Conference Paper

The Development of Ergonomically Designed Automatic Fishing Net to Reduce WMSDs Risk among the Small and Medium Scale Fishermen

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Abstract

The main objective of the study is to improve the work condition of the small and medium scale fishermen. Specifically, the study seeks to: (1) provide a tool that can help the fishermen avoid lifting, too much exertion of force and reduction of back and arm pain due to repetitive throwing and pulling of net, and (2) reduce the 0.84 cumulative trauma disorder level of WMSDs among the Fishermen. The study took place in Muzon II, Rosario Cavite, Philippines. The study involves qualitative and quantitative concept of research using survey-interviews, ergonomics assessments to quantify ergonomics risk such as McCauley Bush Fuzzy, Rapid Upper Limb Assessments, Visual Analogue Scale and job demand analysis, and Time and Motion Study. The respondents of the study were 70 fishermen; 48 are small-scale fishermen, 70 are medium scale and 5 of them has no own boat. The data were treated using weighted mean and paired t-test. The researcher patterned the design of the product with fishermen work demand. The results showed cumulative trauma disorder was reduced to 64.05%. RULA posture score, weight and process time were also reduced by 43.08%, 66.67%, and 21.14%, respectively. Number of activities were still the same, but the time and task is lessened. Furthermore, the researchers recommend continuing study in other external and internal factors that contribute risk in Work-Musculoskeletal Disorder such as boat layout and equipment, the type of material and power source.

Keywords: Automatic fishing net, ergonomics, work-related musculoskeletal disorder

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1. Introduction

Fishermen or fishery workers were ranked second on the list of workforces having the highest rate of risk exposure to work related musculoskeletal disorders or commonly known as WMSD. Based on the Fourth European Working Conditions Survey result,

35% of all workers such as skilled agriculture, fishery workers, craft related trades workers, and plant and machine operators and assemblers of all ages were found out most exposed to risk due repetitive motion, implore awkward positions, carrying and moving heavy loads for at least a quarter of their working time [1]. Based on the study of Rosnah Mohd Yusuff (2008) results shows that 77% of small scale fishermen experienced symptoms of WMSD, 61% low back pain and 37% shoulder pain. And since, geographically Philippines is an archipelago consist of thousands of islands surrounded by water. Fishing become one of the major economic activity. Based on the recent national account estimates of Philippine Statistics Authority in 2014, fisheries sector contributes 19.6% of the total Gross Value Added (GVA). The Philippines ranked 7^{th} place among the top fish producing countries in the world in 2012.

There are three sectors involved in Philippines fishery: aquaculture, municipal, and commercial fishery. Aquaculture is fishery operations involving all forms of raising and culturing fish and other fishery species in fresh, brackish and marine water areas. While, municipal fishery refers to fishing within municipal waters using fishing vessels of three (3 gross tons or less, or fishing not requiring the use of fishing vessels). Commercial fishery is the taking of fishery species by passive or active gear for trade, business and profit beyond subsistence or sports fishing, to be further classified as: small-scale, medium scale and large-scale fisheries [2]. Small scale fishery is the subsector using vessels of less than 3 gross tonnage operating in Zones 1 and 2. Some small-scale commercial fisheries from 3.1 to 20 gross tonnage vessels operating in Zone 2; can also operate within 10.1 - 15 km (within Zone 1) if authority is granted by the concerned local government unit (LGU). On the other hand, medium-scale commercial fisheries are from 20.1 to 150 gross tonnage operating in Zone 2; can also operate within 10.1 to 15 km (within Zone 1) if authority is granted by the commercial local government unit (LGU). They commonly used netting, trolling, lining methods, trawling, Danish seining, and purse seining. Large scale fisheries or large commercial fisheries are more than 150 gross tonnage operating in Zone 2 uses purse seiners and surface longlines.

Among these scales, small and medium scale fishermen are those who suffer most ergonomically. This due to the extent of activities performed. Based on studies, among the small scale coastal fishermen, seventy-seven per cent experienced symptoms of the musculoskeletal system during the previous 12 months of the survey, 61% low back pain and 37% shoulder pain. The largest number of fishermen considered the motion of the vessel to be a major strain, not only on the musculoskeletal system, but on the individual. A higher prevalence of symptoms of the upper limbs was found among

those with jobs involving high repetitiveness or forceful movements, as compared to those who had jobs with low repetitiveness and low-force movements [3].

Work-Related Musculoskeletal Disorder (WMSDs) are injuries and disorders caused by work that affect the human body's movement or musculoskeletal system (i.e. muscles, tendons, ligaments, nerves, discs, blood vessels, etc.). It includes Carpal Tunnel Syndrome, Tendonitis, Muscle or Tendon strain, Ligament Sprain, Tension Neck Syndrome, Thoracic Outlet Compression, Rotator Cuff Tendonitis, Epicondylitis, Radial Tunnel Syndrome, Digital Neuritis, Trigger Finger or Thumb, De Quervain's Syndrome, Mechanical Back Syndrome, Degenerative, Disc Disease, Ruptured or Herniated Disc [4]. The phenomenon of WMSDs must therefore be treated very seriously. Treating these musculoskeletal disorders have a considerable socio-economic impact. First, they drive up costs for workers, companies, and society in general. This applies to both advantage and disadvantages. Such as direct costs (compensation of victims, Medicare, etc.) and indirect costs (loss of production, replacement costs, absenteeism, etc.) associated with occupational diseases and industrial accidents [5].

As of today, Philippines small and medium scale fishermen are still using the traditional way. There are no personal protective equipment nor safety equipment to support and prevent them from having the risk of WMSD. Unlike large-scale fishery, in terms technology and profitability these sectors are somewhat left behind.

2. Objectives of the Study

The main objective of the study is to improve the working condition of the small and medium scale fishermen. Specifically, the study seeks to: (1) Provide a tool that can help the fishermen avoid lifting, too much exertion of force and reduction of back and arm pain due to repetitive throwing and pulling of net. (2) Reduce the 0.84 cumulative trauma disorder level of WMSDs among the Fishermen as transpire from the pre-assessment.

3. Materials and Methods

The researcher used qualitative and quantitative method of research. An assessment was conducted to find out occurrence of WMSDs risk to the population of 70 fishermen from Muzon II, Rosario, Cavite.

3.1. Job demand analysis

This method helped identify the actual activities performed by the respondents. Through observation all task performed by the fishermen were tagged and assessed.

3.2. Rapid entire body assessment (REBA)

analysis was used to evaluate the posture of the workers. The REBA provides a quantitative value to the evaluation that indicates the level of severity of each task. The calculation was made by using the REBA Employee Assessment Worksheet that has been divided into two groups; Group A (Trunk, Neck and Legs) postures and Group B (Upper Arms, Lower Arms and Wrists) postures for left and right.

Figure 1: Rapid Entire Body Assessment.

Analogue scale (VAS) was used to measure how fishermen assess the pain they are experiencing. VAS is a psychometric response scale, a measurement instrument for subjective characteristics or attitudes that cannot be directly measured. When responding to a VAS item, respondents specify their level of agreement to a statement by indicating a position along a continuous line between two end-points. The respondents evaluated VAS based on the pain they are experiencing while fishing according to the range of: 0 – as no pain, 1 to 2 – if there's mild, annoying pain, 3 to 4 – if the pain they're feeling is nagging, uncomfortable pain, trouble some pain, 5 to 6 – if

the pain is distressing, miserable pain, 7 to 8 – if it's intense, dreadful and horrible pain and 9 to 10 – which is the highest intensity if there is unbearable, excruciating pain. Then, the researchers get the frequency of each level to know which is the highest among them.

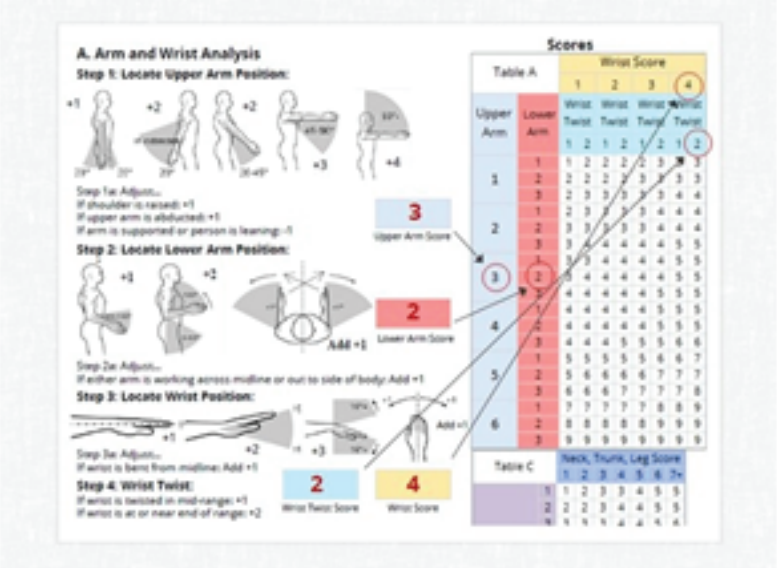
Figure 2: Visual Analogue Scale (VAS).

McCauley Bush Fuzzy Rating Scale, this is an ergonomic assessment use to quantify the level of ergonomics risk factors in a work area or a work place. The six to seven items as risk factors for each three modules (task, personal and organizational) were evaluated for relative significance. The weighting factors represent the relative significance of the given risk factor category's contribution to the likelihood of injury. These factors were determined through the AHP analysis. The numeric risk levels obtained from the previous equations exist on the interval [0, 1]. On this interval 0 represents 'no risk of injury' and 1 represents 'extreme risk of injury'. The interpretation and categorization are shown in Table 3.7. Also, the results that obtained in this test have used as the basis in reducing the level of work related musculoskeletal disorder among the fishermen of Muzon II, Rosario, Cavite.

Table 1: Categoriation of Aggregate Risk.

NUMERIC RISK LEVEL	EXPECTED AMOUNT OF RISK ASSOCIATED WITH NUMERIC VALUE
0.00 – 0.20	**Minimal Risk:** Individual should not be experiencing any conditions that indicated musculoskeletal irritation
0.21 – 0.40	**Some Risk:** May be in the very early stages if CTD development. Individual may experience irregular irritation but is not expected to experience regular musculoskeletal irritation
0.41 – 0.60	**Average Risk:** Individual may experience minor musculoskeletal irritation on a regular but not excessive irritation
0.61 – 0.80	**High risk:** Individual is expected to be experiencing regular minor or major musculoskeletal irritation.
0.81 – 1.00	**Very High Risk**: Individual is expected to presently experience ongoing or regular musculoskeletal irritation and/or medical correction for the condition

Rapid Upper Limb Assessment (RULA) is developed to evaluate the exposure of individual workers to ergonomic risk factors associated with upper extremity MSD.



Score	Level of MSD Risk
1-2	negligible risk, no action required
3-4	low risk, change may be needed
5-6	medium risk, further investigation, change soon
6+	very high risk, implement change now

Figure 3: Rapid Upper Limb Assessment Worksheet.

The same questionnaire was implemented for the pre and post assessment of the fishermen. This is to validate the significant differences between the traditional way of fishing and the application of the device. Through paired-sample t-test significant difference was measured.

As mentioned above that the reduction of WMSD increases productivity of workers, time study was also performed to measure the improvement in terms of time and the effectiveness of the device in increasing productivity.

4. Results and Discussion

Based on the survey conducted, among the 70 fishermen of SMDRC, are mostly belongs to the cluster of 30-34 years old whom are all male. All the fisherman affiliated with SMDRC has 6 years and above experience of being a fisherman. Working time ranges from 12 hours and above fishing. In normal days, fisherman can catch a fish of

minimum 11-20 kg and maximum of 21-30 kgs. The normal depth of the net of 11-20 meters and 30 meters below the sea with the minimum capacity of 11-30 kg of load.

The current state of the fishermen and ergonomic risk factor involved (1) Repeated pulling and throwing of the net and (2) Repeated bending forward action to lift heavy load and transfer that heavy load. P**hysically,** the researchers observed that: (a) Fishermen transfer weight of more than thirty (30) kg every day from catching site to the place where the fish is preserve. (b) throwing the net into the water (3-12) times in a day (3) pulling the net from the water repeatedly, loading and unloading heavy fish. The **mobility** of the fishermen's job involves more mobility; they can stand in long hours, approximately ten to twelve hours (10-12 hrs.) And the **environment**, fishermen always work in both summer and rainy seasons. Working in summer make them vulnerable to abnormal fluid loss. Also, the parts of the body mostly affected due to their usual activities were the arms (93%), shoulder (99%), waist (90%), hands (80%), fingers (96%) and back (90%). Based on these results, the upper body parts of the respondents were the areas usually affected by fishermen's activities. All these lead for the researchers to the development of an ergonomically designed device that helped improve the working condition of the fishermen.

The design was based from the anthropometric measurement of the Filipino [7]. The device is composed of three major parts: pole, body and the base. The pole is 12 feet high. The assigned height is suitable for the capacity of both small and medium scale fishing boat. It has attached ring bend U bolt for the attachment single wheel pulley fixed ring. This is where the fishing rope will roll just like the flag pole mechanism.

The body of the device is composed of the motor, switch, stopper, reel and rope and electrical cord. The motor used in the tool is 11 DC Capacitor, weighing 16 kg, most of the weight of the tool is coming from the motor. The height is 33.5 cm, inner width and length is 20 cm by 15 cm and outer width and length is 15 cm by 27 cm. It has output rotational speed of 46.7 r/min. It is in-charged for the automatic ups and downs mechanism of the tool.

The base is the lay board of the tool when not in use. It has four wheels when it's in the ground and it is floating and detachable when it's in the water. It is made up also from aluminium and stainless steel. It measures 21 cm by 16 cm.

The pain was measured by the researcher and found out that all the pain experienced by the fishermen as early as setting up the net and setting the boat and other fishing materials was reduced with the use of the device. 80% of the respondents agreed that there was minimal pain obtained by using the device. Also, the results pertaining to the areas mostly affected due to fishing activities such as arms (92.86%),

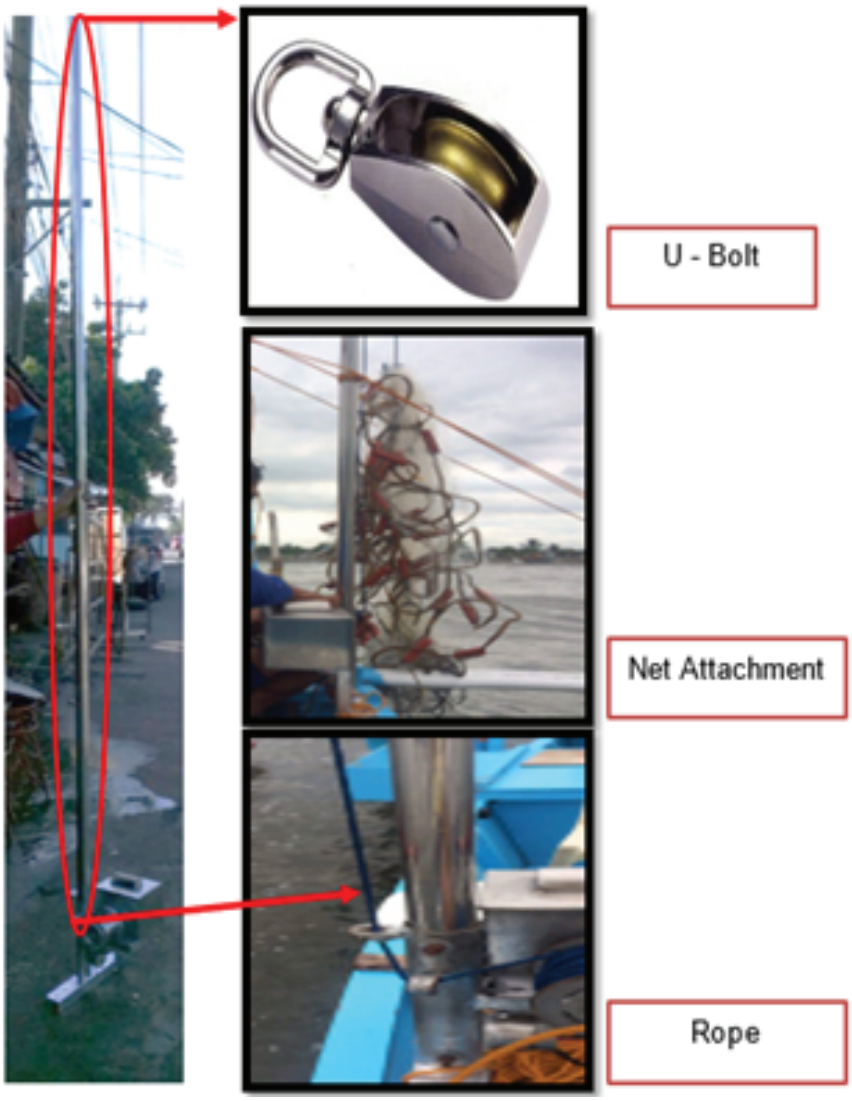


Figure 4: The Pole.

low back (90%), hand (80%), fingers (95.71%), shoulder (98.57%), and waist (90%) on pre-test, were received lower percentages of pain by: arms - 9%, low back -11%, hand- 4%, fingers -39%, shoulder -6%, and waist- 11%.

McCauley Bush Fuzzy Rating Scale score in pre-test is z = 0.84 which is in the category of very high risk while in the post-test z = 0.30 which means some risk in the category.

While, the Rapid Upper Limb Assessment (RULA) score in pre-test is 7 reduce to post-test score of 3. It is obvious that there is a change of intensity of pain. There's a decreasing of rating in Visual Analogue Scale, from 7-8 rating which has the highest percentage in pre-test, while in post-test, 1-2 has the highest percentage and 7-8 rating has the no score. The most affected areas (pre-test), as observed, upper

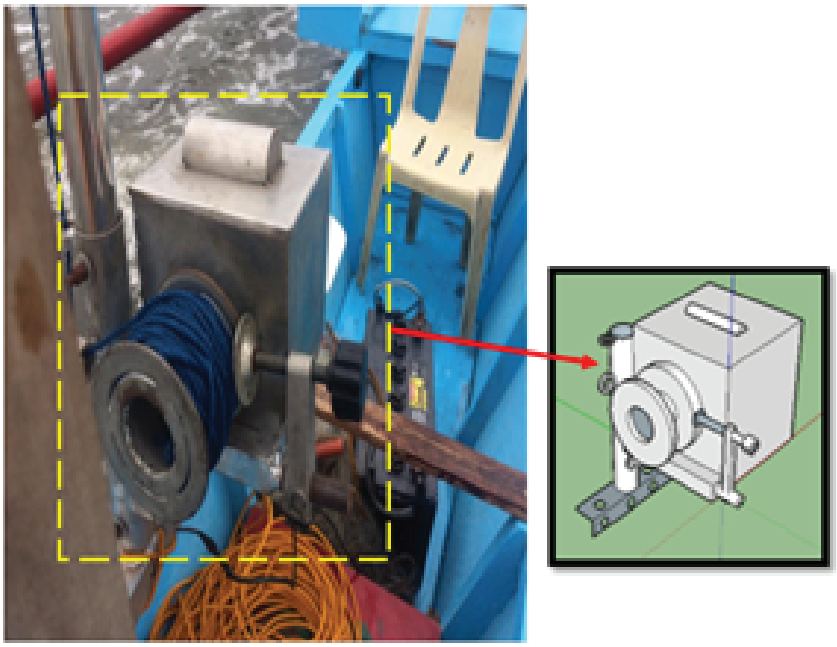


Figure 5: The Body.

Figure 6: The Base.

extremities are involved while the post-test, lower extremities are involved. It can be observed that the pain in upper extremities are gone because of the existence of fishing net tool, while the lower extremities are involved in the other activities (refers to the process flow chart and job demand analysis) that are not consider in developing the said tool. Second, the statistical treatment paired sample t-test used to analyse

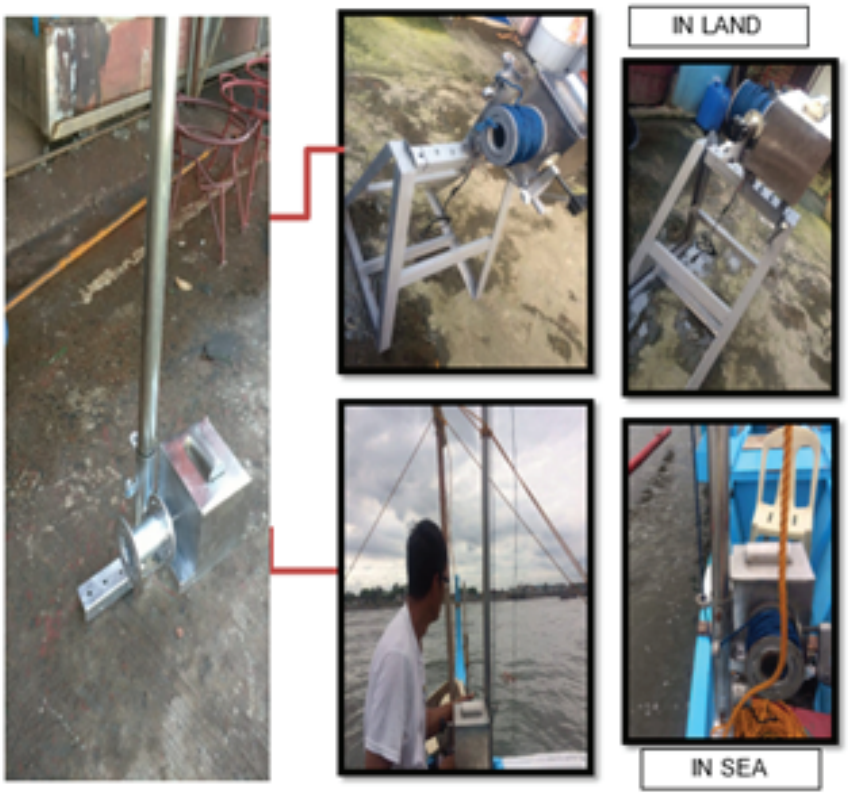


Figure 7: Actual Photo of the Device in Use.

and interpret the difference between level of risk of Work Musculoskeletal Disorder attained by using ergonomics assessments such as McCauley Bush Fuzzy Rating Scale and RULA. The percentage reduce of process time in fishing by 21.14% (waiting time for the fish is not included). The fast mechanism of the tool and net allows the easy up and down causes the 20.47% increase of the pulling and pushing of the net.

5. Conclusion and Recommendation

The researcher concludes that an ergonomically designed automatic fishing net will reduced the risk of WMSD. The results showed cumulative trauma disorder was reduced to 64.05%. RULA posture score, weight and process time were also reduced by 43.08%, 66.67%, and 21.14%, respectively. The tool designed increased the productivity of the respondents since time required to finish the job was also improved.

Author's Note

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2. Lyceum of the Philippines University-Cavite; Prof. Aldren Narzoles; Engr. Annalyn Romero; Engr. Jelyn Rodriguez; Engr. Arnel Avelino.

3. The device was contrain to (a) The automatic fishing net has the capacity to lift 35kg. (b) The rope of the automatic fishing net has the ability go down 20ft. (c) The automatic fishing net is for single use only. (d) The automatic fishing net can help only in throwing and lifting the net not in clawing bigger amount of fish.

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