

## INDONESIA ERGONOMICS ROADMAP: WHERE WE ARE GOING?

SRITOMO WIGNJOSOE BROTO\*

*Ergonomics and Work System Design Laboratory, Industrial Engineering Department,  
Institut Teknologi Sepuluh Nopember Kampus ITS Sukolilo, Surabaya 60111, Indonesia*

*\*Email: msritomo@rad.net.id*

There are so many definitions for ergonomics terms such as human factors, human factors engineering, human engineering, human factors psychology, engineering psychology, applied ergonomics, occupational ergonomics, industrial ergonomics and industrial engineering. The most inclusive terms are ergonomics and human factors. Both represent the study of work and the interaction between people and their work environmental systems. The main objective is especially fitting with the need to design, develop, implement and evaluate human-machine and environment systems that are productive, comfortable, safe and satisfying to use. The work of the ergonomists in Indonesia - most of them are academicians - have one thing in common, i.e. with the appropriate type of ergonomic approaches to interventions; there would be improvements in productivity, quality of working conditions, occupational safety and health (OSH), costs reduction, better environment, and increase in profits. So many researches, training, seminars and socialization about ergonomics and OSH have been done concerning micro-to-macro themes; but it seems that we are practically still running at the same place up to now. In facts, workers are still working using their traditional or obsolete methods in poor working conditions. Accidents are still happening inside and outside industry with the main root-cause being human "unsafe behavior" and errors. Industrial products cannot compete in the global market, and so many manufacturing industries collapsed or relocated to foreign countries. This paper discusses such a roadmap and review what we ergonomists in Indonesia have done and where we are going to? This review will be treated in the field of ergonomics and OSH to take care the future Indonesia challenges. Some of the challenges faced are care for the workers, care for the people, care for the quality and productivity of work, care for the new advanced technologies, care for the environment, and last but not least care for the nation.

**Key words:** Indonesia; ergonomics; roadmap; future challenges; occupational safety and health.

### INTRODUCTION

Between the 1970s and the 1990s, the Indonesian economy has been transforming from an agriculture-based to an industry-based economy; a process which is often called "industrialization". Indonesia is a country which mostly has natural resources and unskilled labor. According to this condition, Indonesia has been gaining most in the industries based on these factors of production, the natural resources and unskilled labor. The popular indicators to show the industrialization process are the share of manufacturing industry value-added in GDP, and the share of manufacturing exports in total exports.

In 1970, the manufacturing industry value-added accounted for only 7.5 % of the GDP, while the agriculture sector contributed more than 35% of the GDP. Then the share of manufacturing industry in the GDP increase doubled in the 1990s. And in the 1990s, prior to the economic crisis, the share of manufacturing industry continued to increase to more than 20%, exceeding the share of agri-

culture in GDP. In the composition of exports, the share of manufacturing industry also grew from only three percent in the 1970s to almost 60 percent in the 1990s. Although Indonesia has experienced the industrialization process, the level of industrialization is still relatively low compared with that in other Asian countries. The industrialization development grew significantly until the 1990s, and then the economic crisis had an immediate impact of significant decline in manufacturing output and exports in the mid-1990s. This situation is called “deindustrialization”. Despite the crisis, the economy is now on the path to recovery; and the country’s industrial competitiveness remains unchanged in general, but there are several changes in the pattern of industrial competitiveness.

Why does Indonesia still lag behind in industrial competitiveness? Based on the World Competitiveness Report in 2005, Indonesia ranked 74th out of 117 countries. Asian countries such as Malaysia, Thailand, India, South Korea, Japan, etc. are ranked higher and topped the list in terms of competitiveness and also national productivity. Between 1980 and 1990, the catch-up adjustment stagnated; relative productivity remained unchanged despite considerable productivity growth in Indonesia. Comparisons with other Asian economies show that labor productivity in Indonesia was somewhat higher than that in India, but was still lower in 1990 than that of South Korea in 1970.

We have all recognized the importance of productivity in national development and are seeking various avenues to increase productivity in all sectors. Productivity growth is the key for improving competitiveness, economic growth and prosperity. Productivity is a measure of a nation's efficiency in producing goods and services measured by the size of output relative to inputs. Productivity growth occurs when additions to output rise relative to changes in inputs and is dependent upon the complex interplay of a wide variety of factors. The level of productivity varies not only between nations, but also varies across sectors, industries and individual enterprises. Productivity differences result from varying levels of worker skills and education as well as differences in inputs of capital and technology but are also crucially affected by organization, managerial skills and performance of institutions. The weakened industrial competitiveness and improvement in productivity are the most important issue, which would correlate with the development of the ergonomics discipline.

#### *Industrial ergonomics, productivity and competitiveness*

Ergonomics actually impacts our everyday life, from the home and especially to the industrial workplace. We describe ergonomics as designing products, work facilities and workplaces to increase the effectiveness, efficiency and productivity of the worker, and, more importantly, to improve the worker's safety and health. There are so many definitions for ergonomics terms such as human factors, human factors engineering, human engineering, human factors psychology, engineering psychology, applied ergonomics, occupational ergonomics, industrial ergonomics and industrial engineering. The most inclusive terms are ergonomics and/or human factors. Both represent the study of work and the interaction between people and their work environmental systems. The main objective is especially fitting with the need to design, develop, implement and evaluate human-machine and environment systems that are productive, comfortable, safe and satisfying to use.

According to the International Ergonomics Association, ergonomics is defined as a science that applies knowledge of human physical and mental abilities to the design of products, processes, workplaces and complex human-technology (and also environment) interaction. The simple definition of ergonomics is the study of work, which is associated with human psychology and physical work. Looking at how ergonomics impacts the workplace, future ergonomists could contribute to the design and assessment of workplaces across the country. Many ergonomists typically focus on the evaluation and design of workplaces, where both the physical (such as lifting, repetitive motion, lighting, noise and energy consumption) and the cognitive (such as perception, attention, decision making, etc.) would operate. Preventing eyestrains, headaches and musculoskeletal disorders and obtaining optimal performance can be achieved when equipment, workstations, products and working methods are designed according to human capabilities and limitations, that is by applying the principles of ergonomics. Ignoring these basic principles of ergonomics will cause many problems such as injuries and occupational diseases, increased absenteeism, higher medical and insurance costs, increased

probability of accidents and errors, higher turnover of workers, less production output, lawsuits, low quality of work, less spare capacity to deal with emergencies, etc.

The adoption of an ergonomic approach in the workplace (industries) has a proven track record. Indeed, an ergonomics study of people-powered farming tools (e.g. axes, sickles, scythes, etc.) in the agricultural era reveals changes over time that reflect the work system development cycle. Moreover, the changes are continuous until the development of machine-powered and computerized machine-controlled equipment in the era of industrialization and information technologies. The ergonomics principles could also be applied in micro-scale (man-machine system) as well as in macro-scale (industrial organization) focusing on human factors at different levels. Ergonomics principles advocated by many studies thus led to a new paradigm and useful tools for safe and productive technology. Moreover, they developed standards, recommendations, procedures, etc. concerning working conditions and occupational, health and safety (OHS) to improve productivity, competitiveness and quality of work life.

Industry should be specially treated in the field of ergonomics because of their need to apply ergonomics in their work. They face many problems, such as poor quality, low productivity, health and safety problems of workers and high rejection costs because of so many waste or unproductive activities (idling, delay, materials handling, accidents, etc.). These problems are mostly caused by the lack of ergonomic workstation design, machine and tools design, products design, work processes and work environment. Many ergonomic researchers and organizations attempted to fulfill the needs of the industry by promoting the use of ergonomics to solve their problems. Their work is reviewed, presented and discussed in so many seminars and other scientific forums. Some cases are not only beneficial for promoting academic degrees, but also implemented as real means of problem solving from the industrial ergonomics viewpoints.

Ergonomics was a new and emerging field in the Indonesian industries and was a useful tool for safe and productive technology transfer from the industrially advanced countries. It should be noted that the standards, recommendations, procedures, etc. concerning working conditions and occupational health and safety (OHS) developed in the industrially advanced countries would not be fully applied because of the differences in climate, people (anthropometric measurements, cultures), methods of work, facilities, infrastructures of technology, finance, etc. The education and training are essential in creating ergonomics and OHS awareness and motivating employees to utilize their creative problem-solving capacities. Hopefully, these will continue to help Indonesia industries in tackling low productivity, lack of quality and OHS problems.

#### *Ergonomics movement and socialization in Indonesia*

In Indonesia, ergonomics as a discipline of science is still new. The term of ergonomics is often confused with agronomy or economy. Some definitions have been developed based on their field of interest. Mostly, ergonomics is simply defined as designing around a comfortable chair. Others try to relate it with healthy and safe work, human factors in product design, man-machine systems, motion and time study, productivity improvement, etc. As a science, ergonomics is taught explicitly in engineering, medical or psychology courses by different names but with the same substance. Ergonomics was introduced in Indonesia many decades ago by academicians and the local universities, industries and the government.

Furthermore, the ergonomics movement came from academicians from abroad who worked in some Indonesian universities. Ergonomics courses are given especially in the curriculum of industrial engineering departments, e.g. applied ergonomics, industrial ergonomics, work design and measurement, facilities design and layout, safety engineering and management, human factors engineering in product design; and macro-ergonomics such as industrial organization, TQM, productivity analysis, performance measurement, supply chains management, etc. These departments conducted ergonomics research and courses in the engineering and management undergraduate and postgraduate programs; and also conducted seminars, workshops and conferences and did consultancy with the local industries. They already developed a network with other disciplines not only in the field of engineer-

ing such as engineering physics, architecture, mechanical engineering, environmental sciences, informatics, etc.; but also outside engineering such as industrial product design, agricultural technologies, psychology, medical sciences, public health, etc.

Ergonomics and OHS are also practiced mostly in industrial large companies, such as Toyota Astra Motors, IPTN, etc., where there are manufacturing technology (and also management) transfers from their parent companies in industrially advanced countries such as Japan, The United States, Germany and other countries. Some chemical and mining industries such as petrochemicals, cements, oil and gas industries, are particularly concerned with occupational health and safety. The ergonomics and OHS awareness or movement actually came from the top management of the multinational companies or from the industrially advanced industries. They could see the benefits of ergonomics in terms of improving productivity, quality and OHS of the workers when it was practiced in their own countries, thus they encouraged the local firms to adopt ergonomics. However, because of the limited education or training courses in the field of ergonomics, most local engineers and managers in many industries are not aware of ergonomics and OHS.

For that reason, Perhimpunan Ergonomi Indonesia (Indonesia Ergonomics Association) was officially established by national ergonomists meeting on October 10, 1987 in Institut Teknologi Bandung (ITB) with the mission of providing education, research and consultancy on ergonomics application for enhancing productivity and quality of work life. Perhimpunan Ergonomi Indonesia (PEI) was particularly developed for organizing academicians, researchers, industrial practitioners, and professionals to implement the ergonomics methods and approaches in the area of micro- or macro-ergonomics. PEI programs include conducting joint research programs, development of ergonomics curriculum and standardization of laboratories in higher education, organizing seminars or workshops (national/international) periodically, development of cultural and national ergonomic standards (e.g. anthropometry) and socialization and publication schemes to promote ergonomics and OHS.

#### *Indonesia Ergonomics Roadmap: where we are going?*

The following information will give a brief chronological description for some ergonomics activities which are sponsored by PEI in around two decades (1987–2006). In the first decade (1987–1996), Perhimpunan Ergonomi Indonesia (PEI) did not organize many activities such as seminars, training, consultancy, etc. As a professional organization, PEI is so dependent on its members mostly with academy backgrounds. The main problem is that not so many disciplines offer ergonomics courses in their curriculum. Ergonomics is not a unique specialization in engineering, psychology and/or probably medical sciences. Many engineers also have wrong perception of ergonomics. In spite of industrial engineering, ergonomics is not looked on as an important and significant course to develop engineering or managerial careers. Most engineers have a strong perception that engineering should deal with mathematics formula, physical phenomena (material, machine and equipment) and manufacturing processes and is not related with human interactions with machinery. On the other hand, there were too few ergonomics scientists - commonly called as *ergonomists* - able to promote and socialize ergonomics as a relevant course for improving productivity and quality of work life in industry.

Although in the first decade, the association (PEI) was not formally organized and did not function well; but in the last years of the 1990s the situation changed. In accordance with the global issue of industrial competitiveness and the increasing environmental awareness, a national ergonomics seminar and conference was held on September 6-7, 2000 in Surabaya. The theme of the seminar was Industrial Ergonomics Role to Increase Global Competitiveness for Entering the Era Third Millennium. This seminar was organized by PEI jointly with the Laboratory of Ergonomics and Work System Design, Department of Industrial Engineering of ITS in Surabaya. At the same moment, a conference was also held to rejuvenate and revitalize the organization of Perhimpunan Ergonomi Indonesia (PEI).

In the second decade (1987-2006), PEI organized and sponsored many activities such as semi-

nars, symposia and other scientific forums. Almost every year we held an ergonomics seminar, symposium or workshop arranged in the national or international scope to give a chance for Indonesian ergonomists to present their research results; sharing experience, knowledge and how to implement methods or ergonomics approaches to solve industrial problems. Some important seminars sponsored by PEI in the last three years may be mentioned as follows:

- National Seminar on Ergonomics: “The Role of Ergonomics Discipline in order to Strengthen Small-Scale Traditional Industry and Tourism”. It was conducted on September 13, 2003 and organized by the Faculty of Agriculture Technology Gajah Mada University in Yogyakarta. More than 70 research papers were presented and published.

- National Seminar on Applied Ergonomics in Industry: The Role of Ergonomics to Support Industrial Processes in Effort to Improve Productivity and Quality. This seminar was performed on March 27, 2004 in Yogyakarta and organized by Industrial Engineering Forum of Yogyakarta and Industrial Engineering Department of Universitas Pembangunan Nasional (UPN) in Yogyakarta. Almost 115 papers were presented in this forum.

- National Seminar on Ergonomics 2: Ergonomics and Its Roles on Industrial Development in Indonesia. It was arranged on October 9, 2004 in Yogyakarta; and again organized by the Faculty of Agriculture Technology, Gajah Mada University in Yogyakarta. About 80 research papers were presented in this seminar.

- Joint Conference of the South-East Asia Ergonomics Society and the Indonesian Physiological Society (SEAES-IPS 2005): International Seminars and Conference on Ergonomics “Bridging the Gap” held from May 23-25, 2005 in Denpasar, Bali. This was a joint meeting of the 8th South-East Asia Ergonomics Society (SEAES) Conference and the 12th National Congress and 15th Scientific Seminar of the Indonesian Physiological Society. The theme “Bridging the Gap” called for closer cooperation and better networking between various disciplines in meeting the goals of the conference. The international conference and seminars were organized by the Postgraduate Program on Ergonomics and Sport Physiology, School of Medicine, Udayana University in cooperation with the International Ergonomics Association and the South-East Asia Ergonomics Society (SEAES). There were more than 200 research papers presented by academicians, experts, professionals, etc. from the main disciplines of ergonomics and physiology.

- National Seminar on Human-Computer Interaction: Human Aspects in Computer-Based System. This seminar was organized by the Laboratory of Work System Design and Ergonomics, Department of Industrial Engineering, ITB and held on September 21-22, 2005 in Bandung. More than 20 papers were selected and presented; they discussed the influence of computers, multimedia and information technology on human work.

- National Seminar on Ergonomics 2006 – Human Factors Engineering and Productivity. This seminar was arranged on June 14-15, 2006 in Bandung, and managed by Perhimpunan Ergonomi Indonesia (PEI) and the Laboratory of Ergonomics, Industrial Engineering Department of ITB.

- National Seminar on Ergonomics and OSH - The Role of Ergonomics and OSH for Enhancing Productivity and Quality of Work. This seminar was conducted on July 29-30, 2006 in Surabaya and presented more than 120 research papers dealing with many topics from micro- to macro-ergonomics. Beside the seminar, a workshop on OHS Management was also conducted. Both activities were organized by the Laboratory of Ergonomics and Work System Design, Industrial Engineering Department of ITS.

- Ergo Future 2006 - International Symposium on Past, Present and Future Ergonomics, Occupational Safety and Health. This symposium was organized on August 28-30, 2006 in Denpasar, Bali and by the School of Medicine, Udayana University.

- National Seminar on Macro Ergonomics’ Approach for Improving Organization Performance; and Workshop on Mannequin in Catia and 3D-Max for Ergonomics Analysis and Product Design. This seminar was held on November 21-22, 2006 in Jakarta and organized by the Industrial Engineering Department of Trisakti University, the Industrial Engineering Department of Tarumanegara University and the Product Design Department of Trisakti University.

These seminars have contributed to the review of such a roadmap involving the work of Indonesian ergonomists from many different disciplines and institutions. Their work has one thing in common; i.e., with the appropriate types of ergonomic interventions, there would be improvements in quality, productivity, working conditions, occupational health and safety (OHS), better environment, reduction of rejects and rejection costs and increase in profit. These experiences will also be treated in the field of ergonomics and OHS to take care the future Indonesia industrial challenges, such as still many wrong perception of ergonomics, the lowly educated and timid nature of the workers (especially who work in home, agricultural or traditional industries), the lack of concern and commitment for OHS and the lenient OHS regulations and other problems. Some of the challenges faced should take care for the worker, care for the people, care for the quality and productivity of work, care for the new advanced technologies, care for the environment, and last but not least care for the nation.

In many cases, Indonesian ergonomists have found that some of the machines or equipment used in industry might not be appropriate to be applied, because of their differences in anthropometric dimensions. These differences have ergonomic consequences on industrial machinery, equipment and tools; e.g. some transferred machinery from the Western countries require excessive physical strength to operate for the workers in Indonesia and other Asian countries. Therefore, the equipment needed to be redesigned or modified to increase effectiveness, efficiency, safety and comfort. The main problem there is still the lack of references to the anthropometric characteristics data of the Indonesian population and the sources of variations.

Most industrial ergonomics engineers did many studies to solve the real ergonomic and OHS problems in industry. Some ergonomic improvements have been planned and most of them were implemented. Moreover, these improvements have increased productivity, as shown by the more effective use of materials, energy costs of work, better work quality and more comfort. Many other studies also found much mismatch between workers and the machinery they were forced to work with, which hampered productivity and caused frictions in the workplaces. Ergonomics has thus been used to solve the problems to increase productivity, maximize product quality, improve usability and enhance job satisfaction of the workers.

Ergonomic problems could be found commonly in traditional industries, especially the areas of agricultural, home or small-scale industries. Many studies have presented the use of ergonomic interventions for various types of agricultural projects (small farming), textile industries, furniture firms, smallholder farming, etc. We have found that with the appropriate types of ergonomic interventions, productivity, safety, quality of the product outputs and the effectiveness of the production system would improve. Production cost could also be minimized. Industrial ergonomic problems are not only found on the production floor, but also at the whole production system. Ergonomic studies are initially focused on the interaction between human-machine or human-workplace environment; and then shifted to devising appropriate responses to social-environmental changes. Many macro-ergonomics studies has been conducted to find the suitable method and approach to solve the industrial problems which are more complex with uncertainties, such as participatory ergonomics, systems approach, SHIP, TQM, supply-chain management, etc.

In Indonesian factories, most of the workers are lowly educated, with only basic six to nine years of school education. Also, most of the factory workers are from the poor. Although ergonomics may be taught to these workers, they are too timid to question the authorities when they are faced with poor OHS conditions, fearing that they may lose their jobs and that it may also mean to lose their future life. The industrial management is generally not concerned with the operators' OHS because cheap labor is in abundance. Some lowly educated workers are also not safety conscious. Many surveys on factory managements reported that their workers refused to wear safety apparatus. When interviewed, these workers reported the inconvenience of wearing the apparatus during doing their tasks. Thus, with these poor attitudes, the ergonomists find a great challenge to change the mind-set of the management or the workers to adopt ergonomics. Enforcing the OHS regulations is difficult, as there are too many companies to audit. Much manpower is needed to audit every compa-

ny at least once a year. Moreover, since auditing is just one observation, many OHS violations may not be found in that single observation. Besides, if the enforcer is too strict, the foreign investors may relocate their factories to other countries. Thus, with these situations, the regulations and their enforcement do not create any urgency for the companies to adopt ergonomics programs and improve the working conditions of the workers.

## CONCLUSION

Although many studies, researches, training, seminars and socialization about ergonomics, human factors and OHS have been done with respect to micro- and macro-ergonomics themes; but it seems that we are practically still running at the same place up to now. In fact, workers are still working with their traditional or obsolete methods and poor conditions. Accidents are still occurring inside and outside industry often with the main root-cause of human unsafe behavior. Industrial products cannot compete in the global market, and so many manufacturing industries collapsed or relocated to foreign countries. Ergonomics analysis and evaluation provide a roadmap for what issues must be addressed and what actions will be needed for improvements.

The successful ergonomics implementations in the national industries, as presented in so many seminar and conference papers, have shown the effectiveness of ergonomics in improving productivity, quality and OHS, increasing profits and reducing rejection costs and industrial accidents. Ergonomics interventions and design innovations can improve global competitiveness as well as enrich prosperity at work, in industry and in the nation. The future management with new mind-set is really needed to start and anticipate the changes in solving the industrial ergonomics problems.

An effective industrial ergonomic program should contain at least two points of reference to ensure successful navigation of the ergonomic terrain. These are management commitment and employee involvement. Without management commitment, most programs fail in a company. For an ergonomics program it is important to tangibly demonstrate that commitment. This can be done by assigning ergonomic and OHS staff directly to the program and providing time during the workday to deal with ergonomic concerns, by establishing clear goals for the program and evaluating the result, by communicating to all stakeholders the importance of the program and finally, by making resources available for the program itself, such as training and tools for implementing improvements. Employee involvement ensures that employees are motivated to take ownership of ergonomics-driven changes. This can easily be accomplished by creating teams to collect input and evaluate and make recommendations on corrective actions for workplace problems.

## REFERENCES

- Hermansyah, M (1999) Proceedings of Symposium and Indonesian Ergonomics Exhibition 2000 (Written in Bahasa Indonesia). Bandung, Indonesia. Technology Business Operation Unit (TBOU), IPTN, Indonesia.
- Khalid, HM (1997) Proceedings of the 5th Southeast Asian Ergonomics Society Conference on Human Factors Vision: Care for the Future. IEA Press, Published in collaboration with UNIMAS, Kuala Lumpur, Malaysia.
- Moroney, WF (1995) The evolution of human engineering; A Selected Review. *In: Research Techniques in Human Engineering*, ed. By Weimer J, Prentice Hall PTR, Englewood Cliffs, NJ.
- Purnomo, H (2004) Proceedings of National Seminar on Ergonomics: Applied Ergonomics in Industry (Written in Bahasa Indonesia). Indonesian Ergonomics Association & Industrial Engineering Communication Forum – Yogyakarta, Yogyakarta.
- Purwanto, Wahyu, et al. (2003) Proceedings of National Seminar on Ergonomics: The Role of Ergonomics Discipline in Order to Strengthening Small-Scale Traditional Industry and Tourism (Written in Bahasa Indonesia). Indonesia Ergonomics Association and Faculty of Agriculture Technology, Gajah Mada University, Yogyakarta, Indonesia.
- Purwanto, Wahyu, et al. (2004) Proceeding of 2nd National Seminar on Ergonomics (Written in Bahasa Indonesia). Indonesia Ergonomics Association and Faculty of Agriculture Technology, Gajah Mada University, Yogyakarta, Indonesia.
- Wignjosoebroto, Sritomo et al. (2000) Proceeding of National Seminar on Ergonomics: Industrial Ergonomics Role to Increase

Global Competitiveness for Entering the Era 3rd Millenium. Indonesia Ergonomics Association and Laboratory of Ergonomics & Work System Design of Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia.

Wignjosoebroto, Sritomo et al. (2006) Proceeding of National Seminar on Ergonomics & OSH - The Role of Ergonomics and OSH for Enhancing Productivity and Quality of Work. Indonesia Ergonomics Association and Laboratory of Ergonomics & Work System Design - Industrial Engineering Department of Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia.

Yeow, PHP, and SEN, RN (2002) The Promoters of ergonomics in Industrially Developing Countries, Their Work and Challenges. <http://cyberg.wits.ac.za/cyberg/sessiondocs/symposia/ide/ide2/ide2.htm>