Predictive Models of Work-Related Musculoskeletal Disorders (WMSDs) Among Sewing Machine Operators in the Garments Industry

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Date Received: December 16, 2014; Dare Revised: February 11, 2015

Abstract: *The Philippine garments industry has been a driving force in the country's economy, with apparel manufacturing firms catering to the local and global markets and providing employment opportunities for skilled Filipinos. Tight competition from neighboring Asian countries however, has made the industry's situation difficult to flourish, especially in the wake of the Association of Southeast Asian Nations (ASEAN) 2015 Integration.*

To assist the industry, this research examined one of the more common problems among sewing machine operators, termed as Work-related Musculoskeletal Disorders (WMSDs). These disorders are reflective in the frequency and severity of the pain experienced by the sewers while accomplishing their tasks. The causes of these disorders were identified and were correlated with the frequency and severity of pain in various body areas of the operator. To forecast pain from WMSDs among the operators, mathematical models were developed to predict the combined frequency and severity of the pain from WMSDs. Loss time or "unofficial breaktimes" due to pain from WMSDs was likewise forecasted to determine its effects on the firm's production capacity. Both these predictive models were developed in order to assist garment companies in anticipating better the effects of WMSDs and loss time in their operations.

Moreover, ergonomic interventions were suggested to minimize pain from WMSDs, with the expectation of increased productivity of the operators and improved quality of their outputs.

Keywords:*Work-related Musculoskeletal Disorders, Risk Factors, Ergonomic Interventions, Severity and Frequency of Pain, Predictive Models*

INTRODUCTION

Musculoskeletal Disorders (MSDs) are broadly categorized as joint diseases, physical disability, spinal disorders and conditions resulting from trauma, according to the European Commission[1]. They are prevalent in any workforce as workers engage themselves in diverse activities. From the sedentary work-style in the office, prolonged sitting in the garment industry, to the strenuous activities in construction sites, transportation and shoe sectors, MSD is one of the main health problems faced by every employee today. MSD is characterized by an inability to perform activities in the work place due to repetitive use of movement or maintenance of awkward postures which cause fatigue, muscle weakness, swelling and decline in work performance. Other risk factors include repetition and dynamic forces which lead to work-related injuries and diseases including MSD, thus the term work-related musculoskeletal disorders or WMSDs. Other than the above causes of WMSD, there are others that are considered noteworthy: the characteristics of work environment and practices, and the inherent and unique characteristics of the workers[2].Aside from the aforementioned risk factors, other possible causes of WMSDs in the various industries have been mentioned in an article by the Canadian Center for Occupational Health and Safety[3].To mention some of them, which have also been said in other articles, these are physical factors, such as repetitiveness of task and its pace of work, force of movements of workers, vibration in the workplace; environmental risk factors such as temperature in the workplace; and psycho-social issues such as communications flow in the organization, control in one's work, monotony of work and support from peer and management.

Furthermore, in an article entitled Musculoskeletal Disorders in Great Britain,[4] said article mentioned that age, gender and workplace size could have significant effects on musculoskeletal disorders. The article further showed various statistics on the prevalence of these disorders on the different body areas

In a study by Tokuc, [5] whose research was made in textile firms, which have similarities in the garments industry, he mentioned several worker risk factors which can have a significanteffect on work-related musculoskeletal disorders. These are gender, age, height, educational background, marital status, employment period, working hours, physical exercises and even smoking.

In today's world of tight competition, formation of trade blocks, integration of economies and the like, opportunities for improvement should always be considered by business firms. This study has seen an opportunity to improve the sector by analyzing WMSDs among the sewing machine operators in the said sector. To be more specific, this study is highly significant due to the following:

1. Considering the competitiveness in the industry, especially with the ASEAN 2015 integration, productivity studies geared toward the same industry would be highly relevant. Given that cost is one major factor in the area of competitiveness, this study is very relevant as it could decrease the costs brought about by WMSDs.

2. One of the two mathematical models (which are both predictive in nature) developed by this study could be used as a tool to forecast the pain level due to WMSDs affecting the sewing machine operator. The prediction of this pain level (which incorporates severity and frequency of pain) would be very helpful for management to individually assess their operators a. and carry out strategies to reduce the pain theoperator experience. Similarly, the same model would be utilized to determine the variables or risk factors which bring about pain from WMSDs. Management of apparel companies could therefore use these information to develop action plans to address the concerned risk factors causing pain.

3. The second model developed by this study would forecast the break times brought about by the pain from WMSDs. These break times are assumed to take place whenever the operator stops working and instead rests, does body stretching or simply walks around to relieve himself/herself of the pain from WMSDs. These breaktimes data would be very important for the company's production planners since the said planners would be able to know in advance, on an individual and group bases the unproductive time of the operators and thus, can incorporate these information on the company's production capacity. The early determination of the firm's production capacity will lead to better planning of manpower, machines, materials and other resources, thereby delighting customers in terms of costs, quality and quantity.

OBJECTIVES OF THE STUDY

Based on literature reviews, WMSDs, in various severities and frequencies, have indeed been experienced by many workers and in almost all industries. Thus, the questions for this study do not argue anymore the existence of WMSDs in the garments industry, but rather how said disorders affect the operators. The questions being raised by this research, which are parallel to the objectives of this project, have been segregated based on the Primary and Secondary Questions, and then further divided based on the two models presented.

Primary Questions:

a. **Model 1**: What are the variables which cause pain from WMSDs among sewing machine operators in the garments industry?

Model 2: Does the variable "Pain Level" from WMSD have a relationship with "Breaktimes" expended by the operators due to WMSD's?

b. What mathematical model could be developed to predict the "Pain Level" due to WMSDs and the "Breaktimes" expended by the operator to relieve himself/herself of the pain from WMSDs.

Secondary Question

What are the ergonomic interventions that could be suggested to avoid or minimize the "Pain Level" from WMSDs among sewing machine operators and thus improve productivity of operators and quality of outputs?

METHODS

Cronbach's Alpha

Output from the SPSS software for Cronbach's is 0.70, which is the minimum number of acceptability to prove internal reliability for the survey questions, specifically those which have to do with Psycho-Social Factors.

Research Design

The research design that this study utilized is the Causal type. This project makes an in - depth analysis

P-ISSN 2350-7756 | E-ISSN 2350-8442 | www.apjmr.com

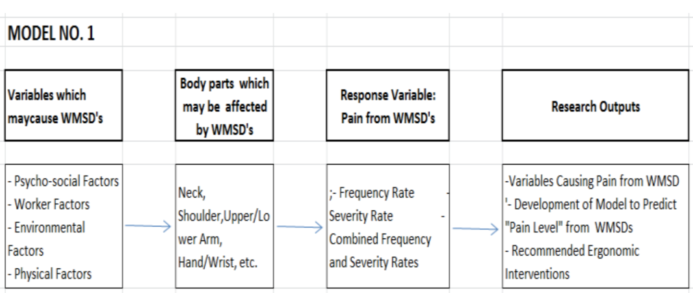
of the “cause” and “effect” of the variables considered in this study. “Causes” of pain from WMSDs, based on literature, may be any or all of the following: psych-social risk factors, worker risk factors, environmental risk factors and physical factors. The “effect” would be the pain brought about by WMSDs experienced by the operators.

Another “cause” and “effect” procedure, which this study similarly analyzed, has to do with the pain from WMSDs as the “cause” and the break times as the “effect”. In as much as operators may stop from working to relieve themselves of the pain from WMSDs, this work stoppage will bring about loss or unproductive time, which will affect the company’s productivity.

For this study, two mathematical models or equations were developed. One would be a predictive model to determine the “Pain Level” (which includes severity and frequency) to be experienced by the sewing machine operator. Before the process of developing this model, the different variables which may have an effect on the “Pain Level” were be identified and measured accordingly. After measurements have been gathered, the data for both dependent and independent variable were subjected to the Multiple Regression statistical technique. The outputs of this software were: the significant variables causing the pain and after a series of tests, the mathematical model to forecast the “Pain Level”.

The process of developing the second model is basically the same as that of the first, except that a Linear Regression statistical tool was utilized, instead of a Multiple Regression technique used for the first model. The variable “Pain Level” which was used in the first model as the dependent variable has become the independent variable instead for this second model. The dependent variable for this second model is thus the “Breaktimes”, which has been described earlier.

Figure 1 is the Theoretical Framework of this study, illustrating the flow on how this project would be carried out.



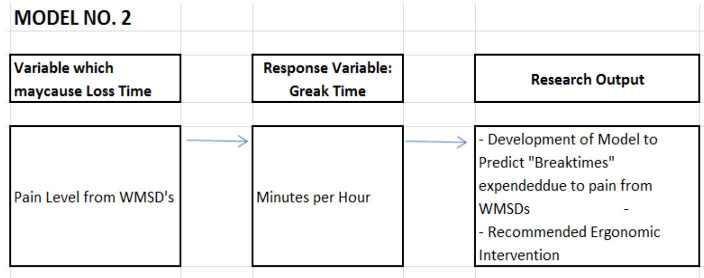


Figure1. Theoretical Frameworks for Model Numbers 1 and 2

Participants

This study was conducted in small and medium garment enterprises (SME) in Metro Manila, whose description, based on the Magna Carta for SmallEnterprises,” [8], are those which have assets,excluding land, amounting to P20 million pesos and below.

As for the sample size for this research, the equation came from Elder[11] who used the same equation for a study which she did for the International Labor Organization.Based on a 95% confidence level and a 5% error, the minimum sample size required for this study is 73 operators.

Before administering the survey questionnaire, a screener questionnaire was first answered by the respondents. The objective of this screener questionnaire is to determine if the respondent’s musculoskeletal disorder, if any, is work-related. If the musculoskeletal disorder is not work-related, the operator concerned should be replaced by another one. If the respondent does not experience any WMSD, said operator was still considered a part of the study.

Considering the possibility that not all operators, who were given survey questionnaire, are qualified (based on the Screener Questionnaire mentioned above) for this study or that operators will deliberately not answer the survey questionnaire, this study distributed the questionnaire to a total of 123 operators. After collating and analyzing all accomplished questionnaires (main questionnaire and screener survey), a total of 93 operators were considered for this study, which is above the 73 operators required.

Sewing machine operators who are involved in this study are those who are using industrial sewing machines. Though 5 organizations were visited for this study, operators from two firms, one located in Tondo, Manila, while the other in PotreroMalabon, were considered as the respondents for this study.

Variables Under Consideration

The following are the major categories and the specific number of the independent variables (IVs) used in this study

a. Psycho-social Risk Factors – 10 IVs
b. Environmental Risk Factors – 3 IVs
c. Physical Risk Factors - 6 IVs
d. Worker Risk Factors – 15 IVs

The following are the response or dependent variables used in this research: Frequency Rate, Severity Rate,Combined Frequency and Severity Rate or “PainLevel”, and “Breaktimes”

RESULTS AND DISCUSSION

Regression Model 1

After performing Stepwise Regression on 1 dependent variable (Pain Level) and 34 independent variables, only 5 independent variables came out to be significant, with its p-value less than the set level of significance (alpha) of 0.05

These 5 significant variables are: Type of Break time Preferred, Gender, Degree of Difficulty of Sewing Task, Empowerment and Company policies

Comparing the level of significance (alpha), which is equal to 0.05 and ANOVA’s p-value or “Sig.”, which is less 0.001 this research can conclude that the first Regression Model 1 (Equation 1), which is,

$$\hat{y} = -31.681+0.236x_{30}+15.467x_{15}+13.788x_{31}+5.619x_{6}-6.722x_{23}$$
(Equation 1)

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

is useful in predicting “Pain Level”. For this model as well, the Coefficient of Determination (R-square) is 30.2%. This means that 30.2% of the variability in the “Pain Level” could be explained by the variability in the 5 significant independent variables.

Improvements in the Model 1

The R-square for the Regression Model 1 is 0.302. This value can be improved by checking further the relationship between the dependent variable, “Pain Level” and each of the 5 independent variables identified earlier. Upon analysis, improvement in R-square was achieved by transforming into square the values of the variables, “Empowerment” and “Company Policies”, and consequently having new variables called “Empowerment-square” and “Company Policies-square”. Through these transformations, the R-square improved to 32.2% as seen from Table 3.

Table 3. Model Summary for Model 1

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.568[a]	.322	.283	16.838

a. Predictors: (Constant), Gender, Type Of Breaktime, empower_square, copol_square, Degree Of Difficulty Of Sewing Tasks

Checking for Outliers

As part of the process of finalizing the mathematical model, outliers which are deemed to have undue influence on the regression line, were analyzed and if necessary, removed from the set of observations. This is to be done to have a regression model that is a representative of the data.

One of the common methods used to check for outlier influence is called Leverage. This is a measure of the distance of an observation/respondent from the center of the data. If the distance is quite far, the observation/respondent might have a potential influence on the regression model and therefore, should be removed. Employee no. 28, 31, 73, 21, 107 were removed after using the Leverage technique.

Cook’s Distance is also another measure, whose objective is the same as that of Leverage. For an observation/respondent to be included in the data set, Its Cook’s Distance value should not be greater than 1.0. For this paper, no respondent in the data set has a value greater than 1.0. (Please see Table 4.)

Table 4. Cook’s Distance from SPSS

	N	Minimum	Maximum	Mean	Std. Deviation
Cook's Distance	93	.00000	.42071	.0138086	.04535654
Valid N (listwise)	93				

The software SPSS also automatically identifies respondents with highest and lowest outliers in terms of error (These respondents are 73, 80, 96, 47, 97 and 62, and the same were removed from the set of observations. Thus, a total of 10 observations/respondents were removed from the set of data to be used for this research, with the final sample size now equal to 83.

Final Regression Model 1

In view that outliers have been removed in the previous steps, another regression equation was generated. In this new regression model, there was no more respondent who was removed from the data set. Similarly, in this last model, the independent variable, "Company Policies-square" was removed since it was no longer statistically significant. Thus, below is the final actual regression equation,

Model 1:

$\hat{y} = -36.817 + 12.540x_{30} + 11.225x_{15} + 14.640x_{31} + 0.917x_6^2$

(Equation 2)

Where

$\hat{y}$ = Estimate of Pain Levelfrom WMSD

x_{30} = Independent Variable, Type ofBreaktime Preferred

x_{15} = Independent Variable, Gender

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

x_6 = Independent Variable, Empowerment-square

Table 5 below, which was taken from the SPSS output shows the new p-values/"Sig" values of the four independent variables, having a significant relationship with the independent variable, "Pain Level".

Table 5. Coefficients for Model 1

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-36.817	14.200		-2.593	.011
Type of Breaktime Preferred	12.540	3.020	.386	4.152	.000
Gender	11.225	3.728	.297	3.011	.004
Degree of Difficulty of Sewing Task	14.640	4.505	.326	3.250	.002
Empowerment -_square	.917	.396	.222	2.317	.023

$R = .568$. $R^2 = .329$, Adjusted $R^2 = .295$; $F = 8.267$, $p = .000$

Assumptions for Final Regression Model 1

To check if the last regression model, Model 1,followed the assumptions for regression models, the following tests were carried out: Linearity between Observed and Predicted values of Pain Level, Homoscedasticity, Normality of Residuals, Normalityof Q-Q Plots and Multicollinearity.

From the output of the software, all the above assumptions were satisfied.

Analysis of Errors

An analysis of the difference between the actual and the estimated (from the model) "Pain Level" values was carried out to determine how close the two mentioned values are. From the 83 respondents, the "error" was computed by subtracting the estimated value from the actual "Pain Level" value. After which, these errors were made into a Histogram for interpretation purposes. Below is Table 6 showing the composition of the errors as represented through a Histogram procedure.

From the same Table 6, it can be seen that more than one-third of the errors (36.14%) are within the range where the same errors are very small or none at all, which is a good indicator of the model's accuracy. Other interpretations can be seen on the same.

Table 6. Details of Histogram of Errors

LOWER BOUNDARY	UPPER BOUNDARY	FREQUENCY	PERCENT	REMARKS (with zero error indicating a perfect prediction)
-56	-46	1	1.20	1.20% of the errors are within the -56 to -46 error value range
-45	-35	1	1.20	1.20% of the errors are within the -45 to -35 error value range
-34	-24	4	4.82	4.82% of the errors are within the -34 to -24 error value range
-23	-13	10	12.05	12.05% of the errors are within the -23 to -13 error value range
-12	-2	15	18.07	18.07% of the errors are within the -12 to -2 error value range
-1	9	30	36.14	36.14% of the error are within the -1 to 9 error value range
10	20	22	26.51	26.51% of the errors are within the -10 to -20 error value range

Analysis of Predictive Model.

The model labelled Equation2 can be used to predict "Pain Level" of sewing machine operators. Upon determination of a respondent's "Gender" and his/her reply to a short survey about the "Type of Breaktime Preferred," "Degree of Difficulty of Sewing Task" and "Empowerment", organizations can easily forecast the pain level the operator will experience. A sample calculator in Table 7 is illustrated for one's guidance and appreciation. This predictive know-how of a firm will be very helpful in individually determining who among its employees are prone to high pain levels. This knowledge can in turn allow organizations to carry out pro-active strategies to minimize this pain level among the operators.

Though the ANOVA for the final model shows that the said model is very useful, with "Sig" less than 0.001, it is important to take note that R-square is only 32.9%. This means that only 32.9% of the variation in "Pain Level" could be explained by the 4 significant, independent variables namely, "Gender", "Type of Breaktime Preferred", "Degree of Difficulty of Sewing Tasks" and "Empowerment-Square".

In this light, it is recommended that future researchers may want to improve this study by looking for other significant variables which have a relationship with "Pain Level", and in the process, increasing the value of R-square or the new model's fit to the data.

Table 7. Estimated "Pain Level" Calculator

INDEPENDENT VAR.	COEFFICIENT	RESPONSE	AIN LEV	REMARKS
(Constant)	-36.817		-36.82	
Type of Breaktime Preferred	12.54	2	25.08	1: short time but frequent 2: long time but seldom
Gender	11.225	2	22.45	1:Male 2: Female
Degree of Difficulty of Sewing Task	14.64	2	29.28	1: Very Easy 2: Easy 3: Difficulty 4: Very Diffic.
Empower_square	0.917	9	8.253	Statement: Operators are given the power to make decisions regarding their tasks. 1:Very agreeable 2: Agreeable 3: Disagreeable 4: Very Dis.
	ESTIMATED PAIN LEVEL		48.246	Low Risk

INTERPRETATION	
1-13	No Risk
14-52	Low Risk
53-117	Medium Risk
118-208	High Risk

Ergonomic Interventions

1. Type of Breaktime Preferred

From the results of the data analysis, when operators carry out short but frequent breaktimes, the same operators experience low pain levels. This is supported by an article by Lombardi, [12] which stated that short, frequent rest breaks bring about higher output from the operators and lesser chances of injuries for the same.

Given that the total breaktime normally practiced in an organization is around one hour and twenty minutes, a suggested distribution scheme of this80 minutes is recommended to effect short and frequent breaks, assuming that work starts at 8 am and ends at 5 pm. The distribution of the 80 minutes below is also based in Lombardi's article [12] which stated that around 3-9 minutes of rest per hour is suitable.

1. First break: 8:50 am – 9:00 am
2. Second break: 9:50 am –10:00 am
3. Third breaktime: 10:50 am –11:00 am
4. Fourth breaktime: 12:00 nn –12:30 pm
5. Fifth breaktime: 1:50 pm – 2:00 pm
6. Sixth breaktime: 2:50 pm – 3:00 pm

2. Empowerment

Results of the data analysis show that when operators are less empowered, they experience high pain levels. Individually, operators may hesitate to do changes in his/her workplace design, layout and others. The operator may feel that any changes which he/she does may lead to disciplinary action, insubordination or worst, being fired from the organization.

Hence, to empower these operators to be pro-active in making their work more safe, efficient and effective, it is suggested that management allows the formation of small teams of operators from the same work area, whose main objective is to study their own workplace and then give suggestions to management on how to improve productivity and quality in their own work area.

3. Degree of Difficulty of Sewing Task

Different types of garments entail different sewing techniques. From the data analysis results, the more difficult the sewing tasks are, the higher pain level the operators experience. Training, through a buddy system or mentoring is recommended as a means of making the sewing tasks easier for the operators. Since operators are paid per operation/piece, the mentors or those who will conduct the training, are suggested to be given honorarium, to compensate for the time they will spend on training their co-workers.

Regression Model 2

The procedure for determining regression Model 2 is not as complicated as that of Model 1 since Model 2 is just a simple linear regression equation. For this model, the dependent variable in Model 1, "Pain Level", is now considered as the independent variable, while the dependent variable is the "Breaktimes". "Breaktimes" refers to the "unofficial" breaktimes that the operators spend in order to relieve themselves of the pain from WMSD's. This may also be referred to as "loss time".

Table 8. Relationships and Parameters Model 2

Dependent Variable: log Breaktime

Equation	Model Summary					Parameter Estimates	
	R Square	F	df1	df2	Sig.	Constant	b1
Linear	.015	1.014	1	68	.317	.674	-.002
Logarithmic	.007	.495	1	68	.484	.816	-.059
Inverse	.001	.095	1	68	.759	.571	1.000
Quadratic	.022	.758	2	67	.473	.567	.003
Cubic	.025	.560	3	66	.643	.429	.011
Compound[a,b]	.	.	.	.	.	.	.
Power[a,b]	.	.	.	.	.	.	.
S[a,b]	.	.	.	.	.	.	.
Growth[a,b]	.	.	.	.	.	.	.
Exponential[a,b]	.	.	.	.	.	.	.
Logistic[a,b]	.	.	.	.	.	.	.

Table 8 shows that no relationship or "Equation" could best describe the two variables. This is obvious by looking at the "R-square" and "Sig" columns. All "R-square" values are quite small, indicating that "Pain Level" cannot be used to predict "Breaktimes".

Analysis of "Breaktimes"

This refers to the time that the operator spends in order to relieve himself/herself of the pain from WMSDs. These rest periods are done outside of the official breaktimes and therefore can be considered as loss or unproductive time.

This dependent variable used in this model was similarly analyzed on its own through a Histogram.

Table 9. Details of Histogram of "Breaktimes"

LOWER BOUNDARY	UPPER BOUNDARY	FREQUENCY	PERCENT	REMARKS
0	2	42	45.16	45.16% of the operators rest for 2 min at most to relieve themselves of pain from WMSD's
3	5	42	45.16	45.16% of the operators rest for 3-5 min to relieve themselves of pain from WMSD's
6	8	0	0.00	No operator rest for 6-8 min to relieve themselves of pain from WMSD's
9	11	4	4.30	4.30% of the operators rest for 9-11 min to relieve themselves of pain from WMSD's
12	14	0	0.00	No operator rest for 12-15 min to relieve themselves of pain from WMSD's
15	17	4	4.30	4.30% of the operators rest for 15-17 min to relieve themselves of pain from WMSD's
18	20	1	1.08	1.08% of the operators rest for 18-21 min to relieve themselves of pain from WMSD's

Table 9 shows the details of the Histogram. From the table mentioned, it can be seen that out of 93 respondents, 84 respondents or around 90% spend anywhere from 0 to 5 minutes per hour resting to relieve themselves of the pain fromWMSDs. In the same table, it can be further dedused by specifying that 45% of the operators take unofficial breaks for 2 minutes at most per hour (16 minutes per 8-hour workday) and the same percentage for 5 minutes at most per hour (40 minutes per 8-hour workday).

Table 10. Details of Histogram of "Breaktimes"

NO. OF EMPLOYEES		50		
NO. OF WORK HOURS (MIN.)		600		
STD. TIME(MIN./PC.)		1		
STD. TIME (min./pc.)	WORK HOURS (MIN)	OUTPUT	90 PERCENT	REMARKS
1	600	600	27,000	WITHOUT "BREAKTIMES"
			45 OPERATORS	
1	584	584	13,140	WITH 2 MINUTES "BREAKTIMES"
			45 OPERATORS	
1	560	560	12,600	WITH 5 MINUTES "BREAKTIMES"
		SUM OF OUTPUT WITHOUT "BREAKTIMES"	27,000	pcs/day
		SUM OF OUTPUT WITH "BREAKTIMES"	25,740	pcs/day
		DEFICIENCY*	**1,260**	**pcs/day**

****Production deficiency per day if "Breaktimes" are not incorporated.***

From an organization's viewpoint, these information on loss time would be very relevant in terms of planning production capacity. The planners would now be in a better position to be able to incorporate these information into the firm's production forecasts, which in turn, will determine if the firm would need to either increase or decrease workforce capacity, to satisfy customer requirements.

Table 10 shows an example on how these "Breaktimes" will affect production output if it is not incorporated in the forecast

CONCLUSION

A multiple linear regression model was seen as an inadequate model to start with. Though the 5 independent variables which initially came out from the SPSS output were very significant and so was the initial regression model, Model 1, the R-square of the said regression was quite small, at 30.2%. Though further, curve-fitting procedures were done, such as using the quadratic relationship between "Pain Level" and the other significant variables, and the use of Leverage technique, Box-and-Whisker Plots and Cook's Distance were likewise carried out, not much improvement in the model's fit to the data took place. R-square increased only from 30.2% to 32.9% Thus, the final 4 significant variables and their effect to "Pain Level" are described as follows: a. Type of Breaktime Preferred – short time and frequent breaktimes bring out lesser "Pain Level" to operators; b. Degree of Difficulty of Sewing Task – more difficult sewing task bring about higher "Pain Level" to operators; c. Gender – female operators experience higher "Pain Level" compared to male operator; and d. Empowerment – lesser empowerment of operators effect higher "Pain Level" among them.

Various relationships or equations for Model 2, such as linear, logarithmic and others, were used to determine if a relationship exist between "Breaktimes" and "Pain Level" The p-value of the "Pain Level" whether a linear, logarithmic, inverse, square/quadratic or cubic relationship was used, was very insignificant as seen from Table 8.

Informal discussions with the sewing machine operators and medical practitioners revealed that indeed, "Pain Level"and "Breaktimes" may not necessarily have a relationship. Accordingly, different people have different "Pain Level" tolerance and "Breaktimes" scheduling. A person who might have high pain levels and high pain tolerance levels may actually need only a few minutes of "Breaktimes". On the other hand a person who might have low pain levels and low pain tolerance levels might need more numberof minutes of "Breaktimes" to relieve himself/herself of the pain from WMSDs. It is this variability that this study further justifies that "Pain Level" does not really have a relationship with "Breaktimes".

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