Development of a Survey Instrument for Measuring Workers Satisfaction on Usability of Manual Handling Equipments at the Warehouse: A Pilot Study

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Abstract Scientific evidence show that manual handling devices are one of the effectives controls that can lower the physical demands of manual material handling (MMH) activities. Incidence and severity of the musculoskeletal injuries might happen to workers while company's productivity, product quality, and overall business competitiveness also will be affected. However, few studies had been done regarding on manual handling devices provided in the industries especially in term of user satisfaction on the usability of the devices when performing their job and task. The aim of this study is to develop a survey instrument for the evaluation of worker satisfaction on usability of manual handling device among warehouse worker in manufacturing industry. A set of questionnaires was developed which consist of three sections; demographic profile of respondent, work nature and discomfort survey and worker satisfaction on the usability of the manual handling devices. The content of the questionnaire was derived through extend literature reviews and expert's opinions. A pilot study was conducted at four manufacturing companies in their warehouse's operation. The reliability and validity of the instrument were determined through Cronbach's Alpha, face validity and content validity. Cronbach's Alpha values for each section of the questionnaire range from 0.937 and 0.961 while the value for Cronbach's Alpha for all 35 standardized items is 0.921. The finding shows that the survey instrument has face and content validity at acceptable level. In conclusion, finding indicated that this instrument had acceptable and adequate reliability and

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validity to meet its objectives. The survey instrument now ready to be distributed in larger data sets.

Keywords Manual material handling · Instruments development · Warehouse · Pilot study · Manufacturing

1 Introduction

Manual material handling (MMH) tasks have been identified as one of the major sources of work-related musculoskeletal disorders (WMSDs), which is one of the big concerns in manufacturing industry [1, 2]. MMH consist of activities that utilizing human capability to perform frequent lifting, lowering, carrying, pulling and usually associated with several ergonomics risk factors. It is including awkward posture, excessive force, repetitive task, tools or material mobilization from one point to another point. Despite the widespread use automation system such as of robots, mechanisation and work-related interventions in industry, several tasks are still performed manually by workers especially in warehouse operation. Several jobs are necessary to be perform manually, when requiring observation and decision-making, also in other instances tasks benefit from human precision, skill and movement capabilities [1, 3, 4]. Hence, despite increased automation, many jobs still require workers to perform task manually.

In warehouse operation, poor working conditions such as repetitive back bending while lifting objects, twisting and pulling or pushing of heavy objects, are all kinds of poor posture conditions can lead to a significant impact on performance as well as postural stresses. A research found that heavy physical demand and improper posture while performing a task can cause musculoskeletal disorders [5–9]. For example, tasks that need lifting activity and pulling or pushing tasks in various sectors such as manufacturing and warehouses [5]. The excessive physical demands placed on the human operator under these working conditions on continuous basis have shown to be a major contributor to WMSD [6, 7]. Previously two epidemiological studies, which is each conducted among more than 31,000 American workers in warehouse superstores, show a consequence between MMH activities with the development of back pain [8, 9]. The study was conducted involving a total of 92 warehouse workers for evaluating the musculoskeletal disorders. The study found that ergonomics risk factor related to manual handling task in warehouse was identified, which the result showed that the task highly significantly impacted low back pain among all participants [5].

In this day, industry revolution (IR-4.0) happens to be the present and future of the manufacturing sector especially using artificial intelligence with the synchronization of automation system. Incorporating internet technology advances to optimize automated system in production industry, where logistics system is one of the core activities, could end up being more flawless and self-decision making [10]. Flexible and modular material handling system facilitates easier configuration to meet ever changing market demands and new product launch. In order to prevent back disorders

related to high-risk manual handling activities, attempts to control these disorders should focus on assessing and redesigning the tasks of manual material handling and equipment used [11, 12]. One of the strategies to improve efficiency in MMH activities in warehouse operation is to introduce assistive devices that can reduce exertion requirements and poor working postures. To make the large item handling activities more efficient and safer, mechanical aids are usually used to assist workers. The planning and choice of right material handling equipment rely on materials to be handled, quantities and distances to be moved, routing and workplaces facilities dan layout. Based on the study by Wurzelbacher et al. [13], additional research that examines the effectiveness of ergonomic engineering interventions need to be conducted.

The main objective of this paper is to describe the development and validation of survey instrument for measuring workers satisfaction on usability of manual handling devices. The devices such as trolley, hydraulic pallet lifter, conveyor system and vacuum assist device will be considered at manufacturing's warehouse operation. For the future, this study target to evaluate workers satisfaction on manual handling devices at warehouse operation because most of the high significant task related to ergonomics exist at warehouse and few studies show that warehouse personnel experienced body discomfort and pain [14, 15], despite some prior research that indicates ergonomic material handling equipment can reduce biomechanical risk factors for musculoskeletal disorders [7, 13, 16, 17].

2 Methodology

A structured approach for the development of the survey instrument was adopted based on a guideline in designing research questionnaire, research paradigm and theory in a survey-based research [18]. In developing the survey instruments that are valid and reliable, several sequential steps involved must consist the construction of survey instrument, validation and verification of the instruments, ethical approval and pilot study. All steps are depending on fine tuning and testing. Previous step must be completed before next step is taken. Figure 1 shows the development step of the survey questionnaire used in this study.

2.1 Construction of Survey Instrument

In this study the first step is construction of survey instrument. The goal and objectives, research questions and hypothesis of the set of questionnaires for the proposed research was examined and discussed in order to come out with the content and structure of the research questionnaire. Part of this process is deciding the target respondent, respondent background as well as their demographic profiles. This is because questionnaire should not only suit with the research and the researcher but

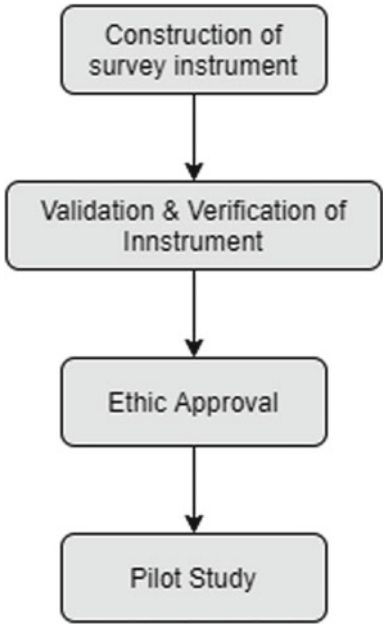

Fig. 1 Development of survey questionnaire

also to respondents [19, 20]. Then, the content of the questionnaire needs to be constructed after an understanding through theoretical framework from an extensive literature review and transformed into structures of the questions being developed.

The questionnaire consisted of 61 standardized items with four main sections consist of: (A) demographic profile of respondents, (B1) nature of jobs and tasks of respondent, (B2) history of body discomfort and pain, and (C) workers satisfaction on usability of manual handling devices. The question in section A is a demographic profile of the respondents such as gender, race, age, citizenship, work designation, workstation area, working experience, working duration, job activities and involvement with manual material handling devices. For section B1 the question is more about the performance of workers with job task and the evaluations of sub-capabilities related to the increased workforce. The question in section B2 is related to history of body discomfort and pain for specific body region is based on a modified Nordic discomfort assessment tool [21]. Meanwhile, for section C, a scale questionnaire is constructed and modified from a design requirements and user satisfaction for the ergonomic design of a hand tool [22] to evaluate the agreement of the respondent to the factors found on the manual handling devices that are being used. The factor consists of energy expenditures, effectiveness, efficiency, productivity, design, user friendliness, safety and comfortability when using manual handling devices. A closed ended questionnaire has been used in all section to reduce the amount of thinking and effort required by respondent in answering the question.

Table 1 List of experts for face and content validation

Panel	Expertise	Experience (years)
1	Health and safety, warehouse operation	20
2	Warehouse management, production engineering	7
3	Health and safety, auditing, industrial operation	9
4	Statistical data analysis, ergonomics, education	11
5	Education, R&D, ergonomics, industrial hygiene	10
6	Ergonomics, education, R&D, consultation	7
7	Ergonomics, risk assessment, safety and health	17
8	Industrial hygiene, ergonomics, industrial inspection	10

2.2 Validation and Verification

Next for ensuring the consistency and high confidence level of the survey result, validation and verification of the questionnaire were conducted. Face and content validity is the common methodology to establishing the validity of an instrument or survey questionnaires [23]. In this study, face and content validity are secured and reviewed by panel of experts which are three persons from industrial representatives, three persons from academics' representatives and two persons from ergonomics practitioners as per Table 1. The survey's appearance, relevance and representativeness of its elements were judged the panel of experts. Following these reviews, some items that are irrelevance were removed from the questionnaire, other items were added and rephrase for enhanced precision and clarity.

2.3 Ethic Approval

Ethical approval for all relevant aspects of the development process was received from the National Institute of Occupational Safety and Health Malaysia Ethics Committee. This ethic was applied under "The Study on Ergonomics Intervention Control for Manual Material Handling in Manufacturing Sector (Reference number: NIOSH/03/JEP/2020(8))".

2.4 Pilot Study

After the survey instruments were approved by the ethics committee, a pilot study was conducted by targeting about ten percent (10%) of the required sample size. Statistical data from Department of Statistic Malaysia (DOSM) shows that the number of workers in Malaysia manufacturing industry as in September 2019 are about

1,087,179 persons [24]. Using Krojchie and Morgan table (1970), the sampling size should be considered is 384 for the sampling population size over 100,000 population [25]. The unit of analysis for this study is worker. So, a total of 50 warehouse workers were chosen randomly from various manufacturing sub sector to participate in the pilot study. Then, reliability of the questionnaire was assessed by using Cronbach's alpha (α) considering minimum value of 0.6 [26].

3 Results and Discussion

3.1 Instrument Administration and Respondent Profiles

The pilot study was conducted at four (4) manufacturing company in southern region of peninsular Malaysia with a different type manufacturing sector. A total of 50 respondents from warehouse operation were chosen randomly to participate in the survey. A face-to-face interviews session were conducted between the respondents and researchers in order to fill in the questionnaire. The majority of the respondents are general worker which is involve directly with the manual handling activities in warehouse storing area and frequently using manual handling devices when performing the task as in Table 2. The demographic profiles of the respondent in this study were summarize in Table 2.

3.2 Analysis of the Validity and Reliability of Questionnaire

The result for the validity of the questionnaire based on the expert judgement for all 61 items was found to be good as the questionnaire can be measure and evaluate the worker satisfaction toward the manual handling devices that are used in warehouse operation. Face and content validity by the panel of experts consist of several criteria which include such questions understanding, clarity and language, content and suitability as well as questionnaire template, style and responses time. Summary of the comment were summarized in Table 3. Minor modification and adjustment of the questionnaire have been revised accordingly based on experts' comments to enhance the content of the questionnaire.

Result for reliability of the questionnaire shows that the Cronbach's alpha value ranged from 0.610 for the nature of jobs and tasks of respondent (section B1), 0.961 for the history of body discomfort and pain (section B2) and 0.937 for the workers satisfaction on usability of manual handling devices (section C) as per Table 4. Total Cronbach's alpha (α) for all three section (B1, B2 and C) with 35 standards items is 0.921. The value of Cronbach's alpha was calculated using IBM SPSS statistics for windows version 21.0. Armonk, NY: IBM Corp. The α reliability coefficient of the Cronbach usually is between 0 and 1. As per the rule of thumb, the reliability

Table 2 Table demographic profile of the warehouse workers involved in the pilot study

Profile		Frequency	Percentage (%)
Gender	Male	38	76
	Female	12	24
Citizen	Malaysia	21	42
	Non-Malaysia	29	58
Sector	Transportation	0	0
	Electrical equipment/electronics	27	54
	Petroleum, coal, chemicals, plastics and rubber	15	30
	Wood, paper, printing	0	0
	Primary metal/metal fabrication/machinery	0	0
	Food/beverage/tobacco	0	0
	Textiles, leather/apparel	0	0
	Furniture and fixture	0	0
	Others	8	16
Age	<20 years	0	0
	20–29 years	26	52
	30–39 years	16	32
	40–49 years	5	10
	>50 years	3	6
Designation	General workers	42	84
	Supervisor	6	12
	Others	2	4
Workstation area	Incoming/receiving	10	20
	Storing	23	46
	Order picking/kitting	7	14
	Packaging/delivery/outgoing	7	14
	Others	3	6
Working experience	<1 year	3	6
	1–5 years	28	56
	5–10 years	11	22
	>10 years	8	16
Working duration	≤8 h	1	2
	8–12 h	31	62
	>12 h	18	36
Work schedule	Shift	7	14
	Normal working hour	43	86

Table 3 Experts comments for validation of questionnaire

Panel	Comment
1, 2, 3, 4, 5, 6, 7, 8	Format acceptable
5, 6, 8	Grammar and typing error
6	Unclear wording
3	Additional others box for sector, designation and workstation area
4, 5	Need to do correction in sentences structure
7	Divide left/right side for body symptom survey
1, 8	Suggest to have multilanguage
2	Suggest to have a simple word for criteria for satisfaction
4	Might consider to have semi-quantitative scale

Table 4 Cronbach's alpha value for each section of the questionnaire

Section	No of items	Cronbach's alpha	Cronbach's alpha based on standardized items
Section B1			
• Work natures	6	0.610	0.609
Section B2			
• History of discomfort • Body symptom survey	21	0.961	0.959
Section C			
• Workers satisfaction on usability of control measures	8	0.937	0.941
Section B1, B2 and C	35	0.921	0.917

coefficient of 0.6 is considered to be sufficient. If the value of the Cronbach alpha is less than 0.6, it is recommended to rewrite/rephrase questions and modify their questionnaire items. The rule of thumb for Cronbach's alpha are 0.9—Incredible, 0.8—Nice, 0.7—Acceptable, 0.6—Controversial, 0.5—Bad, and 0.5—Unacceptable [27].

4 Conclusion

In this research, a reliable, accurate, empirically validated instrument was established based on the analysis of pilot test samples. In general, an outstanding Cronbach alpha was obtained. Further study may be needed to validate the findings of these pilot tests from larger data sets. The outcomes from the proper larger data set of the study might be useful in supporting and designing manual handling device for manual material

handling activities in manufacturing warehouse operation based on user criteria and agreements.

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