



**UNIVERSITI PUTRA MALAYSIA**

**EFFECTIVENESS OF INTEGRATED ERGONOMICS INTERVENTION  
APPROACH IN REDUCING MUSCULOSKELETAL DISORDERS AMONG  
OIL PALM HARVESTERS IN JOHOR BAHRU, MALAYSIA**

**NG YEE GUAN**

**FPSK(p) 2015 1**



**EFFECTIVENESS OF INTEGRATED ERGONOMICS INTERVENTION  
APPROACH IN REDUCING MUSCULOSKELETAL DISORDERS AMONG  
OIL PALM HARVESTERS IN JOHOR BAHRU, MALAYSIA**

By

**NG YEE GUAN**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,  
in Fulfilment of the Requirements for the Degree of Doctor of Philosophy**

**November, 2014**

All material contained within the thesis, including without limitation text, logos, icons, photographs and all other artwork, is copyright material of Universiti Putra Malaysia unless otherwise stated. Use may be made of any material contained within the thesis for non-commercial purposes from the copyright holder. Commercial use of material may only be made with the express, prior, written permission of Universiti Putra Malaysia.

Copyright © Universiti Putra Malaysia



© COPYRIGHT UPM

## DEDICATION

Thank Allah s.w.t., the Almighty, the All-knowing who has given me the time, blessing, assistance, guidance and tenacity to finish this dissertation. I would like to dedicate this work to my family and many friends. A special feeling of gratitude to my loving parents, whose words of encouragement and unwavering supports who have never left my side and are very special.

I also dedicate this dissertation to my friends and colleagues who have supported me throughout the process. I will always appreciate all they have done, especially my supervisors for guiding me, developing my skills, all those who spent many hours of assisting me in facing hardship and difficulties. Those who were around me to remind me, helping and easing the burden.

Also special thanks to the organizations involved in this research, those who's acquainted with me in the course of this dissertation work, thank you all for permissions, the kind company, assistance and help, no matter how big or small you have all provided and granted.

May Allah s.w.t. bless us all.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment  
of the requirement for the degree of Doctor of Philosophy

**EFFECTIVENESS OF INTEGRATED ERGONOMICS INTERVENTION  
APPROACH IN REDUCING MUSCULOSKELETAL DISORDERS AMONG  
OIL PALM HARVESTERS IN JOHOR BAHRU, MALAYSIA**

By

**NG YEE GUAN**

**November, 2014**

**Chairman:** Associate Professor Shamsul Bahri Mohd Tamrin, PhD

**Faculty:** Medicine and Health Sciences

**Objective:** This study intend to determine the effectiveness of an integrated ergonomics interventions approach, highly promoted by International Labour Organization to resolve ergonomics issues specifically among oil palm harvesters and to improve Occupational Safety and Health aspects of the workplace during early harvesting stage in oil palm plantation.

**Methodology:** Divided into two phases, the first phase of the cross-sectional design involved 446 male respondents working as harvesters (263 fresh fruit bunch (FFB) cutters; 183 FFB collectors). Questionnaires were used to collect information on socio-demographic data, occupational history, social lifestyle, prevalence of musculoskeletal disorders (MSDs) and productivities data. Video recording was used to assist postural assessment of harvesters using Ovako Working Posture Analysis System (OWAS). An intervention package based on Participatory Action Oriented Training (PAOT) approach were subsequently designed and implemented in the second phase of the study. The intervention program features video, interactive lectures, games and action checklist. Two instruments were used to assess the effectiveness; knowledge, attitude and practice as well as body symptom questionnaire. Besides that, qualitative observation were also used to determine physical improvement or change from the intervention program.

**Results:** Ergonomics risk factors particularly awkward postures, repetitive motion and forceful exertion were predominant among harvesters (both FFB cutters and FFB collectors) in oil palm plantation. Evidently, the 12 months and 7 days prevalence of MSDs at any body parts were 86% and 45% for respective duration. Lower back pain was the most commonly self-reported symptoms followed by knee neck and shoulder

for both FFB cutters and FFB collectors. Significant risk factors of MSDs among the harvesters such as education level, body mass index, awkward postures, daily working and resting hours, working overtime and hobby (fishing) explain some but not all of the risk factors. Significant productivity loss were also observed among harvesters with acute MSDs where they were almost 3 times likely to be still working (presenteeism, OR=2.87; CI=1.34, 6.14) but produce only half as much as their healthy (without MSDs) colleagues (daily productivity, OR=2.09, CI=1.02, 4.29). The ergonomics intervention, PAOT approach were successfully implemented despite severely unanticipated and unavoidable limitations. The post-intervention assessment indicates that although the total knowledge, attitude and practices (KAP) score increased within IG (Friedman test,  $\chi^2=16.831$ ,  $p<0.01$ ), there were however no significant difference as compared to CG. In terms of MSDs, the post-intervention assessment were not effective to reduce the prevalence of MSDs within the intervention group (IG) as well as between control group (CG).

**Conclusion:** Findings in this study indicates that effective intervention strategy among oil palm harvesters during early harvesting stage is crucially required considering the health effect in terms of MSDs and the productivity loss. Despite being reported effective in various other agricultural application, the application of PAOT approach did not indicate effectiveness on multinational corporate oil palm plantation potentially attributable to the severe limitation of this study. Thus, it is recommended that future research work consider the limitations as reported in this study besides further exploration of other ergonomics risk factors and biomechanics of harvesting tasks using prospective research design.

**(Keywords:** oil palm plantation, harvesters, ergonomics, MSDs, intervention, PAOT)

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**KEBERKESANAN INTERVENSI ERGONOMIK DALAM  
MENGURANGKAN GANGGUAN OTOT-RANGKA DI KALANGAN  
PENUAI KELAPA SAWIT DI JOHOR BAHRU, MALAYSIA**

Oleh

**NG YEE GUAN**

**November, 2014**

**Pengerusi: Profesor Madya Shamsul Bahri Mohd Tamrin, PhD**

**Fakulti: Perubatan dan Sains Kesihatan**

**Objektif:** Kajian ini bertujuan untuk menentukan keberkesanan pendekatan intervensi ergonomik bersepadu, sangat digalakkan oleh Pertubuhan Buruh Antarabangsa untuk menyelesaikan isu-isu ergonomik khususnya di kalangan penuai kelapa sawit dan untuk meningkatkan aspek Kesihatan tempat kerja Keselamatan di ladang sawit pada peringkat penuaian awal di ladang kelapa sawit .

**Kaedah:** Terbahagi kepada dua fasa, kajian keratan rentas yang melibatkan 446 responden lelaki bekerja sebagai penuai (263 pemotong buah tandan segar, BTS; 183 pengumpul BTS). Borang soal selidik digunakan untuk mengumpul maklumat mengenai data sosio-demografi, sejarah pekerjaan, gaya hidup sosial, kelaziman gangguan muskuloskeletal (MSDs) dan data berkaitan produktiviti. Rakaman video digunakan untuk membantu penilaian postur penuai menggunakan *Ovako Working Posture Analysis System* (OWAS). Pakej intervensi berdasarkan Pendekatan Latihan Berorientasikan Penyertaan Tindakan (PAOT) digunakan dalam fasa kedua kajian intervensi menggunakan pemerhatian kualitatif dan hasil kuantitatif analisis di dalam fasa pertama.

**Keputusan:** Faktor-faktor risiko ergonomik terutamanya postur janggal, gerakan berulang-ulang dan kerahan tenaga secara paksa adalah ketara di kalangan penuai (kedua-dua pemotong BTS dan pengumpul BTS) di ladang kelapa sawit. Prevalens MSDs bagi 12 bulan dan 7 hari di mana-mana bahagian badan adalah sebanyak 86% dan 45% masing-masing. Sakit belakang adalah gejala yang paling tinggi dilaporkan diikuti oleh leher, lutut dan bahu bagi kedua-dua pemotong BTS dan pengumpul BTS. Faktor-faktor risiko utama MSDs bagi penuai adalah tahap pendidikan, indeks jisim badan, postur janggal, jumlah jam bekerja dan berehat harian, bekerja lebih masa dan

hobi (memancing) menjelaskan beberapa tetapi tidak kesemua faktor-faktor risiko MSDs. Kehilangan produktiviti yang ketara telah juga diperhatikan di kalangan penuai yang mengalami MSDs akut di mana mereka hampir 3 kali mungkin masih bekerja (presenteeism, OR=2.87; CI=1.34,6.14) tetapi hasil tuaian hanya separuh daripada kuantiti rakan-rakan sekerja mereka yang sihat (tanpa MSDs) (produktiviti harian, OR=2.09, CI=1.2, 4.29). Sungguhpun intervensi ergonomik menggunakan pendekatan PAOT telah dilaksanakan dengan jayanya tetapi terdapat pelbagai batasan dan limitasi yang telah memberi kesan kepada hasil intervensi tersebut. Penilaian selepas intervensi menunjukkan bahawa tiada perbezaan signifikan yang dilihat bagi skor pengetahuan, sikap dan amalan (KAP) dan juga prevalens MSDs. Walaupun skor KAP meningkat di kalangan kumpulan intervensi (IG) (ujian Friedman,  $\chi^2 = 16,831$ ,  $p < 0.01$ ), tiada perbezaan ketara yg dapat dilihat bagi prevalens MSDs di dalam kumpulan yang sama.

**Kesimpulan:** Penemuan dalam kajian ini menunjukkan bahawa strategi intervensi yang berkesan di kalangan penuai kelapa sawit pada peringkat penuaian awal amat diperlukan berikutan kesan kesihatan dari segi MSDs dan kehilangan produktiviti. Walaupun dilaporkan berkesan dalam pelbagai aplikasi pertanian yang lain, keberkesanan pendekatan PAOT terutamanya di ladang kelapa sawit korporat multinasional berupaya disisihkan oleh sistem pengurusan berdasarkan hierarki dan konflik organisasi. Maka, adalah disyorkan bahawa kerja-kerja penyelidikan masa depan mengambil kira faktor-faktor risiko ergonomik lain yang tidak diterokai di dalam kajian ini termasuk kajian biomekanik dalam menggunakan reka bentuk kajian penyelidikan prospektif.

(**Kata kunci:** kelapa sawit, penuai, ergonomik, MSDs, intervensi, PAOT)





© COP YRIGHT UPM

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

**SHAMSUL BAHRI BIN MOHD TAMRIN, PhD**

Associate Professor  
Faculty of Medicine and Health Sciences  
Universiti Putra Malaysia  
(Chairman)

**ZAILINA BINTI HASHIM, PhD**

Professor  
Faculty of Medicine and Health Sciences  
Universiti Putra Malaysia  
(Member)

**ISMI ARIF BIN ISMAIL, PhD**

Associate Professor  
Faculty of Educational Studies  
Universiti Putra Malaysia  
(Member)

**GOH YONG MENG, PhD**

Associate Professor  
Faculty of Veterinary Medicine  
Universiti Putra Malaysia  
(Member)

---

**BUJANG KIM HUAT, PhD**

Professor and Dean  
School of Graduate Studies  
Universiti Putra Malaysia

Date:

## Declaration by graduate student

I hereby confirm that:

- this thesis is my original work;
- quotations, illustrations and citations have been duly referenced;
- this thesis has not been submitted previously or concurrently for any other degree at any other institutions;
- intellectual property from the thesis and copyright of thesis are fully-owned by Universiti Putra Malaysia, as according to the Universiti Putra Malaysia (Research) Rules 2012;
- written permission must be obtained from supervisor and the office of Deputy Vice-Chancellor (Research and Innovation) before thesis is published (in the form of written, printed or in electronic form) including books, journals, modules, proceedings, popular writings, seminar papers, manuscripts, posters, reports, lecture notes, learning modules or any other materials as stated in the Universiti Putra Malaysia (Research) Rules 2012;
- there is no plagiarism or data falsification/fabrication in the thesis, and scholarly integrity is upheld as according to the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) and the Universiti Putra Malaysia (Research) Rules 2012. The thesis has undergone plagiarism detection software.

Signature: \_\_\_\_\_

Date: \_\_\_\_\_

Name and Matric No.: \_\_\_\_\_

## Declaration by Members of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

Signature: \_\_\_\_\_  
Name of  
Chairman of  
Supervisory  
Committee: \_\_\_\_\_

Signature: \_\_\_\_\_  
Name of  
Chairman of  
Supervisory  
Committee: \_\_\_\_\_

Signature: \_\_\_\_\_  
Name of  
Chairman of  
Supervisory  
Committee: \_\_\_\_\_

Signature: \_\_\_\_\_  
Name of  
Chairman of  
Supervisory  
Committee: \_\_\_\_\_

## TABLE OF CONTENT

<b>ABSTRACT</b>	<b>i</b>
<b>ABSTRAK</b>	<b>iii</b>
<b>APPROVAL</b>	<b>v</b>
<b>DECLARATION</b>	<b>vii</b>
<b>LIST OF TABLES</b>	<b>xiii</b>
<b>LIST OF FIGURES</b>	<b>xvi</b>
<b>LIST OF ABBREVIATIONS</b>	<b>xx</b>

### CHAPTER

<b>1</b>	<b>INTRODUCTION</b>	<b>1</b>
1.1	Research Background	1
1.2	Problem Statement	7
1.3	Study Justification	9
1.4	Objectives	10
1.4.1	General Objectives	10
1.4.2	Specific Objectives	10
1.5	Hypothesis	11
1.6	Conceptual Framework	12
1.7	Conceptual and Operational Definition	16
1.7.1	Musculoskeletal Disorders	16
1.7.2	Ergonomics risk factors	16
1.7.3	Productivity	17
1.7.4	Knowledge, attitude and practices	19
	Chapter Summary	20
<b>2</b>	<b>LITERATURE REVIEW</b>	<b>21</b>
2.1	Oil Palm: A Brief Introduction	21
2.2	The Oil Palm Industry	22
2.3	The Cycle and Tasks in Oil Palm Plantation	24
2.4	Musculoskeletal Disorders	32
2.4.1	Definition	32
2.4.2	Epidemiology of Musculoskeletal Disorders – Prevalence and Risk Factors Among Workers	34
2.4.3	Prevalence of MSD: A General Overview	34
2.4.4	Prevalence of MSD in the Agricultural Industry	35
2.4.5	Musculoskeletal Disorders in Oil Palm Plantation	38
2.4.6	The Risk Factors of Musculoskeletal Disorders	39
2.4.7	Musculoskeletal Disorders of the Neck	39
2.4.8	Musculoskeletal Disorders of the Shoulder	41
2.4.9	Musculoskeletal Disorders of the Back	41
2.4.10	Musculoskeletal Disorders of the Knee	41
2.4.11	Productivity Loss due to MSDs	42
2.5	Assessment Method	44

2.5.1	Nordic Musculoskeletal Questionnaire	44
2.5.2	Postural Assessment using Ovako Working Posture Analysis System	44
2.6	Ergonomics Intervention	45
2.6.1	Ergonomics Intervention in Agriculture	45
2.6.2	Participatory Ergonomics Intervention	46
2.6.3	Participatory Action Oriented Training Intervention	47
2.6.4	Unsuccessful Ergonomics Intervention	49
2.6.5	Summary of different intervention studies	50
	Chapter Summary	54

<b>3</b>	<b>METHODOLOGY</b>	<b>55</b>
3.1	Study Design	55
3.1.1	Cross-sectional study (Phase 1)	55
3.1.2	Intervention Study (Phase 2)	55
3.2	Sampling Method	57
3.2.1	Study Location	57
3.2.2	Sampling Population	58
3.2.3	Sampling Frame	58
3.2.4	Sample Unit	58
3.2.5	Sample Size Calculation	60
3.3	Instruments and Tools	62
3.3.1	Phase 1: Walk-through survey	62
3.3.2	Phase 1: Video camera – recording of observation	62
3.3.3	Phase 1: General Questionnaire	62
3.3.4	Phase 1: Nordic Musculoskeletal Questionnaire	65
3.3.5	Phase 1: Productivity Data	65
3.3.6	Phase 1: Anthropometric measurement – Body Mass Index	66
3.3.7	Phase 1: Ovako Working Posture Assessment System (OWAS)	68
3.3.8	Phase 2: Intervention Package	70
3.3.9	Phase 2: Evaluation of Intervention Program	84
3.3.10	Statistical Analysis	90
3.4	Quality Control	90
3.4.1	Questionnaires and Forms	90
3.4.2	Anthropometric Measurement	91
3.4.3	Postural Analysis – OWAS	91
3.5	Study Flow Process	93
3.5.1	Phase 1 – Cross-sectional database collection	93
3.5.2	Phase 2 – Intervention study	95
3.6	Statistical Analysis	96
3.7	Ethics of study	98
	Chapter Summary	99

<b>4</b>	<b>RESULTS</b>	
4.1	Objective 1: Ergonomics Observation – Harvesting Tasks at Oil Palm	100
4.1.1	Harvesting activities – FFB cutter	102
4.1.2	Harvesting activities – FFB collector	103
4.1.3	Ergonomic problems during harvesting – FFB cutters	103
4.1.4	Ergonomic problems during harvesting – FFB collectors	105
4.2	Objective 2: Prevalence of musculoskeletal disorders among harvesters in oil palm plantations	106
4.3	Objective 3: Determine the severity of awkward posture adopted during harvesting work tasks in oil palm plantations	110
4.4	Objective 4: Determine the loss of productivities (in terms of sick leave – absenteeism, presenteeism, daily harvest quantity and efficiency score) among oil palm harvesters	113
4.5	Objective 5: Determine the association between productivities with the prevalence of musculoskeletal disorders among harvesters in oil palm plantation located at the state of Johor, Malaysia	115
4.6	Objective 6: Determine the association between prevalence of musculoskeletal disorders and the potential risk factors among harvesters in oil palm plantation located at the state of Johor, Malaysia	117
4.7	Objective 7: Determine the effectiveness of intervention program between pre- and post-intervention among the intervention and control group	122
4.7.1	Evidence from qualitative observation	122
4.7.2	Knowledge, Attitude and Practices	123
4.7.3	Prevalence of musculoskeletal disorders (MSDs)	128
	Chapter Summary	133
<b>5</b>	<b>DISCUSSION</b>	134
5.1	Objective 1: Ergonomics Observation – Harvesting Tasks at Oil Palm	134
5.2	Objective 2: Prevalence of musculoskeletal disorders among harvesters in oil palm plantations	136
5.3	Objective 3: Determine the severity of awkward posture adopted during harvesting work tasks in oil palm plantations	137
5.4	Objective 4: Determine the loss of productivities (in terms of sick leave – absenteeism, presenteeism, daily harvest quantity and efficiency score) among oil palm harvesters.	138
5.5	Objective 5: Determine the association between productivities with the prevalence of musculoskeletal disorders among harvesters in oil palm plantation located at the state of Johor, Malaysia	138

5.6	Objective 6: Determine the association between the potential risk factors with prevalence of musculoskeletal disorders among harvesters in oil palm plantation located at the state of Johor, Malaysia	139
5.7	Objective 7: Determine the effectiveness of intervention program between pre- and post-intervention among the intervention and control group	140
5.7.1	Qualitative Findings	140
5.7.2	Musculoskeletal Disorders	141
5.7.3	Knowledge, Attitude, Practices	141
	Chapter Summary	143
<b>6</b>	<b>SUMMARY, CONCLUSION AND RECOMMENDATION</b>	<b>144</b>
9.1	Summary of study and links to articles	144
9.2	Significant Findings/Contributions	146
9.3	Conclusion	146
9.4	Recommendations	146
	<b>REFERENCES</b>	<b>148</b>
	<b>APPENDICES</b>	<b>168</b>
	<b>BIODATA OF STUDENTS</b>	<b>341</b>
	<b>LIST OF PUBLICATIONS</b>	<b>344</b>



## LIST OF APPENDICES

<b>Appendix</b>		<b>Page</b>
1:	General Questionnaire	168
2:	Modified Nordic Musculoskeletal Questionnaire (NMQ)	173
3:	Simplified NMQ	182
4:	Productivity information – Efficiency score, absenteeism and presenteeism	184
5:	Seca 761 and Seca 206 Bodymeter Manual	186
6:	Modified Ovako Working Posture Analysis System Technical	195
7:	Video of Intervention Training	203
8:	Slides of Intervention Training	205
9:	Intervention PAOT Action Checklist	208
10:	Knowledge, Attitude and Practices Questionnaire	220
11:	PAOT Certificate of Training and Trainer's	228
12:	Ethics Committee Approval of Study	231
13:	Organizational Approval	233
14:	Respondent Information and Consent Sheets	238
15:	Article 1 - Ergonomics Observation: Harvesting Tasks at Oil Palm Plantation	242
16:	Article 2 – The Prevalence of Musculoskeletal Disorder and Association with Productivity Loss: A Preliminary Study among Labour Intensive Manual Harvesting Activities in Oil Palm Plantation	253
17:	Article 3 – A Cross-Sectional Study of Musculoskeletal Symptoms and Association with Postures during Oil Palm Harvesting Tasks	262
18:	Article 4 – Risk Factors of Musculoskeletal Disorders among Oil Palm Fruit Harvesters during Early Harvesting Stage	295
19:	Article 5 – Effectiveness of a Participatory Action Oriented Training Intervention Approach among Harvesters in Oil Palm Plantation	327

## LIST OF TABLES

<b>Table</b>		<b>Page</b>
1.1:	Operational definition of productivity expressed in four derivatives	27
2.1:	Summary of selected literatures reviews, agricultural and participatory ergonomics intervention studies	81
3.1:	Summary decision of definition and cut-off point used in dichotomy category	105
3.2:	WHO classification of weight categories based on BMI	106
3.3:	Action category for each individual OWAS classified posture combination	109
3.4:	Comparison of basic characteristics between IG and CG	113
3.5:	Specific areas underlying each sub-domain in the KAP survey questionnaire	133
3.6:	Score value of response answer in KAP survey questionnaire	135
3.7:	Example of KAP score calculation	136
4.1:	Productivity of oil palm harvesters	174
4.2:	Association between MSD complaints (past week) and work productivity	176
4.3:	The impacts of musculoskeletal disorders on the odds of productivity loss	177
4.4:	Risk factors associated with 12 months musculoskeletal symptoms among FFB cutters	179
4.5:	Risk factors associated with 7 days musculoskeletal symptoms among FFB cutters	180
4.6:	Risk factors associated with 12 months musculoskeletal symptoms among collector	182
4.7:	Risk factors associated with 7 days musculoskeletal symptoms among FFB collector	183
4.8:	Comparison of KAP raw score between IG and CG	188

4.9:	Comparison of KAP raw score within IG	189
4.10:	Comparison of KAP raw score within CG	190
4.11:	Comparison of self-reported MSDs between IG and CG in the past 2 months	193
4.12:	Comparison of self-reported MSDs between IG and CG in the past 7 days	194
4.13:	Comparison of self-reported MSDs within IG during the intervention period	195
4.14:	Comparison of self-reported MSDs within CG during the intervention period	196



## LIST OF FIGURES

<b>Figure</b>		<b>Page</b>
1.1:	Conceptual framework of Palm Oil Industry Sustainability	5
1.2:	Entire value chain of Malaysia palm oil industry	7
1.3:	Portfolio of New Key Economics Area (NKEA) sectors	7
1.4:	Entry point projects to scaling up production of oil palm plantation	8
1.5:	Conceptual Framework of Phase 1 Research	22
1.6:	Conceptual Framework of Phase 2 Research	23
2.1:	A typical view of oil palm plantation	33
2.2:	Summary of palm oil industry activities	35
2.3:	An example of oil palm nursery	37
2.4:	Land clearing – deforestation for oil palm plantation	37
2.5:	Cover crop to prevent soil erosion after land clearing	38
2.6:	Oil palm trees transplanted from nursery to prepared land	38
2.7a:	Harvester – FFB cutter (trees age < 5 years old)	39
2.7b:	Harvester – FFB cutter (trees age 5 – 8 years old)	39
2.7c:	Harvester – FFB cutter (erecting pole attached with sickle)	40
2.7c:	Harvester – FFB cutter (trees age >15 years)	40
2.8a:	Harvester – FFB collector lifting FFB	41
2.8b:	Harvester – FFB collector unloading FFB onto wheelbarrow	41
2.8c:	Harvester – FFB collector pushing wheelbarrow	42
2.8d:	Harvesters collecting loose fruits	42
2.9:	Loaders loading gathered FFB onto lorry/truck	43
2.10:	The Human Musculoskeletal System	45
2.11:	Farmers – tomato trainer tying up suspended straws/ropes	51
2.11:	Farmer harvesting grapes	52

2.12:	Nursery workers stooping to place seedlings on ground	52
2.13:	Dairy farmers milking cow	53
2.14:	Conceptual model of potential factors contributing to development of musculoskeletal disorders	60
3.1:	Quasi-experimental (non-equivalent group) design used in this intervention study	90
3.2:	Sampling strategy for recruiting respondent in this study	93
3.3a:	Breakdown of FFB cutters' task	101
3.3b:	Breakdown of FFB collectors' tasks	102
3.4a:	Seca 761	107
3.4b:	Seca 206 Bodymeter	107
3.5a:	Video screenshot – a brief history of oil palm in Malaysia	115
3.5b:	Video screenshot – main content of the educational video	115
3.5c:	Video screenshot – types of hazards commonly found in oil palm plantation	115
3.5d:	Video screenshot – examples of physical hazards	116
3.5e:	Video screenshot – burn injury by electricity due to accidental cutting of high voltage tension wire	116
3.5f:	Video screenshot – example of chemical hazard and exposure to chemical (pesticides)	117
3.5g:	Video screenshot – example of biological hazard: wild boar in oil palm plantation	117
3.5h:	Video screenshot – example of ergonomics hazard: stooping while collecting loose fruits	118
3.5i:	Video screenshot – back pain due to ergonomic hazard	118
3.5j:	Video screenshot – Working overtime is a psychosocial hazard	118
3.5k:	Video screenshot – comparison of productivity of healthy and diseased harvesters	119

3.5l:	Video screenshot – Guide to reduce bending forward/awkward posture: bend knees and expand crotch area	119
3.5m:	Video screenshot – lift FFB using both hand, close to body and as low as possible	120
3.5n:	Video screenshot – collect loose fruit by squatting rather than stooping	120
3.5o:	Video screenshot – exercise guide before and after work	121
3.5p:	Video screenshot – frequently massage pain or fatigue body area	121
3.5q:	Video screenshot – use hotpack/coldpack to poultice painful body area	121
3.5r:	Video screenshot – interview with experienced workers	122
3.6:	Distribution of certificates for participants	124
3.7:	Group Discussion	126
3.8:	Voting Activity	127
3.9:	Summary of interventional components and reinforcement activities	128
3.10:	Process flow of questionnaire design and construction	132
3.11:	Standing height position	141
3.12:	Study flow diagram	144
3.13:	Evaluation of intervention	147
3.14:	Categories of test and statistical test used for analysis	149
4.1a:	FFB cutter stooping while performing harvesting task	155
4.1b:	canopy arrangement of oil palm trees affecting posture	155
4.1c:	FFB cutter performing harvesting task with head tilted upward and both hand above shoulder	155
4.1d:	FFB cutter balancing and manoeuvring long sickle to erect pole for harvesting task	155
4.2a:	FFB collector lifting FFB using hook from the ground with a single hand to load into wheelbarrow	159

4.2b:	FFB collector lifting FFB using hook with both hand to load onto wheelbarrow	159
4.2c:	FFB collector lifting FFB using metal pole onto wheelbarrow	159
4.2d:	FFB collector lifting and carrying FFBs over a distance to where wheelbarrow are left	159
4.3a:	FFB collector collecting loose fruit scattered on ground by sweeping in stooping posture	160
4.3b:	FFB collector collecting loose fruit scattered on ground by sweeping in stooping posture	160
4.3c:	FFB collector pushing fully loaded wheelbarrow with back posture bent forward	160
4.3d:	FFB collector unloading wheelbarrow at truck collection route point	160
4.4	Total self-reported 12 months and 7 days prevalence of MSSs for all body parts	165
4.5	Self-reported 12 months and 7 days prevalence of MSSs among FFB cutters	167
4.6	Self-reported prevalence of MSS by duration and work categories among FFB collectors	168
4.7	Summary result of OWAS action category for FFB cutters	170
4.8	Summary result of OWAS action category for FFB collectors	172
4.9a	Participants in interactive question and answer session	186
4.9b	Participants during voting activity using coloured label	186
4.10a	Examples of low cost improvement – gunny bag was filled with soil to patch eroded sloppy hill for prevention of slip, trip and fall and for safer vehicle passage	186
4.10b	Examples of low cost improvement – soil of sloppy hill carved into stairs used as passage	186
4.10c	Examples of low cost improvement – discarded wood pallet used to cover drainage for safer passage	186
4.10d	Examples of low cost improvement – discarded wood from cable roller used as seats	186

## LIST OF ABBREVIATION/GLOSSARY OF TERMS:

IEA	-	International Ergonomics Association
FAO	-	Food and Agriculture Organization
PEMANDU	-	Performance Management & Delivery Unit, a unit under Prime Minister Department of Malaysia
MVO	-	Margarine, vetten en Oliën, a Netherland-based organization in the oil and fat business
UNDP	-	United Nations Development Programme
3P	-	Profit (Economics), People (Social) and Planet (Environment); the three elements of sustainability
CIA	-	Central Intelligence Agency, United States of America
EPP	-	Entry Point Projects under the Economic Transformation Programme to spur growth of the Malaysia National Key Economic Areas
NKEA	-	National Key Economic Area is the initiative of Malaysia government to drive potential economic activities which will contribute economic growth in Malaysia
R & D	-	Research and Development
GNI	-	Gross National Income
ETP	-	Economic Transformation Programme is an initiative by the Malaysian government to turn Malaysia into a high income economy by the year of 2020
MSDs	-	Musculoskeletal disorders
PAOT	-	Participatory Action-Oriented Training
ILO	-	International Labour Organization
FFB	-	Fresh Fruit Bunch
BMI	-	Body Mass Index
RSIs	-	Repetitive strain injuries
CTDs	-	Cumulative trauma disorders
OOS	-	Occupational overuse syndromes



OCDs	-	Occupational Cervicobrachial Disorders
NMQ	-	NORDIC Musculoskeletal Questionnaires
OWAS	-	Ovako Working Posture Assessment System
CDC	-	Center for Disease Control and Prevention
KAP	-	Knowledge, attitude and practices
SAFework	-	Safety and Health at Work and the Environment
OSH	-	Occupational Safety and Health
OSHE	-	Occupational Safety, Health and Ergonomics
OPPs	-	Oil Palm Plantations
MPOC	-	Malaysian Palm Oil Council
WHO	-	World Health Organization
NRC	-	National Research Council
IOM	-	Institute of Medicine
US OSHA	-	United States Occupational Safety and Health Administration
NIOSH	-	The National Institute for Occupational Safety and Health
REBA	-	Rapid Entire Body Assessment
QEC	-	Quick Exposure Checklist
PAR	-	Participatory action research
WISE	-	Work Improvements in Small Enterprises
WIND	-	Work Improvement in Neighbourhood Development
FELDA	-	Federal Land Development Agency
FELCRA	-	Federal Land Consolidation and Rehabilitation Authority
UNEP	-	United Nations Environment Programme
MPOB	-	Malaysia Palm Oil Board
FIOH	-	Finland and the Finnish Institute for Occupational Health
IG	-	Intervention Group

CG	-	Control Group
RHEF	-	Rural Health Education Foundation
NWCHPC	-	Northwest Center for Public Health Practice
BSS	-	Body parts symptoms survey
ICC	-	Intraclass Correlation Coefficients





© COP YRIGHT UPM

# CHAPTER 1

## INTRODUCTION

This chapter provide a brief introduction to the background of this research with an outline of the problem faced by the oil palm industry. Subsequently, the necessity of this research is being justified, followed by the objectives and the corresponding hypothesis. The conceptual framework of this research is also being presented while the conceptual and operational definition of some key terminology used in this research is also outlined.

### 1.1 Research Background

Used inter-exchangeable with the term Human Factor, ‘Ergonomics’ refers to an interdisciplinary sciences of physiology, psychology, anthropometry, biomechanics and various aspects of engineering in attempt of adapting human in terms of their physiology capacity to the work tasks and environment (Grandjean, 1980).

In a much contemporary definition (Hancock, 1997), this scientific study of relationship is a branch of science which seeks to turn human-machine interaction from antagonism into human-machine synergy. In simple term, ergonomics emphasize in fitting tasks and its environment to the workers with the purpose of bettering the human condition (Hancock and Diaz, 2002).

The most recent definition of ergonomics by International Ergonomic Association (IEA) broadly focuses on human–system interface design, inclusive of micro- and/or macro-systems are as follow:

*Ergonomics (or Human Factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design in order to optimize human well-being and overall systems performance (IEA, 2011).*

Regardless of discipline or field, the ultimate aim of ergonomics is to improve human health, safety and performances through the sound application of people and workplace principles (Kohn, 1998) corresponding to the long history of occupational accidents, injuries, disorders and diseases attributable to the human-machine interaction or workplace design (EU-OSHA, 2011).

Ergonomics in agricultural industry has long been recognized for optimization of productivities in various agricultural settings where human labor is concerned (O’Neill and Rogan, 1993; Jafry and O’Neill, 2000; O’Neill, 2005). Various improvements of health and safety of farm workers as well as their quality of life socially and economically has been demonstrated to further reduce healthcare bill and compensation as a whole (Lundqvist and Gustafsson, 1992; Niu, 2010).

As with other agricultural sectors, the flourishing oil palm industry in Malaysia relies heavily on the production of the oil palm seeds from oil palm plantation. The palm oil

industry is currently the fourth largest contributors of Malaysia economy accounting of RM53 billion in gross national income (GNI) in 2009. As the global population continue to expand, the world food and energy consumption has increases accordingly. Changes in eating habits and increases in global food demand require that the food productions to be intensified to keep up with the already shortage in global food supply and cultivable land (Seegräf et al., 2010; Nellesmann, et al., 2009; FAO, 2009).

Additionally, the fast depleting fossil fuel energy reserves has also led the search for a viable substitute source of energy to food as biofuel (Atabanii, et al., 2012). Eventually, palm oil has emerged as the most productive oil crop with value chain spanning from upstream plantation to downstream processing industrial activities (Thoenes, 2006; Sheil et al., 2009; PEMANDU, 2010; MVO, 2012).

While it has been suggested that palm oil may indeed be the solution towards uprising food and energy consumption and demand (FAO, 2002; Corley, 2005; UNDP, 2007; MVO, 2012), the industry has also been associated with social development in uplifting of poverty through employment in various stream of value chain as well as infrastructure development (Basiron, 2007; Cheng, 2010; Rist, Levang, and Feintrenie, 2010; Seegräf et al., 2010).

In recent advancement, the sustainability of the palm oil industry has gained much attention from various international stakeholders; both governmental and non-governmental organization. Particularly, the sustainable plantation practices addressing the 3P – profit (economics), people (social) and planet (environment) has been highlighted (Figure 1.1) following rapid expansion of the palm oil industry in various aspects (FAO, 2002; Corley, 2005; Hashim and Yuen, 2007; Cheng, 2010; Henriksson, 2012).

As of the year 2009, the Malaysia palm oil industry accounts for 71% (4.7 million hectares) of the 6.6 million hectares Malaysia national agricultural land bank for oil palm plantations in the upstream activities in additional of possessing 416 mills, 43 crushers, 51 refineries, 18 oleochemical plants and 25 biodiesel plants for the downstream processes – Figure 1.2 (PEMANDU, 2010).

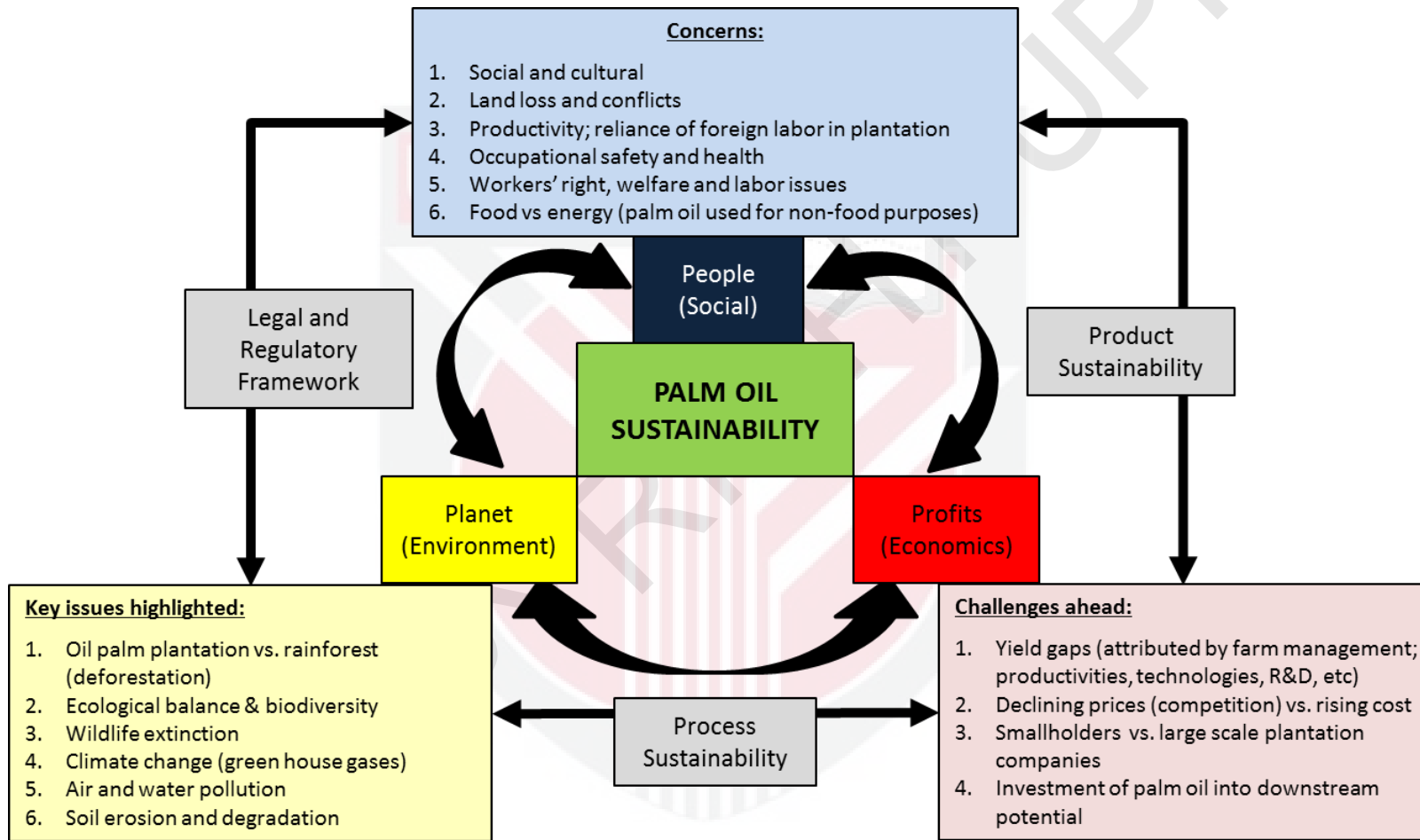
With the Malaysia Economic Transformation Programme (ETP) launched on 2010, palm oil industry has been highlighted as one of the key sector towards national economic development. The mechanism through which the goal of becoming high income and developed nation by 2020 will be fostered by various concrete Entry Point Projects (EPP).

Various action strategies through the National Key Economic Area (NKEA) (Figure 1.3) were outlined in the goal of becoming developed nation by 2020 (PEMANDU, 2010). This following the fact that the realization that palm oil industry is still heavily skewed towards upstream activities albeit spans of value chain from upstream plantation to downstream processing (PEMANDU, 2010).

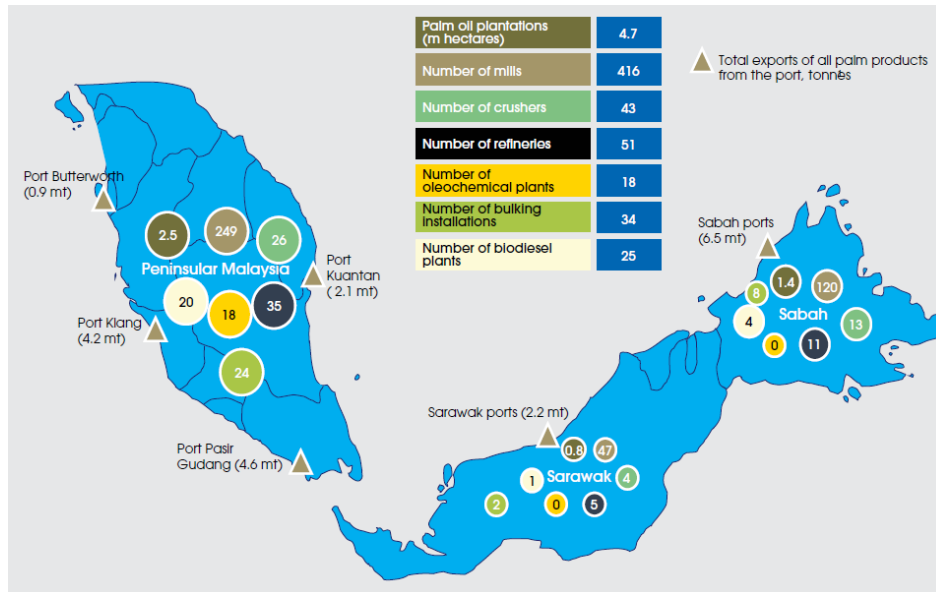
Although the upstream oil palm plantation activities is generally considered as agricultural subsectors, the ETP has extracted the palm oil industry as a standalone portfolio of the national key economic area (NKEA) in considering the contribution towards the national

economics (PEMANDU, 2010). Eight entry point projects (EPP) had been set comprising of contribution in upstream and downstream segment of oil palm industry.



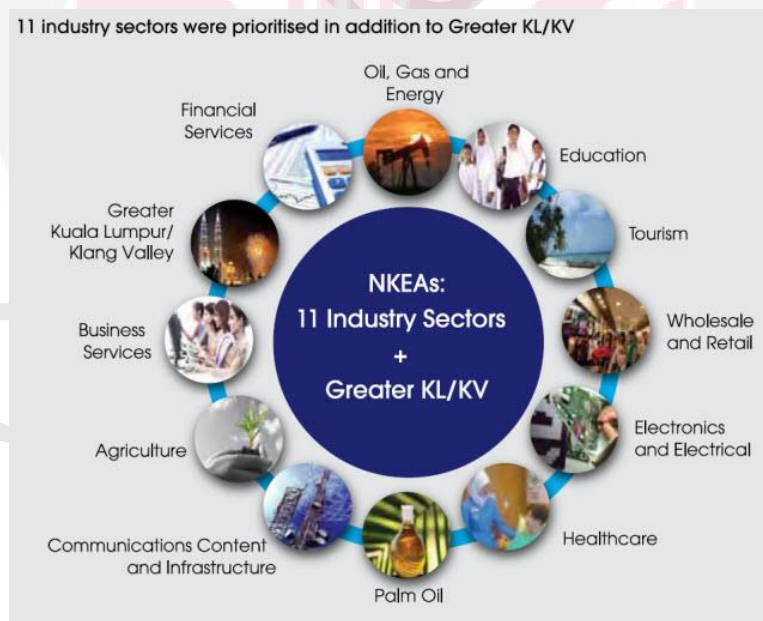


**Figure 1.1: Conceptual framework of Palm Oil Industry Sustainability**



**Figure 1.2: Entire value chain of Malaysia palm oil industry**

(Source: PEMANDU, 2010)

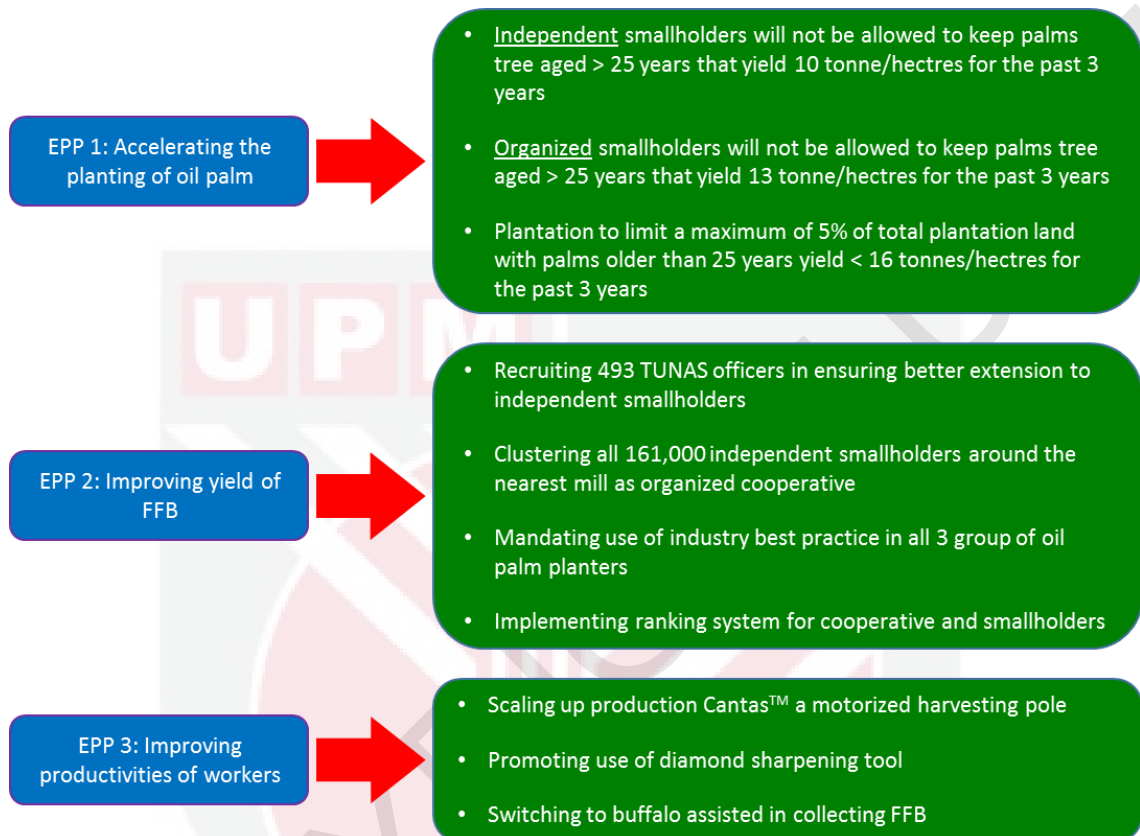


**Figure 1.3: Portfolio of New Key Economics Area (NKEA) sectors**

(Source: PEMANDU, 2010)



Among the EPPs, the 3 EPP outline the strategies to reduce the dependency of foreign labor in the upstream oil palm plantations as in Figure 1.4 as follow:



**Figure 1.4: Entry point projects to scaling up production of oil palm plantation**

*(Source: PEMANDU, 2010)*

## 1.2 Problem Statement

The sustainability of oil palm industry has been consistently challenged in the international arena. Various issues, particularly the environmental and social aspect of the oil palm cultivation has become the central focus of debates ranging from destruction of the forest and pollution to animal rights, natives land loss, welfare, etc.

It appear that while the socio-economics advantage and environmental impact were being appropriately addressed by the stakeholders, there has been lack of published data on any surveillance information, current status, experimental or intervention study with respect to safety, health and ergonomics of oil palm plantation..

For example, research application of biotechnology for better thriving and resistance seeds, crossbreeding and/or engineering technological innovation aids such as harvester, fertilizers, pesticides etc (Mohd. Anim, 2010) – to increase yield appears to be extensive. However, there were not as many internationally published studies on safety, health and ergonomics among oil palm workers.

A quick and simple search using google scholar search engine (keywords: ergonomics occupational safety and health Malaysia agriculture) only manage to find three related articles; a review of overturning accidents and safety involving farm tractors by Abubakar et al. (2010), an ergonomics study among rubber tappers by Shan et al. (2011) and a study of energy expenditure among rice cultivation workers by Nawi et al. (2011).

Thus, from the existing literature, there is insufficient knowledge of the harvesting tasks in oil palm plantation despite the values and investment in the industry. Moreover, although high prevalence of MSDs was reported by Nizam and Rampal (2005), Hendra and Rahardjo (2008) as well as Henry et al. (2013), studies which describe the awareness of workers were not found.

From the perspective of productivity, the three entry point projects (EPP) outlined specifically for upstream oil palm plantation by the Malaysia Economic Planning Unit (2010) in the Economic Transformation Programme (ETP) has also failed to recognize the potential of safety, health and ergonomics in reducing losses in terms of productivity despite abundance of studies showing productivity loss due to neglected Occupational, Safety, Health and Ergonomics.

Predominantly, musculoskeletal disorders (MSDs) were being reported as the single most prevalent injuries among agricultural workers (Fathallah, 2010; Chapman and Meyers, 2001), although respiratory disease, noise induced hearing loss, pesticide-related illnesses, and cancers were also among the concerned (Nelson et al., 2005; Miyakita and Ueda, 1997; Alavanja; 2003; Calvert et al., 2008; Von Essen and Banks, 2009; Linaker and Smedley, 2002; Fuhs, 2008).

Publications of articles in various journals (Aronsson et al., 2000; Hagberg et al., 2002; Pelletier et al., 2004; Boles et al., 2004; Burton et al., 2006; Ricci et al., 2007; Alavinia et al., 2009) has found significant productivity losses in their studies particularly in terms of loss of work time which can be expressed in absenteeism as well as presenteeism.

It was estimated that on year 2010, there are approximately 400,000 oil palm harvesters in Malaysia to cover more than 4 million hectares of land planted with oil palm trees (Abdullah et al., 2010). Based on Abdullah et al. (2010), the land to labour ratio indicates labour shortage which was also been consistently reported by Adnan (2010) affecting the upstream production yield.

In terms of the gaps in knowledge, there was also lack of fundamental studies which describes the biomechanical actions of tasks performed by oil palm harvesters from the aspect of ergonomics as well as the risk factors associated with the development of musculoskeletal disorders. Without these knowledge, appropriate intervention or effective control cannot be applied where resources may be wasted on factors which were non-essential.

Besides that, from the various types and categories of intervention approach, socio-demographic background of agricultural workers particularly education level were among challenges and difficulties in ensuring the success of the intervention implemented (Belay and Abebaw, 2004). In Malaysia, although agricultural extension officers and courses exist in Malaysia, there seems to be lack of reporting or publication associated with the success of any such intervention.

It is noteworthy that an integrated intervention approach known as participatory action-oriented training (PAOT) approach has recently been highly promoted by International Labour Organization (ILO). This following the effectiveness demonstrated in developed and various developing countries (Kogi, 2006a; 2006b; 2007; 2008; 2012a; 2012b; Kawakami, et al., 2009) such as Japan, Vietnam, Thailand, Myanmar, Indonesia, etc.

Nevertheless, such approach in Malaysia has yet to be delved or if it has been tested, were not reported or published despite its potential to resolve the ergonomics, safety and health issues in workplace.

### 1.3 Study Justification

Malaysia palm oil industry is one of the national primary economics' contributors that span the entire value chain from plantations to downstream activities recording a high export volume of RM59.77 billion worth in revenue for 2010. It is estimated that more than half of a million workers are engaged in the upstream plantation sectors alone in the year 2010 (Abdullah et al., 2011).

Taking into account Occupational Safety and Health as a component in the sustainability framework (Figure 1.1), further investigation particularly of the upstream oil palm plantation sectors is required. This considering researches worldwide has consistently highlighted agricultural sectors as among the most hazardous industry with musculoskeletal disorders the most prevalent and costly of all work-related injuries (Rainbird and O'Neill, 1995; Mazza et al., 1997; Sesto, 2000; Chapman and Meyers, 2001; Davis and Kotowski, 2007).

The significance of this study is to provide an ergonomics insight to harvesting activities in oil palm plantation. The result from this research will reveal current scenario of safety and health cultures, awareness, and practices in Malaysia palm oil sectors including health impacts arises from work task. The primary findings of the existing hazards and exposure of oil palm plantation harvesters will further aid management of these risks in the field.

Proactive measures for controlling these risks can hence be planned the future to reduce exposure or risks level through necessary workplace improvements for the stakeholders. As such, this research will provide a platform for inculcating safety and health awareness through intervention program. It is expected that workplace improvement in terms of costs, productivities increase, knowledge, attitude, and practices will be achieved from reduced prevalence of MSD.

Following that, the critical success and failure factors can then be analyzed for a more comprehensively improved intervention program to be implemented for other similar oil palm plantations in the future. This will in turn benefit many stakeholders in the country especially by the government agencies in the planning and review of policy, guidelines, standards and practices.

Furthermore, it may be worthwhile to test the flexibility of PAOT approach which concept was simple, low-cost focusing on locally available good examples. Being practical, the improvement may be better accepted or applied on workers of lower socio-economics and communication difficulties. This further advantages the target group of this study; foreign labors, which were particularly hired by large profit-oriented multinational companies in Malaysia.

## **1.4 Objectives**

### **1.4.1 General Objective**

To determine the effectiveness of integrated ergonomics interventions approach in resolving ergonomics issues of harvesters and improve workplace during early harvesting stage in oil palm plantation in Johor, Malaysia.

### **1.4.2 Specific Objective**

The specific objectives of this research are to:

- i. Identify existing ergonomics risk factors of the work tasks performed by harvesters in oil palm plantations.
- ii. Determine the prevalence of musculoskeletal disorders among harvesters in oil palm plantation.
- iii. Determine the severity of awkward posture adopted during harvesting work tasks in oil palm plantations.
- iv. Determine the loss of productivities (in terms of sick leave – absenteeism, presenteeism, daily harvest quantity and efficiency score) among oil palm harvesters.
- v. Determine the association between productivities with the prevalence of musculoskeletal disorders among harvesters in oil palm plantation located at the state of Johor, Malaysia.
- vi. Determine the association between the potential risk factors with prevalence of musculoskeletal disorders among harvesters in oil palm plantation located at the state of Johor, Malaysia.
- vii. Determine the effectiveness of Participatory Action Oriented Approach intervention program between pre- and post-intervention among the intervention and control group to compare:
  - a. the knowledge, attitude and practices of ergonomics among harvesters in oil palm plantation located at the state of Johor, Malaysia.
  - b. the prevalence of musculoskeletal disorders complaints among harvesters in oil palm plantation located at the state of Johor, Malaysia.

## 1.5 Hypothesis

- i. There is significant association between the prevalence of musculoskeletal disorders with productivities among harvesters in oil palm plantation
- ii. There is significant association between the prevalence of musculoskeletal disorders and risk factors among harvesters in oil palm plantation
- iii. The PAOT intervention significantly increases knowledge, attitude and practices score from pre- to post-intervention among intervention and control group.
- iv. The PAOT intervention significantly decreases musculoskeletal disorders symptoms from pre- to post-intervention among intervention and control group.

## 1.6 Conceptual Framework

The conceptual framework (Figure 1.5) in this research is divided into two phases; Phase 1 describes the inter-relationship of dependent and independent variables while Phase 2 describes the concept of intervention approach. In this framework, harvesters interact with their tools as well as their working environment in a complex network of relationship.

This relationship derives the multitude of risk factors, which can be further divided into two major risk factors; the occupational risk factor and individual risk factors (Sanders, 2004; Karwowski and Marras, 1999). Individual risk factors can be further categorized into non-modifiable and modifiable individual risk factors. The occupational risk factors can be classified into ergonomics risk factors and exposure level based on the work environment and job demand at the workplace (Wahlstedt et al., 2010; David, 2005; Devereux, Buckle and Vlachonikolis, 1999).

The risk factors can co-exist in various combination based on different harvesting tools used (i.e.: chisel or sickle, motorized FFB collector or manual wheelbarrow) as well as different working environment (early harvesting stage, mid harvesting stage or late harvesting stage). These are among the primary variables potentially attributes to the development of musculoskeletal disorders (Greene, Goggins and Peterson, 2008; Sanders, 2004; Karwowski and Marras, 1999).

For instance, mechanically aided harvesters may have different risk factors as compared to harvesters using intensive manual labour. Concurrently differences may also be amplified by management of the plantation which practice different work system or work organization. Further differences can also characterized by the individual risk factors are non-modifiable risk factors such as age, gender, ethnicity, medical history and biodynamic response are among the variables that has been associated with work-related MSDs.

Another major non-modifiable risk factor is previous medical history. Past injuries or diseases such as fractures, tendon or ligament injuries from sports or arthritis may further increase risk of musculoskeletal disorders or aggravate existing MSDs (Sanders, 2004). Although the injuries or fractures may heal over time, alteration or exhaustion of the body sites may increase the susceptibility of developing musculoskeletal disorders.

On the other hand, the modifiable risk factors such as increased body mass index (BMI), smoking status, hobbies or sports activities and household chores or responsibilities has also been positively associated with MSDs. These adjustable factors if being modified or intervened towards a healthier lifestyle will reduce the risk of developing musculoskeletal disorders to a certain extent although excessive sports activities can be detrimental to some extent (Tsuboi et al., 2002).

While it has been shown in various epidemiological studies that exposure to occupational psychosocial and ergonomics risk factors (Karwowski and Marras, 1999); such as

awkward posture, forceful exertion, static loading, contact stress, vibration, repetitive motion and extreme environment as well as can cause MSDs, most workplace expose workers to a combination of two or more of these risk factors (Greene, Goggins and Peterson, 2008).

Exposure to the ergonomics risk factors are also highly dependent upon the level of exposure such as working history, frequency and duration of exposure as well as work organization (Marras and Karwowski, 2006). In particular, previous employment is an important consideration with regards to onset of development where past exposure may have been underlying cause and further aggravated by current work practices.

Conceptually, there are 4 types of intervention (Figure 1.6) targeted to reduce the overall musculoskeletal disorders of harvesters. Participatory Action Oriented Training program is an administrative design intervention developed to directly modify job or task, potentially through engineering improvement while increasing awareness.

It is expected that the increase of awareness may facilitate change of attitude and behavior. These changes including engineering improvement were ultimately targeted to reduce the ergonomics risk factors and the level of exposure as well as modifiable individual risk factors (Sanders, 2004; Marras and Karwowski, 2006).

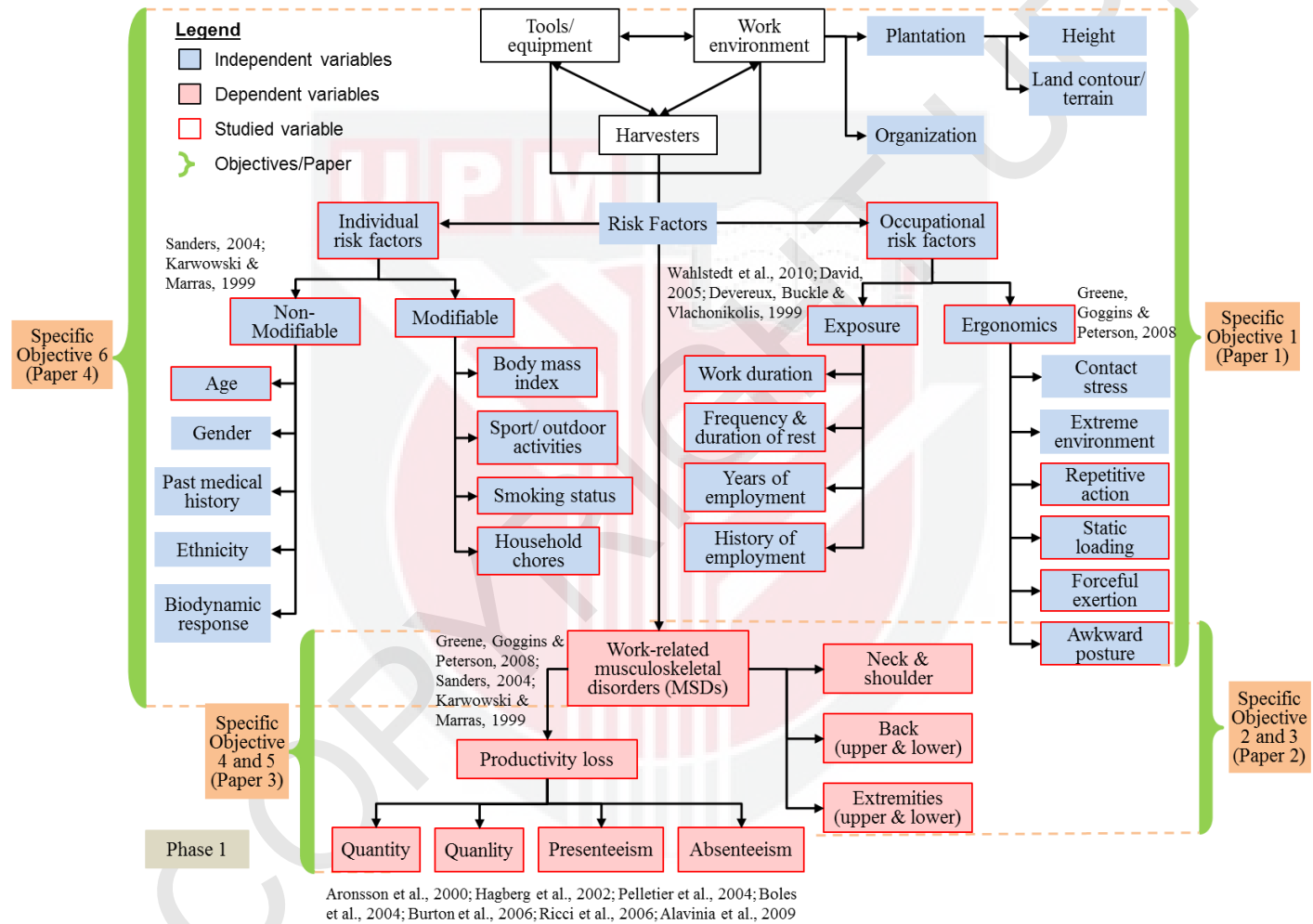
An example of engineering approach is the use of tools which are ergonomically designed to modify the risk factors. Compared to traditional work method or existing tool used, tools engineering approach target to alter the postural and force demand in reducing the risk of musculoskeletal disorders.

Alternatively, administrative strategy re-design workplace or work pace to allow longer rest or recovery period which is ergonomically sound and acceptable to the workers. Likewise, increase of awareness can be achieved through seminars, workshops or hands-on practical which target was to modify risk factors through increase of knowledge hence attitude, behavior and practices.

Integrating the hierarchy of controls, PAOT was designed to concurrently consider all approach which can be potentially applied at workplaces. The intervention is facilitated through a participative training session which focus highly on the use of a modified action checklist. The suggested intervention should originate from participants – usually the workers as they understand their workplace best.

The action checklist (ILO, 2010; 2012) is a concept based on local good practices which is low cost and simple to reduce the prevalence of intended health effect designed against it while increasing workplace safety, health and productivity (Kogi, 2006a; 2006b; 2007; 2008; 2012a; 2012b; Kawakami, 2009).

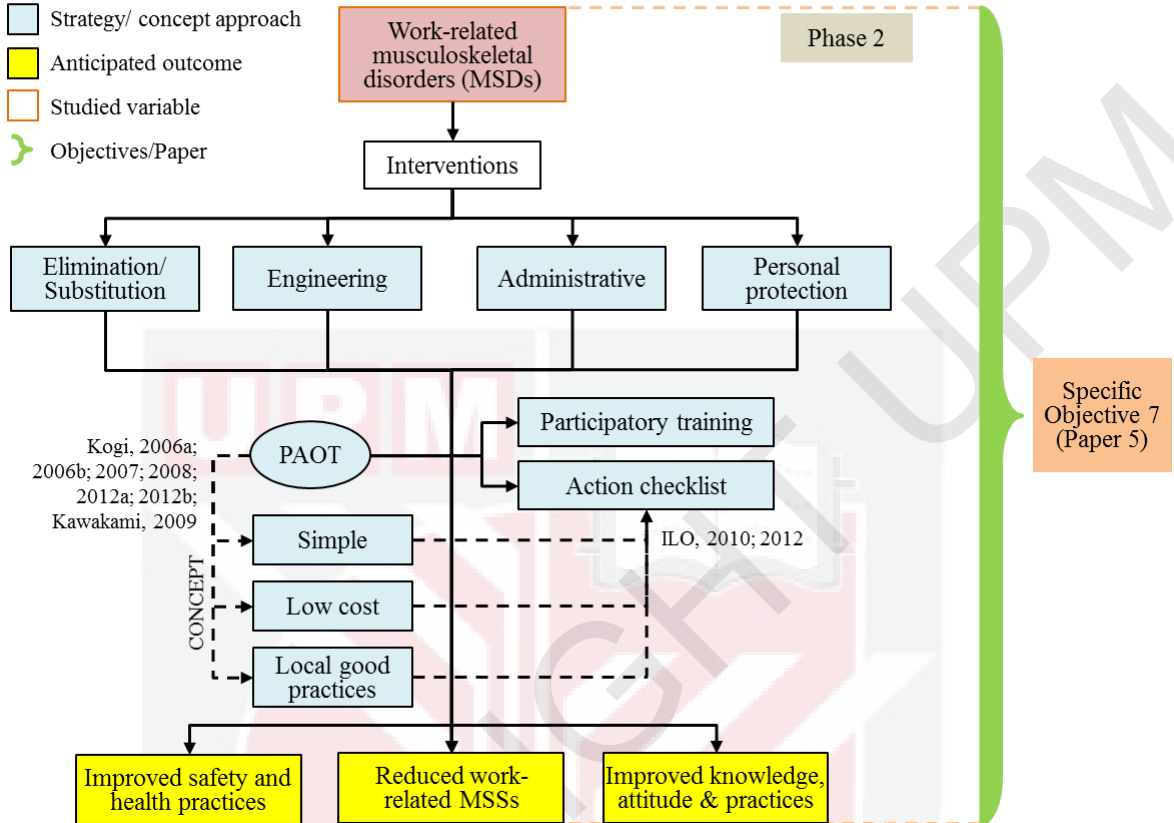




**Figure 1.5: Conceptual Framework of Phase 1 Research**

**Legend**

- Dependent variables
- Strategy/ concept approach
- Anticipated outcome
- Studied variable
- } Objectives/Paper



**Figure 1.6: Conceptual Framework of Phase 2 Research**

## **1.7 Conceptual and Operational Definitions**

### **1.7.1 Musculoskeletal disorders**

#### **i) Conceptual Definition**

By focusing the musculoskeletal anatomical counterpart of the disorders being address, MSDs can be defined as an umbrella term of the disorders or diseases affecting soft tissues of the body such as the muscles, tendons, ligaments, peripheral nerves, joints, cartilage, bones and/or supporting vessels which exclude acute or instantaneous attribution (US Department of Labour, 2012; Herrick and Dement, 2005).

#### **ii) Operational Definition**

The self-reported symptomatic complaints of pain, aches or discomfort on any of the body region; neck, shoulder, elbow, hand/arms, upperback, lowerback, one or both thigh(s), one or both knee(s), one or both ankle(s) at any time over the past 12 months and 7 days as obtained by modified NORDIC Musculoskeletal Questionnaires (NMQ) (Kuorinka et al., 1987) in this research.

### **1.7.2 Ergonomics risk factors**

#### **i) Conceptual Definition**

Ergonomics risk factors are the aspects of a job or task, behavior or work condition or situation that has been demonstrated through research which increases the risk of developing musculoskeletal disorders through biomechanical stress imposed on a worker such as awkward posture, forceful exertion, static loading, contact stress, vibration, repetitive motion, extreme environment (temperature, lighting, and noise), etc.

#### **ii) Operational Definition**

Ergonomics risk factors were the collective risks of developing musculoskeletal disorders based on the conceptual definition which were qualitatively identified during site visit and further observed through video recording. Specifically, awkward posture were quantitatively evaluated using Ovako Working Posture Assessment System (OWAS) (Karhu et al., 1977) for each harvesters based on postures adopted during harvesting tasks observed from their videos recorded.

### 1.7.3 Productivity

#### i) Conceptual Definition

The term productivity since first coined by Quesnay (1768) in the *Journal de l'Agriculture* has been defined and used widely by various people and organization. As Tangen (2005) and Mangat (2010) described, the multidimensional use of the term are dependent upon context within which it was used.

Nevertheless, based on an extensive review, productivity can be defined as “the ratio of what is produced to what is required to produce it” (Preece, 1983). This was concurrently the definition adopted by ILO (SAFEWORK, 2006), the Third Agenda of Global Employment Agenda discussing contribution of OSH in improving productivity.

In this study, productivity loss can be conceptually defined as the reduction of productivity due to unanticipated conditions – in this case health-related, injuries or illnesses. In layman term, loss of productivity is thus the differences of productivity which is actually observed and that of might have been expected without the unanticipated conditions – ideal situation.

#### ii) Operational Definition

Productivities of the workers are expressed as losses in this study where the four different dimensions were as described in Table 1.1.

**Table 1.1: Operational definition of productivity expressed in four derivatives**

<b>Productivity</b>	<b>Operational definition</b>
Daily weight of FFB harvested	The weight of daily harvest for each pair of harvested as recorded by the plantation management
Sick leave	Self-reported absence of harvesters from work due to pain or disorders of the musculoskeletal system
Presenteeism	Self-reported attendance to work despite experiencing pain or disorders of the musculoskeletal system
Efficiency	A 10-point quantity and quality numerical rating scale which are rated by harvesters of the work performed during presenteeism.

## **1.7.4 Knowledge, Attitude and Practices**

### **i) Conceptual Definition**

Knowledge in terms of health refers to a set of understanding and of science. The degree or the body of knowledge commonly acquired either via formal education and informal education provides one's capacity for imagining or perceiving which translates into attitude and practices in the domain of health (Gumucio et al., 2011).

Practice or sometimes used inter-exchangeable with behavior is an observable actions of individual. Although it is common to attribute actions as a response to the specific health event as a result of the knowledge acquired, it is however not always the case as the individual may subjectively act contrastingly (Gumucio et al., 2011).

On the other hand, attitude explains the subjective idea or perception which exists between the state of knowledge and practice response to the environment as a way of being or position towards the event. Attitude is not an observable intermediate variable but may help explain among the possible practices when the individual is subjected to stimulus (Gumucio et al., 2011).

Hogg and Vaughan (2005) on the other hand describe attitude as tendencies in terms of beliefs, feelings and behavioral towards objects, events, groups or symbols while Eagly and Chaiken (1993) define attitude as psychological tendency of expression or evaluation with certain degree of favor or disfavor towards a particular entity.

### **ii) Operational Definition**

Current and post-intervention knowledge, attitude and practices of harvesters on Occupational Safety, Health and Ergonomics (OSHE) related to their work tasks were measured using a set of self-administered questionnaire. Respondents' score of knowledge, attitude and practices are calculated and classified respectively which will be further described in Chapter 3.

## CHAPTER SUMMARY

This chapter has provided a brief introduction to the background of oil palm and the problem faced by the oil palm plantation. The importance of this research has also been justified, where the objectives and the corresponding hypothesis of this study were being specified. The conceptual framework of this research has been presented whereas the key terminology used in this research has also been defined conceptually and operationally.



## REFERENCES

- Abdullah, R., Ismail, A., Khomeini, A., & Rahman, A. (2011). – Labor Requirements in the Malaysian Palm Oil Industry in 2010. *Oil Palm Industry Economic Journal*, 11(2), 1-12.
- Abubakar, M. S. A., Ahmad, D., & Akande, F. B. (2010). A Review of Farm Tractor Overturning Accidents and Safety. *Pertanika Journal of Science & Technology*, 18(2).
- Adnan, H. (2010). Labour Shortage Affecting Oil Palm Plantations. Retrieved from The Star Online: <http://biz.thestar.com.my/news/story.asp?file=/2010/2/9/business/5637194&sec=business>
- Adnan, H. (2012). Help for palm oil industry. Kuala Lumpur, Federal Territories, Malaysia: The Star. Retrieved November 28, 2012, from <http://biz.thestar.com.my/news/story.asp?file=/2012/5/15/business/11290403&sec=business>
- Adnan, H. (2012, May 29). Labor shortage to get worse with Indonesian oil palm boom. Retrieved from The Star Online: <http://biz.thestar.com.my/news/story.asp?file=/2012/5/29/business/11372483&sec=business>
- Alexopoulos, E. C., Burdorf, A., & Kalokerinou, A. (2003). Risk factors for musculoskeletal disorders among nursing personnel in Greek hospitals. *International Archives of Occupational and Environmental Health*, 76(4), 289-294.
- Åkesson, I., Johnsson, B., Rylander, L., Moritz, U., & Skerfving, S. (1999). Musculoskeletal disorders among female dental personnel—clinical examination and a 5-year follow-up study of symptoms. *International archives of occupational and environmental health*, 72(6), 395-403.
- Åkesson, I., Schütz, A., Horstmann, V., Skerfving, S., & Moritz, U. (1999). Musculoskeletal symptoms among dental personnel;-lack of association with mercury and selenium status, overweight and smoking. *Swedish dental journal*, 24(1-2), 23-38.
- Alavanja, M. C., Samanic, C., Dosemeci, M., Lubin, J., Tarone, R., Lynch, C. F., Knott, C., Thomas, K., Hoppin, J. A., Barker, J., Coble, J., Sandler, D. P. & Blair, A. (2003). Use of agricultural pesticides and prostate cancer risk in the Agricultural Health Study cohort. *American Journal of Epidemiology*, 157(9), 800-814.
- Alavinia, S. M., Molenaar, D., Burdorf, A. (2009). Productivity Loss in the Workforce: Associations With Health, Work Demands, and Individual Characteristics. *American Journal of Industrial Medicine*, 52, 49-56.



- Allen, H., Hubbard, D., & Sullivan, S. (2005). The burden of pain on employee health and productivity at a major provider of business services. *Journal of Occupational and Environmental Medicine*, 47(7), 658-670.
- Anderson J.J., Felson D.T. Factors associated with osteoarthritis of the knee in the first national health and nutrition examination survey (HANES I): evidence for an association with overweight, race and physical demands of work. *Am J Epidemiol*. 1988; 28: 179-189.
- Aronsson, G., Gustafsson, K., Dallner, M. (2000). Sick but yet at work. An empirical study of sickness presenteeism. *J Epidemiol Community Health*, 54, 502-509.
- Ariëns, G. A. M., Bongers, P. M., Douwes, M., Miedema, M. C., Hoogendoorn, W. E., van der Wal, G., ... & van Mechelen, W. (2001). Are neck flexion, neck rotation, and sitting at work risk factors for neck pain? Results of a prospective cohort study. *Occupational and Environmental Medicine*, 58(3), 200-207.
- Ariëns, G. A., van Mechelen, W., Bongers, P. M., Bouter, L. M., & van der Wal, G. (2001). Psychosocial risk factors for neck pain: a systematic review. *American journal of industrial medicine*, 39(2), 180-193.
- Arphorn, S., Brooks, R., & Permsirivanich, P. (2006). Chainat: a case study in occupational health and safety promotion for farmers. *Industrial health*, 44(1), 98-100.
- Atabanii, A. E., Silitonga, A. S., Badruddin, I. A., Mahlia, T., Masjuki, H. H., & Mekhilef, S. (2012, May). A comprehensive review on biodiesel as an alternative energy resource and its characteristics. *Renewable and Sustainable Energy Reviews*, 16(4), 2070–2093.
- Barnekow-Bergkvist, M., Hedberg, G. E., Janlert, U., & Jansson, E. (1998). Determinants of self-reported neck-shoulder and low back symptoms in a general population. *Spine*, 23(2), 235-243.
- Basiron, Y. (2002). Palm Oil and Its Global Supply and Demand Prospects. *Oil Palm Industry Economic Journal*, 2(1), 1 - 10.
- Basiron, Y. (2007, April). Palm oil production through sustainable plantations. *European Journal of Lipid Science and Technology*, 109(4), 289–295.
- Belay, K., & Abebaw, D. (2004). Challenges Facing Agricultural Extension Agents: A Case Study from South-western Ethiopia. *African Development Review*, 16(1), 139-168.
- Benavides, F. G. (2006). Ill health, social protection, labour relations, and sickness absence. *Occup Environ Med*, 63, 228-229.
- Bernard, C., Courouve, L., Bouée, S., Adjémian, A., Chrétien, J. C., Niedhammer, I. (2011). Biomechanical and psychosocial work exposures and musculoskeletal symptoms among vineyard workers. *Journal of Occupational Health*, 53(5):297-311

- Boles, M., Pelletier, B., Lynch, W. (2004). The Relationship Between Health Risks and Work Productivity. *J Occup Environ Med*, 46, 737-745.
- Boocock, M., J.M.K., C., McNair, P., M., S., Larmer, P., & B., A. (2009). A Framework for the Classification and Diagnosis of Work-Related Upper Extremity Conditions: Systematic Review. *Seminars in Arthritis and Rheumatism*, 38(4), 296-311.
- BorneoPost. (2012, November 28th). Addressing shortage of labour in the oil palm industry. Kuching, Sarawak, Malaysia. Retrieved from <http://www.theborneopost.com/2012/06/17/addressing-shortage-of-labour-in-the-oil-palm-industry/>
- Brouwer, W. B. F. , van Exel, N. J. A., Koopmanschap, M. A., Rutten, F. F. H. (2002). Productivity costs before and after absence from work: as important as common? *Health Policy*, 61, 173-187.
- Brouwer, W. B. F., Koopmanschap, M. A., Rutten, F. F. H. (1999). Productivity losses without absence: measurement validation and empirical evidence. *Health Policy*, 48, 13-27.
- Burton, W. N., Chen, C. Y., Conti, D. J., Schultz, A. B., Edington, D. W. (2006). The Association Between Health Risk Change and Presenteeism Change. *J Occup Environ Med*, 48, 252-263.
- Burton, W., Conti, D., Chen, C., Schultz, A., Edington, D. (2002). The economic burden of lost productivity due to migraine headache: a specific worksite analysis. *J Occup Environ Med*, 44(6), 523-529.
- Calvert, G. M., Karnik, J., Mehler, L., Beckman, J., & Morrissey, B., Sievert, J., Barrett, R., Lackovic, M., Mabee, L., Schwartz, A., Mitchell, Y. and Moraga-MCHaley, S. (2008). Acute pesticide poisoning among agricultural workers in the United States, 1998–2005. *Am. J. Ind. Med.* 51:883–98.
- Carter, G. W. (1959). Action research. *Community Organization in Action*, 194-200.
- Cassou, B., Derriennic, F., Monfort, C., Norton, J., & Touranchet, A. (2002). Chronic neck and shoulder pain, age, and working conditions: longitudinal results from a large random sample in France. *Occupational and Environmental Medicine*, 59(8), 537-544.
- CDC (2007). Third National Health and Nutrition Examination Survey. Anthropometry Procedures Manual, Revised December 2000. Available at <http://www.cdc.gov/nchs/data/nhanes/bm.pdf>. Accessed in December 2000.
- Chapman, L. & Meyers, J. (2001) Ergonomics and musculoskeletal injuries in agriculture: recognizing and preventing the industry's most widespread health and safety problem. *Agric. Saf. Heal. Conf. Proc.*
- Chapman, L. J., Newenhouse, A. C., Meyer, R. H. and Taveira A. D., Karsh, B. Z., Ehlers, J. J. and Palermo, T. (2004). Evaluation of an intervention to reduce

musculoskeletal hazards among fresh market vegetable growers. *Applied Ergon.*, 35: 57-66. DOI: 10.1016/j.apergo.2003.05.001

Chapman, L. J., Newenhouse, A. C., Pereira, K. M., Karsh, B. T., Meyer, R. M., Brunette, C. M., & Ehlers, J. J. (2008). Evaluation of a four year intervention to reduce musculoskeletal hazards among berry growers. *Journal of safety research*, 39(2), 215-224.

Chapman, L., Meyers, J. M. (2004, October). Ergonomics and musculoskeletal injuries in agriculture: recognizing and preventing the industry's most widespread health and safety problem. Retrieved October 17, 2012, from National Agricultural Safety Database: <http://nasdonline.org/document/1839/d001771/ergonomics-and-musculoskeletal-injuries-in-agriculture.html>

Cheng, H. (2010). Key Sustainability Issues in the Palm Oil Sector. Retrieved October 10, 2012, from International Finance Corporation: [http://www.ifc.org/ifcext/agriconsultation.nsf/AttachmentsByTitle/Discussion+Paper/\\$FILE/Discussion+Paper\\_FINAL.pdf](http://www.ifc.org/ifcext/agriconsultation.nsf/AttachmentsByTitle/Discussion+Paper/$FILE/Discussion+Paper_FINAL.pdf)

Choi, B. C. K. and Pak, A.W.P. (2005). A catalog of biases in questionnaires. *Prev. Chronic Dis.*, 2: A13.

Cole, D., Rivilis, I., Van Eerd, D., Cullen, K., Irvin, E., & Kramer, D. (2005). Effectiveness of participatory ergonomic interventions: a systematic review. Toronto: Institute for Work & Health.

Corley, R. (2005, October - December). Palm Oil for World Food Needs. (B. Sron, Ed.) *GLOBAL OILS & FATS BUSINESS MAGAZINE*, 2(4), pp. 7-13. Retrieved October 10, 2012, from: <http://theoilpalm.org/wp-content/themes/oilpalm/pdf/GOFB%202-4.pdf>

Costa, B. R., & Vieira, E. R. (2010). Risk factors for work-related musculoskeletal disorders: a systematic review of recent longitudinal studies. *American journal of industrial medicine*, 53(3), 285-323.

Daniel W. W. (1999). *Biostatistics: A Foundation for Analysis in the Health Sciences*. 7th edition. New York: John Wiley & Sons

David, G. C. (2005). Ergonomic methods for assessing exposure to risk factors for work-related musculoskeletal disorders. *Occupational Medicine*, 55(3), 190-199.

Davis, K. G., Kotowski, S. E. (2007). Understanding the ergonomic risk for musculoskeletal disorders in the United States agricultural sector. *Am. J. Ind. Med.* 50(7):501-11.

de Zwart, B. C., Broersen, J. P., Frings-Dresen, M. H., & van Dijk, F. J. (1997). Musculoskeletal complaints in The Netherlands in relation to age, gender and physically demanding work. *International archives of occupational and environmental health*, 70(5), 352-360.

- Devereux, J. J., Buckle, P. W., & Vlachonikolis, I. G. (1999). Interactions between physical and psychosocial risk factors at work increase the risk of back disorders: an epidemiological approach. *Occupational and Environmental Medicine*, 56(5), 343-353.
- Dillon C. F. (2004). The Medical Context. In Sanders M.J. (2004). *Ergonomics and the Management of Musculoskeletal Disorders*, 2nd Edition. St. Louis, Missouri: Butterworth-Heinemann.
- DOSH (2009). "Annual Report," Department of Occupational Safety and Health (DOSH): Putrajaya.
- DOSH (2010). "Annual Report," Department of Occupational Safety and Health (DOSH): Putrajaya.
- DOSH (2011). "Annual Report," Department of Occupational Safety and Health (DOSH): Putrajaya.
- Driessen, M. T., Proper, K. I., van Tulder, M. W., Anema, J. R., Bongers, P. M., & van der Beek, A. J. (2010). The effectiveness of physical and organisational ergonomic interventions on low back pain and neck pain: a systematic review. *Occupational and environmental medicine*, 67(4), 277-285.
- Eagly, A. H., & Chaiken, S. (1993). *The psychology of attitudes*. Harcourt Brace Jovanovich College Publishers.
- Elkind, P. D. (1993). Correspondence between knowledge, attitudes, and behavior in farm health and safety practices. *Journal of Safety Research*, 24(3), 171-179.
- Elliott, A. M., Smith, B. H., Penny, K. I., Cairns Smith, W., & Alastair Chambers, W. (1999). The epidemiology of chronic pain in the community. *The lancet*, 354(9186), 1248-1252.
- Engholm G., Holmström, E. (2005). Dose-response associations between musculoskeletal disorders and physical and psychosocial factors among construction workers. *Scand. J. Work. Environ. Health*. 57–67.
- Eriksen, W. (2003). The prevalence of musculoskeletal pain in Norwegian nurses' aides. *International archives of occupational and environmental health*, 76(8), 625-630.
- ETP, 2013. Deepening malaysia's palm oil advantage. ETP.
- EU-OSHA, European Agency for Safety and Health at Work. (2009, October 04). The human-machine interface as an emerging risk. Retrieved from The human-machine interface as an emerging risk - Safety and Health at Work - EU OSHA: [https://osha.europa.eu/en/publications/literature\\_reviews/HMI\\_emerging\\_risk](https://osha.europa.eu/en/publications/literature_reviews/HMI_emerging_risk)
- Eva, V., Lars, A., Evy, F., & Christer, H. (1992). Disability Pensions Due to Musculo-Skeletal Disorders among Men in Heavy Occupations A Case-Control Study. *Scandinavian Journal of Public Health*, 20(1), 31-36.

- Fairhurst, T. H. and Mutert, E. (1999). Introduction to palm oil production. *Better Crops Int.*, 13: 3-6.
- FAO (2009). Global agriculture towards 2050. (2009, October 12-13). Retrieved from United Nation Food and Agriculture Organization: [http://www.fao.org/fileadmin/templates/wsfs/docs/Issues\\_papers/HLEF2050\\_Global\\_Agriculture.pdf](http://www.fao.org/fileadmin/templates/wsfs/docs/Issues_papers/HLEF2050_Global_Agriculture.pdf)
- FAO. (2002). Small-Scale Palm oil processing in Africa. *FAO Agricultural Services Bulletin*. 148, Rome, Italy.
- Fathallah, F. A. (2010). –Musculoskeletal disorders in labor-intensive agriculture–. *Applied Ergonomics*, 41(6), 738-743.
- Fathallah, F. A., Meyers, J. M., & Janowitz, I. (2004). Stoop and Squatting Postures in the Workplace. *Stoop and Squatting Postures in the Workplace* (pp. 8-9). Oakland: University of California.
- Faucett, J., Meyers, J., Miles, J., Janowitz, I., & Fathallah, F. (2007). Rest break interventions in stoop labor tasks. *Applied ergonomics*, 38(2), 219-226.
- Felson, D. T., Hannan, M. T., Naimark, A., Berkeley, J., Gordon, G., Wilson, P. W., & Anderson, J. (1991). Occupational physical demands, knee bending, and knee osteoarthritis: results from the Framingham Study. *The Journal of rheumatology*, 18(10), 1587-1592.
- Fewtrell, M. S., Kennedy, K., Singhal, A., Martin R. M. and Ness A., Hadders-Algra, M., Koletzko, B. and Lucas, A. (2008). How much loss to follow-up is acceptable in long-term randomised trials and prospective studies? *Arch. Dis. Child.*, 93: 458-461. DOI: 10.1136/adc.2007.127316
- Figá-Talamanca, I. (1972). Inconsistencies of attitudes and behavior in family-planning studies. *J. Marriage Family*, 34: 336-344.
- FIOH (2009, June). OWAS (Ovako Working Posture Analysis System). June 2009. Available at [http://www.ttl.fi/en/ergonomics/methods/workload\\_exposure\\_methods/table\\_and\\_methods/Documents/OWAS.pdf](http://www.ttl.fi/en/ergonomics/methods/workload_exposure_methods/table_and_methods/Documents/OWAS.pdf). Accessed October 1, 2013.
- Fjellman-Wiklund, A., Brulin, C., & Sundelin, G. (2003). Physical and psychosocial work-related risk factors associated with neck-shoulder discomfort in male and female music teachers. *Medical Problems of Performing Artists*, 18(1), 33-41.
- Fredriksson, K., Alfredsson, L., Thorbjörnsson, C. B., Punnett, L., Toomingas, A., Torgen, M., & Kilbom, A. (2000). Risk factors for neck and shoulder disorders: A nested case-control study covering a 24-year period. *American journal of industrial medicine*, 38(5), 516-528.
- Forde, M. S., Punnett, L., & Wegman, D. H. (2002). Pathomechanisms of work-related musculoskeletal disorders: conceptual issues. *Ergonomics*. 45(9), 619-630.

- Friedrich, M., Cermak, T., & Heiller, I. (2000). Spinal troubles in sewage workers: epidemiological data and work disability due to low back pain. *International archives of occupational and environmental health*, 73(4), 245-254.
- Fuhs, E. (2008). Pesticide-Related Cancers in Farmers. *The Journal of Undergraduate Nursing Writing*, 2(1):10-16
- Gatchel, R. J. (2004). Musculoskeletal disorders: primary and secondary interventions. *Journal of Electromyography and Kinesiology*, 14(1), 161-170.
- Goetzel, R. Z. and Ozminkowski, R. J. (2008). The health and cost benefits of work site health-promotion programs. *Annu. Rev. Public Health*, 29: 303-323. DOI: 10.1146/annurev.publhealth.29.020907.090930
- Gomez, M., Hwang, S., Stark, A., May, J., Hallman, E., Pantea, C. (2003). An analysis of self-reported joint pain among New York farmers. *Journal of Agricultural Safety and Health*, 9(2), 143-157.
- Goutille, F., Crini, V., Jullien, P. (2009, October). Knowledge, Attitudes and Practices for Risk Education: how to implement KAP surveys. *Handicap International*.
- Grandjean, E. (1980). *Fitting the task to the man*. London: Taylor & Francis.
- Greene, L., & Goggins, R. W. (2008). *Save Your Hands!: The Complete Guide to Injury Prevention and Ergonomics for Manual Therapists*. Body of Work Books.
- Gumucio, S., Merica, M., Luhmann, N., Fauvel, G., Zompi, S., Ronsse, A., Courcaud, A., Bouchon, M., Trehin, C., Schapman, S., Cheminat, O., Ranchal, H., Simon, S., du Monde, M., (January, 2011). *The KAP Survey Model (Knowledge, Attitude Practices)*. IGC Communigraphie.
- Guo, H. R., Chang, Y. C., Yeh, W. Y., Chen, C. W., & Guo, Y. L. (2004). Prevalence of musculoskeletal disorder among workers in Taiwan: a nationwide study. *Journal of occupational health*, 46(1), 26-36.
- Gusetoiu, R. I., & Smaranda, A. (2012). *Musculoskeletal Disorders in Agriculture*. Retrieved October 15, 2012, from General Association of Engineers in Romania (AGIR): <http://www.agir.ro/buletine/1276.pdf>
- Hagberg, M., Tornqvist, E. W., Toomingas, A. (2002). Self-Reported Reduced Productivity Due to Musculoskeletal Symptoms: Associations with Workplace and Individual Factors Among White Collar Computer Users. *Journal of Occupational Rehabilitation*, 12(3), 151-162.
- Hagen, K. B., Magnus, P., & Vetlesen, K. (1998). Neck/shoulder and low-back disorders in the forestry industry: relationship to work tasks and perceived psychosocial job stress. *Ergonomics*, 41(10), 1510-1518.
- Hancock, P. A. and Diaz, D. D. (2002). Ergonomics as a foundation for a science of purpose, *Theor. Issues Ergonomics Sci.* 3 (2), 115–123.

- Hancock, P.A. (1997). *Essays on the future of human-machine systems*. Minneapolis, MN: Banta.
- Hashim, K., & Yuen, Y. (2007, April - June). Peaceful Co-existence. (Y. Basiron, Ed.) *Global Oils and Fats Business Magazine*, 4(2), pp. 6-12.
- Helali, F., 2009. Using ergonomics checkpoints to support a participatory ergonomics intervention in an Industrially Developing Country (IDC)--a case study. *Int. J. Occupat. Safety Ergon.*, 15: 325-337. PMID: 19744374
- Hendra, Rahardjo, S. (2009). Risiko Ergonomi Dan Keluhan Musculoskeletal Disorders (MSDs) Pada Pekerja Panen Kelapa Sawit. *Prosiding Seminar Nasional Ergonomi IX* (pp. D11-1 - D11-8). Semarang: TI-UNDIP.
- Henriksson, J. (2012, June). The Malaysian Palm Oil Sector – Overview. Retrieved October 10, 2012, from National Institute for Foreign Trade: [http://www.ice.gov.it/paes/asia/malaysia/upload/173/Palm%20Oil\\_overview\\_2012.pdf](http://www.ice.gov.it/paes/asia/malaysia/upload/173/Palm%20Oil_overview_2012.pdf)
- Henry, L. J., Jafarzadeh Esfehiani, A., Ramli, A., Ishak, I., Justine, M., and Mohan, V. (2013). Patterns of Work-Related Musculoskeletal Disorders Among Workers in Palm Plantation Occupation. *Asia Pac J Public Health*. (Epub 2013 Feb 14)
- Herrick, R. F. & Dement, J. M., (2005). Principles of Industrial Hygiene. In Rosenstock L., Cullen M.R., Brodtkin C.A., Redlich C.A. (2005). *Textbook of clinical occupational and environmental medicine* (p. 495). Philadelphia: Elsevier-Saunders.
- Hogg, M., & Vaughan, G. (2005). *Social Psychology* (4th edition). London: Prentice-Hall.
- Hignett, S., Wilson, J. R., & Morris, W. (2005). Finding ergonomic solutions—participatory approaches. *Occupational medicine*, 55(3), 200-207.
- Hildebrandt, V. H. (1995). Musculoskeletal symptoms and workload in 12 branches of Dutch Agriculture. *Ergonomics*, 38, 2576-2587.
- Holmberg, S., Stiernström, E., Thelin, A., Svärdsudd, K. (2002). Musculoskeletal symptoms among farmers and non-farmers: a population-based study. *International Journal of Occupational and Environmental Health*, 8(4), 339-345.
- Holmberg, S., Thelin, A., Stiernström, E. L., Svärdsudd, K. (2003). The Impact of Physical Work Exposure on Musculoskeletal Symptoms among Farmers and Rural Non-Farmers. A population-based study. *American Journal of Industrial Medicine*, 10, 179-184.
- Howe, L.D., Tilling, K., Galobardes, B., and Lawlor, D. A. (2013). Loss to follow-up in cohort studies: Bias in estimates of socioeconomic inequalities. *Epidemiology*, 24: 1-9. DOI: 10.1097/EDE.0b013e31827623b1

- ILO (2010). Ergonomic Checkpoints: Practical and Easy-To-Implement Solutions for Improving Safety, Health and Working Conditions. 2nd Edn., International Labour Office, Geneva, ISBN: 978-9221226666.
- ILO (2012a). Ergonomic checkpoints in agriculture: Practical and easy-to-implement solutions for improving safety, health and working conditions in agriculture. International Labour Organization.
- ILO (2012b). Stress Prevention at Work Checkpoints. Practical improvements for stress prevention in the workplace. International Labour Organization.
- ILO. (2000, June 15). Safety and Health in Agriculture. Report VI (1) - Sixth item on the Agenda. Geneva, Switzerland. Retrieved from: <http://www.ilo.org/public/english/standards/relm/ilc/ilc88/rep-vi-1.htm>
- International Ergonomics Association (2011). What is Ergonomics. [http://www.iea.cc/01\\_what/What%20is%20Ergonomics.html](http://www.iea.cc/01_what/What%20is%20Ergonomics.html). (Accessed 6 December 2011)
- Janowitz, I., Tejada, D. G., Miles, J. A., Duraj, V., Meyers, J. M., & Faucett, J. (2000, July). Ergonomics interventions in the manual harvest of wine grapes. In Proceedings of the Human Factors and Ergonomics Society Annual Meeting (Vol. 44, No. 22, pp. 628-630). SAGE Publications.
- Jafry, T., & O'Neill, D. H. (2000). The application of ergonomics in rural development: a review. *Applied Ergonomics*, 31(3), 263-268.
- Johns, G. (2010). Presenteeism in the workplace: A review and research agenda. *Journal of Organizational Behavior*, 31, 519-542. doi:10.1002/job.630
- Kaliyaperumal, K. (2004) Guideline for Conducting a Knowledge, Attitude and Practice (KAP) Study. *AECS Illumination* Vol. IV, No.1, Jan - Mar 2004.
- Karhu, O., Kansil, P., Kuorinka, I. (1997). Correcting working postures in industry: a practical method for analysis. *Appl. Ergon.* 8(4):199-201.
- Karsh, B. T., Moro, F. B., & Smith, M. J. (2001). The efficacy of workplace ergonomic interventions to control musculoskeletal disorders: a critical analysis of the peer-reviewed literature. *Theoretical Issues in Ergonomics Science*, 2(1), 23-96.
- Karwowski, W., Marras, W. S. (1999). *The Occupational Ergonomics Handbook*, Boca Raton, FL: CRC Press.
- Karwowski, W., Marras, W. S. (2003) *Occupational Ergonomic Principles of Work Design*. Boca Raton: CRC Press.
- Kawakami, T., Khai, T. T., & Kogi, K. (2003). Work improvement in neighbourhood development-Training programme on safety, health and working conditions in agriculture. ECHO, Can Ton, Viet nam.
- Kawakami, T., Khai, T.T. and Kogi, K. (2009). Developing the WIND Training Programme in Asia; Participatory Approaches to Improving Safety, Health and



Working Conditions of Farmers. ILO Subregional Office for East Asia, Bangkok.

Kawakami, T., Khai, T.T., Kogi, K. (2003). Work Improvement in Neighbourhood Development programme (WIND): training programme on safety, health and working conditions in agriculture. International Labour Organization.

Keyserling, W. M. (1986). Postural analysis of the trunk and shoulders in simulated real time. *Ergonomics*, 29(4):569-583.

Khai, T. T., Kawakami T. and Kogi, K. (2011). Participatory action-oriented training. International Labour Organization.

Kirkhorn, S. R., Earle-Richardson, G. and Banks, R. J. (2010). Ergonomic risks and musculoskeletal disorders in production agriculture: Recommendations for effective research to practice. *J. Agromed.*, 15: 281-299. DOI: 10.1080/1059924X.2010.488618

Kogi K, Kawakami T (1996) JILAF POSITIVE program—Training manual for occupational safety and health—. Japan International Labour Foundation and Institute for Science of Labour.

Kogi, K. (2006a). Advances in participatory occupational health aimed at good practices in small enterprises and the informal sector. *Indus. Health*, 44: 31-34. DOI: 10.2486/indhealth.44.31

Kogi, K. (2006b). Participatory methods effective for ergonomic workplace improvement. *Applied Ergonom.*, 37: 547-554. DOI: 10.1016/j.apergo.2006.04.013

Kogi, K. (2007). Action oriented use of ergonomic checkpoints for healthy work design in different settings. *Journal of human ergology*, 36, 37-43.

Kogi, K. (2008). Facilitating participatory steps for planning and implementing low-cost improvements in small workplaces. *Applied Ergonom.*, 39: 475-481. DOI: 10.1016/j.apergo.2008.02.017

Kogi, K. (2012a). Roles of participatory action-oriented programs in promoting safety and health at work. *Safety Health Work*, 3: 155-165. DOI: 10.5491/SHAW.2012.3.3.155

Kogi, K. (2012b). Practical ways to facilitate ergonomics improvements in occupational health practice. *J. Human Factors Ergonom. Society*, 54: 890-900. DOI: 10.1177/0018720812456204

Kohn, J. P. (1998). Ergonomic process management. CRC Press. Boca Raton, FL.

Korhonen, T., Ketola, R., Toivonen, R., Luukkonen, R., Häkkinen, M., & Viikari-Juntura, E. (2003). Work related and individual predictors for incident neck pain among office employees working with video display units. *Occupational and environmental medicine*, 60(7), 475-482.

- Kotowski, S. E., Davis, K. G., & Waters, T. R. (2009). Investigation of Select Ergonomic Interventions for Farm Youth. Part 2: Wheelbarrows. *Journal of Agromedicine*, 14(1), 44-57.
- Krause, N., Ragland, D. R., Fisher, J. M., & Syme, S. L. (1998). Psychosocial job factors, physical workload, and incidence of work-related spinal injury: a 5-year prospective study of urban transit operators. *Spine*, 23(23), 2507-2516.
- Kristman, V., M. Manno and P. Cote (2004). Loss to follow-up in cohort studies: How much is too much? *Eur. J. Epidemiol.*, 19: 751-760. DOI: 10.1023/B:EJEP.0000036568.02655.f8
- Kumkum, P. (2012). An OWAS-Based Analysis of Workers Engaged in Brick Making Factories, Faizabad District of Uttar Pradesh, India. *Journal of Ergonomics*.
- Kuorinka, I., & Patry, L. (1995). Participation as a means of promoting occupational health. *International Journal of Industrial Ergonomics*, 15(5), 365-370.
- Kuorinka, I., Jonsson, B., Kilbom, A., Vinterberg, H., Biering-Sørensen, F., Andersson, G., Jørgensen, K. (1987). Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms. *Appl Ergon*, 18, 233-237.
- Lee, C. (2012). Work-related musculoskeletal disorders in Korean farmers. *J Korean Med Assoc.*, 55(11), 1054-1062.
- Lehtola, M. M., Rautiainen, R. H., Day, L. M., Schonstein, E. and Suutarinen, J., Salminen, S., Verbeek, J. H. (2008). Effectiveness of interventions in preventing injuries in agriculture-a systematic review and meta-analysis. *Scandinavian J. Work Environ. Health*, 34: 327-336.
- Leigh, J. and Sheetz, R. (1989). Prevalence of back pain among fulltime United States workers. *British Journal of Industrial medicine*, 46(9), 651-657.
- Lerner, D., Amick III, B. C., Lee, J. C., Rooney, T., Rogers, W. H., Chang, H., & Berndt, E. R. (2003). Relationship of employee-reported work limitations to work productivity. *Medical Care*, 41(5), 649-659.
- Lesaffre, E. and Verbeke, G. (2005) Clinical trials and intervention studies. In: Everitt B, Howell D, editors. *Encyclopedia of Statistics in Behavioral Science*. Second Edition ed. Wiley.
- Levin, K. A. (2006). Study design III: Cross-sectional studies. *Evidence-based dentistry*. 7(1), 24-25.
- Lewin, K. (1946) Action research and minority problems. *J Soc. Issues*. 2(4): 34-46.
- Linaker, C., & Smedley, J. (2002). Respiratory illness in agricultural workers. *Occupational Medicine*, 52(8), 451-459.
- Lipscomb, J. A., Trinkoff, A. M., Geiger-Brown, J., & Brady, B. (2002). Work-schedule characteristics and reported musculoskeletal disorders of registered nurses. *Scandinavian journal of work, environment & health*, 394-401.

- Liv, P. Efficient strategies for collecting posture data using observation and direct measurement. Doctoral dissertation, Umeå University. 2012.
- Loo, H. S. and Richardson, S. (2012). Ergonomics issues in Malaysia. *J. Soc. Sci.*, 8: 61-65. DOI: 10.3844/jssp.2012.61.65
- Lundqvist, L. and Gustafsson, B. (1992). Accidents and accident prevention in agriculture. A review of selected studies. *Int. J. Ind. Ergon.*, 10 (4), 311–319.
- Malaysia Palm Oil Council (MPOC) (2012). The Oil Palm Tree. Retrieved from [http://www.mpoc.org.my/The\\_Oil\\_Palm\\_Tree.aspx](http://www.mpoc.org.my/The_Oil_Palm_Tree.aspx)
- Malchaire, J., Cock, N., & Vergracht, S. (2001). Review of the factors associated with musculoskeletal problems in epidemiological studies. *International Archives of Occupational and Environmental Health*. 74(2):79-90.
- Mangat, M. (2010, September 5). Productivity Concepts and Definitions. Retrieved from MushtaqMangat.Org: <http://www.scribd.com/doc/31097394/Productivity-Concepts-and-Definitions>
- Manninen, P., Riihimäki, H., Heliövaara, M. (1995). Incidence and risk factors of low-back pain in middle-aged farmers. *Occupational Medicine*, 45(3), 141-146.
- Marras, W. S. & Karwowski, W. (2006). Interventions, controls, and applications in occupational ergonomics. Boca Raton: CRC Press.
- Matte, S., Balakrishnan, A., Bergamo, G., Newberry, S.J. (2007). A Review of Methods to Measure Health-related Productivity Loss. *The American Journal of Managed Care*, 13(4), 211-217.
- Mazza, J., Lee, B., Gunderson, P., Stueland, D. (1997). Rural Health Care Providers' Educational Needs Related to Agricultural Exposures. *Journal of Agricultural Safety and Health*, 3(4), 207-215.
- McBeth, J., & Jones, K. (2007). Epidemiology of chronic musculoskeletal pain. *Best Practice & Research Clinical Rheumatology*, 21(3), 403-425.
- McCurdy, S. A., Samuels, S. J., Carroll, D. J., Beaumont, J. J., & Morrin, L. A. (2003). Agricultural Injury in California Migrant Hispanic Farm Workers. *American Journal of Industrial Medicine*, 44, 225-235.
- McLaughlin, A. C., Fletcher, L. M., & Sprufera, J. F. (2009, October). The aging farmer: human factors research needs in agricultural work. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting (Vol. 53, No. 18, pp. 1230-1234)*. Sage Publications.
- Meerding, W., Ijzelenberg, W., Koopmanschap, M., Severens, J., Burdorf, A. (2005). Health problems lead to considerable productivity loss at work among workers with high physical load jobs. *Journal of Clinical Epidemiology*, 58, 517-523.

- Meyers, J. M., Miles, J. A., Faucett, J., Janowitz, I., Tegeda, D. G., Weber, E., Smith, R., Garcia, L. (2001). Priority risk factors for back injury in agricultural field work: vineyard ergonomics. *Journal of Agromedicine*, 8(1), 39-54.
- Meyers, J. M., Miles, J. A., Faucett, J., Janowitz, I., Tejada, D. G., & Kabashima, J. N. (1997). Ergonomics in agriculture: workplace priority setting in the nursery industry. *American Industrial Hygiene Association Journal*, 58(2), 121-126.
- Ministry of Human Resource (MOHR) (2010). Annual report, 2009. SOCSO. Malaysia
- Ministry of Human Resource (MOHR) (2011). Annual report, 2010. SOCSO. Malaysia
- Ministry of Human Resource (MOHR) (2012). Annual report, 2011. SOCSO. Malaysia
- Ministry of Human Resource (MOHR) (2013). Annual report, 2012. SOCSO. Malaysia
- Miyakita, T., & Ueda, A. (1997). Estimates of workers with noise-induced hearing loss and population at risk. *Journal of Sound and Vibration*, 205(4), 441-449.
- Mohd Nizam, J., & Rampal, K. G. (2005). Study of Back Pain and Factors Associated with it Among Oil Palm Plantation Workers in Selangor. *Journal of Occupational Safety and Health*, 2, 36-41.
- Mohd. Anim H. (2010, July). Agriculture in Malaysia. Retrieved from <http://animagro.blogspot.com/2010/07/agriculture-in-malaysia.html>
- Mutert, E., & Fairhurst, T. H. (1999, May). Twenty-Two Tips for Practical Oil Palm Planters. (D. L. Armstrong, Ed.) *Better Crops International*, 13(1). Retrieved October 16, 2012, from International Plant Nutrition Institute: [http://www.ipni.net/ppiweb/bcropint.nsf/\\$webindex/8598EF8FA5D9EAA1852568CB005E57D4/\\$file/i99-1.pdf](http://www.ipni.net/ppiweb/bcropint.nsf/$webindex/8598EF8FA5D9EAA1852568CB005E57D4/$file/i99-1.pdf)
- MVO. (2012). Fact Sheet - Palm Oil. Retrieved October 9, 2012, from Productschap Margarine, Vetten en Oliën: <http://www.mvo.nl/LinkClick.aspx?fileticket=jsFVMZwZzkc%3D>
- Naing, L., Winn, T., & Rusli, B. N. (2006). Practical issues in calculating the sample size for prevalence studies. *Archives of Orofacial Sciences*, 1(1), 9-14.
- National Research Council and Institute of Medicine. (2001). *Musculoskeletal disorders and the workplace: low back and upper extremities*. Washington D.C.: National Academy Press.
- Natvig, B., Bruusgaard, D., & Eriksen, W. (2001). Localized low back pain and low back pain as part of widespread musculoskeletal pain: two different disorders? A cross-sectional population study. *Journal of Rehabilitation Medicine*, 33(1), 21-25.

- Nawi, N. M., Yahya, A., Chen, G., Bockari-Gevao, S. M., & Maraseni, T. N. (2012). Human energy expenditure in lowland rice cultivation in Malaysia. *Journal of agricultural safety and health*, 18(1), 45-56.
- Nellemann, C., MacDevette, M., Manders, T., Eickhout, B., Svihus, B., Prins, A. G., & Kaltenborn, B. P. (2009). The environmental food crisis – The environment's role in averting future food crises. United Nations Environment Programme. Birkeland Trykkeri AS: GRID-Arendal. Retrieved from [www.grida.no](http://www.grida.no)
- Nelson, D. I., Nelson, R. Y., Concha-Barrientos, M., & Fingerhut, M. (2005). The global burden of occupational noise-induced hearing loss. *American journal of industrial medicine*, 48(6), 446-458.
- Ng, Y.G., Shamsul, B. M. T., Irwan, S. M. Y. , Mori, I. and Hashim, Z. (2013). Ergonomics observation: Harvesting tasks at oil palm plantation. *J. Occup. Health*, 55: 405-414. DOI: 10.1539/joh.13-0017-FS
- Nguyen, T. P. (2009). A trial evaluation of the participatory action oriented training programme in small and medium scale enterprises in Vietnam (Doctoral dissertation, University of Birmingham).
- NIOSH (2013). Musculoskeletal Disorders. Available at: <http://www.cdc.gov/niosh/programs/msd/>. Accessed October 1, 2013.
- NIOSH. (1997, July). Musculoskeletal Disorders and Workplace Factors: A Critical Review of Epidemiologic Evidence for Work-Related Musculoskeletal Disorders of the Neck, Upper Extremity, and Low Back. Retrieved October 18, 2012, from Centre for Disease Control and Prevention: [www.cdc.gov/niosh/docs/97-141/pdfs/97-141.pdf](http://www.cdc.gov/niosh/docs/97-141/pdfs/97-141.pdf)
- Niu, S. (2010). Ergonomics and occupational safety and health: An ILO perspective. *Applied Ergonom.*, 41: 744-753. DOI: 10.1016/j.apergo.2010.03.004
- Nonnenmann, M. W., Anton, D., Gerr, F., Merlino, L., & Donham, K. (2008). Musculoskeletal symptoms of the neck and upper extremities among Iowa dairy farmers. *American journal of industrial medicine*, 51(6), 443-451.
- Nordin, M., Andersson, G. B., & Pope, M. H. (1997). Musculoskeletal disorders in the workplace. Principles and practice. Philadelphia, PA, Mosby CV.
- Noro, K., & Imada, A. S. (1991). Participatory ergonomics. Taylor & Francis.
- NWCPHP (2012). Effective adult learning: A toolkit for teaching adults. Northwest Center for Public Health Practice.
- O' Neill D.O. (2005). Agriculture in International Encyclopedia of Ergonomics and Human Factors, 2nd Edition, ed. Karwowski W., pp. 2501. Taylor Francis: London
- O'Neill, D. H. (2000, July). Ergonomics Interventions in Agricultural Development Projects. In Proceedings of the Human Factors and Ergonomics Society Annual Meeting (Vol. 44, No. 22, pp. 620-623). SAGE Publications.

- Osborne, A., Blake, C., Fullen, B. M., Meredith, D., Phelan, J., McNamara, J., & Cunningham, C. (2012). Prevalence of musculoskeletal disorders among farmers: A systematic review. *American Journal of Industrial Medicine*, 55(2), 143-158.
- OSHA, (2002). *Injuries, Illnesses and Fatalities, 2000*. Occupational Safety and Health Administration.
- Pallant, J. (2010). *SPSS Survival Manual: A Step by Step Guide to Data Analysis Using SPSS*. 1st Edn., McGraw-Hill International, Maidenhead, ISBN-10: 0335242391, pp: 352.
- Palmer, K. T. (1996). Musculoskeletal Problems in the Tomato Growing Industry: 'Tomato Trainer's Shoulder'?. *Occupational medicine*, 46(6), 428-431.
- Palmer, K. T., Cooper, C., Walker-Bone, K., Syddall, H., & Coggon, D. (2001). Use of keyboards and symptoms in the neck and arm: evidence from a national survey. *Occupational Medicine*, 51(6), 392-395.
- Parot-Schinkel, E., Descatha, A., Ha, C., Petit, A., Leclerc, A., & Roquelaure, Y. (2012). Prevalence of multisite musculoskeletal symptoms: a French cross-sectional working population-based study. *BMC musculoskeletal disorders*, 13(1), 122.
- Pelletier, B., Boles, M. and Lynch, W. (2004). Change in Health Risks and Work Productivity Over Time. *J Occup Environ Med.*, 46, 746-754.
- PEMANDU. (2010, September 21). Chapter 9: Deepening Malaysia's Palm Oil Advantage. Retrieved October 9, 2012, from Economics Transformation Programme:  
[http://etp.pemandu.gov.my/upload/etp\\_handbook\\_chapter\\_9\\_palm\\_oil.pdf](http://etp.pemandu.gov.my/upload/etp_handbook_chapter_9_palm_oil.pdf)
- Pett, M.A. (1997). *Nonparametric Statistics for Health Care Research: Statistics for Small Samples and Unusual Distributions*. 1st Edn., Sage Publication, London, ISBN-10: 0803970382, pp: 307.
- Picavet, H. S. J., & Schouten, J. S. A. G. (2003). Musculoskeletal pain in the Netherlands: prevalences, consequences and risk groups, the DMC-study. *Pain*, 102(1), 167-178.
- Pohjonen, T., Punakallio, A., & Louhevaara, V. (1998). Participatory ergonomics for reducing load and strain in home care work. *International journal of industrial ergonomics*, 21(5), 345-352.
- Poku, K. (2002). *Small-Scale Palm oil processing in Africa*. FAO Agricultural Services Bulletin 148. Rome, Italy.
- "Probst, T. M., & Graso, M. (2012). Reporting and Investigating Accidents: Recognizing the Tip of the Iceberg. *Occupational Health and Safety*, 71. Chicago
- Productivity. (2014). In *Encyclopaedia Britannica*. Retrieved from <http://www.britannica.com/EBchecked/topic/478036/productivity>

- Punnett, L., Cherniack, M., Henning, R., Morse, T., Faghri, P., Faghri, P., & CPH-NEW Research Team. (2009). A conceptual framework for integrating workplace health promotion and occupational ergonomics programs. *Public Health Reports*, 124(Suppl 1), 16.
- Punnett, L., Wegman, D.H. (2004). Work-related musculoskeletal disorders: the epidemiologic evidence and the debate. *Journal of Electromyography and Kinesiology*. 14(1):13-23.
- Nevala-Puranen, N. (1996). Effects of occupationally-oriented rehabilitation on farmers' work techniques, musculoskeletal symptoms, and work ability. *Journal of occupational rehabilitation*, 6(3), 191-200.
- Quesnay, F. (1768). *Analyse de la formule mathematique du tableau economique de la distribution des depenses annuelles d'une nation agricole*. History of Economic Thought Chapters.
- Rainbird, G., & O'Neill, D. (1995). Occupational Disorders Affecting Agricultural Workers in Tropical Developing Countries. *Applied Ergonomics*, 26(3), 187-193.
- Razali, M., Halim, A., Roslan, S. (2012). A Review on Crop Plant Production and Ripeness Forecasting. *International Journal of Agriculture and Crop Sciences*, 4(2), 54-63.
- Rempel, D. M. & Evanoff, B. A., (2005). Musculoskeletal Disorders. In Rosenstock L., Cullen M.R., Brodtkin C.A., Redlich C.A. (2005). *Textbook of clinical occupational and environmental medicine* (p. 495). Philadelphia: Elsevier-Saunders.
- Reville, R. T., Neuhauser, F. W., Bhattacharya, J., & Martin, C. (2002). Comparing severity of impairment for different permanent upper extremity musculoskeletal injuries. *Journal of occupational rehabilitation*, 12(3), 205-221.
- RHEF (2008). *Rural health education foundation resource: A guide to facilitating adult learning*. Australian Government Department of Health and Ageing.
- Ricci, J. A., Chee, E., Lorandeanu, A. L., Berger, J. (2007). Fatigue in the US workforce: Prevalence and implications for lost productive work time. *J Occup Environ Med*, 49, 1-10.
- Rist, L., Levang, P., & Feintrenie, L. (2010). The livelihood impacts of oil palm: smallholders in Indonesia. *Biodiversity and Conservation*, 19, 1009-1024.
- Rivillis, I., D. Van Eerd, K. Cullen, D.C. Cole, E. Irvin and J. Tyson et al. (2008). Effectiveness of participatory ergonomic interventions on health outcomes: A systematic review. *Applied Ergonom.*, 39: 342-358. DOI:10.1016/j.apergo.2007.08.006
- Rogan, A., & O'Neill, D. (1993). Ergonomics aspects of crop production in tropical developing countries: a literature review. *Applied ergonomics*, 24(6), 371-386.

- Roquelaure, Y., Ha, C., Rouillon, C., Fouquet, N., Leclerc, A., Descatha, A., Touranchet, A., Goldberg, M. & Imbernon, E. (2009). Risk factors for upper-extremity musculoskeletal disorders in the working population. *Arthritis Care & Research*, 61(10), 1425-1434.
- Rosecrance, J., Rodgers, G., Merlino, L. (2006). Low Back Pain and Musculoskeletal Symptoms Among Kansas Farmers. *American Journal of Industrial Medicine*, 49, 547-556.
- SAFework. (2003, March 1). Occupational safety and health: Synergies between security and productivity - GB 295th Session. Retrieved from International Labour Organization: [http://www.ilo.org/wcmsp5/groups/public/---ed\\_protect/--protrav/---safework/documents/meetingdocument/wcms\\_110380.pdf](http://www.ilo.org/wcmsp5/groups/public/---ed_protect/--protrav/---safework/documents/meetingdocument/wcms_110380.pdf)
- Sanders, M. J. (2004). *Ergonomics and the Management of Musculoskeletal Disorders*, 2nd Edition. St. Louis, Missouri: Butterworth-Heinemann.
- Scientific Publishing (2003). *Musculoskeletal System*. Scientific Publishing Limited.
- Seegräf, M., May, D., Breuer, T., & Schukat, P. (2010). *Palm Oil – sustainability is possible!* Eschborn: Deutsche Gesellschaft für Technische Zusammenarbeit (German Agency for Technical Cooperation).
- Sesto, M. (2000). *Chronic Musculoskeletal Disorders in Agriculture for Partners in Agricultural Health*. Retrieved October 17, 2012, from National Centre for Farm Workers Health: <http://www.ncfh.org/pdfs/6208.pdf>
- Shalat, S. L., Robson, M. G., Mohr, S. N. (2003). Agricultural workers. In: Rosenstock L, Cullen MR, Brodtkin CA; Redlich CA, editors. *Textbook of Clinical Occupational and Environmental Medicine*, 2nd ed. Saunders, Philadelphia.
- Tamrin, S. B. M., Yokoyama, K., Jalaludin, J., Aziz, N. A., Jemoin, N., Nordin, R., ... & Abdullah, M. (2007). The association between risk factors and low back pain among commercial vehicle drivers in peninsular Malaysia: a preliminary result. *Industrial health*, 45(2), 268-278.
- Shan, L. C., Adon, M. Y. B., Rahman, A. B. A., Hassan, S. T. S., & Ismail, K. B. (2012). Prevalence of Neck Pain and Associated Factors with Personal Characteristics, Physical Workloads and Psychosocial Among Male Rubber Workers in FELDA Settlement Malaysia. *Global journal of health science*, 4(1).
- Shannon, H. S., Woodward, C. A., Cunningham, C. E., McIntosh, J., Lendrum, B., Brown, J., & Rosenbloom, D. (2001). Changes in general health and musculoskeletal outcomes in the workforce of a hospital undergoing rapid change: A longitudinal study. *Journal of Occupational Health Psychology*, 6(1), 3.
- Sheil, D., Casson, A., Meijaard, E., Noordwijk, M. v., Gaskell, J., Sunderland-Groves, J., Wertz, K. and Kanninen, M. (2009). *The impacts and opportunities of oil palm in Southeast Asia: What do we know and what do we need to know?* Occasional paper no.51. Bogor Barat, Jakarta, Indonesia: CIFOR.



- Silverstein, B., Viikari-Juntura, E., & Kalat, J. (2002). Use of a prevention index to identify industries at high risk for work-related musculoskeletal disorders of the neck, back, and upper extremity in Washington state, 1990–1998. *American journal of industrial medicine*, 41(3), 149-169.
- Silverstein, B., & Clark, R. (2004). Interventions to reduce work-related musculoskeletal disorders. *Journal of Electromyography and Kinesiology*, 14(1), 135-152.
- Smedley, J., Inskip, H., Trevelyan, F., Buckle, P., Cooper, C., & Coggon, D. (2003). Risk factors for incident neck and shoulder pain in hospital nurses. *Occupational and Environmental Medicine*, 60(11), 864-869.
- Solecki, L. (2001). Current State of Ergonomics in Agriculture - Future Needs. *Annals of Agricultural and Environmental Medicine*, 8(2), pp. 297-298. Retrieved October 17, 2012, from: <http://www.aaem.pl/pdf/aaem0143.pdf>
- Stanton, B.F., Clemens, J.D., Aziz, K. M. A. and Rahman, M. (1987). Twenty-four-hour recall, knowledge-attitude-practice questionnaires and direct observations of sanitary practices: A comparative study. *Bull. World Health Organ.*, 65: 217-217.
- Stave, C., Törner, M., & Eklöf, M. (2007). An intervention method for occupational safety in farming—evaluation of the effect and process. *Applied ergonomics*, 38(3), 357-368.
- Synodinos, N. E. (2003). The “art” of questionnaire construction: some important considerations for manufacturing studies. *Integrated manufacturing systems*, 14(3), 221-237.
- Tagum R. (2013). Participatory research and Participatory Action Research [Powerpoint slides] Retrieved from: <http://www.slideshare.net/reynantetagum/participatory-action-research-16414985.html>
- Takala, E. P., Pehkonen, I., Forsman, M., Hansson, G. Å., Mathiassen, S. E., Neumann, W. P., ... & Winkel, J. (2010). Systematic evaluation of observational methods assessing biomechanical exposures at work. *Scandinavian journal of work, environment & health*, 3-24.
- Tangen, S. (2005). Demystifying productivity and performance. *International Journal of Productivity and Performance Management*, 54(1), 34-46.
- Thoenes, P. (2006). Biofuels and Commodity Markets – Palm Oil Focus. Retrieved October 9th, 2012, from United Nation Food and Agriculture Organization from: [http://www.fao.org/es/esc/common/ecg/629/en/full\\_paper\\_English.pdf](http://www.fao.org/es/esc/common/ecg/629/en/full_paper_English.pdf)
- Tornqvist, E. W., Kilbom, Å., Vingård, E., Alfredsson, L., Hagberg, M., Theorell, T., ... & MUSIC-Norrtälje Study Group. (2001). The influence on seeking care because of neck and shoulder disorders from work-related exposures. *Epidemiology*, 12(5), 537-545.

- Trinkoff, A. M., Brady, B., & Nielsen, K. (2003a). Workplace prevention and musculoskeletal injuries in nurses. *Journal of Nursing Administration*, 33(3), 153-158.
- Trinkoff, A. M., Lipscomb, J. A., Geiger-Brown, J., & Brady, B. (2002). Musculoskeletal problems of the neck, shoulder, and back and functional consequences in nurses. *American journal of industrial medicine*, 41(3), 170-178.
- Trinkoff, A. M., Lipscomb, J. A., Geiger-Brown, J., Storr, C. L., & Brady, B. A. (2003b). Perceived physical demands and reported musculoskeletal problems in registered nurses. *American Journal of Preventive Medicine*, 24(3), 270-275.
- Tsuboi, H., Takeuchi, K., Watanabe, M., Hori, R., & Kobayashi, F. (2002). Psychosocial factors related to low back pain among school personnel in Nagoya, Japan. *Industrial health*, 40(3), 266-271.
- UNDP. (2007). *Malaysia Generating Renewable Energy From Palm Oil Wastes*. Kuala Lumpur: United Nations Development Programme.
- UNEP (2012). *Converting waste oil palm trees into a resources*. United Nations Environment Programme, Division of Technology, Industry and Economics, International Environmental Technology Centre. Osaka, Japan.
- University of Calgary, 2004. *Principles of Effective CME. Background Information for Facilitators of Small Group Learning*. Office of Continuing Medical Education and Professional Development, Canada.
- Urwin, M., Symmons, D., Allison, T., Brammah, T., Busby, H., Roxby, M., Simmons, A. & Williams, G. (1998). Estimating the burden of musculoskeletal disorders in the community: the comparative prevalence of symptoms at different anatomical sites, and the relation to social deprivation. *Annals of the Rheumatic Diseases*, 57(11), 649-655.
- US Department of Labour. (2012, December 18). CDC - NIOSH Program Port Folio: Musculoskeletal Disorders.net. Retrieved from CDC- National Institute for Occupational Safety and Health: <http://www.cdc.gov/niosh/programs/msd/risks.html>
- Vavken, P., & Dorotka, R. (2011). Burden of musculoskeletal disease and its determination by urbanicity, socioeconomic status, age, and sex: results from 14,507 subjects. *Arthritis care & research*, 63(11), 1558-1564.
- Vingard E. *Work, sport, overweight and osteoarthritis of the hip*. Epidemiological studies. *Arbete och halsa* 25, doctoral thesis, 1991, Karolinska Institute, Stockholm, Sweden.
- Vingard E., Alfredsson L., Goldie I., Hogstedt C.. Sports and osteoarthritis of the hip. An epidemiologic study. *Am J Sports Med*. 1993; 21:195–200.
- Vingård E, Hogstedt C., Alfredsson L., Fellenius E., Goldie I., Koster M. Coxarthrosis and physical work load. *Scand J Work Environ Health*. 17:104-109, 1991.

- Von Essen, S. G., & Banks, D. E. (2009). Life-Long Exposures on the Farm, Respiratory Symptoms, and Lung Function Decline. *Chest*, 136; 662-663.
- Von Essen, S. G., McCurdy, S. A. (1998). Health and Safety Risks in Production Agriculture. *Western Journal of Medicine*, 169(4), 214-220.
- Wahlstedt, K., Norbäck, D., Wieslander, G., Skoglund, L., & Runeson, R. (2010). Psychosocial and Ergonomic Factors, and Their Relation to Musculoskeletal Complaints in the Swedish Workforce. *International Journal of Occupational Safety and Ergonomics*, 16(3), 311-321.
- Walker-Bone, K., Palmer, K. (2002). Musculoskeletal disorders in farmers and farm workers. *Occupational Medicine*, 52(8), 441-450.
- Walker-Bone, K., Palmer, K. T., Reading, I., Coggon, D., & Cooper, C. (2004). Prevalence and impact of musculoskeletal disorders of the upper limb in the general population. *Arthritis Care & Research*, 51(4), 642-651.
- WHO (2008). Advocacy, communication and social mobilization for TB control. A guide to developing knowledge, attitude and practice surveys. Geneva, World Health Organization, 2008 (WHO/HTM/STB/2008.46).
- Widanarko, B., Legg, S., Stevenson, M., Devereux, J., Eng, A., Mannetje, A. T., Cheng, S., Douwes, J., Ellison-Loschmann, L., McLean, D. & Pearce, N. (2011). Prevalence of musculoskeletal symptoms in relation to gender, age, and occupational/industrial group. *International Journal of Industrial Ergonomics*, 41(5), 561-572.
- Wilson, J. R., Haines, H. M., & Morris, W. (1997). Participatory ergonomics. *Handbook of human factors and ergonomics*, 2, 490-513.
- Woolf, A. D., Pfleger, B. (2003). Burden of major musculoskeletal conditions. *Bull. World Health Organ.* 81(9):646–656.
- Yu, W., Ignatius, T. S., Wang, X., Li, Z., Wan, S., Qiu, H., Lin, H., Xie, S. and Sun, T. (2012). Effectiveness of participatory training for prevention of musculoskeletal disorders: a randomized controlled trial. *Int. Arch. Occup. Environ. Health*, 86: 431-440. DOI: 10.1007/s00420-012-0775-3.