

Workplace Redesigns through Ergonomics

Pilot Trial

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1) Introduction

This proposal describes a pilot study of two companies from each of four industry sectors that will address ergonomics analysis and interventions in selected workplaces, followed by a review of the outcomes of the investigation by management and MOM. The selected industry sectors are:

- Wholesale and Retail Trade
- Transport and Storage
- Restaurants
- Sectors with office environments

Ergonomics is concerned with the physical, environmental, cognitive, social, affective and temporal aspects of work with the purpose of improving quality, productivity, health, safety and satisfaction of all stakeholders in a sustainable way. An ergonomics “hazard” can be any feature of the workplace, context or organization that may be the root or contributing cause of failure to achieve any of these objectives. However it must be noted that real world situations are often complex and involve interactions among many individual factors and tradeoffs among different outcomes.

A particular focus of this investigation will be the situation facing older workers and the opportunities that are available to provide continued, rewarding and satisfying employment for this growing cohort. Note also that many established ergonomics methods and standards were developed for Western countries, such as North America and Europe and for younger populations; consequently these methods and guidelines will have to be adapted where there are known dissimilarities among the target Singaporean cohorts.

2) Requirements of Ergonomics Investigations

Ergonomics investigations require sufficient knowledge of human characteristics, capabilities, limitations and aspirations based on physiology, psychology, sociology and statistics as well as a compendium of validated ergonomics analysis tools and design guidelines. In addition ergonomics investigations presuppose knowledge of the target domain which is obtained by direct experience or substantial interaction with a local domain expert.

3) The Ergonomics Process

- a) The ergonomics process starts with the establishment of an atmosphere of management commitment and employee involvement, trained and focused ergonomics advocates / monitors and a pertinent collection of ergonomics tools and methods.
- b) Next ergonomics investigations conduct an **outcome** analysis; that is a review of the prevalent outcomes such as quality, productivity, health, safety and satisfaction of employees and management. This analysis can be obtained from existing production and medical records that are supplemented by surveys, focus groups and one on one conversations with employees and management.
- c) Whereas ergonomics may often be applied on an individual basis a key aspect of this initial analysis is denominator data – the number of individuals in particular cohorts exposed to particular hazards.
- d) The second phase involves investigation of work structures and processes, including furniture, equipment, materials, information, work environments and work practices; these investigations generally involve checklist analysis, although secondary and tertiary analysis methods may be warranted in certain situations.
- e) Link analysis of the data from these two investigation phases leads to the recommendation for immediate intervention – the low hanging fruit – or more in depth investigations using validated specialized ergonomics methods, such as anthropometric and postural analysis, work and activity measurement, manual materials handling, work physiology and cognitive task analysis.
- f) The results of this link analysis are then mapped into alternative ergonomics interventions that may address physical, cognitive, environmental or operational factors. These mapping are accompanied by a risk benefit analysis to establish the costs and potential changes in outcomes, as well as the customer (employee and management) acceptance of the proposed changes.
- g) A cost analysis should be made that addresses both structural and activity costs in order to support intervention decisions
- h) The chosen interventions are then implemented, reviewed and adjusted accordingly, using a process of continuous monitoring and improvement.
- i) Finally a case study prepared for the corporate technical memory.

4) Workplace Assessment

- a) Pre-assessment Planning and Engagement
 - i) MOM will shortlist 8 volunteer companies, 2 each from the following industry sectors:
 - Wholesale and Retail Trade
 - Transport and Storage
 - Restaurants
 - Sectors with office environments
 - ii) The selected companies will be briefed regarding the scope, requirements, processes, anticipated outcomes and expected costs of the ergonomics investigation.
 - iii) Each company will be required to appoint an ergonomics advocate / monitor to manage the programme at the workplace as well as be the liaison person between the company and vendor for the entire duration for the programme. This advocate will undergo introductory training by the vendor in ergonomics theory and methods

iv) A pre-programme investigation will be carried out to assess the ergonomics related **outcomes** of the organization, using company records analysis, surveys, focus groups and one on one interviews with management and employees.

(1) In this context it is proposed that a country wide health and safety investigation be carried out that includes biometric, social, economic, occupational and medical factors. This “ergonomics” pilot study could serve as a pilot study for the proposed wider health and safety survey, which will also make use of existing demographic, occupational and medical databases

v) Preliminary assessment of likely problems and intervention options

(1) Wholesale and Retail Trade

(a) These activities have two major physical issues

- (i) Front end service, such as checkout and customer interactions. Common cumulative injury and illness outcomes include cumulative trauma to the upper limbs and lower limb circulatory problems. Fatigue is a frequent contributory factor, which in turn leads to cognitive lapses in pricing etc. These duties generally involve long periods of repetitive work involving standing postures, focused reading, data entry or scanning and repetitive upper limb activity. An essential first step is to create a workplace that is adjustable to the size of the operator. Secondly the opportunity for alternative working postures – standing, sitting or lean sitting must be provided.
- (ii) Behind the scenes activity involves shelf stocking and warehouse duties. These require manual materials handling of sometimes heavy loads and reaches beyond an acceptable work envelop. As space is usually at a premium the use of vertical space for storage is attractive, which brings with it safety concerns of step ladders and hazardous reaches. The major intervention opportunity lies in appropriate shelving, access facilities and materials handling aids.
- (iii) Further back up the supply chain there are the logistics activities associated with the movement of materials from containers to warehouses, often on pallets, sorting and then distributing to the retail outlets. Again the ergonomics issues relate to manual materials handling, fatigue and sorting / distribution errors. The intervention options include a variety of materials handling aids such as scissor lifts, conveyors, shelving, hoists and convenient powered equipment such as high loaders, fork trucks, tuggers and trains. This mobile equipment introduces potential safety hazards which are mitigated by appropriate warehouse layout, operating procedures, training and supervision.
- (iv) All of these warehouse and retail activities lend themselves to job specialization which increases the opportunity for cumulative motion trauma. Furthermore such specialization practices create inflexible operations difficulties. Both these issues can be addressed by job restructuring that involves cross training and assignments.

- (v) Another issue in retail and wholesale operations is that of shift work in order to provide desirable customer service. Poor shift work arrangements create cumulative fatigue and long term metabolic and behavioral issues, as well as social and domestic stresses.

(2) Transport and Storage

- (a) The principle ergonomics issues related to transport and storage have been covered in the previous section. However a major challenge arises from the long duration exposure to crowded traffic and congested delivery points. These issues are complicated by fatigue due to long duration exposure to intense vigilance demands of driving. Thus a major concern in this activity is that of traffic accidents as well as the manual materials handling demands at both ends of the delivery chain.
- (b) Other cohorts in the transportation industry include bus and taxi drivers. Typically these jobs involve shift work, long duration static sitting postures and continual demands for vigilance. Such occupations are conducive to metabolic disorders (circulation, obesity etc.) and musculo-skeletal disorders due to extended exposure to static sitting and whole body vibration.
- (c) The ergonomics interventions to these situations include the use of contemporary vibration absorbing seats, but more importantly the formal inclusion of rest / exercise breaks throughout the daily schedule.

(3) Restaurants

- (a) Restaurants present two major physical hazards – slips, trips and falls, and cuts, burns and scalds. Less acute illnesses are caused by long duration customer service activities, shift work and fatigue which are exacerbated by the continual demand for the provision of “good customer service.”
- (b) The physical hazards are addressed by work place layout, equipment choice and maintenance, appropriate training and supervision and the establishment of a work climate that is intolerant of risky behaviors.
- (c) Work place layout opportunities are found in the food preparation areas, behind the counters and among the tables. Pressure to maximize the use of limited space compounds these hazards. Again, routine, sustained attention to layout and employee behaviors can go a long way toward lowering the risk of acute incidents.
- (d) Another ergonomics issue related to restaurants is caused by job specialization. The customer pressures the waiter who in turn pressures the food preparers. These pressures can give rise to considerable work stress and an increase in the likelihood of unsafe behaviors. The solutions to these operational and associated workplace layout challenges may be gleaned by observation of the efficiencies found in the major fast food chains, where strict training and adherence to procedure is instilled and sustained among all employees.

(4) Sectors with office environments

- (a) The office in its various guises represents a large and growing portion of Singapore employment. A common feature of the office is the computer in

its various forms, which leads to intense, sometimes complex cognitive demands. "Human error" can give rise to major operational incidents and the potential for human error is exacerbated by the physical, cognitive, environmental, social and operational demands associated with the office.

- (b) The office has become a major focus for the attention of physical ergonomists over the past two decades. Most of the attention has been towards furniture and equipment aimed at providing appropriate work postures. This is the low hanging fruit and there are many suppliers of "ergonomic" desks and chairs and operational attachments such as keyboard rests, foot stools, document holders and anti-glare screens. Whereas these physical interventions may sometimes be important they may also be used as a placebo aimed at intervening in more serious social and operational situations.
- (c) Other interventions in the office that have had considerable success have been the creation of self-directed teams, with appropriate work group areas. Such operational arrangements have the advantage of allowing cross training and operational flexibility. The teams, given sufficient autonomy and time to develop mission oriented cohesion can also take on the responsibilities of first line management, some personnel functions, process quality and safety.

b) Workplace Assessment

- i) The ergonomics vendor and company appointed ergonomics advocate / monitor will conduct a broad assessment of all workplaces and tasks using a checklist approach. The results of this screening study will be linked to the outcome analysis and recommendations made for primary intervention strategies.
- ii) The following workplace ergonomics issues will be addressed:
 - (1) Work place factors such as:
 - (a) Collective and personal layouts
 - (b) Work surfaces
 - (c) Seats
 - (d) Equipment, including computers
 - (e) Materials storage and handling aids
 - (2) Employee activities such as
 - (a) Work postures, forces and movements
 - (i) Upper limb, trunk and legs
 - (b) Manual materials handling
 - (c) Work shifts and work – rest arrangements
- iii) Work environment factors such as:
 - (a) Lighting and Glare
 - (b) Ambient and specific noise
 - (c) Indoor Air Quality (IAQ) and thermal environment
 - (d) Other health and safety factors
- iv) Work stress factors
 - (a) Pacing, output requirements
 - (b) Mental workload and decision pressures

- (c) Job scope and autonomy
- (d) Job specialization
 - (i) Opportunities for job enlargement and rotation

c) Provide Recommendations

- i) After completing the assessment, the vendor, together with the company ergonomics advocate will meet with company management to discuss the findings and advise them accordingly on the alternative solutions that are available for them, the timelines and costs.
- ii) The primary vendor – Dr Brian Peacock will work with FAM solutions Pte. Ltd to provide the needed hardware.

5) Workplace Re-design

- a) Workplace and job redesign interventions that are approved by the company and MOM will be implemented, monitored and adjusted using a process of continuous improvement
- b) The pilot study will address 8 workplaces (2 in each sector) in the first instance
- c) The vendor will train the company's ergonomics advocate and management on the alternative changes and advise on the subsequent steps that could be taken to raise ergonomics awareness in the organization.

6) Submission of Workplace Report

- a) The vendor will conduct post-programme survey to obtain user feedback 2-3 weeks after the re-design of the workplaces and tasks to evaluate the effectiveness of the interventions. Particular attention will be made to the opinions and suggestions of older workers.
 - i) **In this context it should be noted that there will be a "Hawthorne effect" in that any form of positive attention to a group of workers, such as the provision of new chairs or simply listening to their concerns, will result in a positive response to follow up surveys. Consequently this pilot study should also include plans for longer term follow up investigations.**
 - ii) **There is also the potential danger of a "prescription without a diagnosis, or even a sufficient investigation". Notwithstanding the possible useful short term placebo effect, it is essential to note that sometimes "work related musculo skeletal disorders" are an indication of more deeply rooted operational and social stresses. These more insidious, long term issues need careful and sensitive analysis.**
 - iii) **The major pathology associated with the "information revolution" is an increasing prevalence of metabolic disorders such as obesity and diabetes, , with enormous individual, company, medical and societal costs. The solutions to this "global epidemic" lie in the human centered approach of ergonomics in which occupational, domestic, social and (lack of) recreational experiences are seen as a collective cause of ill health.**
- b) The vendor will obtain feedback from management of participating companies regarding the cost and impact of the programme and their opinions regarding widespread implementation within the company / sector.
- c) The vendor will submit a full programme report for each workplace / task intervention.

- d) The report will include pre- and post-programme survey findings and analytic descriptions and pictures of the workplaces and tasks before and after the re-design.

7) Timeline

- a) The project will be completed in 10 weeks upon award of ITQ.
- b) Schedule of Deliverables:
 - i) Detailed project plan and timeline – 1st week after award of contract
 - ii) Pre-engagement and workplace assessments for all selected workplaces 2nd week
 - iii) Development of training and analysis material 1st to 3rd weeks
 - iv) Company training programs and focus groups 3rd week
 - v) Workplace assessments 3rd and 4th weeks
 - vi) Analysis and decision period 5th week
 - vii) Interventions 6th- 8th weeks
 - viii) Interim updates to MOM on results of workplace assessments prior to commencement of re-design of workplaces 3rd to 9th weeks
 - ix) Submission of workplace reports 9th to 10th week

8) Content of analytic approach

- a) Training of ergonomics advocate / monitor
 - i) Basic anatomy, physiology, psychology, sociology and statistics
 - ii) Ergonomics outcome analysis methods for productivity, quality, health, safety and satisfaction
 - iii) Work related musculo skeletal, metabolic and behavioral disorders
 - iv) Operational failures due to “human error”
 - v) Unique characteristics of the older population
 - vi) Ergonomics checklist methods
 - vii) Secondary ergonomics analysis methods
 - viii) Ergonomics intervention and redesign alternatives
 - ix) Ergonomics process
- b) Checklist methods
 - i) Workplace arrangements / posture analysis
 - ii) Task arrangements / motion analysis
 - iii) Manual materials handling
 - iv) Cognitive task screening analysis
 - v) Environmental analysis
 - vi) Operations analysis
- c) Secondary task analyses
 - i) Anthropometry and Work place design
 - ii) RULA, REBA
 - iii) Strain index
 - iv) Hand activity Level
 - v) NIOSH lift evaluation
 - vi) Physical Work Strain Index
 - vii) Environmental measurement methods
 - viii) Survey and focus group methods
 - ix) Etc.

- d) Introduction to tertiary methods
 - i) Biomechanics
 - ii) Work Physiology
 - iii) Cognitive Task Analysis
 - iv) Environmental analysis
 - v) Field survey methods
 - vi) Formal experimental studies

9) Content of intervention deliverables

- a) Workplace arrangements
- b) Furniture design and adjustment
- c) Equipment / interface design
- d) Task and job design (administrative controls)
- e) Lighting design
- f) Display design / adjustments
- g) Work method design (administrative controls / training)
- h) Work restructuring (operational controls)

10) Preliminary estimate of costs

- a) Development of analysis, training and workplace intervention materials
 - i) 40 hours @ \$250 / hour = \$10000
- b) Training delivery
 - i) Offsite training of ergonomics advocates / monitors
 - (1) 8 hours @ \$250 / hour = \$2000
 - ii) Onsite training of 8 targeted workplaces
 - (1) 8 x 2 hours @ \$250 / hour = \$4000
- c) Workplace investigations
 - i) Preliminary walk through and surveys
 - (1) 8 x 2 hours @ \$250 / hour = \$4000
 - ii) In-depth focus groups and task analyses
 - (1) 8 x 4 hours @ \$250 / hour = \$4000
- d) Data analysis and hardware solution selection with equipment supplier
 - i) 20 hours @ 250 / hour = \$5000
- e) Solution implementation, monitoring and follow up surveys
 - i) 40 hours @ 250 / hour = \$10000
- f) Final report compilation
 - i) 8 hours @ 250 / hour = \$2000
- g) Hardware costs (preliminary estimate) Details from FAM Solutions
 - i) \$3000 per workplace = 8 x \$3000 = \$24000
- h) Training materials and transportation \$5000
- i) Total costs \$70000

11) Personnel

- a) Principal investigator / Project Manager - Brian Peacock
 - i) Fellow of the Human Factors and Ergonomics Society (USA)
 - ii) Fellow of the Institute of Ergonomics and Human Factors (UK)
 - iii) >40 years' experience in ergonomics

- (1)** Currently Adjunct Professor at NUS and SIM University
- (2)** Physical therapist in industrial and sports rehabilitation (4 years)
- (3)** Academia – 20 years – ergonomics, industrial engineering, statistics, safety
- (4)** General Motors, Manager of Ergonomics (15 years)
 - (a)** Responsible for industry, national and global ergonomics programs
 - (b)** Member of NIOSH / NORA committee on Work Related Musculo Skeletal Disorders
- (5)** NASA / NSBRI Discipline Coordinating Scientist for Space Human Factors (4 years)
- iv)** Books on Statistical Distributions, Automotive Ergonomics, The Laws and Rules of Ergonomics in Design
- v)** Over 200 publications, presentations and reports on ergonomics
- vi)** Broad ergonomics practice / consulting experience in manufacturing, automobile design, product design, office workplace design, aerospace, gas and oil exploration and transportation
- b) FAM Solutions Pte Ltd.
- c) Student assistants: Pauline Chong (SIM), Stella Ng(NUS)