Determining the Effects of Back Support on the Comfortability and Productivity of BPO Employees

Almarose Villapando, Daniel Raven B. Gollayan, and Janka Andrea F. Magaling
School of Industrial Engineering and Engineering Management
Mapúa University
658 Muralla St. Intramuros, Manila
almarosevillapando@yahoo.com, drbgollayan@mymail.mapua.edu.ph,
jafmagaling@mymail.mapua.edu.ph

Abstract

Back pain is the leading common occupation disease found in industries with activities requiring manual labor and sitting for long periods for the years 2015, 2013 and 2011. The nature of sedentary work is at potential source of work-related musculoskeletal symptom. Back support has been known as a support device on chairs. However, it still does not meet the needs of user to ease comfort while performing work seated tasks (Olabode et al., 2017). This paper intends to assess the current component of the back support, identify which component has the greatest impact on productivity and comfortability, and develop an ergonomic design of back support to increase comfortability and productivity level of employees. Regression analysis was utilized to determine the component that have the most impact on comfortability and productivity. Results showed that curve on the lumbar region greatly affects comfortability whereas the greatest predictor for productivity was the height of the back support. Therefore, the proposed back support would serve as a supporting device in call center industry to help increase comfortability and productivity of BPO employees.

Keywords
BPO employees, Back Support, Back Pain, Comfortability Level, Productivity Level

1. Introduction
As of April 2020, records from the Philippine Statistics Authority (2020) showed that there is a total of 82.3% employment rate from the total population of 73,722,000 people above the age of 15 years old. Employees play vital roles in a company because they carry out the tasks needed to meet the organizational goals. In a company, an office worker is someone who works and most of the time stationed in the office performing diverse tasks as assigned based on the position occupied. And most of the nature of work done in the office requires long sitting hours for desk job tasks, computer setting, reading, and meeting. Research shows that work-related factors are one of those which are associated with occupational sitting, and it varies from office groups. Highly sedentary groups with more workloads are more prone to sitting and sedentary behavior (Yang et al., 2017). Computer and office-based workers are more frequent to sit and extend their computer use on a normal working day.

Today, lumbar support has been an effective device for individuals with seating discomfort and treatment for low back pain. It has also been a source of reducing the exposure of workers to lower back pain and musculoskeletal disorders (Lanhers et al., 2016). Lumbar support had been widely known as a supporting device on chairs while performing seated tasks. However, there are still problems with back support on office chairs and it causes health discomfort on their work (Olabode et al., 2017). Existing back support still does not meet the needs of the user. There are still lacking in the structure and design of the back support that needs to be worked on to maximize its use as an effective device for office workers.

Work-related discomfort is affected by the extent of exposure and the use of computers. Back support devices maintained the S-shaped curve which helped in increasing comfort and good posture when sitting. The back of an individual varies differently, and it is important to have lumbar support enough to cover the lumbar vertebrae. Employees have difficulty being productive when they are not physically comfortable with the structure of their workstation (Corlett, 2006). As the employees work in a hazardous environment and workstation, they become more exposed to injury that causes them to decrease their performance level. Productivity is greatly affected by the design of the workplace and the environment. It is important to note that the comfortability of the workers should be prioritized and be invested to improve productivity. Fitting the environment to the employee will improve the wellbeing, comfortability, and productivity of workers. Thus, financial gains and the company's competitiveness.

1.1. Objectives

The study is directed to achieve the following objectives: 1. Assess the current components of the back support such as type of material, height, the curve on the lumbar region, cushion thickness, width, and evaluate the comfortability experienced at the upper and lower back, and productivity level of office workers, 2. Identify the components in the back support that affect the comfortability and productivity of office workers, and 3. Develop an ergonomic design of back support that will increase comfortability and productivity levels of employees.

2. Literature Review

Lumbar support fixtures are efficient for postural correction for it helps to maintain neutral posture when sitting. Sedentary work with a long period of continuous sitting increases stress and pressure in muscles in the neck and lower back region. (Kim et al, 2016) investigated the effects of thoracic and lumbar support fixtures on forward head posture (FHP) on office workers. The result was lumbar support has a significant effect on the ligaments and muscles in the thoracic, and lumbar spine region. It provided comfort for workers in continuous sitting and increased productivity when doing work-related tasks. Back support devices are commonly prescribed by health care practitioners to improve sitting posture and comfort when working. Research (Grondin et al, 2013) studied lumbar support devices and spinal curvatures to determine the type of lumbar support pillow that will help in the comfort and health of individuals. Lumbar support with a cut-out for the posterior pelvic tissues improved comfort in individuals with low back pain and those without low back pain. Back support devices maintained the S-shaped curve which helped in increasing comfort and good posture when sitting. The back of an individual varies differently, and it is important to have lumbar support enough to cover the lumbar vertebrae. The lumbar pad on the lumbar area of the back support fitted the natural spine curvature. The contact pressure of the lumbar region is directly proportional to the lumbar support (Guo et al., 2016).

A design with a good amount of inclination on the back can improve S-curve formation, relieves fatigue, and increase worker’s efficiency (Kim et al., 2015). A study was done on the effect of a lumbar pillow on the comfortability and lumbar posture of a person. The right kind of foam for seat cushion and thickness reduced the stress level at the lower back region. Productivity of the workers has a significant impact on an organization's growth and financial performance. (Kaushik et al., 2020). Office’s design elements such as seating, density and proximity directly affect the occupant’s working performance and work pattern (Lee, 2010). Comfortability in the workplace is greatly affected by the physical working environment (Chua, 2016).

3. Methods

The researchers assessed the current design of back support used by office workers, anthropometric measurement and conducted evaluations associated with discomfort and productivity. The tools used are evaluation questionnaires, Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA) to determine the MSD risk of the workers using their back support. The researchers used the results of the CMDQ score, components discomfort score, and productivity score as a basis for assessing the effect of back support including the design, type of material, and other components on comfort level and productivity of the workers. They used statistical tools such as Hypothesis testing, Analysis of Variance (ANOVA) and Regression Analysis in identifying the components in back support that have the greatest effect on comfortability and productivity of employees. This was analyzed at the Minitab which is a software used for statistical analysis. The researchers used the identified components of back support that affected the comfortability and productivity of workers in creating the design for back support. The design tools that will be used are Product Design and Development, Quality Function Development (QFD), Failure Mode and Effect Analysis (FMEA), and Cost-Benefit Analysis. The design tools were relevant in designing the new design of back support to improve the comfort and productivity of office workers. Also, the outcome will be the recommended anthropometric measurements for back support as a basis for designing back support in future research.

4. Data Collection

The researchers gathered data from 100 BPO employees. The questionnaires are distributed to the respondents. It contained questions about their personal and work information, productivity, body discomfort, and comfortability of components in using the back support. The participants are those who perform inbound calls, outbound call, and answering emails in the company. The researchers conducted a study in XYZ Company. The company is a Business Process Outsourcing (BPO) company that provides business solutions to its clients in companies and institutions. The two designs of back support used by the employees in XYZ company are D-shaped and pillow-shaped. The D-shaped back support has a convex shape primarily for the back and lumbar region of the body. Pillow-shaped back support has the same thickness from top to bottom and has no curve on the lumbar region.

5. Results and Discussion

5.1. Rapid Upper Limb Assessment

Table 1 shows the RULA score of each type of chair and back support used by the employee at work. Employees seated on a computer chair and D-shaped back support, standard office chair and pillow-shaped back support, and executive chair and pillow-shaped back support has the highest RULA score which is 5 which indicates that there must be further investigation and change soon.

Table 1. Summarized data of RULA Score for type of chair and variation of back support

	RULA SCORE		RULA SCORE
Employee seated on a foam office chair and using D-shaped	4(further investigation, change may be needed)	Employee seated on an executive office chair and using pillow-shaped back support	5 (further investigation, change soon)
Employee seated on an executive office chair and using D-shaped back support	4 (further investigation, change may be needed)	Employee seated on a standard office chair and using pillow-shaped back support	5 (further investigate, change soon)
Employee seated on a computer chair and D-shaped back support	5 (further investigation, change soon)		

5.2. Rapid Entire Body Assessment

Table 2 shows the REBA score per type of chair and type of back support used by the employees. Employee seated on an executive office chair and using D-shaped back support obtained the lowest REBA score which stated that there is low risk and change may be needed. Employee seated on an executive chair and pillow-shaped back support obtained the highest REBA score which indicates that there is a medium level of risk and further investigation and change is needed in the future. Employee seated on a standard office chair with pillow-shaped and computer chair with D-shaped are also at medium risk.

Table 2. Summarize data of REBA Score for the type of chair and variation of back support

	REBA SCORE		REBA SCORE
Employee seated on a foam office chair and using D-shaped	3 (Low risk, change may be needed)	Employee seated on an executive office chair and using pillow-shaped back support	6 (Medium Risk, further investigate, change soon)
Employee seated on an executive office chair and using D-shaped back support	3 (Low risk, change may be needed)	Employee seated on a standard office chair and using pillow-shaped back support	5 (Medium Risk, further investigate, change soon)
Employee seated on a computer chair and D-shaped back support	5 (Medium Risk, further investigate, change soon)		

5.3. Anthropometric Data

In the study conducted (Prado-Lu, 2007), the anthropometric measurement of Filipino manufacturing workers was used to establish recommended measurements to improve the back support. Since there are no previous studies regarding an anthropometric size for back support, the researchers utilized the measurement for backrest as references for it is associated with the back region of the body. In the study, there is a relationship between lumbar curvature with backrest (Vergara & Page, 2000). The dimensions of back rest are associated with the discomfort in the back region and on the lumbar area. Therefore, the researchers made use of anthropometric dimensions for backrest as a basis for back support since both have the same functions in terms of supporting the back region and its relationship to the lumbar region. Based on the survey results, most of the respondents experienced discomfort on the upper (thoracis) and lower back (lumbar) region. In Table 5, the relevant anthropometric measurements corresponded to the dimension of back support including sitting shoulder height and chest breadth. The sitting shoulder height was used to determine the height of the back support. It was formulated by getting the differences of the standing shoulder height, buttock popliteal height and popliteal height. Shoulder width was used to determine the width of the back support.

Table 3. Anthropometric measurement for back support

Back Support Dimension	Actual Measurement (cm.)		Anthropometric Data	Percentile Criteria	Recommended Measurement (cm
	D-shaped	Pillow-shaped			
Height of Back Support	31	31	Sitting Shoulder Height: Standing shoulder height-buttock popliteal height-popliteal height	5th % F	148-40-36=42
Width of Back Support	34	34	Shoulder Width	95th %M	49.40

The percentile criteria of the anthropometric measurement will be used for the design of the back support shown in table 3. The sitting shoulder height was based on the 5th percentile of the female population and the value obtained is 42 cm. The percentile was adapted for the height of back support to avoid the size being low or high that will cause discomfort on the spine. The shoulder width was 49.40 cm from the 95th percentile of male measurement to have enough width to cover the back region of the user and reduce the MSD discomfort of employees.

5.4. Two-way ANOVA and Tukey Post Hoc Results

Table 4. Result of Two-way ANOVA between the gender and variation of back support based on the CMDQ score of upper back, CMDQ score of lower back, productivity and the comfortability experienced in each component of the back support.

Factors	P-Value			Decision	Tukey Test Result	Variation of Back Support (Average)	
	Gender	Variation of Back Support	Gender * Variation			Pillow-shaped	D-shaped
CMDQ Score of Upper Back	0.907	0.004	0.714	only Variation has SD	Pillow-shaped vs D-shaped	44.49	21.79
CMDQ Score of Lower Back	0.912	0.009	0.803	only Variation has SD	Pillow-shaped vs D-shaped	43.81	25.29

Productivity	0.784	0.000	0.164	only Variation has SD	Pillow-shaped vs D-shaped	92.99	95.913
Components							
Height	0.494	0.85	0.867	no SD	-	3.66216	3.93333
Width	0.258	0.017	0.655	only Variation has SD	Pillow-shaped vs D-shaped	3.67568	4.05758
Thickness	0.282	0.000	0.501	only Variation has SD	Pillow-shaped vs D-shaped	2.85135	3.64242
Type of material	0.308	0.002	0.610	only Variation has SD	Pillow-shaped vs D-shaped	3.28378	3.78788
Design	0.066	0.000	0.659	only Variation has SD	Pillow-shaped vs D-shaped	2.48649	3.46364
Curve on the Lumbar Region	0.182	0.000	0.923	only Variation has SD	Pillow-shaped vs D-shaped	2.24324	3.56364

Based on Table 4, the variation of the back support only had significant difference for the CMDQ score of upper and lower back, and productivity. It can also be said to the comfortability experienced in the six components of the back support except for the height. This is because pillow-shaped and D-shaped has the same dimension on the height and width. Width can also be observed that it has the highest p-value excluding the height. The pillow-shaped and D-shaped back supports are also significant different from each other with D-shaped in terms of the CMDQ score, productivity and comfortability experienced in the components. It has a lower mean in the CMDQ score for both upper and lower back, this means that pillow-shaped is more uncomfortable compared to D-shaped. For productivity and comfortability experienced in the components, D-shaped has a higher mean, meaning that it is more comfortable compared to pillow-shaped.

Table 5. Correlation Analysis

Variables	R		
	CMDQ Score:		Productivity
	Upper Back	Lower Back	
Comfortability at:			
Height	-0.508	-0.493	0.033
Width	-0.511	-0.492	0.049
Thickness	-0.591	-0.583	0.128
Type of Material	-0.407	-0.388	0.139
Design	-0.591	-0.566	0.218
Curve on the Lumbar Region	-0.686	-0.663	0.259
Additional Information			
Standing Time	-0.238	-0.204	-0.125
Number of Sick Leaves	0.641	0.605	-0.264

5.5. Correlation and Regression Analysis

The researchers wanted to identify the relationship between the productivity, discomfort at the upper and lower back, and the comfortability experienced at the components of the back support. Table 5 shows that the highest R observed in the discomfort upper and lower back was the comfortability experienced at the curve on the lumbar region. It has a moderate negative relationship with the component meaning the higher the value of the CMDQ score, the lower the comfortability experienced in the curve of the lumbar region. Compared to productivity, the curve on the lumbar region rather has a weak positive relationship with it. For the additional information, the standing time for the employees has a weak negative relationship with the discomfort in the upper and lower back, and productivity. This means that it does not affect that much the discomfort in the upper and lower back, and productivity of an employee whether they stand more often or not. For the number of sicks leaves, it has a moderate positive relationship with the discomfort in the upper and lower back, and a weak negative relationship with productivity. The more an employee takes sick leaves, he/she is more susceptible to discomfort in the upper and lower back.

Regression Equation

UPPER BACK = 32.9 + 0.0 [Height]_2 + 56.0 [Height]_3 + 45.2 [Height]_4 + 38.7 [Height]_5
+ 0.0 [Thickness]_2 - 2.30 [Thickness]_3 - 18.3 [Thickness]_4
- 18.6 [Thickness]_5 + 0.0 [Design]_1 - 15.5 [Design]_2 - 9.3 [Design]_3
- 12.6 [Design]_4 - 10.5 [Design]_5 + 0.0 [Curve on the Lumbar Region]_1
- 15.89 [Curve on the Lumbar Region]_2 - 39.8 [Curve on the Lumbar Region]_3
- 45.3 [Curve on the Lumbar Region]_4 - 44.4 [Curve on the Lumbar Region]_5

Figure 1. Regression equation for the CMDQ score in the upper back

Regression Equation

LOWER BACK = 33.5 + 0.0 [Height]_2 + 51.4 [Height]_3 + 41.2 [Height]_4 + 36.7 [Height]_5
+ 0.0 [Thickness]_2 - 2.86 [Thickness]_3 - 18.3 [Thickness]_4
- 25.0 [Thickness]_5 + 0.0 [Design]_1 - 11.5 [Design]_2 - 4.8 [Design]_3
- 7.2 [Design]_4 - 7.3 [Design]_5 + 0.0 [Curve on the Lumbar Region]_1
- 15.94 [Curve on the Lumbar Region]_2 - 36.4 [Curve on the Lumbar Region]_3
- 45.6 [Curve on the Lumbar Region]_4 - 36.2 [Curve on the Lumbar Region]_5

Figure 2. Regression equation for the CMDQ score in the lower back

Figure 1 shows that the comfortability experienced at the curve on the lumbar region is the greatest predictor for the CMDQ score in the upper back. Referring to Table 2, it can also be observed that the comfortability experienced at the curve on the lumbar region has the highest R-value for both the scores. For the discomfort at the lower back, Figure 2 shows that there is no significant predictor. The greatest non-significant predictor for it would be the curve on the lumbar region, the same as the discomfort at the upper back. Figure 3 shows that most of the coefficients for the equation are negative. This means that they have mostly negative relationship with the productivity of the employees.

Regression Equation

Productivity = 102.04 + 0.0 [Height]_2 - 7.08 [Height]_3 - 7.02 [Height]_4 - 7.77 [Height]_5
+ 0.0 [Thickness]_2 - 0.723 [Thickness]_3 - 1.72 [Thickness]_4
+ 0.46 [Thickness]_5 + 0.0 [Design]_1 - 1.68 [Design]_2 - 1.27 [Design]_3
- 0.54 [Design]_4 - 0.60 [Design]_5 + 0.0 [Curve on the Lumbar Region]_1
- 0.360 [Curve on the Lumbar Region]_2 + 2.94 [Curve on the Lumbar Region]_3
+ 2.90 [Curve on the Lumbar Region]_4 + 0.67 [Curve on the Lumbar Region]_5

Figure 3. Regression equation for productivity

5.6. Proposed Improvements

The researchers chose a design with a cut-out on the posterior pelvic area (Grondin et al. 2013), with a D-shaped design on the upper portion of it. Figure 4 and 5 shows the dimension of the back support for the height, width, thickness, and curve on the lumbar region. The thigh clearance was used to determine the height of the cut-out. The 5th percentile of anthropometric data of thigh clearance for females was used, which was 10 cm. The same was applied on the bottom side of the back support as shown in Figure 5, where it is measured to be 8.7 cm. It was based on the anthropometric data for the hip-width/breadth of the 5th percentile of the females, which was 34 cm, which is also the whole length of the posterior pelvic cut-out. They have also improved the height and width of the back support by following the anthropometric measurement as shown in table 5. The width of the proposed design was 49.40 cm and the height was 42 cm. The thickness of the back support was 5 cm and the thickness on the sides was 10 cm. The curve on the lumbar region was adapted from the current D-shaped back support, whichvhad the same curvature.

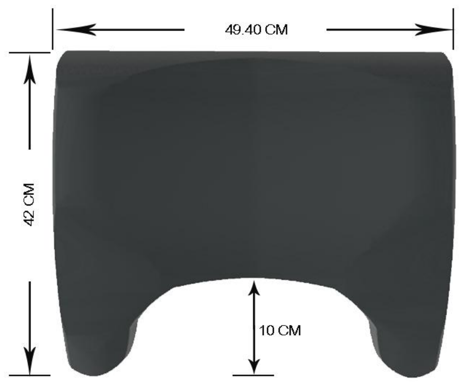

Figure 4. Top View of the Proposed Design with Dimensions

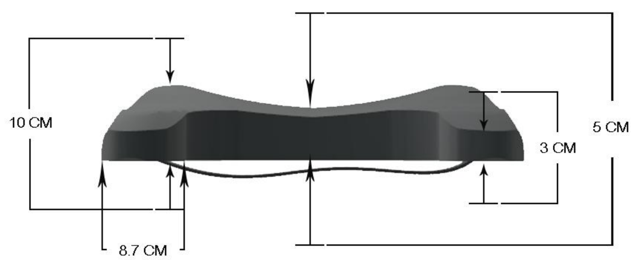

Figure 5. Front View of the Proposed Design with Dimensions

Table 6. Comparison of the components of the three back supports

Components	Pillow-shaped	D-shaped	Proposed Design
Height	31 cm	31 cm	42 cm
Width	34 cm	34 cm	49.40 cm
Thickness	3 cm	5 cm	5 cm
Type of Material	Polyester	Foam	Copper Memory Foam
Design	Pillow-shaped	D-shaped	Posterior Pelvic Cut
Curve on the Lumbar Region	None	3 cm. x 6 cm. x 5 cm.	3 cm. x 6 cm. x 5 cm.

The proposed design has similar components to the D-shaped based on the statistical analysis. The height and width of the back support was based on the anthropometric data as shown in table 6. The thickness is the same as the D-shaped being 5 cm. The type of material and design/shape was based on the RRL. The curve on the lumbar region was based on the D-shaped back support.

6. Conclusion

Most of the workday of BPO employees required long periods of sitting hours and performing sedentary work that are prone to risk. Back supports are supporting devices that are used to alleviate discomfort to the back region of the body. In this study, comfortability and productivity of employees were assessed on the use of back support. The components of back support that have an impact on comfort are height, width, type of material, cushion thickness, design, and curve on the lumbar region. In XYZ company, the employees used two designs of back support, namely the D-shaped and pillow-shaped back support. The researcher assessed the components through surveys distributed to 100 participants. The respondents were asked about their personal & work information, evaluation of components of back support, comfortability experienced with the components, Cornell Musculoskeletal Discomfort Questionnaire (CMDQ), and productivity evaluation.

Based on the results of the survey, most of the respondents used Pillow-shaped back support than D-shaped back support. The components curve on the lumbar region and the design of back support obtained the least comfort level experienced by the employees using the current back supports. In the CMDQ section, results showed that the back and lower regions were the parts that experienced the most discomfort. The researchers conducted RULA and REBA to assess the level of MSD risk. The results indicated that investigation and implementation change is needed to prevent workers from exposure to high risks of injury with the two designs of back support. Moreover, they conducted recommended anthropometric dimensions to the back support regarding backrest to achieve the supporting function on the back region.

The statistical analysis shows that there is a significant difference in the productivity of the workers and the back support. It is also the same as the CMDQ score of the upper and lower back. For the comfortability in the components, the comfortability experienced at the height of the back support was the only exception that has no significant difference for the variation of the back support. The greatest predictor for productivity was the height of the back support but it is not significant according to its standardized effect, and for the upper and lower back was the curve on the lumbar region. The proposed design of the back support was based on an ergonomic design and the anthropometric measurements of Filipinos. The posterior pelvic cut was used based on the Review of Related Literature. The measurements followed the anthropometric data.

References

Chua, S. J., et al. (2016). Physical Environment Comfort Impacts on Office Employee's Performance. *MATEC Web of Conferences, 66*, 00124. doi:10.1051/matecconf/20166600124

Corlett, E. N. (2006). Background to sitting at work: Research-based requirements for the design of work seats. *Ergonomics, 49*(14), 1538-1546. doi:10.1080/00140130600766261

Corlett, E. N. and Bishop, R. P. (1976) A technique for measuring postural discomfort. *Ergonomics*, 9, 175-182.

Grondin, D. E., et al. (2013). The effect of a lumbar support pillow on lumbar posture and comfort during a prolonged seated task. *Chiropractic & Manual Therapies, 21*(1). doi:10.1186/2045-709x-21-21

Guo, C. Q., et al. (2018). Fabrication, Structure and Property of Copper Foam. Materials Science Forum, 933, 41-48. doi:10.4028/www.scientific.net/msf.933.41

Guo, L., et al. (2016). Effect of lumbar support on seating comfort predicted by a whole human body-seat model. *International Journal of Industrial Ergonomics, 53*, 319-327. doi:10.1016/j.ergon.2016.03.004

Kaushik, D. A., et al. (2020). Effect of thermal comfort on occupant productivity in office buildings: Response surface analysis. *Building and Environment,* 107021. doi:10.1016/j.buildenv.2020.107021

Kim, C. Y., et al. (2015). Development of Ergonomic Backrest for Office Chairs. *Journal of the Ergonomics Society of Korea, 34*(2), 151-165. doi:10.5143/jesk.2015.34.2.151

Kim, Y.,et al. (2016). Research the Effects of Thoracic and Lumbar Support Fixtures on Forward Head Posture during Visual Display Terminal Work. *Journal of The Korean Society of Physical Medicine, 11*(3), 41-47. doi:10.13066/kspm.2016.11.3.41

Kreuzfeld, S., Seibt, R., Kumar, M., Rieger, A., & Stoll, R. (2016). German version of the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ): Translation and validation. *Journal of Occupational Medicine and Toxicology*, 11(1). doi:10.1186/s12995-016-0100-2

Lanhers, C., Boutevillain, L., Pereira, B., & Coudeyre, E. (2016). Lumbar support and nonspecific low back pain: Evidence for daily practice. *Annals of Physical and Rehabilitation Medicine, 59*. doi:10.1016/j.rehab.2016.07.068

Lee, Y. S. (2010). Office layout affecting privacy, interaction, and acoustic quality in LEED-certified buildings. *Building and Environment, 45*(7), 1594-1600. doi:10.1016/j.buildenv.2010.01.007

Olabode, S. O., et al. (2017). Ergonomics Awareness and Employee Performance: An Exploratory Study. *Economic and Environmental Studies, 17*(44), 813-829. doi:10.25167/ees.2017.44.11

Philippine Statistics Authority (2018). Safety and Health in the Workplace-Cases of Occupational Diseases. Retrieved from https://psa.gov.ph/sites/default/files/LABSTAT%20Updates%20Vol%2022%20No%206_0.pdf

Philippine Statistics Authority (2020) Employment Situation in April 2020. Retrieved from:http://www.psa.gov.ph/system/files/TABLE%204%20%20%20Total%20Population%2015%20Years%20Old%20and%20Over%20and%20Rates%20of%20Labor%20Force%20Participation%2C%20Employment%20Unemployment%20%20and%20Underemployment%2C%20by%20Region%20%20April%202020.xlsx

Prado-Lu, J. L. (2007). Anthropometric measurement of Filipino manufacturing workers. *International Journal of Industrial Ergonomics*, 37(6), 497-503. doi:10.1016/j.ergon.2007.02.004

Taifa, I., and Desai, D. (2017, March 01). Directory of Open Access Journals. Retrieved October 19, 2020, from https://doaj.org/article/2a0c993894804d73b715266496cd8be3

Torres EB, et al. Occupational health in the Philippines. *Occup Med*. 2002 Jul-Sep;17(3):455-68, v. PMID: 12028954.

Vergara, M., and Page, Á. (2000). System to measure the use of the backrest in sitting-posture office tasks. *Applied Ergonomics, 31*(3), 247-254. doi:10.1016/s0003-6870(99)00056-3

Yang, L., et al. (2017). Work-related correlates of occupational sitting in a diverse sample of employees in Midwest metropolitan cities. *Preventive Medicine Reports, 6*, 197.

Biographies

Almarose C. Villapando is a professor of Mapúa University, Master of Engineering Management at Mapúa University and Bachelor of Science in Industrial Engineering at Mapúa University. Her expertise is on Methods Engineering and Work Measurement, Compensation Administration, Human Resource Management, and Total Quality Management.

Daniel Raven B. Gollayan is a graduate of Mapúa University with a degree of Bachelor of Science in Industrial Engineering. He joined organizations such as Philippine Institute of Industrial Engineers (PIIE) and Operations Research Society of the Philippines (ORSP).

Janka Andrea F. Magaling is a graduate of Mapúa University with a degree of Bachelor of Science in Industrial Engineering. She joined the organization of Philippine Institute of Industrial Engineers (PIIE).