

Ergonomics Study on Productivity of Middle-aged Workers in the Shoe Industry

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Abstract

Majority of the local footwear manufacturers still impose the traditional or hand-made processes with low-level of technology. A correlational research design, using linear regression analysis, aimed to understand the relationship between health issues, work environment, and efficiency that can affect the productivity of middle-aged and older workers in the shoe industry. There are 139 respondents from 16 shoe manufacturing companies within Marikina City participated in this study. Rapid Upper Limb Assessment and 10-point rating scale survey questionnaires, worker evaluation, and company evaluation checklists were used to gather data directly from the respondents and to assess their posture, tasks, and work environment. RULA scores show that 53 out of 139 workers (38%) experience medium to very high MSD risk. Chi-square test of significance and correlation test results show that there are fourteen (14) statistically significant factors with moderate linear relationships that affect the productivity of the workers. Safety measures, surface features, tool features, tool activities, illumination, and ventilation are the main categories that should be given utmost importance for improvement in every workplace. Health issues and efficiency have a weak degree of relationship with productivity, but pareto charts and fishbone diagrams show the factors under these variables that need consideration.

Keywords

Ergonomics, Shoe Manufacturing Industry, Linear Regression, Correlational Research, Health Issues

1. Introduction

According to the World Health Organization (2017), most middle-aged workers suffer from common occupational risks like injuries, airborne particles, ergonomic risk and noise which results in different types of chronic diseases. Based on the record, back pain has recorded 37% cases, deafness has 16% cases, 13% of cases for pulmonary diseases, 11% cases of asthma, 9% cases of lung cancer, 8% of injuries, 8% of depression and 2% of leukemia. Middle-age is often the beginning of chronic health conditions that have a significant impact on a person's productivity. Disabling conditions like back impairments, heart disease, diabetes, orthopedic impairments, and cancer increase as a function of age (Roessler and Rumrill 2015). According to Li et. al (2015) double disadvantages of disability and age may begin to emerge in middle adulthood. Older workers with disabilities are more prone to the physical and psychological weight of aging. Research shows that the employment growth declines for workers of this age in different industries and business sectors except for industries that require client interaction, similar to business-auto services, other personal services, medical services, educational services, and social services. (Wegman 2014) Blue-collared jobs may prefer younger people since they are more capable to do work that requires heavy lifting and repetitive tasks. Career opportunities might decrease for middle-aged workers in other industries, particularly in the manufacturing industry. This business sector shares a significant part in the industry of different developed countries. According to Aldaba (2014), labor-intensive products dominate the exports of the Philippines. The manufacturing industry in the Philippines is mostly made up of human labor and machinery.

1.1 Objectives

As of January 2019, the Philippine Statistics Authority reported 42% of the total number of employed workforce in the Philippines are middle aged adults with age range of 35 to 54 years old and 16% are older adults that are 55 years

old and above, which means that 58% of the total population belonged to middle-aged and older adults with the age range of 35 to 65 years old and above. The growing population of middle-aged and older workers, especially if skills shortages intensify learning to incorporate the experience of older workers, will be considered a competitive edge.

The ultimate objective of this study is to identify the relationship between productivity, work environment, health conditions, and efficiency of middle-aged and older workers in the shoe manufacturing industry. Particularly, the following are the objective of the researchers:

1. To identify the degree of relationship between variables under health issues, work environment, and efficiency in order to maximize the capabilities and working opportunities.
2. To identify the significant factors that may affect the productivity and safety of middle-aged and older adult workers with affliction in order to gain true productivity.
3. To utilize the linear regression and other statistical tools to understand the correlations between health conditions and work conditions of the workers that can affect their daily output rate

2. Literature Review

This section presents general information, related works and studies that explain the problem and plausible answers to the research questions. It also provides simple information and knowledge, statistical data, surveys and results by previous researchers that will aid the readers in the understanding of the topic and its background.

Middle-age is often the beginning of chronic health conditions that have a significant impact on a person's productivity. According to Li et al. (2015) double disadvantages of disability and age may begin to emerge in middle adulthood. Older workers with disabilities are more prone to the physical and psychological weight of aging. Hypertension, high cholesterol, and obesity are common health conditions experienced by workers aged 45-64 (Luckhaupt et al. 2014). According to Adams et al. (2014), workers aged 45-69 years old are more likely unable to work due to health conditions compared to workers aged 18-35 years old. Middle-aged and older adults need more time to take rests in between work periods unlike young adults. King et al. (2013) stated that 13.2% of respondents aged 46-64 have work limitations. Since they may not be able to work well even if they fit in a certain job, they may prefer retiring once they reach this age bracket. These people may be working for a long time in certain blue-collared jobs, including some factories, production lines, and assembly lines. Reports show that half of nonprofessional workers are at risk for early retirement due to arthritis symptoms (Caban-Martinez et al., 2011); since most of the work in blue-collared jobs require most body functions. These nonprofessional workers are prone to heavy lifting, repetitive tasks, and tedious activities that are required in their workplace. According to Goyer (2013), declining health was also the reason for the retirement of 32% of adults. Thus, these workers tend to lose jobs in the industry due to aging and associated health issues.

Recent studies conclude that physical and mental health problems arise from middle-aged adults who feel stressed, powerless, or overworked on their job compared to workers who feel contentment. (Rapaport 2018) Additionally, workplace stress are linked to poor health outcomes among employees, especially with demanding jobs. Workplace stress has been one of the known risk factors for other chronic health issues such as heart disease and diabetes. Reports show that older Filipinos deem themselves as healthy on average. However, they also experience illnesses and functional disability including arthritis, rheumatism, hypertension, chronic back pain and cataracts. (Jadloc et al. 2017) According to Sanders (2018), both work environment safety and workers' chronic health issues added to their job performance. The wear and tear of the human body is related to the increasing age, which makes adults more prone to different afflictions. Heavy physical work or lifting heavy objects, manual material handling, awkward postures, static activities, vibration, and repetitive tasks mainly causes MSDs. Studies show that 25% cases are related to backache and 23% are related to muscular pains. (Takala 2016) Ghasemkhani et.al. (2015) concluded that 44.0% of the workers experience pain on their lower back, 33.3% on their shoulders, and 32.0% on their neck. The pain experienced by workers in the three areas are the most common symptoms of musculoskeletal disorder. High repetition and forces, working with arms overhead, local contact forces, long-term static postures, and vibration are commonly identified physical risk factors.

Musculoskeletal disorder from repetitive tasks, heavy lifting, awkward postures and operation which requires exertion of effort can be avoided through an optimal work environment. (Sanjog 2019) Poor posture, heat, over-work, poor ventilation, and chemical exposure are considered as the top five identified hazards in most manufacturing industries in the Philippines. Visual strain, overtime and overwork on the other hand are noted to be the top three physical and

psychomotor stresses. Whereas backache, fatigue, and weaknesses are noted to be the most common illnesses related to ergonomics. Cuts and bruises associated with slippery floors and falls would likely occur when there is an existence of slippery and uneven floors while head trauma are most likely to happen when small and narrow places are part of the working areas; these are three of the most common injuries (Del Prado-Lu 2007). Studies have identified work-related diseases associated with manufacturing industries into: occupational lung diseases, occupational skin diseases, work-related musculoskeletal disorders (WMSDs), and other diseases acquired from non-ergonomically designed work environments, tools, and equipment (Szeszenia-Dąbrowska, 2014). Raziq et al. (2015), proposes that organizations can improve the physical conditions of a work environment to increase its productivity through increased job satisfaction. It was concluded that there is a positive relationship between work environment and job satisfaction. Musculoskeletal Disorders (MSDs) are one of the prominent and recent issues in the manufacturing industry that causes low work-related satisfaction. (Battini 2017) When workers are exposed to hazards, occupational risk factors increase likewise. These are also associated with repetitive tasks while doing different activities in the workplace. (Mohd Fazi 2019) Intense force, non-neutral posture, repetitive tasks, and vibration are some of the factors that contribute to the WMSDs incidents. (Charles, 2018) The occurrence of MSDs in the manufacturing industry are due to the continuous practice of repetitive activities, doing required tasks in a challenging or sustained posture, heavy lifting, and even repeated forceful exertions. (Mohd Fazi 2019)

The physical work environment has a strong interaction with job performance. It is also critical to an employee's overall performance, satisfaction, social relations, and overall health. The air, temperature, sound, light and color, and space are the five factors that make up a work environment. Some of the effects of high temperature levels are increased body temperature, employee lethargy, and tiredness. Cooler body heat and shivering are the possible effects of low temperature to a worker's body. These effects may possibly decrease worker efficiency. (Al-Omari 2017) According to Sanjog (2019), the design should consider the needs of the users. These designs should be user-centric and focus on the worker's safety and ease of use. Proper tools, machines, and equipment should be provided to the worker. According to Sarika (2016), efficiency increases when physical injuries and employee absenteeism are reduced. Worker fatigue also reduces the productivity of the workers, which may lead to low worker performance and further loss to a business. WMSDs could also increase with high job demands, low job satisfaction, frequent changing pace of work, job stress, and working in too high or too low environments (Takala 2016). Work-related risks including strains can contribute to the increase in the number of sick days. (Labuttis 2015) It was also reported that around 25% of sick days are caused by work-related musculoskeletal disorders while one-third of sick leaves in industrialized countries are caused by work-related musculoskeletal disorders. Ergonomic issues in the workplace should not only be addressed but to be a part of a product life cycle. (Beuß et al. 2019) A proactive approach with the use of ergonomics can reduce the occurrence of work-related risks. Mun et.al. (2017) stated that under Maslow's hierarchy of needs, safety is also considered as the basic need and in order to satisfy the needs it is important to identify the conditions that are able to satisfy these needs as well the different types of threats that will put their safety at risk, especially the workplace itself. Additionally, friendly and supportive coworkers in the workplace relationship may lead to apprentices and unity inside the organization.

According to the International Labour Organization (n.d), an estimation of 2.2 million employees that work in medium and large enterprises experience and benefit from effective occupational safety and health (OSH) provisions, protection, and services. This only means that 17 out of 18 workers or an equivalent of 38.8 million Filipino employees work under unacceptable working conditions. Additionally, studies concluded that micro enterprises and firms, including the informal sector, have higher work-related risks and hazards since most of these incompletely observe OSH standards. According to the labor force survey conducted by the International Labour Organization (ILO), 38.3% employed workers or an equivalent of 2 out of 5 workers are part of the informal economy. Employers only work with small capital while employees receive less than minimum wage. This means that formal work arrangements and employment that gives access to worker protection might be unavailable to most of these people. The national labor laws and regulations do not cover most of the workers in the informal economy. As a result, employers with low capital might not give their employees or invest for proper working conditions, environment, and safety.

3. Methods

Specifically, the researchers used a correlational research design in order to know the relationship between dependent and independent variables. This research design is non-experimental, wherein the researchers would not control the variables nor manipulate the interactions of the variables of the study. Relationships were carefully assessed, and the causes for these trends or patterns were drawn out from the results.

Univariate analysis was performed to show descriptive statistics results of a data with only one variable; specifically, to define, describe, summarize, and see patterns in the data. It does not deal with causation and correlation of variables or factors. Test of significance using the Chi-square test of Independence was performed to identify the association or statistical independence between two or more categorical variables. The correlation test was performed to assess strength and direction of association between two variables. The result shows that most variables have weak to no relationship Pearson Correlation value. Also, no variables showed a strong relationship. Therefore, the researchers focused on the factors that have moderate positive and negative linear relationships and are statistically significant, which are presented using fitted line plots. To perform these statistical analyses and interpretation, IBM-SPSS was used to compute the Pearson's Correlation values, Chi-square p-values, and perform Univariate Analysis. Graphs and charts were generated using Minitab.

4. Data Collection

The researchers gathered data directly from the respondents using survey questionnaires with 10-point rating scale items that focused on the health conditions, minor accidents, discomfort, and work-related injuries experienced by the respondents. Rapid Upper Limb Assessment was used to evaluate the ergonomic risk factors associated with the upper extremity of the worker. This evaluation focused on the worker's neck, trunk, and upper limbs. Worker evaluation and company evaluation checklists based on Niebel's Methods, Standards, & Work Design 12th Edition by Freivalds and Niebel with 10-point rating scale items were used to assess the activities of the workers while they perform their required tasks, and their work environment, respectively.

5. Results and Discussion

RULA shows that among the 139 respondents, only 2 workers experience very high risk score (7) and wherein change needs to be implemented soon. These two workers are both male and in-charge of lasting and finishing. The 37% experience medium risk (5-6 Score), needs further investigation and change soon. Majority or 63% experience low risk (3-4 Score). Around 26% to 36% of the total number of workers with cutting, finishing, lasting, and upper making tasks/ job descriptions mostly compose the assessment scores of 5-6, which indicate medium MSD risks.

5.1 Numerical Results

Table 1. Design of work environment

Rating		Unavailable	Below Average	Average	Above Average	Excellent
Sufficient illumination for the task	F	0	1	3	8	4
	%	0%	6%	19%	50%	25%
Arranged lighting to avoid glare	F	0	3	3	7	3
	%	0%	19%	19%	44%	19%
Worker within the thermal comfort zone	F	1	1	3	6	1
	%	6%	6%	19%	38%	6%
Escape of heat controlled at the source	F	9	3	0	2	1
	%	56%	19%	0%	13%	6%
Radiation shields in place	F	16	0	0	0	0
	%	100%	0%	0%	0%	0%
Provided ventilations	F	0	0	9	6	1
	%	0%	0%	56%	38%	6%
Air dehumidifiers	F	16	0	0	0	0
	%	100%	0%	0%	0%	0%
Air-conditioning	F	16	0	0	0	0
	%	100%	0%	0%	0%	0%
Workers adequately clothed for the equivalent wind chill temperature	F	1	6	5	4	0
	%	6%	6%	31%	25%	0%
Gloves provided	F	16	0	0	0	0
	%	100%	0%	0%	0%	0%
Appropriate ventilation	F	0	6	4	5	1
	%	0%	19%	13%	31%	6%
Noise level below 90 dBA	F	0	8	7	1	0
	%	0%	50%	44%	6%	0%
Noise isolated/ controlled at source	F	11	3	0	2	0
	%	69%	19%	0%	13%	0%
Acceptable vibration levels	F	9	2	2	3	0
	%	56%	13%	13%	19%	0%

Table 1 shows the availability of the following work environment features and how are appropriately designed. Some workstation features are unavailable in all shoe manufacturing companies, such as features related to ventilation.

Table 2. Summary of statistically significant factors with moderate linear relationship that affect productivity

Factors	Pearson Correlation	Chi-square P-value
Safety Measures		
Wearing safety/ close shoes	0.5620	0.001
Workstation Evaluation: Surface features		
Surface can be lowered or raised	0.2620	0.0001
Tool Evaluation: Tool Features		
Performs the desired function effectively	0.3690	0.0001
Matches the size and strength of the operator	0.3860	0.0001
Can be used without undue fatigue	0.3470	0.0001
With appropriate handle/grip	-0.3780	0.0001
Tool Evaluation: Tool Activities		
Tool maintenance	0.2660	0.0001
Tool proper storage	0.2810	0.0001
Work Environment Features		
Sufficient illumination for the task	0.3930	0.0001
Arranged lighting to avoid glare	0.3820	0.0001
Escape of heat controlled at the source	0.2680	0.0001
Provided ventilations	0.2999	0.0001
Workers adequately clothed for the equivalent wind chill temperature	0.2900	0.0001
Appropriate ventilation	0.2930	0.0001

Table 2 shows the P-value results using Chi-Square test of independence and Pearson R value using correlation analysis. All factors listed in the table has significant p-value and medium degree correlation with productivity.

5.2 Graphical Results

A. Survey Questionnaire Results

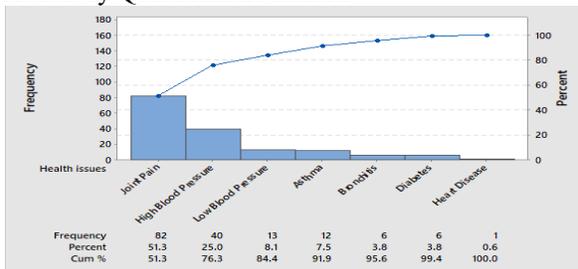


Figure 1. Pareto chart of worker's afflictions

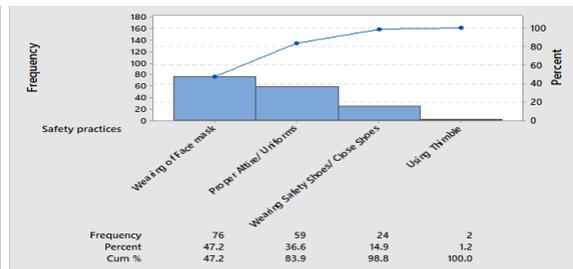


Figure 2. Pareto chart of safety measures

Figure 1 shows that the most common worker afflictions among the respondents are joint pain, high and low blood pressure, and asthma. Figure 2 shows that most workers do not wear facemask, proper attire, safety/close shoes.

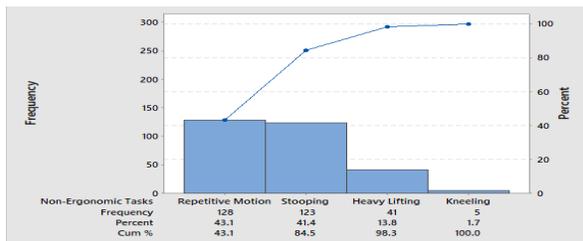


Figure 3. Non-ergonomic activities

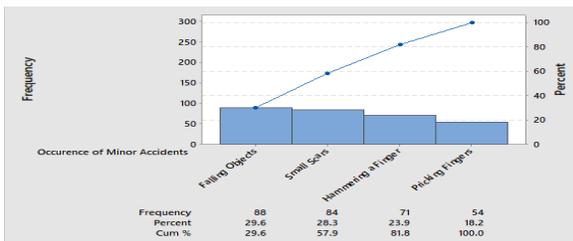


Figure 4. Minor accidents occurrence/cases

Among the non-ergonomic activities identified in figure 3, shows that repetitive motion and stooping are the most common in the industry while falling objects, small scars, and hammering of fingers are the common minor accidents in figure 4. These factors belongs to the 80% which means these needs to be check and corrected.

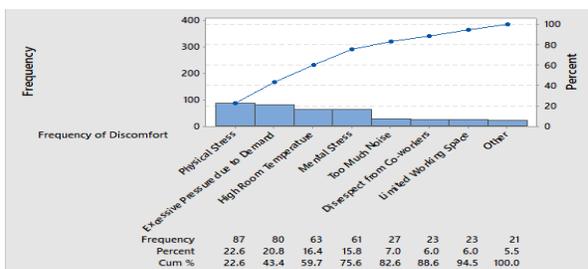


Figure 5. Working environment discomfort frequency

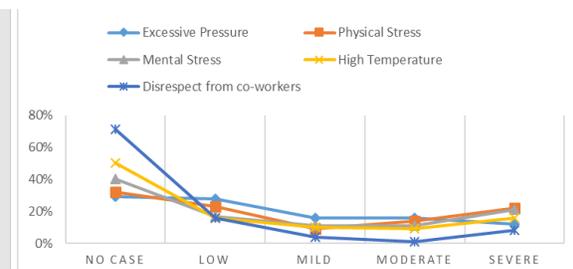


Figure 6. Working environment discomfort severity

The most common working environment discomfort shown in figure 5 are physical stress, excessive pressure due to demand, high room temperature, mental stress, and too much noise. Figure 6 shows the severity of these discomforts.

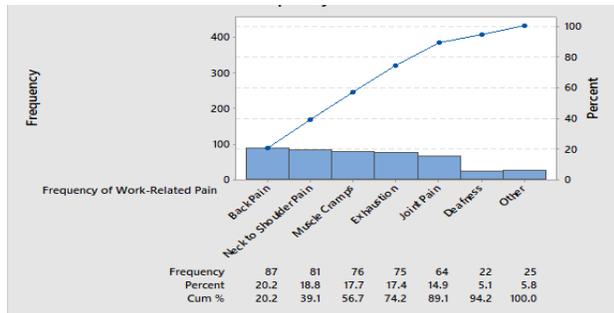


Figure 7. Frequency of work-related injuries

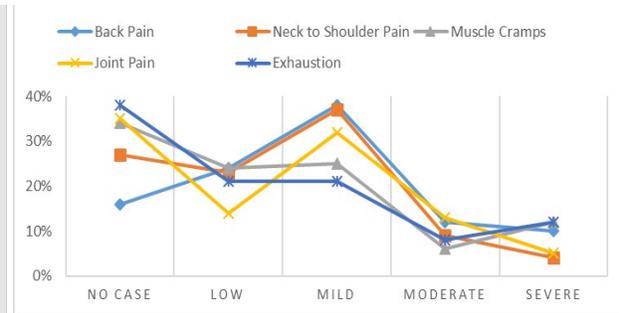


Figure 8. Severity of work-related injuries

The most common work-related injuries shown in figure 7 are back pain, neck to shoulder pain, muscle cramps, exhaustion, and joint pain. These are developed due to the nature of their work. Figure 8 shows the severity of these work-related injuries.

B. Worker Evaluation Results

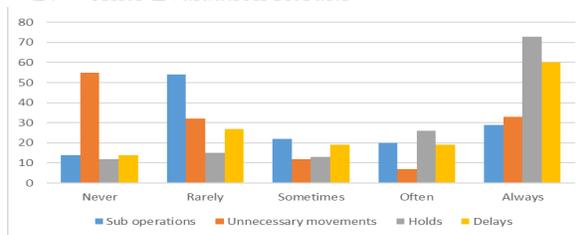


Figure 9. Frequency of cases while working (motion economy)

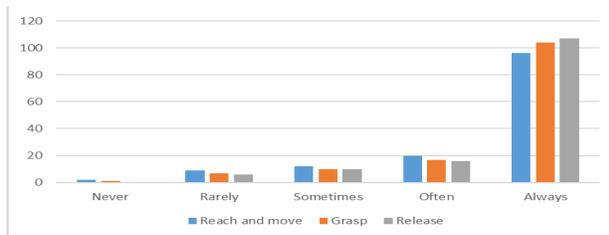


Figure 10. Frequency of actions while working (Therblig Analysis)

Figure 9 shows that Holds and Delays are the most frequent cases observed while working, while figure 10 shows that majority of the workers always reach and move, grasp, and release while working.

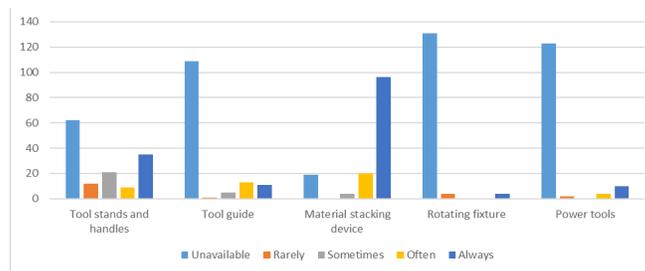


Figure 11. Availability and usefulness of tool features

Figure 11 shows that majority of the workers always utilize a material stacking device while Tool stands and handles, tool guide, rotating fixture, and power tools are unavailable in most workstations.

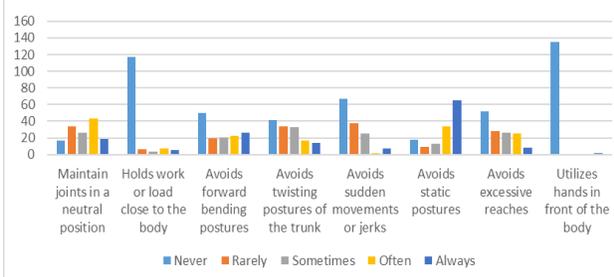


Figure 12. Frequency of the practices NOT observed (General Posture Evaluation)

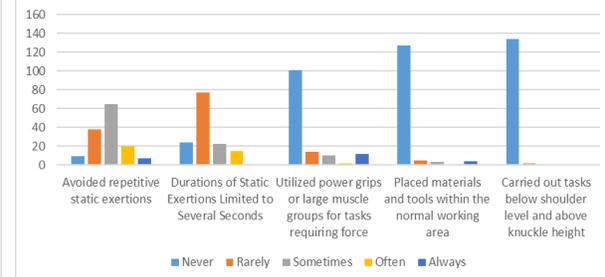


Figure 13. Frequency of the practices NOT observed (General Task Evaluation)

Figure 12 shows that majority of the following proper postures are observed, however, Most of the workers do NOT maintain joints in a neutral position and do NOT avoid static postures. Figure 13 shows that majority of the following proper task executions are observed but most of the workers (sometimes) do NOT avoid repetitive static exertions.

C. Company Evaluation Result

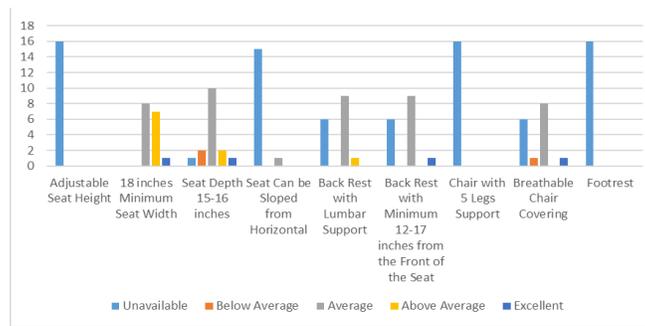


Figure 14. Design of workstation features

Figure 14 shows that some workstation features are unavailable in all shoe manufacturing companies. However, Some workstation features are unavailable in all shoe manufacturing companies.

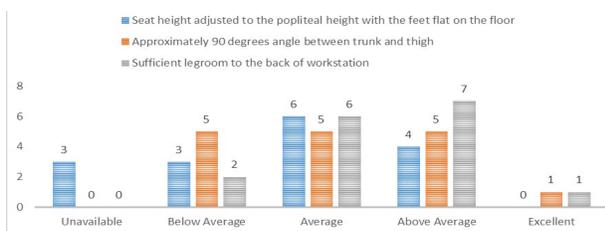


Figure 15. Design of seat features

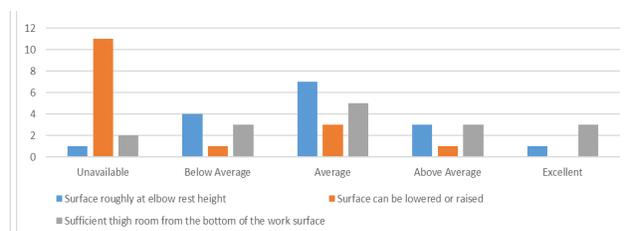


Figure 16. Design of surface features

Figure 15 shows that the following seat features are mostly available with average to above average designs while figure 16 shows that most companies have fixed surfaces.

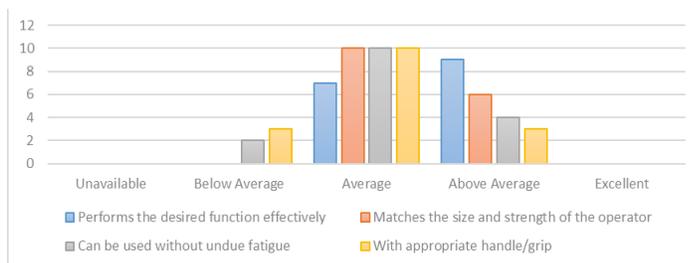


Figure 17. Design of tool properties

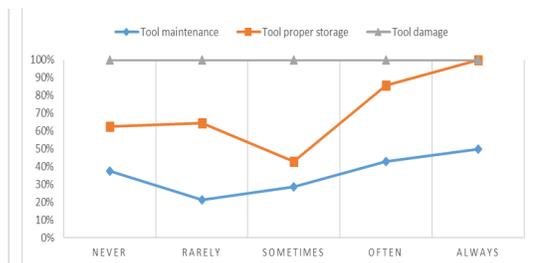


Figure 18. Frequency of tool activities

Figure 17 shows that all tool properties listed are with average to above average designs. When it comes to activities done to the tools, figure 18 shows that workers never or rarely perform tool maintenance and proper storage.

5.3 Proposed Improvements

The following are the significant factors with moderate linear relationship that affect the productivity of the workers in the shoe industry.

Safety Measures

1. *Wearing of safety shoes/ close shoes*: Most of the workers wear their usual footwear and sandals while working. The obvious reason for the workers not to wear safety shoes or close shoes is that they live within the proximity of their workplace. Some of them just walk when they go to work. These micro and small enterprises do not impose strict rules and regulations, which includes not requiring their workers to wear uniforms, safety attire (PPEs), and even safety shoes/ close shoes. Another reason for not wearing safety shoes/ close shoes is the high temperature within the workplace and the dry season in the Philippines. Sandals or open-toe shoes help the workers to adjust to the temperature and feel more comfortable.

Recommendations

- OSHA mandatory foot-protection rules, employers should require employees to use protective footwear to guard against foot injuries due to falling or rolling objects, punctures of the sole or from exposure to electrical hazards.
- In addition to safety shoes, employers should also implement the strict usage of brush when applying rugby on shoe materials. Although it was already implemented, some companies seem to ignore this practice because workers are more comfortable using their fingers to apply the rugby. This only shows that the implementation was not successful.
- Additional measures like educating these workers on the hazards and negative consequences of doing the right thing instead of doing the usual thing will help them realize and follow the safety measure. Strict implementation and control must also be done by the employers and business owners.

Surface Features

2. *Surface can be lowered or raised:* Most tables are fixed and flat since there are job descriptions that require force exertion tasks and hammering. These tasks need firm and fixed tables. However, some job descriptions need adjustable surfaces to better perform their tasks and mitigate WMSDs.

Recommendations

- Occupational health and safety standards suggest that ergonomic chairs are one of the must have especially in manufacturing areas. A steady or typical type of chair does not guarantee that it will suit every worker. It might be too high or too low as a result they will adjust their working position which will make them feel uncomfortable while performing their task and in the long run it will result in work related injuries. OSHA standards for a good chair must have these features; seat height adjustability, comfortable seat surface and backrest, seat depth which will suit the tallest and shortest users, armrests, and stability.

Tool Features

3. *(Tools) Perform desired function effectively:* The interviews and observations confirmed that workers use the appropriate tools for their tasks. According to them, their tools, such as brushes, hammer, and scissors/shears, are easy to use and convenient.

4. *(Tool) Matches the size and strength of the operator:* The interviews and observations confirmed that tools being used match the size and strength of the workers. There are also certain job descriptions that fit based on the workers' sex (i.e. mostly upper makers are female since the required tasks need not to use heavy and large tools while most sapateros are male since these require hammering and force exertion).

5. *(Tools) Can be used without undue fatigue:* Most of the tools can be used without straining of muscles, but heavy and large tools, such as hammer and shoe mold, could cause undue fatigue when frequently used. The workers in the shoe manufacturing are used to fatigue, muscle strain, and joint pain. Some respondents said that they could only feel tired once they got home after work, but they would endure the work-related pain and fatigue while working.

Frequency of tool activities

6. *Tool maintenance:* The tools are rarely maintained which results in rusty steel parts, greasy handles, and dusty storages. Some shears are dull but still being used in most micro and small enterprises. Tools are continuously used without or infrequent maintenance as long as it performs the desired function.

7. *Tool proper storage:* After their work/shift, workers tend to leave their tools on their work surface/ workstation without knowing the possibility of uncertainties, such as a disaster, that might affect the condition of the tools. When they get back to work, they just see these tools and use them right away. This is a common practice to micro and small enterprises since they do not observe 5S. Medium and large companies promote 5S and require their employees to clean and keep their tools after their shift.

Recommendations

- Housekeeping includes the practice of 5S, which also includes proper tool storage and maintenance. Poor housekeeping may lead to delays due to missing tools, rusty or inefficient tools that do function properly. Providing proper storage can also help eliminate minor accidents and tool maintenance can increase the lifespan of the tools.

Work Environment (Illumination)

8. *Sufficient lighting:* Most shoe manufacturing companies provide sufficient lighting due to keenness in terms of shoe quality and details using the traditional handmade processes. Some workers even open their windows to utilize the sunlight when working on a usual daytime.

9. *Arranged lighting to avoid glare:* Almost every lighting unit are placed appropriately in each workstation so that glare, shadows, and blinding light can be avoided.

Recommendations

- OSHA standards mandate that adequate artificial lighting shall be provided when daylight illumination is insufficient. It has to be designed in a uniform level, widely distributed to avoid shadows or glares.
- The recommended maximum daily exposure to an artificial lighting should be between 3 to 6 hours at 12 inches distance to the light bulb. Natural lighting is also necessary however, windows should be provided and located with means to avoid glare. It should have a regular cleaning schedule especially that the most common types of windows in the Philippines are jalousie and awning windows. It is very prone to attract dust and dirt from vehicles passing by.

Work Environment (Ventilation)

10. *Escape of heat controlled at the source:* Machines are used even in some micro and small enterprises. These machines in the shoe manufacturing, such as sewing machines and stamping machines, also produce heat. However, these are not placed on isolated places. The machines are easily accessible within the facility that makes the heat escape and spread throughout the workplace. Workers are used to this kind of work environment so they do not pay much attention to it while working.

11. *Provided ventilations:* All shoe manufacturing companies provided ventilations, mostly for each workstation or work area/ department. However, the room temperature is still high even if ventilations are provided. Electric fans are the only type of ventilation being provided. Some of the workers also rely on the open windows where wind could pass through. Medium to large companies have the advantage in terms of large spaces/ wide workplace areas, even with high ceilings that could create a good air circulation and ventilation. In addition, small working spaces or workstation areas per worker, in most micro and small enterprises, contribute to poor heat control and air circulation. Therefore, high room temperature level can be experienced in most micro and small enterprises.

12. *Provided ventilations:* All shoe manufacturing companies provided ventilations, mostly for each workstation or work area/ department. However, the room temperature is still high even if ventilations are provided. Electric fans are the only ventilation provided. Some of the workers also rely on the open windows where wind could pass through. In addition, small working spaces or workstation per worker, in most micro and small enterprises, contribute to poor heat control and air circulation. Therefore, high room temperature level are experienced in these.

13. *Workers adequately clothed for the equivalent wind chill:* Workers at micro and small enterprises wear inadequate clothing since the management are lenient. Uniforms and PPEs are not required in these workplaces compared to medium to large companies. The workers also pointed out that workplace temperature is also one of the reasons why they wear light clothes since these are comfortable to wear on a hot sunny weather.

14. *Appropriate ventilations:* The Philippines is a tropical country, there are only two seasons in this country, which are rainy and dry seasons. By default, daytime in the Philippines is hot and humid. Industries that do not provide air conditioning are challenged due to poor or inappropriate ventilation. Micro and small enterprises provide electric fans but these may be not enough for the usual room temperature in the workplace. Most micro and small enterprises only have small spaces which also contributes to the poor air circulation and high temperature of the workplace.

Recommendations

- Apt atmospheric condition must be maintained in workrooms by artificial or natural means to reduce the occurrence of insufficient air supply. Section 807 of the NBCP requires a minimum space of 12.00 cubic meters of space per person in workshops, factories, and offices to promote optimal air space and circulation. Window openings shall be available for every room with no artificial ventilation system provided, according to Section 808 of the NBCP. Section 811 of the NBCP requires the provision of artificial ventilation for rooms or spaces with industrial equipment to avoid immoderate thermal conditions.
- OSHA standards suggest that air movement in enclosed workplaces shall be arranged in a way that workers are not subjected to unacceptable circumstances. In terms of temperature and humidity, suitable room temperature must be maintained and employees must be protected against radiation and excessive temperature from heated machinery or equipment. Employers are the ones in-charge of maintaining and controlling the working environment in comfortable and healthy conditions.
- Ventilation and exhaust equipment must be inspected and clean daily since dust and small particles from the leather might be present in the equipment and it is harmful to the user.

5.4 Validation

The reliability test measured the consistency of a set of items within the data gathering tool used since these are multiple rating scale items. The data gathering tools, which are the survey questionnaire, worker evaluation checklist, and company evaluation checklist, have Cronbach's alpha values of 0.875, 0.721, and 0.882, respectively. These Cronbach's alpha values are greater than 0.70, which means that the data gathering tools used are highly reliable and

the results are acceptable. Additional reliability test were also done for the entire data collection tools (excluding RULA) and for the statistically significant factors with moderate positive or negative linear relationship with Cronbach's alpha values of 0.825 and 0.903, respectively.

6. Conclusion

Health issues have a weak degree of relationship with productivity. Therefore, these health issues do not necessarily affect productivity. The relationship between the two variables might be weak based on the correlation test but health issues still have an impact with the productivity of a worker. Although it does not necessarily mean that the worker is less productive if the worker is sick or experiencing this health issue. Working environment has a moderate relationship with productivity. Therefore, the effects of adjusting the discomforts will necessarily have moderate impact with the productivity of the workers. However, it will have a significant effect not just on their productivity but also on their well-being in the long run. Efficiency and productivity also have weak relationships. However, Pareto chart reveals that falling objects, small scars and hammering of fingers are the three most common accidents that happen on a daily basis from mild to severe levels of pain. On the other side, physical stress, excessive pressure, high room temperature, mental stress, and excessive noise are the most frequent discomfort that may have been the reasons why efficiency decreases. Efficiency is the best possible output per unit of time. Therefore, doing the right things increases efficiency and productivity, and these two variables matter at the same level that will lead to true productivity (Stack, 2019).

Bronchitis, coronary heart disease and diabetes are the three health issues that appear to be significant with productivity. Pareto charts however, suggest that joint pain, high blood pressure, and low blood pressure must be prioritized based on the 80/20 rule. This is because 51.3% suffer from joint pain, 25% have high blood pressure and 8.1% have low blood pressure. These percentage of respondents are suffering pain from mild to severe. Therefore, these are the significant factors that affect the productivity of workers. These common health issues may lead to absenteeism or delays while working. More than a handful of factors under working environment discomfort and improper practices that may lead to work related injuries appears to be significant with productivity. These significant factors under discomfort can lead to many consequences and domino effect not only with productivity but also in terms of health issues and efficiency. The biggest chunk of factors that are significant were all under the work environment. The chi-square test for p-value significance reveals that none of the factors under efficiency was significant. However, Pareto charts suggest that falling objects, small scars, and hammering of fingers need attention based on the 80/20 rule. Therefore, these factors are also considered as significant because these minor accidents frequently happen multiple times per day. Also, a follow up question reveals that 55.40% of the workers still make mistakes despite mastering their job. It also indicates that 55.40% of the respondents are not completely efficient while performing their task. There are several ways to improve the degree of relationship between productivity and the independent variables (health issues, work environment, and efficiency). Since the gathered data are opinion-based, retrospective data from companies, such as employees' records of sick leaves/ vacation leaves, number of absences, number of accidents/cases, annual tool and equipment replacements, and turnovers, could help to improve the correlation between the average daily output of workers and the independent variables. The output per day also varies per job description that incurred a large variance since the workers declared these values like an open-ended statement. Thus, setting up a ranged-based question could improve the degree of relationships. Increasing the sample size in order to reduce the effect of a random error would improve the results of significance tests. However, factors that are insignificant but have at least a moderate linear relationship should also be considered.

The relationship between the dependent and independent variables can be shown using linear regression analysis. This tool could also be used as a predictive model to compute for the output per day. The results drawn from the linear regression could help the employers to work closely with the workers in order to assess their welfare, especially their work environment. To better hear the workers' insights about ergonomics and get their interest in workplace health and safety, the management for each company could incorporate a Participatory Ergonomics Approach, in which the workers would be involved in the conceptualizing, developing, and implementing of workplace designs and improvements. (Burgess-Limerick, 2018) Employers should also conduct training programs about ergonomics for their workers. Additionally, it is recommended that periodic auditing or workplace assessment should be conducted to maintain the appropriateness of tools, seats, surfaces, and optimal working conditions.

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