• Checking for Outliers
  – Data from respondents who might give undue influence on the regression model
  – Leverage
  – Cook’s Distance
  – SPSS Box-and-Whiskers Plots

• From 93 respondents, 83 respondents’ data were used for Model 1C
Model 1C

- Model 1C

\[ \hat{y} = 36.817 + 12.540x_{30} + 11.225x_{15} + 14.640x_{31} + 0.917x_{6}^2 \]

Where

\( \hat{y} \) = Estimate of “Pain Level” from WMSD
\( x_{30} \) = Independent Variable, “Type of Breaktime Preferred”
\( x_{15} \) = Independent Variable, Gender
\( x_{31} \) = Independent Variable, Degree of Difficulty of Sewing Task
\( x_{6} \) = Independent Variable, Empowerment
Model 1C

• Model 1C Indicators
  – Individual Significance
  – Model Significance: Analysis of Variance (ANOVA)
  – R-Square: 32.90% (from 32.20%)
  – Root Mean Square Error: 14.36 (from 16.37)

• Assumptions Satisfied
  – 1. Linearity between Observed and Predicted values of Pain Level
  – 2. Homoscedasticity: constancy of residuals across values of predicted values
  – 3. Normality of Residuals
  – 4. Normality of Q-Q Plots
  – 5. Multicollinearity
Model 2

• Linear Regression
  – IV: “Pain Level”
  – DV: “Breaktimes”

• Looking for Relationships
  – Linear ?
  – Quadratic ?
  – Cubic ?
  – Logarithmic ?
  – Inverse ?
Recommendations

• Type of Breaktime Preferred – short time and frequent breaktimes bring out lesser “Pain Level” among operators.

• Degree of Difficulty of Sewing Task – more difficult sewing task bring about higher “Pain Level” to operators.

• Gender – female operators experience higher “Pain Level” compared to male operators.

• Empowerment – lesser empowerment of operators effect higher “Pain Level” among them.
For Further Study

• Determination of more IVs to increase R-square/Adjusted R-square
• Increase sample size
Thank you.