



# Ergonomics and sustainable development in the past two decades (1992–2011): Research trends and how ergonomics can contribute to sustainable development



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## ABSTRACT

The need for sustainable development has been widely recognized and sustainable development has become a hot topic of various disciplines even though the role of ergonomics in it is seldom reported or considered. This study conducts a systematic survey of research publications in the fields of ergonomics and sustainable development over the past two decades (1992–2011), in order to identify their research trends and convergent areas where ergonomics can play an important role in sustainable development. The results show that ‘methods and techniques’, ‘human characteristics’, ‘work design and organization’, ‘health and safety’ and ‘workplace and equipment design’ are the top five frequently researched areas in ergonomics. Ergonomics has an opportunity to contribute its knowledge especially to ‘industrial and product design’, ‘architecture’, ‘health and safety’ and ‘HCI’ (especially for energy reduction issues) categories of sustainable development. Typical methodologies and general guidance on how to contribute the expertise of ergonomist to sustainable development are also discussed.

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## 1. Introduction

Defined as “meeting the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987), sustainable development has been becoming the center of attention and concerns for researchers as well as practitioners in various fields such as design, engineering and business over the past few decades (Barbier, 1987; Lele, 1991; Palmer et al., 1997; Wise, 2001; McLennan, 2004; IISD, 2013). Sustainable development is usually considered to have environmental, economic and social dimensions which should be balanced and jointly optimized (Blevis, 2007; Hanson, 2013; Zink, 2014). Ergonomics (or its synonym human factors) is “the scientific discipline concerned with the understanding of the interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human wellbeing and overall system performance” (IEA, 2010) and it considers both a social goal (human wellbeing)

and an economic goal (overall system performance) (Dul and Neumann, 2009), these two goals are corresponding to aforementioned two dimensions of sustainability.

Statements above indicate both ergonomics and sustainable development are human centered and concerned with the joint optimization of the elements of complex socio-technical systems (Legg and Brown, 2010; Zink, 2014), implying that ergonomics could play an important role in assisting the transition to sustainable development (Moray, 1995; Dekker et al., 2013; Martin et al., 2013; Zink and Fischer, 2013; Bolis et al., 2014). Even though a few case studies on how ergonomics can help in achieving transition to sustainability have been reported (Wise, 2001; Rodriguez, 2004; Legg and Brown, 2010; Miller et al., 2012; Ryan and Wilson, 2013), a recent literature review conducted by Martin et al. (2013) reported that only seven articles on ergonomics, design and sustainability were in ergonomics journals and thus there is a lack of clear published contributions from ergonomics to sustainable development, showing still very weak sign of ergonomists tackling sustainability issues.

Since the demands in dealing with the issues related to sustainable development are increasing (IISD, 2013) and the goals of ergonomics and sustainable development are somewhat congruent, integrating ergonomics into the field of sustainable

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development might offer promising solutions to solve sustainability related problems (Moray, 1995; Ryan and Wilson, 2013; Zink and Fischer, 2013) and open a window of opportunity for the discipline of ergonomics to devote attention to global problems (Haslam and Waterson, 2013; Martin et al., 2013). A number of efforts have been initiated in recent years to call for ergonomics to become more involved with sustainability. Steimle and Zink (2006) initially applied the term sustainable development to ergonomics (or human factors), and special IEA technical group on “Human Factors and Sustainable Development” (chaired by Professor Klaus J. Zink and Professor Colin G. Drury) has been established afterward in 2008. A special issue titled ‘Ergonomics and Sustainability’ was also recently published in *Ergonomics* in 2013. However, since the perspective on sustainable development is relatively new for ergonomists, very few publications are available on where and how ergonomics can contribute well to the sustainable development (Thatcher, 2009; Haslam and Waterson, 2013). Following, the main goal of this study is to identify the research trends and the convergent areas of ergonomics and sustainable development through a systematic survey of the relevant research publications over the past two decades (1992–2011). The findings from this study are expected to provide some preliminary answers to the basic question: where and how can ergonomics contribute to sustainable development?

## 2. Methodology

### 2.1. Literature searching strategy and inclusion criteria

All 24 ‘ergonomics journals’ in the *Ergonomics List 2004* developed by Dul and Karwowski (2004) were initially considered to search peer-reviewed English language publications in the field of ergonomics. Among 24 journals, 5 (Ergonomia-Italy, Ergonomia-Poland, Ergonomics-Australia, Ergonomics-New Zealand, Ergonomics-South Africa) are regional/national journals, 3 (Le Travail Humain, Tijdschrift voor Ergonomie, Zentralblatt für Arveitsmedizin Arbeitsschutz und Ergonomie) are non-English language journals, 2 (Ergonomics International, Workplace Ergonomics) are not included and accessible in the major online databases of Web of Science, Scopus and Ergonomics Abstract, 2 (Human Factors and Ergonomics Society Bulletin, Ergonomist) serve as the forum for Human Factors and Ergonomics Society members to exchange society news and events, 1 (International Journal of Cognitive Ergonomics) has ceased publication since 2002. These 13 journals were further excluded and thus 11 journals listed in Table 1 were selected to study the research trend in ergonomics. From 1992 to 2011, in total 9717 papers were published, 1551 were excluded based on the following filtering rules, thus, 8166 papers were further reviewed and analyzed.

- (1) Review, comments, erratum and advertisement papers;
- (2) Papers being judged without substantial contents in ergonomics.

Since the meaning of the term ‘sustainable’ has shifted and evolved over the years (Haslam and Waterson, 2013) and sustainable development covers a wide range of topics across many disciplines in natural sciences, professional and applied sciences, and social sciences (Rodriguez, 2004), it is difficult to use a list of a few journals to represent the entire research field of sustainable development. Thus, a general keyword search was conducted on online databases through a commonly used reference management software package-EndNote X5(Thomson Reuters). In this study, three very general keywords ‘sustainable development’ or ‘sustainable design’ or ‘eco design’ were used to retrieve peer-reviewed

**Table 1**

Journal titles and the corresponding numbers of papers during the investigated period in the field of ergonomics.

| Journal title   | Investigated period | Number of initially retrieved papers | Number of papers after exclusion |
|---|---------------------|--------------------------------------|----------------------------------|
| Applied Ergonomics  | 1992–2011           | 1522                                 | 1352                             |
| Ergonomics  | 1992–2011           | 2484                                 | 2227                             |
| Ergonomics in Design  | 1995–2011           | 396                                  | 242                              |
| Human Factors   | 1992–2011           | 1208                                 | 1012                             |
| Human Factors and Ergonomics in Manufacturing               | 1996–2011           | 473                                  | 355                              |
| International Journal of Industrial Ergonomics              | 1992–2011           | 1786                                 | 1490                             |
| International Journal of Occupational Safety and Ergonomics | 1995–2011           | 534                                  | 497                              |
| Occupational Ergonomics                                     | 1998–2011           | 175                                  | 172                              |
| The Japanese Journal of Ergonomics <sup>a</sup>             | 1992–2011           | 501                                  | 291                              |
| Theoretical Issues in Ergonomics Science                    | 2000–2011           | 348                                  | 309                              |
| Zeitschrift Für Arbeitswissen <sup>a</sup>                  | 1999–2011           | 290                                  | 219                              |
| Total   | 1992–2011           | 9717                                 | 8166                             |

<sup>a</sup> These two non-English language journals are also reviewed since they provide enough information (title, keywords, abstract) in English for most papers.

English language publications from 1992 to 2011 from three online databases-Web of Science (WoS), EBSCO and PubMed. The Boolean operators “or” among those general keywords were used to ensure the inclusion of publications as broad as possible at the beginning and then to filter out articles judged to be outside of scope of sustainable development. The databases were chosen for their coverage of literature relating to sustainable development and their accessibilities through EndNote and our university libraries. Overall 5648 papers were retrieved in the initial searches, 3015 were excluded if they are duplicated or can't pass through the similar filtering rules applied to ergonomics, and thus 2633 papers were left for further review.

### 2.2. Classification scheme and trend analysis

The retrieved and filtered research publications in ergonomics and sustainable development were classified into 11 and 9 categories (Table 2) respectively based on an established classification flowchart (Fig. 1). The 11 ergonomics categories were adopted from classification scheme for ergonomics proposed by the Ergonomics

**Table 2**

Categories used to classify publications in ergonomics and sustainable development.

| Ergonomics categories (N <sub>1</sub> = 11) <sup>a</sup> | Sustainable development categories (N <sub>2</sub> = 9) |
|--|---|
| Human characteristics                                    | Agriculture   |
| Workplace and equipment design                           | Architecture  |
| Social and economic impact of the system                 | Economy   |
| Environment  | Environment and social issues                           |
| Information presentation and communication               | Education   |
| Display and control design                               | Industrial and product design                           |
| Work design and organization                             | Human-computer interface (HCI)                          |
| Health and safety  | Health and safety                                       |
| System characteristics                                   | Renewable energy and technology                         |
| Methods and techniques                                   |   |
| General  |   |

<sup>a</sup> Adopted from Ergonomics Abstracts (2004) and Karwowski (2005).

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