OCCUPATIONAL HEALTH, SAFETY AND ERGONOMIC ISSUES IN SMALL AND MEDIUM-SIZED ENTERPRISES IN A DEVELOPING COUNTRY

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Department of Process and Environmental Engineering and Work Science Laboratory, University of Oulu

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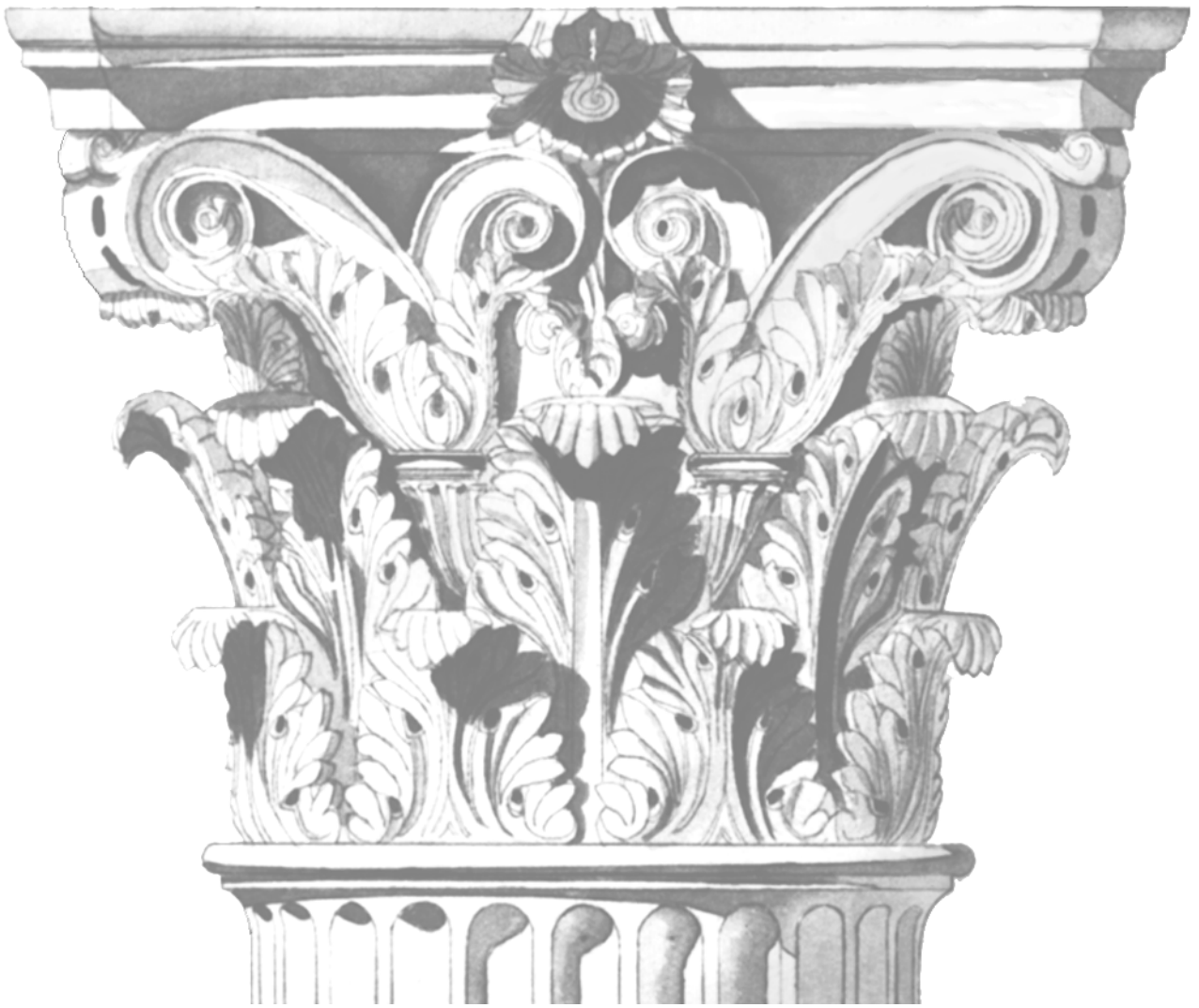

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Abstracts

Data and information accumulated during several years of questionnaire and checklist surveys; site visits and walk-thorough investigations in some small and medium-sized enterprises provided the basis of this thesis. Seven articles are included in this thesis, dealing with workers' physical, physiological, cognitive and psychosocial issues. The data were collected on the target group of workers from different work sites in Bangladesh for a comprehensive assessment of tasks, jobs and ergonomic issues. Jobs and tasks were classified according to the job content and task activity they performed. Most of the subjects were interviewed and some of them volunteered for physiological tests to bring attention to their occupational exposure to potentially strenuous activities in a hot and humid climate.

The results showed that their working environment was non-ergonomic, not only because of the work-related problems themselves but also because of stressful tasks, extensive use of muscle force, old machinery, economic constraints, and a lack of enforcement of work regulations and labour legislation. The findings also demonstrated that the workers were associated with an increased risk of occupational hazards due to various local reasons. The results of the case studies give some insight towards a better understanding of health, safety and ergonomics applications that may contribute to bring working society together and initiate a broad-based improvement of the working environment in many developing countries like Bangladesh.

The practical concern of this thesis is to improve the design of the workstation as well as to improve a worker's safe manipulation of tools and equipment and control of machinery, critical posture, and so on. This thesis also attempts to contribute the author's own views and suggestions with the hope of drawing workers' and employers' awareness and public attention towards unsafe acts and conditions, and for increasing the implementation of work regulations and labour legislation. In order to discern probable solutions, this thesis implies a prerequisite of low cost engineering solutions in the small and medium-sized enterprises. As such, it outlines applications of locally available technology utilising practical knowledge, which also provide practical approaches so that work-tasks are less stressful but productive, and safe. So, to help ergonomic application to be effective, some technical measures appropriate for local environments are thus illustrated that can be directly implemented in the developing countries like Bangladesh to prevent and control work-related problems. However, the ultimate improvement will depend on the attitude of the people involved at all levels of an interactive system, while health and safety measures are introduced in synchronisation with local systems and/or existing environments.

Emphasising the workers' cognitive, psychosocial and socio-economic improvement through self-help and self-care strategies, this thesis also concludes with the belief that the attitude of the local workers, and an indifferent working culture are the arbiters of work-related problems. It is therefore essential that a concrete implementation of locally available measures be made, establishing ergonomic changes in collaboration with all the parties concerned for particular job-tasks and work processes. To help initiate this process, a more work-thorough investigation is necessary through the guidance of co-ordinated research and studies. For this, an understanding of employers' attitudes and workers' involvement is essential; as well as having a grasp of the logic and reasoning behind workplace survey and the need for adequate injury records and work-related information.

Keywords: ergonomics application, job training, low-cost intervention, participatory action, self-help, sustainable workplace improvement, vocational education, work-culture

Ahasan, M. Rabiul, Työterveys, turvallisuus ja ergonomia pienissä ja keskisuurissa yrityksissä kehitysmaissa.
Prosessi- ja ympäristötekniikan osasto; Työtieteen laboratorio, Oulun yliopisto, PL 4300, 90014 Oulun yliopisto, Finland
2002
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Tiivistelmä

Väitöskirjaan sisältyy seitsemän artikkelia, jotka käsittelevät työntekijöiden fyysisiä, fysiologisia, kognitiivisia ja psykososiaalisia asioita. Tiedot kerättiin eri kohteista Bangladeshissa keskittyen työtehtävien arviointiin ja ergonomiaan liittyviin tekijöihin. Aineisto on kerätty useiden vuosien ajan kyselykaavakkeiden ja tarkastuslistojen avulla; vierailut ja tutkimukset paikan päällä pienissä ja keskisuurissa yrityksissä muodostivat perustan tälle väitöskirjalle. Työtehtävät jaettiin sisällön ja aktiviteetin mukaan. Tutkimukseen osallistuneita työntekijöitä haastateltiin ja jotkut heistä olivat vapaaehtoisia fysiologisiin testeihin, joilla selvitettiin heidän altistumistaan mahdollisesti rasittaviin töihin kuumassa ja kosteassa ympäristössä. Tulokset osoittivat, että tutkittujen henkilöiden työympäristö oli epäergonominen, ei ainoastaan työhön liittyvien ongelmien takia, vaan myös stressin, liiallisen voimankäytön, vanhojen koneiden, taloudellisten tekijöiden sekä työhön liittyvien säännösten ja lainsäädännön puutteiden vuoksi.

Tulokset osoittivat myös, että työntekijöiden riski työtapaturmiin oli kasvanut paikallisten syiden takia. Tulokset auttavat paremmin ymmärtämään terveys-, turvallisuus- ja ergonomiasovelluksia, joiden avulla työyhteisöjen osapuolet voivat käynnistää laaja-alaisen työympäristön parantamisen monissa kehitysmaissa kuten Bangladeshissä. Väitöskirjan käytännöllisen puolen tarkoituksena on työpisteiden ja -paikkojen suunnittelu ja työkalujen turvallisen käytön ja koneiden hallinnan sekä työasentojen edistäminen. Väitöskirja tuo myös esille kirjoittajan omia ehdotuksia ja näkökantoja mahdollisuuksiin lisätä työntekijöiden sekä työnantajien että julkista huomiota, vaarallisiin työtehtäviin ja -oloihin. Väitöstyö pyrkii lisäämään työn säännösten ja työvoimalainsäädännön huomioon ottoa. Työ esittelee myös teknisiä ratkaisuja pieniin ja keskisuuriin yrityksiin. Väitöskirja esittelee sovelluksia, joita paikallisen teknologian puitteissa voidaan käyttää hyväksi. Lisäksi se tarjoaa ergonomisia malleja, jotta työt olisivat vähemmän rasittavia ja sekä tuottavia että turvallisia. Ergonomisen toimenpiteen tehokkuus on pyritty nojaamaan myös paikallisuuteen. Ne voidaan suoraan toteuttaa kehitysmaassa, kuten Bangladeshissä estämään ja kontrolloimaan työperäisiä ongelmia.

Kuitenkin lopulliset parannukset riippuvat paikallisten ihmisten asenteista, joita on vuorovaikutteisen järjestelmäkokonaisuuden kaikkien osapuolien tasoilla. Terveys- ja turvallisuustekijät esitetään liitettyinä paikalliseen kulttuuriin ja yhteiskuntaan tai olemassa olevaan ympäristöön. Painottaen työntekijöiden kognitiivisia, psykososiaalisia ja sosioekonomisia parannuksia oman avun kautta tämä väitöskirja myös päätyy siihen, että paikallisten työntekijöiden asenteet ja välinpitämätön työkulttuuri voivat olla työperäisten ongelmien alkusyitä. Sen tähden on olennaista, että paikallisten toimenpiteiden konkreettinen toteutus saadaan aikaan. Ergonomiset muutokset tehdään yhteistyössä kaikkien työprosessin osapuolten kanssa. Jotta tätä kehitysprosessia helpotettaisiin, on tehtävä enemmän toimenpiteitä myös tutkimuksen ja opiskelun alueilla. Tämän takia työnantajien asenteiden ymmärtäminen ja työntekijöiden osallistuminen on olennaista; sekä se, että löydetään käsitys toimenpiteiden logiikasta ja seurauksista työpaikalla. Näiden lisäksi tarvitaan myös onnettomuusrekisteri sekä työtä koskevaa informaatiota.

Asiasanat: ammatillinen koulutus, edullinen interventio, ergonominen sovellus, itsehoito, osallistuva toiminta, työharjoittelu, työhön opastus, työkulttuuri

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While doing my research in the Work Science Laboratory of Oulu University, Finland, I have picked my battle wisely and studied health, safety and ergonomic issues under the supervision of some experts who have decades of experience on work-related issues. At the time they passed along guidance and provided many valuable pieces of advice and suggestions, making an outlandish prediction of my future as an active professional on this subject, which is multidisciplinary. When I was accepted for doctoral studies (30th August 1998), it was a great challenge to continue research on such a topic that has both technical and medical aspects. In the beginning of my studies, I thought I could not succeed in this battle due to various local constraints such as taking courses without regular class attendance, applying for funding, travelling from Finland to Bangladesh, and so on.

The industrial workplaces in Bangladesh are also vibrant in regard to non-compliance of work regulations, and thus, allowing a researcher by the factory owners and labour union in their factory premises is not easy. The factory owners are usually afraid about workplace survey and investigation believing that the study would cause them penalty or such action. Notwithstanding the difficulties encountered, I focused on technical and medical ideas in setting up suitable protocol measurements and questionnaire designs using local concepts for collecting work-related data and information. I think it is highly desirable to bring forward such work-related issues in developing countries to "fill a special need" for workplace improvement that is lacking in today's scientific literature.

While this thesis could undertake this role by focusing on occupational health and safety, I wonder whether a more appropriate way of making the workplace intervention or ergonomic application might be the collaboration of all the parties concerned. As few publications are as yet interdisciplinary, I still wonder and am afraid if the thesis is ready for public defence. At any rate, I believe that this thesis will provide the current state of some problems, with an identification and assessment of work-related risk factors—in which further research is required to provide systematic insight to draw public attention on the subject. I am therefore grateful to many persons who have contributed in different ways to achieve this thesis in the final stage.

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Oulu, Finland, September 2002 Rabiul Ahasan

Abbreviations

ADB	Asian Development Bank [www.adb.org]
ASA	A non-governmental organisation in Bangladesh [www.asabd.org]
ATDP	Agro-based Technology Development Project
BaNINet	Bangladesh National Information Network
BANSDOC	Bangladesh National Scientific and Technical Documentation Centre
BARD	Bangladesh Academy for Rural development
BARDEM	Bangladesh Academy for Research on Diabetics Endocrine Medicine
BCIC	Bangladesh Chemical Industries Corporation [www.bangladeshgov.org/pmo/wpeceng/bcic.htm]
BCSIR	Bangladesh Council for Scientific and Industrial Research
BEPZA	Bangladesh Export Processing Zone Authority [www.bangladesh-epz.com]
BGMEA	Bangladesh Garment Manufacturers and Exporters Association [www.bgmea.com]
BIRPERT	Bangladesh Institute of Research for Promotion of Essential Reproductive Health and Technology
BIT	Bangladesh Institute of Technology [www.bitkhulna.org]
BITAC	Bangladesh Industrial and Technical Assistance Centre
BMDC	Bangladesh Management Development Centre
BMET	Bureau of Manpower Employment and Training
BMTF	Bangladesh Machine Tools Factory
BOESL	Bangladesh Overseas Employment Service Ltd. [www.bdcom—online.com/boesl/]
BRAC	Bangladesh Rural Advancement Committee [www.brac.net]
BSCIC	Bangladesh Small and Cottage Industries Corporation [www.fbcci.org/smlcoteg.html]
BSTI	Bangladesh Standard and Testing Institute
BUET	Bangladesh University of Engineering and Technology [www.buet.edu]
CD-ROM	Compact disk—read only memory
CIDA	Canadian International Development Agency [www.cida.ca]
DANIDA	Danish International Development Assistance [www.umi.dk/danida]
DIFE	Department of Inspection for Factories and Establishments

DOE	Department of Environment
EU	European Union [http://ue.eu.int/en]
FINNIDA	Finnish International Development Agency [global.finland.fi/english]
ICDDRB	International Centre for Diarrhoeal Diseases & Research-Bangladesh [www.icddrb.org]
IEB	Institute of Engineers—Bangladesh [www.ieb-bd.org]
ILO	International Labour Organisation [www.ilo.org]
IMF	International Monetary Fund [www.imf.org]
IPGMR	Institute of Post Graduate Medicine and Research
ISO	International Organisation for Standardisation [www.iso.org]
JICA	Japan International Co-operation Agency [www.jica.jp]
NORAD	Norwegian Agency for International Development [www.norad.no]
OHSA	Occupational Health and Safety Administration [www.ohsa.gov]
OWAS	Ovako Working Posture Analysing System [http://turva.me.tut.fi/owas]
PROSIKA	A non-governmental organisation in Bangladesh
SAARC	South Asian Association for Regional Co-operation [www.saarc.org]
SIDA	Swedish International Development Agency [www.sida.org]
SPSS	Statistical Programme for Social Sciences
UNDP	United Nations Development Programs [www.undp.org]
USAID	United States Agency for International Development [www.usaid.gov]
WHO	International Health Organisation [www.who.ch]

Key terms

Climatic stressor:	heat radiation problems from tin-roof shed of the factory and other source (e.g. furnace), form of warmth due to high air temperature and/or high humidity content.
Confounding factor:	factors those are not directly visible but have risks at workplace, an endpoint determinant that is not under primary consideration but is correlated in the data with the determinant under study and it may thus confound or bias the estimated effect of determinant (or exposure).
Contributing factor:	more visible factors that are long lasting risks at workplace due to poor workplace layout, old equipment, critical posture, excessive muscle exertion, heat, noise, vibration, smokes, dusts, and other hazards.
Determinant:	risk factors that include exposure level and influences probability of cumulative exposures, peak or remote exposures, recent or lagged exposures according to duration, place, environment, etc.
Ergonomics:	preventative measures, which help in designing workstations, work processes, tools or equipment to fit the individual worker, and an innovative tool for increasing safety, efficiency, and productivity.
Good workplace:	ergonomic workplace with the potential to increase workers' health, safety and work performance or productivity.
Hazard:	occupational or environmental exposure sometimes to individual susceptibility that increase risk, a source of possible injury to workers or damage to the environment or material assets, and disturb work process.
Hazardous workplace:	workplaces in which a worker interacts with hazards.
Heat stress:	a situation when human body feels thermal discomforts (e.g., heat load) in dissipating excess heat and sweating to the surrounding (nearby) environment.

Heat strain:	result of heat load or physiological response to heat stress, differences between internal or metabolic heat production and heat loss due to a hot and humid climate, or occurrence of heat exhaustion with change of excessive sweating, heart rate, body temperature, high blood pressure, feeling of thirst, etc.
Hours of exposure:	total number of hours worked in a particular job task, shift or time spent (how many hours) in a specific work environment.
Implementation:	carry out various steps to provide health and hygiene measures, as well as safety and ergonomic applications for workplace improvement or intervention.
Information system:	system that provides the data needed for decisions relating to safety, health and the work environment.
Intervention:	an instrument of something that enhances way of modification, increase work value and control measures to minimise work-related problems, and/or to find some changes for improvement in the workplace.
Job-safety analysis:	a series of logical steps to enable systematic assessment of job tasks for implementing health, safety and hygiene measures as well as ergonomic applications.
Management system:	organisational structure, procedures, processes and resources needed to implement health and safety management.
Monitoring:	systematically testing, measuring or observation aspects of working conditions over a certain period of time in order to find some changes (improve) in the workplace.
Nonergonomic condition:	poor manipulation (incorrect use) of machinery or tools, intense work with frequent movement of arms, legs or trunks, handling of heavy materials or carrying a heavy load without using ergonomic aid such as lifting device, wheel barrows, push or pull carts.
Occupation:	when a person engages in a job-task that brings livelihood (salary, fringe benefits or other facilities), or work experience, the identity of a profession, designation or employee status.
Occupational health:	workers' physical, social, and cognitive elements for better efficiency in job-tasks.
Occupational safety:	working situations where injury risks or production loss have not begun, or unsafe act, poor work environment, or non-ergonomic practices are minimised by safety measures and adopting ergonomic means to control work hazards.
Occupational health/safety:	competence of a healthy work force, safe handling operation, clean or hygienic workplace, suitable work schedule, provision of labour welfare through a maintaining of work regulation and labour legislation.

Physical fatigue:	the result in muscle pain, postural discomfort, symptoms of musculoskeletal disorders from heavy physical work, or tired from long working hours without enough food or nutrition, drinking of water, tea or coffee, and sufficient rest.
Physical stress:	results from a relatively high work exposure (heavy manual work or strenuous tasks, muscle force without using powered hand tools), physically tired from poor working posture, or from long working hours without sufficient rest, etc.
Poor workplace:	when the work environment is hazardous, non-hygienic, unsafe, non-ergonomic and/or unproductive.
Psychosomatic symptom:	symptom arises from a situation of poverty, poor salary, family burden, mental fatigue, working on a non-suitable shift, lack of cognition, bad relation with co-workers, factory owners and managers, for instance.
Prevention:	the act of reducing work-related problems and work injuries or hindering the obstacles (physical or chemical hazard, radioactive substance, or biological exposure) in the workplace.
Risk:	probability of an adverse endpoint (cumulative risk of hazards in workplace, for instance).
Shift design:	making the shift schedule in some way (course or direction of time) or replace a worker that it brings less work stress (both from physical and mental), minimise sleep debts and fatigue.
Shift work:	activity carried out by several workers in different periods of day or night, a portion of an extended production process covered by two or more teams for an equal number of working hour per shift that relieve each other over a period of 24 hours by day and night.
Symptom:	a deviation of the normal health of workers due to abnormal environment, condition or hazardous system at workplace.
Strenuous task:	hard work, intolerable task, and a heavy workload for excessive physical exertion (e.g., stressful manipulation with non-ergonomic tools) in hot and humid work environment.
Sustainable workplace:	poverty alleviation through gradual improvement of workplace safety and health since it contributes to clean or hygienic work environment as well as productivity and welfare.
Thermal comfort:	a state when a worker feels comfortable in a climate or specific environment without any change of a worker's physiological or metabolic parameters such as sweating rate, variation of oral temperature, heart rate, etc.
Thermal discomfort:	feeling of heat exhaustion and thirst, heat cramps from the effects of excessive heat-load either from direct heat source, or radiation temperature at workplace.

Thermoregulatory response:	physiological response within a hot and humid working climate that results in the greater sweat loss, or evaporation of sweat to the local environment or change in oral temperature or heart rate increase.
Variety:	type and number of state or situation of a system/environment
Workplace:	a location, place or environment where a worker normally performs his/her job tasks, or spends a reasonable time working in that place, location or environment.
Workplace assessment:	a systematic investigation of job-tasks or evaluation of work-related factors in order to find ergonomic solution to reduce and control of accidents and injuries, or ill health, or to improve health, hygiene and safety.
Working condition:	a job, task, machinery, tools, layout, factory premises or working climate that covers factory environment. It can be also workers' physical, social and mental workload, psychosocial and organisational context of job-tasks under which job-task has to be performed or influences the work (or job tasks), or work environment.
Working environment:	work space, illumination, noise, dust, fumes, or humidity level at workplace, climate or environment inside factory premises.
Work hazard:	source of risks of an activity, conditions of a system, or other local situations that result in a work injury, damage to or loss of equipment, materials, etc.
Workplace improvement:	process of improving workplace or the state of improved work environment, or the act of and process of improving working conditions (e.g., task, activity, tools).
Workplace intervention:	improved health, safety and ergonomic applications through collaborative efforts from all the parties concerned, or an efficient use of local resources for good work, increased productivity and less injuries in the workplace.
Work-related injury:	result of an accident that gives rise to poor health, musculoskeletal disorders or other bad symptoms that results in sick leave, production losses or increased compensation claims.
Work-related risk:	the incidence rate combined with the severity of work hazard, probability or possibility of a mishap in terms of hazard severity, activation of a hazard that can result injury in workplace, or result in accident or loss of production.

List of original studies

Study I Ahasan MR, Ahmad SkA, Khan AW & Ahmed TP (2000) Occupational exposures and respiratory illness symptoms among the textile industry workers in a developing country. *Applied Occupational and Environmental Hygiene,* 15 (3): 313–320.

Study II Ahasan MR, Khan AW, Al-Mahtab M & Faruquee SM (1998) Small and medium-sized chemical factories in Bangladesh—occupational health and safety measures. In: PA Scott, RS Bridger and J Charteris (Eds.), *Global Ergonomics*, Elsevier Science, pp. 271–275.

Study III Ahasan MR, Quddus R, Väyrynen S, Virokannas H & Mohiuddin G (1999) Work-related problems in metal handling tasks in Bangladesh: obstacles to the development of safety and health measures. *Ergonomics,* 42 (2): 385–396.

Study IV Ahasan MR, Väyrynen S & Kirvesoja H (1996) Physical workload analysis among small industry activities using postural data. *International Journal of Occupational Safety and Ergonomics,* 2 (1): 27–34.

Study V Ahasan MR, Mohiuddin G & Faruquee SM (2002) Strenuous task in hot climate—a case study in Bangladesh. *Work Study,* 51 (4): 175–181.

Study VI Ahasan MR, Khaleque A & Mohiuddin G (1999) Human aspects of shift work in the developing countries I:—a case study in Bangladesh. *Journal of Human Ergology,* 28 (1/2): 59–65.

Study VII Ahasan MR, Campbell D, Salmoni A & Lewko J (2001) Some intervening and local factors among shift workers in a developing country--Bangladesh. *Journal of Workplace Learning,* 13 (3): 164–169.

Contents

Abstracts
Tiivistelmä
Acknowledgements
Abbreviations
Key terms
List of original studies
1 Introduction 21
1.1 Background 23
1.2 Socio-economic and employment issues 24
1.3 Industrial issues 26
2 Rationale for the study 28
2.1 OHS/ergonomics—sustainable workplace improvement 30
2.2 OHS and ergonomics—national perspective 32
2.3 OHS and ergonomics—global perspective 33
3 Scope and objectives 35
3.1 General objectives 35
3.2 Scope of the study 36
4 Materials and methods 38
4.1 Subjects, tasks and activities 38
4.2 Methods 39
5 Results 43
5.1 Health and safety profile of textile mill workers (study I) 45
5.2 Occupational exposure to handling of agro-chemicals (study II) 46
5.3 Work-related issues in metal handling tasks (study III) 46
5.4 Physical workload in small industry activities (study IV) 47
5.5 Heat stress and physical effort of steel mill workers (study V) 47
5.6 Human aspects of shift work in shoe factory (study VI) 48
5.7 Intervening and local factors in shift work (study VII) 49
6 Recommendations 50
6.1 Workplace intervention 50
6.2 Participatory action 53
6.2.1 Praticipatory action through NGO-collaboration 54
6.3 Low cost measures 57

6.4 Job training and vocational education 59
6.4.1 Workshop session and short courses 61
6.4.2 Mobile training 62
6.5 Information and network center 63
7 Discussion 66
7.1 Validity and consistency 69
7.2 Difficulties encountered 71
7.3 Implications for further study 71
7.3.1 Importance of workplace investigation 73
7.3.2 Systematic methods of workplace survey 74
8 Conclusion 78
References 80

1 Introduction

Occupational health and safety (OHS) primarily seeks to maintain the working ability of the labour force as well as to identify, assess and prevent hazards within the working environment. Ergonomics, on the other hand, combines all of these issues to improve workers' efficiency and well being and maintain industrial production through the design of an improved workplace. OHS and ergonomic applications therefore work together to satisfy the needs of changing local people's attitudes, local work methods and/or traditional ways of doing things. These issues are important for many developing countries (DCs), because the effects of poor health and lack of safety facilities, and non-ergonomics conditions exist in various workplaces are a hindrance to the national economy and social progress. Since implementing the full concept of OHS and ergonomics application is a priority, understanding the meaning of the terms related to OHS and ergonomics applications is a major source of workplace improvement. It is therefore important for both foreign and local investors to investigate workplaces, to know how a tool, machinery and production process would match the local workers' physical and mental capabilities of the local population.

OHS and ergonomics issues have a connection with various components in the regional economy since the provision of health, hygiene and safety in the workplace contributes to economic growth processes in a number of ways (Takala 1992). OHS and ergonomic issues are also related with the production economy and social progress, and thus, important components of gross domestic product (GDP)—which are considered as inputs into the national economy through industrial development. ILO (1999) indicated that approximately 4% of GDP disappears in many countries, soaring even up to four-fold that, on OHS losses due to lack of basic health and safety facilities in workplaces. It is therefore important to know what socio-economic and industrial strategies would be most fruitful if OHS and ergonomic applications are to be implemented in practice.

It is also observed that the relative share of GDP spent on health and safety does not conform to a consistent pattern in DCs (Takala 2000). This is because the GDP lost in work-related injuries and occupational diseases stemming from a poor work environment is not counted in DCs. Studies carried out by Ahasan *et al*. (2000) pointed out the fact that workers' lives in many of these nations are often marked with a serious deficit on the part of their health, safety and hygiene measures. In many DCs, physical work practised as manual materials handling (MMH) and strenuous tasks which usually take a toll as

injuries, accidents and production loss, because numerous risky and hazardous jobs and strenuous tasks still have yet to be semi-automated or be transferred to other forms of controlled environment. Sen (1965) expressed concerns on physical environmental factors as vital stressors in many tropical DCs, affecting health, hygiene and safety of industrial workers. Hundreds of thousands of workers living in DCs will be at risk (Ahasan & Partanen 2001) if no future attempts are made successful for the improvement of health and hygiene. For unhygienic workplaces, these risks are real, and there is a long term trends in occupational exposure in DCs (Kromhout and Vermeaulen 2000).

The rapid rate of changes in working life today also requires several types of flexibility with the consideration of occupational health, industrial hygiene and safety requirements in various workplaces (Leamon 2001). The realisation that discrepancies in work situations between prescribed and real work has undoubtedly contributed to the recent interest in work analysis with respect to OHS and efficiency objectives on the one hand and the desire to form competent workers on the other hand. Whatever the case, work-related data is important to synchronise local peoples' tradition, culture and work ability, working climate, labour profile, and the existing layout of work sites (Ahasan 2000a).

Currently, there is also very little data and information available in the literature that supports the design of better work processes. In this regard, the attitudes of concerned parties (e.g., workers, employers, labour unions, Inspectorates, etc.) on OHS and ergonomics applications are important while recognising that any approach to change or improve working conditions must be consistent with the local economy and competitive environments. The attitudes of the concerned parties can be improved from different angles: participatory planning, workplace intervention, worker motivation, on-the-job training and vocational education (JTVE), implementation of work regulations and labour legislation (WRLL), and enhancement of collaboration and co-operation with key persons, regulatory agencies and work organisations to increase production and reduce work-related problems (WRPs), accidents and injuries.

It is believed that if OHS and ergonomics issues (Ahasan *et al*. 1998a) are considered in the national agenda, then the local economy, after a time lag, will record higher levels of growth. Therefore, conditions of variability in which local workers are placed must leave them room to manoeuvre and space for their expertise so that they may develop ways of doing things better that will allow them to attain the expected production objectives. For sustainable workplace improvement, this leads to effective productivity levels through the appropriate levels of workers' welfare and job satisfaction which can be improved through the mechanisation of production activities and ergonomic applications (Oxenburgh 1991, Laflamme 1993, Kawakami *et al*. 1999). Nevertheless, major lessons from the experience of other neighbouring countries (e.g., Malaysia, Vietnam, Thailand, etc.) can also facilitate some ideas for the sustainable improvement of the workplace in DCs like Bangladesh.

With the aim of creating a source of work-related information, this thesis, hence, summarises a few case studies (already published in various international journals), which are followed by simulated discussions and suggestions, and deepen the existing working condition and environment in Bangladesh.

1.1 Background

The workers are the driving forces of the national economy, and thus their working lives should be protected from WRPs. Since there is an intense competition in the establishment of various types of machinery and tools, the evaluation of work-tasks and the identification of work exposure is a major occupational issue for workplace improvement. In this regard, work-related data is very important that would help industrial entrepreneurs in many ways (Ahasan 2000a). In Bangladesh, businessmen, entrepreneurs and multinational companies are also investing in capital and machinery in the current business boom mentality. These entrepreneurs may have some data and information but those seem to be outdated or old. They may be unsure about whether they should acquire updated information in investing their capital and machinery according to the local workers' tradition, culture, climate, labour profile, and the existing layout of work sites, for instance (Ahasan 2000a).

Ahasan (1993, 1994, 2000b), Khan (1994, 1997, 2000) and Raihan (1997) have investigated many industries in Bangladesh and found that majority of SMEs do not have a long-term stake in environmental and climatic considerations. Some others (Fariduddin *et al*. 1975, Rahman 1993, Ahmad *et al*. 1997, Sadeque *et al*. 1998) surveyed different workplaces in Bangladesh and analysed local workers' energy expenditure, and health, safety and ergonomic issues. Rahman *et al*. (2000) expressed concern on potential factors of using injury information for injury surveillance at local level in Bangladesh. From these studies, it has been proved that the workers usually worked long hours in unsafe conditions without using any personal protective devices (PPDs), for instance. Most of the workers' health, safety and well being are therefore deteriorating because an interest in OHS has yet to be reached in SMEs. There are long-term trends in occupational exposure—that are a real problem in Bangladesh not only for workers' health and safety risks but also for the society as well. It is also well known that the present status of OHS/ ergonomics is still at the rudimentary level in Bangladesh because the factory owners (FO) and employers association (/EA) usually considers these elements as a costly luxury. It is also true that they usually lacks money, resources and other elements for providing improved health and safety facilities to all the workers.

In Bangladesh, as far as field surveys and workplace inspections are concerned in, only a few such studies and research, however, have been conducted based on in-depth case studies. Workers' physical workload, heat stress and thermoregulatory related studies were conducted (Ahasan *et al*. 1997a,b,c) but those do not contain all types of empirical data and ergonomic information. Some anthropometric data of female garment workers (Khan 1997) and other work-related information can be found in a few studies (Sadeque *et al*. 1997a,b, Ahasan *et al*. 1997d,e, Ahasan *et al*. 1998b). Other studies have highlighted female workers' economic, social and health aspects (Jahan 1989, Rahaman *et al*. 1991, Majumder & Chowdhury 1992, Majumder & Begum 1997, Zohir & Majumder 1996a, b) those may contribute some data and information but these studies do not emphasise the practical importance of OHS and ergonomic applications. In some other studies (Khaleque 1991, 1994, Khaleque & Pervin 1994, Sadeque *et al*. 1997a,b, Ahasan *et al*. 1997f, Ahasan *et al*. 2002a,b) shift workers' psychosocial, economical and labour management issues were evaluated and analysed. There are some other studies conducted by different organisations and individuals (Khan 1988, ILO 1990, BSCIC

1998, NIPSOM 1999), but those are compiled either as reports or other forms of information. Bangladesh University Press (1990) published a work concerning female and child workers' socio-economic, production profile and working life. Khan (2000) surveyed child workers' health and safety those are working in the capital city. Khan (1994) surveyed sickness, diseases, treatments and medical costs by socio-economic variables in Bangladesh. General data on health and safety can be found from other sources [www.bangladeshgateway.org/sdnp/health]. Al-Mahtab (1998) has also assessed specific risk factors in the agro-chemical factories. Laskar *et al*. (1999) compiled some information on occupational health but it does not reflect the views of the Government of Bangladesh (GOB). Experiences on labour issues can also be found in the ILO regional office (Khan 1988).

Studies by the Asia-Pacific Regional Project for Labour Administration (ARPLA 1991), the Ministry of Labour and Employment (1996) and Hossain (1996) also published some books and reports which may be of interest to readers concerned with work-related issues. ILO's (1990) perspective on an improved technology project tells the key challenges for the future programs in SMEs. The World Bank (1990, 1999) also reported what national strategies are vital for enhancing the role of local workers in the socio-economic and industrial development in Bangladesh. However these studies do not present the current state and future prospects of OHS and ergonomic application in SMEs. Nonetheless, it has been proven that clean, hygienic and ergonomic work environment has the potential for sustainable improvement of health, hygiene and safety, as well as production increase.

1.2 Socio-economic and employment issues

The total size of the working population in Bangladesh is about 51.2 million (World Bank 1999). The unemployment rate was 26% (14 million) in the financial year (FY) of 1998-99 among the economically active population [http://laborsta.ilo.org/cgi-bin/broker.exe]. About 1.20 million who have completed a high school and university education remain unemployed (World Bank 1999). There are approximately a total of 5 million people involved with various types of jobs mainly in SMEs (Statistical Year Book 1998). In all, 2.4 million skilled technicians, semi-skilled mechanics and general workers are working abroad (e.g., Malaysia, Korea, Taiwan, Saudi Arabia, and the Gulf countries) [http://migrantnet.pair.com/files/Rbangladesh98.com] and they contribute more than 25% of the country's foreign exchange (approximately 1.34 billion USD in FY 1997). Table 1 describes the country profile of the workforce, employment situation and socio-economic status in Bangladesh and other neighbouring countries.

Table 1. Background information regarding socio-economic and employment issues in Bangladesh and other neighbouring countries (World Bank 1999, Pandita 2001).

	Bangladesh	Nepal	Sri Lanka	Pakistan	India
Population (million)	120	18.5	18.1	131.6	897
Labour force (million)	51.2	7.17	6.1	36.7	321
Literacy rate (%)	35	39	89	38	52
GDP growth rate (%)	4.7	6.1	5.5	6.1	7
Per capita income (USD)	265	180	709	495	282
Wage rate (USD)	0.24	--	0.39	0.49	0.56
Employment (%)					
Agriculture	66	80	37	52	65
Service	22	7	40	29	22.5
Industry	12	3	23	19	12.5

N.B. Data are found for India and Bangladesh in the year of 1996; Sri Lanka and Nepal in the year of 1994; and Pakistan in the year of 1997 [USD –United States Dollar].

More than 750,000 people are employed regularly or on a full-time basis in different sectors in Bangladesh (Labour Force Survey 1995). The majority of the population are engaged in farming activities, some in small-scale enterprises and a relative few in the medium-sized factory or industrial work. Salahuddin and Sharmim (1992) noticed that a marginal segment of the labour force was mainly tapped for various informal (small-scale cottage industries, agro-based rural industry) sector activities. They found that workers were hired for working long hours in household services, manufacturing and other types of jobs.

The selected issues in the employment and job-market were also discussed in several papers (Maqtada & Islam 1986, ARTEP 1986, Faruque 1996, Dowlah 1998). Less educated and semi-skilled labourers are frequently employed in SMEs with lower wages than adult males earn in a state owned industry. It has been indicated that urban workers' wages (mainly in the state owned industries) would have to be at least 30% higher than the average rural or agro-based industries because of production needs. At this urban wage level, the supply of labour is also considered to be perfectly elastic (Rahman 1986). Local economists postulate that migration of rural people to the cities and towns proceeds in response to workplace differences rather than differences of wage earnings (Salim 1995, Asraf 1996).

A World Bank (1999) report showed that 65% of total employment in Dhaka was in the urban informal sector that differs from agro-based rural and cottage industrial employment. However traditional industries like SMEs (both formal and informal), possess the highest labour productivity in Bangladesh, besides making a significant contribution to earning foreign exchange for the country (Bangladesh Bank 1998). This sector have been proven successful in 68% of national exports earnings (e.g., 54,000 millions US$ in 1998-99 especially from the ready made garment factories). SMEs employ 80% of the work force but many of these factories do not maintain and provide health, hygiene and safety services.

SMEs also employ ten times as many workers as heavy industry in Bangladesh (World Bank 1999). It is estimated that there are 24,000 small factories and various types of metal and wood workshops, 6000 medium-sized enterprises and a few hundred state owned big industries established in Bangladesh (BSCIC 1998). Jute, textile, sugar, energy, food and beverages, chemicals and petroleum, fertiliser, iron and steel, cement, paper and electronics are some of the major industries which contribute about 10% of GDP. Among the state owned industrial units, a total of 142 industries were identified as sick, those that are losing financially (e.g., 220 million US $ in the FY 1997-98), mainly due to poor maintenance, frequent power (e.g., electricity) failures, general strikes by the opposition political parties and/or labour disputes.

Bangladesh still has a sizeable foreign debt (15.9 billion USD in FY 1998), a high inflation rate (7%), a high infant mortality rate (78 per 1000 live births) and population growth (2.17%) and slow export growth (World Bank 1999). There is also an increase in hard currency reserves due to the disbursements and such slow growth of export earnings. The Gross National Product (GNP) per capita is however increasing [USD 350 in FY 1999-2000], although, a 3% average per capita GDP growth per annum is not a commendable achievement. It is not sufficient for an over populated country in which 60 million people still live below the poverty line (World Bank 1999). The national economy will be healthy if there is a planned policy in Bangladesh for OHS/ergonomics in the industrial workplaces. Therefore, the concerned professionals, industrialists, bureaucrats, policy makers and others should understand that OHS/ergonomics are essential for a good work environment that affects industrial production as well as national economy.

1.3 Industrial issues

Small and medium-sized enterprises (SMEs) are mostly privately owned companies and more profitable than the state run enterprises due to an efficient use of the labour force, and the joint effort of workers and factory owners (FO). However, it is known that labour management and productivity profile are not identical in all industries. SMEs have always remained outside the pale of organised industries, however, this sector influences the national economy. The garments sector, for instance, has achieved their unprecedented influence simply by increased production and 68% of national export (BGMEA 2001). But, the industrial development potential for SMEs in Bangladesh, and with it, the growth prospects of the national economy are not going to be achieved without health and safety. The workers should be protected from unsafe activities and conditions, otherwise industrial production will be hampered due to other pressures in the economy, decline in investments and political chaos, corruption, and other disputes. Health, safety and ergonomic measures should therefore be strengthened in various industries so that every workplace can meet the minimum standard of health and safety. It is also important because industrial production is the backbone of a national economy, for which there needs to be a consideration of the harmonisation of work-tasks. Heavy industry usually needs to be located in urban areas by investing a lot of money and effort, but SMEs can be located almost anywhere throughout the country. SMEs also facilitate

the dispersion of economic activity to semi-skilled and less educated workers in Bangladesh (BSCIC 1998).

SMEs play a useful role in many DCs like Bangladesh, as much as they make production available and bolster the retail trade, which is providential. But this sector is not generally assisted by commercial banks, on the grounds of either the cost or the risk involved. It is believed that the working population in SMEs will have a significant impact on economic growth if there is an access to OHS services, including personal hygiene and environmental protection. There is also a correlation between industrial production and national economy, life expectancy and OHS (Takala 1992). A wider access to health and safety serves to improve working conditions and enhances the efficiency of workers, which assists to contribute to higher productivity and business profits (Elgstrand 1985). In this regard, Ahasan (2002b) defined the important consequences of OHS and ergonomic applications as:

- Industrial and social development is not possible without considering health, hygiene, safety and ergonomics applications
- Health and hygiene cannot be achieved without an investment in safe and healthy behaviour among the workers, factory owners and others
- Job satisfaction may not be possible without an awareness of labour welfare facilities
- Workplace intervention is not possible without considering OHS/ergonomics
- Workplace change is not possible without considering job training, technical skills, and vocational education
- Health and safety at the workplace will not occur without a conscious awareness of work regulation and labour legislation (WRLL)
- Implementation of WRLL will be hard without a sincere commitment of the local government authority (LGA) or regulatory agency
- Transparency of regulatory agency cannot be achieved without formation of a neutral watch dog body, like the National Health and Safety Council (NHSC)
- Formation of a watch dog agency like NHSC will not be effective without an organised committee and effective co-operation and collaboration from all the parties concerned.

2 Rationale for the study

Health, safety and ergonomic issues are concerned with the evaluation of the human workforce, and the design of the working environment to obtain maximum satisfaction in productivity, and workers' health, safety and well being. OHS and ergonomics may include various local components (Ahasan 2002b), including work-related data and be expanded to cover the prevention and control of WRPs. OHS and ergonomic application focuses on the ways in which the workers should be protected from various exposures in their workplace (Phoon 1976). Health, safety and ergonomic application can be treated as the form of a three dimensional (3-D) model for improved working life (through job satisfaction) that also includes workers' physical, social and mental elements affecting industrial productivity, national economy and social development (Fig. 1).

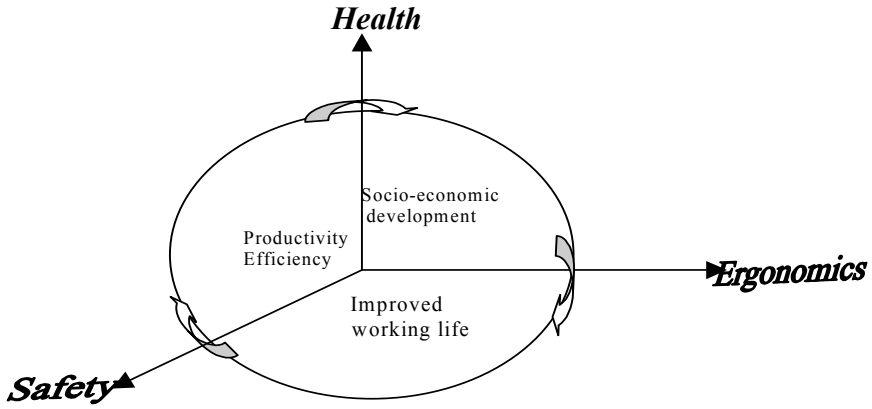

Fig. 1. A 3-D model for improved working life encompassing productivity, national economy and social development.

Health, safety and ergonomics deal with interactions between humans and other elements of a system in carrying out a purposeful activity (Kawakami *et al*. 1999). OHS/ ergonomics also concerned with human-system interaction and design considerations that include physical, cognitive, social, organisational and environmental factors aiming to improve workers' well-being and overall system performance by optimising human-system compatibility (Ahasan & Benincasa 1999a). However, interest in OHS/

ergonomics has yet to be reached in all the private and public sector industries in Bangladesh (Ahasan 2000b) and it remains a weak branch of the health and safety programs in many other developing nations (Ahasan *et al*. 2000).

OHS and ergonomic applications are also composed of compromise and adjacent strategies, which are determined by work execution conditions that covers all the health and safety situation in which workers are placed to meet their production objectives. Since health, safety and ergonomics applications are the basic needs for an individual worker's mental, physical, and social development, therefore many aspects of strenuous tasks or manual materials handling (MMH) that are intense but usual in DCs need to be addressed. These issues should be addressed not just because poor workplaces exist in DCs (Ahasan & Partanen 2001) but also because of inadequate infrastructure, old factory buildings, congested work space, etc. It is also believed that an OHS/ergonomics program will be enhanced by a "*go ahead spirit*" through workers' and employers' participation in improved health and safety. Therefore, a great deal of emphasis has to be placed on the improvement of the work environment with the collaboration of all parties concerned (Abeysekera 1997b). It is also necessary to control all the factors that influence human performance (both physical and mental) and industrial productivity. To create a good work environment, a conceptual model is thus explored in Fig. 2, which tells how human activity (job-tasks) interacts with work environment and how work-related problems (WRPs) can be minimised through direct and indirect actions.

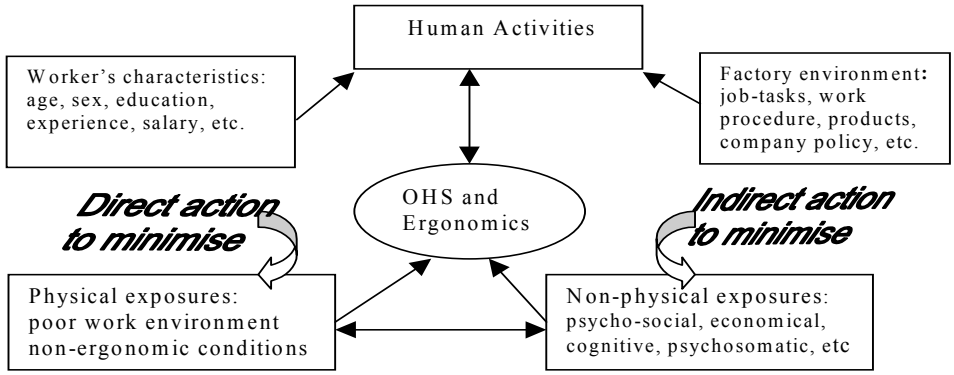

Fig. 2. Interaction between human activities (e.g., task and jobs) and OHS/ergonomics.

Increased productivity can be achieved through improvements in the organisation of work, job-satisfaction, workplace layouts or suitable work schedules (Ahasan 2001b). In many instances, workers' health and safety related perceptions are based on several factors such as management decision making, organisational safety, cultural norms, safety practices, local policies, and work procedures. These factors all communicate the commitment of an organisation to health, safety and well being with the intervention group (workers, linemen, foremen, etc). All of these issues cannot capture the essence of existing working condition and environment in SMEs, since workers' health and safety is not usually considered for higher productivity or increased efficiency not only in Bangladesh but also other developing countries (DCs).

2.1 OHS/ergonomics—sustainable workplace improvement

Improving the conditions of the work environment and opportunities for providing workers' health, safety and wellbeing essentially means contributing to sustainable improvement of OHS/ergonomics. Local perceptions about OHS/ergonomics in many countries have not captured headlines in the newspapers. However safe and hygienic workplaces contribute to sustainable development, and this issue can be raised through proper media exposure. The process of protecting workers, the surrounding communities and the environment for future generation have important common elements, such as pollution control and exposure reduction (Goldstein *et al*. 2001). It must, however, be published through the important avenue of OHS programs and health, hygiene and safety campaigns that are also key strategies for poverty alleviation (Annan 1997).

It is true that work system in many poor countries has become more challenging from the physical workload standpoint (Kuorinka 1993). The strenuous tasks, with which most of the manual workers are involved in various workplaces, has demand for immediate attention because indigenous people habituated on MMH (or strenuous tasks) cannot be easily relocated or replaced by other means in many DCs. Since physical working capacity (Kuorinka 1983) is considered as the income source of individuals in DCs (Mamansari & Salokhe 1996), therefore, the key to ensure the development of safe and healthy societies is the good working environment that reflects workers' concerns and needs. There is also a need for the protection of physical working capacity (manual labour) and for the sustainable development of both physical and mental health of poor workers living in DCs. It is also understandable that when a worker performs job-tasks, he/she follows a combination of formal and informal methods of doing things, but the physical and ecological setting of job activities should be carefully maintained or improved so that work-tasks become easier, safe and ergonomically sustainable.

Human activity also refers to the cognitive, physiological, perceptual, socio-cultural and psychic strategies of the local people to execute their work, as well as the means at their disposal for accomplishing sustainable work. Physical work can be treated as sustainable if the poor workers in DCs are able to keep their health in good shape using ergonomic techniques while they perform MMH or strenuous tasks. Further, an important virtue of the traditional methods of work activity that exist in SMEs is the utilisation of manual or muscle power, which seems to be more ergonomically sustainable, despite its low productivity. It is also believed that physical work reduces their cognitive problems, while mentally demanding jobs and automation can create more problems in the future (Rantanen 1994). However, it is also very true that mechanical work reduces the exposure period of workers to a polluted environment. In this regard, Ahasan (2002c) and Cullen & Harari (1995) emphasised more comprehensive research and empirical ergonomic studies—those are necessary to find practical solutions in different workplaces in DCs.

New industrial entrepreneurs also need to have the capacity to provide a rational basis of new thinking and solutions for sustainable development of workplace safety and health [www.sdnbd.org/sdi]. The efficiency of the work force should increase as the workers could devote their attention to the jobs rather than to the tools needed to pursue their job-tasks. This devotion can be introduced as formal and informal methods to assist individuals in acquiring knowledge on OHS, as well as an ergonomic way of doing things. It is also believed that the sustainable development of the workplace will be

achieved for long term benefits if health, safety and ergonomic issues are given priority in the local context. A model is therefore explored (Fig. 3) that tells how working people respond in a human-machine environment based on a physical and mental workload, and how work capacity becomes higher (i.e., sustainable) than workload through changes of non-productive work or hazardous tasks, and/or using personal protective devices (PPDs) and ergonomic applications, for instance.

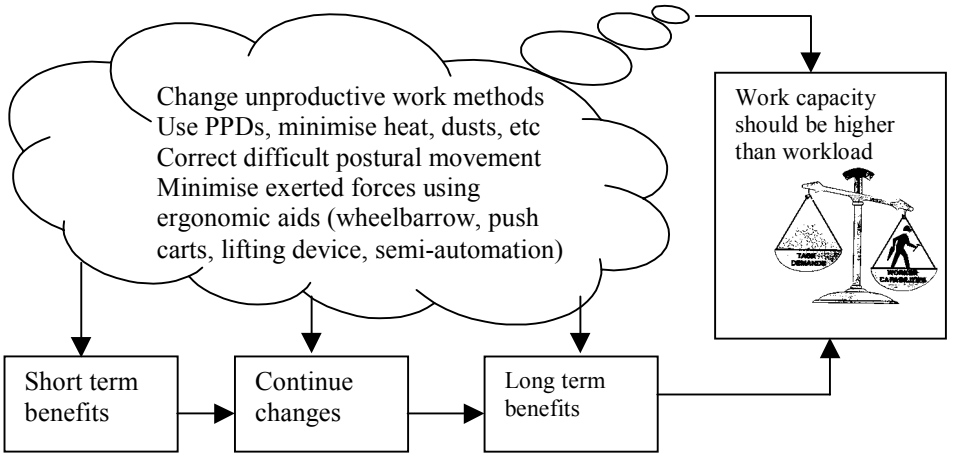

Fig. 3. A conceptual model based on health, safety and ergonomic measures for sustainable workplace improvement that increase working capacity and decrease workload.

The physical capacities (e.g., load handling technique) and work performance of local workers should synchronise with the existing work environment and production objectives. In this regard, job tasks are to be harmonised with the physical, social, cultural and cognitive variations of the local workers (Ahasan & Benincasa 1999a). Further, the organisational structures of SMEs, labour policy, as well as work regulation need to be revised, modified or updated, because rapid industrial growth in many DCs and the global economy has generated an increasing demand for OHS/ergonomics. This is very important for professionals, academicians, politicians, union leaders (UL), decision-makers and others because rapid industrialisation in DCs and the migration of indigenous people to the cities and towns compound problems in workplaces. The intervention groups such as FO, EA, UL & LGA should have a significant role and responsibility to organise people from all the concerned parties, and to implement local measures effectively. In this regard, the rational basis of health and safety studies and ergonomic research (Abeysekera 1997b, Kogi & Kawakami 1997) is important for sustainable development of job tasks and work environment.

2.2 OHS and ergonomics—national perspective

Health and safety are basic rights that workers in Bangladesh should not be denied in their workplaces. The ever-increasing human resources in Bangladesh have not been properly utilised due to various local constraints (Hossain 1996). There is also the very pertinent fact that the process of change of improving working environments in SMEs has been slow (Hossain 1996, Majumder & Begum 1997). It is undoubtedly a challenge for Bangladesh, mainly because of the increasing demands of foreign investors. Import quotas (BGMEA 2001) imposed by the foreign countries were a great threat to Bangladeshi products due to child labourers and non-hygienic working conditions (Khan 2000), especially in garment factories and other sectors (e.g., frozen fish, vegetables, fruits, etc.). The workers need to be encouraged to report their health and safety problems despite the predominant role of FO/EA's strict attitudes towards workers, and flexible role of the Inspectorates. However, immediate action could be found for an ergonomic solution through locally available means. For this, nationally legislated legal frameworks, national industrial policies, service delivery systems, and access to vocational training or technical education will work to ensure the realisation of workers' rights. Health, hygiene and safety measures are therefore essential for an effective national policy through which workers' rights will be protected (Holkeri 2001).

Health and safety measures may be hard to implement in Bangladesh, although they are for both the workers' and employers' benefits. OSH/ergonomic issues are also the key considerations in all-industrial investment and production decisions (Ahasan 2002b) because it focuses on the ways in which workers should be protected from work exposures. The need for OHS/ergonomics also brings a host of benefits for industrial production, national and regional economy. The means for acquiring health and safety knowledge, and ergonomics needs to be increased among both professionals and non-professionals (Ahasan *et al*. 1998c). OHS/ergonomics should be extended in its field of action to the design of technical and organisational methods in the workplace. It should come to consider not only the protection of employee health but also the reliability of machinery installations and production in the local context (Ahasan 2002b). OHS and ergonomics applications achieve this by integrating an improved work system or task-activity based on local population and environment and considering the conceptual underpinnings of anthropotechnical systems (Wisner 1989, 1995).

The evolution of OHS and ergonomic applications in the national perspective is related not only to transformations in the nature of work, but also to changes in the active population and social movements. The social debate on better working conditions has focused on the implementation of health and safety, because OHS/ergonomics influences workers' life expectancy, quality of life and work efficiency. About OHS, all that can be said at this point is that over the years it has largely been an absence of inspection that has nullified collective efforts towards enforcing work regulation and labour legislation (WRLL) in Bangladesh. The concept of health, safety and ergonomics, and its applicability to designing better work systems is thus important for workers, entrepreneurs, and other concerned parties.

The components of job tasks and local factors are to be considered in designing work systems (Shahab 1998) where millions of indigenous people are working in the privately owned enterprises in DCs. However in designing a better work system, which strategies

the workers, FO & EA can use in SMEs is still unclear. For FO/EA, it is also an evident challenge in controlling the pace of work, such as non-ergonomic working conditions exists in industrial and other workplaces. The level of understanding on work-related issues and the conception of OHS/ergonomics at the national and enterprise level are very important because it enhances workers' consciousness against WRPs, and concern and commitment of regulatory agencies (e.g., DIFE, DOE, BSTI) toward improved health, hygiene and safety facilities. OHS needs to be understood among workers, first in order to question and understand the capacities of local tools. These issues should be introduced through everyday language, so that semi-skilled or comparatively less educated workers can easily grasp the ergonomic idea or consciousness of health, safety and work hygiene. Work-related issues needs to be divided between technical, social and perceptual in quality to a better understanding of employers', managers', and workers' responses which are also needed to address their individual's problems. Understanding work ability (Kuorinka 1993) is also a factor that can influence each of those local people and the environment they are habituated to work with. Therefore OHS/ergonomics application must not make reference to concepts or technical or medical terms that are not readily understood by the general population. OHS attempts to harmonise working society and the local environment to promote an individual's well-being (Jafry & O'Neill 2000). From a national perspective, it is therefore vital that OHS and ergonomics applications include curative services because investment in health and safety is certainly beneficial not only for local workers but also for FO/EA, and society as well. If they understand the value of keeping their workplaces clean, healthy and hygienic, then someday, OHS/ ergonomics measures will perhaps be implemented in SMEs through multidisciplinary ways of prevention and control.

2.3 OHS and ergonomics—global perspective

The rapid growth of human resources and global free market opportunity have called for the implementation of OHS/ergonomics application as an important issue. With regard to both industrialisation and economic reform, health and safety strives towards the global commitment (WHO 1995, Leichnitz 2001, Phoon 2001) that should be considered as a matter of urgent attention. There is a need to elaborate the ways that structural changes in the global economy (Ahasan 2001d) have affected our societies, climates and quality of life, including workers and working conditions. Globalisation leads to subcontracting and flexibility, which may cause a further compromising of health and safety standards in many DCs (Holkeri 2001). Multinational companies want to produce cheap products and may at the same time ignore the needs of the workers who cannot become consumers. It is therefore necessary to abandon the outmoded trickle-down policy of importing hazardous product, non-ergonomic process, complex operation, and age-old machinery to the DCs. However though some DCs including Bangladesh are importing second handed or old machinery from industrialised and other nations and making good profit for investors with less injuries and accidents in workplaces.

OHS/ergonomic issues have brought our attention globally to resist the importing of hazardous materials from foreign countries (LaDou & Jeyaratnam 1994). OHS/

ergonomics is also treated as the principal factor around which workplace improvement efforts are to be planned in spite of various obstacles in DCs (Mwaniki 1992). For the implementation of OHS to be efficient in the workplace, there needs to be care that it correctly fits with the implication of the local economy, climate, infrastructure, and so on (Ahasan & Benincasa 1999a, b). The rights-based approach to development needs should be particularly focused on OHS/ergonomics application from which the workers are protected not only in poor countries but also in rich countries. The global burden of occupational disease (Murray & Lopez 1996) and work-related injury (Takala 2000) remains unacceptably high because the majority of the world's workforce is still not served by occupational health services (Goldstein *et al*. 2001), for instance. The global corporate policy is not favourable for financing health facilities and safety services in many DCs (Ahasan & Partanen 2001) mainly due to other pressure in global competition, and especially for structural adjustment policy (Ahasan 2001d) suggested by IMF, the World Bank and other foreign consultants working for third world nations.

At the moment, health and safety is a global issue (Manuaba 2001)—which should consider the local characteristics of the occupation and work culture. Major changes in the enterprise structure of SMEs and associated technology must now be taken into consideration in policies affecting working people because of growing internationalisation, global competition, and changes in regulatory strategies (Goldstein *et al*. 2001). The stress of global competition may also lead employers to view the prevention of occupational injuries and the protection of workers' health not as an integral part of quality management but as a barrier to production, trade and commerce.

The greatest challenges for SMEs is the difficulties with the transformations involved in adapting to the new work situations, such as complex shift schedules (Ahasan *et al*. 2001, 2002a,b) and opportunities for investing time, money and efforts on OHS. However, health, safety and ergonomic studies are composed of linked research (Abeysekera 1997b, Kogi & Kawakami 1997) in the areas of readiness and effectiveness in the face of minimising diverse sources of occupational hazards. In this regard, we have to emphasise a global need for OHS/ergonomics that is interdisciplinary.

It can be said that work-related risk factors are lessened from an understanding of work activity that politicians and decision makers, however, may not be always ready to provide. Professionals living in DCs should, therefore, be involved in the creation of innovative programs in such intervention strategies to suit the local contexts in which they intervene (Ahasan 2000b). Improved workplace layout along with health and safety facilities can enhance the physical, cognitive and psychosocial integrity of local workers, aid adjustment to a new work system or facilitate the reasoning or decision making process (Kawakami *et al*. 1999). Therefore, a major programme of OHS should aim at supporting a wide range of health, safety and ergonomics research globally.

3 Scope and objectives

3.1 General objectives

The general aim of this thesis is to create a source of work-related information for different small-scale and medium-sized factories in Bangladesh. This will help to identify possible future research opportunities as well as individual study appropriate for such opportunities in other industrial units. It also considers some key issues with relevant work-related literature that serve as a resource and means of information exchange through which practitioners, professionals and others can benefit from the case studies included in this thesis. Hence, general objectives of the case studies are to:

- present the present art-of-state of working conditions in SMEs
- provide a comprehensive evaluation of OHS and ergonomic issues in different workplaces in Bangladesh
- introduce, monitor and validate uniform procedures for recording and analysis of work-related data and information
- explore important determinants of physical workload (critical work posture, MSD, heat stress, etc), illness symptoms, non-hygienic parameters, psychosocial, intervening and local factors of shift work
- explain health, hygiene, safety and ergonomic issues for sustainable workplace improvement in SMEs where physical work (i.e. MMH) is intense, but it is usual practice
- draw workers' awareness and public attention towards unsafe acts and conditions
- encourage national and enterprise level consultation and cooperation for health, hygiene, and safety measures in various workplaces
- explore low-cost engineering solutions (e.g., available, easily applicable, harmless for local workers) that may intervene in developing ergonomic strategies in SMEs
- address concerns to the preparation of job training and vocational education for the less educated and semi-skilled workers

- implement health, safety and ergonomic measures in the workplace through the consultation, guidance and collaboration, and participation of the local government authorities (LGA), NGOs and international orgations.

This thesis also reviews the work-related data and information regarding people's work culture, and explores possibility of ergonomic application through low-cost intervention, participatory action, etc. as the essential components of national productivity and social progress. Certainly, most of the work-related issues raised in this thesis merit immediate consideration for sustainable workplace improvement in SMEs. The primary and secondary objectives of the individual study are illustrated below in Table 2.

Table 2. Primary and secondary objectives of the individual study.

Case studies	Primary objective	Secondary objective
Study I Health/safety profile of textile mill workers.	Provide data on exposure-disease association (respiratory health profiles) mainly due to excessive cotton dusts, unhygienic shop-floor and other environmental hazards (e.g. congested space, in-efficient air circulation, etc).	Develop workers' awareness and ensure cleaning, maintenance and servicing of machinery, tools, etc. and implementation of work regulation (e.g., PPD use).
Study II Exposure to handling of agro-chemicals.	See how incorrect handling, manufacturing, and storing of agro-chemicals contribute to a serious risk of human health and work environment.	Ensure how health/safety are to be synchronised with safety codes, and see basic hygiene facilities (toilet, latrine, washing, storage, canteen, eating food) for sustainable or ergonomic workplace improvement.
Study III Work-related issues in metal handling tasks.	Identifies stressful tasks related to MSD and psychosocial symptoms.	See how ergonomic interventions can be fruitful through LCM, PPD use, and job training and vocational education.
Study IV Postural work load analysis among small industry activities.	Determine physical workload and postural discomforts by identifying harmful or critical posture.	Develop recommendations for body mechanisation and ergonomic practice for adaptability and flexibility by allowing tasks or materials within easy reach.
Study V Heat stress and physical effort of re-rolling and steel mill workers.	Define important factors (determinants) related to strenuous tasks, thermal discomfort and other heat related risks.	Identifies thermal response to heat load, physical work effort in strenuous tasks, and records climatic/environmental data.
Study VI–VII Intervening and local factors in shift work.	Explores worker's attitudes, aptitudes, labour-management relationship, welfare benefits and other intervening factors in shift work.	See how differential effects of shift work is an important determinant for coping strategies that can help to minimise sleep debts, fatigue and other problems.

3.2 Scope of the study

Work-related data and information covered by seven case studies (*study I—VII*) contain some important recommendations and expert suggestions that may be more stringent over

national regulations for work environment, and labour legislation over the Factory Act (1965) and Factory Rules (1979). Thus, this thesis increases the scope and effectiveness of the workplace investigation of causes of WRPs, and the identification, assessment and implementation of preventive measures in SMEs. It also enhances the scope of recording at enterprise level data that includes various types of job, task, and activities in SMEs. It also considers the basic requirements for OHS/ergonomics issues in all types of workplaces in Bangladesh.

This thesis can be also considered as the first issue of OHS and ergonomics information in SMEs, in particular, since there were no in-depth studies and applied research conducted before, except for a few reports in different forms. Even though it may not be an exhaustive list for any in-coming solutions, it could be so, nevertheless, the information compiled in this thesis can be a starting point for workplace reform in SMEs, in particular.

The provisions of the recommendations suggested in the thesis apply to all small-scale industries and medium-sized enterprises, and all workers in Bangladesh regardless of their status of employment. And because those suggestions offer practical guidance in the local context on the policy and standard setting in OHS and ergonomic application in Bangladesh.

The recommendations illustrated in this thesis have also priority over international standards (e.g., ISO, OHSA, NIOSH rules) or threshold limit values (TLVs) in order to promote health, safety and hygiene measure at national level and enterprise level. However a national code of practice, unless otherwise mentioned, is not necessarily a substitute for national legislation and regulations (Factory Acts 1965; Factory Rules 1979) and other enacted safety standards by regulatory agencies (e.g., DIFE, DOE, BSTI).

4 Materials and methods

4.1 Subjects, tasks and activities

In this thesis, work-related data and information were collected from various types of workplaces in Dhaka and other districts in Bangladesh. A total of 8880 subjects participated in the study to register work-related problems (WRPs). Altogether, 291 industrial units (250 small-scale and 41 medium-sized) were surveyed. The number of subjects by sex and total number of subjects who participated from different industrial units are illustrated in Fig. 4. Out of a total 578 workers, 210 male subjects (age 35.6 ±10.8) participated in *study I* from four major sections of three different textile mills, such as: blow and card room (n = 43), spinning section (n = 64), finishing section (n = 44) and general section (n = 59). These workers were engaged in working for drawing, feeding, monitoring machines, repair-brakes, and doff-bobbing tasks. The subjects in the general section mainly dealt with administrative and clerical jobs.

In *study II*, a total of 1025 male and 4100 female subjects (from small-scale factories) were engaged in preparing and packaging raw materials, and a total of 2755 male and 305 female subjects (from medium-sized factories) worked in the manufacturing of selected agro-chemicals. Both small units (n = 36) and medium-sized factories (n = 205) were privately owned. They handled different types of raw materials to produce semi-finished and finished agro-chemicals (insecticide, pesticides, herbicides), aggravate, asbestos, battery acids, dying solvents, synthetic paint, varnish, resin, photochemicals and pharmaceuticals. The work schedule was usually 8 hours a day, and six days a week. The annual amount of product packaged was about 200,000 litres as liquid and 70 metric tons of granules or powder stored in these factories.

In *study III*, a total of 293 men (age 20–40 years); 17 female (age 19–32 years) and 33 child labourers (age 14–17 years) participated in blacksmith (n = 7), steel furniture (n = 14), metal workshops (n = 13) and utensil factories (n = 3). Most of the subjects migrated from destitute rural areas and they have had primary schooling and others have high school education. Their salary was paid weekly for temporary workers and monthly (Taka 1500—3000) for fixed term workers. These factories and workplaces were located in two different districts in Bangladesh. The jobs and tasks varied according to the sex and age of subjects, type of factories, and the production system. Most of these factories,

however, manufacture agricultural tools, steel furniture, nuts, bolts, utensils, tabs, basins and other kitchen materials.

The number of subjects participating in *study IV* was 48, and they were selected from five different districts in Bangladesh. All were medium aged and male subjects but their work was purely manual (loading, lifting, packaging, binding, fixing, clay-mixing, cleaning, etc). Some tasks were performed with powered hand tools (hammering, cutting, logging, sawing, sizing, overhauling, pressing, knitting, and laundering). The working units in this study were mostly home based, small and cottage industries.

In *study V*, a total of 34 subjects (age 36±4.1 years) with no major physical health problems were selected for a questionnaire interview and physiological examination. The tasks were manually operated in a hot temperature for making steel bars, rods and angles. The process started with backing or heating steel bars and billets, causing a high temperature in the furnace of up to 1250°C. The workers in group B were standing at 1.5–2.0 meters away from the furnace and a few of them worked with a pliers to pull out hot bars (40–50 kg) from the furnace. They took hot bars and billet down to the rail and pushed it on to the roller conveyor, putting the pliers into the cold water for reuse. Physically, these jobs involved standing and twisting the trunk for picking and pushing the hot rods/bars to the rail/roller using pliers, and cutting and hammering the hot rods to a required length. The rods are continually followed through each of the rolling stations, sequentially becoming thinner and longer at each stage. There were four rolling stations, and one worker was involved in each station. Each exposure lasted for 1–1½ hours, having few rest pauses while they were drinking water, eating betel leaf, smoking, walking, sitting and talking with each other mainly on women and family affairs.

The sample of the subjects in *study VI* comprised a total of 60 adult male workers (medium aged, approximately 30–40 years) who were selected randomly from three working sections, such as the cutting, soling and modelling section of a shoe factory in Dhaka. They were involved in cutting leather into pieces for different parts of shoes, the preparation of soles, and designing and shaping the shoes while operating small machines and equipment. In all, 49 (82%) subjects were married and 11 (18%) were unmarried, having secondary school to college level education. The subjects were working on a weekly rotating three-shift system of 8-hours in a day, and 6-days in a week (Saturday–Thursday) on a cycle of rotation followed by a day off on Friday, the day of Muslim prayer. As such, they worked in the first week on the morning shift (06:00–14:00), the second week on the afternoon shift (14:00–22:00), and the third week on the night shift (22:00–06:00). There was a half-hour break during each shift, however. The salary of shoe factory workers was paid monthly (USD 70–90). They also received fringe benefits, such as religious festival bonuses (e.g., *Eid*-bonus for the Muslims and *Durga Puja*-bonus for the Hindus), gratuity or provident funds, and other incentives, but to a limited extent.

4.2 Methods

In order to shed work-related information, 291 SMEs were surveyed for a walk-thorough investigation. Important determinants of work-related exposures were identified; verified and evaluated which seemed to be risky and hazardous for workers' health, hygiene and

safety. Tasks and jobs were also classified on the basis of raw materials, products and the tools the workers considered stressful. A questionnaire and checklist survey was conducted for subjective responses in order to obtain an understanding of the degree of job stress and WRPs. As such, if the mean subjective scale is high, then the work being undertaken can be classified as hazardous or strenuous. An observational checklist was also used to investigate the work pattern and use of local tools. A high level of fatigue intensity was generally conjectured from higher points. Group results were described by the means of percentage occurrences. The differences for peer group-means were tested and compared by a student t-test among the subjects, in some cases. The crude prevalence of exposure outcomes, which were obtained from subjective scales, was statistically assessed using a binomial probability distribution. Each subject was observed for his/her activity to score the specific tasks and jobs he/she was involved with. A schematic diagram (Fig. 4) showed detail methods of investigation such as work-sites visited, type and number of factories inspected, and the number of workers interviewed, or the subjects participated in the individual study.

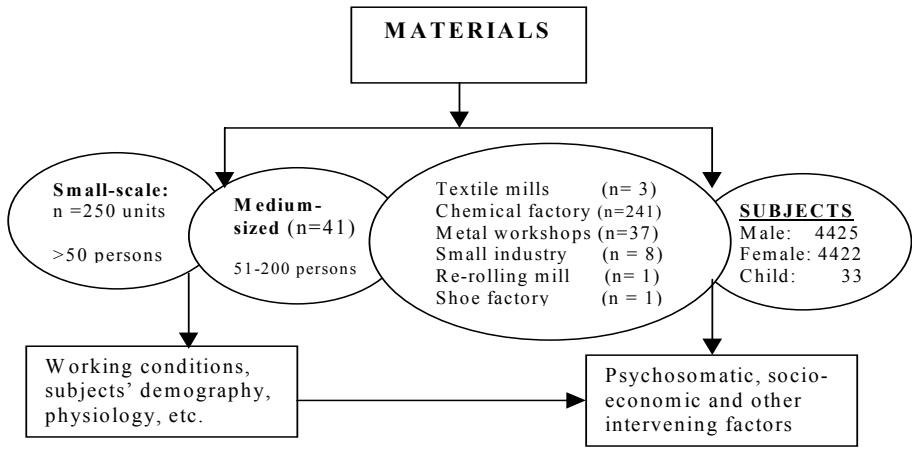

Fig. 4. A schematic diagram of materials used in the workplace survey and investigation.

In *study I*, the workers exposed to occupational hazards mainly related to cotton dusts were surveyed for exposure-disease outcomes among textile mill workers. The main problems in this study were identified as respiratory illness symptoms. Hazards related to the handling of agro-chemicals and existing facilities for health and hygiene were surveyed in *study II*. Sanitary system (e.g., latrines, toilets), water supply (e.g., drinking, washing) and canteen facility, provision of storage, first aid facility, and so on were investigated since agro-chemical factories were built in the vicinity of human habitation without maintaining enough health, hygiene and safety precaution. In *study III*, workers' complaints from the metal handling and manual tasks were recorded using a questionnaire. The questions contain information about tasks, jobs, products, tools, equipment, and work processes from which they have acquired spinal difficulties, musculoskeletal problems (MSD) and physical fatigue. General background information,

health history data, job stress symptoms and so on, were also included in *study III*. A preliminary health check was conducted to select the workers to participate in the study. The prevalence of psychosomatic and health problems were identified using questionnaire and checklist interviews.

Manual handling and postural tasks were evaluated using OWAS software in *study IV*—where job tasks were categorised in order to determine the physical workload among the workers involved with MMH or strenuous tasks, such as frequent lifting, carrying or walking with heavy weight of load. Each score was calculated as an arithmetic mean on the items of workers' rating response of work characteristics that provided an impact on the risk of developing postural discomforts and MSDs. A schematic diagram of the methodology applied in different workplaces is plotted below (see Fig. 5).

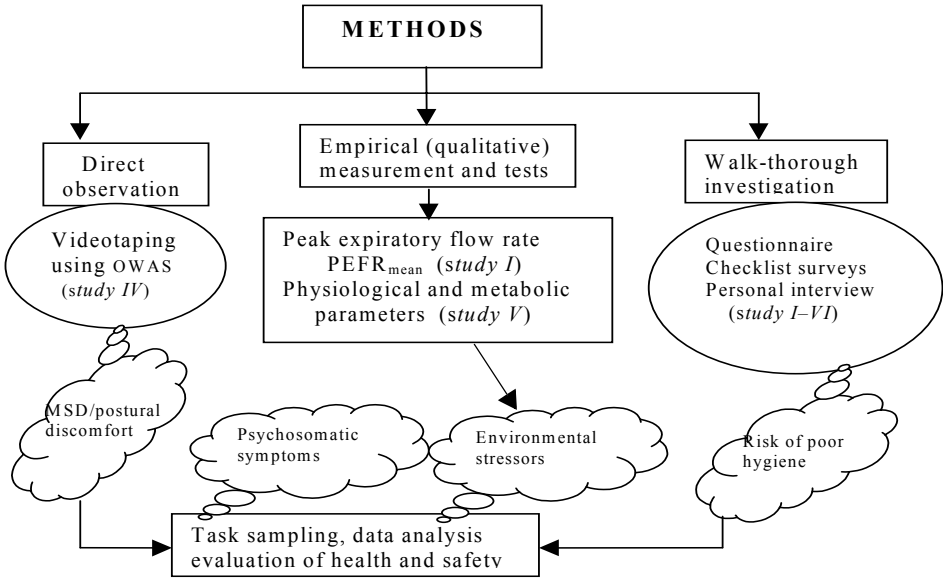

Fig. 5. A schematic diagram of the methodology applied in different workplaces.

In *study V*, heat stress, physical effort, and thermal discomforts were defined and assessed from re-rolling steel mill workers, while a task sampling method was used to quantify tasks, jobs and activity. Physiological parameters (e.g., heart rate, sweating, oral temperature, height, and weight) were noted in order to find cause and effect connections of physical effort due to strenuous tasks. Statistical analysis focused on the response scales for some items on work conditions while job-tasks were also ranked as causing heat stress and physical fatigue. A fluctuation of heart rates (comparing various heart rate stress indices) was considered as cardiovascular response to heat stress and physical effort. A higher heart rate at work was considered work strain in this study. The continuous heart rate records were obtained throughout the entire work shift using a portable telemetric device (Polar Electro, made in Finland) which was convenient to use, and worn by the subjects without much interference with their work activities. An

adjustable band containing electrodes and a transmitter was attached to the subject's chest. The climatic parameters such as air velocity, relative humidity and ambient air temperature were measured to see the general view of the existing work environment. The level of heat, noise, dusts, fumes and smokes were also identified to understand the level of job stress from environmental exposures such as dusts, noise, smokes, etc.

In *study VI*, shoe factory workers' subjective perceptions of the pressures of an non-suitable shift schedule were investigated on a rating scale for measuring psychosomatic and other shift related symptoms. The workers' attitudes, aptitudes, and other relevant factors (e.g., health complaints, sleeping difficulties, perception of family and social life) were evaluated by the job attitude questionnaire and Likert scoring system (Brayfield and Rothe 1951). The symptoms and feelings of the fatigue scale were also considered to identify general and specific symptoms of fatigue.

Job satisfaction, psychosocial, socio-economical and the family aspects of shift work and some recommendations were explored in the last paper (*study VII*) since shift work in many DCs like Bangladesh can be seen as one of the many factors and conditions associated with the health, safety and well being of industrial workers.

5 Results

The flora and fauna of the working environment in SMEs are of a delicate variety due to culturally accepted ways of doing things. Jobs were varied in respect to product, process, and operation and were performed both individually, and in groups. Hence, the work practices surveyed in different places in Bangladesh were traditional, naïve or untrained and mostly manual. Typically, muscle-force was extensively used with varying frequencies and duration in hot-humid climate. Fans and blowers were used in some factories but airflow in most of the workplaces was usually supplied naturally.

The jobs were less structured and not routinely organised, and thus, repetitive tasks in a rushed workplace (e.g., congested space, time pressure) with uncomfortable body posture made the task perhaps more tiring and physically stressful. The tasks were physically demanding and involved mostly hammering, lifting and carrying without an ergonomic aid. However, some sort of handling aid was used only when the workload was heavier than muscle capacity alone. It was observed that equipment and tools were mostly locally made and non-suitable for the use of workers involved in strenuous tasks. Due to a deficiency in a planning of tasks (irregularities, conflicts and hazards), workers carried out many jobs with varying frequencies and duration, which made it impossible to compose homogeneous groups performing a fixed set of tasks. The survey results however detected a strong correlation between long working hours and the risk of psychosocial imbalance.

Workplaces are often seen as crowded and poorly designed and the workers worked in poor ergonomic positions, sometimes sitting cross-legged, crouched or leaning forward, and worked without a sufficient rest pause. In many cases, job demand was higher than the physical working capacity alone. Some work activities are conducted in open-air facilities, exposing the workers to hot summer and rainy days in the monsoon periods.

During the walk-thorough investigation, it was also observed that there were poor welfare services and a lack of health, hygiene and ergonomic measures taken by the factory owners (FO) for workers' legal protection. The concerned authority (Ministry of Labour and Employment; Ministry of Industry, DIFE, DOE, BSTI) has not enacted health and safety protection measures for the workers employed in SMEs. It is mainly because of some flexible legislation. In Bangladesh, factories with fewer than 50 workers employed (in small-scale workshops or factories) are not subject to all regulation (Factory Act 1965, Factory Rules 1979). The results of the case studies (for the industrial

workplaces with more than 50 working people) showed that the workers' poor work process, unsafe acts and conditions, and lack of respect for work regulation attributed to various types of work-related problems (WRPs). These problems are believed to be linked with socio-economic development of Bangladesh by the way of loosing industrial production. The constraints of using local resources or low-cost engineering solutions (i.e., LCM) do not permit them to adequately cater to the needs of all sections of workers' benefit because there are political instability, lack of infrastructure, regulatory uncertainty, corruption and inflation in Bangladesh.

The temperature and humidity (in general) were noted as high in the workplaces [e.g., air temperature = 34–38°C, relative humidity (RH) = 70–80%] due to the tropical climate prevailing in Bangladesh. The dry season occurs in the cooler months generally during November–January, when the temperature and humidity are lower (e.g., daytime air temperature = 25–30°C, RH = 68–72%) than in the summer season. Usually, summer is hot (June–September) and humidity is very high (>90%) especially in the rainy season (e.g., average rainfall = 1930 mm).

The workers in agro-chemical factories (*study II*) have less access to health and hygiene practice as well as safety measures because a low priority of OHS/ergonomics application is attached to the national programs. The workers have had poor health due to a poor hygienic situation and non-ergonomic tasks (*study III–V*). In addition to the physical workload and thermal discomforts (*study III–IV*), they also suffered from psychosomatic imbalance (*study III & VI*) due to poor salary, repititive tasks, and unreasonable or unconventional working hours (*study VI*). Other stress syndromes are known to be both work-related (e.g., postural discomforts, muscle or joint pain,) and non-work related (mental fatigue, psycho-social problems).

The survey results in the metal workshops (*study III*) also showed that working conditions are unlikely to change or improve unless the workers and FO themselves stand up against unsafe acts or non-ergonomic practices. It is therefore necessary to broaden the job tasks as well as shift system (*study VI*), for instance, emphasising both the rights (e.g., compensation claim, welfare benefits) and obligations of the workers. It will then contribute to increased health and safety of shift workers upon considering local and intervening factors (*study VII*). A summary of the worker complaints (study results in general) from the different case studies is given below in table 3.

Table 3. Worker complaints on different stressors in different case studies.

Case studies	MSD	Postural discomfort	Thermal stress	Time pressure	Health and hygiene complaints	PSP	SRP
Study I Textile mill work	✓				✓	✓	✓
Study II Handling agro-chemicals					✓		
Study III Metal handling tasks	✓	✓	✓	✓		✓	
Study IV Small industry activity	✓	✓	✓	✓			
Study V Strenuous task in steel and re-rolling mills	✓		✓	✓		✓	
Study VI Shift work in shoe factory				✓		✓	✓

✓ indicates the prevalence of major occupational problems in each of the individual studies [where PSP—psychosocial or psychosomatic problems; SRP—Shift related problems]. Thermal discomfort or heat stress is supposed to be affected but data were not available in all studies.

5.1 Health and safety profile of textile mill workers (*study I*)

The jobs and tasks in textile mills varied according to the product, process and operations since the subjects were selected from four major sections, such as the blow and card room, spinning mills, finishing section and general section. Respiratory illness symptoms were identified as highest among the subjects in the blow and card room, and in the spinning section. In all, 53% of the workers have had such symptoms who had a low peak expiratory flow rate (<290 litres/minute). The differences of mean peak expiratory flow rate were highly significant (409 litres/minute) between those who had respiratory problems, and who had no such symptoms (504 litres/minute). The occurrences of such problems were also significant ($p<.001$) in the production section compared with the subjects in the general section because no one had the symptoms of chest tightness or breathlessness from the general section. However, many of them had symptoms of cough with or without phlegm (e.g. 43%), symptoms of chronic bronchitis (6%) and also chest tightness and/or breathlessness (4%).

Regular smoking was significantly associated with the occurrence of respiratory related illness symptoms. A number of ‘biri’ (local name of cigarette sticks that contain more nicotine than usual cigarettes) smokers worked in the production section. They smoked 2-to 25 sticks (mean 13 sticks) per day. Non-smokers were less likely to be affected, but many of them suffered from casual fever (20%) and morning headaches (8%).

Prevalence of other health problems were also identified as restlessness at night (24%), daytime sleepiness (11%), snoring (19%), impotence (31%), and feeling physically weak (10%). The prevalence of hypertension (14%) were also noted among some workers.

Only 16% of the workers in the production section had been using masks (e.g., PPDs for protection from cotton dusts) for more than 5–7 years, and no significant association was found between respiratory illness symptoms and the length of their service. However, some evidence from their health record (personally kept at home and from doctors' prescription) proved that respiratory illness symptoms were suspected for working for more than a six-year duration.

5.2 Occupational exposure to handling of agro-chemicals (*study II*)

Many toxic substances are available in Bangladesh and many workers are thus exposed to poisonous effects from handling of agro-chemicals. The agro-chemical factories were built in the vicinity of human habitation with a poor maintenance of health, hygiene and safety precaution. The sources of WRPs in these factories were suspected to be the unhygienic and congested space, informal work-setting, and rare use of PPDs. In regard to health, hygiene and safety measures, 90% of the small-scale factories were found to be poorly maintained. About 58% of the medium-sized factories did not have health and safety measures according to any bylaw or revised article of the Factory Act (1965) and Factory Rules (1979). Approximately 31% of the small-scale factories had poor latrines and 50% of these factories had no good supply of safe drinking water and canteen facility. In the medium-sized factories, 83% of the latrines were found to be of average condition (e.g., limited access to women workers), with no toilet papers and other facilities. Small number of factories (14%) had a good system for safe drinking and washing water (e.g., supplied by the local municipality) but working environment was observed as very poor and non-hygienic. In all, 28% of the medium-sized factories had subsidised food (or *nasta*, a piece of bread and a banana) for the workers but these are perhaps offered as incentives.

5.3 Work-related issues in metal handling tasks (*study III*)

The workers' negative attitude on working conditions were surveyed in metal workshops and other small factories and it was found that 34—58% complained of problems with congested space, bad tools or a hazardous work environment. But 52-—73% of the subjects complained more of problems of non compliance with health and hygiene by the FO, as well as poor welfare and social facilities. The workers also complained of stomach pain and fever (15%) and some of them suffered from headache and dizziness (18%). Despair and feeling upset was common (43%) among the workers. A few workers also had hearing problems (27%) due to a higher noise level [96–109 dB (A)] and eye irritation (24%) due perhaps to low illumination in the factory (it is estimated from eye estimation).

The prevalence of physical stress, MSD and work injuries were found to be critical in this study. As such, the prevalence of repetitive stress injuries (RSI) affecting hands, wrists and forearms were prevalent and significantly higher among the black smith and

steel furniture workers. The problems in their lower back (55–59%) and upper extremities (arms, hands, knees) were much higher (55–62%) among the manual day labours (those worked without powered hand tools) than the workshop mechanics (discomfort or pain in their lower back: 28–32%, upper extremities: 27–28%). The workers also experienced lower levels of pain in their hips and thighs (20–30%), knees and legs (24–28%) and ankles or feet (15–22%).

The prevalence of psychosocial stress (i.e., PSP) was found significantly higher among the temporary workers or daily labourers (salary paid on daily basis) than the workers those salary was paid monthly. In addition, a lack of economic support (no unemployment benefit or sickness allowance) contributed psychosocial or psychosomatic problems. Most workers showed dissatisfaction with their salary (74%), job demands (55%) and restlessness (53%). Some of them (39%) also showed a negative response for the employers' (EA) or FO's critical attitudes.

5.4 Physical workload in small industry activities (*study IV*)

Workers' perceived stresses were evaluated by OWAS [http://turva.me.tut.fi/owas]. Due to critical or very difficult postural activity (e.g., prolonged standing, bending or twisting, difficult or unusual movement), complaints were prevalent that results prevalence of postural difficulties along with muscle and joint pain. Postural discomforts seemed a serious problem among small industry activity. The workers were also experienced muscle pain (40%) and problem of tendinous (36%). In all, 13% of the tasks were noted as critical (*category: III*) and 5% as very critical (*category: IV*) due to working in a position that corresponds to prolonged standing or bending and twisting. The aggregate percentage of the most critical postures (*category: III + IV*) was found to be 23% for which immediate action is necessary. Workers' complaints for repetitive stress injuries (RSI) were high enough (50%) affecting their hand, wrists and forearms because of the movement carried out by hard-arm motions for performing job tasks.

5.5 Heat stress and physical effort of steel mill workers (*study V*)

The worker complaints seem to be related to the work environment (i.e., factory climate) due to high heat, excessive noise, dusts or fumes. High air ambient temperatures, dusts, and noise level seemed disturbing or annoying to the workers. Therefore heat load due to tropical climate (outside factory: 34–40°C) and working near a furnace (48–50°C) affected the workers by allowing less ability to work for a specific time. Additional heat was radiated from sunshine into the factory environment through tin-roofed sheds. The environmental variables were recorded (light intensity = 800–900 Lux; T_{air} = 48–50°C; RH = 60–62%; noise level = 98–115 dB(A); air velocity = 0.8--1.2 m/sec). Noise, smoke, dusts and heat load were perceived highest among the workers in group B those worked very near the rolling mills and swing station, as well as near the furnace area.

The subjects spent a large percentage of their working time (32.1±21 %) carrying metal ingots and handling raw materials. Some activities, such as moving hot slabs (131±17 bpm) showed higher heart rates (142±19 bpm) than other activities, but it occupied less than 12% of the total time. Most of the job-tasks in the steel and re-rolling mills were found as strenuous, repetitive and continuous which affected hands, wrists and forearms as pain and injuries. The occurrence of injuries (17 incidents during one month) was prevalent and significantly higher during the night shifts, as compared to morning and day shifts. The workers had burn injuries due to contact with hot objects. Injurious accidents were also prevalent due to slips, trips and falls, and for both mechanical and electrical fault. The workers were also caught between hazardous machinery.

The subjects in group B showed a higher HR_{mean} ranging from 131 to 142 bpm which indicates that the job-tasks seemed strenuous that caused higher heart rates (HR_{av} = 143–162 bpm) especially when the workers were involved with rolling, pulling and swinging tasks. Overall, the rise in oral temperature (36.7–37.8°C) and average heart rate among the workers proved that the jobs were physically stressful. The total heart rate (HR) is regarded as a sum of several components and, in general, is linearly related to the metabolic heat production for heart rates above 120 bpm. Classification of metabolic rates by job activity was illustrated in ISO-8996 (1989). As such, when mean metabolic rate was 290 W/m^2, it was considered as strenuous tasks. Similarly, 230 W/m^2 was considered for intense work, 165 W/m^2 for moderate activity and 65–100 W/m^2 for resting time while workers were sitting at ease or standing and walking without heavy workload. The physical working capacity (1.51–1.90 l/min) indicated high metabolic responses to strenuous tasks that required high-energy consumption (28.5–31.8 ml/kg-min). However, there were no significant differences in regard to their heights & weights at a similar age.

5.6 Human aspects of shift work in shoe factory (*study VI*)

Restlessness, despair and weariness among shoe factory workers were identified to be caused by many reasons, for instance, sleep debt, low salary, family burdens, and employers' strict attitudes. All of these symptoms (e.g., shift related symptoms, SRS) had a correlation with the workers' perceived stress to odd shift schedules. However, informal breaks were often observed for lunch and praying which gave better results in production and efficiency. Many subjects (73%) had a general negative attitude regarding existing shift systems. They were found to be upset due to sleep disturbance (85%), restricted social life (65%) and mealtime irregularities (78%). In all, 71% of the workers had to curtail leisure activities. Sixty five percent of the subjects had restrictions in their social life from a non-suitable work schedule. The complaints of disturbed family lives (75%) due to lack of opportunity to maintain a happy conjugal life (72%) was also noted. The workers' job satisfaction and dissatisfactions were not significantly associated (λ^2 = 1.06) with their jobs and tasks they preferred in the shoe factory. Job satisfaction (57%) among some subjects was satisfactory on other components such as task activities, wage, fringe benefits, job-security and management relationship.

5.7 Intervening and local factors in shift work (*study VII*)

In this study, intervening and local factors in shift work were explored which vary widely among individual factories in Bangladesh. These factors also depend on local situations such as workers' family and social life, religion, climate and other issues. Intervening and local factors are also related to the organisational environment (management relationship, job satisfaction, work attitudes), working conditions (safety, ergonomics, hygiene), economical (number of income earners in the same family, total family members, amount of salary, overtime hours, housing, living conditions), cultural (social status, community size, superstition) and psychosocial conditions (family aptitude, work attitude, aptitude) involved in their work. These factors or determinants should carefully be considered in the design and development of shift work. Table 4 described some important factors which were found common in shift work in Bangladesh.

Table 4. Intervening and local factors influencing tolerance to shift work in Bangladesh.

1. Individual's characteristics	2. Family situations	3. Social conditions
age, sex, eating and sleeping habits, fitness, experiences, personality traits such as circadian style, neuroticism, morning–eveningness and/or introversion-extraversion.	marital status, number and age of children, housing such as rented or own or shared, socio-economy, family attitudes, family location, living area, and so on.	local shift traditions, human-relations, leisure activities, social supports, community size, commuting times, means of transports, distance of workplace from home, and type of communication, and so on.
4. Working conditions	5. Shift schedules	6. Economic situations
factory environment, climate seasonal variations, job-task, work load, canteen, separate toilet for woman, rest rooms, first aids, safety poster, etc.	type of schedules, direction of rotation, length/number of shift cycles, number of consecutive night shift, cues, number of free weekends, shift cycle, time of start and end of shift, and so on.	income level, vocational or technical education, economy, career opportunity, medical facility, labour market, overtime hours, salary or wage, fringe benefits, and so on.

6 Recommendations

6.1 Workplace intervention

The implementation of OHS and ergonomic applications in SMEs assumes a socio-industrial consensus and thus it is important to publicise the risks of work hazards, not only to the workers, but also to the general public. Improvement of health, hygiene and safety consciousness should be seen beyond the focus of paycheques and profits. The workers must be well aware of what workplace intervention is (Kogi *et al*. 1999), and how work-related stress factors might influence someone to implement local measures. They should follow good, time proven examples of work organisation styles to enhance efficiency and productivity. Although there could be difficulties, obstacles and constraints for workplace intervention in Bangladesh due to multi-factorial effects (Fig. 6) on the workers, factory owners (FO) and employers association (EA) but they need all the more to undergo modifications by demonstrating high optimal levels of health, hygiene and safety measures in SMEs.

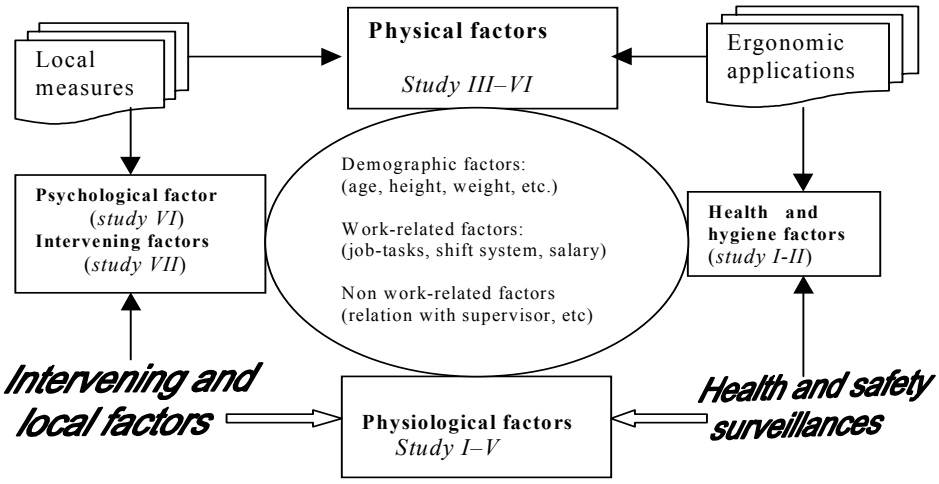

Fig. 6. Multi-factorial effects on the workers, FO & EA and intervention factors for OHS.

Workplace intervention can lead to a better health and safety process when semi-automation, job rotation or a good shift-schedule allows workers' flexibility in repetitive and strenuous tasks. Such intervention mechanisms may be introduced in metal workshops and other factories (*study III*), agro-chemicals factories (*study II*) and other small industry activities (*study IV*) to minimise WRPs. In such a case, major changes should not bother other avenues of OHS. The procedure of such changes (in layout, working height, work-line, etc.) should, above all, be realistic and pragmatic to ensure successful workplace intervention through appropriate design and development. Some modifications in work sites (*study III & V*) could result in new ways of fostering sustained improvement. Changes of non-ergonomic job tasks in small industry activities (*study IV*) are also necessary as practical means for the improvement of OHS.

Workplace intervention means improved health, safety and ergonomic applications through collaborative efforts from all the parties concerned. It is also treated as an efficient use of local resources for good work, increased productivity and less injuries in the workplace. It is believed that the effectiveness of health and safety practice will be achieved—once the new work routines become established and WRLL is implemented in practice. Workplace intervention also based on workers' performance response through physiological and psycho-behavioural adaptation and other local issues (Ahasan *et al*. 2001). Therefore professionals living in DCs need to be concerned about workers' physiological and psychological limits with regard to working hours and of the human circadian rhythm in shift work (see *study VI—VII*) in particular. Therefore, physiological and behavioural adaptation, as well as an understanding of such workplace intervention by local workers and factory owners (FO), is required to recommend local measures.

The workers in SMEs need a whole new set of adaptations, both on the part of their physical and mental capacity. Maximum adaptability of local workers will occur when dynamic stability among the work-tasks or job content is ergonomically designed. For this, an improved mechanism (motivating key persons) should be put in place to seek workers' and employers' opinions (Fig. 7). Researchers should therefore consult with the local workers in order to encourage or empower them to think about adaptability procedure since they are not truly habituated with sudden change or ergonomic applications. Recommendations should be based identifying key variables that influence workers' performance level and auto response or habituated performance (cultural significance in work systems) and the existing maintenance criteria (sweeping, cleaning, brushing, servicing, etc).

In case of strenuous tasks, changing positions throughout the day will also help to reduce stress and strain on the muscles. A short break (7—10 minutes), for instance, is better for small industry activity (*study IV*) that it allows a worker's eyes, neck, back and shoulders to rest. Frequent short breaks, along with the provision of drinkable water can be treated as counter measures to heat stress. It is especially helpful for steel and re-rolling mill workers (*study V*). Malchaire *et al*. (1999) illustrated some strategies to prevent an excessive physical stress and the reduction of heat stress and physical work effort. The work effort, physical and cognitive capacities of manual workers are also involved in various types of work activity that should be safe, healthy and hygienic. The relationship between local workers' demographic profiles, personal health, physiological characteristics, other factors (salary system, day off, sick leave, welfare, transportation,

housing) and work environment (work pattern, climate, layout, factory premises) is therefore important for workplace intervention.

Supportive processes of workplace intervention in SMEs should consider an organisational commitment because immediate action is not possible to correct dangerous work situations where no organised safety management (Zohar 1980) system exists. It is also believed that a management without a strong safety climate consistently weakens workers' general perceptions about health and safety. Hence, the role of an organisational structure is important especially for textile industries (*study I*) and steel mills (*study V*), for instance, that need to be changed or updated. It is better to advise workers to keep themselves healthy and safe from dangerous operations, especially when strenuous tasks are concerned (*study III–V*), than encouraged them to report occupational problems. An in-plant service system may be beneficial for some industries (*study I & V*) in providing environmental monitoring, and safety and hygiene surveillance for other type of factories (*study II*). It should, however, start at the grass-roots level because workers in SMEs are generally less educated or semi-experienced and may not be easily convinced of the need for workplace improvement. Most importantly, the workplace intervention program will be successful if FO, EA & UL are non-resistant to provide health, safety and hygiene measures or any ergonomic changes in workplace layout.

For workplace intervention, it is also important to grasp the possibilities of how 'team spirit' through group work initiative as well as self-initiative spirit can help less educated or inexperienced people work nicely, and how to include them constructively in harmony with health, hygiene and safety conception as well as production objectives. In this regard, Westlander *et al*. (1993) expressed concerns on general strategies for intervention studies and reserach.

OHS/ergonomics could be tailored with intervening factors in shift work that boost productivity through integrating various local factors (*study VII*). In this regard, few scientists (Sekimpi 1992, Sakari 1995) illustrated prerequisites for successful health and safety measures in DCs. Workplace intervention should, however, be embodied in national regulations on OHS/ergonomics, which FO, EA and UL have a responsibility to implement WRLL in this region. Since the methods of operation in SMEs are both expeditious and flexible in many DCs, and therefore, possible ways to improve the working environment are:

- suspension and removal of hazardous activity or non-hygienic conditions at all levels
- simplification and/or change of layout, and implementation of ergonomic measures
- greater scrutiny of work methods, particularly from the grass root level
- recognition of workers' labour, social support and allowing welfare or fringe benefits
- setting up a health and safety commission under the auspices of a neutral watchdog body, the national health and safety council (NHSC)
- revising labour law, updating work regulation, and enacting labour legislation
- articulating a consolidated structure for regulating labour law and legislatory issues

6.2 Participatory action

The participatory approach (PA) is one of the best techniques in facilitating the recognition of workers' own efforts to restore heath and safety. OHS itself becomes the content of change through the participatory process on promoting health and safety (Sakari 1995, Shahab 1998). It also improves motivation by helping FO/EA to understand the benefits of a safe and hygienic workplace. PA has also been successfully applied in many DCs (Kogi 1991, 1996) as a process for the workplace improvement. The major prerequisites of PA are having the adequate time, place and opportunity to participate in the process of sustainable workplace improvement. However it acknowledges explicitly the competence and the workers' skill for improving their working conditions through collaborative efforts. For this, an opportunity to get involved in PA should be synchronized with the maximum ability of key persons (e.g., FO, EA, UL) to challenge those actions since participatory planning taps the creativity of workers and factory owners (FO) by motivating their involvement—as a subject of commitment of PA (Fig. 7). Therefore, proper communication should be made to ensure taking them into participatory planning.

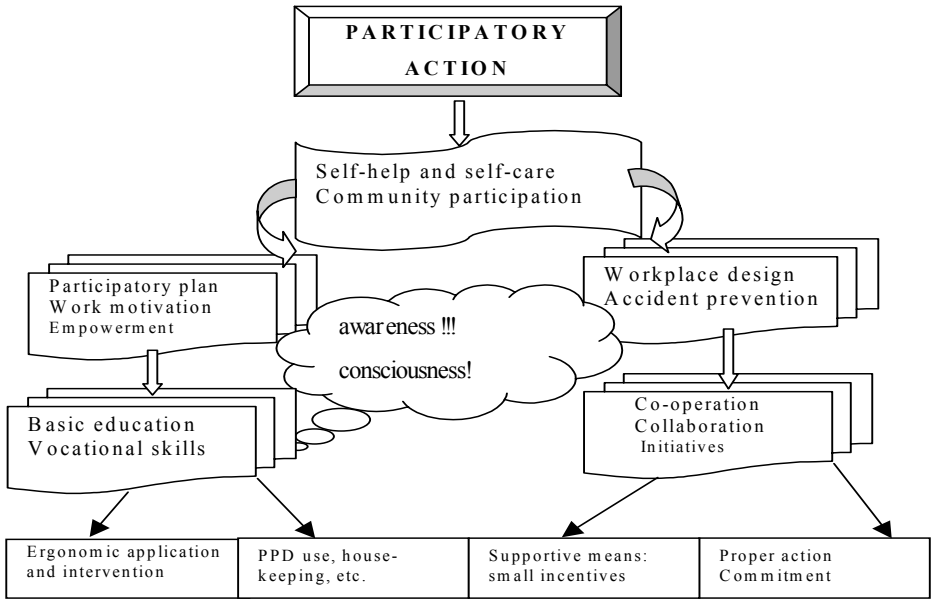

Fig. 7. Work motivation among the workers, factory owners, employes' association and others as a subject of commitment to a participatory action.

The principle of such participation must be pursued with the idea of improving the existing working condition because it motivates workers to contribute multiple ideas that differ from an individual's decision. It is also believed that UL/EA can be supportively involved with such programs, which also helps to motivate them in participation. A person's participation can be considered as a social process (Sekimpi 1993) by which a worker becomes personally involved in an organization and wants to see how his/her

work become safe and productive. It also clarifies the workers' activity toward productivity and efficiency through being given a higher responsibility. Workers will then be psychologically empowered, rather than through physical effort in hot humid climate, or being merely strenuous task-involved. In some cases, however, the UL and/or EA may not approve of PA, suspecting that it renders them powerless. The LU/EA's activity should be based on an honest commitment towards the interest of workers, not only for the interest of FO or themselves.

Since PA brings a mutual understanding or shared ability to communicate with each other, it could therefore be utilised for building joint effort in providing expertise, consultation and guidance to improve health and safety. PA works better in certain situations when it acts within the area of job freedom and relevance to workers' own interests. Solution-oriented actions are also useful for participatory planning (Noro & Imada 1991), especially in guiding the workers and FO towards self-help and self-care initiatives because structural adjustment programs (Ahasan 2001c,d) are supposed to be undermining the workers' basic rights for health and safety in many DCs. All perhaps agree on the need for such participatory planning; especially when work redistribution among various ethnic groups is concerned because resettling workers, those are coming to the cities and towns from destitute rural areas, into new or ergonomic environment is a difficult task. However effective participation may result in an acceptance of change for health, safety and ergonomics application and a commitment to goals with an encouragement toward better performance of local workers. PA should therefore be pursued through a better performance of ensuring workers' involvement, and the employers' contribution for providing health/safety facilities. Otherwise; the participatory process will not provide opportunity for the personal growth of workers as well as industrial growth for the country.

6.2.1 Praticipatory action through NGO-collaboration

Non-governmental organisations (NGOs) and international consulting agencies (JICA, NORAD, DANIDA, CIDA, FINNIDA, Oxfam, USAID, etc.) need to work together with local government officials not only on OHS/ergonomics but also other sectors related to work, efficiency and production to improve community and social life. Further, socio-technical measures (Saarela 1991) can be synchronised with this that will perhaps contribute to the sustainable development of their working and community life. Khan (1992) also explored peoples' participation in one recent development—which dealt with this. We should also focus on the process of updating the labour administration, policy of union UL/EA, and the initiative of LGA for joint responsibilities of improved health and safety (Fig. 8).

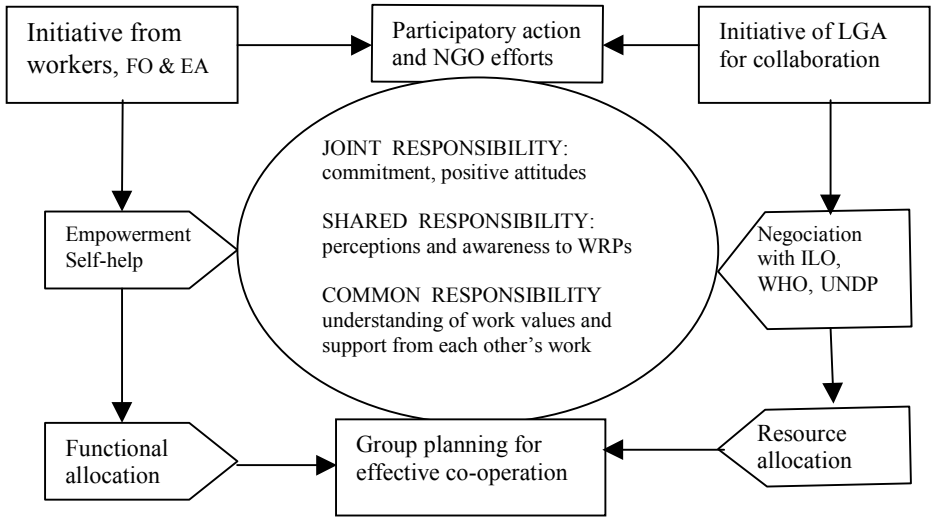

Fig. 8. Relationship identified for participatory planning and joint responsibilities.

NGO activity is believed to be practical and helpful in many sectors (industrial & non-industrial) since they are working side-by-side with LGA of DCs [www.wn.org/programs.asp] to strengthen the ability of individuals and communities to solve their problems. Supportive data/information [www.oxfam.org.uk/policy/papers/listenhear.htm] from a British NGO (e.g., oxfam) can be also helpful, which contains policy-relevant research digests. Sustainable development network programs [http://sdnp.delhi.nic.in/] provides practical information on various development projects to enable poor people to use their traditional skills through intermediate technology [www.itdg.org.pe/]. The UNDP, IMF, ADB, and the World Bank have focused on impacting sustainable human development in DCs over the years. But collaborative efforts should be synchronised with such a need that human development is not possible without the improvement of working life. This has to be created by innovative planning and supporting health and safety facilities for workplace improvement.

Presently, NGOs are activity involved in socio-economic development in many countries rather than health, safety, hygiene. Therefore LGA and other international organisations based in the regional areas or big cities and towns should be involved in the collaborative efforts (Kogi 1998) so that co-ordinated co-operation (Fig. 9) would give rise to make aware of NGOs in sustainable workplace improvement.

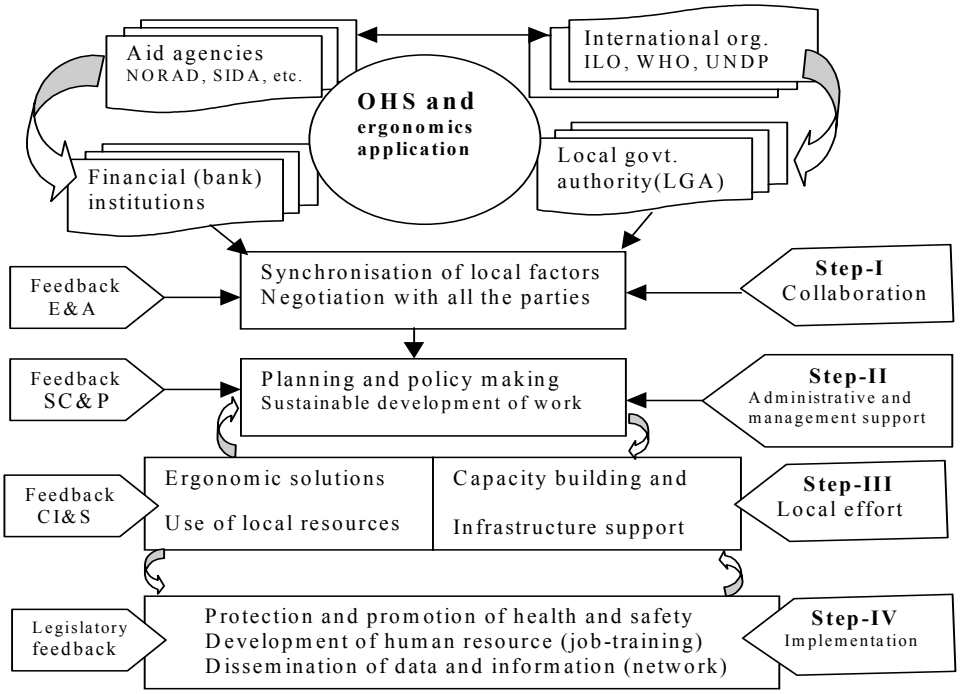

Fig. 9. An effective model for improving supports from all the parties concerned [Where E&A—Economic and Administrative Support, SC&P—Social, Cultural and Political Support; and CI&S—Consultancy and Institutional Supports].

The local government authority (LGA) should have an important role to promote alternative approach for sustainable workplace improvement. Government subsidies and international help are also needed to make health/safety programs affordable. It is also important to address the root cause of basic need for sustainable improvement of workplace rather than asking direct material relief from NGOs and/or international community (e.g., food aid by World Food Program, WFP). The concerned authorities needs to develop their own programs by integrating existing regulations for both industrial activity and community-based health and safety. It will then be fruitful for environmental protection, water and sanitation programs through the agrobased technology development project (ATDP) applications for instance.

Partanen *et al*. (1999) have called for such collaboration between developing and industrialised nations in OHS research and surveillance. Professionals, academicians and practitioners should therefore co-operate with industry and government officials, since experts like ergonomists, industrial hygienists or occupational health officials are rarely employed in the concerned department (DIFE, BSTI, DOE, BMET, MBTF, BOESL, BEPZA). With the help of local administration and financial institutions in Bangladesh (e.g., Shilpa Bank, Bangladesh Shilpa Rin Shangstha, Bank of Small Industries and Commerce) City Corporation and municipal authorities may develop their individual initiatives in the cities and towns through Paurashava Ordinance (1977). In the agrobased rural and cottage industries. The collaboration between different professionals in

Bangladesh is however encouraging for launching health, safety and ergonomic programs (Ahasan *et al*. 1998c) that should result in the improvement of working conditions.

6.3 Low cost measures

Simple changes in the industrial workplace can bring massive advantages to better productivity, safety and health (Table 5). Local measures are also believed to be an influential tool for enhancing the impact of workplace intervention. Low-cost measures (LCM) will probably be accepted quickly and will be the best option for reducing the probability of workers hurting themselves from work injuries. This is also because most of the factory owners (FO) and employers association (EA) in Bangladesh can not afford to buy expensive tools or make sudden changes of layout, for instance. In this regard, LCM should be implemented first by the FO/EA themselves, and then by the responsible officials, and NGOs, if possible. In spite of various local constraints existing in SMEs, LCM can be considered fruitful because it involves lower costs and saves time and money. Several ergonomists (Kogi *et al*. 1989, Conferido 1997, Kawakami *et al*. 1999) postulates that these measures have multiple impacts on improving safety and health that can also help in achieving a safer work design (see Kogi & Kawakami 1997). Manuaba (1979) has proposed a successful application of LCM that has been demonstrated in some countries at various levels. Kogi *et al*. (1999) have also devised low-cost improvement features for correcting the ways of non-ergonomic work methods. Batino (1997) proposed a model of system design for workplace improvement in the Philippines. However, this model needs to be adopted in other countries as a useful means of reducing physical stress, for instance. Kogi and Sen (1987) illustrated various examples how third world countries are advancing towards implementing ergonomic application. Schuster (1996) showed how workplaces are being improved by low-cost ergonomics application in South Africa.

In solving WRPs, LCM should practically be introduced in various workplaces by ensuring the acquisition of locally available resources (e.g., ergonomic handling aids for reducing the weight of loads). WRPs can be also controlled by timely prevention through LCM when local resources or available materials are used for making ergonomic tools, for instance, according to individual cases. These tools and equipment should be either ergonomically designed or semi-powered to assist workers' manipulation with job-activities because workers' physical variations needs to be accustomed to better cope with job demands by ergonomic ways of body movements, for instance. The workers in these workplaces can improve their body motions and reduce physical stress or postural discomforts by—

- enlarging the span of workers' control over strenuous tasks or postural movement
- adjusting work and keeping suitable distance when repetitive tasks are concerned
- adjusting job-tasks, fixture/fittings, tools/equipment with the correct anthropometrics
- controlling dexterity, stature and movement to specific job-tasks
- placing the needed materials in front of the workers

- storing materials within easy reach considering people's average working height, distance, between point of action and body parts (head, arm, leg, finger) position, etc.
- using adjustable tools, fixtures, fittings and furniture for better work performance

As such, various tools such as pushcarts, lifting devices, wheelbarrow, and so on play a major role in reducing physical stress while strenuous tasks are concerned. Kogi (1985, 1991) illustrated the role of the local measures and Ahasan (2002b) emphasised grass-root level change in workplace design. We should therefore establish general ergonomic principles (Sen 1979) so that LMC (Table 5) are effective to reinforce and channel health and safety into consistent systems that are locally affordable. Handling aids such as powered hand-tools can be used when the weight of a load is heavier than muscle capacity alone.

Table 5. Low cost measures--some examples from the studies conducted in Bangladesh.

	Control measures and general recommendations
Study I	Improve hygiene level by regular cleaning and maintenance of machinery and tools Emphasize good house keeping, first aid facility, health, hygiene and safety surveillance Compulsory PPD use, protective clothing, modification of work system, layout, etc. Provide regular health checking and monitor hazardous contamination such as cotton dust
Study II	Monitor air samples, verify chemical and biological contamination in the workplace Provide first aid facility, health and safety surveillance, good housekeeping, PPD use Provide latrines and washing facility and protective clothing against chemical poisoning
Study III	Semi-automation, modify or change of workplace, use conveyors or push carts or multi-level rack Use simple hoist crane or lifting devices, adopt easier work and improve safety culture Reduce obstacles for implementing work regulations, and co-operate with Inspectorates & NGOs
Study IV	Adjust working heights, place the needed materials within easy reach, prefer ergonomic devices Use suitable tool, reduce postural activity, minimise static workload, avoid posture with bent back Do not work alone if the load is heavy, take or initiate participatory and collaborative action
Study V	Shorten the exposure time, allow frequent rest breaks, drink safe/clean water, use ergonomic aid, Minimise radiant heat, spray water into the sand to minimise floor dusts, do servicing & cleaning
Study VI	Appreciate community support and recognition from the society, keep good relations with family. Co-operate with factory owners, allow fringe benefits, recreation facilities Adjust timing to individual's family situation, and minimise psycho-social and/or cognitive stress
Study VII	Consider social, geographical, climatic and cultural way of working in shifts Implement local measures according to various intervening factors locally exist

Safety inspectors, occupational hygienists and health officials should find LCM with the implication of indigenous characteristics. Further, LCM should be used in practice so that health, hygiene and safety requirements adjust with the local situation, at each of the stages of strategy. Since small-scale entrepreneurs in Bangladesh are poor economically, it is thus to be recommended that they follow local solutions which are low-cost and easily available. Local technology or available means for developing such tools has also made it possible to transfer the worker from a risky environment to better place (Schuster 1995). The importance of developing such low cost and ergonomic tools is to be thought

through in order to improve OHS in the form of legal, organisational and economic solutions. The workers in Bangladesh were habituated on indigenous practice, such as those seen in the metal workshops (*study III*), re-rolling steel mills (*study V*) and small industry activities (*study IV*). These measures can be brought within the organised sector of sustainable workplace improvement. The management and productivity will improve—if the available steps of production processes are fulfilled through low-cost ergonomic measures, hygiene precaution, and the use of correct PPDs. Hence, FO/EA should be encouraged to use such local tools and equipment that are easily available. Further, ergonomic checklists, action manuals, group work and good examples of such local measures (Kogi *et al*. 1999) are to be followed in cases where sudden change or workplace intervention is not possible. This also includes workplace layout designs in the local context, own plans for better health and hygiene, and the other support services for work safety.

6.4 Job training and vocational education

Currently, many people in Bangladesh who complete basic literacy (or primary education) courses do not have the opportunity to continuously use and enhance their vocational skills in order to make them an effective tool for improving their social and economic life. It has been also observed that many workers have a low access to job training and vocational education (JTVE), though it is a very appropriate means for learning and practicing about health and safety. JTVE has multiple positive impacts (Gold 1995, Kogi 1995), since it reduces work-related risks and job stress, and enhances worker's skill and employability. On-the-job training, in many instances, improves feedback in recognition and appreciation of health, hygiene and safety, and increase awareness on occupational and environmental issues. Yuk-lun and Wah-shing (1995) illustrated examples how OHS/ergonomics application is promoting through training and education in Chinese territory. Others (Shahnavaz *et al*. 1990, Abeysekera 1994, 1997c) illustrated success stories in industrially developing countries. Findlay (1995) explored a university perspective on training and education in health and safety issues.

JTVE enhances workers' motivation, usefulness of safe acts, relevance of newly acquired knowledge, and increases the level of new work experience. JTVE will surely bring appropriate knowledge to deal with potential measures, and help workers to improve working conditions and encompass the maintenance and promotion of workers' health and work performance. JTVE helps to prepare workers to adjust to a different situation, such as the maintenance and design of shift work, productivity planning and safety precautions. Assenga (1991) supported various aspects of on-going training programs in DCs. Brown and Nguyen-Scot (1992) and Mukherjee *et al* (2000) evaluated a training manual for health and safety programs. The NIOSH (1999) model can be considered for research on training effectiveness, however, those models and manuals should be based on the integration of practical and goal-oriented lectures in the arena of providing basic knowledge on OHS.

JTVE raises workers and employers knowledge for identifying problems and implementing solutions. In this regard, Johnston *et al*. (1994) explored the efficacy of

such training for occupational injury prevention. It is true that JTVE has an impact on reduction of injuries, improvement of safety morale, and most importantly, an intuitive understanding of health and hygiene needs. Basic education programs and vocational training are also undeniably helpful in the full process of positive change in the working life of modern labourers because job training enhances understanding of what they do, consciousness against WRPs, and a concern and commitment toward workplace improvement. Ahmed and Momin (1986) developed a scheme of successful rural training programs in Bangladesh that can be used in the agricultural training institutes (ATI) and other organisations (BCIC, BSCIC, etc.) for the entrepreneurialship development programs. The objectives of such training can be introductory, but it is believed to be beneficial for:

- a practical understanding of health, hygiene, safety and ergonomic applications in various workplaces
- familiarisation with the terminology of OHS and basic concepts of the recognition of work exposures and other determinants
- familiarisation with analysis, sampling, evaluation of job tasks and control methods for work-related problems (WRPs)
- hands-on-labs experience with up-to-date equipment those are available in the concerned offices (DIFE, DOE, BSTI, ATI, BOESL, BMET, BMTF, etc.)
- demonstration sessions by showing examples of work exposures and how to prevent them from stressful tasks, or non-ergonomic manipulation of hands and arms
- problem-solving exercises using reference materials (injury data), Inspection Manual (1986) or NIOSH (1999) guidelines, if any
- shared experiences with course participants and instructors from NGOs, LGA, public and private sector industries, research institutes, university and polytechnics
- follow-up question and answer sessions through an attendee and instructor joint session and certificate of completion

Job training and vocational education (JTVE) certainly helps workers' personal values and improves their consciousness of health and safety. To address the multi-skilling process as an integral part of JTVE in Bangladesh, some guidelines can be found in the Inspection Manual (1986) and other sources (e.g., BANSDOC) that world be beneficial for strengthening workers' and employers' safe operation with correct tools, or safe handling of hazardous materials, for instance. It is being recognised that JTVE can promote change in a workstation design through a change in workers' behaviour, or changes the perceptions of local workers. Control of an unhealthy environment and unsafe conditions would be easier through job training and basic education that can also lead to productivity, health and safety. Therefore, JTVE should be pursued by first considering traditional work practice, and then, workers can gradually improve their skills to improve their work practices. Further, JTVE has to be considered as a means of action, an action that applies not only to the general workers but also to foremen, linemen and others who play a key role in defending, promoting or making decisions about the defining and transformation of work situations. It is likely that the effectiveness of JTVE will benefit more if the following matters are emphasised to:

- promote a comprehensive skill training program and enhance non-formal education
- offer technical expertise to help setting up programs on health and safety skills
- support improved post-literacy education and integrate techno-medical consequences
- promote ergonomic literacy with functional knowledge to give workers' understanding on health, hygiene and safety measures as well as ergonomics application
- ensure that workers are able to apply literacy skills to real opportunities in real place in real time
- strengthen and develop practical courses (e.g., goal or action oriented) for continuing education and skill development programs
- link learners with opportunities for employment generation, workplace improvement and safe behaviour at work

6.4.1 Workshop session and short courses

For industrial training, short courses and workshop sessions/practices can be held in different educational institutions and polytechnics at the district and sub-district level. Harun *et al*. (1994) argued that knowledge-based training influences the participation of workers with whom WRPs are most associated with. In this regard, an alternative model (Fig. 10) can be developed for self-help training benefits from theoretical to applied aspects of relevant cases. The effects of workshop session and short course outcomes can be uncertain if there is no systematic arrangement of vocational education and on-the-job training involving various work organisations and educational institutes (Lovell & Fatema 1989). Therefore an improved mechanism needs to be developed for workshop sessions and short courses to elicit the competence among the workers, FO, EA, NGOs & LGA through collaborative efforts (Fig. 10).

Workshop sessions and short courses can be held where general workers can establish a more personal dialogue, presenting on subjects related to industrial health and hygiene, work safety, and ergonomics. The results of such efforts will have a satisfactory effect in influencing workers' understanding for implementation of OHS/ergonomic measures. The GOB, with the help of international agencies (UNDP, UNICEF, ILO, WHO) and NGOs, has allocated some budget money towards a number of training projects. A part of this training program was held (conducted) in the Labour Welfare Centres and have shown successful achievement (Quddus 1996) where UL, FO and mid level managers have been participating in awareness training. The World Bank (1988) reviewed the use of educational performance indicators in Bangladesh, drawing on lessons from many case studies. The World Bank (2000) has taken steps to help literacy among people and approved a US$ 53.3 million credit. Bangladesh spends only 2% of GNP ($260 with an overall growth of 4—5%) on education, compared to 3.2% in an average low-income country. The post-literacy and continuing education programs have also been funded by ADB, IMF and the World Bank aiming to support the graduate students, technical workers and others in sustaining their literacy skills. The fifth five-year (1998–2002) project is expected to benefit 1.6 million learners, half of them women. However these

participants must be equipped with the basic knowledge through such knowledge that is an integral component of OHS/ergonomics.

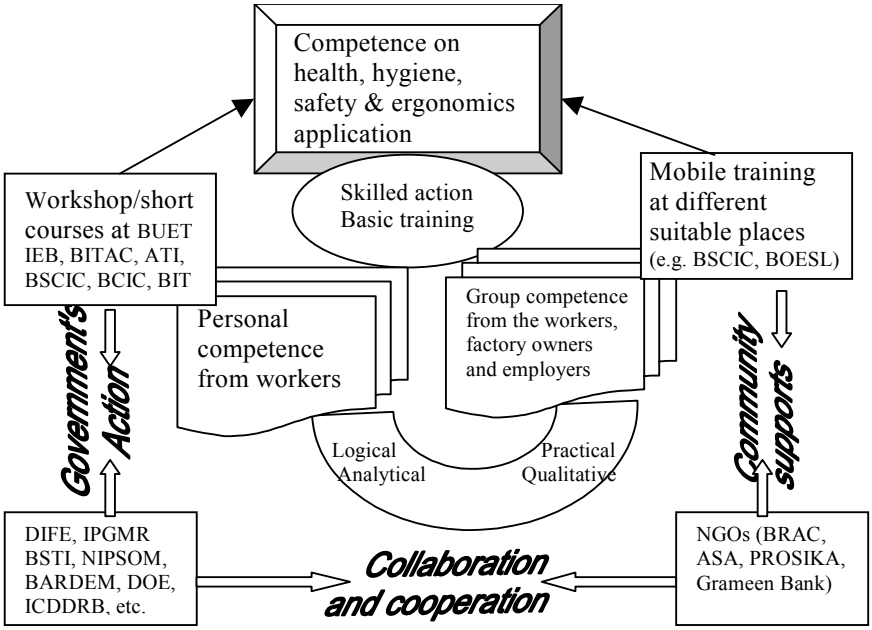

Fig. 10. An effective model for launching workshop sessions, short courses and mobile training.

The new project is also designed to benefit female workers in SMEs, allowing more people to improve their family, work and community (World Bank 2000). Approximately 230 field offices are linked with service providers so that 6,900 village-level continuing education and training centres will participate in this campaign. However, these foreign aided training and education projects may not be implemented fully due to other pressure in the corruption that exists in Bangladesh. From the recent United Nations report, Bangladesh was branded as the most corrupt nation on earth for the year, while Finland was declared as the most corruption free nation in the world. So with that designation, Bangladesh did earn that unique distinction, two years in a row. Whatever this brings an unpleasant surprise (!) but opportunities could, and should, be made the best of—if all of them work together including LGA, NGOs and international communities by exchanging their practical knowledge, competence and skills so that these projects will be successful.

6.4.2 Mobile training

Covering practical knowledge related to the personal experience of workers and FO, mobile training units are able to offer audio-visual training. It tends to be highly effective for the workers, managers and FO involved, as video based programs make them understand and increase their health, hygiene and safety behaviour. Mobile training can be held in different workstations because it is much easier and low-cost method than

arranging formal training and education. Assenga (1991) illustrated how education and training plans could promote health and safety in the form of showing picture or videos. The regulatory agencies (DIFE, BSTI, DOE) do not have to spend much for establishing mobile training. Kassler (1990) used projection arrangement and overhead projectors for such programs. He also used sound techniques for workers' education (Kassler 1989). Safety, health and ergonomic posters near to task or work sites are also helpful for showing better ways of utilising muscle-force, for instance, with the proper tools. The provision of health and safety oriented pictures, meaningful comics and jokes (Packalen & Odi 1999) can raise the workers' awareness on unsafe acts and conditions. However practical examples and success stories should be emphasised for less educated and/or unskilled people so that the concept of OHS/ergonomics is understood easily among them. In this regard, Fernau (1981) demonstrated the use of photograph, slides and videos to maintain optimal safety in the workplace.

Workers' consciousness can also developed through environmental awareness training (Bimontie 1995, Behrens & Brackhill 1993). In a follow up survey, Cole and Brown (1996) showed how workers' participation could improve through such a training scheme (e.g., temporary shows, mobile units) in a hazardous situation. The workers need functional skills, sufficient literacy to support such skills, and a realistic belief that they can succeed in applying their skills and vocational or technical education to improve their working and community lives. They also need to learn and practice in modern machinery utilisation and using new technology. Mobile training should therefore be launched not only for ergonomic manipulation with tools and equipment but also to acquire knowledge on general epidemiology, industrial hygiene, legislative and regulatory issues. Regulatory agencies should be equipped with proper tools and be provided with logistic support and training kits (e.g., computers, cameras, tape recorders, videotapes, slides, and projectors) so that mobile training is successful. Provisions for higher education and training abroad should be made for Inspectorates and other concerned officials, because inadequately qualified and poorly trained personnel cannot guide or teach them properly.

6.5 Information and network center

A network of work-related data and information is very important for DCs like Bangladesh because the process of reporting verified data stimulates feedback on the strategy of prevention and control. All workers are to be encouraged to report WRPs so that data are recorded for finding practical solutions. Work-related data and information is also considered as a supportive tool for distributing research methodologies with analytical skills to the researchers. It is strongly felt that an efficient, independent and objective network of work-related information could contribute immensely towards preventing and controlling work hazards. There are benefits on reporting hazards (Singer & Endreny 1987). Proper recording and documentation of these hazards will show national statistics that are important for researchers to compare injury or accident data with other neighbouring countries. Therefore a nation-wide network system needs to be established so that correct information is disseminated with the integration of all the

determining factors. This is also an important prerequisites for network and information service.

The officials in Bangladesh (BaNINet, DIFE, DOE, BSTI) may have some capacity to record work-related information but there is an ignorance of the exact diagnosis of illness symptoms in terms of the types and categories (Ahasan 2000a). There is also an urgent need to increase the number of the network centres in the export processing zones (EPZ) located in different places (e.g., BEPZA). It would not be difficult to compare the national figures with those of neighbouring countries if there are effective network systems developed to promote the progressive development of procedures and methods of recording, and the notification of work hazards and injury incidence. It is also necessary that an efficient record management system should be put in place for the compilation of work-related information at the national level which will create an enabling recording system of various information. However, inactive records should be destroyed or sent to secondary storage and a manual should be prepared for documenting the new system and standards. The major elements of this new system should include:

- rules for setting-up SMEs, rules for numbering case files, etc.
- methods of handling injury cases including access to records
- determination of the number of workers employed in each sector (labour registries)
- synchronise other record management equipment (e.g., Computers, CD-ROM, etc.)

Along with accident, injury and compensation data, a CD-ROM may also contain other information published by the Labour Department, the Ministry of Industry, the Ministry of Health and other concerned organisations. This information could include approved codes of practice, guides to safe regulations, etc. The CD-ROM can also be a handy source of information that can help new investors, industrial entrepreneurship, contractors, professionals, and other interested parties understand their legislative requirements and enhances their knowledge of safety, health and hygiene at work. There are non-technical officers in the concerned departments and institutes in Bangladesh (BaNINet, DIFE, DOE, BSTI), and they are sometimes assigned to use computers in their offices. Surely, they may have problems to use computer-based statistical programs (e.g., SPSS) for evaluation and analysis of those data. Officials assigned for such jobs should be trained good so that they are able to handle basic computer programs, the recording and analysis of data and use a CD-ROM. The inspectors need to be more familiar with the new systems of reporting injury data, because the reporting system has changed from traditional paper work to an upgraded system (i.e., computer based or CD-ROM recording), according to the system developed by ILO/WHO (Takala 2000).

In Bangladesh, accident and injury data have been recorded on the basis of compensation claims (in the labour court), mainly for the workers employed in state owned or other big industry. In this regard, some information can be found in the Internet [www.state.gov/www/background_note/sabgnhp.html] linked with and other information as country profile [www.bangladeshonline.com/gob/bdscont.htm]. However regional networking for work-related data should be connected with the ILO/WHO network to provide access to various work-related data and information within SAARC regions [www.saarc.org]. Development projects (ATDP, BSCIC-entrepreneurship development project) initiated by the regional offices of international organisations based in Dhaka are

to harmonise knowledge-base data. UNDP, WHO and ILO's regional activity is also important to establish or set-up programs in the individual district HQs with enough resources. The WHO-collaborating centre is located in NIPSOM (Dhaka) for instance, that needs to play a vital role in other district HQs.

There are official web sites [www.asosh.org, www.sheafrica.info] for the WHO/ILO joint effort on OHS. ILO/WHO should also keep close co-operation with the LGA and other concerned departments with wider availability of recording systems. For this, an effective tool, that can be preferably and locally adapted, is to be formulated for better recording and notification systems, and access to all information.

The Internet with all its information sources offers a tool for networking (Lehtinen 2002) and professionals can improve the technical process of disseminating required data. In this regard, ILO programs [www.ilo.org/public/english/90travai/sechyg/index.htm] provide international features needed to compile, register and disseminate data and information. ILO has also launched some other work-related data and information, which are available on the Internet [www.ilo.org/public/english/180publn/books]. ILO safe work program [www.ilo.org/public/english/protection/safework/management/guide.htm and [www.ilo.org/public/english/protection/safework] may also provide practical data (ILO 2001). Some more informational are available [http://www.ccOHS.ca/who/contents.htm] from the ILO Encyclopaedia of OHS (Takala 2000), that have been developed in conjunction with the WHO/UNDP projects. Takala (1999) also illustrated international efforts on health/safety information to protect working people and the environment they work with. International OHS information centre (CIS, www.ciscentres.org) shares useful information through global networking that provides various information around the world. These could be helpful in the promotion of local networks (Clevenstine 2002).

Internet-based online data and information may not help much to determine or change guidelines or standards because of various local reasons. Internet surfing is expensive in many DCs like Bangladesh. The response from computers for downloading webpages can be very slow and annoying. It is therefore very difficult to download those web-based information. In this connection, Lehtinen (2002) suggested for face-to-face meeting, interaction and communication among the experts living in DCs.

7 Discussion

Given the many constraints in preventing work-related problems (WRPs) in Bangladesh, the major focus is on practical solutions, which are to be considered within the local circumstances, that the FO/EA could afford through the available means. Apart from legislative actions, FO/EA should keep their factory premises or workplaces clean, healthy and hygienic. Suitable tools and equipment should be used to ensure safety and reduce work injuries. For the gradual improvement of working conditions, machinery, tools or equipment should be installed in an ergonomic way (Ahasan 2002b) that affect and direct the work content. OHS facilities and ergonomics knowledge, however limited, must be organised in such a way that these facilities and knowledge enhance workers' efficiency and production. OHS should continually be received by the local workers, and be realised in the local workers as part of their skills, as well as within the tools they use, and the machinery and equipment they handle. The working situation in SMEs can be characterised by work demands and the workers' decision latitude, since it influences the local workers' own way to adopt postures, execute movements, and exert forces on their environment. And therefore, the extent of autonomy for adopting safe work and opportunity for ergonomic practice is important to improve tasks and activities by altering their job demands. This can lead to actual working methods, in which the workers in SMEs are habituated with their work culture (i.e., indigenous way of doing things) to perform a activity ergonomically in a certain environment.

OHS would help workers if there were provisions for a safe work environment in all investment and production decisions. A dynamic way of improving working conditions is to achieve some local objectives so that the work process is concrete, easy to handle and desirable to the local workforce. Therefore, the components of OHS and ergonomic ideas should be equally distributed among the various elements of job tasks. It is, however, possibly difficult to enhance OHS and ergonomic application in the individual workplace where the unskilled and/or less educated people are overwhelmingly employed in many Bangladeshi industries without JTVE.

There are implications of social conservatism, cultural restrictions, superstition, and illiteracy among the workers in Bangladesh, which may be associated with lower levels of awareness about OHS/ergonomics. It is however believed that health and safety measures will be implemented in SMEs by adopting participatory action (PA) in workplace intervention. Workplace intervention, to be successful and sustainable, must be the result

of a joint initiative between workers, employers and legislatory agencies. It is also true that without implementation of work regulation and labour legislation (WRLL), certain changes in workplaces may not be happen because FO/EA have yet to be committed to maintaining all the aspects of health/safety. It is also vital to realise that local constraints may hinder the process of extensive changes in the workplaces. And thus the introduction of rapid changes in layout or by revised work regulation does not imply that WRPs should be minimised immediately.

Given so many people coming from rural areas to work in the cities and towns, there should be a revised guideline in the labour profile for this issue. Takala (1991) emphasised that the ILO-Conventions [No. 155 on OHS (ILO 1981) and No. 161 on occupational health services (ILO 1985)] should be implemented in all the aspects of jobs, tasks and environment [www.ilo.org/public/english/protection/safework]. A high priority option must be placed on the national agenda according to the ILO (2001) guidelines [www.ilo.org/public/english/protection/safework/management/guide] so that there would be calls for immediate action to control occupational problems. An intensive program for implementing WHO-Conventions and ILO checklists is yet to be manifested for industrial workers in Bangladesh covering compliance with WRLL. However this should include a refined and changeable portfolio to understand its priorities and options for SMEs in Bangladesh.

The introduction of ergonomic rules (OHSA' checklist or other NIOSH standards), ISO or TLVs is not in itself a good solution if certain changes are not rationalised appropriately. Because, it is still not clear how and what features of working conditions are productive and how practically both workers and FO/EA are to be involved with health, safety and ergonomic practice. It is easy to recommend a series of standard measures but difficult to implement in many instances. International standards and other measures may not be easily implemented in Bangladesh, due to a different work-pattern, indigenous culture, workers' poor health and nutrition, and other local reasons. It may be more difficult to synchronise workers' ways of doing things and relevant aspects of modern or updated work systems. Also, there is no ideal style of making certain work process or job tasks applicable for all individual workers in Bangladesh. And thus, OHS/ ergonomics measures must be taken into account to better fit local systems. This can be followed with two basic principles, which are participative effort and collaborative effort. Preventive mechanisation could also help when active participation and routine wise (systematic, step-by-step) planning are planned which enlarge a worker's span of control over existing working traditions. It is also important that they partially change or alter non-productive machinery or minimise hazardous situations by cleaning, servicing and maintenance. By so doing, WRPs can be reduced substantially.

Workers should be motivated and encouraged for workplace improvement through self-help and self-care strategies. For this, incentives, welfare benefits or workers' ownership plans are to be planned. However these can be opposed to popular wisdom in some factories that do not necessarily result in greater control of WRPs, as long as there is no direct involvement of workers and FO/EA in workplace intervention. These measures can be problematic rather than a process of workplace improvement, especially when work motivation fails to gain a sufficient level of maturity because a process of stagnation can set in, making it hard to achieve desirable goals. Therefore, links between work organisations, NGOs, Inspectorates and other concerned parties are helpful here (Lukindo

1991, Khamis 1992), and other management goals (Shahab 1998) those are locally feasible, are obviously very important for workplace intervention.

When an ergonomic aid is introduced from locally available materials—then it helps local work system or job tasks and improves health and safety by reducing illness, accidents and injuries. It will be creditable only if features of such measures do not irritate the workers and do not cost much. Such irritation may be presented in the form of stress symptoms when a helmet, for instance, does not match properly (Abeysekera & Shahnavaz 1988) or working clothing (Abeysekera 1997a, Ahasan & Salovaara 2000) does not allow for the evaporation of perspiration. Further verification of local measures is needed to see how these are effective and economic in each of the individual factories. LCM was effective in many workplaces in Africa where heavy physical work was practised (Tornberg 1996). LCM will be effective if solutions are practical and socio-culturally acceptable to the local context in individual factories or workplaces.

Local measures are supposed to be less polluting for human and the environment, however it may not be helpful for all work organisations where imported machinery or spare parts need other forms of solutions in the workplaces. It cannot be substituted for the needed workplace improvement in these places, because local solutions are not improved or advanced enough in many DCs like Bangladesh. In some cases, the needed tools are not effective to control hazardous work processes (*study I*) or a non-hygienic (*study II*) work environment. Many of the machinery, tools and spare parts used in the agro-chemical and textile mills are imported and no available solutions exist without purchasing or altering the old ones. The workers in SMEs seem unable to control or keep up with the pace of job-tasks due to poor adaptation with work processes. Therefore, it is important that they adopt correct postures or use ergonomic tools for easy manipulation with hands, wrists or arms against stressful tasks exist in SMEs.

All problems cannot be eliminated immediately, as the culturally accepted way of doing things becomes entrenched in many workplaces. But efforts of the workers and FO, closest to the WRPs are of vital importance for bringing practical solutions. Problems also emerge when managers, supervisors and/or FO face difficulty in adjusting job-tasks for an individual worker because recruitment is not usually done according to the specific job-tasks. If improvements and some changes in workplace layout, production line or other places are not made possible in ergonomic planning, the realisation of OSH will be even more difficult in the future.

Sustainable workplace improvement may not be possible, if practical methods based on an ergonomic way of manipulating tools and equipment are not given importance for actual needs and local practices. An attainment of a safe and healthy work environment must become the goal of each work process. It is possible only when OHS/ergonomics applications are combined in a joint effort between the workers and employers. We need to realise that the combined efforts of the workers, FO, UL, Inspectorates, and others can miraculously improve health and safety at work. They all need to participate toward a common goal of ensuring a good work environment that brings workers' job satisfaction and reduces employers' costs on work-injuries (Takala 2000), for instance.

There is very little that international agencies can do unless we redirect policies toward better health, hygiene and safety. NGOs, international organisation, EA and the local community should be involved in the process of workplace change. The commitment of

LGA, NGOs, and decision-makers become a must before starting the implementation of their individual programs on health and hygiene (Sekimpi 1992, Kromhout 1999).

Several productive goals can be accomplished if health, safety and ergonomics measures are implemented in the existing settings. If improvements are made only to increase production, then health and safety hazards will remain constant. Technical, medical and social prevention of occupational hazards is to be prioritised in accordance with the improved or updated regulations. It is, however, believed that health and safety will be improved in DCs through step-by-step changes (Ahasan 2002b).

It is an enormous task to develop OHS and implement ergonomics application in the entire situation in Bangladesh. However, the promotion of the integration of working life and the society at large, is to be provided in order to ensure local peoples' work ability and employability. It is therefore necessary to promote and develop strategies for substantial changes in workplaces. A serious attention should be given importance for considering the individual worker's health status, absenteeism, physical strength and other issues. In this case, some vital factors (Ahasan 2002b) such as consultation, intervention, validity, feasibility, consistency) need to be carefully planned before reporting and/or implementing local measures.

7.1 Validity and consistency

The methodology applied in the case studies and the quality of the work-related data and information gathered in this thesis have some limitations. Evaluating workers' reactions to physical, psychosocial and socio-economic stress factors was complex because Bangladeshi workers' nutrition levels, muscle utilisation and other parameters were not considered with the determining factors that are related to the level and route of exposures. The type of determinants and workplace variables also varied between different factories. Therefore, it was not possible to determine whether there was any relationship between productivity and the quality of working life. The workers in their workplaces yielded an unreliable assortment of subjective responses to questions on work-related issues. Some of the determinants, such as the level and route of work exposures, were not exactly identified because sufficient time, resources, and necessary help from local workers was lacking during the interview period. Therefore, the limitations of the methodologies in each case study are based on both work related and non work-related factors.

It was even more complicated to predict the real causes of WRPs due to differences in the reporting styles of the subjects selected in different workplaces. Many of the workers reported having various problems during the personal interview and questionnaire study, which were perhaps falsely perceived. Indeed, the interviews were conducted in their native language (Bengali), showing good examples so that the workers could grasp the meaning of each question. The assessments would show more accurate results if more workers were freely or voluntarily allowed to take part in the case studies.

Under reporting for WRPs is a serious problem in Bangladesh because of the lack of participation on health and safety programs, flexible or outdated labour legislation and other local constraints. The number of workers exposed to WRPs may be, therefore,

higher than expected because of such under-reporting habits. The workers in SMEs are often denied the right to have compensation, and therefore they do not report injury cases. In many cases, the FO/EA do not record work-related data because of fear of penalty and other reasons. And consequently, widespread non-recognition and identification of WRPs has brought about immense sufferings to general workers.

The confounding factors, magnitude, nature and severity of such hazards in each of the individual workplaces investigated are not exactly known. It was not easy to evaluate all the work-related parameters in the existing situations because the identification of work environmental exposures (*study I–II*), external workloads (*study III–V*), physiological reactions (*study V*) and psychological aspects (*study III & VI*) were difficult to determine. It would be enlightening to cover all the intervening and local factors (*study VII*), to come to an understanding and reach final conclusions.

The inter-individuals' variability such as attitude and aptitudes on the night shift, for instance, among the workers in a steel re-rolling mill (*study V*) and shoe factory (*study VI*) was not observed systematically. It was not possible to determine the exact relationship between productivity and the quality of working life for shoe factory (*study VI*) and textile mill workers (*study I*). The subjective perceptions collected from these workers need to be synchronised with a physiological study that can serve to develop a profile on individuals' endurance or physical capacity for strenuous tasks, for instance. Where strenuous tasks are concerned (see *study III–V*), a definite correlation has yet to be found, especially among the small industry activity and postural tasks (*study IV*) that why the work strains become excessive for some subjects but tolerable for some others. Therefore, it was very difficult to say who is physiologically fit or psychologically unfit. In the steel re-rolling mills (*study V*), physiological tests among subjects and some environmental data were collected at the work sites (i.e., inside factory premises) instead of in laboratory or controlled conditions.

In Bangladesh, no field surveys have been conducted in SMEs using diagnostic procedures or following an epidemiological method. There is perhaps a trickle information available from the results of studies and research conducted by few organisations and individuals because the opportunity of conducting workplace investigations, analysis and evaluation of OHS/ergonomics is rare for a university (e.g., BUET, BIT, IPGMR) or individual research centre (BIDS, BRAC). However some good research and studies are carried out by ICDDRB, NIPSOM, BARDEM, BCSIR, BIRPERT, etc but those are not exactly connected with OHS and/or ergonomics application. Nevertheless, a nation-wide survey and walk-thorough investigation would be then conducted for work site monitoring, analysis, evaluation and identification of WRPs with the collaboration of all parties concerned.

In this thesis, an evaluation and detailed discussion of the results in each case study were not compared with control subjects; however, a two-page citation is listed in the list of references (e.g., various studies conducted by Ahasan and other co-authors). Overall, though, it appears that these list of references have unearthed a valuable trove of information concerning the work-related factors encountered in various workplaces studied in Bangladesh and elsewhere.

Direct comparisons of work-related data were not accurately made because of a lack of '*before*' and '*after*' studies on OHS/ergonomic issues. There were no clear figures available for normal physical and mental conditions among the workers for an average

population of similar age and gender. At any rate, work-related data and information should be based on scientifically proven experiments and epidemiological studies based on anthropometry, demography and other factors. Qualitative and quantitative methods are prerequisite for the analysis and evaluation of work-related data, which may be lacking in the case studies. Nevertheless, field inspection and walk-thorough investigation should be conducted in the direction of application-oriented research, especially for the validity of the work-related data.

7.2 Difficulties encountered

Due to many of the local constraints and other reasons, various types of difficulties were encountered, especially during the workplace survey in the textile industry (*study I*) and the steel re-rolling mills (*study V*). The agro-chemical factory owners (*study II*) were more suspicious than the metal workshops and other small-scale industries (*study III*). This is because the management systems in individual industries and other workplaces may have differing assumptions about the varying demands of job-tasks. Many of them were aware of workplace visits to their factory premises. It is usual in Bangladesh that FO/EA are reluctant to provide basic facilities. Many of them do not follow work regulation and labour legislation (WRLL) and other relevant standards, ISO or TLVs because extra costs are involved in maintaining OHS, for instance, or in changing factory layout ergonomically. They are, perhaps, afraid of penalties or such actions by the regulatory agencies. The FO and/or production managers were sceptical about the researcher's investigation (*study I–II* & *study V–VI*), believing that the study would cause a disturbance in the workers' activities, and a loss of production. However it is believed that they will report the special cases of WRPs when they understand that it sucks (!) production and profit earnings.

Further, the workers were sometimes hesitant to co-operate with the researcher due to a lack of trust towards the interview and questionnaire studies, and for the fear of losing jobs. The workers were generally afraid that the employer might fire them after testing the subjects, on the speculation that this study might prove them to be physically weak and inefficient. Therefore the types, causes and occurrences of work exposures may be related to certain individuals in particular circumstances. The complexity of conducting work-related research in such a situation in Bangladesh may make the job of the researcher tiring and more challenging. Therefore the information provided by this thesis is not always accurate or sufficient to demonstrate workplace intervention.

7.3 Implications for further study

From the case studies, it has been shown that several occupational factors are related to health, safety and ergonomic problems. Heavy physical workload along with heat stress or thermal discomfort, psychosocial imbalance, and individual factors contribute to the development of WRPs. These problems have their origin in exposure to particular

hazardous agents, mostly health, hygiene, safety and ergonomic problems. In DCs like Bangladesh, individual workers' characteristics as well as working conditions and environments are more important than social and organisational factors at work. Therefore, three scientific disciplines can be involved in the assessment of physical exposure measures, these being biomechanics, work physiology, and psychophysics. There is, however, a need to investigate ergonomic factors according the specific tasks, jobs and activities with the aim of improving health and safety. Internal exposures are usually estimated with bio-mechanical modelling to achieve exposure profiles of occupational tasks in SMEs, mostly in the consideration of lower-back or upper limb disorders. It requires information on postures of different body segments and exerted forces, completed with movement data in case of dynamic models. Both biomechanical and electromygraphic measurements are useful methods to assess internal exposure but these are rarely used in DCs.

There is a little opportunity to conduct empirical studies and in-depth research on OHS in DCs like Bangladesh but the involvement of professionals, academicians and practitioners will fill this gap. All they need to work together for discovering satisfactory solutions which, however, might not be found even after a detailed analysis. Therefore, conducting work-related research is vital, collaborating with universities, LGA, industrial entrepreneurs and NGOs (Fig. 14). Research and educational institutes located in each divisional and district head quarters (HQs) should therefore launch effective programs (Ahasan *et al*. 1998c) to conduct field studies, not only in terms of increasing awareness, but also in terms of increasing self-responsibility, knowledge and academic or research skills. Nevertheless, implications for future study must deal with specific conditions that should involve ergonomic measurement when exposure is real, unavoidable and serious. All types of SMEs should therefore be included in routine inspection (Fig. 11) with the support of the national budget, however limited, and with the support of workers, UL, FO, EA, and other concerned parties.

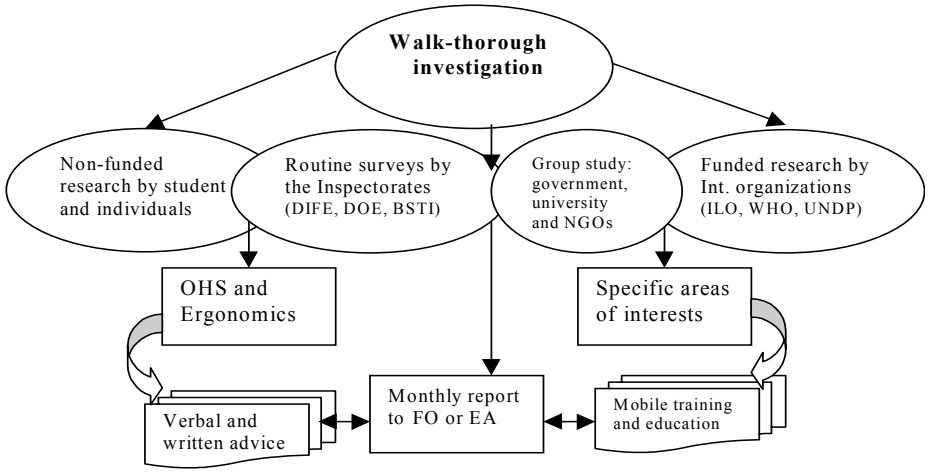

Fig. 11. Ergonomic studies and applied human factors research in different levels through workplace survey, field inspection and walt-thorough investigation.

7.3.1 Importance of workplace investigation

Inspection, analysis and evaluation of work-related factors have potential use in SMEs for a better harmonization of work content, health, hygiene and safety. Walk-thorough surveys are also important especially in changing or modifying workplace situations, and for implementing a correct (locally adjustable) measure to reduce work-related diseases in SMEs. Workplace assessment may be looked at as practical fact-finding at the shop-floor or grass roots level since OHS and ergonomic issues have roots relating to the quest for optimum adaptation and performance from the local workers (Ahasan *et al*. 2001, 2002b). Many researchers (Phoon 1976, Sen 1965, 1979, Tornberg 1996, Kogi 1985, 1991, 1996, 1997) argued that low-cost ergonomic measures should be implemented through proper assessment of workplace and environmental variables. Other scientists (Rantanen 1989, 1994, Cullen & Harri 1995, Partanen 1996) emphasized the needs of work-related research not only for exposure-disease association but also for reducing WRPs. Tornberg *et al*. (1996) illustrated some follow up case studies especially for WISE (workplace improvement in small-scale enterprises) projects in Africa—that can be helpful resources for investigating work related data in other DCs. Regular inspections and workplace visits also contribute in building awareness on OHS/ergonomics requirements among the workers, UL, FO, EA, civil society and others (Fig. 12).

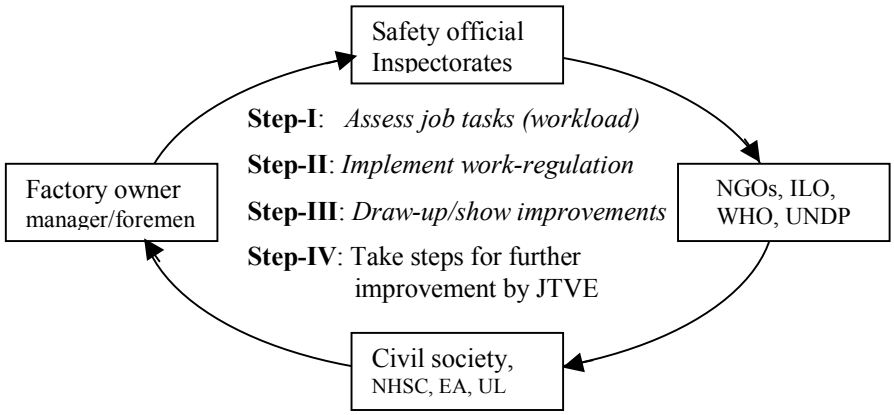

Fig. 12. Workplace improvement cycle through investigation of workplaces, assessment of workload, provision of job training and implementation of work-regulation.

To make an exact evaluation, epidemiological surveys with realistic data on workers' employment, local situation and cumulative exposure records are of vital importance. Further, work analysis can be used to clarify or make decisions to improve worker's efficiency and safety. However the methodology to be used, the measurements to make, and the evaluation to perform will be largely depending upon the contributing and confounding factors because of various problems existing in the workplaces of SMEs, in particular. In this context, field studies and walk-through investigations need to be designed in the direction of application-oriented research. Work survey can be based on the experience of effective planning, group discussion, self-care and self-help basis. Work

related surveys should be carried out not only to investigate WRPs but also to improve the adaptation of work (Ahasan 2001b) in the context of a worker's ageing, gender, culture and other socio-economic characteristics (Ahasan & Benincasa 1999a). Periodical evaluations are also important for continued improvement and adaptation to changing needs, especially on the work abilities of the various team members that need to be matched well. In many studies, ergonomists found large variations in anthropological, cultural and physical factors among the working people in DCs—those are rarely considered by the investors, producers or exporters (Abeysekera 1997b).

The nature and content of workplace investigation should be considered, as part of an economic reflection on the means required enriching effective intervention strategies for workplace improvement. In this regard, workplace investigation should focus on ergonomic intervention practice, as well as restore links between research, practice and job training. Optimal solutions are to be designed through health, safety and ergonomics research based on local needs so that immediate action can be taken place in time, and in order. It is also believed that work-related research in Bangladesh is an evident stimulant for controlling hazards, accidents and injuries for which OHS/ergonomics must be addressed. In many instances, health, safety and ergonomic measures can be found to be cost-effective due to many of these reasons. And because, the evaluation of work hazards requires substantial evidence obtained by means of extensive research (Kogi & Kawakami 1997). The majority of the risk factors (determinants) at different workplaces in Bangladesh have to be detected, however difficult is, in order to get a primary overview of the working conditions. Otherwise, the country will suffer due to other pressure in paying injury cost and production loss.

7.3.2 Systematic methods of workplace survey

The key to dealing with workplace improvement should include systematic methods of work-thorough investigation, routine inspection, and recognition, classification and assessment of jobs, tasks and activity. There may be realistic alternatives from which choices can be made by future endeavours in the way of workplace improvement. For this, a national policy and plan for health and safety programs should be developed in such a way that it includes identification, evaluation, assessment, prevention, protection and control strategies. The first step that should be taken is to develop a method for the collection of work-related data mainly for the implementation of comprehensive and multidisciplinary solutions. Correct data and information should be disseminated from the results of qualitative research and field studies. Therefore, identification and assessment of potential problems at workplace is more important than just visiting a factory which is very important for workplace intervention strategy (Westlander 1993). For determining how health, safety and production are affected by WRPs, workplace improvement procedure must be translated into pragmatic control solutions in the local context through the procurement, compilation and recording of work-related data. A model (Fig. 13) is therefore devised for systematic inspection and regular investigation of workplaces, sector or zone wise monitoring, and implementation of work-regulation (e.g., WRLL).

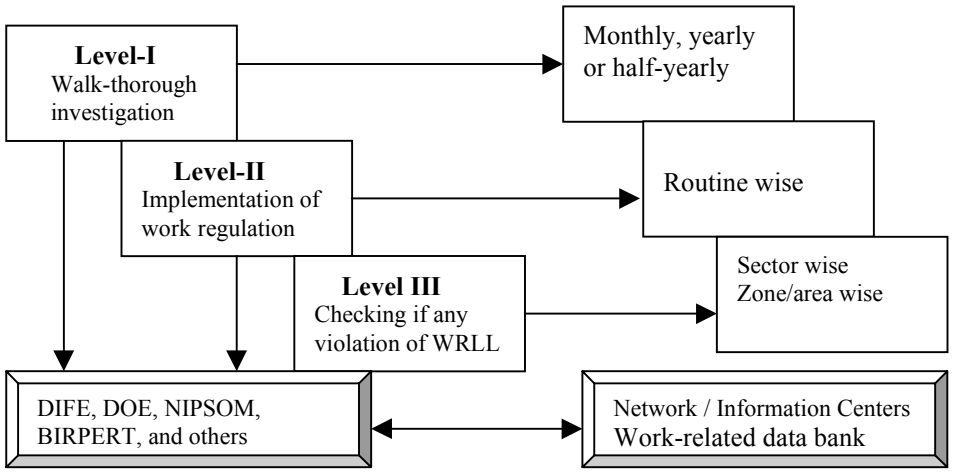

Fig. 13. An improved model for systematic workplace survey and inspection for implementing work regulation and labour legislation.

As far as DCs are concerned, low-cost methods (Kogi 1997, 1998) are to be advised for the assessment of work-related factors, however, these methods should not result in biased exposure estimates. It is, because low-cost method can have serious consequences for risk estimates in the measuring of more aspects of risk factors. Accurate measurement and empirical analysis should however be carried out with simple instruments (see *study I–III*). These must be done for the sake of workplace intervention (enterprise level) as well as the prevention and control of work exposures at national level. For this, a safety climate is to be implement in practice (Zohar 1980) synchronising workers shared responsibility and FO/EA's joint collaboration.

A systematic workplace investigation must also take into account of the socio-technical process (Saarela 1983). It helps to characterise job tasks and the possibilities of control measures to identify the local reasons why the working condition deviates from the optimum (ergonomic) ways of correcting work tasks. A systematic workplace survey is needed to carry out with the help of local experts (BUET, BIT, NIPSOM, IEB) and other institutes (BCSIR, BIRPERT, ICDDRB) who should be able to decide the best procedure to collect the data and information necessary to solve the problem. This sort of investigation may be one of the best initiatives for researchers and professionals that would find some possibilities for compliance with OHS.

The methods of a systematic workplace survey must be designed in such a way that its analysis can be used by officials, that is, by occupational physicians, hygienists, ergonomists and safety engineers with a general training in the management of work-related exposures. Whatever the case, job stresses or illness symptoms may remain after such inspection mainly due to various contributing and confounding factors locally exist those can not be minimized or removed easily. In this case, further assistance of an expert will be required for corrective short-term protection measures. An example of systematic workplace investigation is illustrated in table 6.

Table 6. Characteristics of systematic workplace investigation and participatory strategy.

	Stage I Preliminary visit	Stage II Observation	Stage III Analysis	Stage IV Expert's views
When?	Regular, routine wise and systematic	When a specific problem is identified or known	When a complex situation is identified	In a very complex situation
How?	Joint and share responsibility of worker, FO & EA	Qualitative observation	Ordinary test and measurements	Specialized test and measurements
By whom?	Workers, linemen, foreman, and/or managers.	FO/EA, investors, new entrepreneurs, and others	Local experts: DIFE/DOE/BSTI	BUET, BARDEM, NIPSOM, IPGMR
Duration?	Minimum 1 hour	Minimum 2 hours	One day	Few days
Cost?	Low-cost	Low-cost	Affordable	Expensive

In many DCs, assessment of external exposures are also done by subjective judgement but on site video recordings as observational methods (i.e., direct measurements) can be useful to investigate the dimension of the level, duration and frequency of work exposure. Extensive survey and investigation (*stage IV*) will obviously be costly, and it will take a longer time and require sophisticated instruments and competencies. It is also better to avoid complex methods since concerned Departments (DIFE, DOE, BSTI) or Ministries (e.g., Ministry of Industry, Ministry of Health, Ministry of Manpower & Employment) may not have enough resources. It is worth insisting on the fact that not all stages are systematically performed because the procedure of systematic workplace investigation actually stops when adequate solutions have been implemented. However it has to be practical and fact-inding methods as with advisory inspections that should start from the grass roots level (Zalk 2001). The Information Booklet Series (1996) also tells about the EU practice for assessing working conditions. The European Commission (1995) published the "Self Audit Handbook" for systematic workplace surveys in SMEs. However, the aim of this handbook is to do much more than the procedure described. The Finnish Institute of Occupational Health (Ahonen *et al*. 1989) also developed a systematic workplace survey procedure. But it is believed that local methods are always better to study basic information about job tasks, work culture, individual's postural technique, task characteristics, workers' behaviour, and other factors such as thermal discomfort, clothing, factory climate, etc. Analysis of such work-related data must use research concepts but with observational techniques commonly used in many work studies. An observation method should be applied in such research which can best be combined with direct measurements of exposure to posture, movement and exerted forces, for instance.

Local procedures, priorities and options can also be used extensively for more realistic purposes in the context of time, money and other resources available in DCs. It must cover briefly the majority of the contributing and confounding factors related to workers' health, safety and well-being, indicating whether there are complaints related to the factory environment (heat, humidity, smoke, noise, vibration), non-ergonomic conditions, or other regional problems. Clearly, this can be done by or with the help of local people and FO/EA who should have a thorough knowledge of local working conditions.

Easy and readily available methods can be used rather systematically, because simple measurement methods can make it possible to best identify the causes of the job stress symptoms, and the means to solve them properly. An expert judgement and self-report can give only limited insight into the occurrence of tasks and activities.

8 Conclusion

Work-related information serves the labour force and the working society as a source of important data to improve production and the national economy. Systematic work-related research and an unbiased collection of data through extensive field investigation are very important, not only for an increase in production, but also for the need of decreasing accidents and injuries and protecting workers' health and the environment. It is therefore necessary to identify the correct measures to eliminate an eventual biasing effect. In the future, professionals, academicians, practitioners, NGOs and other organisations should carry out extensive field surveys instead of having to use the conventional methodology applied in the case studies.

The information complied and work-related data presented in this thesis, however, cover no more than a preliminary approach for SMEs towards the design of an ergonomic work environment. There may be more realistic alternatives from which an implementation of health and safety measures and workplace intervention can be made by future endeavours. The cost-effectiveness of implementing health, safety and ergonomic measures should be therefore evaluated through comparisons with other neighbouring or SAARC countries [www.saarc.org] because the cultural way of doing things, industrial economy and other local factors (exist in Bangladesh) dominate OHS/ergonomics measures differently. However the results in each case study realised that work-related data are the most important tool for industrial production and national economy.

Through determining such work-related exposures in SMEs, an assessment of job-tasks and work environment provides an opportunity to establish some reliable research findings that brings forth an interest in investments towards machinery, production process and technology. Further, work-related hazards need to be identified not only for health research and safety studies but also for appropriate workplace intervention. A work-related research needs well-defined materials (e.g., subjects, work culture, working climate, shift system), reliable methods of work-related field studies and an in-depth discussion of the results.

New ideas and methodology could be developed to carry out further field surveys aiming for the sustainable improvement of working conditions in Bangladesh. In this connection, an improved model is proposed below (Fig. 14) for implementation of OHS measures and ergonomics application in various workplaces. This is believed to be useful for general health and safety inspections in other industries and workplaces. It will also

fulfil labour protection demands by implementing OHS measures and ergonomics application in the local context. This thesis likewise includes published and unpublished results involved in work-related data and information as a tool for action—which also presents a do-able agenda for workplace intervention in SMEs through multiple steps, as well as collaboration and co-operation from all the parties concerned.

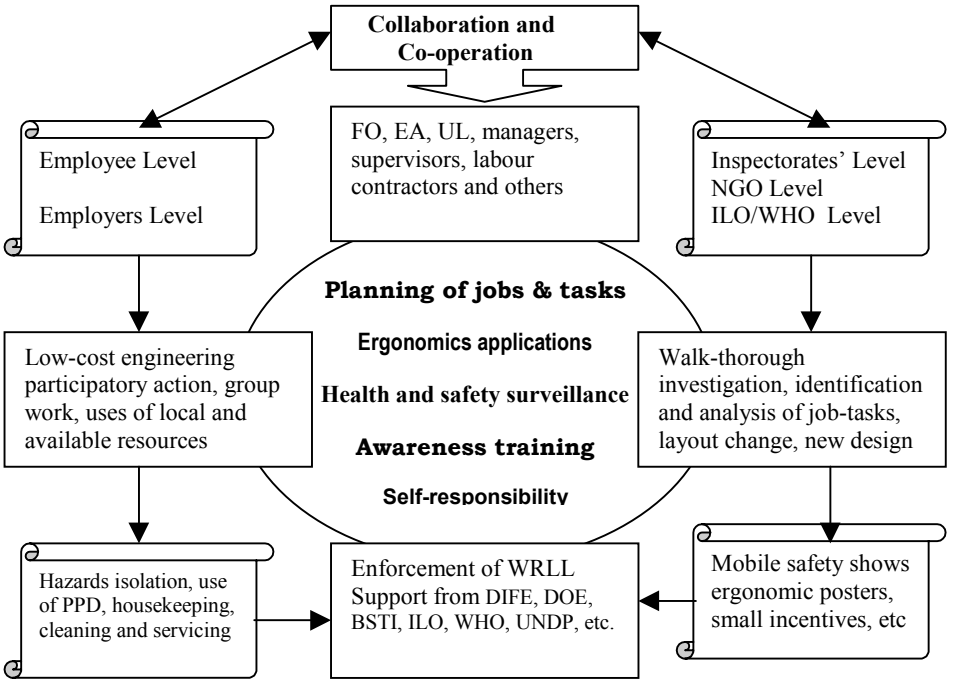

Fig. 14. A proposed model for workplace intervention through collaborative efforts.

A successful approach for controlling WRPs can be developed by joint initiatives of all concerned parties that intricately involves the worker, factory owners (FO) and employers association (EA) within each step of the process. The development of effective workplace interventions also depends on a better understanding of the FO's roles and workers' safety behaviour, their work culture, and of their attitudes of injury prevention and risk perception. Therefore, attitudinal change through workplace intervention is a necessity for any change in work methods and/or ergonomics application in DCS like Bangladesh.

References

Abeysekera JDA & Shahnavaz H (1988) Ergonomics evaluation of modified industrial safety helmets for use in tropical environment. International Journal of Industrial Ergonomics 31 (9): 1317–1329.

Abeysekera JDA (1994) Ergonomic education and technology development in industrially developing countries. International Seminar on Technological Education-II, p 19–27.

Abeysekera JDA (1997a) Ergonomic problems outside work establishments in industrially developing countries: an example from Sri Lanka. In: Seppalä P, Luopajärvi T, Nygård C-H and Mattila M (eds), From Experience to Innovation, Finnish Institute of Occupational Health, vol 7: 63–65.

Abeysekera JDA (1997b) Ergonomics through collaboration—editorial. African Newsletter on Occupational Health and Safety, 7 (2).

Abeysekera JDA (1997c) Ergonomics education and training in industrially developing countries: an example from Sri Lanka. In: HM Khalid (ed), Human Factors Vision–Care for the Future, Proc. of the 5th South East Asian Ergonomics Society Conference (Kuala Lumpur, Malaysia), International Ergonomics Association Press, p 177—181.

Ahasan MR (1993) An ergonomic study on the manual pump for lifting surface water. In: Nielsen R and Jorgensen K (eds), Advances of Industrial Ergonomics and Safety–V, Taylor & Francis, p 659–665.

Ahasan MR (1994) Small and Cottage Industries in Bangladesh–ergonomic perspective, proposals and prospects for the development of working conditions and environment. Licentiate Thesis, University of Oulu, Finland.

Ahasan MR, Väyrynen S, Virokannas H & Kangas E (1997a) Thermoregulatory response and muscle pain in steel mill workers. In: Khalid HM (ed), Human Factors Vision–Care for the Future, Proc. of the 5th South East Asian Ergonomics Society Conference (Kuala Lumpur: Malaysia), International Ergonomics Association Press, p 117–121.

Ahasan MR, Väyrynen S & Virokannas H (1997b) Mathematical model in the estimation of heat stress and sweat loss. In: Constanda C, Seikkala S & Saaranen J (eds), Analytical Methods, Addition Wesley Longman, vol 1: 21–26.

Ahasan MR, Väyrynen S & Virokannas H (1997c) Prediction of physical workload using fuzzy concepts. In: Constanda C, Seikkala S & Saaranen J (eds), Analytical Methods, Addition Wesley Longman, vol 1: 27–31.

Ahasan MR, Väyrynen S, Virokannas H & Kisko K (1997d) Postural workload in metal handling tasks. In: Seppalä P, Luopajärvi T, Nygård C-H & Mattila M (eds), From Experience to Innovation, Finnish Institute of Occupational Health, vol 7: p 69–71.

Ahasan MR, Quddus R & Rahman T (1997e) Occupational injuries in different industries in Bangladesh. In: Seppalä P, Luopajärvi T, Nygård C-H and Mattila M (eds), From Experience to Innovation, Finnish Institute of Occupational Health, vol 3: p 411–414.

Ahasan MR, Khaleque A, Sadeque S & Uddin Z (1997f) Psycho-physical responses of shift workers in hot working environment. In: Härmä M (ed), New challenges for the organisations of night and shift work, Proc. of the XIIIth International Symposium on Night and Shift Work [23–27 June, Finland.], Abstracts no 67.

Ahasan MR, Hannan MA, Uddin Z & Khaleque A (1998a) Critical issues for ergonomic development as well as occupational safety and health measures. In: Haseeb MA (ed), The Institute of Engineers–Bangladesh, Dhaka, p 269–276.

Ahasan MR, Mohiuddin G, Kutubuddin M & Hannan MA (1998b) Musculoskeletal discomforts for manual day labours in Bangladesh. In: Scott PA, Bridger RS & Charteris J (eds), Global Ergonomics, Elsevier Sciences, p 127–130.

Ahasan MR, Quddus R & Mohiuddin G (1998c) Lunching Ergonomics in Bangladesh –effective collaboration between engineers and others. Asian-Pacific Newsletter on Occupational Health and Safety 5 (3): 64–66.

Ahasan MR & Benincasa T (1999a) Technology, society and human factors. In: Straker L, Pullock S & Smith R (eds), The 2nd International Virtual Conference on Ergonomics, [Online: http://cyberg.curtin.edu.au/members/papers/45s.html].

Ahasan MR & Benincasa T (1999b) Relevant aspects with new technology and business transaction. In: Straker L, Pullock S and Smith R (eds), Proc. of the 2nd International Virtual Conference on Ergonomics [Online: http://cyberg.curtin.edu.au/members/papers/45s.html].

Ahasan MR (2000a) Ergonomics evaluation of strenuous tasks in hot environment— (in: abstract). Finnish Work Environment Fund [www.tsr.fi/tutkimus/tut4_a_f.html], Helsinki: Finland.

Ahasan MR (2000b) Occupational Health and Hygiene in Bangladesh. Proc. of the 3rd Nordic Conference on Health Promotion (6—9th September, Tampere: Finland), Online: [www.uta.fi/laitokset/tsph/conference/sessions/b6/b6_9.html].

Ahasan MR & Salovaara J (2000) Working clothing—thermal properties and comfort criteria. International Encyclopedia of Human Factors and Ergonomics, 2: 1063–1069.

Ahasan MR, Partanen T & Lee K (2000) Occupational health and safety in the third world–a simple case of neglect. In: Sohn JY (ed), Human Space Time–Environment, Proc. of the 5th International Congress on Physiological Anthropology (1–5th October, Seoul: Korea), Online: [http://aesl.hanyang.ac.kr/icpa2000.html], p 247–252.

Ahasan MR (2001a) Legacy of implementing industrial health and safety in the developing countries. Journal of Physiological Anthropology and Applied Human Sciences 20 (6): 311–319.

Ahasan MR (2001b) Human adaptation to shift work in improving health, safety and productivity—some recommendations. Work Study 51 (1): 9–17.

Ahasan MR (2001c) Global corporate policy and financing health services in developing countries. International Journal of Self-Help & Self Care 1 (4): 351–363.

Ahasan MR (2001d) Global corporate policy for financing health services in the third world: the structural adjustment crisis. International Quarterly of Health Education 20 (1): 3–15.

Ahasan MR & Partanen TJ (2001) Occupational health and safety programs in the less developing countries –a serious case of negligence. Journal of Epidemiology 11 (2): 74–80.

Ahasan MR, Lewko J, Campbell D & Salmoni A (2001) Adaptation to nightshifts and synchronisation process of night workers. Journal of Physiological Anthropology and Applied Human Sciences 20 (4): 215–226.

Ahasan MR (2002b) Socio-technical and ergonomic aspects of industrial set up. Work Study, 51(9).

Ahasan MR (2002c) Work-related research, education and training in developing countries. International Journal of Occupational Safety and Ergonomics (in press, TW/JOSE/227/02).

Ahasan MR, Laukkala H and Sadeque S (2002a) Psychosocial and socio-economical aspects of female garments workers in Bangladesh. Work Study, 51(7) (in press).

Ahasan MR, Khaleque A & Mohiuddin G (2002b) Psychosocial and family aspects of shift work—a case study. Work Study 51 (3): 116–120.

Ahmad SkA, Ahasan MR, Salim-Ullah MH, Hadi SkA & Khan AW (1997) Respiratory symptoms among textile mill workers in Bangladesh. In: Khalid HM (ed), Human Factors Vision–Care for the Future, Proc. of the 5th South East Asian Ergonomics Society Conference (Kuala Lumpur, Malaysia), International Ergonomics Association Press, p 111–116.

Ahmed S & Momin MA (1986) The Comilla Youth Development Scheme in Bangladesh— study of successful rural training scheme. Series-1, Geneva: International Labour Office.

Ahonen M, Launis M & Kuorinka T (eds) (1989) Ergonomics Workplace Analysis. Finnish Institute of Occupational Health (FIOH), Helsinki; Finland.

Al-Mahtab AM (1998) Effects of organophosphate pesticides on the health of agrochemical workers in Bangladesh. Asian-Pacific Newsletter on Occupational Health and Safety 5 (2): 48–50.

Annan KA (1997) Occupational health and safety: a high priority on the global, international and national agenda. Asian-Pacific Newsletter on Occupational Health and Safety 4: 59–59.

ARTEP (1986) Bangladesh–selected issues in employment and development. Asian regional team for employment promotion (ARTEP), Geneva: International Labour Office, 297p.

ARPLA (1991) Profile on occupational safety and health in Bangladesh. In: Ono H (ed), Asian–Pacific Regional Project for Labour Administration (ARPLA), Bangkok: Thailand, 46p.

Asraf A (1996) On formalisation of Bangladesh economy. In: Asraf A & Kuddus R (eds), Proc. of the development issues of Bangladesh, Dhaka University Press Limited, Dhaka, Bangladesh.

Assenga TJ (1991) Education and training plans for promoting occupational health and safety. African Newsletter on Occupational Heath and Safety (suppl 2): 22–23.

Batino JM (1997) Work improvement in small enterprises (WISE) project in the Philippines. In: Khalid HM (ed), Human Factors Vision–Care for the Future, Proc. of 5th South East Asian Ergonomics Society Conference, International Ergonomics Association Press, p 536–541.

Bangladesh University Press (1990) A study on female garment workers in Bangladesh. Bangladesh Unnayan Parishad (in Bengali), Dhaka, Bangladesh.

Statistical Pocket Book (1998) Statistical Pocket Book of Bangladesh. Government of Bangladesh.

Bangladesh Bank (1998) Yearly Report of the Bangladesh Bank, Government of Bangladesh, Dhaka.

Behrens VJ & Brackhil, RM (1993) Worker awareness of exposure: industries and occupations with low awareness. American Journal of Industrial Medicine 23 (5): 695–701.

BGMEA (2001) Quota monitoring profile [http://www.bgmea.com/quota.htm] of Bangladesh garments manufacturing and exporting association (BGMEA), Dhaka, Bangladesh.

Bimontie A (1995) Environmental awareness training–professional safety. Journal of the American Society of Safety Engineers, p 22–23.

Brown M & Nguyen-Scott N (1992) Evaluating a training for health and safety program. American Journal of Industrial Medicine, 22: 739–749.

BSCIC (1998) Annual Report of Bangladesh Small and Cottage Industries Corporation, Dhaka.

Brayfield AH & Rothe HF (1951) An index of job satisfaction. Journal of Applied Psychology, 35: 307–311.

Cole BL & Brown MP (1996) Action on work site health and safety problems: a follow-up survey of workers participating in a hazardous waste. American Journal of Industrial Medicine, 30: 730–743.

Conferido RD (1997) Low-cost solution to improving Philippine working conditions: is it wise? Environmental Management and Health, 8: 171–172.

Clevenstine E (2002) The CIS—centres network. African Newsletter on Occupational Health and Safety 12 (2): 28–31.

Cullen MR & Harari R (1995) Occupational health research in developing countries—the experience of Ecuador. International Journal of Occupational and Environmental Health 1: 39–46.

Dowlah CAF (ed) (1998) The consequences of the general agreement on trade and tariff (GATT), Proc. of the Uruguay round for the textile and garments sector in Bangladesh. BIDS, Dhaka.

Elgstrand K (1985) Occupational safety and health in developing countries. American Journal of Industrial Medicine, 8: 91–93.

European Commission (1995) Self-Audit Handbook for SMEs. Official publications of the European Union, Luxembourg.

Fariduddin KM, Rahman MM & Ahsanullah AB (1975) Study of energy expenditure and food intake of some working class people of Bangladesh. Bangladesh Medical Research Council Bulletin 1 (1): 24–30.

Faruque FI (1996) Country report on Bangladesh. Proc. of the International Workshop on Management Exchange, Asia Vision-2000, Seoul: South Korea.

Factory Act (1965) The Factory Act--1965. Ministry of Labour & Employment, B'desh Government.

Factory Rules (1979) Revised Factory Rules--1979. Ministry of Labour & Employment, Government of Bangladesh, Dhaka, Bangladesh.

Fernau CN (1981) The use of photographs in workers' education. Geneva: International Labour Office, 2nd Impression, 110p.

Findlay C (1995) A university perspective on training and education in occupational health and safety. Asian-Pacific Newsletter on Occupational Health and Safety 2 (3): 80–81.

Gold D (1995) Training and education in occupational safety and health in Asia-Pacific region. Asian-Pacific Newsletter on Occupational Health and Safety 2 (3): 65–68.

Goldstein G, Holmer R & Fingerhut M (2001) The WHO-global strategy on occupational health and safety. Asian-Pacific Newsletter on Occupational Health and Safety 8 (3): 52–56.

Harun AR, Kabir MH & Mollah AH (1994) An evaluation of workshop approach in research and manpower development. Bangladesh Medical Research Council Bulletin, 20: 36–42.

Holkeri H (2001) Globalisation and its effect on occupational health and safety. Asian-Pacific Newsletter on Occupational Health and Safety 8 (3): 51–51.

Hossain MA (1996) Human resources development—Bangladesh perspective. Proc. of the Annual Paper Meet Conference [Chittagong: 31 Oct—02 Nov], Mechanical Engineering Division, The Institute of Engineers, Bangladesh, p 1–6.

ILO (1981) Occupational Safety and Health Convention (no—155). Geneva: International Labour Organisation, Switzerland.

ILO (1985) Occupational Health Services Convention (no—161). Geneva: International Labour Organisation, Switzerland.

ILO (1990) Bangladesh women: an improved technology project. Report no—BGD/89/MO3/NOR, Geneva: International Labour Organisation.

ILO (1999) Proc. of the 15th World Congress on Occupational Safety and Health, São Paulo: Brazil (12–16 April), Geneva: International Labour Office.

ILO (2001) Guidelines on occupational safety and health management systems. Online: [www.ilo.org/public/english/protection/safework/management/guide.htm].

Information Booklet Series No-25 (1996) Assessing Working Conditions—the European practice. European foundation for the improvement of living and working conditions, Official Publications of the European Communities, 126p.

Inspection Manual (1986) Guidelines for the Inspectors of Factories. Department of Inspection for Factories and Establishments (DIFE), The Government of Bangladesh, Dhaka: Bangladesh.

ISO-8996 (1989) Ergonomics—determination of metabolic heat production. International Organisation for Standaisation, Geneva: Switzerland.

Jahan R (1989) Women workers in garments industry. Journal of Political Economy, 9 (3).

Jafry T & O'Neill DH (2000) The application of ergonomics in rural development: a review. Applied Ergonomics, 31: 263–268.

Johnston JJ, Cattledge GT & Collins JW (1994) The efficacy of training for occupational injury control. Occupational Medicine: State of the Art Reviews 9 (2): 147–158.

Khaleque A (1991) Effects of diurnal and seasonal sleep deficiency on work effort and fatigue of shift workers. International Archives of Occupational and Environmental Health, 62: 591–593.

Khaleque A (1994) Performance and job satisfaction in short cycle repetitive work. In: Sell RG and Shipley P (eds), Proc. of the international conference on Satisfaction in Work Design, London: Taylor & Francis, p 95–100.

Khaleque A & Pervin N (1994) Perceived effort, fatigue and health of male and female shift workers. In: Aghazadeh F (ed), Advances of Industrial Ergonomics and Safety–VI, p 217–221.

Khamis MM (1992) Occupational health services and the role of factory Inspectorate. African Newsletter on Occupational Heath and Safety 2 (2): 58–61.

Khan M (1988) (ed) Labour administration: profile on Bangladesh. Asia—Pacific Labour Administration, Geneva: International Labour Office, 118p.

Khan A (1992) Peoples participation in rural development: some important questions and issues. The Journal of Rural development 22 (1): 63–68.

Khan MR (1994) Sickness, disease, treatment and medical costs by socio-economic variables in Bangladesh. Bangladesh Institute of Development Studies, Research Monograph-15, 279p.

Khan Z (1997) Musculoskeletal problems of female garments worker in Bangladesh: some anthropometrics. Unpublished Masters Thesis, Department of Human Work Science, Luleå University of Technology, Luleå: Sweden.

Khan MA (2000) Health and living conditions of child labourers: a study in Dhaka city. Masters' Thesis, Department of Geography, Norwegian University of Science and Technology, Trondheim: Norway.

Kassler R (1989) The use of sound for workers' education. Geneva: International Labour Office, 2nd Impression, 121p.

Kassler R (1990) Projection arrangements and overhead projector. Geneva: International Labour Office, Switzerland.

Kawakami T, Batino JM & Chai TT (1999) Ergonomic strategies for improving working conditions in some developing countries in Asia. Industrial Health, 37: 187–198.

Kogi K (1985) Improving working conditions in small enterprises in developing Asia. Geneva: International Labour Office, 158p.

Kogi K & Sen RN (1987) Third world ergonomics. In: Oborne DJ (ed), International Reviews of Ergonomics, London: Taylor & Francis, 1: 77–118.

Kogi K, Phoon WO & Thurman JE (1989) Low-cost ways of improving working conditions: 100 examples from Asia. Geneva: International Labour Office, 179p.

Kogi K (1991) Supporting tools for participatory workplace improvement in small enterprise in developing countries. In: Queinnec Y and Daniellou F (eds), Proc. of the 11th International Ergonomics Association, Designing for Everyone, p 1682–1682.

Kogi K (1995) Participatory approach in occupational safety and health training. Asian-Pacific Newsletter on Occupational Health and Safety 2 (3): 70–73.

Kogi K (1996) Participatory action training for workplace improvements in small enterprises in developing countries. Environmental Sciences, 4 (suppl): 123–133.

Kogi K (1997) Low-cost ergonomics solutions in small-scale industries in the developing countries. Asian–Pacific Newsletter on Occupational Health and Safety, 4: 68–70.

Kogi K & Kawakami T (1997) Current research on ergonomics. Environmental Management and Health, 8: 188–190.

Kogi K (1998) Collaborative field research and training in occupational health and ergonomics. International Journal of Occupational and Environmental Health, 4: 189–195.

Kogi K, Kawakami T, Itani T & Batino M (1999) Low-cost improvement that can reduce the risk of musculoskeletal disorders. In: Straker L, Pullock S & Smith R (eds), Proc. of the 2nd International Cyberspace Conference on Ergonomics. [Available, Online: cyberg.curtin.edu.au/members/papers/45s.html].

Kromhout H (1999) Occupational hygiene in developing countries: something to talk about? Annals of Occupational Hygiene 43 (8): 501–503.

Kromhout H & Vermeulen R (2000) Long-term trends in occupational exposure: are they real? What causes them? What shall we do with them? Annals of Occupational Hygiene 44 (5): 325–327.

Kuorinka I (1983) Work capacity with respect to tropical climate and diseases. In: Shahnavaz H and Babri M (eds), In: Proc. of the International Conference on Ergonomics on Developing Countries (Luleå: Sweden), p 77–85.

Kuorinka, I (1993) Trends in manual material handling with respect to occupational safety and health In: Marras WS et al. (eds), Proc. of the international conference on Ergonomics of Manual Work, Taylor & Francis, p 9–10.

Laflamme L (1993) Technological improvement of the production process and accidents: an equivocal relationship. Safety Science 16 (3): 249–266.

Lasker MS, Harada N & Rashid HA (1999) The present state and future prospects of occupational health in Bangladesh. Industrial Health 37 (1): 116–121.

LaDou J & Jeyaratnam J (1994) Transfer of hazardous industries: issue and solutions. In: Jeyaratnam J & Chia KS (eds), Occupational health in national development, Singapore: World Scientific Publishing Co Pte Ltd.

Leamon TB (2001) The future of occupational safety and health. International Journal of Occupational Safety and Ergonomics 7 (4): 403–408.

Lehtinen S (2002) Information networking: a tool for productive collaboration in the globalized world. African Newsletter on Occupational Health and Safety 12 (2): 27–27.

Leichnitz, K (2001) External relations of the EU (European Union)— a global commitment, globalisation and its effect on occupational health and safety. Asian-Pacific Newsletter on Occupational Health and Safety 8 (3): 60–61.

Lukindo JK (1991) Focus on the factory Inspectorate: challenges and prospects in the 1990s. African Newsletter on Occupational Heath and Safety, (suppl 2): 11–14.

Lovell CH & Fatema K (1989) The BRAC non-formal primary education programs in Bangladesh. Bangladesh Rural Advancement Committee (BRAC), Dhaka: Bangladesh.

Labour Force Survey (1995) Labour Force Survey—1995. Ministry of Planning Commission, Government of Bangladesh, Dhaka.

Majumder PP & Chowdhury S (1992) Poshak Shilpa Niojito Narisramik Samajik Nirapattahinotar Gati Prokiti (in Bengali). Mashik Chinta, 14th Edition (March 1992), p 18–21.

Majumder PP & Begum S (1997) Upward occupational mobility among female workers in the garment industry of Bangladesh. Research Report No 153, Bangladesh Institute of Development Studies (BIDS), Dhaka, 58p.

Manuaba A (1979) Choices of technology and working conditions in rural area. In: ILO seminar on technology to improve working conditions in Asia, Geneva: International labour Office.

Manuaba A (2001) Impacts of globalisation on working conditions and the environment —an Asian perspectives. Asian-Pacific Newsletter on Occupational Health and Safety 8 (3): 62–63.

Martino VDi (1995) Improving productivity by means of better working conditions. African Newsletter on Occupational Health and Safety 5 (2): 28– 29.

Malchaire J, Gebhardt HJ & Piette A (1999) Strategy for evaluation and prevention of risk due to work in thermal environments. The Annals of Occupational Hygiene, 43: 367–376.

Mamansari DU & Salokhe VM (1996) Static strength and physical work capacity of agricultural labourers in the plain land of Thailand. Applied Ergonomics 27 (1): 53–60.

Maqtada M & Islam R (1986) Bangladesh: selected issues in employment and development. Asian Employment Programs. In: Proc. of the International Conference on Regional Development, New Delhi: India.

Ministry of Labour & Employment (1996) Yearbook of Labour Statistics. Dhaka: Bangladesh.

Mongoni JM (1996) Heavy physical work in Kenya. African Newsletter on Occupational Heath and Safety 6 (2): 105–107.

Murray C & Lopez A (eds) (1996) The Global Burden of Disease. Harvard University Press.

Mukherjee S, Overman L, Leviton L & Hilyer B (2000) Evaluation of worker safety and health training. American Journal of Industrial Medicine, 38: 155–163.

Mwaniki NK (1992) Obstacles to the development of occupational health services in developing countries. African Newsletter on Occupational Health and Safety 2 (suppl 2): 21–27.

NIOSH (1999) A model for research on training effectiveness. United States Department of Health and Human Services, Washington DC:National Institute for Occupational Safety & Health.

NIPSOM (1999) Musculoskeletal disorders among the garment workers. In: Ahmad SkA, Elias M, Khan AW & Hadi SkA (eds), National Institute of Preventive and Social Medicine (NIPSOM), Final Report (Mohakhali: Dhaka), Bangladesh, 30p.

Noro K & Imada A (eds) (1991) Participatory Ergonomics. London: Taylor & Francis.

Oxenburgh M (1991) Increasing productivity and profit through health and safety. CCH-Australia Limited, North Ryde: Australia.

Phoon WO (1976) Application of ergonomic principles in the factories of a developing countries. Journal of Human Ergology, 5: 161–166.

Phoon WO (2001) Impacts of globalisation on small enterprises and the informal sector. Asian-Pacific Newsletter on Occupational Health and Safety 8 (3): 64–65.

Pandita S (2001) India—Health and safety at work. Asian Labour Update, 39 (April-June): 15–17.

Paurashava Ordinance (1977) Laws relating to protection of environmental health of Bangladesh. Ministry of Local Government, Dhaka: Bangladesh.

Packalen L & Odoi F (1999) Comics with an attitudes–a guide to the use of comics in development information. Ministry for Foreign Affairs (FINNIDA), Helsinki: Finland 96p.

Partanen TJ (1996) Improving the work environment by means of risk surveys. African Newsletter on Occupational Health and Safety, 6: 28–29.

Partanen TJ, Hogstedt C, Ahasan MR, Aragon A, Arroyave ME, Jeyaratnam J, Kurppa K, Loewenson R, Lundberg I, Ngowi AVF, Mbakaya CFL, Stayner L, Steenland K, Weiderpass E & Wesseling C (1999) Collaboration between developing and developed countries and between developing counties in occupational health research and surveillance. Scandinavian Journal of Work Environment and Health 25 (3): 296–300.

Quddus R (1996) Training programs in Bangladesh—country news. African Newsletter on Occupational Health and Safety, 6 (2).

Rahman F, Anderssen & Syanstrom L (2000) Potential of using existing injury information for injury surveillance at the local level in developing countries: experiences from Bangladesh. Public Health 114 (2): 133–136.

Rahman RI (1986) The wage employment market for rural women in Bangladesh. Bangladesh Institute of Development Studies (Research Monograph—6), Dhaka: Bangladesh, 97p.

Rahman M, Laz TH & Fukui T (1999) Health related research in Bangladesh: MEDLINE based analysis. Journal of Epidemiology 9 (4): 235–239.

Rahman RI (1993) Occupational mobility among women in manufacturing industries of Dhaka city: findings from an enterprise level survey. ILO/ARTEP: Delhi, India.

Rahaman MM, Tarafder MAI & Ahmad SAA (1991) A study on disease pattern among the workers of a paper mill in Bangladesh. Journal of Preventive and Social Medicine, 10: 62–65.

Raihan A (1997) Ergonomics approaches in industrilisation of developing countries: a case study in

Bangladesh. In: Seppalä P, Luopajärvi T, Nygård C-H & Mattila M (eds), From Experience to Innovation, Finnish Institute of Occupational Health, vol 7: 148–150.

Rantanen JE (1989) Occupational health and safety research: current status and priorities. East African Newsletter on Occupational Health and Safety, 3 (suppl): 51–52.

Rantanen JE (1994) Research in the prevention of work-related diseases Työterveiset, 3: 21–24.

Saarela KL (1985) Methods of hazard analysis applied in the light metal industry. Scandinavian Journal of Work Environment and Health 9 (2): 136–139.

Saarela KL (1991) Promoting safety in industry: focus on informational campaign and participatory programs. Doctoral Thesis, Industrial Psychology Lab, Helsinki University of Technology.

Sadeque S, Ahasan MR & Uddin Z (1997a) The second half: socio-economic status and development perspective of rural women workers in Bangladesh. Journal of Rural Development 27 (2): 59–76.

Sadeque S, Ahasan MR, Khaleque A & Uddin Z (1997b) Psychosocial problems of female workers in garment factory. In: Seppalä P, Luopajärvi T, Nygård C-H & Mattila M (eds), Finnish Institute of Occupational Health, vol 7: 533–536.

Sadeque S, Ahasan MR & Uddin Z (1998) Health, nutrition and population program in rural Bangladesh (in: abstracts). Paper presented in the international conference of Open Care, Oulu Deaconess Institute, Finland, p 26–26.

Sakari WDO (1995) Prerequisites for successful health and safety measures. African Newsletter on Occupational Health and Safety, 5: 51–51.

Salahuddin K & Shamim I (1992) Women in urban informal sector—employment pattern activity types and problems. Women for Women, Trade Vision Ltd, Dhaka: Bangladesh.

Salim R (1995) Migration and Bangladesh's economic development—thoughts and initiatives. Journal of Bangladesh Studies 2 (2): 23–52.

Schuster L (1995) South Africa finds low-cost ergonomics solutions: REPRINT from safety and health. African Newsletter on Occupational Health and Safety 5 (3): 62–63.

Sen RN (1965) Physical environmental factors affecting health of workers in industry. Indian Labour Journal, 6: 735–746.

Sen RN (1979) Ergonomics science and technology of man at work its role in our national development. Proc. of the 66th Session of the Indian Science Congress, p 53–77.

Sekimpi DK (1992) Surveillance of the general health situation of workers. African Newsletter on Occupational Heath and Safety 2 (2): 55–57.

Sekimpi DK (1993) Changes in the social culture of work in Africa: implications of occupational health and safety. African Newsletter on Occupational Health and Safety, 3: 66–68.

Shahab S (1998) Development and implementation of an occupational safety and health management programs for the small and medium-sized, indigenous, privately owned enterprise in Pakistan. Applied Occupational and Environmental Hygiene, p 811–816.

Shahnavaz H, Abeysekera JDA & Chapman L (1990) Ergonomics education and training for students from industrially developing countries. Proc. of the Annual International Industrial Ergonomics and Safety Conference (10–13th June), Montreal: Canada.

Singer E & Endreny O (1987) Reporting hazards: their benefits and costs. Journal of Communication 37 (3): 10–26.

Takala J (1991) Trends of national legislation on safety and health based on ILO--Conventions and recommendations. African Newsletter on Occupational Heath and Safety, (suppl 2): 44–56.

Takala J (1992) Safety and health information systems: analysis of local, national and global methods. Doctoral Thesis, Publication no—109, Tampere University of Technology, Finland.

Takala J (1999) International agency efforts to protect workers and the environment. International Journal of Occupational and Environmental Health 5 (1): 30–37.

Takala J (2000) Safe work—the global program on safety, health and the environment. Asian-Pacific Newsletter on Occupational Health and Safety, 7: 4–8.

Tornberg VP, Lauwo CN & Kitunga LJ (1996) WISE follow-up case study: metal products. African Newsletter on Occupational Health and Safety, 6: 47–49.

Tornberg VP (1996) Ergonomic principles in solving problems of heavy physical work. African Newsletter on Occupational Heath and Safety 6 (2): 108–111 .

World Bank (1988) Evaluation Report on BRAC Schools, World Bank Office, Paribagh, Dhaka.

World Bank (1990) Bangladesh: strategies for enhancing the role of women in economic development. The World Bank, Washington DC: USA.

World Bank (1995) Workers in an integrating world—World Development Report, New York: Oxford University Press, USA.

World Bank (1999) Key challenges for the next millennium. The World Bank, Dhaka: Bangladesh.

World Bank (2000) World Bank report on education in Bangladesh. World Bank Office, Dhaka.

WHO (1995) Global strategy on occupational health for all—the way to health at work. Document no VMO/OCH/951, Geneva: World Health Organisation.

Zalk DM (2001) Grassroots ergonomics: initiating an ergonomics program utilising participatory techniques. The Annals of Occupational Hygiene 45 (4): 283–289.

Zohir SC & Majumder K (1996a) Occupational health of garments workers in Bangladesh. Unpublished Report, Bangladesh Institute of Development Studies (BIDS), Dhaka.

Zohir SC & Majumder PP (1996b) Garment workers in Bangladesh: economic, social and health condition. Research Monograph No 18, Bangladesh Institute of Development Studies.

Zohar D (1980) Safety climate in industrial organisations: theoretical and applied implications. Journal of Applied Psychology, 65: 96–102.

Westlander G (1993) General strategies for conducting intervention study. In: Nielsen R & Jorgensen K (eds), Advances of Industrial Ergonomics and Safety–V, Taylor & Francis, p 97–105.

Wisner A (1989) Variety of physical characteristics in industrially developing countries—ergonomic consequences. International Journal of Industrial Ergonomics, 4: 117–138.

Wisner A (1995) The irruption of new technology: a new challenge for ergonomics and anthropo-technology. Journal of Human Ergology, 24: 45–55.

Yuk-lun Y & Wah-shing T (1995) Promoting occupational safety and health through training, education and information. Asian-Pacific Newsletter on Occupational Health and Safety 2 (3): 78–79.