A Predictive Model of the Severity of Musculoskeletal Disorders among Poultry Layer Workers

Ma. Janice J. Gumasing
School of Industrial Engineering and Engineering Management
Mapua Institute of Technology
Intramuros, Manila 1002, Philippines

Abstract

Poultry Industry is one of the fastest growing sectors of the Philippine agriculture today. The production of eggs and chicken layer has increased by 10.14% and 6.57% from the 2011 growth rates to 2012, respectively. Though there is a tremendous growth in poultry industry and already providing employment to about 90,000 farmhands in Philippines, the poultry industry ranked ninth among the different industries with high occupational injuries due to musculoskeletal disorders. The main objective of this study is to formulate an equation to predict the severity of musculoskeletal disorders that the poultry layer workers have been experiencing. This is done by analyzing the literature review, respondent survey and ergonomics assessment results (NMQ, CMDQ, RULA, NIOSH, etc.), and statistical study. Stepwise Regression Technique and Residual Analysis were done after analyzing the gathered data. Another output of this study is the design of the automatic feeder. The design is based from the analysis of the study and formulated predictive equation. To fully accomplish the design, Quality Function Deployment (QFD) matrix, and Product Costing were completed. The result of the final model was being tested in the poultry farm to validate the usability issues, safety measures and its function. Time and Motion Study was used to analyze the improvements in the standard time of the feeding task. It is concluded that feeding using the automatic feeder is more stress-free, time-saving and convenient when compared with the existing manual feeding of the poultry workers.

1. Introduction

1.1. Background of the Study

The poultry industry, despite some ups and downs over the years, is a fast growing sector in the Philippine agriculture. According to the Bureau of Agricultural Statistics (2012), the Philippine poultry production went up by 4.62%. The subsector shared 14.28% in the total agricultural production. Gross earnings of the subsector amounted to Php121.7 billion (as of September 2012), higher by 4.82% from the 2011 record. Chicken production was translated to 3.18% growth in the gross value of production while the gross output values of chicken eggs increased by 10.14%. Chicken egg production in the Philippines is a minor industry compared to the broiler sector that takes center stage in the Philippine chicken trade. But the chicken layer sector had the most growth in which the population of chicken layer increased by 6.57% from 2011 level of 30.46 million birds to 32.46 million birds in 2012.

Because of the continuous growth of chicken layer sector, it already provides employment to about 90,000 farmhands, managers, traders, market vendors and transit/store helpers. There are about 1000 egg farmers in the country where 70% are from Luzon, 15% are from Visayas and 7% are from Mindanao. Poultry sector has maximum number of laborers who are working and performing most of the activities manually. Poultry work involves considerable degree of manual efforts which are associated with body movements. According to the US Bureau of Labor Statistics-US Department of Labor (2011), poultry industry ranked ninth among the industries with high occupational injuries due to musculoskeletal disorders. Since the poultry industry ranked 9th in the US, it is expected that it is ranked much higher in the Philippines. This is for the obvious reason that Filipinos are not fully aware of the cause of this disorder.

It is clear that musculoskeletal disorders can become serious and can cause injuries to the men that work every day at poultry facilities. (Hammock, 2010) Poultry workers, who spend most of the time in buildings therefore, experience the greatest amount of exposure and are at greatest risk. (Srivastava and Vats, 2012) They perform different activities manually and mechanically. Their jobs are physically demanding and involve the main risk factors because of repetitive motion, heavy physical work load and excessive body motion which can result in high risk for back injury, neck, shoulders, arms and upper limbs. MSDs produce major impacts to the workers in which 60%-75% loss in their productivity happens due to absenteeism. (Lotters, 2005). According to the statistical data of median days away from work, poultry industry has the highest number of days away from work among the industries with high occupational injuries due to MSDs.

1.2. Review of Previous Literature

Some studies dealt with MSD reductions in the poultry processing industry. Ergonomic guidelines for the prevention of MSDs for poultry processing have been implemented to address the need of focus on particular hazards in the workplace. This helps the poultry industry to form an effective occupational safety and health practices in their work (Berry et al, 2009). Others are about the solving strategies to reduce musculoskeletal disorders in poultry industry. Srivastava and Vats (2012) found that the workers working in the farm have very high energy expenditure, high heart and pulse rate while performing the different activities. Paired t-tests, two sample t-tests and correlation coefficient showed that there was significant relationship between physiological cost due to different activities and physiological cost before and after the activity. Then Carvalho (2011) evaluated the ergonomic factors, and effect on posture and biomechanics of workers in poultry houses equipped with manual or automatic feeder. While Kumar (2012) redesign a grain feeder and egg collection system in poultry farm for productivity improvement. Both researchers have focused on the feeding process of chickens.

1.3. Gaps in Existing Literature

Most studies are concerned on the ergonomic hazards in meat processing industry and not in the poultry farm. They did not deal with MSDs but of experimenting on how to increase the profit in a condition of low production of meat and eggs. A number of studies have been conducted regarding the poultry technology and management but very few have been done on poultry workers. Some focuses only on the feeding process and equipment wherein they redesigned the feeders to address the issue of ergonomic hazard. While some focus only on the activities that contribute physiological stress. In this study, all possible risk factors that contribute to MSDs were identified. The process subjected was not only on the feeding process but also in the collection of eggs, and lifting of sacks of feeds and collected eggs. Moreover, no studies yet attempted to make a model to predict the extent of MSDs among the poultry layer workers as well as designing of ergonomic feeder and ideal workplace for the workers.

1.4. Objectives of the Study

- To assess the current working conditions and identify the common types of musculoskeletal disorders in poultry layers industry
- To determine the significant risk factors that can cause musculoskeletal disorders to the workers of the industry
- To identify the effect of significant risk factors to the severity of musculoskeletal disorders.
- To formulate a multiple regression model that would predict the extent of musculoskeletal disorders experienced by the workers
- To design the ideal workplace of the workers that will be based from the analysis of the study

1.5. Significance of the Study

The workers of the poultry industry are the major beneficial of the study. The efforts were meant for the monitoring and implementing proper working conditions for the workers. This would also help the employers in terms of profitability and may be able to ascertain the productivity of their workers and be able to expedite an effective plan for the workers' working conditions using the formulated predictive model. The chance of continuous growth of poultry layers may also increase. Thus, the value of share of layer sector may contribute a lot in the total poultry production. Moreover, the continuous increase of growth of poultry farmers may lead the poultry industry to be globally competitive. This would contribute large value of share in the total agricultural production of the country and this may attract additional layers in the poultry sector that would possibly generate more income to the government through additional taxes. The study may also result for a better and intensified understanding of the students with the use of ergonomics and statistical tools, which are the main tools used in the study. Students may increase their interest on Ergonomics since most problems seen in every workplace can be addressed using this field. While the professors and instructors may use this as a material for reference in the future.

1.6. Scope and Limitation

The study focused on the caretakers who are highly exposed to the risk factors of MSDs due to their heavy workload and repetitive motion tasks. It was conducted in Manuel Anupol Poultry Farm which generates the largest gross sales among all the poultry layer farms in Nueva Ecija. The study does not offer a treatment for the problem in the reason that many poultry layers are established in the country and not all of them will use the recommendations depicted. The study only aimed to increase the occupational safety and health of the workers and help them lessen the extent of the MSDs they've been experiencing.

2. Methodology

2.1 Conceptual Framework

At the beginning, all data of the variables obtained from the data gathering were used in the entire methodology. Independent variables are the working posture, task design, physiological, demographical profile and physical working condition factors. The dependent variable is the severity of MSDs experienced by the caretakers. NMQ was used to determine the common types of MSDs among the caretakers. Upon obtaining all the data, frequency count and percentage distribution were utilized and results were standardized using the rubrics rating scale. Correlation analysis was used to identify the effect of the significant risk factors to the MSD severity. Simple regression was used to verify the true predictors of MSDs. The stepwise regression technique was used to formulate the predictive model. The residual analysis validated the accuracy of the model that was formulated. Furthermore, a prototype of the automatic feeder was created using the QFD for the analysis of the design. The predictive model formulated, and other analysis and findings were the design basis. The final model output was tested in the poultry farm and time study was used to analyze the improvements in the standard time of the feeding task.

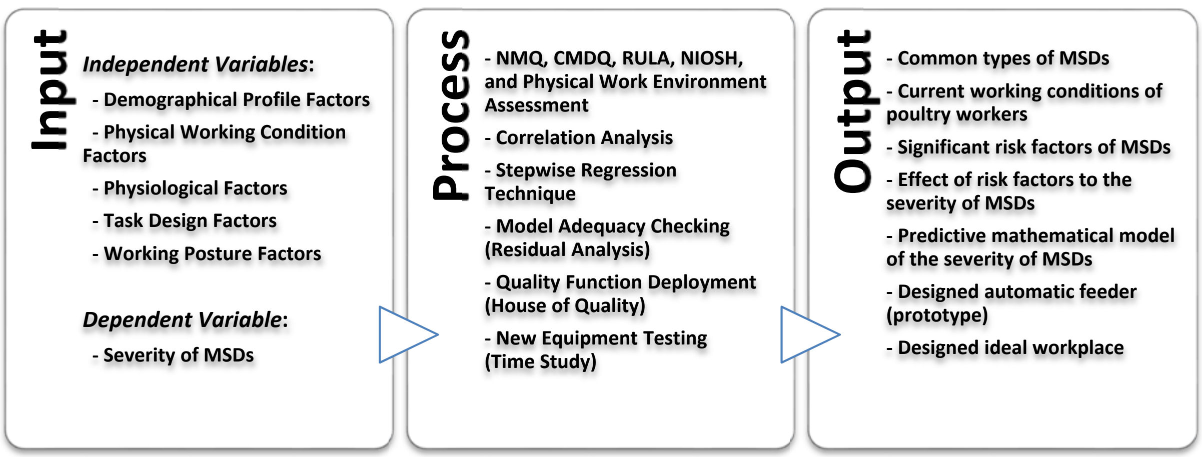

Figure 1: Conceptual Framework of the Study

2.2 Research Design

The study describes what exists, which may help to uncover new facts, about the working conditions of the caretakers. They were described factually based from the observations, surveys, interviews, and tests made. It is a descriptive research wherein the results obtained were recorded, interpreted, and analyzed.

2.3. Respondents of the Study

The participants of the study were the caretakers working in M.M Anupol Poultry Farm. The total number of caretakers employed in the poultry farm is forty (40) caretakers.

2.4. Research Locale

The study was conducted in Manuel Anupol Poultry Farm which generates the highest amount of gross sales among the poultry farms in Nueva Ecija.

2.5. Instrumentation

- **Survey Form.** This was used to obtain the data for the demographical profile factors.

- **Nordic Musculoskeletal Questionnaire.** This was used in determining the discomfort location and knowing the common types of MSDs among the poultry caretakers.

- **Cornell Musculoskeletal Discomfort.** It was used to assess the frequency and extent of pain felt in each body segment.

- **NIOSH Lifting Equation.** This was used to determine if task redesign is needed to reduce the risk of lifting-related low back pain.

- **Rapid Upper Limb Assessment (RULA).** This tool was used in the study to investigate the exposure of the caretakers to risk factors associated with work-related upper limb disorders.

2.6. Data Gathering Procedure

All the data were gathered using the apparatuses, devices and instrumentations. First, the caretakers were asked to answer the survey and questionnaires provided by the researcher. While answering, their blood pressures were taken and recorded. Then they were taken videos while working for RULA scoring purposes and data for other variables. Each one of them was carefully observed while working. Then, the equipment and building were measured for the size of the prototype. Lastly, the devices were used to record the data for the working condition factors.

3. Results and Discussion

- Objective 1: Assessment of Caretakers' Current Working Conditions

The results of the Nordic survey questionnaire are presented in the table below. On average, lower back pain is the most frequent MSD the caretakers are experiencing. This is followed by wrists/hands, upper back, shoulders, neck and elbow pain.

Table 1: Nordic Musculoskeletal Questionnaire Results

	Before	**During**	**After**	**Consulted a Doctor**
Neck	17	31	37	24
Shoulders	23	34	37	12
Upper Back	16	33	38	22
Elbows	12	28	31	7
Wrists/Hands	23	36	35	6
Lower Back	30	35	39	30
Hips/Thighs	12	16	22	6
Knees	8	23	17	7
Ankles/Feet	8	24	17	7

The table below shows the average computed risk for each part of the body of the caretakers. The percentage of each risk was also computed in order to get the body part which has the highest risk.

Table 2: Cornell Musculoskeletal Disorder Questionnaire Results

	Risk	**%Risk**
Neck	15.2875	14.0 %
Shoulder		
Right	16.9875	15.5 %
Left	10.8	9.9 %
Upper Back	11.2625	10.3 %
Upper Arm		
Right	8.45	7.7 %
Left	3.9375	3.6 %
Forearm		

Right	4.3375	4.0 %
Left	3.7125	3.4 %
Wrist		
Right	19.8	18.1 %
Left	14.85	13.6 %
Lower Back	20.15	18.4 %
Hips/Buttocks	4.5875	4.2 %
Thigh		
Right	4.0625	3.7 %
Left	1.5875	1.5 %
Knee		
Right	6.05	5.5 %
Left	1.9125	1.7 %
Lower Leg		
Right	2.475	2.3 %
Left	1.45	1.3 %
Foot		
Right	8.4	7.7 %
Left	6.3875	5.8 %

It can be seen that lower back has the highest risk. It has a risk percentage of 18.4%. Next is the right wrist which is 0.03% lesser than the risk percentage of the lower back. The right shoulder, neck, left wrist, upper back and left shoulder are also shown to be exposed to risks for they have risk percentage of 15.5%, 14.0%, 13.6%, 10.3%, and 9.9%, respectively. It is shown in the feeding RULA results below that the task needs to be investigated and changed immediately since the postures of the feeding task exposed the caretakers to risk.

	Upper Arm Score	Lower Arm Score	Wrist Score	Wrist Twist
	3	3	4	2
Feeding Score A	5			
Muscle Use	1			
Force/Load	2			
Final Wrist & Arm Score	8			

	Neck Score	Trunk Score	Legs
	3	4	1
Feeding Score B	5		
Muscle Use	1		
Force/Load	2		
Final Neck, Trunk & Leg Score	8		

FINAL RULA SCORE
7

Figure 2: Rapid Upper Limb Assessment Results (Feeding)

Like the feeding task, collecting RULA score below shows that the task should be investigated and changed immediately since the task postures are risky to the caretakers.

	Upper Arm Score	Lower Arm Score	Wrist Score	Wrist Twist
	4	3	4	2
Collecing Score A	6			
Muscle Use	1			
Force/Load	0			
Final Wrist & Arm Score	7			

	Neck Score	Trunk Score	Legs
	3	3	1
Collecting Score B	4		
Muscle Use	1		
Force/Load	0		
Final Neck, Trunk & Leg Score	5		

FINAL RULA SCORE
7

Figure 3: Rapid Upper Limb Assessment Results (Collecting)

It is shown in the results below that every lifting index of lifting-related tasks of the caretakers exceeds to the standard/acceptable value of 1.0. This means that these tasks are risky to the caretakers.

Table 3: NIOSH Lifting Results

Lifting Activities	Acceptable Lifting Index	Computed Lifting Index	Remarks
Feeds (Truck to Floor)	1.0	13.46	Risky
Feeds (Floor to Pushcart)	1.0	8.85	Risky
Egg Trays (Pushcart to Floor)	1.0	1.15	Risky
Egg Trays (Floor to Truck)	1.0	2.65	Risky

- Objective 2: Determination of Significant Factors

All factors being examined were proven to be good predictors of MSDs for having p-values less than 5%, using 95% confidence level. The computations only show the proof of what the authors of the related literatures have been saying: that the factors examined are causes of MSDs. This means that all of these variables are significant factors of MSDs.

- Objective 3: Determination of the Effects of Significant Variables to the Severity of MSDs

After re-examining each factor, the results show that only the variables height, working experience and light show a negative correlation to the MSD severity. This implies that as these variables increase, the MSD severity will decrease. The rest are positively correlated with the severity of MSDs which basically relates that as these variables increase, the severity of MSDs also increases.

Moreover, since all the values of R^2, coefficient of determination, ranged between 0.25 and 0.80, this indicates that the variables are moderate predictors of the severity of musculoskeletal disorders.

- Objective 4: Formulation of the Predictive Model

Using the Statistica software, the equation below computed to be able to predict the MSD severity given the 27 variables with coefficient of determination, R^2 equal to 95.02%. See Equation (1) below for the demonstration.

$$Y = 0.019981 - 0.028982 * \mathit{Work\ Experience} + 0.247106 * \mathit{UAP\ Feeding} + 0.093594 * \mathit{Obesity} + 0.124507 * \mathit{Blood\ Pressure} + 0.107289 * \mathit{Feeding\ Frequency} + 0.205666 * \mathit{NP\ Feeding} + 0.047670 * \mathit{Feeding\ Duration} + 0.142496 * \mathit{NP\ Collecting} + 0.123649 * \mathit{TP\ Feeding} - 0.041096 * \mathit{Light} - 0.069888 * \mathit{Height} + 0.037025 * \mathit{WBGT} \quad (1)$$

It can be seen that out of the 12 variables, only 4 can be considered as good predictors of MSD severity in the presence of other variables. These are upper arm position (feeding), blood pressure, feeding movement frequency, and neck position (feeding). These can be deduced from the column ‘p-level’ where the p-level value customarily used, 0.05, is treated as the border-line acceptable error level. Thus, with all 4 variables having a p-value of less than 0.05, they can be considered as significant predictors of MSDs, while the remaining 8 as poor indicators of musculoskeletal disorders.

- Model Adequacy Checking

Residual analysis was performed in the process, the examination of a normal probability plot, a plot of residuals VS fitted values were done with the help of the Statistica software.

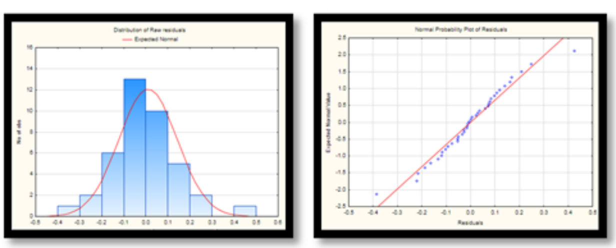

Figure 4: Residual Analysis Result

From the figures above, one can notice that there was no violation in terms of normality. The residuals are normally distributed and the points are randomly scattered around the line, implying that the points are following the normal distribution, which is what is required when using the multiple regression technique.

- Objective 5: Designing of the Ideal Workplace

Table 4: Improved NIOSH Lifting Results

Lifting Activities	Standard Value	LI Original Results	Improved LI Results
Feeds (Truck to Floor)	1.0	13.46	2.47
Feeds (Floor to Pushcart)	1.0	8.85	1.93
Egg Trays (Pushcart to Floor)	1.0	1.15	0.957
Egg Trays (Floor to Truck)	1.0	2.65	0.92

The improved results show that both lifting indices of lifting the egg trays are below the standard value. This means that the caretakers are exposed to lesser risk. However, the lifting indices of feeds sack lifting still exceed the standard value. Though no more improvements can be done since any further changes are not practical to the task anymore, the lifting indices are still highly improved and the new values are nearer to the standard value.

- Designing of Automatic Feeder

Product specifications are based from the analysis of the study and the predictive model. Additional specifications are gathered from the caretakers' product requirements. The customer requirements are listed below.

Table 5: Product Specifications based on the Customer Requirements

Customer Requirements	
Affordable	Less Feeds Wastage
Durable	Controllable
Availability of Material	Reliable
Multi-purpose	Stress-free
Easy to Use	Cost Effective
Convenient	Feeding Efficiency
Time-saving	Safe to Use
Do-it-yourself	Stable

- Quality Function Deployment

Based on the analysis using the Quality Function Deployment, it has been known that the requirements of the automatic feeder should be affordable, durable, multi-purpose, easy to use, convenient, time-saving, less feeds wastage, controllable, reliable, stress-free, cost effective, efficient, safe to use, stable, materials are available and do-it-yourself concept.

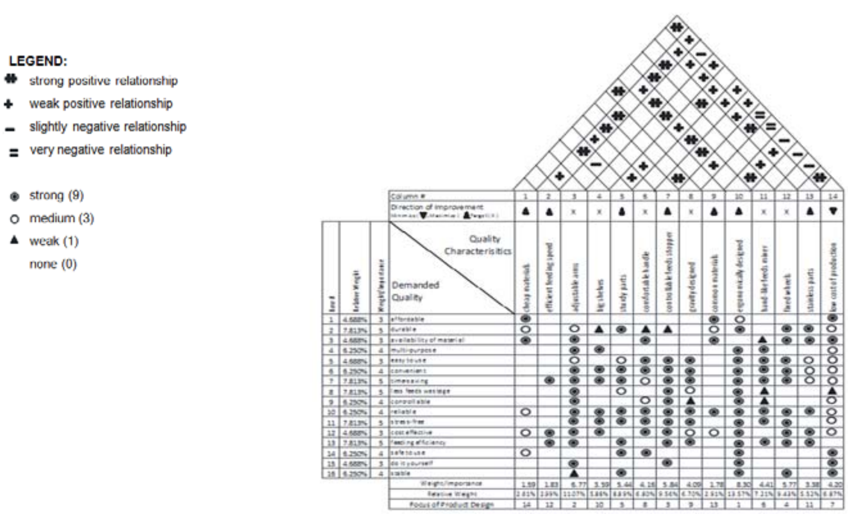

Figure 5: QFD Analysis

- Product Design and Drawing

The image above is the perspective view of the Automatic Feeder. Its initial color is gray (final color is red orange). It can carry a capacity of 25 kg of feeds. Its hopper has a volume of 0.046 m^3 and a lateral surface area of 0.567 m^2.

Figure 6: Automatic Feeder Design

The width of the whole automatic feeder was based from the width of the rail of the poultry farm. The height was based from the minimum height the feeds will fall because of the gravity. Then the feeds controller and handle heights were based from the overhead fingertip reach and waist height of male anthropometric measurement of Filipinos, respectively.

Table 6: Measurements of the Feeder Parts

Part	**Length (meters)**	**Height (meters)**
Hopper/Silo	0.70	0.30
Silo Mouth	0.22	0.01
Feeder Arms		
Upper Arm	0.88	1.15
Lower Arm	0.57	0.65
Handle	0.70	0.025
Angle Bar Frame	0.70	2.0
Shelves		
Upper Shelf	0.70	0.85
Lower Shelf	0.70	0.095
Rubber Wheel	0.025	0.05

Table 7: Product Costing (25 kilos capacity)

MATERIAL COST			
Quantity	**Unit**	**Material Name**	**Amount**
DIRECT MATERIALS			
Hopper			
1	pc	Galvanized Iron Sheet #18 4x8	Php 780.00
1/2	pcs	Galvanized Iron Sheet #18 2x8	Php 390.00
Arms			
1	pc	C Purlins 2x6 1.0	Php 450.00
1	pc	Rubber Tire	recycled
Shelves			
1	pc	Angle Bar 3/16x1	Php 382.00
1	pc	Flat Bar 3/16x1	Php 110.00
Structural Frame			
2	pcs	Angle Bar 1.5x1.5x3/16	Php 490.00
70	pcs	Blind Rivets 5/32x1/2	Php 45.00

Arm Support			
1/2	pcs	Square Bar White	Php 120.00
Handle			
1	kilo	Galvanized Iron Pipe #40 1”	Php 45.00
Whole Body Support			
4	pcs	Wheels	Php 132.00
2	kilos	Welding Rod	Php 190.00
		Paint (spray)	Php 500.00
		Total Direct Materials Cost	Php 3, 634.00
INDIRECT MATERIALS			
1	pc	Grinding Disc	Php 40.00
0.9	L	Gas	Php 50.00
		Total Indirect Materials Cost	Php 90.00
		TOTAL MATERIAL COST	**Php 3,724.00**
LABOR COST			
DIRECT LABOR			
Labor and Finishing			Php 5, 000.00
INDIRECT LABOR			
Electricity			Php 500.00
Total Labor Cost			**Php 5, 500.00**
TOTAL PRODUCT COST			
Total Material Cost			Php 3, 724.00
Total Labor Cost			Php 5, 500.00
Total Product Cost			**Php 9, 224.00**

- Time and Motion Study

The standard time in manual feeding is 21.65 minutes for 54.56 meters. Time study is also conducted while using the automatic feeder. It shows that the standard time for feeding using the feeder is 1.45 minutes for 2.5 meters.

It shows that compared to the standard time of manual feeding, 21.65 minutes, feeding the chickens using the automatic feeder is faster since the estimated standard time is 15.96 minutes or lesser. By using the automatic feeder, the standard time improves by 26.28%.

4. Conclusion

According to the results, it has been known that the common types of MSDs are low back pain, hands/wrists pain, upper back pain and upper limb disorders. It can be concluded that the current working conditions of the poultry caretakers are at risks since all the values assessed exceed the acceptable standard values provided by the OSHA and NIOSH. All factors examined have p-values less than 0.05, thus all of them are considered to be good predictors of MSDs. After re-examining, the results show that only the variables height, working experience and light show a negative correlation to the MSD severity. The rest are positively correlated with the severity of MSDs. Since all the values of R^2, coefficient of determination, ranged between 0.25 and 0.80, this indicates that the variables are moderate predictors of the severity of MSDs.

By utilizing the residual analysis, it is proven that the formulated predictive model is accurate for having normal distribution of residuals. Thus, the equation below can predict the MSD severity of the caretakers.

$$Y = 0.019981 - 0.028982 * \textit{Work Experience} + 0.247106 * \textit{UAP Feeding} + 0.093594 * \textit{BMI} + 0.124507 * \textit{Blood Pressure} + 0.107289 * \textit{Feeding Frequency} + 0.205666 * \textit{NP Feeding} + 0.047670 * \textit{Feeding Duration} + 0.142496 * \textit{NP Collecting} + 0.123649 * \textit{TP Feeding} - 0.041096 * \textit{Light} - 0.069888 * \textit{Height} + 0.037025 * \textit{WBGT}$$

In addition, by using the automatic feeder, the standard time of feeding improves from 21.65 minutes to 15.96 minutes, a 26.28% improvement. Then the final RULA score when using the feeder decreases from 7 to 4. Thus, the automatic feeder improves the tasks of the caretakers and at the same time reduces their risks from injuries and other MSDs.

5. Recommendation

For further researchers, it is suggested that they focus their attention in looking for other factors of MSDs. Granted that R^2 is 95.02%, other researchers can venture into analyzing other variables in the same poultry set-up which may induce MSDs. It is also recommended that future researchers should focus in designing the facilities and layout of poultry farms, instead of designing the equipment used by the caretakers. With this, different views of MSDs may be found. Furthermore, future researchers are suggested to formulate a predictive model that can be used to other industries and not only to the poultry farm. By formulating a model which is applicable to all industries, tasks of workers in every industry will be standardized and monitored from any injuries caused by MSDs.

References

Bellingar, T. A.(2009).Preventative Measures For Common Musculoskeletal Disorders.

Bevan, S., Mcgee, R., & Quadrello, T. (2009). Fit For Work?: Musculoskeletal Disorders And The Irish Labour Market.

Bradley, N. (2007). The Response Surface Methodology.

Capp And Cppi Ergonomics Working Group (2000). Ergonomic Risk Identification And Assessment Tool.

Carvalho, C. S. (2011). Safety, Health And Ergonomics Of Workers In Poultry Houses Systems Equipped With Different Feed Supply. *Associação Brasileira De Engenharia Agrícola*,*31*(3), 438-447.

Chen, Y., Mcdonald, J. C., & Cherry, N. M. (2006). Incidence And Suspected Cause Of Work-Related Musculoskeletal Disorders. *Occupational Medicine*, *56*, 406–413.

Cooper, C., & Baker, P. D. (1996). Upper Limb Disorders.

Craig, R. R. (2009). A QFD Methodology For Product Development.

Cruz, J., Deada, J., & Mejia, S. (2001). An Ergonomic Study On The Analysis Of Lifting And Carrying Tasks Of A Stevedore.

Guo, H. R., Chang, Y. C., Yeh, W. Y., Chen, C. W., & Guo, Y. L. (2004). Prevalence Of Musculoskeletal Disorder Among Workers In Taiwan: A Nationwide Study. *Journal Of Occupational Health*, *46*, 26-36.

Hammock, B. T. (2010). Ergonomics In The Poultry Industry: A Review Of 25 Years Of Industry Efforts.

Kashani, H. A., Coobineh, A., Bakand, S., Gohari, M. R., Abbastabar, H., & Moshtaghi, P. (2010). Validity And Reliability Of Farsi Version Of Cornell Musculoskeletal Discomfort Questionnaire (CMDQ). *Iran Occupational Health*, *7*(4).

Kumar, G. D., Unakal, P., & Das, S. (2012). Redesign Of Grain Feeder, Distributor And Egg Collector System In Poultry Farm.

Lee, H. Y., Yeh, W. Y., Chen, C. W., & Wang, J. D. (2005). Prevalence And Psychosocial Risk Factors Of Upper Extremity Musculoskeletal Pain In Industries Of Taiwan: A Nationwide Study. *Journal Of Occupational Health*, *47*, 311-318.

Li, G., & Buckle, P. (1999). Current Techniques For Assessing Physical Exposure To Workrelated Musculoskeletal Risks, With Emphasis On Posture-Based Methods. *ERGONOMICS*, *42*(5), 674-695.

Lotters, F., Meerding, W. J., & Burdorf, A. (2005). Reduced Productivity After Sickness Absence Due To Musculoskeletal Disorders And Its Relation To Health Outcomes.*Scandinavian Journal Of Work, Environment & Health*, *31*(5), 8.

Lu, J. P. (2004). Risk Factors To Musculoskeletal Disorders And Anthropometric Measurements Of Filipino Manufacturing Workers. *International Journal Of Occupational Safety And Ergonomics*, *10*(4), 349–359.

Lugay, Jr., C. P. (1999). A Predictive Model Of Loss Time Due To LBP Among Garment Sewers In Bulacan.

Magnavita, N., Elovainio, M., De Nardis, I., Heponiemi, T., & Bergamaschi, A. (2011). Environmental Discomfort And Musculoskeletal Disorders. *Occupational Medicine*, *61*, 196-201.

Menzel, N. N. (2001). Manual Handling Workload And Musculoskeletal Discomfort In Nursing Personnel.

Mohammadi, G. (2012). Risk Factors For The Prevalence Of The Upper Limb And Neck Work-Related Musculoskeletal Disorders Among Poultry Slaughter Workers. *Journal Of Musculoskeletal Research*, *15*(1), 1-8.

Punnett, L., & Wegman, D. H. (2004). Work-Related Musculoskeletal Disorders: The Epidemiologic Evidence And The Debate. *Journal Of Electromyography And Kinesiology*,*14*, 13-23.

Ramli, S. (2007). Assessment Of Working Posture In Manufacturing Industry Using RULA Method.
Saldaña, N. (2011). Active Surveillance Of Work-Related Musculoskeletal Disorders.
Shang, H. S. (2007). Analysis Of The Philippine Chicken Industry: Commercial Versus Backyard Sectors. *Asian Journal Of Agriculture And Development*, *4*(1), 41-56.
Singh, J., Lal, H., & Kocher, G. (2012). Musculoskeletal Disorder Risk Assessment In Small Scale Forging Industry By Using RULA Method. *International Journal Of Engineering And Advanced Technology (IJEAT)*, *1*(5), 1-6.
Srivastava, T., & Vats, A. (2012). Musculoskeletal Disorders Among The Workers Engaged In Organized Poultry Farm. *International Journal Of Advanced Engineering Technology*, *3*(2), 4.
Thirion, A. P., Macías, E. F., Hurley, J., & Vermeylen, G. (2009). A Sector Perspective On Working Conditions.
Valsangkar, S., & Sai, K. S. (2012). Impact Of Musculoskeletal Disorders And Social Determinants On Health In Construction Workers. *International Journal Of Biological & Medical Research*, *3*(2), 1727-1730.