Ergonomic Assessment of Copra Cake Manual Material Handling Process: A Basis for the Design of an Ergonomic Equipment

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Abstract

Ergonomics studies how people interact with other system components, thus ensuring that the task and individual are compatible. Musculoskeletal disorders (MSDs) are the leading causes of poor ergonomics. Meanwhile, ABC Oil Mill is a producer of coconut oil and copra cake. Manual copra cake handling was one of the processes being observed in the company and chosen due to most workers encountering MSDs such as fatigue, back pain, shoulder pain, etc. The researchers used different ergonomic assessments such as the Rapid Upper Limb Assessment (RULA), Rapid Entire Body Assessment (REBA), and the Washington Industrial Safety and Health Act (WISHA) lifting analysis. Based on the result, REBA had a final score of seven (7), while RULA resulted in a score of ten (10), with an equivalent of *High Risk,* indicating that the process must be investigated, and change must be implemented. Moreover, the WISHA results show that the lifting index is greater than 1, denoting a high risk in the process. From the ergonomic assessment results, the researchers have developed a design of copra cake lifting equipment. Using the anthropometric data of the workers, some of the highlights of the designs are: (1) it is maneuverable with an adjustable platform; (2) with push buttons for the lift; and (3) with a motor that helps to lift the sacks.

Keywords
Ergonomic lifting equipment, MSDs, RULA, REBA, and WISHA

1. Introduction
ABC Oil Mill is a company located in the center of Quezon Province – part of the region considered as one of the leading coconut producers in the Philippines (Philippine Statistics Authority 2022). One of their by-products is the copra cake which is the residue left after oil is physically extracted from copra (dried coconut kernels). The process of extracting the oil begins with grinding and heating copra to reduce excessive moisture; using an expeller machine, colorless oil is then extracted from the flakes producing copra cakes that contain about 7% of oil. Hexane can be used to further extract the remaining oil, resulting in copra cakes with less than 3.5% oil by weight. These cakes are valued and commonly used as livestock feed.

Workers in ABC Oil Mill use shovels to scrape up and store the copra cakes in sacks. Each sack, weighing an average of 40 kilograms, is manually lifted into trucks for transport. According to a study by Azevedo et al. (2012), when performing a bi-manual whole-body lifting task while holding a load, the center of mass shifts forward, placing stress on the dynamic balance control and impeding the continuous extension action, which results to a disruption in the internal equilibrium. Manually lifting heavy loads may affect postural balance, increasing the risk of falling, discomfort, and injury.

In addition to the lack of reliable manual lifting tools, the workers at the oil mill were not properly oriented about the ideal lifting postures to reduce discomfort and health risks. Their working conditions show potential factors that can lead to the development of work-related musculoskeletal disorders (WMSDs) such as sprains, strains, back discomfort, hernia, and carpal tunnel syndrome. Such musculoskeletal problems, due to awkward postures and prolonged periods

of labor in unhealthy positions, remain a significant cause of disability, absences, and time losses at work (Enshassi and Swaity 2013).

The primary goal of implementing ergonomic improvements is to ensure that the task and workers are compatible – establishing safe and healthy working conditions that permits high productivity while reducing the risk of developing WMSDs. Examining how people interact with other system components and applying theory, concepts, data, and design methodologies are all part of the development of engineering controls to ergonomically improve processes, especially those involving manual tasks which are prone to higher risks (Berlin and Adams 2017). In labor-intensive industrial tasks, such as the manual material handling of copra cakes at ABC Oil Mill, workload measurement in terms of anthropometry and physiological parameters is also essential in creating more effective work methods or developing ergonomic interventions (Parida and Ray 2023).

To address the health and safety risks in the oil mill associated with poor manual lifting standards, the researchers developed a design for an effective equipment that can promote a safe and efficient transfer and lifting of copra cakes. The researchers employed several ergonomic assessments – Rapid Entire Body Assessment (REBA) and Rapid Upper Limb Assessment (RULA) – that are used by numerous studies to develop tools that mainly focus on improving work posture to reduce the associated health risks (Kusuma, 2020) (Al Madani and Dababneh, 2016). Anthropometric data of the workers were as well integrated to the design dimensions to promote comfortability and ease of use, as exhibited in previous studies that emphasized the role of anthropometry as a guide in designing equipment and facilities (Ayodeji et al. 2009) (Chuan et al. 2010).

The purpose of this study is to promote the use of an ergonomic equipment in reducing the risk of developing WMSDs linked with the manual lifting of copra cake. The researcher intends to develop and propose an effective design of a lifting aid that can improve the manual material handling process at the ABC Oil Mill – addressing the health and safety issues experienced by the workers involved.

1.1 Objectives

The study aims to design and develop an ergonomic equipment to assist workers in lifting copra cake sacks. It analyzes the present manual material handling process at ABC Oil Mill using the following ergonomic assessments: Rapid Upper Limb Assessment (RULA), Rapid Entire Body Assessment (REBA), and the Washington Industrial Safety and Health Act (WISHA) lifting analysis. The initial results of these assessments, as well as the data gathered from a series of interviews and observations, serve as the baseline in identifying potential solutions that can be adapted to address the existing ergonomic issues in the company's working conditions concerning the manual lifting of heavy loads. Furthermore, the study involves gathering workers' anthropometric data to determine the ideal specifications of the ergonomic lifting equipment. Lastly, the design has been evaluated in terms of functionality, efficiency, and cost benefit.

2. Methods

2.1 Research Design

The study follows a research and development method in conceptualizing and developing the design of the copra cake lifting equipment to assist the workers at ABC Oil Mill. The researchers integrated the pertinent data gathered from the company and workers with the theories and principles in ergonomics to develop a product capable of addressing the problem that the study addresses.

2.2 Research Environment

The researchers collaborated with the executives and workers at ABC Oil Mill which is headquartered at Pagbilao, Quezon, Philippines. It is an enterprise supplying the markets in Quezon Province with their products: copra oil and copra cakes. A total of 15 workers participated in the study who were all exposed daily to the manual task of lifting copra cake sacks.

2.3 Data Gathering Procedures

The researchers conducted initial observation of the conditions at ABC Oil Mill and a series of interviews with the workers and the supervisor, focusing on the manual lifting of copra cake sacks, to determine the existing problems in

the process. A survey was also conducted to determine the workers' level of satisfaction (5 for Highly Satisfied, 4 for Satisfied, 3 for Less Satisfied, 2 for Dissatisfied and 1 for Highly Dissatisfied) with their present working conditions using a Modified Likert Scale. Ergonomic risks were examined utilizing the REBA (for postural conditions), RULA (for the upper limb's exposure to risk factors), and WISHA lifting analysis (for the weight of the load being lifted). Meanwhile, anthropometric data was gathered among the workers to obtain their specific body proportions to be used in designing the ergonomic lifting equipment. In addition, why-why analysis and root cause validation was used to identify the true causes of the identified risks that compromises the health and safety of workers during the conduct of manual lifting.

2.4 Design of the Ergonomic Copra Cake Lifting Equipment

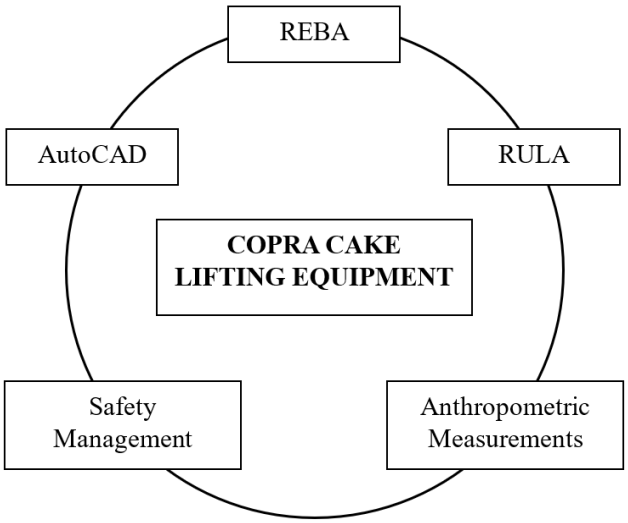

Figure 1. Ergonomic Block Diagram of Copra Cake Lifting Equipment

After collecting and analyzing the preliminary data, the researchers conceptualized the design of the ergonomic copra cake lifting equipment. REBA and RULA were used to assess and identify areas where improvements can be made to reduce workers' postural risks, while ergonomic design concepts and anthropometric measurements were incorporated in the specifications of the equipment to promote comfortability and ease of use while performing the lifting task. The principles of safety management were employed to reduce the likelihood of workers being exposed to work accidents, particularly those caused by lifting hazards. Meanwhile, WISHA lifting analysis was used to determine the recommended weight limit supportive of a safer manual lifting process. The design of the prototype was then constructed using the AutoCAD software for precise measurements and accurate visualization of the equipment's features.

2.5 Testing and Evaluation

The researchers evaluated the design of the ergonomic copra cake lifting equipment in terms of functionality, efficiency, and cost benefit. Comparison of the present and proposed lifting equipment in terms of reducing discomfort among workers (reflected in the number of absences per month) were used to assess whether the new lifting method is effective in its functions. The efficiency of the proposed lifting equipment was evaluated in terms of worker's productivity that is measured by the average lifts they can accomplish per minute. A cost benefit analysis was conducted, taking into account the historical expenses of the workers to relieve muscle pain caused by poor lifting conditions and comparing it with the cost of developing the ergonomic copra cake lifting equipment. The acceptability of the proposed equipment was then assessed through a survey using a Modified Likert Scale, wherein the level of satisfaction of each respondent was measured (5 for Highly Satisfied, 4 for Satisfied, 3 for Less Satisfied, 2 for Dissatisfied and 1 for Highly Dissatisfied).

3. Results and Discussion

3.1 Analysis of the Existing Conditions

To design the ergonomic copra cake lifting equipment, the researchers assessed the company's current material handling practices and the workers' perspective regarding their working conditions, as well as identified the existing tools that they have been using to assist in the manual lifting of copra cake sacks. According to their operations engineer, they solely use manual lifting which entails carrying the sack from the ground to the truck. The only tools available that the workers can use to haul and sack copra cake is a shovel and a basic lifting tool shown below (see Figure 2).

Figure 2. Existing Copra Cake Lifting Tool

Table 1. Dimensions of the Existing Copra Cake Lifting Tool

	Actual Dimension		**Degrees**
	Inches	*Centimeter*	
Handle	4	10.16	-
Body	9	22.86	-
Hook	2	5.08	40

The existing tool is a bare steel hook that workers can use to prick a sack for a better grip before lifting it with the aid of the tool handle. However, the process still highly depends on the physical strength of the workers; the workers were continuously exposed to risks associated with manual lifting of heavy loads without the appropriate lifting tool to reduce the required effort.

Table 2. Discomfort Experienced by Workers with Frequent Absences

	Number of Workers
Back Pain	3
Shoulder Pain	2
Arm Pain	1
Hand Pain	1

The interview results revealed that most respondents had difficulties in manually lifting the bags of copra cake which manifested into health problems (46.7 % of the respondents are less satisfied with the existing material handling practices). The researchers also discovered that among the respondents, seven workers were on sick leave in the past four months due to the discomfort that they have experienced, including pain in the back, shoulder, arms, and hand (see Table 2).

Figure 3. Actual Lifting Conditions at the ABC Oil Mill

Figure 3 shows the current procedure of lifting copra cake sacks at ABC Oil Mill. Two workers were needed to lift at a rate of 1 sack per minute. Workers tend to bend down to reach the sack before lifting it onto the truck.

Table 3. Postural Assessment Results of the Actual Lifting Conditions

Assessment	Score	Remarks
RULA	7	Investigate and implement change
REBA	10	High risk. Investigate and implement change

Rapid Upper Limb Assessment (RULA) of the process of lifting a copra cake sack had a final score of 7 (refer to Table 3), indicating that a worker is exposed to a very high risk of acquiring work-related injury. Excessive and abrupt force exertion and a high rate of job repetition were the risk factors for this process. Meanwhile, the Rapid Entire Body Assessment (REBA) of lifting a sack had a score of 10, which also indicates a high risk of injury (caused by factors such as repetition, trunk bending, and excessive physical exertion). The findings from both assessments necessitate that changes be done to minimize or prevent the development of WMSDs by mitigating the associated risk factors.

Table 4. WISHA Lifting Analysis of the Actual Load

Process	Actual Weight	Lifting Index	Remarks	Recommended Weight Limit
Shoveling, sacking, and transfer of copra cake sacks	88.1849 lbs (~ 40 kg)	1.86	High risk; may increase the risk of low back or lifting injury. Controls should be considered.	47.50 lbs (~ 22 kg)

The recommended weight limit (RWL) that was calculated given the initial lifting conditions at ABC Oil Mill was 47.50 lbs (~ 22 kg)**,** which defines the maximum acceptable weight (load) that workers should lift over the course of an eight-hour shift without increasing the risk of musculoskeletal disorders (MSDs). Table 4 displays the WISHA lifting analysis results for the process of shoveling, sacking, and transfer of copra cake sacks into the trucks. The actual weight of each sack is 88.1849 lbs (~ 40 kg). Given the value of the RWL, the calculated lifting index is 1.86 which denotes that the task is at high risk (workers have a higher chance of suffering from work injuries). To be considered safe, the lifting index must be equal or less than 1.0, meaning that the load must have a weight equal to or less than the RWL. As the lifting index increases, the level of risk increases proportionally.

3.2 Why-Why Analysis and Root Cause Validation

Table 5. Why-Why Analysis of the Discomfort Experienced by the Workers

Questions	Reasons
Why do the workers experience discomfort?	Because the workers are experiencing fatigue
Why do the workers experience fatigue?	Because they are exerting too much effort
Why do the workers exert too much effort?	Because of they are lifting heavy loads of copra cake
Why are they lifting heavy loads of copra cake?	Because they manually lift the copra cake
Why are they lifting the copra cake manually?	Because they do not have enough equipment for lifting heavy loads

After posing a series of "why" questions, the researchers clarified the underlying causes of the discomfort experienced by the workers at ABC Oil Mill (see Table 5). It seems that the fatigue experienced by workers after performing their tasks are rooted in the lack of effective equipment to minimize the required effort to manually lift the heavy loads of copra cake.

Table 6. Root Causes of Discomfort Experienced by the Workers

Category	Causes	Remarks	True Root Cause	Not True Root Cause
Man	Fatigue	Lack of equipment to support in carrying heavy loads	/	
	No proper training	Basic lifting is required to perform the task		/
Machine	Use of old tools	Equipment lacks functional features	/	
	Lack of Equipment	Limited to one tool for every worker	/	
Method	Manual Material Handling	Excessive bending and manual lifting	/	
Material	Transferring of the cake to the cooker	No copra cakes shall be stored uncooked		/

	Sweeping of copra cake	Copra cakes are often blown away being in an open area exposed to heavy winds	/	
	Recooking	Wet copra cake (often due to rain) must be recooked	/	
Environment	Rusty roof	Exposes copra cakes to rain, thus, requiring another recooking process	/	
	Temperature	Warm air (while cooking the copra cakes) contributes to workers' fatigue	/	
	Unorganized workplace	Ineffective stacking of sacks		/
	Long travel distance	Far distance from storage to loading area	/	

Based on the data shown on Table 6, the true root causes of discomfort that were identified are: fatigue, use of old tools, lack of equipment, manual material handling, sweeping, recooking, rusty roof, temperature, and long travel distance. Ineffective tools and lack of equipment to support the manual lifting of heavy sacks are some of the factors that induce fatigue among the workers. Unnecessary tasks in the process, such as sweeping, recooking, and long travel distance, further add to the workload of the workers by requiring additional effort, which eventually lead to discomfort after several repetitions. In addition, recooking exposes the workers to high heat that affects their comfortability.

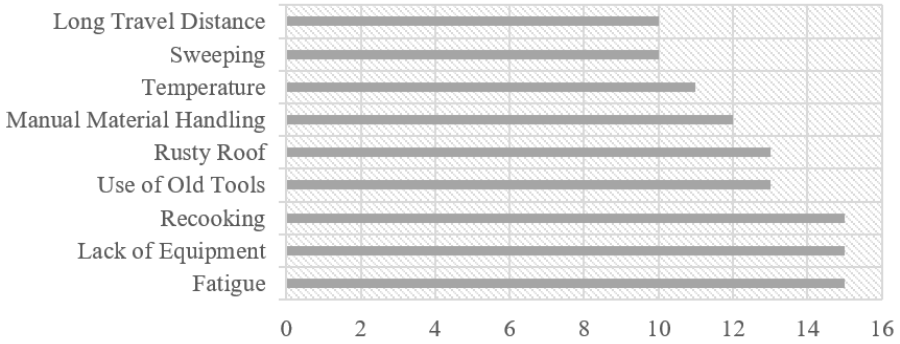

Figure 4. True Root Cause Validation by the Workers

Fifteen workers were selected through purposive sampling and served as the respondents in validating the true root causes. As shown in Figure 4, the leading causes of discomfort were fatigue, lack of equipment, and recooking.

3.3 Design of the Ergonomic Copra Cake Lifting Equipment

Table 7. Anthropometric Measurements of the Workers at ABC Oil Mill

	5th percentile	**50th percentile**	**95th percentile**	**Mean**	**Standard Deviation**
Height (cm)	126.6	144	162.3	145.2	12.9
Weight (kg)	51.7	62	69.3	61.4	6.33
Shoulder (cm)	41	45	49	45.267	2.69
Arm (cm)	67.1	75	78.3	73.4	4.48
Elbow to Hand (cm)	40	45	49	44.47	3.09

Waist (cm)	86.5	90	93.6	90.33	3.02
Waist to Heel (cm)	81.7	85	89.3	85.27	2.52
Knee to Heel (cm)	41.7	46	49.3	46.13	2.75

The researchers took the anthropometric measurements from a sample of fifteen workers at the ABC Oil Mill (as shown in Table 7). The 5th, 50th, and 95th percentiles were utilized as the minimum and maximum dimensions. In height, the minimum value is 126.6 cm while the maximum value is 162.3 cm; in weight, the values were 51.7 kg and 69.3 kg; in shoulder length, 41 cm and 49 cm; in arm length, 67.1 cm and 78.3 cm; in elbow to hand length, 40 cm and 49 cm; in waist length, 86.5 cm and 93.6 cm; in waist to heel length, 81.7 cm and 89.3 cm; lastly, in knee to heel length, the values were 41.7 cm and 49.3 cm, respectively.

Table 8. Proposed Specifications of the Ergonomic Lifting Equipment

Specifications	Body Parts	Considered Percentile	Measurement (cm)	Characteristics
Lifting Height	Body Stature	95th	162.3	Fixed
Platform Height	Body Stature	95th	162.3	Adjustable
Platform Length	Shoulder	50th	45	Fixed
Buttons	Arm	50th	75	Fixed
Manual Pedal	Knee	5th	41	Fixed
Handle	Arm	50th	41.7	Fixed
Motor	Waist	50th	90	Fixed

Table 8 summarizes the design specifications of the proposed copra cake lifting instrument. The researchers incorporated the required components and the anthropometric data collected from workers. The measurements used to fabricate the prototype were rounded based on the corresponding percentile of the body part that was considered for each specification.

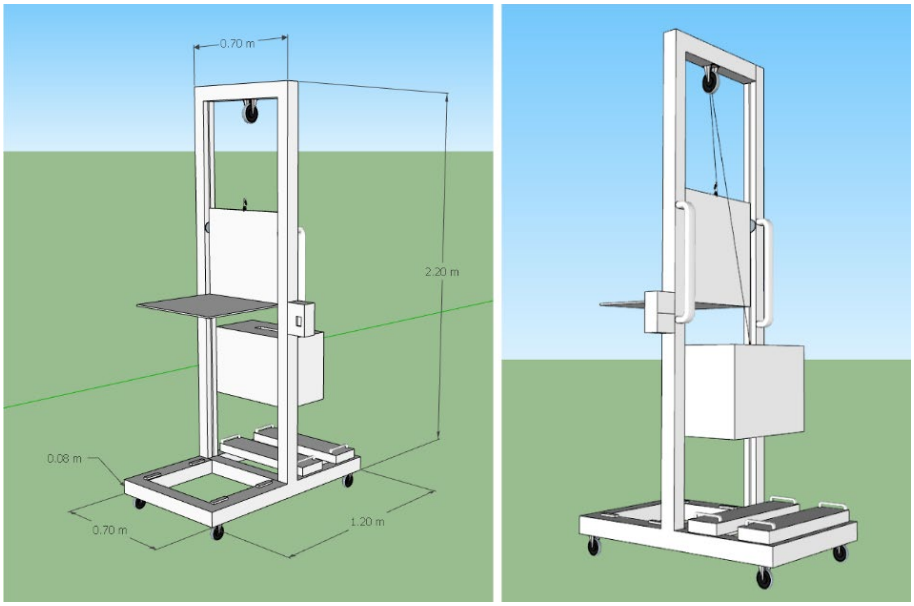

Figure 5. Proposed Copra Cake Lifting Equipment

The design specifications of the ergonomic copra cake lifting equipment were conceptualized considering ergonomic principles and suggestions that were gathered from the workers and supervisor who have direct experience in the task. The copra cake lifting equipment has the following features (refer to Figure 9 for visualization):

1. *Highly Maneuverable*. Adding wheels to the equipment makes it portable without requiring too much effort to transport it from one location to another.
2. *Adjustable Platform.* This platform can be used to lift the copra cake sacks from the ground up to the desired height, allowing the workers to transfer the sacks into the track without having to bend excessively.
3. *Motor and Buttons*. The electrical winch motor provides pulling power that allows the mechanical lifting of the sacks through a pulley system.
4. *Manual Pedal*. In the absence of electricity, a manual pedal may be used to power the lift.

Table 9. Dimensions of the Proposed Ergonomic Lifting Equipment

Parts	Description	Actual Measurement in inches (cm)
Lifting Height	Height of the equipment	71 (180.34)
Platform Height	Height of the platform that lifts the copra cake	64 (162.56)
Platform Length	Width of the platform that lifts the copra cake	17 (43.18)
Buttons	Buttons to activate mechanical lift	29 (73.66)
Manual Pedal	Manual pedal to lift the platform	16 (40.64)
Handle	Handle of the equipment for transport	29 (73.66)
Motor	Motor to mechanically lift the platform	35 (88.9)

Table 9 summarizes the actual dimensions of the proposed equipment measured in inches (centimeters). It also includes the description of the features included in the prototype such as the lifting height of the pulley system, lifting platform, motor and buttons, manual pedal (substitute to motor during the absence of electricity), and an improved handle.

3.4 Evaluation of the Ergonomic Copra Cake Lifting Equipment

The proposed lifting equipment was evaluated in terms of its functionality, efficiency, and cost benefit. Table 10 shows the number of absences in the previous four months compared to the number of absences observed during the four-month period when the proposed equipment was used.

Table 10. Absences Before and After using the Proposed Equipment

Month	Number of Absences	
	w/o the equipment	w/ the equipment
1	3	1
2	2	0
3	1	0
4	1	0

Based on the records, there were fewer absences during the period when the proposed ergonomic lifting equipment is in use. This result entails that fewer workers experienced extreme discomfort when lifting copra cake sacks with the help of the new equipment. In a follow-up interview, the researchers discovered that the sole worker who was absent during the four-month test experienced only minor back and shoulder pain.

Table 11. Lifting Efficiency Before and After using the Proposed Equipment

	No. of worker/s required	Lift/s per minute
Using the existing tool	2	1
Using the proposed equipment	1	2

The efficiency of the workers in lifting copra cake sacks increased when using the proposed equipment. As can be seen in Table 11, the number of workers required to lift a sack was reduced to one worker when using the proposed equipment. The number of lifts per minute also increased from one sack to two sacks – which implied greater productivity.

Table 12. Expenses Incurred for Pain Remedy

Month	Total Expenses (PHP)	
	w/o the equipment	w/ the equipment
1	450.00	150.00
2	300.00	0.00
3	150.00	0.00
4	150.00	0.00

With the reduced exposure to extreme discomfort which often manifests as muscle pain, workers were able to avoid incurring additional expenses for their usual remedies such as massage and pain reliever (see Table 12).

Table 13. Cost of Making the Proposed Equipment

Materials	Use	Quantity	Unit Cost	Total Cost
Motor	Mechanical Lift	1	P 4999	P 4999
Welding Rod (N6013/2.5)	Attachment	1	P 250	P250
Cutting Disc	Metal Cutting	2	P120	P240
Flap Disc	Metal Shaping	1	P240	P240
G.I tubular rectangular tube	Body and Support	1	P600	P600
Spray paint	Metal Coloring	2	P169	P338
Others	Labor	-	-	P1000
	TOTAL			**P7,667**

Listed in Table 13 are all resources (materials and labor) involved in the production of the ergonomic copra cake lifting equipment. To construct the prototype, the researchers also utilized some reusable materials present at ABC Oil Mill that the operations manager has provided. The total cost of the equipment is PHP 7,667.00.

Table 14. Results Summary of the Acceptability Survey

Questions	Weighted Mean	Remarks
Functionality		
The proposed design became more suitable for the workers.	4.73	Strongly Agree
The proposed design satisfies the desired height of the users.	4.86	Strongly Agree
The proposed design eliminates discomfort experienced by the workers.	4.66	Strongly Agree
The proposed design provides better posture for the workers.	4.86	Strongly Agree
The proposed design allowed the workers to lift effectively.	4.66	Strongly Agree
Efficiency		
The proposed design provides an accuracy of function that is reliable.	4.6	Strongly Agree
The proposed design reduces the sick leave of the worker.	4.73	Strongly Agree
The proposed design makes the worker more productive.	4.8	Strongly Agree
The proposed design makes the lifting more at ease.	4.73	Strongly Agree
The proposed design is easy to use.	4.93	Strongly Agree
Cost		
The cost of making the copra cake lifting equipment is not expensive.	4.46	Strongly Agree
The proposed design reduces the buying of painkillers.	4.6	Strongly Agree
The proposed design is convenient and prevents waste of time.	4.8	Strongly Agree
The proposed design increases the productivity of the worker.	4.73	Strongly Agree

The proposed design reduces the tearing of the sack.	4.93	Strongly Agree
Overall Mean	**4.73**	Strongly Agree

The researchers used a Modified Likert Scale wherein the level of agreement of each respondent to the statements was measured. Statements were designed to assess the functionality, efficiency, and cost of the proposed ergonomic copra cake lifting equipment. According to the survey (see Table 14), the respondents showed strong agreement that the proposed equipment is functional in terms of reducing ergonomic risks and discomfort in the handling of copra cake sacks, efficient in terms of increasing workers' productivity and reducing the difficulty of the task, and cost effective.

4. Conclusion

Based on the findings of the ergonomic assessments (RULA, REBA, and WISHA Lifting Analysis) and initial observations at the ABC Oil Mill, the researchers have determined the existing risk factors (high lifting index, high repetition, improper posture, and excessive physical exertion) that compromises the health and safety of workers who are exposed to manual lifting of heavy loads of copra cake. The actual root cause of the discomfort, usually manifesting as muscle pain, through a series of why-why analysis and root cause validation in collaboration with the selected workers with direct experience to the task. The lack of effective lifting equipment was found to be the major issue that contributes to high risk of developing WMSDs among the workers at the oil mill.

To address the problem, the researcher integrated various tools and techniques in designing the ergonomic copra cake lifting equipment. Anthropometric measurements of the workers and ergonomic principles were integrated to specify the features and dimensions of the lifting equipment. The proposed equipment has the following new and improved functions: high maneuverability/portability, an adjustable lifting platform, an electrical motor to support the lift through a pulley system, a manual pedal), and an improved handle. Using the ergonomic lifting equipment, there has been a reduction in the number of absences of workers due to experienced back and shoulder pain. Efficiency also increased; the number of required workers in the manual lifting task was reduced from two to one, while also increasing the average lifts per minute from one sack of copra cake to two sacks – suggesting an increase in productivity. The workers were able to avoid additional expenses associated with availing remedies to alleviate the pain that they experienced before after performing the task without the use of the lifting equipment. Meanwhile, the respondents of the survey assessing the acceptability of the proposed equipment showed strong agreement that the proposed equipment is effective in eliminating risk factors and improving worker performance in lifting copra cake sacks.

The study benefits the workers and owners at ABC Oil Mill by improving their current process and promoting health and safety in their workplace. Developing the ergonomic copra cake lifting equipment highlights the significance of using ergonomic tools and equipment to reduce risk factors that contribute to the development of WMSDs, as well as to boost the productivity and performance of workers through the improved working conditions. For future studies, the researchers recommend the use of other in-depth assessments and measurement tools to further improve the overall design and specifications of the equipment; it is also important to consider other factors (e.g. environmental factors) that may have direct effect on the performance and well-being of the workers.

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Biographies

Roland Emerson Mabuting is a fourth-year student of Bachelor of Science in Industrial Engineering at Manuel S. Enverga University Foundation (Lucena City). He takes interest in studying ergonomics and its diverse applications in different fields, especially in the manufacturing industry. During his Lean Six Sigma Yellow Belt training and certification, he gained significant project management skills, became proficient with quality tools and planning methodologies, and enhanced his leadership and communication skills – further enriching his knowledge and passion in developing relevant and effective solutions using industrial engineering concepts and designs.

Dr. James Louie R. Meneses is an experienced professor, consultant, Industrial engineer, and researcher. In his early professional life, he worked as a Quality control engineer and Management trainee in a Manufacturing company. Currently, he is working as a full-time professor and a research coordinator at Manuel S. Enverga University Foundation, Philippines. His work as a researcher is mainly associated with using the lean six-sigma methodology, ergonomics design, and Partial Least Square Structural Equation Modeling (PLS-SEM). As a consultant, he works in industrial engineering designs, management, quality management systems, and data analysis.

Laurence Binasa is a fresh graduate of Bachelor of Science in Industrial Engineering in Lucena City (Manuel S. Enverga University Foundation) that opened many new avenues of learning for him. Laurence learned the importance of applying Industrial Engineering tools and techniques to our daily lives from different industries in the Philippines. Recently, he finished a research paper on ergonomics intervention where he discovered that he could execute the job of being a leader of a group. Laurence is inspired daily by his family and friends. Laurence likes to play video games with his friends in his free time. In a nutshell, he is a citizen of the world, an explorer, and a learner of life.