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Editorial

Bridging the Gap Between Academia & the SH&E Practitioner

It is a pleasure to serve as guest editor of this special issue of *Journal of Safety, Health and Environmental Research (JSHER)*, "Research to Practice (RtP): Bridging the Gap Between Academia and the SH&E Practitioner," which demonstrates the vital role of transferring SH&E knowledge and interventions into highly effective prevention practices for improving worker safety and health. The articles in this issue will provide a snapshot of ways to translate academic research into workplace practices, narrowing the gap between research and practical solutions to SH&E challenges.

The first article's authors, Sang D. Choi, James G. Borchardt and Travis L. Proksch, came together as academic researcher, safety and health practitioner and university student to apply NIOSH's r2P initiative to one of the construction industry's most frequent and serious worker injury exposures—overexertion from manually lifting materials on jobsites. Their study's aim was to investigate the physical workloads associated with manual lifting activities and to translate the academic research findings into effective prevention good practices for the reduction of injury risks in the construction workplace.

The authors used NIOSH's revised lifting equation as their roadmap to guide them through the process of data collection and task observations at various construction worksites. They found that the weight of common construction material being manually lifted at worksites was generally unknown to workers, difficult to determine because of their size or irregular shape and the median and average weight of materials significantly exceeded NIOSH's recommended weight limit for the majority of lifting or lowering tasks observed. The authors also pointed out that safety, health and ergonomics educators need to more effectively communicate the importance of each component of the NIOSH lifting equation to evaluate manual lifting tasks so that practitioners can†decide which component would be†most feasible and effective to change. Moreover, this article advocates possibly extending the RtP concept to a Practice to Research (PtR) model by encouraging SH&E practitioners to communicate real-world exposures to academia.

In the second article, the authors Tsuyoshi Kawakami, Ton That Khai and Kazutaka Kogi carried out a series of direct observation research and developed a participatory training program named Work Improvement for Neighborhood Development (WIND). This article reviews and describes the birth and growth of the WIND program that was devised from the findings of the field research. The main research methods used were the time-motion study on the real work of farmers and subjective fatigue monitoring to find practical improvement points. The time-budget study method was also applied to known seasonal changes of working time and compared the workload between male and female farmers.

In addition, the authors and research team visited 400 local farmer families to collect and analyze existing local good examples in safety and health. Based on the findings, the research team developed a 32-item action checklist for the WIND training program, which covers the improvements of both working conditions (materials storage and handling, machine safety, work environments and welfare facilities) and living conditions (healthy eating habits, safe drinking water and hygienic living environments, safety and health of children, financial planning and neighborhood cooperation) of local farmers.

The WIND program focused on simple, low-cost ways of improving working conditions and was designed to support the self-help initiative of local farmers. The first WIND training was carried out in a small village in the Mekong delta, and equal numbers of male and female farmers actively participated in the discussion for improving their work. After the WIND training, participating farmers implemented practical improvements by using locally available, low-cost materials. The WIND program has been widely applied in different provinces in Viet Nam and then in neighboring Asian countries and has further spread to several countries in Africa, Central Asia and Latin America to improve safety, health and working conditions of local farmers. The WIND program provided significant impacts on a national policy level. Viet Nam adopted safety and health in agriculture as a priority area for action in the First National OSH Program in 2006. The WIND training method was widely used to implement the national OSH program. The research and development experiences in the WIND training program confirmed the importance of practical observation studies that can immediately lead to practical improvements. Equally important was to respect local efforts for improvements and to learn from existing good examples and initiatives. Applying practical, easy-to-apply participatory training tools and methodologies, such as action checklists, were the key to support action by farmers. The practical experiences of the development of the WIND training program provide a useful model on how the research can effectively assist local farmers in improving safety, health and working conditions.

Next, professional curiosity led author Todd William Loushine to explore potential differences in publications based on author education and professional title. In his own perception, advanced graduate education was not focused on content but rather on developing a disciplined approach to collecting, analyzing and presenting information. The SH&E profession cannot expect to expand what it knows or to learn from mistakes if it does not fully appreciate or understand the foundation of its knowledge base.

The study used counts and type of cited references as a measure of knowledge-base quality. This practice is used for assessing a journal's impact factor, which is a form of bibliometrics. From a practitioner's perspective, individual experiences should not be considered "the norm" of understanding but rather compared and contrasted against peer-reviewed literature to make unbiased judgments of what was learned. Results exceeded the author's expectations for significant findings by showing that advanced scientific training (doctoral degree) led to a greater number of total references and especially citations from respected research journals. The author points out that this article makes a valid argument for *Professional Safety* to review and update its editorial process and identifies a need for either more authors/reviewers with advanced degrees or increased participation by those individuals. In many ways, this article could be conceived as PtR or bringing a better understanding of scientific inquiry to the practitioner.

Finally, the last article by Y. Chen, S. Tan and S. Lim represents the Singapore Workplace Safety and Health (WSH) Institute's RtP endeavor to identify WSH research priorities at the national level. The WSH Institute was set up as a think tank to raise workplace safety and health performance for Singapore. To enable the interested parties to better focus on a concerted research effort, a stakeholder-based national WSH research agenda was developed. These WSH research priorities also constitute an important component of the institute's larger RtP framework.

Through the RtP process, the Institute plans to work closely with the industry to ensure a smooth translation and adaptation of research findings to relevant solutions via an effective knowledge dissemination channel. Using a modified Delphi method, the authors engaged various stakeholder groups through interviews, an online questionnaire and focus group discussions. The authors also took into consideration the current WSH landscape and emerging WSH risks to ensure that both the short- and long-term WSH issues would be addressed.

Priorities in the Singapore WSH Research Agenda were grouped under two distinctive research themes: 1) organizational and business aspects of WSH and 2) WSH risks and solutions. This classification is a combination of both top-down and bottom-up approaches and was envisioned to be a more effective and efficient way to assist the industry. Compared to countries with better WSH performance, such as the U.K. and Finland, Singapore may still be in its infancy in the area of occupational health, as most stakeholders were more concerned with safety issues.

Sang D. Choi, Ph.D., CSP, CPE

Translating Academic Research on Manual Lifting Tasks Observations into Construction Workplace "Good Practices"

Sang D. Choi, James G. Borchardt and Travis L. Proksch

Abstract

The purpose of this study was to examine physical workloads associated with manual lifting activities and to translate the academic research into effective prevention "good practices" for the reduction of injury risks in the construction workplace. Fourteen different construction trades participated, including carpenter, ceiling installer, drywall installer, electrician, fitter, floor finisher, floor tile layer, flooring installer, insulator, laborer, mason, painter, plumber and sod layer.

A total of 292 observations were taken at the origin and destination of lifting or lowering tasks. NIOSH's 1991 revised lifting equation was used to determine the recommended weight limit and lifting index for each task. Results indicate that the observed tasks in this study posed the risk for lifting-related low-back injury. NIOSH lifting equation calculations imply there is greater room for ergonomic improvement associated with horizontal and frequency task factors. The research findings were used to develop highly effective prevention practices, titled "Good Practices of Manually Handling Materials, Tools and Equipment (GP-MH-MTE)." This paper offers a "real world" exemplar of the "Research to Practice: Bridging the Gap Between Academia and Safety, Health and Ergonomics Practitioner" model.

Keywords

Manual lifting, low-back injury, musculoskeletal disorder, construction, ergonomics, research to practice

Introduction & Review of Literature

Work-related musculoskeletal disorders (WMSDs) and injuries are prevalent and account for a considerable amount of human suffering and economic burden to the nation. The most commonly reported biomechanical risk factors with at least reasonable evidence for causing WMSDs include excessive repetition, awkward postures and heavy lifting (da Costa & Vieira, 2010). Overexertion in manual lifting was among the most frequent exposure leading to injury or illness involving days away from work (Bureau of Labor Statistics [BLS], 2010).

Since 1975, multiplicative "lifting equations" in the U.S. and Europe have provided ways to evaluate and quantify the stressfulness of manual lifting tasks (Pinder & Frost, 2011). In the 1990s, researchers believed each factor of the multiplicative lifting equations contributes about the same amount of risk to the overall risk of low-back injury due to a given lifting task. Evaluation of manual material handling tasks often aim to reduce work-related back injuries through the study of lifting strategies (Haddad & Mirka, 2010).

Many construction occupations/trades still require substantial manual lifting and lowering of materials, which often result in overexertion. Occupational safety and ergonomics researchers have begun to focus on the causes and controls of strains and sprains in the construction workplace. WMSDs and low-back injuries are common among construction workers (Holmstrom & Engholm, 2003). This is likely due to high mechanical loading of the spine involved in tasks frequently performed during work, such as manual lifting (da Costa & Vieira, 2010).

Excessive weights, awkward postures and repetitive motions are some of the known ergonomic risk factors that contribute to this type of injury. Currently, how much a worker lifts is left to his or her discretion at the jobsite. Often, weights of construction materials will exceed a worker's physical capacity, and pain or injury to the worker will result. For construction workers to reduce their exposure to these injuries, they may need to know the weights of common construction materials. A few data sources provide the weights of common construction materials and related manual lifting task observations available to workers, managers, and health and safety professionals to aid in preventing WMSDs and injuries. Awareness of construction materials' weight and task-related specific variables prior to manually lifting or lowering may be as important as how the materials are handled (Choi, Proksch & Borchardt, 2009).

Objectives

The purposes of this paper are to 1) investigatethe weights of common construction materials and related physical workloads associated with manual lifting or lowering activities and 2) translate academic research into effective prevention "good practices" to reduce risks of WMSDs and injuries in the construction workplace.

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Background

Application has always been the goal of safety and health (S&H) researchers. Since the 1970s, the S&H practitioner author has been translating S&H research, such as Snook's Gables, 1981 and 1991 NIOSH lifting equations into workplace practices. In the 1990s, NIOSH encouraged research resources to include "real world" applications and developed the research to practice (r2P) model in the 2000s. The academic research author has worked to create a synergy between academic research protocols and classroom teaching methods with university students and S&H practitioners. Furthermore, he has broadened the r2p concept to a practice to research (PtR) model by encouraging practitioners to communicate "real world" S&H exposures to academia for future research.

In 2008, the academic researcher and the S&H practitioner first met at the Construction Safety Conference in Rosemont, IL. They began discussing how S&H research and resources could be made more useful to practitioners. For example, NIOSH's RtP initiative has resulted in "practitioner friendly" manual material handling resources, such as *Simple Solutions—Ergonomics for Construction Workers* (NIOSH Publication 2007-122) and *Ergonomic Guidelines for Manual Material Handling* (NIOSH Publication 2007-131). However, the application of NIOSH's lifting equation with its various components seemed neither widely used nor understood by S&H practitioners. The goal became finding ways to translate academic research projects, using the NIOSH lifting equation, into S&H good practices that practitioners could apply on worksites.

Methods & Procedures

NIOSH's 1991 revised lifting equation has been used in the past primarily as a tool to assess whether an object that is currently lifted can be lifted safely by a healthy worker during a normal workshift (Waters, Putz-Anderson & Garg, 1994). Situations in which the NIOSH lifting equation is a useful tool are 1) estimating the risk of a two-handed, manual lifting task; 2) evaluating a job characterized by multiple lifting tasks; 3) evaluating a lifting task that may include trunk rotation, different types of hand coupling, repetitiveness and duration; 4) determining a relatively safe load weight for a given task; 5) determining a relatively unsafe load weight for a given task; 6) deciding the appropriate style of abatement for a job that had been identified as having a lifting hazard; 7) comparing the relative risk of two lifting tasks; and 8) prioritizing jobs for further ergonomic evaluation.

Using BLS statistics and input from tradespeople, a register of common construction materials was created identifying the most frequently used materials. Next, the manual lifting observation data collection sheet was prepared in an Excel spreadsheet to make recording data collected at jobsites easier and more accurate. BLS (2010) information was used to identify construction contractors who have a high number of nonfatal injuries and illnesses related to exertion in lifting and repetitive motion: masonry contractors; water and sewer line and related structures construction; highway, street and bridge construction; poured concrete foundation and structure contractors; framing contractors; roofing contractors; and power and communication line and related structures construction.

Individuals who performed data collection were provided a training session and guidance before collecting data. Training focused on selecting jobs appropriate for the study, performing the task description and techniques for measuring the required task parameters. Data was then collected on the weights of common construction materials and related manual lifting or lowering tasks observations at various available construction jobsites mainly in Wisconsin and Illinois regions. The protocol for the 1991 NIOSH lifting equation was used to ensure that appropriate data were collected, such as materials of definable size that could be grasped with two hands and moved vertically without mechanical assistance.

Manual Lifting Task Observations

The weight of common materials used by various construction trades was measured at jobsites using a household bathroom scale. The scale was checked before each material was placed on it to ensure that the indicator in fact did read zero. When the scale read zero, the material was placed on the scale and the weight was recorded and rounded to the nearest whole number. Other components of NIOSH's 1991 lifting equation were either measured using a tape measure, such as the distance between the origin and destination of the lift, or observed by the researcher, such as the worker's twisting motion and ability to grasp the materials. After collection in the field, data were then entered into the nonprinted Excel format for further analysis.

Data Collection: NIOSH Lifting Equation

The 1991 NIOSH revised lifting equation was used to evaluate the data collected and to assess the lifts performed in the field (Waters, et al., 1994). To evaluate the situations observed, data on the weight of the object lifted, the horizontal and vertical hand locations at key points on the lifting task, the frequency rate of the lift, the duration of the lift, the type of handhold on the object lifted, and any angle of twisting were collected and analyzed. The data were eventually used to calculate the recommended weight limit (RWL) that is the principal product of the revised NIOSH lifting equation. The RWL is defined for a specific set of task conditions as the weight of the load that nearly all healthy workers (who are free of adverse health conditions that would increase their risk of musculoskeletal injury) could perform over a substantial period of time (e.g., up to 8 hours) without an increased risk of developing lifting-related low-back pain (Waters, et al., 1994).

$$RWL = LC \times HM \times VM \times DM \times AM \times FM \times CM \quad (1)$$

Where:

Load Constant (LC): A constant term in the RWL equation defined as a fixed weight of 23 kg or 51 lb; generally considered the maximum load nearly all healthy workers should be able to lift under optimal conditions (i.e., all the reduction coefficients are unity).

Horizontal Multiplier (HM): A reduction coefficient defined as 10/H, for H measured in inches, and 25/H, for H measured in centimeters.

Vertical Multiplier (VM): A reduction coefficient defined as (1-(.0075 [V-30])), for V measured in inches, and (1-(.003 [V-75])), for V measured in centimeters.

Distance Multiplier (DM): A reduction coefficient defined as (.82 + (l.8/D)), for D measured in inches, and (.82 + (4.5/D)), for D measured in centimeters.

Asymmetric Multiplier (AM): A reduction coefficient defined as (1-(.0032A)) has a maximum value of 1.0 when the load is lifted directly in front of the body and decreases linearly as the Angle of Asymmetry (A) increases.

Frequency Multiplier (FM): A reduction coefficient that depends on the Frequency of Lifting (F), the Vertical Location (V) at the origin and the Duration of Lifting.

Coupling Multiplier (CM): A reduction coefficient based on the Coupling Classification and Vertical Location of the lift.

The LI (Load Weight/RWL) is a relative estimate of the physical stress associated with a manual lifting job. As the degree of the LI increases, the level of the risk for a given worker increases, and a greater percentage of the workforce is likely to be at risk for developing lifting-related injuries. Tasks with an LI greater than a Category 1 pose an increased risk of lifting-related injuries. The ultimate goal of every task should be to have the LI level below Category 1, thus reducing the chance of lifting injuries. It has been verified that as the LI increases, the risk of low-back pain increases (Waters, et al., 2011). It should be noted that the NIOSH lifting equation and its derivatives have a temperature limitation of 19 ºC to 26 ºC (66.2 ºF to 78.8 ºF), which is the normal temperature range for industrial operations. Since the temperature range of construction worksites varies greatly, some worksite data were collected despite temperatures that were above or below the NIOSH lifting equation temperature range.

Results

Part I: Academic Research Project Using NIOSH 1991 Equation

One hundred forty-six tasks were observed in 14 different occupational (trade) groups (i.e., carpenter, ceiling installer, drywall installer, electrician, fitter, floor finisher, floor tile layer, flooring installer, insulator, laborer, mason, painter, plumber, sod layer; Table 1, pp. 6-7). A total of 292 measurements was taken at the origin and destination of lifting/lowering tasks. The median weight of the construction materials manually lifted/lowered was 30.0 lb with an average weight of 32.9 lb and a range of 1.0 lb to 192.0 lb.

Table 2 (p. 8) shows the summary of multipliers (i.e., the reduction coefficient in the NIOSH 1991 lifting equation). A total of 292 observations was measured at the origin and destination of the lifting/lowering tasks. Generally, the observed tasks in this study posed a risk for lifting-related low-back pain (LI > 1). The overall median RWL was 15.96 lb that is approximately 50% less than the median weight (i.e., 30.0 lb) of the construction materials manually handled. As seen in Table 2, the horizontal multiplier (0.56) recorded the lowest value followed by frequency multiplier (0.85). The relative magnitude of each multiplier indicates the relative contribution of each task factor. The result indicates that there is greater room for ergonomic improvement associated with horizontal and frequency task factors.

Table 3 (p. 8) depicts the median and range of RWL for the 14 occupational groups (observations measured at the origin and destination of their lifting or lowering tasks). Ten groups of trades (carpenter, drop-in ceiling installer, electrician, fitter, floor finisher, floor tile installer, insulator, laborer, mason, sod layer) recorded their RWL less than 20 lb. The RWL can be used to guide the redesign of existing manual lifting jobs or to design new manual lifting jobs.

Figure 1 (p. 9) displays the lifting indices of the 14 participating occupational groups. All trades except electricians exceeded a LI of 1.0. The LI can be used to prioritize ergonomic redesign. A series of suspected hazardous jobs could be rank-ordered according to the LI, and a control strategy could be developed according to the rank ordering. Particularly, drywall, drop-in ceiling, sod-laying, floor-finishing and laborer job tasks recorded their lifting indices above or higher than 3.0. This indicates that nearly all workers in these occupations will be at an elevated risk of a work-related injury when performing their highly stressful lifting/lowering tasks (Waters, et al., 1994).

Part II: Translating Research Findings Into Actions or "Good Practices"

To translate the study's findings into workplace good practices, the RWL, the LI and lifting equation's task multipliers were analyzed and prioritized to determine which would provide the best potential reduction of risk factors when lifting construction materials. Good practices were developed on a priority basis to reduce exposures from lifting equation components as follows: 1) weight of the materials lifted; 2) horizontal multiplier; 3) frequency multiplier; 4) vertical multiplier; and 5) asymmetric multiplier.

For example, the first priority was to develop good practices that addressed the weight of construction materials since the median RWL was 15.96 lb and the median 1.54 with an average LI of 2.35 (LI > 1), which pose an increased risk for lifting-related low-back pain (Waters, et al., 1994). Next, the horizontal and frequency multipliers (median 0.56 and 0.85 respectively) indicated room for ergonomic improvement so good practices to improve these lifting task components were considered. Improving the vertical and distance multipliers (median 0.89) was the final objective of developing workplace good practices.

Workplace "Good Practices" Applications

As a product of transferring the research findings into highly effective prevention practices, a one-page "Good Practices of Manually Handling Materials, Tools and Equipment (GP-MH-MTE)" was developed. An "Instructors Guide" explains the principles and application of each GP-MH-MTE.

Trade/Occupation	Construction Material	Size (LxWxH) (in)	Weight (lbs)
Carpenter	Air Conditioner	45 x 25 x 20	60
	Ceiling Grid	24 x 7 x7	40
	Ceiling Tile	34 x 34 x 8	60
	Door Accessories	18 x 10 x 10	30
	Door Handles	15 x 13 x 3	8
	Door Handles	16 x 10 x 12	30
	Door Handles	10 x 6 x 2	5
	Door Hinges	14 x 10 x 6	40
	Insulation	96 x 48 x 3	5
	Joint Compound	18 x 12 x 12	30
	Metal Studs	120 x 5 x 2	10
	Silicon Sealer	18 x 12 x 12	30
	Toilet Partitions	59 x 35 x 2	85
	Wooden piece	8 x 4 x 2	10
Drop-in Ceiling Installer	Grid	49 x 9 x 3.5	60
	Single Grid	49 x 1 x 1	4
	Single Tile	24 x 24 x 10	4
	Tile	24 x 24 x 10	52
Drywall Installer	Dry Wall (2)	144 x 54 x 5/8	192
Electrician	Cable	14 x 12 x 10	20
	Canister Lights	20 x 11 x 10	10
	Ceiling Speakers	26 x 9 x 10	15
	Conduit	144 x 1 x 1	10
	Electrical Outlets	18 x 10 x 10	5
	Exit Lights	15 x 15 x 7	5
	Fluorescent Light Bulbs	48 x 6 x 3	5
	Fluorescent Lights	28 x 14 x 6	15
	Fluorescent Lights	48 x 24 x 5	35
	Wire	16 x 10 x 10	50
Fitter	Heater Panels	88 x 15 x 4	55
	Nipples	15 x 11 x 8	10
	Pipe Fittings	10 x 5 x 5	10
	Pipe Fittings	16 x 11 x 10	30
Floor Finisher	Liquid Hardener	14 x 7 x 9	15
	Terrazzo	20 x 15 x 3	80
Floor Tile Layer	Grout	15 x 10 x 2	25

Flooring Installer	Floor Panels	30 x 30 x 2	10
	Vinyl Trim	36 x 5 x 3	40
Insulator	Insulation	36 x 24 x 24	20
	Insulation	50 x 24 x 16	31
	Insulation	24 x 16 x 50	31
Laborer	Epoxy	13 x 8 x 13	30
	Floor Adhesive	20 x 12 x 12	40
	Floor Tile	12 x 12 x 6	60
	Quartz	20 x 12 x 4	50
	Sand Finish	20 x 12 x 12	70
Mason	Block	20 x 7.5 x 7.5	40
	Brick	7.5 x 3.75 x 2.25	5
	Brick	12 x 5 x 5	10
	Brick	7.5 x 3.75 x 3.75	5
	Cast Stone	16 x 8 x 4	30
	Floor Block	15.5 x 7.5 x 3.5	40
	Grout	19 x 13.5 x 4	80
	Mortar	19 x 13.5 x 6	80
	Plastic Shims	35 x 3 x .5	1
	Roof Blocking	25 x 15 x12	15
	Tile	7.5 x 3.75 x 1	1.5
Painter	Paint	20 x 12 x 12	50
Plumber	Urinals	24 x 16 x 24	60
Sod Layer	Sod	45 x 16 x 3.5	30

Table 1. Occupation & Construction Material Characteristics

A PowerPoint presentation (PPT-MH-MTE) helps safety professionals demonstrate, explain and reinforce good practices in the office with management and engineers and at worksites with workers. To encourage ongoing understanding and application, safety professionals are encouraged to develop an in-house "photo presentation" of "what is wrong with manual lifting tasks and what can be improved?" For example, Photo 1 (p. 9) shows a worker lifting, carrying and positioning a 4 ft x 12 ft x 5/8-in. sheet of drywall at a jobsite.

•What improvements could be preplanned into the task and implemented at the jobsite?

•What are the potential ergonomic risk factors of this task?

Several risk factor reduction recommendations were provided to the contractor:

•Modify task so two workers handle full sheets of drywall.

•Preplan material handling aids into the job, such as carts to move drywall sheets from room to room.

•Provide drywall handling tools for half sheets or smaller.

•Conduct worksite training using the PPT-MH-MTE or similar materials to inform workers of the risk factors and controls to improve manually handling drywall to reduce the exposure to injury, such as strains from overexertion.

The focus of these resources is to assist SH&E practitioners in evaluating manual lifting/lowering tasks to reduce the incidence of low-back injuries in construction workers.

Safety professionals first reviewed the loss experience of contractors for the past several years to identify specific tasks resulting in strains from lifting and other manual handling tasks. They then visited jobsites to observe typical manual handling tasks, such as lifting, to determine which combination of GP-MH-MTEs might be most effective. The MH loss trends, worksite observations and selected GP-MH-MTE were then discussed with contractor management and project engineers to communicate the risk factors of manually handling materials

Total Observations (*n*=292)	Median	STD	Range
Horizontal Multiplier (HM)	0.56	0.29	0.19-1.00
Vertical Multiplier (VM)	0.89	0.07	0.63-1.00
Distance Multiplier (DM)	0.89	0.05	0.82-1.00
Asymmetric Multiplier (AM)	1.00	0.20	0.42-1.00
Frequency Multiplier (FM)	0.85	0.14	0.35-0.94
Coupling Multiplier (CM)	0.95	0.03	0.90-1.00
Recommended Weight Limit (RWL)	15.96	7.13	2.84-33.36
Lifting Index (LI)	1.54	2.44	0.04-12.76

Table 2. Median, Standard Deviation (STD), Range of Task Multipliers

Trade/Occupation	Median	Min	Max
Carpenter (*n*=80)	17.8	8.2	33.0
Drop-in Ceiling Installer (*n*=16)	8.0	4.3	10.8
Drywall Installer (*n*=2)	26.4	24.7	28.0
Electrician (*n*=46)	16.4	6.5	31.5
Fitter (*n*=22)	17.2	7.9	29.9
Floor Finisher (*n*=12)	13.3	10.4	33.4
Floor Tile Layer (*n*=6)	16.0	10.1	29.4
Flooring Installer (*n*=12)	20.4	9.3	27.6
Insulator (*n*=14)	10.3	4.1	16.9
Laborer (*n*=14)	19.2	10.0	26.9
Mason (*n*=58)	13.9	2.8	32.2
Painter (*n*=2)	20.0	19.7	20.3
Plumber (*n*=2)	20.7	18.7	22.8
Sod Layer (*n*=6)	6.2	3.7	11.5

Table 3. Recommended Weight Limit (lbs) by Occupational Group

to determine how work practices and layout could be improved and what material handling equipment could be preplanned into the project. The GP-MH-MTE approved by contractor management and the PPT-MH-MTE were used on worksites to improve material handling methods and to train workers and supervisors so they understand the principles of the GPs and would continuously apply them to their work tasks. A copy of the PPT-MH-MTE was also provided for training of new hires. Some contractors resisted this process since methods of manually handling materials is not specifically required by OSHA or by most state OSHA plans except under the general duty clause. Other contractors with well-developed safety programs viewed this process as an opportunity to expand their safety program to the next level. The potential reduction of injuries from overexertion for contractors who improved their manual material handling methods has not been evaluated.

Borchardt (B) Factor

To make the NIOSH lifting equation and lifting index more user-friendly, it would be helpful if the weight of materials were expressed in terms of easy-to-measure units of measurement. This concept, the Borchardt Factor (B Factor), is defined as: weight (lb or kg) per easy-to-measure unit of measurement, such as weight per unit of area, length, brick, block, gallon or other "useful" measurement.

For example, the B Factor of drywall or rebar could be expressed as: B(1/2-in. std drywall) = 1.7 lb per square foot; B(5/8-in. std drywall) = 2.2 lb per square foot; B(# 4-1/2-in. rebar) = 0.688 lb per linear foot; (#8 1-in. rebar) = 2.67 lb per linear foot. The weight of construction materials can be calculated when the B Factor is known.

A database of B Factors for construction materials could be established and maintained by an organization, such as NIOSH or ASSE's Body of Knowledge, so it would be readily available to S&H professionals.

Manufacturers of construction materials could contribute to this database of current and existing materials. They could also print B Factor information on products and in product literature, again making the weight of material easily apparent to practitioners. Some manufacturers have already experimented with reducing the weight of construction materials, such as 50-lb bundles of roofing shingles, to reduce the exposure to overexertion (Dempsey, 2001). Universities might contribute to a B Factor database by assigning students to identify reliable sources of B Factor information. The days of safety professionals weighing construction materials at jobsites with a bathroom scale to apply NIOSH's lifting equation could be replaced by smartphones using Internet APS and/or QRscan codes. For example, as shown in Photo 1, when a worker lifts and positions a 4 ft x 12 ft x 5/8-in. sheet of drywall, the B Factor method can be used to determine its weight (about 102 lb) because the sheet of drywall may be too large to get an accurate measurement with a bathroom scale.

Figure 1. Lifting Index by Occupational (Trade) Group

Conclusions & Recommendations

Safety, health and ergonomics educators need to more effectively communicate the importance of each component of the NIOSH lifting equation to evaluate lifting/lowering tasks so that practitioners can decide which component would be†most feasible and effective to change. The practitioner will probably have a series of short-term and long-term improvements to the manual lifting tasks.

For example, an administrative†improvement may be to move the material closer to the worker to reduce the horizontal distance; add another worker to reduce the frequency; place the material on something that raises it up, thus reducing the vertical component and amount of bending, or preplan a platform on which workers stand to raise them enough to reduce overhead reaching and the vertical component. Changing to smaller packaging with appropriate handles could reduce exposure by lowering the weight component and by improving the coupling component. Educators and practitioners should consider knowing and modifying both the weight of materials and lifting task variables. A systems-level approach accounting for both injury risk and productivity should be undertaken. Application in practice should consider cumulative exposures and productivity.

In the construction industry, lifting and lowering tasks are often completed on an as-needed basis. For example, as-needed lifting may occur when stacking materials for a specific job task, such as laying construction block. For this task, the laborer stacks block near the mason who uses them "as needed." The laborer also performs other manual tasks, such as mixing mortar and stacking block, only on an as-needed basis. Another challenge to using the NIOSH lifting equation on construction jobsites is the temperature†of most jobsites is not in the limitation of 19 ºC to 26 ºC (66.2 ºF to 78.8 ºF). Lifting tasks performed at temperatures significantly outside the range may cause low-back pain (Waters, et al., 1994). Consequently, the RWL for most construction lifting tasks may need to be lowered when the temperature is outside the above or below the NIOSH lifting equation temperature range. Further investigation of the effects of temperature and humidity on manual lifting tasks at construction sites may be needed.

Photo 1. PPT-MH-MTE Photo Presentation

Employers in Europe must ensure that workers are informed of the weight and center of gravity of materials to be lifted (European Agency for Safety &

Health at Work, 2012). In the U.K., employers are required to train workers to recognize loads whose weight, slope or other features might cause injury (Health & Safety Executive, 2007). Simple methods for estimating weight of materials, such as volume, should be taught. To make the NIOSH lifting equation and lifting index more user-friendly, it would be helpful if the weight of materials were expressed in terms of easy-to-measure units of measurement. Knowing the weight of loads lifted and the geometry of the lifts may also be important for evaluating variable-task manual lifting jobs (Waters, et al, 2009). The B Factor concept may possibly enable safety, health and ergonomics practitioners to "calculate" the weight of large, bulky or irregularly shaped materials at worksites.

While educators may focus on the technical application of the NIOSH 1991 revised lifting equation, practitioners may use it as a tool to achieve improvement of manual lifting tasks. In turn, translating and communicating the results of studies is important so workers know how to perform their lifting tasks safely. ✪

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Research That Can Support Self-Help Initiative of Local Farmers to Improve Safety & Health at Work: Birth & Growth of WIND Training Program in Viet Nam

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Abstract

The Work Improvement in Neighborhood Development (WIND) training program to improve safety and health and working conditions of farmers, which is now widely applied in different countries, was initiated from a small, action-oriented research project in the Mekong Delta area of Viet Nam. This paper reviewed and analyzed the steps of the birth and growth of the WIND training program and examined how a research project contributed to practical improvements in occupational safety and health (OSH) of local farmers. The research project started with the direct observation study of the work and life of local farmers, interactive discussions with them for practical solutions and learning from existing local good examples to improve working and living conditions. Practical training materials, such as an action checklist and good example illustrations, were developed based on the research findings.

The WIND training program spread from the first pilot village to neighboring villages and further to neighboring provinces through the initiative of local farmers and their supporters. Active farmers in different provinces of Viet Nam were trained as WIND farmer volunteers and then trained their neighboring farmers to expand the coverage of the WIND training program. Later, the WIND training program had an impact on the national OSH policy. The First National OSH Program of Viet Nam in 2006 adopted OSH in agriculture as a priority area for action and actively used the WIND training program as a practical methodology to improve OSH of farmers. The International Labor Office (ILO) also found the WIND training program a useful tool and widely applied it in its technical cooperation programs in Viet Nam and the neighboring countries in Asia and further in some countries in Africa, Central Asia, Eastern Europe, and Latin America.

It was concluded that the practical and participatory nature of the WIND training program was the root cause of its wide application in different countries. The findings and approaches in the initial action-oriented research project aiming at understanding the real work and life of local farmers and learning from the self-help initiative of local farmers contributed to making the WIND training program practical and widely applicable.

Keywords

Action-oriented research, developing countries, participatory training, WIND training program, agriculture, low-cost improvements

Action-oriented research aiming to support the existing workplace initiative for practical solution is gaining momentum. Recent developments in OSH research, particularly in industrially developing countries in Asia, provide practical examples of how action-oriented research can support the self-help initiative of local workers and employers to improve safety and health at grassroots workplaces (Chaikittiporn, et al., 2001; Itani, et al., 2006, Kawakami, et al., 1993; Khai, et al., 1996). The research was commonly designed and carried out to understand the real conditions of work and life of local workers in target workplaces and associated their findings directly with simple, low-cost solutions. Participating workers and employers initiated and expanded practical improvements in OSH in their workplaces in a step-wise manner for long-term sustainability.

Participatory training methodologies are now widely applied in many counties in Asia (Arphorn, 2006; Kogi, 1995; Tong, et al., 2007; Yoshikawa, et al., 2003) to improve OSH and working conditions in various grassroots workplaces. Typical examples of the participatory training program include the Work Improvement in Small Enterprises (WISE) training program (Thurman, et al., 1988; International Labor Office, 2002) designed to assist small enterprises and the WIND training program with farmers (Kawakami, et al., 1998). These participatory training programs are action-oriented and have applied practical, locally adjustable training tools, such as good example photo sheets, action checklists and group work dynamics.

The training tools have facilitated active involvement of many people in grassroots workplaces and have supported their self-help initiatives to make positive changes in their workplaces (Khai, et al., 2005). Participating workers and employers

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have implemented practical, low-cost improvements by using their own ideas and available local resources (Kogi, et al., 1988; Kogi, 2006). Later, the participatory training methods were applied to home workers in the informal economy through the WISH program, to construction workers through the Work Improvement in Small Construction Sites (WISCON) program (Kawakami, 2006) and to waste collectors through the Work Adjustment for Recycling and Managing Waste (WARM) training program (Kawakami, et al., 2010). The participatory training methodologies were also used to assist small enterprises in protecting their workers and businesses in the recent human influenza pandemic (Kawakami, 2009).

ILO notes that agriculture is one of the most hazardous of all sectors, and many agricultural workers suffer occupational accidents and ill health each year (International Labor Office, 2010). Farmers face many OSH risks, such as exposure to heat and cold, agricultural chemicals, infectious agents, lifting heavy materials and use of dangerous machines and vehicles. Their work often involves long working hours without regular holidays. Vulnerable groups of workers, such as women, young workers or migrants, are often involved. Farmers need practical support to improve OSH and the efficiency of their work (Arphorn, et al., 2006).

Methods & Results

This paper reviews and analyzes the course of the development of the WIND training program. Special attention was paid to the role of action-oriented research and cooperation with local people for practical OSH solutions. Now, the WIND training program is widely used by ILO, many governments and other organizations (Kawakami, et al., 2009). There were long, substantial collaborative steps with local farmers to shape and disseminate the WIND training program before the WIND program became popular.

Direct Observation Studies on the Workload of Rice-Cropping Work & a Sugarcane Processing Factory

Two technical institutes, the Vi Thanh Hospital School of Viet Nam and the Institute for Science of Labor of Japan, started a collaborative research project in 1991 aiming to improve the quality of working lives of local farmers in the Mekong Delta area of Viet Nam. The project team had studied the real working and living conditions of local farmers. As the first step, the team carried out three research studies to understand the real work and life conditions of local farmers in one village and to discuss improvements with them. The first research carried out was the direct observation study on the work of the rice-cropping, harvesting and land preparation work (Kawakami, et al., 1993). The second study was a year-long time budget record of five rice farmer families to know and analyze the working time and the difference in time used between men and women farmers (Kawakami, et al., 1997). The team, in consultation with the local departments of labor and health in Cantho province, selected average farmer families in the village as the first research target. They produce rice as the main farm product and earn a middle income. The third study was carried out in a small-scale sugarcane processing factory by using the direct observation method and monitoring subjective fatigue symptoms. The team observed the work of farmer sugarcane processing workers from the beginning of their work in the morning until the end after midnight to identify safety and health risks associated with their work (Khai, et al., 1996).

Table 1 summarizes the major findings of the research in both working and living conditions of the targeted rice farmers and sugarcane processing workers and the contribution of the research findings to the development of the WIND training program. The findings in working conditions included broad improvement needs. They were, for example, carrying heavy materials, exposure to strong sunshine, risks of eye-stick injuries during harvesting work and needs of hygienic drinking water and a toilet in the field. The one-year-long time budget study showed the longer working hours of women farmers, who needed to do both farming and household work. The findings in the sugarcane factory were striking. Workers needed to carry heavy sugarcane bundles on the muddy and slippery floor and to accept long working hours from morning until night.

The research team actively discussed workable solutions with farmers and sugar factory owners and their workers while observing their actual work in their workplaces. After each research, the team presented the findings to the farmers, workers, employers and local government officials concerned and discussed the findings and recommendations for improvements with them. After the research, the owners and workers in the same factory implemented the improvements based on the discussions with the research team, such as the cemented floor, machine guards or a resting corner. These findings and experiences assisted the research team to design a practical training program aimed at joint improvements in both working and living conditions.

Learning From Local Good Examples & Developing Training Materials & the Steps Taken for the Development of the WIND Training Program

The research carried out in the rice field and a sugarcane factory assisted the research team in understanding the real-life and work conditions of the target farmers and workers. The research also provided a practical opportunity to learn from the existing good practices and self-help initiative of local farmers and sugarcane workers. From these positive experiences, the research team used a new strategy to support improvement action of local farmers. That is to collect and learn from local good examples and to develop a participatory training program by using the collected good example. Good examples are existing solutions in any community and any workplace to reduce safety and health risks by using locally available materials. The local good practices tell people that, within the limited conditions, actions are still performed and solutions are achieved in a practical, step-wise manner.

The research team visited 400 farmer families in Vi Thanh district and observed their houses and farms to collect good examples in their working and living conditions devised by the farmers themselves. Referring to the research findings and also learning from the local good examples collected, the research team developed an action checklist for improving the working and living conditions of local farmers. The previous direct observation study experiences with farmers gave useful insights into selecting the practical items of the action checklist. The team also referred to the action checklist of the WISE training program developed by ILO (Thurman, et al., 1988) and referred to their practical training methodologies, such as group discussions and low-cost improvement methods (Kogi, et al., 1988).

The local good examples collected through the visit to 400 farmer families covered both working conditions and living conditions. Good examples in working conditions were, for example, use of a hand-truck to transport heavy agricultural products, clear passageways and safe bridges to go to their farms, safe storage of pesticides, use of long-brimmed hats to protect farmers from strong sunlight and short break habits near the rice field. Good examples in living conditions were, for example, well-organized kitchens and eating places, taking sufficient fruits and vegetables for balanced nutrition, bright rooms by using natural light, openings for good ventilation and hygienic toilets. Some families had good plans for family income generation and expenses. The research team counted these also as good examples in their living conditions.

These local good examples were classified into 4 categories of improvement needs in working conditions and 5 categories of those of living conditions. They were materials storage and handling, machine safety, work environments and welfare facilities in working conditions, healthy eating habits, safe drinking water and hygiene, living environments, safety and health of children, financial planning and neighborhood cooperation in living conditions. This categorization became the basis to develop the first action checklist for farmer training. The local good examples collected were later used as presentation materials in the subsequent training workshop.

Research & Major Findings	Contribution to Developing the WIND Training Program
Rice-Cropping *Workload: Muddy passageways, unsafe bridges, long sustained bending posture, moving heavy agricultural machines. *Tools: heavy hand tools, cutting injuries from knives. *Work environment: uncovered machine belts, insect and worm bites, eye injuries caused by the sharp edge of rice stalks, exposure to strong sunshine. *Needs to improve welfare and organization of work: long and irregular working hours, no adequate resting corners, unsafe drinking water and lack of hygienic toilets for both women and men farmers.	*identifying appropriate checklist items; *having strategies for joint improvements in working and living conditions; *promoting neighborhood cooperation to reduce the workload of agricultural work; *establishing good relationships with farmers for long-term cooperation.
One-Year-Long Time Budget Study *Men farmers spent most of their working time for rice-cropping and other farm work. *Women farmers had longer working hours to do both the household work plus the rice-cropping and other farm work. *Seasonal differences of working time. Farmers had longer working hours in the busy harvesting season.	*confirming the need to invite both women and men farmers to the training to reflect both voices; *selecting a training time and place convenient to both women and men; *identifying appropriate checklist items, such as "having regular holidays" and "promoting cooperation of men and women for household work."
Sugarcane Factory *Workload: carrying heavy sugarcane bundles on a muddy and slippery floor, long working hours from early morning until night. *Work environment: no machine guards in sugarcane crushing machines, heat coming from the sugarcane juice boiler, dark workplaces during night work. *Low-cost improvements carried out one year later, such as cemented passageway to prevent workers from slipping, covers on waste canals, installing handmade machine guards or establishing a resting corner.	*promoting group discussions for finding practical solutions; *promoting simple, low-cost improvement methods; *learning from local good examples and self-help initiative for workplace improvements.

Table 1. Research Findings & Contribution to Developing the WIND Training Program

Organizing the First WIND Training Workshops

Pilot training workshops were organized in My Tan village in Vi Thanh district of Vietnam. Twenty pairs of husbands and wives of farmers' families were invited from the village. A 1-day training program was prepared and carried out. The program consisted of four sessions: 1) a farm visit with the action checklist exercise, 2) improving working conditions, 3) improving living conditions and 4) developing improvement proposals. The action checklist and the presentation materials designed based on the research findings and the local good examples collected were applied in the pilot training.

Developing the WIND Action Checklist & Training Materials

An action-style checklist was designed as a training tool for farmers based on the research findings and the discussion with farmers, employers, workers and local government officials. The checklist was to assist farmers in finding practical safety and health solutions that can be made at a low cost. Table 2 shows the 32 items included in the first checklist. Figure 1 is part of the action checklist, which includes illustrations showing local good examples. These illustrations were to assist participating farmers in understanding the action points easily. The research team found from the previous research findings that the farmers' family lives and work were closely interrelated. The original 32-item checklist reflected this practical point and aimed at joint improvements in their working and living conditions.

Organizing the First Training Workshop

Using the training materials developed, a pilot training workshop was organized. The research team invited an equal number of men and women farmers. Forty farmers (20 pairs of husbands and wives) in the same village participated in the training. The team invited the average-income farmer families as the first training target and planned to extend the coverage to poorer farmers after experiencing initial success with the middle-income farmers. The trained farmers were expected to gradually extend practical safety and health information to poorer farmers in the same communities. The research team members served as trainers in the pilot training. The training was carried out in a temple located in their own village for their convenience, particularly to women farmers.

Figure 2 (p. 16) shows the structure of the 1-day pilot training workshop. At the beginning of the training, participating farmers visited a typical rice field and a household in the village for the action checklist exercise to find points for improvements. They were also encouraged to find and learn from existing good examples in working and living conditions in the rice field and household they visited. After the visits, two sessions on working conditions and living conditions were made. In each of the two sessions, the project team, as trainers, presented the local good examples collected. The participants were divided into small groups and discussed the improvements in the rice field and household they had visited.

Every participating farmer was encouraged to participate in the group discussion actively. Trainers paid special attention to participating women farmers to express their ideas in the group discussions. They were shy but had many practical ideas for improvement from their daily work and life experiences. Promoting active participation of both women and men became an important principle of the WIND training program. The participating farmers made realistic proposals to improve the working and living conditions for the farmer family they had visited with the application of the action checklist.

Their improvement proposals in the working conditions were, for example, wearing shoes in the rice field, safe storage of pesticides, using a boat for carrying heavy rice sacks, building a resting corner in the rice field, bringing safe drinking water to the rice field or constructing a latrine near the rice field. The proposals in the living conditions included safety guards for children, planning home economy, more openings in the house for ventilation, washing utensils and clothes in a more hygienic way and purchasing agromachines together with neighbors. After these presentations, the participating couples (husbands and wives) from the same families discussed and presented their own improvement plans in their working and living conditions.

Follow-Up Visits to Participating Farmers

The research team visited the 20 couples of participating farmers 2 months later. Nineteen couples implemented 88 improvements, of which 41 were implemented at less than $1 by using locally available materials. Typical examples included a hand-truck to carry heavy materials or more openings in their houses for better ventilation (Kawakami, et al., 1998). The farmers made these positive changes in their living and working conditions without external financial support. These simple, useful improvements demonstrated that the improvements were possible at a low cost. Based on these success stories, the WIND training program convinced neighboring farmers to make changes to their living and working conditions at low-cost improvement methods. This later also convinced their potential supporters, such as local technical institutions, nongovernmental organizations and the government, to apply the WIND training program for wider coverage and impact.

Training WIND Farmer Volunteers & Efforts for Wider Coverage

After the pilot training workshops, local farmers and their human networks, in cooperation with the research team, expanded the coverage of the training program to other villages. The training program was named Work Improvement for Neighborhood Development (WIND) to promote neighborhood cooperation in improving the quality of the working lives of local farmers. The efforts and approaches taken for increasing the coverage included the following steps: to develop WIND farmer volunteers, to integrate the WIND training program into provincial and national OSH programs and to disseminate the program to neighboring countries.

Spread of Training to Other Villages, Provinces & Countries

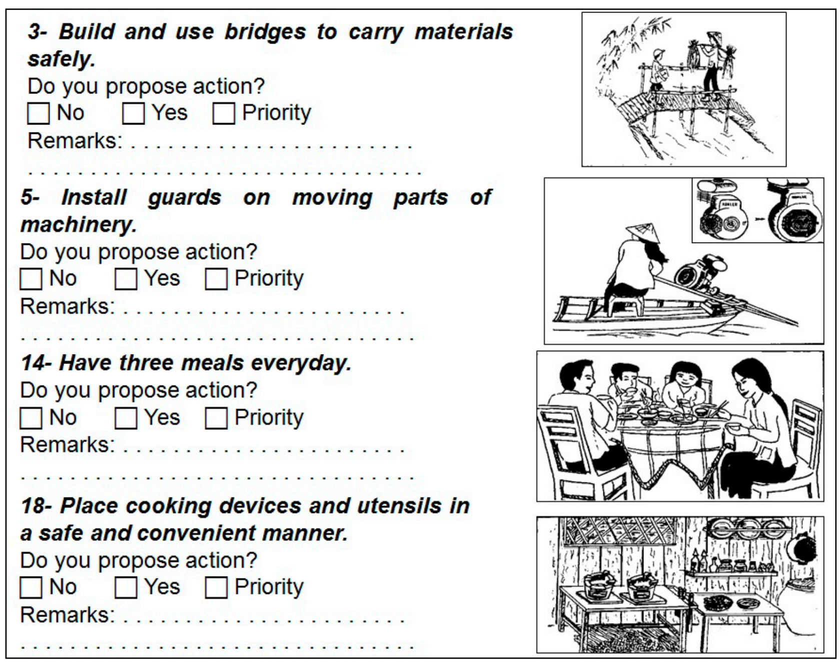
Research team members expanded the coverage of training after the initial pilot training workshops. They trained local trainers and supported them to organize the training workshop to other villages through their networks. Farmers in one village had friends in neighboring villages, relayed their training experiences to their friends and encouraged them to organize a similar style of training. The local trainers trained in the pilot training workshops were sent to the next target villages and organized the subsequent training workshops with responsible village officials. The research team had been convinced that this village-to-village collaboration would be a practical mechanism for the long-term sustainability and wide application of the training program. The belief later produced the idea of the WIND farmer volunteer.

After the initial pilot training, the training program was named WIND to reflect the nature of the program that promotes neighborhood cooperation. Farmers know their working and living conditions best and can become the best WIND trainers to other farmers. The conviction came from original research findings on the self-help initiative of local farmers and led to the birth of “WIND farmer volunteers,” who train their neighboring farmers to improve safety and health at work and at home. The trained WIND farmer volunteers used practical training tools, such as good example photo sheets and an action checklist, and visited and trained the neighboring farmers (Photo 1, p. 17). Cantho Province located in the Mekong Delta area of Viet Nam created this unique WIND farmer volunteer approach. The farmer volunteers were gradually expanded to surrounding provinces.

Improvement Areas	Checklist Items (32 Items in Total)
Working Conditions 1) materials storage and handling; 2) machine safety; 3) work environments; 4) welfare facilities.	Safe passageways; use of carts, boats and buffaloes; safe bridge; safe storage of agricultural equipment. Covering rotating parts; proper maintenance. Safe storage of pesticides; safe and minimum use of pesticides; protection against strong sunshine; Shoes for agricultural work; short break and resting corner; safe drinking water at the farm; toilet at the farm.
Living Conditions 1) healthy eating habit; 2) safe drinking water and hygiene; 3) living environments; 4) safety and health of children; 5) financial planning and neighborhood cooperation.	Regular meal habit (three times a day); nutrition balance; storage of utensils; hygienic dining table; conveniently arranged kitchen. Hygienic water storage; use of boiled water; hygienic toilet; washing utensils and clothes. Storage of clothes and other household materials; maximum use of natural light; window and natural ventilation. Use of fences and cradles to prevent accidents; safe toys; shoes and clothes for children. Planning and recording income and expenses; income generation by producing fruits, vegetables and raising pigs. Cooking together during the busy harvesting period; saving money to buy agricultural machinery.

Table 2. Original 32-Item Action Checklist, Which Became the Basis of the WIND Checklist

Having learned from the initial success in Cantho province, the Government of Viet Nam and ILO jointly launched a technical cooperation project to improve OSH in agriculture from 2004-07. The WIND training program played an essential role in the project, and the WIND farmer volunteer system further spread into 14 provinces in different regions of Viet Nam (Kawakami, et al., 2008). From 2004-07, 480 WIND farmer volunteers in the 14 provinces were trained. They trained their neighboring farmers and expanded their networks. The volunteers trained 7,922 farmers. The trained farmers implemented 28,508 improvements in materials handling, work posture, machine and electrical safety, working environments and control of hazardous chemicals, and welfare facilities.


3- Build and use bridges to carry materials safely.
Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks: . . . .

5- Install guards on moving parts of machinery.
Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks: . . . .

14- Have three meals everyday.
Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks: . . . .

18- Place cooking devices and utensils in a safe and convenient manner.
Do you propose action?
☐ No ☐ Yes ☐ Priority
Remarks: . . . .

Figure 1. Examples From Action Checklist

Further, the First National OSH Program of Viet Nam identified OSH in agriculture as a priority area for action (Ministry of Labor, Invalids & Social Affairs, 2006) and adopted the WIND training program as the practical methodology to reach the national program’s goal. Participatory approaches taken in the WIND training program made an impact on the national policy in OSH and contributed to the practical government service for more grassroots farmers in improving their OSH.

The WIND training program was also transferred to neighboring countries in Asia, including Cambodia, China, South Korea, Laos, Mongolia, the Philippines and Thailand, through the technical cooperation programs of ILO and other organizations. The WIND Program further spread to several countries in Africa, Central Asia, Eastern Europe and Latin America as a practical training methodology and contributed to the improvement of OSH of local farmers (Khai, et al., 2011). The WIND

Figure 2. Structure of 1-Day Pilot Training Workshop

program, through its participatory, practical nature, created a significant impact on the technical cooperation programs of ILO, governments and other technical institutions.

Applying Participatory Training Methodologies to Other Grassroots Workplaces

The WIND training program provided a practical example to apply the participatory training methodologies to other grassroots workplaces in industrially developing countries, which had seldom received OSH services by specialists and the government. Similar participatory training methodologies were applied with home workers, workers in small construction sites, migrants and waste collectors (Kawakami, 2006; Kawakami, 2010; McGuinness, et al., 2011) referring to the practical experiences and achievements of the WIND training program. Now, the WIND training program and the participatory training experiences are further spreading to more farmers and grassroots workers, including informal economy workers. Figure 3 shows a summary of these developments and impacts of the WIND training program.

Discussion

The WIND training program, which is now widely applied to improve OSH and working conditions in agriculture in different countries, originated from a small, action-oriented research project in a local district in Viet Nam. The findings of the action-oriented research at grassroots workplaces and constructive interactions with local farmers and workers shaped the WIND training program's basic structure. This experience provides an example of how research can support the self-help initiative of local people for practical solutions. Later, ILO adopted the WIND training program in its technical cooperation as a practical tool and applied it globally.

A series of action-oriented research played vital roles for the birth and growth of the WIND training program. The research project had a clear aim to support the self-help initiative of farmers in the Mekong Delta area of Viet Nam to improve the quality of working lives and learned from the reality of the working lives of farmers. The main research methodology applied was the direct observation of the work of target farmers and workers through the time study. The methodology and approaches were widely applicable in remote grassroots workplaces. The researchers stayed together with the farmers and workers in their workplaces and observed their real work and actively exchanged ideas with them for improvements in their workplaces. On-site interactive discussions facilitated creating the easy-to-apply WIND training program to meet the practical needs of local farmers. At every step of the WIND training program's development, initial action-oriented research and interaction with local farmers and workers were referred to as the core experience.

After learning from local good examples and the self-help initiative of local farmers and workers, the research team served as a facilitator to further support the local initiative and tried to assist local farmers and workers in finding the practical solutions. Simple and low-cost ways of improvements (Kogi, 2006; Kogi, et al., 1988) stressed in ILO's WISE training program gave insights into further application of practical improvement approaches. Participating farmers and workers initially started with small, easy-to-implement improvements and then expanded their scopes to more challenging improvements in a step-wise manner.

Participatory training methodologies adopted in the WISE and WIND programs, learning from good examples made by local farmers, stressed the importance of designing and using locally adjusted training tools, such as an action checklist or good example photo sheets. These tools have been confirmed effective in different local conditions in agriculture as they present local good practices as workable goals and focus on locally feasible improvements having real impact in the local context. This locally adapted nature of training tools and their use by local people has contributed greatly to the success of the WIND training program in different agricultural settings, in addition to the participatory and practical nature. Initial action research experiences in the local settings assisted the research team in understanding the importance of these locally adjustable training tools.

Participatory approaches taken in the WIND program positively influenced the government OSH policy to place more focus on directly supporting practical action at grassroots level. Many farmers were trained as WIND farmer volunteers in safety and health. These trainers then trained many neighboring farmers to strengthen their self-help initiative and to expand their own action for practical OSH improvement. The precedent research findings and experiences facilitated making the concept

Photo 1. WIND farmer volunteer training neighboring farmers by using a photo sheet showing local good examples.

of WIND farmer volunteers that local farmers are the best trainers to their neighboring farmers. After the initial success at district and provincial levels, this WIND farmer volunteer system received strong attention from the central government and was integrated into the First National OSH Program in Viet Nam for wider coverage.

The rapid transfer of the WIND training program from Viet Nam to regional and international levels was striking. The program is now widely used in different parts of the world as a popular methodology to assist local farmers in improving their OSH and working conditions. Farmers in different countries accepted the WIND training program because of its practical and easy-to-implement style. Collaborative efforts to further improve the WIND training program should continue learning from the self-help efforts and achievements of farmers in different countries.

Conclusion

In conclusion, the experiences of the birth and growth of the WIND training program present how an action-oriented research project focusing on the real work and life study could contribute to practical improvements in OSH and working conditions by local farmers and workers. Learning from the real conditions of work and life of local

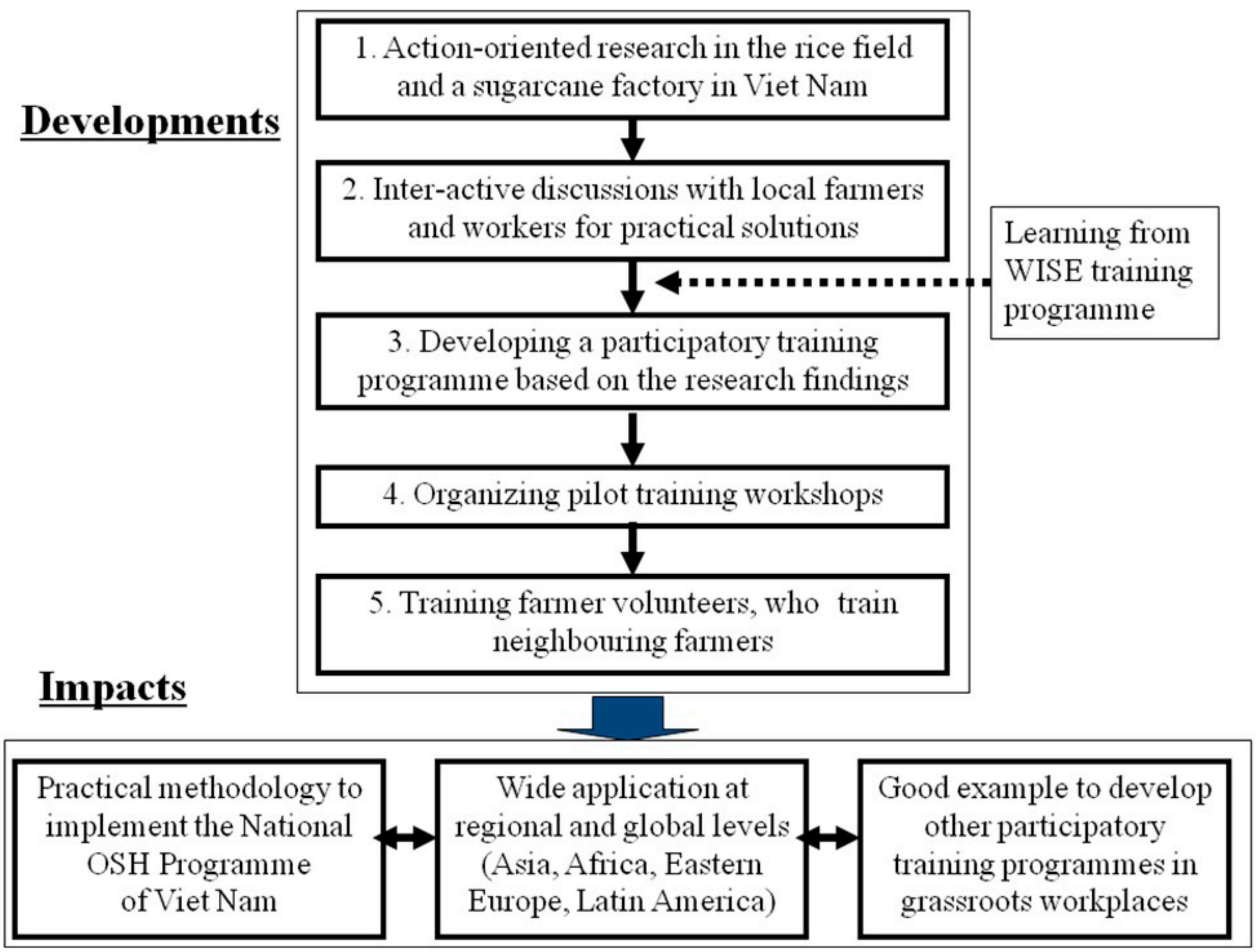


Figure 3. Developments of the WIND Training Program & Its Impacts

workplaces, respecting the self-help initiative of local people and devising practical and locally adjustable training tools and approaches were keys to the successful collaboration. ✪

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The Importance of Scientific Training for Authors of Occupational Safety Publications

Todd William Loushine

Abstract

As the safety profession continues to assess its current standing and plan for its future, the reliability of its body of work needs to be verified. Academics, researchers and other professionals with advanced degrees are trained to assess scientific inquiry and research methodology. Some popular publications do not review manuscripts with the same scientific rigor as research journal editorial boards.

This study contrasted the count and source of references as a proxy for reliability in articles published in Professional Safety (PS). *Author information, authorship rank, reference counts and "type of analysis" were collected from a total of 459 featured articles (from January 2001 through October 2011). Results from t-test, analysis of variance (ANOVA) and post-hoc analyses revealed that articles by author(s) (no matter if first, second or third) who work as academics/researchers or hold a doctorate degree cited a significantly ($p < .05$) greater number of total references and references from peer-reviewed research journals. In addition, those same articles tended to present some form of data analysis versus stories of experiences or author opinions. Based on these findings, attention should be given to coordinating research and publication efforts between practitioners and academics/researchers to validate and advance the safety field's body of knowledge.*

Keywords
bibliometrics, Professional Safety *journal, analysis of references, body of knowledge*

Introduction

The occupational safety and health (OSH) field draws much of its knowledge and skills from other more traditional professions and fields of study, such as medicine, engineering, management, psychology and sociology (Institute of Medicine, 2000). However, unlike medicine, law or engineering, safety practitioners are not required by state regulations to hold a degree or to earn a certification (pass an examination) to practice in the field of OSH. To further muddle the issue, the OSH practitioner is continually required to accept additional work responsibilities, such as environmental programming, quality management and sustainability. The haphazard historical progress of the OSH field is demonstrated by Petersen (2001) in his perspective of the classifications of "eras of safety management" that includes titles, such as inspection era, unsafe act and condition era, industrial hygiene era, safety management era, OSHA era, accountability era and the behavior-based era. Manuele (1997) identified eight requirements for the safety field to pursue for it to be considered a profession:

1) establish a well-defined theoretical and practical base;
2) develop a common language;
3) achieve recognition as a professional by clients whom are served;
4) promote and support research;
5) maintain rigid certification requirements (and promote their significance);
6) adhere to an accepted standard of conduct;
7) have a well-supported professional society and active member base;
8) obtain societal sanction for professionalism.

Without an introspective review of safety literature, it is difficult to ascertain the reliability of the basis of understanding, common professional language, recognition of the profession or accepted standards of conduct. Indeed, unlike other professional fields, OSH does not have occupational closure that requires a degree and/or licensure to be a practitioner (Ferguson & Ramsay, 2010). Efforts are currently underway to identify the OSH field's common language and body of knowledge (ASSE, 2004) and to maintain rigid certification and standards of conduct (Brauer, 2005). But these efforts do not appear to be receiving a balanced and transparent scrutiny to ensure scientific rigor or reliability of research results. Although NIOSH (2004) has an informational webpage and calls for proposals and publications for research to practice (r2p), it is not coordinated through practitioner channels, such as ASSE. Although efforts are underway to collect and advance the knowledge base for the OSH field, there is a definite need to review the reliability of published articles in popular sources of OSH information, such as *PS* journal.

The proposed study collected and analyzed the quantity and type of references cited in *PS* feature articles over the past 10 years. *PS* was selected as the sole source of articles for this study due to three important reasons.

1) *PS* is a shared forum for all types of safety and health professionals with a circulation of close to 34,000 members (ASSE).
2) The *PS* editorial board consists of only 8 members and a review process that is different from research journal editorial board review.
3) *PS* publications are easily accessible via university eLibrary databases.

OSH professionals from all areas and levels of expertise submit their work, speak their minds and share their experiences so that others in the profession may benefit. Featured article topics represent new or popular safety and health topics of the time period, based on the opinion of those who submit

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manuscripts for review and publication. The *PS* editorial board reviews and scores manuscripts on 9 criteria (rating on a scale of 0 to 4): appropriateness of topic, appropriate coverage of topic, current and accurate information, contributes to knowledge, applicable to *PS* readers, presents research or evidence-based information, well-written, illustrations enhance content and adequacy of references.

The expectation on the 8-member *PS* editorial board is enormous, considering the quantity of articles submitted for review (three featured articles per issue, 12 issues per year) and the tools provided to review the wide-range of topics covered in those manuscripts. Research journals, such as the *Journal of Safety Research* (Elsevier publisher, more than 60 members on editorial board, most holding doctoral degrees) or *Safety Science* (Elsevier publisher, more than 35 members on editorial board, most holding doctoral degrees), review submitted manuscripts via subject matter experts who are trained to assess scientific rigor and research methodology. Which begs the question, "How reliable are the conclusions and findings in *PS* articles?"

When evaluating the reliability of published work, it is important to consider the training and experience of the author(s) and their authorship rank (first, second, third, etc.). The OSH field has a limited supply of scientists who mostly work in academia, research centers or consulting firms. The training, study and performance required to achieve a doctoral degree can vary from institution, lead advisor and academic discipline, but it primarily focuses on mastering skills in scientific inquiry and research methodology. Whereas a master's degree student learns about basic research and how to consume and judge research, a doctoral candidate learns a systematic process that guides scientific inquiry in pursuit of better understanding.

Authorship rank is typically based on the level of contribution by each author. The first author is likely the original source for the paper topic or coordinated all work that contributed to the article. The second author likely contributed handsomely as well but not to the extent of the first author. Third and further authors could have contributed by data collection, review and editing or shared a smaller portion of the writing task. So although the first author is given the most credit for the article, all authors provide their expertise to the final published work.

For this study, the basis for data collection and analysis assume the quantity and type of cited references, and type of data analysis performed, as proxy measures for reliability of conclusions and findings expressed in an article. This is a novel study methodology and a simplified approach to research literature assessment studies of bibliometrics, scientometrics and the journal-based measure: impact factor. Bibliometrics is "(An) approach to research evaluation (that can be) as simple as counting. The complexity is in the analysis and use of the numbers, for the statistics obtained can be understood as indicators of achievement or lack thereofî" (Pendlebury, 2008). Scientometrics is basically the quantitative study of scientific, or scholarly, communication (Leydesdorff, 2005). The fields of bibliometrics and sceintometrics attempt to create a "web" of published work that represents the body of knowledge for a particular subject. Incidentally, this is precisely what the OSH field needs.

The most popular, and most debated, form of scholarly publication bibliometrics is the impact factor. The impact factor is an annual assessment representing a journal's division of the number of times a publication from the previous 2 years was cited in the current year divided by the total number of publications in those previous 2 years (Garfield, 1999). The debate over the validity of the impact factor revolves around journals published in specialized fields that tend to cite specifically within its own publications and that those journals are only circulated among that small group of authors

In regard to this study, the impact factor is not a consideration because *PS* does not have an impact factor. Therefore, a simplified method of bibliometrics was developed for this study, as an individualized comparison of the counts of cited references and type of analysis presented against occupation of author(s) (academic/research vs. nonacademic research) and degree of author(s) (doctoral degree vs. non-doctoral degree). These analyses were replicated based on authorship, first author vs. non-first but second or third author vs. no authors as either academic/researcher or doctoral degree. Additionally, the relationship between quantity and type of referenced material and type of analysis presented in the article is evaluated.

The proposed research questions for this study are:

1. Do first authors working as researchers and academics (professor or doctoral candidate) cite more total, research journal, *PS* and online references?

2. Is there a difference in the quantity and type of referenced material in articles published by three authorship groups: first author researchers/academics, non-first but second and/or third author researchers/academics and no authors as researcher/academics?

3. Do first authors with doctoral degrees (Ph.D., Ed.D., Sc.D., M.D.) cite more total, research journal, *PS* and online references?

4. Is there a difference in the quantity and type of referenced material in articles published by three authorship groups: first authors with doctoral degrees, non-first but second and/or third authors with doctoral degrees and no authors with doctoral degrees?

5. Is there a difference in the quantity and type of references depending on whether the article published new data analysis, old data analysis or no data analysis?

Methods

In this study, author, authorship rank, reference information and type of analysis data were collected from every feature article published in *PS* over the past 10 years. A spreadsheet was created in Microsoft Excel to store the data collected from each featured article published in *PS* from January 2001 (vol. 46, issue 1) through October 2011 (vol. 56, issue 10). The spreadsheet column headings included:

1) year, volume, issue, pages, article title and subject term (assigned by *PS*);

2) first author name, job title, highest degree and certifications;

3) (if applicable) second and third author name, job title, highest degree and certifications;

4) assessment of whether the article presented new data analysis, old/referenced data analysis or no data analyzed or results presented;

5) total count of references, count of peer-reviewed research journal references, count of *PS* journal references and count of online source references.

Electronic versions of *PS* journal were available through ProQuest ABI Inform Complete. Printed versions of the publication were used when available (individual subscription). For each issue of *PS* reviewed, the table of contents was assessed to collect feature article pages, title and first author name. Each individual feature article was then retrieved and the remaining data points were identified and collected.

In all, 459 featured articles were included in the data collection. Three volunteer undergraduate research assistants were trained by the author to assist with data collection and coding of the type of analysis reported in the article. For type of analysis coding, each article was reviewed for the presence of data and then assessed whether the data was new/unique to the article or collected/analyzed from a different source. If the data and analysis presented were obviously borrowed from another source, it was coded as "old data analyzed." If no data or analysis was presented, it was coded as "no data analyzed."

After all entries were verified using a spell-check tool and misspelled entries reviewed for accuracy, all data entries for author title, degree and certifications were numerically coded (dummy variable) to prepare for analysis. Five separate analyses were conducted using IBM® SPSS® Statistics Version 19 (Release 19.0.0.1), which required 5 customized datasets created to test the five objectives stated earlier.

The first research question, "Do first authors working as researchers and academics (professor or doctoral candidate) cite more total, research journal, *PS* and online references?" was tested using a *t*-test statistic. The dataset was sorted and coded into two groups: any author with job title "professor," "doctoral student" or "researcher" and no author with a job title containing those terms.

The second research question, "Is there a difference in the quantity and type of referenced material in articles published by three authorship groups: first author researchers/academics, non-first but second and/or third author researchers/academics and no authors as researcher/academics?" was tested using ANOVA and Dunnett T3 Post Hoc test. The dataset was sorted and coded into three groups: first author with academic/researcher job title, second and/or third authors with academic/researcher job titles and no author with a job title containing academic/researcher.

The third research question, "Do first authors with doctoral degrees (Ph.D., Ed.D., Sc.D., M.D.) cite more total, research journal, PS and online references?" was tested using a *t*-test statistic. The dataset was sorted and coded into two groups: any author with a doctoral degree (Ph.D., Sc.D., Ed.D., M.D.) and no author with a doctoral degree.

The fourth research question, "Is there a difference in the quantity and type of referenced material in articles published by three authorship groups: first authors with doctoral degrees, non-first but second and/or third authors with doctoral degrees and no authors with doctoral degrees?" was tested using ANOVA and Dunnett T3 Post Hoc test. The dataset was sorted and coded into three groups: first author with a doctoral degree, second and/or third authors with a doctoral degree and no author with a doctoral degree.

The fifth research question, "Is there a difference in the quantity and type of references depending on whether the article published new data analysis, old data analysis or no data analysis?" was tested using ANOVA and Dunnett T3 Post Hoc test. The dataset was sorted and coded into three groups: article presented new data analysis, article presented old data analysis (previously published or data from the U.S. Bureau of Labor Statistics, etc.), or article with no data analysis (e.g., case study, personal experience, expert opinion, etc.).

The *t*-test statistic (two-group analyses) was used to determine if the variance between the average count of references showed a statistical difference between type of authors based on job title or degree. The ANOVA statistic (three-group analyses) was used to determine whether group means showed a statistical difference, and the Dunnett T3 Post Hoc test was used to show which differences (between groups) were statistically significant. The Dunnett T3 test was selected because equal variances were not assumed and its corrective efforts to compensate for increased potential Type I error (Keppel, 1991).

Results

The aggregate statistics for the entire data set are shown in Table 1 (p. 22). Through 459 articles reviewed, more than 8,500 cited references were counted giving an average number of references per article at more than 18. Overall, 26% of the total references cited peer-reviewed research journals, 5% cited *PS* articles and 13% cited online resources. The remaining references (55.4%) cited other forms of literature, such as books, periodicals and other nonjournal or online sources. Each article was coded for the type of analysis performed, yielding 24% of articles as having analyzed new data, 25% analyzed old data and 51% provided no data analysis in the article (expert opinion or story of experience). Total count by type of reference and count of type of analysis were the dependent variables in the statistical analyses for this study.

Question 1: Do first authors working as researchers and academics (professor or doctoral candidate) cite more total, research journal, professional safety and online references? Tables 2 and 3 (p. 22) display the counts, averages and standard deviations for each group. A total of six cases was removed due to no author job title provided. Results from the independent samples *t*-test, comparing A/R (any author, n = 155) to non-A/R (n = 298), are displayed in Table 4 (p. 22). Significant differences exist between groups for total references ($p < .05$), research journal references ($p < .05$) and type of analysis in the article ($p < .05$).

Question 2: Is there a difference in the quantity and type of referenced material in articles published by three authorship groups: first author researchers/academics, non-first but second and/or third author researchers/academics and no authors as researcher/academics? Tables 2 and 3 display the counts, averages and standard deviations for each group. A total of 6 cases was removed due to no author job title provided. Results of ANOVA with Dunnett T3 Post-Hoc Test are displayed in Table 5). No significant differences exist between first author group and second/third author groups. Significant differences exist between first author group and nonacademic/researcher author group for total references ($p < .05$), research journal references ($p < .05$) and type of analysis in the article ($p < .05$). Significant differences exist between second/third author group and nonacademic/researcher author group for research journal references ($p < .05$) and type of analysis in the article ($p < .05$).

Question 3: Do first authors with doctoral degrees (Ph.D., Ed.D., Sc.D., M.D.) cite more total, research journal, PS and online references? Tables 6 and 7 (p. 24) display the counts, averages and standard deviations for each group. A total of 64 cases was removed due to no author degree provided. Results from the independent samples t-test, comparing doctoral degree (any author, n = 219) to non-doctoral degree (n = 176), are displayed in Table 8 (p. 24). Significant differences exist between groups for total references ($p < .05$), research journal references ($p < .05$) and type of analysis in article ($p < .05$).

Question 4: Is there a difference in the quantity and type of referenced material in articles published by three authorship groups: first authors with doctoral degrees, non-first but second and/or third authors with doctoral degrees and no authors with doctoral degrees? Tables 6 and 7 display the counts, averages and standard deviations for each group. A total of 64 cases was removed due to no author degree provided. Results of the one-way analysis of variance (ANOVA) with Dunnett T3 Post-Hoc Test are displayed in Table 9 (p. 25). A significant difference exists between first author and second/third author groups for type of analysis in article ($p < .05$). Significant differences exist between first author group and nondoctoral author group for total references ($p < .05$), research journal references ($p < .05$) and type of analysis in article ($p < .05$). Significant differ-

Measure	Total Ref	RJ Ref	PS Ref	Online Ref	Other Ref	New Analysis	Old Analysis	No Analysis
Count	8522	2251	444	1105	4722	110	114	235
Average	18.6	4.9	1.0	2.4	10.3			
Standard Deviation	13.4	7.6	1.8	3.6	8.4			

Table 1. Dataset Descriptive Statistics (N = 459)

Group	Count (Percent)	Avg Total Ref (S.D.)	Avg RJ Ref (S.D.)	Avg PS Ref (S.D.)	Avg Online Ref (S.D.)
1st Author Academic/Researcher	121 (26.4%)	22.1 (12.7)	8.2 (8.8)	1.1 (1.7)	2.3 (3.3)
Non-1st, 2nd Author Academic/Researcher	29 (6.3%)	21.2 (11.80)	7.7 (8.0)	1.1 (2.1)	2.7 (3.4)
Non-1st/2nd, 3rd Author Academic/Researcher	5 (1.1%)	18.4 (17.8)	3.8 (3.0)	0.4 (0.5)	1.0 (0.7)
No Authors are Academic/Researcher	298 (64.9%)	16.7 (13.2)	3.2 (6.4)	0.9 (1.8)	2.4 (3.8)
Author Job Title Unknown	6 (1.3%)	25.7 (22.0)	8.7 (14.0)	0.7 (1.2)	4.2 (2.6)

Table 2. Reference Statistics: Dataset Breakdown by Author Job Title

Group	Group Count	Count of New Data Analysis	Count of Old Data Analysis	Count of No Data Analysis
1st Author Academic/Researcher	121	43 (35.5%)	33 (27.3%)	45 (37.2%)
Non-1st, 2nd Author Academic/Researcher	29	15 (51.7%)	7 (24.1%)	7 (24.1%)
***Non-1st/2nd, 3rd Author Academic/Researcher**	5	4 (80.0%)	1 (20.0%)	0 (0.0%)
No Authors are Academic/Researcher	298	46 (15.4%)	72 (24.2%)	180 (60.4%)
Author Job Title Unknown	6	2 (33.3%)	1 (16.7%)	3 (50.0%)

Table 3. Type of Articles: Dataset Breakdown by Author Job Title
**Non-1st, 2nd author and non-1st, 3rd author groups were combined due to low numbers.*

Dep. Var.	Group	N	Mean	Std Dev.	Equality of Variance?	t-value	df	Sig. (2-tailed)
TotalRef	A/R	155	21.8065	12.65378	No	3.987	323.5	.000
	Non-A/R	298	16.7383	13.18268				
RJRef	A/R	155	7.9935	8.49484	Yes	6.713	451	.000
	Non-A/R	298	3.2215	6.38901				
PSRef	A/R	155	1.0903	1.78146	No	1.025	312.4	.306
	Non-A/R	298	.9094	1.78334				
OLRef	A/R	155	2.3290	3.23959	No	-.245	360.8	.807
	Non-A/R	298	2.4128	3.83420				
Type	A/R	155	1.9355	.85795	Yes	-6.600	451	.000
	Non-A/R	298	2.4497	.74704				

Table 4. Results of t-Test Analysis: Comparing Author Job Title Groups

Dep. Var.	F	Sig.	(I) Group	(J) Group	Mean Difference	Std. Error	Sig.
TotalRef	7.863	.000	1st-A/R	2nd/3rd-A/R	1.29679	2.44159	.933
				Non-A/R	5.35265*	1.38602	.000
			2nd/3rd-A/R	1st-A/R	-1.29679	2.44159	.933
				Non-A/R	4.05586	2.28181	.225
			Non-A/R	1st-A/R	-5.35265*	1.38602	.000
				2nd/3rd-A/R	-4.05586	2.28181	.225
RJRef	22.817	.000	1st-A/R	2nd/3rd-A/R	1.08435	1.51863	.855
				Non-A/R	5.00993*	.87805	.000
			2nd/3rd-A/R	1st-A/R	-1.08435	1.51863	.855
				Non-A/R	3.92558*	1.34508	.017
			Non-A/R	1st-A/R	-5.00993*	.87805	.000
				2nd/3rd-A/R	-3.92558*	1.34508	.017
PSRef	.549	.578	1st-A/R	2nd/3rd-A/R	.07803	.36712	.995
				Non-A/R	.19804	.18934	.651
			2nd/3rd-A/R	1st-A/R	-.07803	.36712	.995
				Non-A/R	.12002	.34680	.980
			Non-A/R	1st-A/R	-.19804	.18934	.651
				2nd/3rd-A/R	-.12002	.34680	.980
OLRef	.060	.942	1st-A/R	2nd/3rd-A/R	-.18133	.62154	.988
				Non-A/R	-.12350	.37087	.982
			2nd/3rd-A/R	1st-A/R	.18133	.62154	.988
				Non-A/R	.05784	.58944	1.000
			Non-A/R	1st-A/R	.12350	.37087	.982
				2nd/3rd-A/R	-.05784	.58944	1.000
Type	24.977	.000	1st-A/R	2nd/3rd-A/R	.36947	.15955	.071
				Non-A/R	-.43314*	.08906	.000
			2nd/3rd-A/R	1st-A/R	-.36947	.15955	.071
				Non-A/R	-.80261*	.14585	.000
			Non-A/R	1st-A/R	.43314*	.08906	.000
				2nd/3rd-A/R	.80261*	.14585	.000

Table 5. Results of ANOVA & Post Hoc Test: Comparing Author Job Title Groups

Group	Count (Percent)	Avg Total Ref (S.D.)	Avg RJ Ref (S.D.)	Avg PS Ref (S.D.)	Avg Online Ref (S.D.)
1st Author Doctorate degree	176 (38.3%)	22.1 (15.0)	7.3 (9.5)	1.3 (2.0)	2.1 (3.4)
Non-1st, 2nd Author Doctorate degree	33 (7.2%)	21.5 (11.5)	8.0 (8.2)	0.9 (2.0)	2.2 (3.6)
***Non-1st/2nd, 3rd Author Doctorate Degree**	10 (2.2%)	20.4 (7.8)	7.5 (5.2)	0.3 (1.0)	3.4 (4.0)
No Authors Have Doctorate Degree	176 (38.3%)	16.4 (11.9)	2.9 (4.7)	0.8 (1.7)	2.8 (4.0)
Author Degree is Unknown	64 (13.9%)	13.1 (10.9)	1.8 (5.5)	0.5 (1.2)	2.1 (3.1)

Table 6. Reference Statistics: Dataset Breakdown by Author Degree

**Non-1st, 2nd author and non-1st, 3rd author groups were combined due to low numbers.*

ences exist between second/third author group and nondoctoral author group for total references ($p < .05$), research journal references ($p < .05$) and type of analysis in article ($p < .05$).

Question 5: Is there a difference in the quantity and type of references depending on whether the article published new data analysis, old data analysis or no data analysis? Table 10 (p. 25) displays the counts, averages and standard deviations for each group. No cases were removed from this analysis (N = 459). Results of ANOVA with Dunnett T3 Post-Hoc Test are displayed in Table 11 (p. 26). Significant differences exist between new data analysis and old data analysis groups for total references ($p < .05$) and online references ($p < .05$). Significant differences exist between new data analysis and no data analysis groups for research journal references ($p < .05$) and online references ($p < .05$). Significant differences exist between old data analysis and no data analysis groups for total references ($p < .05$) and research journal references ($p < .05$).

Considering the two criteria used to sort the data set into groups for analysis (i.e., author job title and author degree), the total number of articles published by one or more academic/researcher with a doctoral degree is 123 (out of 155 academic/researcher data-sort and out of 219 doctoral data-sort). In other words, an estimated core group of 56% to 79% of authors were represented in both the doctoral group and the academic researcher group because of their dual affiliations. There are statistically significant differences in groups sorted by both job title and degree in the total number of references, number of research journal references and articles that analyzed some form of data.

The most significant finding is that any authors (be it first, second and/or third) who are trained in scientific inquiry or research methodology and/or perform research-related activities as part of their occupation are more likely to reference (peer-reviewed) research journals in their work, cite more total references in their work and tend to publish work involving some form of data analysis (vs. expert opinion or case study experiences). In fact, the groups with greatest percentage of articles that presented new data analysis had a nonacademic/researcher and no-doctoral degree as first author and academic/research and/or doctoral degree second and third authors. To further support these findings, articles with some form of data analysis cited a significantly greater number of research journal references.

Discussion

The study's goal was to contrast author job title and degree against the quantity and type of cited references and type of analysis presented in featured articles published in *PS* journal. The results showed that articles submitted by authors working as academics or researchers cited a statistically significant ($p < .05$, Tables 4 and 5) greater number of total reference, references from research journals and work that contained data analysis than nonacademic or researcher authors. These results were replicated for analyses comparing authors holding doctoral degrees against authors who did not (Tables 8 and 9). An interesting discovery came from the analysis of authorship rank when a nonacademic/researcher/doctoral degree first author but second and/or third academic/researcher/doctoral degree author(s) also cited a statistically significant ($p < .05$), most notable in Tables 2, 3, 6 and 7) greater number of total references, references from research journals and work that contained data analysis. In fact, this group demonstrated a statistically significant greater percentage of articles that presented new data analysis, which indicates some form of scientific

Group	Group Count	New Analysis (Percent-Group)	Old Analysis (Percent-Group)	No Analysis (Percent-Group)
1st Author Doctorate Degree	176	53 (30.1%)	48 (27.3%)	75 (42.6%)
Non-1st, 2nd Author Doctorate Degree	33	21 (63.6%)	7 (21.2%)	5 (15.2%)
***Non-1st/2nd, 3rd Author Doctorate Degree**	10	6 (60.0%)	3 (30.0%)	1 (10.0%)
No Authors Have Doctorate Degree	176	25 (14.2%)	40 (22.7%)	111 (63.1%)
Author Degree is Unknown	64	5 (7.8%)	16 (25.0%)	43 (67.2%)

Table 7. Type of Articles: Dataset Breakdown by Author Degree

**Non-1st, 2nd author and non-1st, 3rd author groups were combined due to low numbers.*

Dep. Var.	Group	N	Mean	Std Dev.	Equality of Variance?	t-value	df	Sig. (2-tailed)
TotalRef	Doc	219	21.9361	14.24637	Yes	4.153	393	.000
	Non-Doc	176	16.3693	11.86905				
RJRef	Doc	219	7.4064	9.12523	Yes	5.900	393	.000
	Non-Doc	176	2.9318	4.72270				
PSRef	Doc	219	1.1963	1.95893	No	1.908	391.271	.057
	Non-Doc	176	.8466	1.68159				
OLRef	Doc	219	2.1781	3.48789	No	-1.639	351.625	.102
	Non-Doc	176	2.8011	3.95838				
Type	Doc	219	2.0046	.85937	Yes	-5.937	393	.000
	Non-Doc	176	2.4886	.73281				

Table 8. Results of *t*-Test Analysis: Comparing Author Degree Groups

inquiry and represents a greater degree of reliability in research findings. And finally, articles that demonstrated some form of data analysis (old or new data) had a statistically significant ($p < .05$, Tables 10 and 11) greater number of cited research journal references. This result supports the association between scientific inquiry (via data analysis) and reliability (via cited research journal references).

Although nonacademics/researchers may have less access to research journals, Internet sources, such as Google Scholar, are providing better accessibility to research literature. The real issue is the understanding or realization of the need for scientific rigor and reliability of conclusions in OSH publications. These study results show the potential for cooperative work between practitioners and academics, researchers and people trained in scientific inquiry (doctoral degree holders). It also shows the value that advanced degree training toward reliability and scientific rigor in publications such as in *PS*. In the pursuit of a reliable body of knowledge for the safety profession, the goal is to bridge the gap between practical experience and research, and this journal begins with discussion and education.

If the safety field is serious about creating a reliable body of knowledge, or eventually requiring by law a minimum degree and certification for practice, it needs to set a new standard of scientific rigor for its literature. A first step could be actively involving academics/researchers and practitioners with advanced degree training and/or facilitating opportunities for cooperation between them and practitioners. This is not meant to imply that work published by nonacademics or authors without advanced degree training is not important or lacks validity. Rather, that articles published by the safety profession need a bridge by which practitioners share their work or cooperate with individuals trained for scientific inquiry in order to provide more validity or criticality to the work. Partnering safety scientists with safety practitioners provides opportunities for both inductive and deductive scientific inquiry (Trochim, 2001). An example of inductive inquiry could be studying how a practitioner's observations/experiences create concepts and theories. Whereas an example of deductive inquiry could be a case or experimental study in which a practitioner tests concepts and theories at their workplace).

The benefits of teaming academics/researchers with practitioners are potentially three-fold:

1. Educate practitioners on scientific methodology and encourage an appreciation for scientific rigor in work and reporting results.
2. Provide scientists with ample opportunities to conduct real-world studies and to develop research agendas around concerns expressed by practitioners.
3. Improve the scientific rigor of published articles and the generalizability of results, concepts and applications.

The results of this study provide evidence of a need for further investigation, discussion and changes in the way submitted works are evaluated for publication. Some issues that could be addressed to improve the overall scientific reliability of *PS* featured articles would be to adopt some of the practices of research journals, such as the *Journal of Safety Research* (Elsevier publisher, more than 60 members on editorial board) or *Safety Science* (Elsevier publisher, more than 35 members on editorial board). A more realistic approach would use groups of subject-matter experts, with balanced representation, to assess research methods and adequacy of references to improve the scientific rigor of featured articles. Additionally, changes to *PS* could begin by promoting and bridging content to the *Journal of Safety, Health and Environmental Research (JSHER)*.

Some limitations to this study arise from assessing only a subset of cited references and that the quality of an article cannot be assessed solely by cited references and type of analysis presented in the article. The type of references analyzed only represented 49% of the total references cited in the sample. These "other" references were books, reports, conference

Dep. Var.	F	Sig.	(I) Group	(J) Group	Mean Difference	Std. Error	Sig.
TotalRef	8.676	.000	1st-Doc	2nd/3rd-Doc	.84646	1.97833	.963
				Non-Doc	5.73295*	1.44284	.000
			2nd/3rd-Doc	1st-Doc	-.84646	1.97833	.963
				Non-Doc	4.88650*	1.85280	.030
			Non-Doc	1st-Doc	-5.73295*	1.44284	.000
				2nd/3rd-Doc	-4.88650*	1.85280	.030
RJRef	17.468	.000	1st-Doc	2nd/3rd-Doc	-.56501	1.35515	.966
				Non-Doc	4.36364*	.79878	.000
			2nd/3rd-Doc	1st-Doc	.56501	1.35515	.966
				Non-Doc	4.92865*	1.20493	.000
			Non-Doc	1st-Doc	-4.36364*	.79878	.000
				2nd/3rd-Doc	-4.92865*	1.20493	.000
PSRef	3.074	.047	1st-Doc	2nd/3rd-Doc	.50476	.31691	.306
				Non-Doc	.44886	.19586	.066
			2nd/3rd-Doc	1st-Doc	-.50476	.31691	.306
				Non-Doc	-.05589	.30693	.997
			Non-Doc	1st-Doc	-.44886	.19586	.066
				2nd/3rd-Doc	.05589	.30693	.997
OLRef	1.594	.204	1st-Doc	2nd/3rd-Doc	-.41504	.62256	.878
				Non-Doc	-.70455	.39516	.209
			2nd/3rd-Doc	1st-Doc	.41504	.62256	.878
				Non-Doc	-.28951	.63991	.957
			Non-Doc	1st-Doc	.70455	.39516	.209
				2nd/3rd-Doc	.28951	.63991	.957
Type	29.052	.000	1st-Doc	2nd/3rd-Doc	.61337*	.12907	.000
				Non-Doc	-.36364*	.08437	.000
			2nd/3rd-Doc	1st-Doc	-.61337*	.12907	.000
				Non-Doc	-.97701*	.12508	.000
			Non-Doc	1st-Doc	.36364*	.08437	.000
				2nd/3rd-Doc	.97701*	.12508	.000

Table 9. Results of ANOVA & Post Hoc Test: Comparing Author Degree Groups

proceedings, magazine articles and other forms of literature. A broader and better delineation of different forms of cited references would have made counting and coding easier. Without further study of the relationships shown in this study, it should not be assumed that more total references or research journal references always equate to better or more scientific papers. However, it demonstrates an attempt to provide reliable sources of information as a basis for a scientific methodology. A full review of article content would be desired to gain a better understanding of how these articles differ between the comparison groups. It would also be interesting to test the same research questions in another popular safety and health journal, such as National Safety Council's *Safety + Health*.

Conclusions

A comparison of the past 10 years of featured articles in *PS* presented an interesting trend, by which authors with academic/research positions or doctoral degrees cited more overall references, research journal references and produced articles that contained data analysis, regardless of authorship rank. Based on these results, it would seem prudent to identify opportunities for practitioners to work with academics and researchers with advanced degree training. The evidence also shows the value in advanced degree training, which should also be promoted within the occupational safety field. The goal should be to increase the number of applied research studies that either test common beliefs or build on previous knowledge. ASSE is a leader in the safety field and, therefore, facilitates discussions and promotes changes within its publications. *PS* journal's manuscript submission review process could be improved by reviewing practices in *JSHER, Journal of Safety Research* and *Safety Science,* or specifically by promoting *JSHER* in *PS* to its members. Improving the review process of *PS* and promoting cooperation of practitioners and scientists should improve the bibliometrics/scientometrics for the safety field as it continues to build a body of knowledge.

Scientific inquiry and the pursuit of best safety practices need to be based on rigorous study methodology and a foundation of critiqued and reliable literature so new

Table 10. Type of Article Analysis & Cited References

Group	Count (Percent)	Avg Total Ref (S.D.)	Avg RJ Ref (S.D.)	Avg PS Ref (S.D.)	Avg Online Ref (S.D.)
New Data Analyzed	110 (24.0%)	17.4 (11.3)	6.5 (7.9)	1.0 (1.7)	1.6 (2.2)
Old Data Analyzed	114 (24.8%)	21.8 (14.8)	6.2 (8.4)	0.9 (1.9)	2.6 (3.9)
No Data Analyzed	235 (51.2%)	17.5 (13.3)	3.5 (6.8)	1.0 (1.8)	2.7 (4.0)

Table 11. Results of ANOVA & Post Hoc Test: Comparing References to Type of Analysis

Dep. Var.	F	Sig.	(I) Group	(J) Group	Mean Difference	Std. Error	Sig.
TotalRef	4.589	.011	NewData	OldData	-4.39729*	1.75754	.039
				NoData	-.09188	1.38283	1.000
			OldData	NewData	4.39729*	1.75754	.039
				NoData	4.30541*	1.63628	.027
			NoData	NewData	.09188	1.38283	1.000
				OldData	-4.30541*	1.63628	.027
RJRef	7.852	.000	NewData	OldData	.18134	1.09252	.998
				NoData	2.86925*	.87750	.004
			OldData	NewData	-.18134	1.09252	.998
				NoData	2.68791*	.90491	.010
			NoData	NewData	-2.86925*	.87750	.004
				OldData	-2.68791*	.90491	.010
PSRef	.284	.753	NewData	OldData	.15853	.23720	.878
				NoData	.02244	.19831	.999
			OldData	NewData	-.15853	.23720	.878
				NoData	-.13610	.20949	.886
			NoData	NewData	-.02244	.19831	.999
				OldData	.13610	.20949	.886
OLRef	3.788	.023	NewData	OldData	-1.06730*	.42245	.037
				NoData	-1.09478*	.33137	.003
			OldData	NewData	1.06730*	.42245	.037
				NoData	-.02747	.44990	1.000
			NoData	NewData	1.09478*	.33137	.003
				OldData	.02747	.44990	1.000

perspectives or concepts contribute to the body of knowledge. If the OSH field does not demand scientific rigor and reliability, then published findings and conclusions (such as best practices) can be incorrectly applied, misconstrued or blindly accepted. The safety profession needs to admit that it does not know what is unknown and demand that verification and criticism of its body of knowledge. ✪

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Singapore Workplace Safety & Health Research Agenda: Research-to-Practice

Yiquan Chen, Ph.D., Sebastian Tan and Samuel Lim, Ph.D.

Abstract

The Singapore Workplace Safety and Health (WSH) Institute published the first national WSH research priorities agenda as part of its effort to raise the WSH standard in Singapore. This stakeholder-based approach used the modified Delphi method to distill the large amount of stakeholder opinions into a list of focused research priorities. It consisted of interviews, questionnaire and focus group discussions involving all industry sectors. The final list of research priorities were arranged into two broad themes: 1) organizational and business aspects of WSH and 2) WSH risks and solutions. To enhance the true value of research for the WSH landscape, the WSH Institute also put in place a research-to-practice (r2p) framework. This is to ensure that research outcomes will be translated into practical solutions for adoption by the industries. The three components of relevance, translation and effectiveness of the framework will be integrated into all research studies.

Keywords

Workplace/occupational safety and health; Singapore Workplace Safety and Health Institute; modified Delphi method; research priority-setting

Introduction

Safeguarding workers' health and safety is paramount for the Occupational Safety and Health Division of the Singapore Ministry of Manpower (MOM). Despite the efforts, a spate of serious workplace-related accidents in 2004 led to MOM leading a WSH reformation journey for Singapore. A new framework was implemented to cultivate good safety habits to engender a strong safety culture in workplaces. The three guiding principles that underpinned the new WSH framework were 1) reducing risks at source by requiring all stakeholders to eliminate or minimize the risks they create; 2) instilling greater ownership of safety and health outcomes by industry; and 3) preventing accidents through higher penalties for poor safety management. As part of the new WSH framework, the WSH Act was also reformulated to stipulate that every person must take reasonable practicable steps to ensure the safety and health of every worker.

In 2008, the WSH Council was established, comprising leaders from major industry sectors, government, unions and professional bodies. Working closely with MOM and other government agencies, the Council's main functions are to build industry capabilities to better manage WSH, promote WSH and set acceptable WSH practices. The WSH Council's capability and engagement work thus complements MOM's WSH enforcement efforts.

In 2009, MOM released the Singapore's WSH 2018 strategy with the goal of reducing workplace fatalities to 1.8 per 100,000 workers by 2018 (WSH Council, 2009). This would bring Singapore on par with some of the best safety records in the world. Thus, with the revitalized efforts in WSH, Singapore saw a drop in workplace fatalities between 2004 and 2010 from 4.9 to 2.2 per 100,000 workers.

To ensure that the WSH improvements made will be sustained, MOM and the WSH Council set up the WSH Institute in 2011. The WSH Institute functions as a think-tank, providing research-based evidence to support WSH policies and strategies as well as research-based solutions to address the industry's WSH issues. It also serves as a center for WSH intelligence and information, closely monitoring the WSH landscape to anticipate new and emerging WSH risks and to create WSH knowledge for dissemination. As a complement to the WSH Council's capability-building efforts, the WSH Institute also focuses on WSH leadership and professional development to transform mindsets and to influence practices of companies' leaders to go beyond the regulatory requirements.

With research playing a central role for the WSH Institute and the limited availability of funding, it was necessary for the Institute to prioritize its research needs. In addition, the priorities would serve as a focus for WSH research carried out by other research institutions in Singapore, which are often done on an ad-hoc basis.

The identification of national WSH research priorities has been undertaken by various countries, such as the U.K. (Harrington, 1994), Italy (Iavicoli, et al., 2001), Malaysia (Sadhra, et al., 2001), U.S. (Rosenstock, et al., 1998) and the Netherlands (Van der Beek, et al., 1997). The Delphi method and modifications thereof is one of the most commonly employed meth-

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odologies. The Delphi method is essentially a forecasting tool that relies on a group of selected experts and their responses. It enables group problem-solving through the use questionnaires in an iterative process of discussion, feedback and refinements without face-to-face meetings. The process is completed when consensus is achieved. In contrast, the modified Delphi method usually includes face-to-face meetings, such as interviews, focus group discussions or forums. However, it also aims to reach a consensus among experts with differing viewpoints.

The Singapore WSH research priority-setting process employed the modified Delphi method. This was also part of the WSH Institute's r2p framework to ensure the smooth transition from laboratory to workplace. The process began in November 2010 and culminated in the launch of the Singapore National WSH Research Agenda 2011-16 in August 2011. It involved numerous stakeholders and a consensus-building process to ensure maximum buy-in from the industry. Ultimately, the aim was for any finding borne out of the Institute's research to be translated into practicable solutions that may be adopted by the industry to improve their WSH standard.

Figure 1. Schematic Diagram of the WSH Research Priority-Setting Process

Research Areas	Research Categories
Business case for WSH	*correlation of WSH to profits and productivity; *case studies for selected companies with successful implementation of WSH programs; *WSH business practice.
WSH leadership	*characteristics of effective WSH leadership; *roles of leaders in instilling strong WSH culture in organizations/business; *strategies for building WSH leadership capabilities.
Risk management & hazard control measures	*risk management; *redesign of work processes/operations to factor in WSH considerations; *innovative products and new technology to manage WSH risks
WSH management systems	*effectiveness of WSH systems; *safety and health committees; *WSH auditing system; *design for safety; *leading indicators.
Industrial hygiene	*monitoring and control of exposure to hazards; *exposure limits of WSH conditions for local workforce.
Occupational medicine	*characterization of hazards whereby symptoms/disorders appear only after prolonged exposure; *specific occupational health conditions; *medical and hygiene surveillance of workplaces.
Behavioral & WSH culture issues	*underreporting behavior; *off-the-job behavior and workplace injuries; *communication of WSH to workforce and enterprise; *feasibility and tenability of WSH initiatives/measures.
Human factors & ergonomics	*work-related musculoskeletal disorders; *return to work; *adaptation of equipment/facilities for local workforce.
Emerging workplace safety & health risks	*psychosocial issues at workplaces; *green technology; *WSH considerations for the aging workforce.

Table 1. Preliminary List of WSH Priorities

Methods

The WSH priority-setting process may be broadly divided into three phases: generation of an internal preliminary priority list, seeking inputs from stakeholders and WSH experts and public comment and review of the draft national WSH research agenda. A schematic diagram is shown in Figure 1.

In the first phase, relevant departments of MOM were consulted, and a preliminary list of WSH concerns for research was generated. The preliminary list consisted of 15 research areas, which were further classified into 46 research categories.

In the second phase, the local institutes of higher learning (IHLs) and hospitals were engaged with two main objectives: 1) to understand the local WSH research capabilities; 2) to understand the local WSH research needs and gaps. They were also asked to comment on the preliminary WSH research list. With their inputs, the preliminary WSH research list was refined into nine research areas, subdivided into 29 research categories (Table 1).

The refined list was then structured into an online questionnaire and sent to 1,300 participants across the industries and positions. Participants were asked two questions:

1) To rate the importance of each research category, within each research area, for Singapore over the next 5 years. A 5-point rating scale was used, 1 indicating the lowest priority and 5 the highest. The rating average for each research area was then calculated as (Σscore)/(no. of respondents) (Table 2, p. 30).

2) To rank the top 5 research priorities for Singapore over the next 5 years from the list of 29 research categories. A weighted value ranging from 1 to 5 was given for each score. A rank of 1 was given a weighted value of 5 and a rank of 5 was given a weighted value of 1. The weighted ranking score was calculated as [(Σweighted value)/(maximum possible weighted value)] x 100.

Following the responses collected from the online questionnaire, nine separate focus group discussions were held for eight

Question 1: Please rate the importance of each research category for Singapore over the next 5 years.	Calculated rating average	Rating (1-5)
1a) WSH leadership:	[ ]	
Characteristics of effective WSH leadership		[ ]
Roles of leaders in instilling strong WSH culture in organizations		[ ]
Strategies for building WSH leadership capabilities		[ ]
1b) Business case for WSH:	[ ]	
Correlation of WSH to profits and productivity		[ ]
Case studies for selected companies with successful implementation of WSH programs		[ ]
WSH business practice		[ ]

Table 2. Excerpt of Question 1 From Online Questionnaire

industry sectors and 1 "priority areas" (i.e., working at height, working with crane and confined spaces) group. The eight sectors were chemical, construction and landscape, healthcare, academia and professional bodies, logistics and transport, marine, metalworking and manufacturing, and services. Around 20 participants were invited from each industry. Participants included senior management, industry (commerce and association) representatives, professional bodies, unions, IHLs and government agencies. The focus group discussions aimed to 1) solicit feedback on the top 10 research priorities identified in the online questionnaire; 2) identify specific research needs not captured in the top 10 research priorities; and 3) seek consensus for the top 10 research priorities for each sector.

In the drafting of the research agenda, the collective input was compiled and analyzed. To ensure a balanced research agenda that would address both short- and long-term WSH issues, the authors also took into consideration the current WSH landscape as well as emerging WSH risks that Singapore may face in the future. The final list of research categories compiled was then organized under broader research areas, which were further classified under two distinctive themes. The drafted agenda was then put up for public comment. After which, refinements were made and the official National WSH Research Agenda 2011-16 was released in August 2011.

Results

Online Questionnaire

The response rate for the online questionnaire was 27% (350 respondents). For question 1 on rating the importance of each research category, the top 10 research categories are given in Table 3 (p. 30), with risk management, roles of leaders in instilling strong WSH culture in organizations/businesses and effectiveness of WSH systems coming in the top three. From the calculated research area rating averages, the top three were WSH leadership, risk management and hazard control measures, and industrial hygiene. For question 2 on ranking the list of 29 research categories, the top 10 categories are given in Table 4 (p. 30).

Focus Group Discussion

The turnout rate was approximately 50%. The combined top 10 research categories from the nine focus discussion groups are given in Table 5 (p. 31). The top 3 categories were roles of leaders in instilling strong WSH culture, design for safety and correlation of WSH to profits and productivity.

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The final list of research priorities was broadly divided into 2 themes: 1) organizational and business aspects of WSH and 2) WSH risks and solutions. Each theme was divided into 3 priority areas. Under Theme 1 were 1) enhancing WSH leadership and culture; 2) linking WSH to business; and 3) measuring WSH performance. Under Theme 2 were 1) addressing imminent WSH concerns; 2) designing for safety and health; and 3) managing workplace health hazards. Within each area were subcategories. Table 6 (p. 31) shows the complete list of priorities in the Singapore national WSH research agenda.

Discussion

This study represents the very first time Singapore has endeavored to identify WSH research priorities at the national level. The modified Delphi method used to set the WSH priorities has also been employed by other countries, for instance, Australia, the Netherlands and the U.S. Unlike the Delphi method, which starts with a broad question, the modified Delphi usually begins with a more focused scope. For Singapore and the U.S., a preliminary list was generated by the working group; for Australia, a forum was held whereby eight academics presented their WSH research findings for discussion; for the Netherlands, the process started with five themes—work stress, musculoskeletal disorders, biological, chemical and physical hazards, occupational rehabilitation/sociomedical guidance and occupational healthcare/occupational health services. The different countries then had different approaches to achieve consensus. Australia continued its forum with small group discussions and a scoring exercise; the U.S. proceeded with town meetings and liaison committees to seek input from the public, and the Netherlands had interviews, questionnaires and a conference to prioritize and formulate concrete research questions.

In this study, the findings were principally obtained from interviews, questionnaires and focus group discussions from a multidisciplinary group of experts comprising academics, government regulatory bodies, senior management and WSH officers. Heterogeneity in the group of experts was important as the panel of experts formed a crucial part of the Delphi method. Thus, it is noteworthy to state here that participants for the Delphi method should be chosen with care as the outcome relies heavily on participants' responses. In the online questionnaire, a weighted score was assigned to the question on ranking to achieve a fast convergence of results and to eliminate the need for multiple rounds of questionnaires. In the focus group discussions, although the participation rate was below expectation, all except for the services and IHLs groups had the appropriate representatives from senior management and WSH personnel.

The services and education sectors were among the final sectors to be covered under the revamped WSH Act. Coverage under the WSH Act was rolled out in three phases. The first started in March 2006 and targeted high-risk sectors, such as construction and marine. The second phase was in March 2008, and the coverage expanded to include the food and beverage and healthcare services sectors. The final phase was in September 2011 and marked the full coverage of all workplaces under the WSH Act. As such, it could explain the lower interest level by the services and education sectors. For the services sector, WSH awareness level was also not on par with the other sectors, and common issues, such as slips, trips and falls, were not highlighted.

Comparing responses from the questionnaires and focus group discussions, WSH leadership and risk management consistently appeared among the top five priorities. It was interesting to note that the majority was still more concerned with safety rather than health issues. This is perhaps not too surprising as WSH in Singapore is still relatively new. Although the effects of poor safety and health management may both lead to debilitating, if not fatal outcomes, the former can be more immediate and apparent, for instance, a fall from height or a mechanical injury leading to permanent disablement. Most were also unable to anticipate possible new or emerging risks that may occur as a result of technological advances and the transformation of work processes.

WSH Category	Average Rating
Risk management	4.27
Roles of leaders in instilling strong WSH culture	4.24
Effectiveness of WSH systems	4.06
Building WSH leadership capabilities	4.05
Monitoring and control of hazards	4.02
Communication of WSH to workforce/enterprise	4.02
Design for safety	4.01
Redesign of work processes/operations	3.99
Under-reporting behavior	3.99
Characteristics of effective WSH leadership	3.98

Table 3. Top 10 WSH Research Categories Rated in the Online Questionnaire

WSH Category	Weighted Score
Roles of leaders in instilling strong WSH culture	47.1
Risk management	43.6
Characteristics of effective WSH leadership	32
Building WSH leadership capabilities	22
Effectiveness of WSH systems	21.7
Correlation of WSH to profits and productivity	20.6
Design for safety	14.3
Redesign of work processes/operations	14.3
Monitoring and control of hazards	12.1
Communication of WSH to workforce/enterprise	10.7

Table 4. Top 10 WSH Research Categories Ranked in the Online Questionnaire

Compared to other countries, the identification of WSH leadership as one of the top priorities is rather unique, New Zealand being the only other country that has growing safety leadership under its WSH agenda (New Zealand Department of Labor, 2011). Similar to the New Zealand view, WSH leadership is seen as having the commitment and dedication to ensure health and safety as part of the business and at every level of the workplace. The motivation should be the protection of a worker's fundamental right rather than compliance with the law.

In the Singapore context, the issue of WSH leadership embodies the study and development of suitable models for effective WSH leadership and examines how effective WSH leaders can enhance WSH. It also includes developing and verifying appropriate strategies to strengthen underperformed WSH leadership and to explore useful ways of measuring such effectiveness. WSH leadership ties in closely with other WSH issues, such as instilling strong WSH culture and building up WSH leadership capabilities to help small and medium enterprises. It is believed that strong WSH leaders will help change the mindset of their employees and will move them toward taking on WSH as a personal responsibility.

Comparisons may also be made with priorities identified in developed countries with established WSH, such as the U.K. (Rosenstock, et al., 1998) and Finland (Finnish Institute of Occupational Health, 2010). As mentioned previously, Singapore's stakeholders were more concerned with safety issues. Even with health issues, the concern was more on specific occupational diseases. In the U.K. and Finland, WSH issues have moved into the psychosocial realm, for instance, mental stress and workplace aggression. This may be attributed to countries being at different stages of WSH maturity, and Singapore may still be in its infancy in the area of occupational health.

WSH Category	Weighted Score
Roles of leaders in instilling strong WSH culture	71.1
Design for safety	56.7
Correlation of WSH to profits and productivity	55.6
Risk management	54.4
Characteristics of effective WSH leadership	51.1
Strategies for building WSH leadership capabilities	47.8
Redesign of work processes/operations	41.1
Communication of WSH to workforce and enterprise	31.1
Effectiveness of WSH systems	20.0
Specific occupational health conditions	17.8

Table 5. Final Top 10 WSH Research Categories From Focus Group Discussions

In the final decision stage to determine the list of priorities to include in the research agenda, factors, such as current global WSH concerns and issues faced locally, were also taken into consideration. Issues, such as workplace health and emerging risks, which were largely absent from the questionnaire responses and focus group discussions, were added. The final list of WSH research priorities thus included leadership, business, safety and health issues and reflected an attempt to consider both current and emerging, as well as short- and long-term, needs. The categorization of the priorities into two broad themes—1) business and organizational aspects of WSH and 2) WSH risks and solutions—encompassed a

Research Theme	Research Area	Research category
Business & organizational aspects of WSH	Enhancing WSH leadership and culture	*characteristics of effective WSH leadership; *roles of leaders in instilling strong WSH culture; *strategies for building WSH leadership capabilities; *communication of WSH to workforce and enterprise.
	Linking WSH to business	*correlation of WSH to business and productivity; *studies on companies with successful WSH programs.
	Measuring WSH performance	*WSH performance and statistics; *leading indicators; *near-miss and minor injury reporting.
WSH risks & solutions	Addressing imminent WSH concerns	*psychosocial issues at workplaces; *new technologies; *WSH concerns for aging workforce.
	Designing for safety and health	*designing for safety; *redesigning of work processes/operations for WSH; *innovative products/technologies to manage WSH risks; *human factors and ergonomics; *effectiveness of risk assessment, audit and WSH systems.
	Managing workplace health hazards	*monitoring and control of exposure to health hazards; *specific occupational health conditions; *workplace health audit system; *WSH considerations for the aging workforce.

Table 6. List of WSH Research Priorities in the National WSH Research Agenda 2011-16

combination of top-down and bottom-up approaches to tackle WSH research needs. It was envisioned that this two-pronged approach would be a more effective and efficient way to help the industry. This broad-based research agenda thus serves as a guide for both public and private research institutions.

Understanding the need to translate research findings to practical solutions, the development of the stakeholders-based research agenda was also the first step in the WSH Institute's r2p framework. The WSH Institute's r2p framework took reference from NIOSH's r2p initiative (Stout & Hull, 2007). NIOSH's r2p initiative involves the WSH community, including researchers and industry stakeholders, working together to prioritize WSH research, translate research findings into prevention practices and procedures, disseminate the knowledge and evaluate the results to determine the impact on WSH. Similarly, given the in-depth knowledge and experience of the industry on the environment and processes at the workplace, the WSH Institute's r2p framework will see the institute working closely with industry stakeholders, from the identification prioritization of the WSH issues to the translation and adaptation of research findings to relevant solutions to the communication and dissemination of knowledge.

A successful r2p depends on three elements: translation, relevance and effectiveness. Hence, every project undertaken by the Institute would have an industry partner to provide input as well as act as a test bed for new solutions. Together, this would ensure that research outcomes will be translated into feasible and applicable solutions that effectively address WSH problems.

Conclusions

Overall, the information gathered from the stakeholders through the modified Delphi method demonstrated that good WSH leadership was of high importance, a priority that was also found in the New Zealand WSH agenda. However, stakeholders were more concerned with safety issues, and health issues and emerging WSH risks were largely absent. This was a noted difference compared to countries with advanced WSH standards, such as the U.K., U.S. and Finland, whereby psychosocial issues are already tackled as part of workplace health research. As Singapore progresses and the WSH landscape changes, review of WSH priorities would occur periodically to ensure relevance and continuous WSH improvement. ✪

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