8-1-2009

A human factors and ergonomics awareness survey of professional personnel in the American furniture industry

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A HUMAN FACTORS AND ERGONOMICS AWARENESS SURVEY OF PROFESSIONAL PERSONNEL IN THE AMERICAN FURNITURE INDUSTRY

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A Thesis
Submitted to the Faculty of
Mississippi State University
in Partial Fulfillment of the Requirements
for the Degree of Master of Science
in Forest Products
in the Department of Forest Products

Mississippi State, Mississippi

August 2009

A HUMAN FACTORS AND ERGONOMICS AWARENESS SURVEY OF

PROFESSIONAL PERSONNEL IN THE AMERICAN

FURNITURE INDUSTRY

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Title of Study: A HUMAN FACTORS AND ERGONOMICS AWARENESS SURVEY OF PROFESSIONAL PERSONNEL IN THE AMERICAN FURNITURE INDUSTRY

Pages in Study: 172

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Human factors and ergonomics (HF/E) plays a crucial role in business success but is particularly vital to the furniture manufacturing industry. Unfortunately, the furniture manufacturing industry suffers from occupational injuries and illnesses resulting from ergonomically poorly designed systems.

This thesis's objective was to better understand HF/E through the furniture manufacturing industry's managerial knowledge and opinions in order to design more productive, safer, and healthier systems. The study also aimed to raise manager awareness in the industry and introduce the potential HF/E benefits by providing current literature.

Sixty-four American furniture manufacturing industry managers participated in a web-based questionnaire survey. The survey revealed that managers' demographic properties and companies' characteristics were some factors that affect managers' awareness, knowledge, and opinions on HF/E. In general, managers were unfamiliar with

HF/E and lacked a broad background on and knowledge of HF/E. In addition, companies, particularly small companies, lacked sufficient resources for HF/E.

ACKNOWLEDGEMENTS

I would like to express my heartfelt gratitude to Dr. Steve L. Hunter, Dr. H. Michael Barnes, and Dr. Jilei Zhang, who helped me throughout the completion of this thesis with their support and technical expertise. They have always guided me in the right direction and opened their doors to my questions. I am thankful to the participants in my survey for so willingly sharing the information that made this thesis possible. My love and thanks go to my family members, who have all helped get me to where I am today. Their understanding and encouragement supports me to proceed forward. I would like to express special thanks to the Ministry of National Educational of Republic of Turkey for providing me a scholarship. It could not be possible without their generous financial support. Thanks to all of the whole Mississippi State University Forest Products members who added incredible experience to my life. I wish to express my sincere thanks to the members of the Turkish Student Association for providing me with constant moral support and encouragement. My sincere gratitude goes to Mr. Bill Martin for helping me to recruit responders. Lastly, special thanks to Dr. Rubin Shmulsky for his advice, guidance, and assistance and for proving such a wonderful working environment for his students.

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INTRODUCTION

Awareness of human factors and ergonomics (HF/E) in the manufacturing industry is a necessity in order to survive in a highly competitive business world. Human factors and ergonomics is the method for creating safe, healthy, comfortable work systems, resulting in countless benefits to the systems and to the elements of the systems. Awareness is more than a program lasting a short period of time. It is also more than an application used by only human factors specialists and ergonomists. Awareness requires an organization wide participation in the creation, design, implementation, control, evaluation, and redesign of processes. Implementing a culture based on participatory HF/E is a top down process, thus managers are of vital importance in creating awareness.

It is human nature for human beings to be frightened of unfamiliar things. If managers are not aware of advantages and disadvantages and/or costs and benefits, they may fear implementing an HF/E culture. This thesis aims to introduce HF/E to managers, so that HF/E can be indirectly introduced to other human subjects in the furniture manufacturing systems, in order to minimize the fear of the unfamiliar. This thesis also aims to give a strong background in the science of HF/E and to introduce some advantages of HF/E to managers, thereby allowing managers to recognize the philosophy of HF/E and practically apply that philosophy in work systems.

One of the problems the discipline of HF/E faces is that the advantages and benefits of HF/E are not easily understood by managers unless human factors specialists and ergonomists speak "*the language of business*," and properly introduce these advantages and benefits to them (Stanton and Baber 2003). Human factors specialists and ergonomists are, unfortunately, not trained in business management topics such as cost-benefit analysis and cost-justification. They present their projects in aspects of occupational health and safety, quality of work life, and improved engineering design instead of the aspects of management and finance (Hendrick 2003). However, the benefits of HF/E fail to convince managers to allocate their limited resources unless human factors specialists and ergonomists use "*business language*" (Hendrick 2003).

Managers can, in fact, easily justify HF/E programs when they are supported by a plausible cost-benefit analysis (Hendrick 2003). Management can support HF/E activities in their workplaces when they are clearly presented its costs and benefits. Stanton and Baber (2003) strongly advise looking at the economic aspects of HF/E so as to contact managers and convince them to provide financial support for HF/E. Legal, moral, and ethical advantages of HF/E also make it more valuable.

The function of this thesis is to find ways for improving management involvement and integration of HF/E into the broader organizational culture. The thesis intends to encourage the HF/E community to share the economic aspects of their work. Hendrick, the former president of the Human Factors and Ergonomics Society, suggested that a broader macro-level HF/E approach should be taken for greater improvements in health, safety, and productivity, rather than a micro-level HF/E approach (Hendrick and Kleiner 2001; Hendrick and Kleiner 2002; Hendrick 2003).

Human Factors and Ergonomics

The International Ergonomics Association (IEA) Council defines the disciple of HF/E as; "*Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system. The profession applies theory, principles, data and methods to the design of systems, for example, workplace, tasks, processes, in order to optimize human well-being and overall system performance*" (IEA 2000). Thus, HF/E, in microcosm, means fitting humans to the system by assembling information on human characteristics, such as capabilities, capacities, limitations, weakness, and frailties. This information is transformed to the practice in design of products, environment, tasks, equipment, and workplaces (Eastman Kodak Company 1983). Human factors and ergonomics is an applied science concerned with designing human-centric systems in which humans and the other elements in the system interact most efficiently, safely, healthily, comfortably, and productively. In the economical point of view, "*Ergonomics is good business practice, and can effectively contribute to the economic well-being of the company*" (Douphrate and Rosecrance 2004).

In the same parallelism, the IEA defines a human factors specialist and an ergonomist as a contributor "*to the design and evaluation of tasks, jobs, products, environments and systems in order to make them compatible with the needs, abilities and limitations of people*" (IEA 2000). Human factors specialists and ergonomists first analyze the actual system while considering the scientific knowledge, and then define the desired system that complies with human characteristics. Taking action to decrease the difference between the actual and the desired system is the main focus of human factors

specialists and ergonomists. The achievement of the overall system depends on how well the actual system is observed, the desired system is defined, and ergonomic principles are handled to solve problems.

Even though HF/E has existed since human beings have existed, ergonomics was first used to design man-machine or human-machine interfaces. Wojciech Jastrzebowski is the author of the term "*Ergonomics*" by deriving it from two Greek words "*ergon*" meaning work and "*nomos*" meaning laws, principles, or rules; therefore, the rules of work is the literal definition of ergonomics. Jastrzebowski was the first person who created the foundation of ergonomics and used the term ergonomics in his book titled "*An Outline of Ergonomics, or the Science of Work Based upon the Truths Drawn from the Science of Nature"* in 1875 (Karwowski 2006). Thus, even though the concept of ergonomics is not new, the term was used in the literature for some one hundred and fifty years. Chapanis and his colleagues were interested in the interrelationship between men and machines so as to learn the best way to design a user friendly machine (Chapanis *et al.* 1949). These applied experimental psychologists at John Hopkins University published the first ergonomics textbook, "*Applied Experimental Psychology: Human Factors in Engineering Design*" in 1949 (Lavietes 2002). They preferred the term "*human factors*" instead of "*ergonomics.*"

Industrial / Occupational Human Factors and Ergonomics

The discipline of HF/E is made of sub-disciplines. Industrial or occupational (human factors) ergonomics is one of them. It is mainly about the application of theories, principles, methods, and data related to HF/E. Applications include evaluation, design,

and development of industrial work organizations. Workers, equipment, tools, workplaces, work environment, and work schedules are the main interest of industrial [human factors specialists and] ergonomists. The objective of industrial or occupational HF/E is to optimize productivity of the worker and the total production system while still enhancing the well being, job satisfaction, and safety of workers (Black and Hunter 2003). To achieve these goals, an optimal fit between work demands and operator capabilities has to be achieved.

The scope of this study focuses on the aspects of HF/E on an industrial basis. Product design or issues related to sales and marketing are excluded from the concept of industrial human factors and ergonomics and also from the concept of this study.

Relationships between Human Factor and Ergonomics and Other Sciences

Human factors and ergonomics must be multidisciplinary in order to handle the diversity and complexity of human beings, products, and environmental conditions (Eastman Kodak Company 1983). Human factors and ergonomics uses the knowledge and techniques shared with other sciences to meet the demands of this diversity and complexity. Human factors and ergonomics is an applied science whose roots are in basic sciences (Hermans and Peteghem 2006). Human factors and ergonomics combines several sciences such as anatomy, anthropometry, bioinstrumentation, biomechanics, computer science, electrical and mechanical engineering, industrial engineering, kinesiology, medicine, physiology, psychology, and more.

Human factors and ergonomic has interactions with not only other sciences but its own sub-disciplines. Macroergonomics, one of its sub-disciplines, is concerned with

analyzing, designing, and evaluation systems. In addition to physical aspects of work systems, macroergonomics includes industrial, organizational, managerial, and personnel psychological aspects in work systems. The difference between macroergonomics and traditional HF/E (or microergonomics) is that macroergonomics deals with the interaction between humans and the organization while microergonomics deals with the interaction between humans and the other elements of the system such as machine, environment, software, and job. All these interactions are studied under different sub-disciplines. For example, hardware [human factors and] ergonomics is interested in the relationship between human and machine; environmental [human factors and] ergonomics focuses on the interaction between humans and their environment; cognitive [human factors and] ergonomics is more related to human-software interaction and how a human perceives, thinks, and processes information; and work design [human factors and] ergonomics is interested in the interaction between a human and job (Hendrick and Kleiner 2002).

Manufacturing Systems

Systems, especially manufacturing systems, are organizational structures that have purposes and production resources to reach desired goals in a specific environment. Productivity, effectiveness, efficiency, product quality, timeliness, and safety are some of the parameters that should be satisfied in systems. Manufacturing systems are made of elements such as the worker, task, material, equipment and tool, and environment. These elements have interactions among each other. The main element of the system is human. Humans plan, build, manage, and control the system. However, humans have some capabilities and limitations as well. Human factors and ergonomics in the industry is

based on the concept of matching these capabilities and limitations with task demands. The guiding principle of HF/E is that capabilities and limitations must be, ideally, bigger than the task demands. If the demands for the task are bigger than the worker's capabilities and limitations, the worker cannot properly perform the task, resulting in lost productivity, injuries, and illnesses in the workplace (Das and Sengupta 1996). On the other hand, if the worker's capabilities are too excessive, the worker may become bored with performing the task. Thus, systems designers have to consider a worker's capabilities, restrictions, and limitations in designs.

Human in the System

The main problem for ergonomic systems designs is that workers' capabilities, limitations, backgrounds (education, ethnicity, culture, and experience), motivation levels (needs), and abilities (skills) tremendously vary from worker to worker, which makes fitting humans to systems complex. Thus, individual differences should be taken into consideration by managers in the design stage of the system (Genaidy *et al.* 1999). Managers are responsible for matching the worker to the system. Managers should transform the organization into a more humanistic place while complying with the match between worker and system (Oden 1999). Since management is generally incapable of harmonization of all the work system's elements, they should stimulate their employees to participate actively in decisions and activities that directly affect themselves (Hendrick and Kleiner 2002). Engineers and human factors specialists and ergonomists should participate in decisions related to HF/E problems. They have great influence on preventing HF/E problems arising from the complexity and uncertainties in

manufacturing (Broberg 1997). Unfortunately, organizational structure limits the influence of human factors specialists and ergonomists in the system (Perrow 1983). Dul and Neumann (2009) added more to Perrow by arguing that human factors specialists and ergonomists do not have control over an organization's budget and people in the organization and that they are supposed to be protectors of safety and health, rather than taking part in the creation or designing of systems.

Individual differences among humans (the most difficult element to change in the system) can be categorized in three sections;

1. Physiological differences: body dimensions (height, weight, body segment lengths and proportions, and disability), strength properties (muscle contraction and energy storage), and endurance,
2. Psychological differences: inherent properties (intelligence, memory, attention, adaptation, and reaction time), situation related factors (boredom, happiness, fear, and satisfaction), and task related factors (fatigue and stress), and
3. Psychosocial differences: work related factors (workload, frequency, boredom, and time schedule) and organization related factors (organizational demands and in-situ interactions in the organization).

Environment of the System

Another important element of the system is the environment. The environment includes both workplaces and the external environment that surrounds the organization. A workplace can be defined as "*a location where a person or persons perform tasks for a relatively long period of time*" (Eastman Kodak Company 1983). A good ergonomic

approach to workstation design strives for an adequate balance between the worker's capabilities and the work demands including workstation requirements (Black and Hunter 2003). Good HF/E designs comply with biomechanical, anthropometrical, and cognitive features of workers to promote safety and efficiency in task performance.

Besides the physical workplace environment, the external environment has a great impact on the system's success. Open-systems such as manufacturing systems are always in a relationship with their external environment. All systems are a part of another large system; all systems consist of some subsystems, which make systems more complex. Ignoring environmental factors in a system causes the failure of achievement of goals.

Human factors and ergonomics deals with social aspects of systems as well. If a system includes humans, it is considered a sociotechnical system due to the interaction between humans and the other elements of the system. Social systems are more than collections of individuals and inherently include emotionality and unpredictability. The sociotechnical approach, macroergonomics, helps managers to understand social dynamics of systems in order to deal with the optimization of human-system interfaces. Furniture manufacturing systems are, like all production systems, sociotechnical systems. The perspective of sociotechnical systems assumes that every organization is made of at least two subsystems; the social system and the technical system. Humans, the social system parameter, use the technical system parameters like knowledge, technology, and tools and equipment to produce beneficial goods or services for the other social system parameter, the customer (Pasmore 1988).

Because manufacturing systems are open systems, change is everywhere (Oden 1999). Products the company produces, manufacturing processes managers follows,

equipment and tools employees use, the workforce the company employs, policies the company is responsible to follow, and markets the company sells its products in are all dramatically changing every minute (Oden 1999). Companies have to keep up with these changes in order to survive. The most powerful external forces for organizational transformation are (Pasmore 1988; Oden 1999):

- trends in automation,
- education,
- changes in social structure,
- limited resources,
- increasing competition,
- new governmental requirements,
- increased interdependence to other countries,
- the shift from manufacturing industry to service industry,
- greater concern for environmental issues,
- technological innovations,
- shifts in demographic characteristic of the workforce, and
- new attitudes towards work.

Because environments of systems are continuously changing, organizations have to be flexible so as to comply with these rapid and mostly unpredictable changes. If organizations are not flexible enough to change, they can have a difficult time handling difficult environmental factors and reaching their goals in such a competitive world. On the other hand, the same factors can give flexible organizations the opportunity to achieve their goals.

Feedback in the System

Fast, accurate, and continual feedback from systems, particularly from employees, is essential for companies to develop their knowledge and expertise on HF/E while increasing the efficiency and productivity and reducing occupational injuries and illnesses (FMSAH and ILO-Safework 2002). In a manufacturing system, feedback,

considering HF/E, can be obtained from injury forms, absenteeism forms, and employee turnover data. Internal and external customers and other stakeholders can supply beneficial feedbacks as well (Genaidy *et al.* 1999). The dilemma is that designers, managers, and human factors specialists and ergonomists get feedback after the design is implemented, but it is too late to use the feedback for the design (Perrow 1983).

Entropy

It is impossible to create a perfect system that works forever without any problem. As a rule of nature, systems degenerate sooner or later, but successful designs decrease the amount and severity of the problems that cause degeneration. Therefore, systems should be managed by individuals that have the knowledge of entropy and HF/E. Preventing or solving problems before they happen is the best way to handle entropy. Managers with broad knowledge and capabilities can find solutions immediately, which guarantee the integrity of the system.

Motivations for the Study

The furniture manufacturing industry is one of the industries that needs to establish a culture based human factors and ergonomics due to the high existence of stressors causing occupational injury and illness. In the perspective of physical stressors, the furniture manufacturing industry requires considerable physical work demands as a consequence of a great deal of manual handling of heavy, bulky, and awkward materials and manual tasks such as sanding, rubbing, stapling, and spraying (Mirka 2005). Even though the need for HF/E in the furniture manufacturing industry is great, it is not applied

as much as it deserves to be. In this problem statement section, the reasons why HF/E is not applied as much as it should be will be discussed.

Ignoring Human Factors and Ergonomics

Human factors and ergonomics are, unfortunately, ignored in the furniture manufacturing industry. A work environment survey by the Swedish Union for technical and clerical employees and the salaried employees' union was conducted in 2007 to better understand the opinions of safety representatives and trade union members about the problems in physical and psychosocial work environments (Andersson 2008). The survey showed that white-collar workers had a shortcoming of interest and supervision about HF/E, some workplaces had been poorly designed, and approximately 20 percent of the companies did not comply with Swedish laws. Namely, white-collar workers were basically unaware of HF/E. If they were aware, they just ignored HF/E. However, ignoring HF/E in organizations can cause a myriad of problems for both the organization and its elements. For instance, poor design can result in a decrease in productivity and an increase in health problems (Black and Hunter 2003), which results in the organization's failure to achieve its potential (Pulat and Alexander 1991). If HF/E is ignored in workplaces, systems can encounter problems that include but are not limited to the following (Alexander and Pulat 1985; Pulat and Alexander 1991; AFMA and NCDOL 2003):

- Increased probability of accidents and errors,
- Increased injuries, sprains, and strains,
- Increased lost time, rest breaks, absenteeism, and labor turnover,
- Higher medical costs,
- Higher material waste and cost,
- Less production output,

- Lower product quality, and
- Frequent worker complaints.

The cost of even a simple mistake can be extremely high, especially when it occurs over a long period (Beevis and Slade 2003). The solution is to redesign the system by considering HF/E knowledge. Redesigning is also the logical solution because the costs of redesigning workplaces, in comparison, are often far less expensive than even the cost of a single injury (Pulat and Alexander 1991). Human factors and ergonomics is more than something that is nice; it is a necessity.

Management capable of changing the culture to become more open to HF/E in most organizations does not seem to be positively motivated to apply HF/E (Dul and Neumann 2009) because of either misperception or unawareness of HF/E.

Being Unaware of Human Factors and Ergonomics

Human factors and ergonomics awareness has a substantial impact on the industry, organization, management, employees, and overall well-being the system (Sundstrom 2000; Vavra 2003; Westgaard and Winkel 2000); however, management, in general, is not really aware of the advantages of HF/E. Managers in the industry have some understanding of HF/E, but most of them are not sure how to deal with problems resulting from the lack of HF/E interventions (Dolhy 2006). Indeed, unawareness of HF/E discipline is observed not only among managers, but also among employees, employers, and the rest of society. A survey conducted by the Opinion Research Corporation revealed that the majority of office workers in the U.S. believed that they knew the definition of HF/E; however, few of them were able to accurately define it

(Steelcase 2006). Although there was confusion over the definition, those workers were aware of the benefits of HF/E.

There is another dimension in awareness: understanding. Awareness and understanding do not have the same meaning. The public awareness of the word HF/E has increased over the past few decades, but public understanding of what HF/E actually means has been limited and confused (Budnick 2001).

Misperceptions of Human Factors and Ergonomics

Before the discussion of how HF/E is misperceived, providing the reasons why it is misperceived can be beneficial for comprehensive understanding. There are a few reasons for misperception such as lack of cost-benefit analysis, inadequate documentation of HF/E interventions, and poor communication between scientists and businessmen.

Poor Cost-Benefit Analyses: "Needing to Talking with the Language of Money"

Cost-benefit analysis enables managers to justify an investment, whether it improves the organization's profit, competitiveness, and survival ability (Hendrick 1996a). The justification of the costs and benefits of HF/E programs is an essential management tool for an organization's future steps (Douphrate and Rosecrance 2004). The cost-benefit analysis enables decision-makers to justify an HF/E program in business-language: money. That HF/E is "*the right thing to do*" is not a sufficient reason for managers to apply it in their organizations (Hendrick 1996b); it has to be gainful.

In general, managers are not willing to spend money unless there are clear economic benefits (Hendrick and Kleiner 2002). Human factors and ergonomics is, inherently, highly profitable; but, the problem is that scientists cannot exactly transform

their research into "*the language of money.*" Unless the literature focuses on the economical benefits of HF/E programs or unless human factors specialists and ergonomists learn and use "*the language of business*," managers cannot realize the importance of HF/E.

Talking with the business- or money-language is meaningful for management because an organization's survival is dependent on money (Vitalis *et al.* 2001). However, talking with "*the language of money*" is not easy due to the difficulty of cost and benefit calculation. Indeed, costs can be easily calculated, but benefits cannot. The complexity of calculation is caused from the difficulty of the explanation of benefits. Benefits may be qualitative or quantitative. The conversion of qualitative benefits (such as healthier and more satisfied workforces, safer workplaces, and higher quality products) into quantitative benefits (money) causes researchers difficulty. Moreover, the dimension of the benefits makes the calculation harder. For example, benefits can be for today or for the future, and the impact of benefits can be direct or indirect.

Lack of Communication: Poor Literature Documentation

Another problem for not embracing an HF/E culture in an organization is the lack of communication between scientists and management, and possibly employers. Lack of literature and lack of scientific evidences to explain the need for HF/E make communication difficult (Meg 1999). As a broad problem, the U.S. wood products industry, including the furniture manufacturing industry, has not been very attentive to HF/E opportunities, so little research has been done on the topic of HF/E (Gazo *et al.* 2002). Lack of literature related to the financial aspect of HF/E (Beevis and Slade 2003)

is one of problems that motivated researchers to conduct this research. If the literature is reviewed, it can be clearly seen that the benefits of HF/E have not been well documented. Poor documentation results in inadequate reorganization, weak support, and poor endorsement of HF/E by the leaders of both business and government (Hendrick 1996b). Hendrick has blamed himself and his scientist colleagues for inadequate documentation and publication on the cost-benefit analyses of their ergonomic research (Hendrick 1996a). In his 1996 Human Factors and Ergonomics Society Presidential Address, Hendrick introduced a variety of ergonomics interventions resulting with financial benefits. He emphasized that the HF/E community must better document and spread cost and benefit awareness of HF/E programs (Hendrick 1996b).

Besides, human factors specialists and ergonomists generally publish their research in HF/E related journals. Unfortunately, managers follow these journals less than business and/or management journals, which limits the possibility to introduce them to the benefits of HF/E (Dul and Neumann 2009).

As a result of the lack of awareness, poor cost-benefit analyses, and poor documentation of HF/E programs, managers in the industry generally misperceive HF/E. For example, some managers in industry think that HF/E is only related to safety and health issues. Most of the general public and management have the insight that HF/E is just about work-related musculoskeletal disorders; and prevention of these disorders results in heavy financial burdens for companies (Dul and Neumann 2009). In an operator's view of point, HF/E can be nothing more than "*common sense*" (Hendrick 1996b).

The Perception That Human Factors and Ergonomic is Costly

The lack of awareness among managers causes the perception that HF/E is costly (Sundstrom 2000; Dolhy 2006), particularly for small businesses (Vavra 2003). Hendrick (1996b) asks, "*Why is it that both industry associations and members of Congress sometimes view us as simply adding an additional expense burden and, thus, increasing the costs of production and thereby decreasing competitiveness?*". It is obvious from Hendrick's quote that HF/E is perceived as nothing other than a financial burden to companies. Mirka (2005) expressed in his paper, explaining a voluntary HF/E program in the furniture manufacturing industry, that management did not want to be volunteer any HF/E program because they thought Occupational Safety and Health Administration (OSHA) would enforce heavy liabilities on them if researchers found HF/E related problems. Mirka's paper shows that managers in the industry know of current problems and admit that HF/E is a beneficial, preventative discipline; however, they are not willing to embrace HF/E in their organizations because of its misperceived heavy financial burden.

Human factors and ergonomics is in danger of losing its identity as well (Vitalis *et al.* 2001). Managers often associate HF/E with health issues and related health costs such as costs of absenteeism and compensation caused from occupational injuries and illness instead of with organizational effectiveness (Dul and Neumann 2009). As long as the perception is that HF/E focuses on the human needs in workplaces to promote health and well being rather than the efficiency and productivity of the organization, traditional management will not be willing to waste their resources on HF/E (Vitalis *et al.* 2001).

To summarize, misperceptions caused by a lack of awareness, poorly documented literature, and poor communication between scientists and business leaders result in less commitment to HF/E in the furniture manufacturing industry. However, managers should realize that HF/E tools and techniques are highly beneficial for systems. Therefore, individuals responsible for HF/E should give greater efforts to understand the business aspects of the organization so that they can influence their organization's strategies. Scientists should mention the economical aspects in their research results. Introducing HF/E via well documented cost-benefit analyses helps to spread Hendrick's expression of *"good ergonomics is good economics"* (Hendrick 1996b).

Poor Management Commitment and Employee Involvement

Management commitment and employee involvement are complementary and essential elements for implementing an HF/E program in an organization. Without their support, HF/E programs are likely to fail. Human factors and ergonomics offers a wonderful common ground for management and employee collaboration. Managers can get benefits if production costs reduce and the productivity improves, and meanwhile, employees can get benefits if safety, health, comfort, usability of tools and equipment, and overall improvement of work life quality (Hendrick 1996b).

If managers realize the benefits of HF/E, they will probably be more interested in HF/E (Hendrick and Kleiner 2002). Especially, financial benefits have an encouraging impact on managers for commitment to HF/E. If managers experience cost reduction resulting from HF/E programs, their interest will immediately increase. The benefits of

HF/E are not limited only in financial conditions. Social benefits of HF/E also encourage mangers to support HF/E programs. The more managers that are aware of and use of HF/E, the more easily they can reach their strategic business goals (Dul and Neumann 2009).

Management Commitment

One of the ultimate objectives of this study was to encourage managers for initiation of HF/E programs, if there is not one, and to show them the advantages of commitment to these programs. Researchers have searched to solve problems derived from ergonomically poor designs and to provide training for workers. However, efforts are ineffective when they are not supported by the management. The success of these programs requires participation from all levels throughout an organization.

In highly centralized systems, a few high level individuals make the decisions while lower-level supervisors and employees have minimal input in the decisions affecting their jobs (Hendrick and Kleiner 2002). A study in the sawmill industry found that managers responsible for planning, organizing, and leading tended to use autocratic and authoritarian management styles in their organization instead of democratic and participative management styles (Trask *et al.* 2009). Like the sawmill industry, management in the furniture manufacturing industry is inherently highly centralized; therefore, management commitment is critical to establish a culture that values the human. "*Real management commitment*," not just words, increases the probability of the overall success of any HF/E programs (AFMA and NCDOL 2003; Hendrick 2003). For example, a joint project between the Finish Ministry of Social Affairs and Health and

International Labor Organization (ILO)-SafeWork Program revealed that several factors affected the productivity of an organization, but management commitment was the most important factor for high productivity (FMSAH and ILO-Safework 2002). The American Furniture Manufacturers Association (AFMA) lists some of the ways that furniture manufacturer managers can demonstrate their commitments to HF/E by (AFMA and NCDOL 2003):

- Understanding the elements involved in an effective HF/E program,
- Developing and instituting clear goals and objectives for the program,
- Ensuring adequate education and training for employees,
- Establishing a system of responsibility and accountability at all levels,
- Encouraging participation and involvement at all levels,
- Allocating resources to address HF/E issues within the organization,
- Striving to identify and eliminate ergonomics hazards in work operations,
- Maintaining a system to address physical complaints promptly and effectively,
- Integrating safety and health as a value in the workplace while partnering with productivity and quality issues,
- Defining a system for effective documentation and program evaluation, and
- Developing a procedure for equipment evaluation prior to purchase and installation.

Employee Involvement

A successful integration of HF/E into the overall manufacturing processes depends not only on management commitment but on employee participation as well (AFMA and NCDOL 2003; Tornstrom *et al.* 2008). A human is the most important asset of an organization, so management should institute a wider level of participation to utilize this asset (Genaidy *et al.* 1999; Hendrick and Kleiner 2002). Participation in manufacturing processes, such as creation, design, implementation, improvement, and assessment of tasks, tools, equipment, workplaces, and environment, promotes the feeling of individual ownership and the sense of commitment to supporting programs, which is

motivating and beneficial to both individuals and the organization (Robertson 2001; Pehkonen *et al.* 2009). Employees should be given opportunities to discuss and address problems in their jobs. Success requires team effort among the people in the organization (MacLeod 1995).

Employee involvement at all organizational levels in order to establish and maintain an organization culture based on HF/E is called participatory ergonomics, or participatory human factors and ergonomics in a broader point of view. For participatory ergonomics, most of the encyclopedias and HF/E handbooks have quoted Wilson's (1995) definition; "*The involvement of people in planning and controlling a significant amount of their own work activities, with sufficient knowledge and power to influence both processes and outcomes in order to achieve desirable goals.*" As understood from the definition, conscious involvement is vital for the success of an organization.

There are several factors for the success in the participatory approach. First of all, an HF/E program is only effective when the employer and management welcome it. For the success of the participatory program, they should play an active role in analysis, design, implementation, and control. Another necessity for success is the opportunity level for involvement provided by the management. The more managers provide the opportunity for employees, the more employees will participate in the activities and decisions. The participation is more favorable when the number of participants is high (Noro and Imada 1991; Tornstrom *et al.* 2008) and involves people from all levels and functions (AFMA and NCDOL 2003). Taking an HF/E program as a team approach is required for the successful organization (Keller 2008). Lastly, availability of resources such as knowledge, tools, equipment, and power are required to achieve quality

improvement in processes and outcomes and to enhance organizational effectiveness (Nagamachi 1995).

Occupational health teams or practitioners should participate in the HF/E programs as well (Hignett *et al.* 2005). In addition to these safety-hygiene personnel and health care providers, people from all over the organization, such as human resource personnel, engineering personnel, maintenance personnel, and even union leaders, should be involved in these programs (Keller 2008).

Participatory HF/E groups are the same as quality circle teams. These groups are highly motivated to find solutions to their own problems, redesign their own workplaces, and reform their own organizations for themselves (Nagamachi 1995). Participatory HF/E provides employees with the opportunity of learning and developing new skills through collaboration with their colleagues. Some of the advantages of participatory HF/E are less absenteeism, less compensation costs, increased productivity, improved communication between employees and management, and reduction in stressful risk factors (Nagamachi 1995; Hignett *et al.* 2005). As a result of participatory HF/E, employee knowledge and awareness increases, so the ability to handle HF/E problems improves (Pehkonen *et al.* 2009).

While managers can be involved in establishing and implementing HF/E programs, employees can demonstrate their commitment by (AFMA and NCDOL 2003):

- Identifying HF/E issues,
- Participating in control measure development and implementation,
- Contributing to HF/E teams or committees,
- Reporting early signs and symptoms of problems.

CHAPTER II

FURNITURE MANUFACTURING INDUSTRY OVERVIEW

Furniture Manufacturing Industry in the United States

Furniture is, traditionally, made from solid wood. Hardwoods such as oak, hickory, birch, beech, ash, and walnut and softwoods like pine, cedar, redwood, fir, and larch are used as raw materials to manufacture furniture. However, the trend for raw materials in the current furniture manufacturing industry is changing from solid wood material to other materials such as metal, glass, plastics, and rattan. The trend results from the high furniture demands, excessive material costs, shortage on quality and quantity of solid wood materials, durability problems, aesthetics, and many others. The most common materials used in the U.S. furniture manufacturing industry are metal and wood.

Industries in the furniture and related product manufacturing subsector produce furniture and related products such as mattresses, window blinds, cabinets, and fixtures by the cutting, bending, molding, laminating, and assembly of materials (Census Bureau 2003). Because furniture is usually made from several materials, the classification based on the type of furniture is more useful than the classification based on the material used. For example, some wood, metal, foam, and fabric are used to make a sofa, but the sofa is not classified as a wood sofa or a metal sofa, but an upholstered sofa. The place the sofa is used does not change the classification as well. For example, an upholstered sofa is still

considered household furniture although it may be used in a hotel room or a business office (Census Bureau 2003).

The North American Industry Classification System (NAICS) is a classification system that has replaced the U.S. Standard Industrial Classification (SIC) system in 1997. The Federal statistical agencies use NAICS for the collection, analysis, and publication of economic statistics. They no longer use the SIC, and there will be no further revisions of the SIC system. The furniture and related product manufacturing subsector consists of three NAICS coded industry groups:

- Household and Institutional Furniture and Kitchen Cabinet Manufacturing (NAICS 3371),
- Office Furniture (including Fixtures) Manufacturing (NAICS 3372),
- Other Furniture Related Product Manufacturing (NAICS 3379).

This research only covers the furniture and related product manufacturing subsector (NAICS 337). Before NAICS codes, SIC codes were used to classify establishments. NAICS 337 codes match with SIC 25 codes (Furniture and fixtures) (see Appendix 1 for the compatibility). There are some establishments in different SIC codes such as SIC 24 (Lumber and wood products), SIC 39 (Miscellaneous manufacturing industries), and SIC 57 (Home furniture, furnishings, and equipment stores).

Furniture Manufacturing Industry Statistics

The furniture and related product manufacturing industry (NAICS 337) is an important industry with 23,565 establishments (BLS 2009a) and 544 thousands employees (BLS 2009b) in 2007. The industry added $46 billion to the U.S. economy in

2006 (Census Bureau 2009). Unfortunately, the U.S. furniture market is facing a challenging period because of a financial crisis, growing unemployment, falling sales, and high material costs (Ince *et al.* 2007).

The furniture manufacturing industry is suffering from the globalization or global competition in recent years (Pasmore 1988; Ince *et al.* 2007; Drayse 2008; Lihra *et al.* 2008). Firms have outsourced production to other countries where the costs are relatively low. For example, half of the furniture demand in the U.S. is met from China (Ince *et al.* 2007; Drayse 2008). As a result of the devastating competition, some small companies have faced an end to their businesses. Some states, such as Mississippi, Alabama, and North Carolina, have higher dependency on the furniture manufacturing industry; hence, these vulnerable states are severely affected from the global competition. For example, 40 furniture plants in North Carolina were closed from 2001 to 2003, which sharply dropped furniture employment trends (Ince *et al.* 2007). Because the furniture manufacturing industry is fairly labor intensive, these problems have negatively affected both social and economic structures of the nation (Ince *et al.* 2007). In addition to global competition, national competition, governmental regulations, and internal ineffectiveness increase the pressure on companies (Pasmore 1988). As a result, financial crisis, falling sales, expensive material costs, national and international competitions, governmental regulations, and internal ineffectiveness cause the number of businesses (Figure 1) and employment (Figure 2) to decrease in the furniture and related product manufacturing industry.

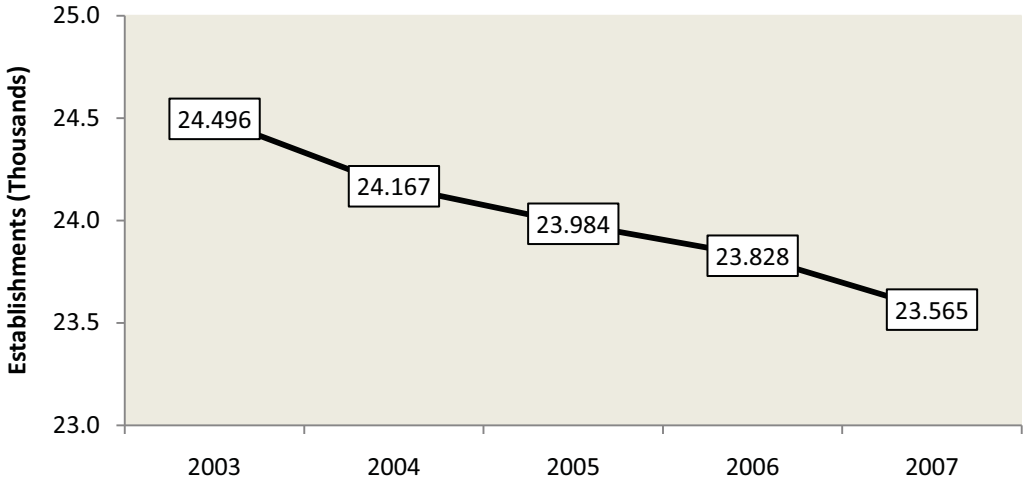

Figure 1 Number of establishments (thousands) in NAICS 337 Furniture and related product manufacturing, Private Industry, All the U.S. from 2003 to 2007

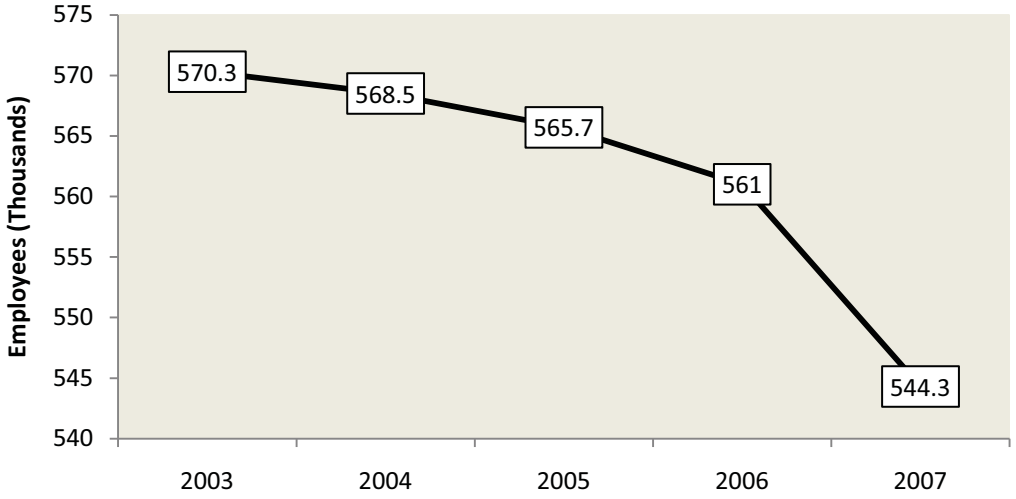

Figure 2 Number of employees (thousands) in NAICS 337 Furniture and related product manufacturing, Private Industry, All the U.S. from 2003 to 2007

Occupational Injuries and Illnesses Statistics

The furniture industry is characterized by a higher number of occupational injuries. There are many risk factors in the furniture industry, leading to millions of people being seriously injured and even dying. According to the recent data by the U.S.

Department of Bureau of Labor Statistics (BLS), there were total 34.5 thousand recordable cases in the furniture and related products manufacturing industry (NAICS 337), 32.7 thousand of which were occupational injuries and the remaining 1.8 thousand were illnesses (BLS 2009b). In the total private industry, there were a total of 4 million recordable cases, of which 3.8 million were occupational injuries. Of the rest of the cases, 0.2 million were illnesses. As a reminder, the rates may be higher due to under-reporting of minor injuries or company-paid cases.

The rate of total recordable injury and illness cases in the furniture and related products manufacturing industry in 2007 was 6.7 cases per 100 full-time workers, which was fairly higher than the rate of total recordable injury and illness cases in the total private industry in 2007: 4.2 cases per 100 full-time workers (BLS 2009b). The summary statistics of the occupational injuries, illnesses, and fatalities in the furniture, manufacturing, goods producing, service producing, and total private industry (Table 1) shows that fifty four percent of the occupational cases in the furniture manufacturing industry resulted in either days away from work (DAFW) or job transfer or restriction (JTR). In 2007, 8.2 thousand cases resulted in days away from work for recuperation and 10.2 thousand cases resulted in transferring to another job and restriction duties at work. The remaining 16 thousand injuries and illnesses were called other recordable cases that

Table 1 Numbers and rates of fatal and nonfatal occupational injuries and illnesses, Private Industry, All the U.S., 2007

Industry	Employment	INJURIES & ILLNESSES														FATAL INJURIES	
		Recordable cases						Cases with DAFW & JTR						Other recordable cases			
		Total		Injuries		Illnesses		Total		DAFW		JTR					
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N*	R*
Goods-producing	23500.5	1236.1	5.4	1152.2	5	83.8	0.4	665.3	2.9	349.4	1.5	315.8	1.4	570.8	2.5	2372	7.8
Manufacturing	14071.4	783.1	5.6	711.9	5.1	71.1	0.5	427.1	3	187.2	1.3	239.9	1.7	356	2.5	400	7.1
Furniture	544.3	34.5	6.7	32.7	6.3	1.8	0.4	18.4	3.6	8.2	1.6	10.2	2	16	3.1	6	0.1
Service-providing	91332.9	2766.6	3.8	2644.1	3.7	122.5	0.2	1370.7	1.9	809.4	1.1	561.3	0.8	1396	1.9	2740	2.9
Total private Industry	114833.4	4002.7	4.2	3796.4	4	206.3	0.2	2036	2.1	1159	1.2	877.2	0.9	1967	2.1	5112	4.1

Furniture: *Furniture and related product manufacturing*
N*: Number (thousands),* ***N****: Number*
%*: the rate of cases per 100 workers,* ***R****: the rate of fatal occupational injuries per 100,000 employed workers*
Employment*: Annual average employment (thousands), in 2007,*
DAFW*: Cases with days away from work,*
JTR*: Cases with job transfer or restriction,*
Industry codes*:* ***Service providing****: SP1AAA,* ***Goods providing****: GP1AAA,* ***Manufacturing****: GP1MFG,* ***Furniture and related product manufacturing****: NAICS 337*

did not result in time away from work. Cases with job transfer or restriction involve shortened work times and temporary job changes and/or restrictions on regular tasks.

The rate of illnesses in manufacturing was 0.5 cases per 100 full-time workers. The illness rate for the furniture and related products manufacturing industry (0.4) was about two times higher than that of the national average (0.2 cases).

About one over third of all injury cases in private industry in 2007 occurred in the goods producing industry. Injury cases in the manufacturing industry were approximately 60 percent of the goods producing industry; thus, manufacturing accounted for 18.8 percent of all private industry illness cases (Figure 3).

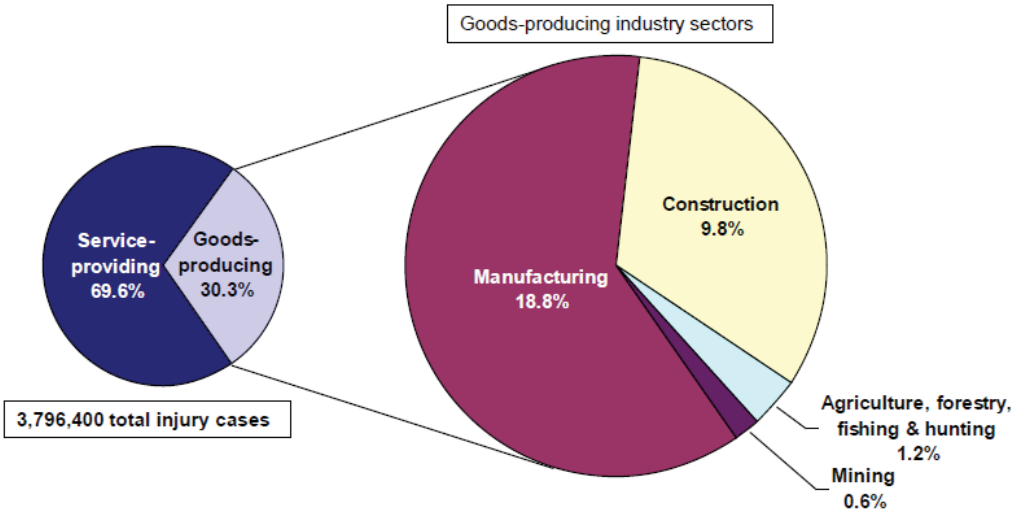

Figure 3 Distribution of nonfatal occupational injuries by good producing private industry in 2007

Every year, millions of Americans experience injuries, illnesses, and even deaths at workplaces. The good news is that trend is going down. As can be seen in Figure 4,

total recordable cases, days away from work, job transfer, or restriction cases, days away from work cases, days of job transfer or restriction only cases, and other recordable cases are in the trend of reduction from 2003 to 2007 (BLS 2009b).

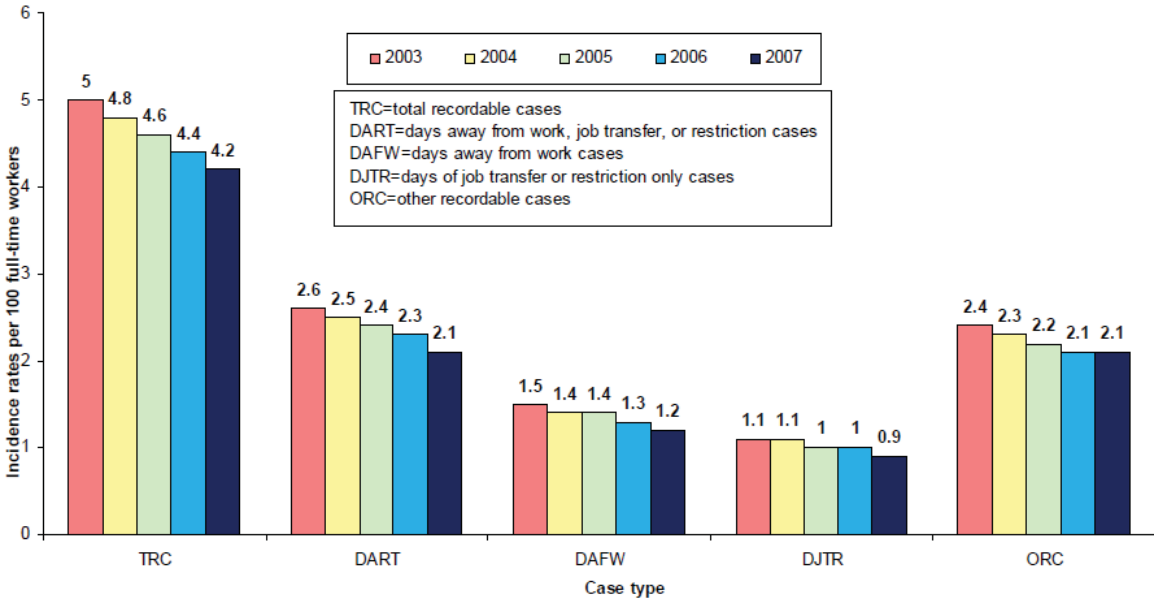

Figure 4 Nonfatal occupational injury and illness incidence rates by case type, private industry, 2003-2007

The same trend can be observed in the furniture and related products manufacturing industry as well. Figure 5 shows the trend of total recordable injuries and illnesses in the furniture and related product manufacturing industry from 2003 to 2007 in the U.S. (BLS 2009b).

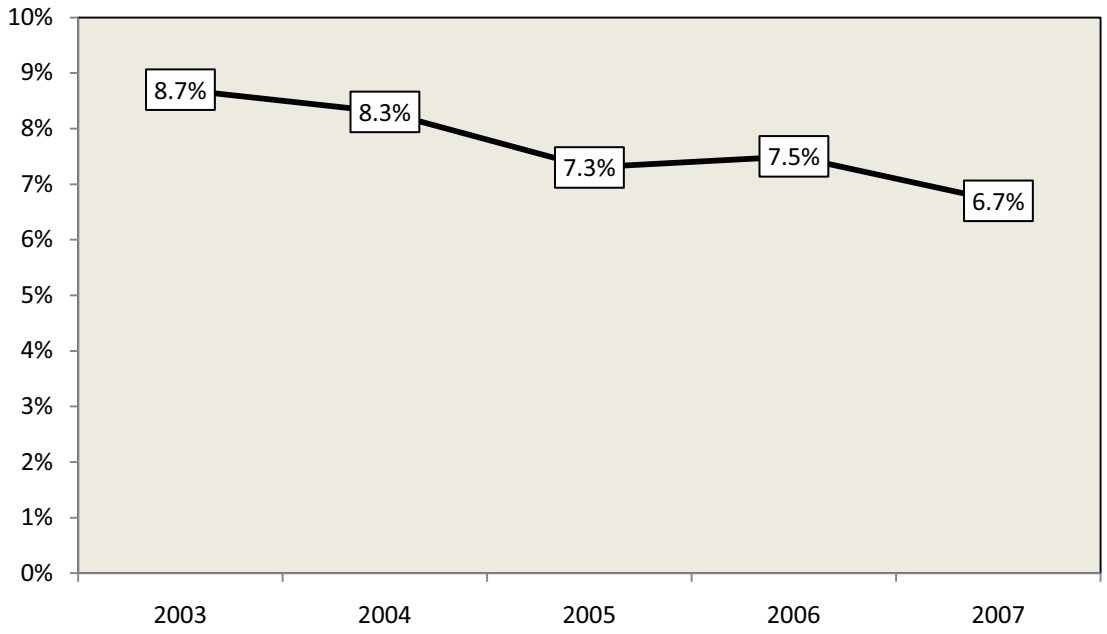

Figure 5 The trend of incidence rates of total recordable injury and illness cases in the furniture and related product manufacturing industry from 2003 to 2007 in the U.S.

In 2007, BLS reported that most occupational injuries and illnesses in the furniture manufacturing industry were sprains, strains (47.1%), cuts, lacerations, and punctures (37.2%) (Table 2) (BLS 2009c). Most of the injuries and illnesses were related to contact with objects, equipment (74.6%) and overexertion (39.4%) (Table 2) (BLS 2009c). A study by Ma *et al.* (1991) found that cut and laceration accidents in the wood-bamboo furniture manufacturing industry caused by unsafe conditions (approximately 60%) and unsafe acts (approximately 40%) were common work related injuries (Ma *et al.* 1991). Other reasons and injury illness types can be seen in Table 2. Extensive research has been conducted showing that HF/E interventions prevent or reduce the risk factors for occupational injuries and illnesses (Douphrate and Rosecrance 2004).

Table 2 Incidence rates of nonfatal occupational injuries and illnesses involving days away from work by case characteristics and industry, All U.S., private industry, 2007

Nature of injury, illness:	Prv. Ind.	Fur. Ind.
Sprains, strains	47.3	47.1
Fractures	10.0	8.1
Cuts, lacerations, punctures	11.3	37.2
Bruises, contusions	10.7	12.9
Heat burns	1.8	0.5
Chemical burns	0.6	0.5
Amputations	0.8	5.3
Carpal tunnel syndrome	1.3	2.9
Tendonitis	0.5	1.4
Multiple injuries	4.9	4.0
With fractures	1.2	1.6
With sprains	1.6	0.7
Soreness, Pain	12.2	12.3
Back pain	3.9	3.5
All other	20.8	27.0

Event or exposure:	Prv. Ind.	Fur. Ind.
Contact with object, equip.	33.5	74.6
Struck by object	17.2	32.2
Struck against object	8.0	15.4
Caught in object, equip., mat.	5.7	21.3
Fall to lower level	8.1	4.1
Fall on same level	17.6	10.2
Slips, trips	4.0	2.2
Overexertion	27.9	39.4
Overexertion in lifting	14.8	23.7
Repetitive motion	3.9	10.1
Exposed to harmful substance	5.6	2.8
Transportation accidents	5.6	2.1
Fires, explosions	0.2	-
Assault, violent act	2.6	0.3
by person	1.8	-
by other	0.8	-
All other	13.3	13.2

Cost of Injuries and Illnesses

The direct and indirect costs associated with occupational injuries, illnesses, and fatalities in the U.S. in a particular year can be estimated by multiplying the number of cases by the average costs of wage and productivity losses, medical expenses, and administrative expenses per case (Leigh *et al.* 1997). The National Safety Council (NSC) makes estimates of the average costs of injuries, illnesses, and fatalities and their impact on the nation's economy (NSC 2009). According to the estimation of the NSC, the average economic loss due to fatal and nonfatal occupational injuries in 2007 was $30.4 billion for the injuries without employers' uninsured costs and $33.4 billion for injuries with employers' uninsured costs.

Estimations are not exact; they are only approximated because of the difficulty of calculating the costs, especially indirect costs, and the quantity and complexity of factors in the calculations make the process harder (NSC 2009). Because many costs associated with occupational injuries, illnesses, and fatalities are ignored, the estimations are likely to be low (Leigh *et al.* 1997). Hendrick's iceberg theory indicates that direct costs are only the costs that are seen on the surface, but indirect costs are not seen and consist of the large percentage of the total occupational injuries and illnesses costs (Figure 6) (FMSAH and ILO-Safework 2002). For example, workers' compensation is just the "*tip of the iceberg*" when costs for lost workdays, lost production, lost income, employee replacement costs, training, and community support of the worker's family are added to the calculation (AFMA and NCDOL 2003).

To calculate indirect costs, MacLeod (1995) suggests that the ratio 1:4 of the direct costs to the indirect cost should be used. MacLeod also mentions that some investigators suggest the ratio 1:10, but many companies have found a good estimation for the total costs for per case by multiplying direct workers' compensation costs by 4.

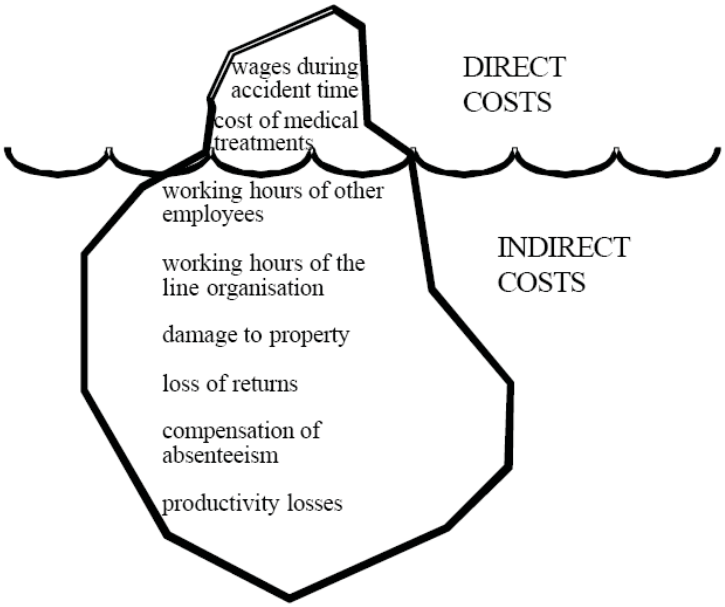

Figure 6 Hendrick's iceberg theory related to direct and indirect costs in occupational injuries, illnesses, and mortalities

Problem Statement

After providing the motivation factors for the thesis and a statistical industry overview, summarizing problems in the problem statement section can be beneficial for readers. As a whole, there are some problems in establishing the HF/E culture in workplaces: (1) HF/E is not applied as much as it deserves; (2) managers are not positively motivated to apply HF/E; (3) managers do not pay much attention to HF/E; (4) HF/E is misperceived by managers; (5) managers are not really aware of the advantages of HF/E; (6) managers are not sure how to deal with problems caused from the lack of HF/E interventions; (7) managers have little knowledge about risk stressors and HF/E principles, issues, and interventions; and (8) there are some problems with communication between scientists and managers resulting from lack of cost-benefit analyses in the current literature and inadequate documentation of HF/E programs and

their outcomes. In order to solve these problems, understanding the barriers and limitations of integrating HF/E into the furniture manufacturing industry is required. The purpose of the present study was to investigate these barriers and limitations to be able to design more productive, safer, and healthier manufacturing systems.

Research Objectives

The objective of this study was to better understand the knowledge and opinions of managers regarding HF/E in the American furniture manufacturing industry. This study explored significant relationships between managers' properties (including their companies' characteristics) and managers' familiarities with HF/E, knowledge levels on HF/E, preferred information resources concerning HF/E, opinions on likely benefits and disadvantages of HF/E, opinions on companies' resource availabilities, equipment preferences, opinions of the importance levels of resources, opinions on the likely causes of occupational injuries, accidents, and illnesses, opinions on who is responsible for HF/E, and who will get benefits from HF/E. In addition to managers' attitudes toward HF/E, the study also explored inspection frequencies and worker involvement and familiarity with HF/E. Lastly, this study aimed to produce results worthy of publication and provide some suggestions to managers and scientists.

CHAPTER III

METHODOLOGY

After the research objectives were clearly defined, they were translated into the key research questions. These questions were used to create a web-based questionnaire survey as the experimental instrument. The survey was created by using a commercial online survey tool. Development, pre-test, and review stages were followed to design the final questionnaire survey. After completing an informed consent procedure approved by the local Institutional Review Board, the link to the survey and descriptions about the survey were published on the web sites of the Department of Forest Products and the Franklin Furniture Institute at Mississippi State University. In the recruitment process, 986 managers were invited to participate in the study. Individual e-mail invitations were sent which included the link of the survey and an individually designated password. 64 managers of sufficient quality were accepted as the subjects for the study.

Participants (Subjects)

The objective of this study was to better understand the knowledge of professional personnel regarding HF/E issues in the American furniture manufacturing industry. To reach the objective, managers were surveyed in this study. In this thesis, the term "*managers*" involves owners, top-level managers (general managers, chief executives, and presidents), and lower-level managers (production managers, directors of

manufacturing, plant managers, human resource managers, and engineers). Their major responsibilities in organizations are (Trask *et al.* 2009):

1. Setting and deciding goals,
2. Organizing resources (labor, capital, and material),
3. Directing and motivating employees for the organization's goals,
4. Hiring, developing, and training employees, and
5. Monitoring organizational performance and comparing performance with established goals.

Based on the above, the subjects for the study were selected from managers who had the capacity for creating and maintaining an organizational culture based on HF/E. They were selected as subjects for the study because they played key roles in establishing company-wide missions for HF/E interventions. Their knowledge, perception, and commitment affected the success.

Population Size

The subject population was limited to managers who work in the U.S. furniture manufacturing industry (NAICS 337). Managers who work in furniture wholesalers, retailers, stores, leasers, or importers were not within of the scope of this study.

According to the Occupational Employment Statistics, there are totally 19,320 managers in the furniture and related products manufacturing industry in 2008 (Table 3) (BLS 2009d). This number was obtained by using the Standard Occupational Classification code of 110000 for the management occupation. Managers who were not related to manufacturing were extracted from the total population because this thesis only

covered manufacturer managers. Thus, the actual population size of the managers in furniture manufacturing was obtained. The population size for this study was 14,650 managers.

Table 3 Occupational Employment Statistics (OES), Furniture and Related Product Manufacturing Industry (NAICS 337), May 2008

Occupation (SOC code)	Employment
Management Occupations(110000)	**19320**
Manufacturer Managers in the Furniture and Related Manufacturing Industry (The subjects of the survey)	
Chief Executives(111011)	1370
Industrial Production Managers(113051)	3730
General and Operations Managers(111021)	7630
Administrative Services Managers(113011)	500
Compensation and Benefits Managers(113041)	60
Human Resources Managers, All Other(113049)	110
Engineering Managers(119041)	610
Managers, All Other(119199)	640
TOTAL	**14650**
Non-manufacturer managers in the Furniture and Related Manufacturing Industry	
Purchasing Managers(113061)	530
Transportation, Storage, and Distribution Managers(113071)	500
Financial Managers(113031)	1120
Marketing Managers(112021)	180
Construction Managers(119021)	90
Sales Managers(112022)	1460
Computer and Information Systems Managers(113021)	730
TOTAL	**4610**

SOC code: Standard Occupational Classification code -- see http://www.bls.gov/soc/home.htm
Data extracted on May 26, 2009

Participation Rate

A total of 986 managers were invited to participate in the survey. This number is 6.7 percent of the total manufacturing manager population. Of the 986 managers in the survey, only 64 of them participated, yielding a participation ratio for this study of 6.5 percent. One of the hypotheses of this study was that professional personnel in the furniture manufacturing industry were not interested in HF/E. If this response rate is considered as a measure of managers' interest, then this low participation ratio supports that hypothesis.

The overall response rate to the questionnaire was about 4.37 individuals per 1000 managers (64/16,450=0.0043686 person). Therefore, with the population size of 14,650 managers and 64 respondents, the margin of error can be calculated as 12.5 percent by assuming a 95 percent confidence level and 50 percent response distribution. The margin of error is the error that researchers are willing to accept. The percent of 12.5 for the margin of error can be considered as high, but it can be plausible if the limitation of recruitment is taken into consideration.

Instrument Design

A questionnaire survey was the most suitable instrument to best understand the opinions, knowledge, awareness, and attitudes of managers in the furniture manufacturing industries. Possible survey techniques included mail surveys, face-to-face interviews, telephone surveys, and internet surveys. A web-based survey was preferred as the instrument because of the increasing use of the Internet as a communication technology and because of the advantages of web-based surveys. The advantages of

electronic surveys over mail surveys include (Czaja and Blair 2005; Stanton *et al.* 2005; Leeuw *et al.* 2008):

- Easy access to samples,
- No geographic limitation to access of samples,
- Speed of data collection,
- Lower costs (paper, postage, and data entry costs),
- Reducing data entry errors,
- High response quality,
- Greater flexibility for the respondents for choosing how and when to respond,
- Ease of administration,
- Ease of formatting for color, sound, image, etc.,
- Elimination of unwanted interviewer effects, and
- More privacy.

On the other hand, web-based surveys have some disadvantages if they are compared with mail surveys (Czaja and Blair 2005; Stanton *et al.* 2005; Leeuw *et al.* 2008):

- Response bias (limited and biased population),
- Higher coverage, sampling, measurement, and non-response errors,
- Low response rate,
- Anonymity,
- Nondeliverabilty, and
- Security.

Besides these disadvantages, there exists a possibility that participants may not have internet access. Moreover, participants may have different levels of education, computer literacy, and computer hardware and software. Therefore, participants with lower education levels, minimal experience with the use of computers, or older computer equipment would probably have a difficult time completing the web-based questionnaire.

Survey Design

After a thorough review of the literature on HF/E issues and managers' commitments to these issues in the furniture manufacturing industry, it became apparent that the survey must address several key topics frequently mentioned in the industry literature. Questions were formulated to address these key topics, and a list of questions was complied. After researchers evaluated the questions, the first draft of the survey was built.

One of the objectives of researchers in survey design was to create a completely self-explanatory questionnaire because there would be no interviewer to explain confusing or complex instructions or questions (Czaja and Blair 2005). Thus, a self-administered questionnaire was prepared.

Another objective of researchers was to design a short questionnaire survey to reduce the likelihood of participant attrition. The survey was designed to yield sufficient information to accurately assess the awareness of managers while still being short enough to be completed in roughly 5-10 minutes.

The choice of vocabulary and the visual design of the survey were carefully evaluated. Questions that contain unfamiliar or excessively technical terms were avoided because of the possibility that managers might not know or understand some of the words. Because visually attractive surveys have higher response rates, the order, form, and layout of questions were meticulously evaluated.

Survey Content

The final questionnaire was generated with the title of "*Human Factors and Ergonomics Awareness Survey*" (see Appendix 2). The questionnaire had eighteen questions in two sections. The questions in the first section asked for demographic properties of participants and information about their companies. The questions in the second section asked for the knowledge and opinions of managers through HF/E. Questions included a mix of yes-or-no, Likert-type rating scale, and multiple-choice (single or multiple answers) questions so that the method of response would most effectively match the individual question. The option of "*other*" for the multiple questions was given so that the participant could fill in the blank with his or her own answer. Yes-or-no type questions included the option of "*not sure.*" Participants had the option to skip any question if they did not wish to answer it.

The questionnaire survey also included a welcome page, an informed consent form page, a definition page, and an appreciation page. In the welcome page, participants were to enter their individually designated passwords. If they did not have one, they could see the questions or even respond to them by entering "*visitor*" as the password, but those who took the survey as a visitor were not accepted as a participant in analyses. This

was to avoid sampling errors. The link of the survey was published on public web sites, thus people who were not eligible to be a subject might see and participate in the survey.

The first page of the survey included a brief introductory message including the purpose of the survey, the confidentiality of data, potential risks of harm, contact information of researchers (if anyone wished to ask questions about the survey or to print out the survey and return it by mail after filling), and contact information of the local Regulatory Compliance Office (if any participant wished to ask questions about his/her rights as a research subject).

Following the questions in the first section, a definition page welcomed participants. This page included the definition of HF/E as defined by the International Ergonomics Association (IEA) and the link of IEA in case anyone desired to learn more about HF/E. The definition page also included a note in all capital letters that "*Human factors and ergonomics are used synonymously in this survey*." The aim of this statement was to prevent confusion of the minor meaning nuances.

When managers completed the survey, they saw an appreciation page. In this page, the researchers thanked to them for their participation. Researchers also encouraged managers to contact them if they had any additional thoughts, comments, or questions. This page also included the researchers' detailed contact information.

Review, Pretest, and IRB Approval

Questions in the survey were revised based on relevance of the goals, ease of answer, effectiveness, comprehension, and professionalism. The questionnaire had to be clear to those managers who might not have been familiar with the concept of HF/E. To

create such a questionnaire, the general scope, vocabulary, visual design of the survey, and the layout of questions were carefully reviewed by the help of committee members of this thesis and some other expert academicians. Three committee members, Dr. Steve L. Hunter, Dr. H. Michael Barnes, and Dr. Jilei Zhang, from the Department of Forest Products, Mississippi State University; Dr. Gary M. Bakken from the Department of Systems and Industrial Engineering, University of Arizona; Dr. Gary A. Mirka from the Department of Industrial and Manufacturing Systems Engineering, Iowa State University; Dr. Kari Babski-Reeves and Dr. Lesley Strawderman from the Department of Industrial and Systems Engineering, Mississippi State University; and Dr. Rubin Shmulsky from the Department of Forest Products, Mississippi State University reviewed the questionnaire survey.

A pre-test was conducted utilizing more than 20 graduate students. These graduate students were from different departments at Mississippi State University such as Chemical Engineering, Mechanical Engineering, Industrial Engineering, Aerospace Engineering, and Landscape Architecture. Most of the students were international students. In the pre-test, wordy, complex, uncertain, unrelated, and repeated questions were reported to the researchers so that researchers could develop the final questionnaire survey. The survey was tested by using different technologies as well. The survey was tested in different web browsers, different operating systems, different monitors, and different screen resolutions. Therefore, problems with the appearance of the questionnaire on different screens were avoided. Because the time needed to complete the survey was

critical, the time was recorded in pre-tests. The feeling of the researchers was: the shorter a survey, the higher participation ratio.

The survey was reviewed and approved by the Institutional Review Board (IRB) at Mississippi State University with the IRB approval number of 08-196 (see Appendix 3). The IRB for Human Subjects ensures that the survey would not harm the participants and would pose them minimal, if any, risk for financial standing, employability, insurability, or reputation. Researchers have been responsible for the protection of the rights and welfare of the human subjects in the study. All of these ethical and legal issues were included in the informed consent form presented to the managers to read and understand the nature of the research. If managers accepted all conditions and were 18 years old or older, they were required to click the button of "*I admit*" to start the survey. They had the option of refusal by clicking the button of "*I decline*." Lastly, contact information of the IRB office was provided to participants if they so wished.

Data Collection

After obtaining the IRB approval to protect human subjects in the research, the description including the link of the questionnaire was published on the web pages of the Department of Forest Products (http://www.cfr.msstate.edu/Forestp/furniture_survey.asp) and the Franklin Furniture Institute, Mississippi State University, and the data collection process initiated in December 2008.

First, contact names and e-mail addresses of managers in the industry were collected: 1) from people who had relationships with them through various professional organizations, associations, and societies managers could be members of; 2) from the

directory or yearbooks of associations, organizations, institutions and societies; 3) from the information of their companies' web pages; 4) from newspapers, journals, books, etc. which included their names, positions, and e-mail addresses; and 5) from the directory lists of conferences, meetings, and fairs; and 6) from direct contact with managers. From this, a list of 1,252 managers including their names, occupations, company names, locations, e-mail addresses, if available, was collected. Managers who were not related to manufacturing (for example, sales or marketing managers) were not included in the list.

Individual invitation e-mails (see Appendix 4) were sent to these managers. However, 266 of them could not be reached by e-mail, yielding a total of 986 invitees. Each e-mail included the aim of the study, a password for each participant, the link of the survey, the data confidentiality, and contact information of researchers. Because the survey was posted to publicly accessible websites, a unique personal password was given to participants. Passwords also ensured that only managers in the furniture manufacturing industry completed the survey and that they completed it only once. For members of associations and societies, only one password was provided for each organization. For example, all of the members of the Franklin Furniture Institute were given a single password to enter and complete the survey. One reminder e-mail was sent to non-respondents in order to increase the response rate. The sending process of the recruitment invitations finished in March 2009, and the data collection process was completed in April 2009.

Limitations in the Data Collection

There were some limitations in the data collection process. The first limitation was related to the sample coverage. The study only covered managers who had an e-mail address, so the coverage was limited to only those managers. Managers who did not have an e-mail account or did not want to give their e-mail addresses were not included in the survey. Incorrect or out-of-date e-mail addresses limited the coverage as well. Another limitation was that there was a little control over who responded to the questionnaire. One possibility was that another person in the company was using the e-mail account on behalf of the manager. Moreover, most of the managers did not want to participate in the survey. Some of the managers stopped during the survey and decided not to continue, or clicked the "*I decline*" button in the survey. Another limitation concerns the possibility that the invitation e-mails were considered as junk e-mails or spam. There was a high probability that managers judged the e-mail to be spam and therefore never opened it, or the managers' email systems judged the e-mail to be spam and therefore never delivered it.

Data Analysis Process

Once all the data was collected, the research hypotheses were investigated by applying statistical analyses. The analyses were performed by the Statistical Package for the Social Science (SPSS) for Windows version 17.0. First, the data was entered into the SPSS analysis software by coding, and then the coded data was processed. The Chi-square statistical test, a cross tabulation of the data, was applied to determine the association of managers' demographic properties (first six questions in the survey) and

managers' interests, knowledge, and commitments on HF/E (the remaining questions). The Chi-square test basically compares observed data (obtained from the sample) with expected data (that researchers expect to obtain according to their hypotheses). If the observed data and expected data distributions fit reasonably well, the Chi-square test assumes there is no significant difference between distributions in a specific significance level. The significant level for this study was set at $p \leq 0.05$. That is, if the probability or p-value is equal or below 0.05, it is interpreted that there is a significant difference between the observed value and the estimated value.

CHAPTER IV

RESULTS & DISCUSSION

Sixty-four managers from the American furniture manufacturing industry responded to the questionnaire survey asking about their awareness regarding HF/E in manufacturing. The distribution of answers, statistical analyses, comparisons with the literature - if any current literature is available - and discussions will be introduced in the section of results and discussion. After demographic profiles of responders are provided, the significant relationships between these profiles and the managers' answers will be evaluated by statistical tests.

Demographic Profiles of Managers

Demographic profiles of managers in the furniture manufacturing industry were asked in the early questions in the survey. A total of sixty-four managers participated in the survey, thirty-one of those were from Mississippi and the others were from other states in the U.S. Descriptive statistics of managers' demographic profiles are reported in Table 4. All demographic features of managers are classified by the states where companies were located.

In addition to demographic features of managers, company characteristics were critical in statistical analyses and interpretations. The data related to company

characteristics are reported in Table 5. The table provides the data of the sector types and sizes of the companies where subjects for the survey have worked.

Table 4 Managers' demographic profiles

	All (64)		**MS** (31)		**Others** (33)	
	Number	Percent	Number	Percent	Number	Percent
Position						
Owner	24	38.1	4	6.3	20	31.7
Top-level manager	8	12.7	4	6.3	4	6.3
Lower-level manager	31	49.2	22	34.9	9	14.3
Education						
High School	9	14.5	2	3.2	7	11.3
College	39	62.9	21	33.9	18	29
Graduate School	14	22.6	7	11.3	7	11.3
Experience in Furniture Industry						
Less than 3 years	7	10.9	3	4.7	4	6.2
3-10 years	13	20.3	8	12.5	5	7.8
More than 10 years	44	68.8	20	31.2	24	37.5
Experience in Current Position						
Less than 3 years	13	20.3	7	10.9	6	9.4
3-10 years	21	32.8	11	17.2	10	15.6
More than 10 years	30	46.9	13	20.3	17	26.6

Table 5 Company characteristics

	All (64)		**MS** (31)		**Others** (33)	
	Number	Percent	Number	Percent	Number	Percent
Sector (NAICS Code 337)						
Household (NAICS 3371)	37	57.8	25	39.1	12	18.8
Office (NAICS 3372)	15	23.4	2	3.1	13	20.3
Other (NAICS 3379)	12	18.8	4	6.2	8	12.5
Number of employees						
0-49	30	46.9	6	9.4	24	37.5
50-249	16	25	10	15.6	6	9.4
249 or more	18	28.1	15	23.4	3	4.7

As can be seen in the tables above related to the managers' profiles and their companies' characteristics;

- most of the owners were from the other states (83.3%), and most of the lower-level managers were from Mississippi (70.9%),
- most of the managers have college degrees (62.9%) and less than a quarter of managers have graduate level degrees (22.6%),
- about 70 percent of managers have more than 10 years of experience in the furniture manufacturing industry (68.8%),
- about half of the managers have worked in the same position for more than 10 years (46.9%),
- half of the managers have worked in the Household and Institutional Furniture and Kitchen Cabinet Manufacturing (NAICS Code 3371). As a detail, the majority of professional personnel working in the Household and Institutional Furniture and Kitchen Cabinet Manufacturing (NAICS Code 3371) industry are actually working in the Upholstered Household Furniture Manufacturing (NAICS Code 337121) sub sector. The rest of the professional personnel have worked in the Office Furniture (Including Fixtures) Manufacturing (NAICS Code 3372) and the Other Furniture Related Products Manufacturing (NAICS Code 3379). The Other Furniture Related Products Manufacturing (NAICS Code 3379) includes mattress, blind, and shade manufacturing sub sectors, and
- about half of the companies were small size companies (46.9%), and the rest of the companies were middle size (25%) and large size (28.1%).

The data distribution in this survey shows the same distribution of the actual population characteristics because (1) Mississippi is one of the nation's top states in furniture production, so most of the large companies are located in Mississippi while other states generally have smaller furniture manufacturing companies; (2) large companies occupy many top- and lower-level managers while small companies generally occupy owners and few managers; and (3) generally, large companies occupy employees who have a high education background. Therefore, if a manager from furniture production is selected from Mississippi, then there is a high possibility that he will probably be a top- or lower-level manager with a high level of education and will be working in a large size furniture manufacturing company. Likewise, if a manager from furniture production is selected from one of the other states, there is a high possibility that he will probably be an owner with a lower-level education and working in a smaller sized furniture manufacturing company.

Managers' Familiarity with Human Factors and Ergonomics

Managers were asked more questions related to their background or their familiarities with HF/E. The first question was whether managers had attended a formal training program in HF/E or not. Human factors and ergonomics education programs have a significant effect on increasing awareness (Albers *et al.* 1997; Pehkonen *et al.* 2009), resulting in safety, health, productivity, and efficiency. Human factors and ergonomics integrated occupational educational programs, especially participatory based, play a key role in occupational injury and illness control strategies (Albers *et al.* 1997).

Human factors and ergonomics programs can provide considerable benefits to organizations when they are properly implemented (Goggins *et al.* 2008). Guastello's literature search (1993) revealed that various accident prevention programs had a considerable effect on reducing occupational accidents by fifty percent. He also mentioned that HF/E interventions were not widely applied even though most of them showed vast achievements in the program (Guastello 1993).

After reviewing literature and searching in the Internet, Goggings and his colleagues summarized 250 case studies in their report. The average productivity increase of 60 HF/E programs was 25 percent (Goggins *et al.* 2008). The summary table of 250 cases is given in Table 6.

Table 6 Effectiveness measures from Goggings *et al.* 2008 Review (250 case studies)

	Number of Studies	**Average Reduction**
Number of MSDs	90	59%
Incidence date	53	65%
Lost workdays	78	75%
Restricted days	30	53%
Workers' comp. costs	52	68%
Cost per claim	7	39%
Labor cost	6	43%
Errors	8	67%
Turnover	34	48%
Absenteeism	11	58%
Payback period	36	0.7 years
Cost:Benefit ratio	5	1:18.7

The other question in this survey was whether managers had any certification in HF/E. The breakdown of the answers to each question is shown in Table 7.

Approximately, 2 out of 3 managers stated that they have not attended a formal training program in HF/E. The rate of occupational injuries and illnesses in the furniture manufacturing industry was 6.7 in 2007 (BLS 2009b). If managers' participation in HF/E training programs increases, the awareness level of managers can increase, resulting in decreased occupational injuries in the industry. Therefore, managers should be advised to participate in training programs.

Table 7 Managers' familiarity with human factor and ergonomics

Questions	**Yes**		**No**		**Total**
	(N)	(%)	(N)	(%)	(N)
Have you ever attended a formal training program in human factors and ergonomics?	18	28.6	45	71.4	63
Do you have any certification in human factors and ergonomics?	0	0	61	100	61

Unfortunately, none of the managers who participated in this survey had certification in HF/E. Certifications show that individuals participate and complete training programs and have sufficient knowledge and experience in the subject. Certified Professional Ergonomist (CPE), Certified Human Factors Professional (CHFP), Certified User Experience Professional (CUXP), Associate Ergonomics Professional (AEP), Associate Human Factors Professional (AHFP), Associate User Experience Professional

(AUXP), and Certified Ergonomics Associate (CEA) are some common certification programs (BCPE 2009).

A Chi-square statistical test was performed. According to the test results (Table 8), there is a significant relationship ($p \leq 0.004$) between the state where managers work and managers' participation in training programs.

Table 8 Statistical test results of managers' demographic properties and managers' familiarity with human factors and ergonomics

		State	Education	NAICS	Employees	Experience in FI	Position	Experience in P
Attending a formal training	χ^2	8.231	1.882	1.015	13.199	0.468	6.566	0.105
	P	***0.004****	0.390	0.602	***0.001****	0.791	***0.038****	0.949

A * indicates a significant relationship between managers' demographic properties and their answers at $p \leq 0.05$.
χ^2 : Chi-square value,
p: p-value (The level of statistical significance).

The participation in training programs is higher among Mississippian managers (Figure 7). Three quarters of managers who have ever attended at least one training program were from Mississippi. On the other hand, 62.2 percent of managers who have never attended a training program were from the other states.

The higher participation of Mississippian managers might be the consequence of Mississippi's leadership in furniture manufacturing. Mississippi has many large furniture companies. Because large companies have generally more opportunity to provide training for their employees, there is a high possibility that attending training programs is higher among Mississippian managers. This interpretation is statistically supported. The test found a significant relationship ($p \leq 0.001$) between company size and attending training programs. Managers who work in smaller companies, those with less than forty-nine

employees, have a lower opportunity to attend training programs rather than managers who work in companies with 250 or more employees (Figure 8).

The last significant relationship ($p \leq 0.038$) is found among attending training programs and managers' current positions. The ratio of owners' participation to training programs is lower than the ratio of lower-level managers' participation (see Figure 9).

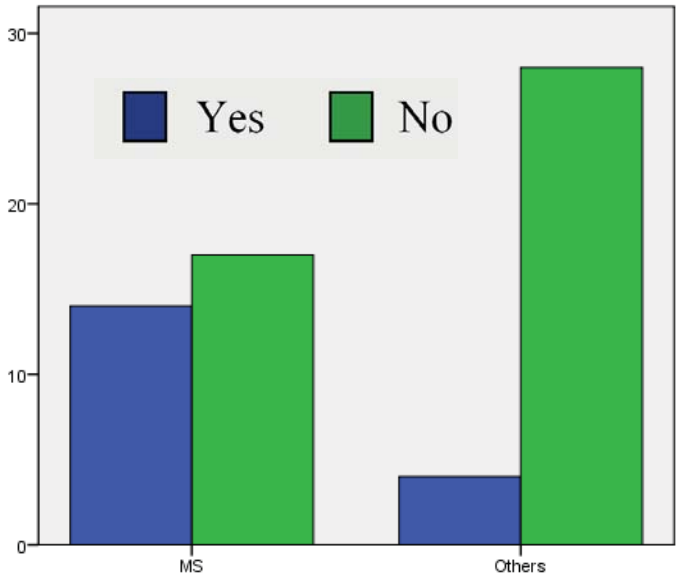

Figure 7 Attending training programs of Mississippian vs. other states' managers

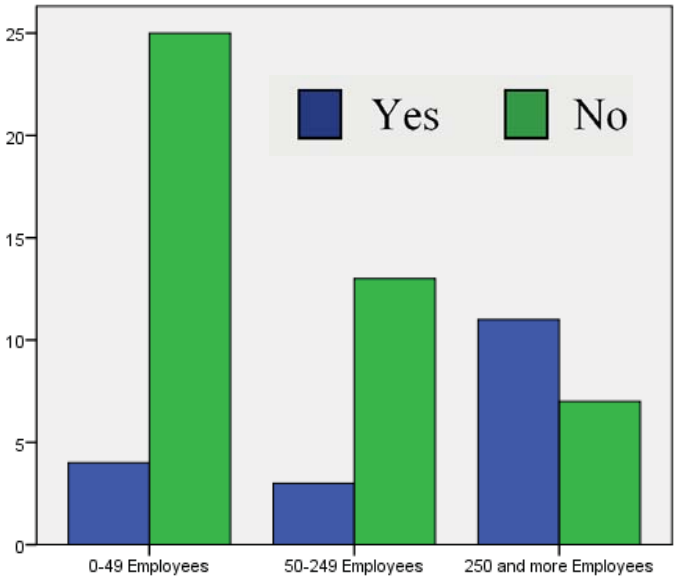

Figure 8 Attending training programs of managers who work in different size companies

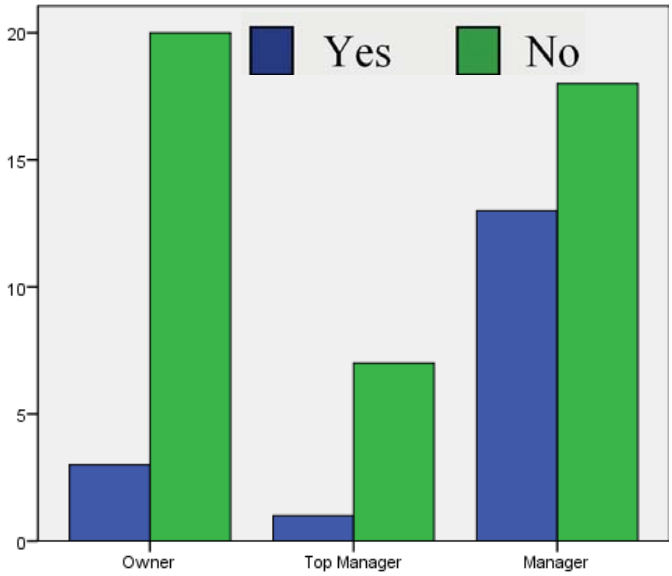

Figure 9 Attending training programs of owners, top-level managers, and lower-level managers

Because there were no managers with certification in HF/E, the statistical analysis could not be performed. Therefore, statistical interpretation was not possible.

To summarize managers' familiarity with HF/E: most of the managers were not familiar with training programs and, possibly certification programs in HF/E, so they might be deprived of many advantages of training programs.

Managers' Knowledge on Human Factors and Ergonomics

Managers were asked to rate their knowledge on HF/E. A five point Likert-scale was provided for them to evaluate their knowledge. The results of answers are shown in Table 9.

Table 9 Managers' knowledge on human factor and ergonomics

Poor (1)		**Fair (2)**		**Average (3)**		**Very Good (4)**		**Excellent (5)**		**Rating Average**
(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)	
11	17.2	13	20.3	24	37.5	15	23.4	1	1.6	**2.72**

According to results of managers' self-evaluations, the average knowledge level was 2.72. This result means that the knowledge level was between fair and average, but it was close to the average level of knowledge. Only a quarter of the managers thought that their knowledge level was higher than the average level; very good (23.4%) or excellent (1.6%). Eleven managers (17.2%) rated their knowledge level as poor. Consequently, the result of the knowledge level scale was compatible with the hypothesis that managers know little about HF/E. There is no significant statistical relationship between managers' demographic properties and their knowledge levels (Table 10).

Table 10 Statistical analysis of managers' demographic properties and knowledge level

		State	Education	NAICS	Employees	Experience in FI	Position	Experience in P
Knowledge Level	χ^2	6.391	8.532	6.854	8.293	2.844	10.637	3.964
	p	0.172	0.383	0.553	0.405	0.944	0.223	0.860

A * indicates a significant relationship between managers' demographic properties and their answers at $p \leq 0.05$.
χ^2 : Chi-square value,
p: p-value (The level of statistical significance).

Manager's Preference for Information Resources Concerning Human Factors and Ergonomics

Amazing developments in science and technology have resulted in the higher availability of information resources concerning HF/E. The higher availability of information resources provides a better learning environment for managers (Broberg 2007). However, managers' preferences on information resources vary from manager to manager. According to the result of the question about preference of the information resources (Figure 10), reading books, journals, newspapers, and magazines (76.7%) were the most preferred information resources.

The Internet (54.7%) was listed as a very important resource for learning about HF/E as well. Some of the managers mentioned that they had attended conferences, meetings, and conventions (42.4%), consulted a human factors specialist or an ergonomist expert (23.4%), used computer software (7.8%), and applied to other types of information resources (6.3%). Unfortunately, 17.2 percent of managers mentioned that they were not aware of information resources about HF/E. That is, those managers did not use any of these information resources to learn about HF/E.

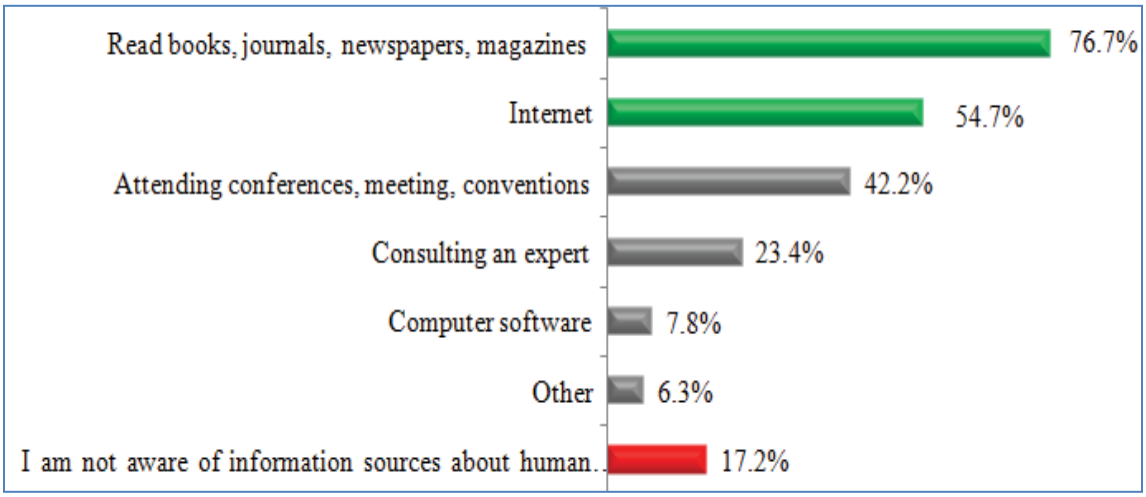

Figure 10 Managers' preference for information resources related human factors and ergonomics

The Chi-square statistic analysis was performed to understand the relationship between managers' demographic properties and managers' preferences on information resources. The result of the analysis is given in the Table 11.

The statistical analysis showed that there was a significant relationship between the states where the companies were located and whether managers attended conferences, meetings, and conventions ($p \leq 0.000$) or consulted an expert ($p \leq 0.027$). Managers from Mississippi attended conferences, meetings, and conventions more than managers from the other states (Figure 11). They also consulted an HF/E expert to get information or to find a solution to their problems (Figure 12).

Table 11 Statistical analysis of managers' demographic properties and preference for information resource

		State	Education	NAICS	Employees	Experience in FI	Position	Experience in P
Reading	χ^2	0.188	1.880	1.525	2.545	0.729	0.051	0.507
	p	0.665	0.391	0.467	0.280	0.695	0.975	0.776
Attending meetings	χ^2	12.290	0.341	0.698	6.006	0.953	7.102	0.094
	p	***0.000****	0.843	0.705	***0.050****	0.621	***0.029****	0.954
Internet	χ^2	0.001	2.536	1.056	0.643	0.367	1.488	0.077
	p	0.981	0.281	0.590	0.725	0.832	0.475	0.962
Consulting to an expert	χ^2	4.862	2.509	0.410	1.771	0.729	2.180	1.415
	p	***0.027****	0.285	0.851	0.413	0.695	0.336	0.493
Computer software	χ^2	2.163	1.593	1.506	1.827	0.693	0.702	0.471
	p	0.141	0.451	0.471	0.401	0.707	0.704	0.790
Not aware of information sources	χ^2	0.047	1.545	6.569	3.003	0.102	2.677	1.476
	p	0.828	0.462	***0.037****	0.223	0.905	0.262	0.478

A * indicates a significant relationship between managers' demographic properties and their answers at $p \leq 0.05$.
χ^2 : Chi-square value,
p: p-value (The level of statistical significance).

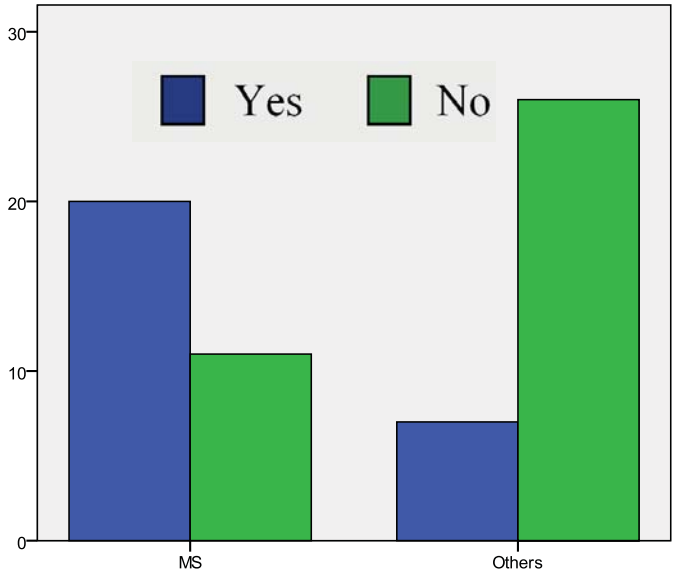

Figure 11 Conference, meeting, and convention attendance of managers from Mississippi vs. other states

In fact, attending conferences, meetings, and conventions was a function of the companies' resource availability. Larger size companies have more resources to allocate for conferences, meetings, and conventions related to HF/E. This significant relationship ($p \leq 0.050$) can be seen in Figure 13.

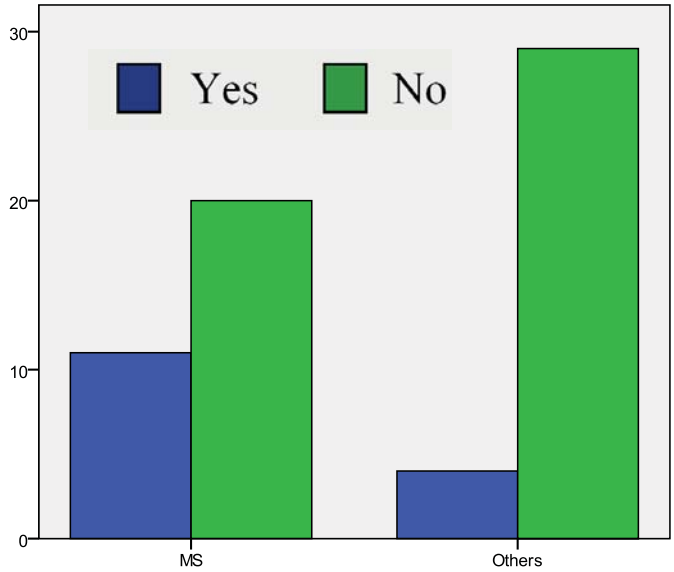

Figure 12 Consulting an expert of human factors and ergonomics, Mississippi managers vs. other states

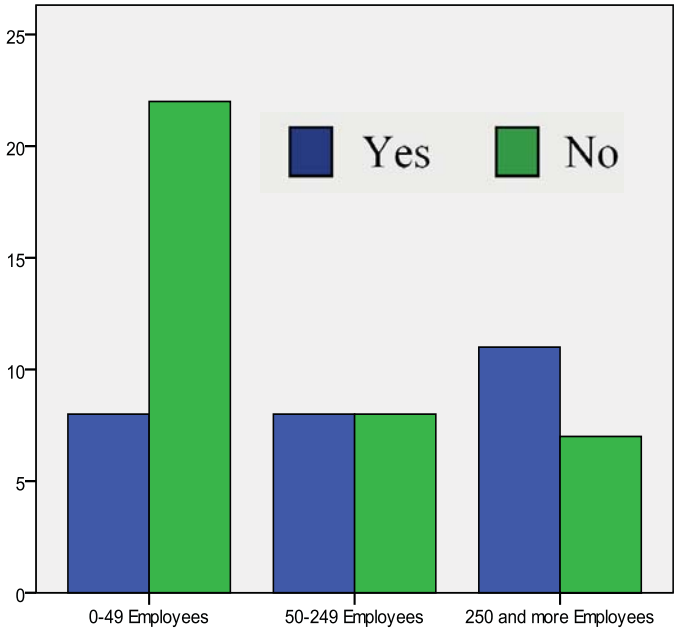

Figure 13 Conference, meeting, and convention attendance of managers from different size companies

There is also a significant relationship ($p \leq 0.029$) between attending conferences, meetings, and conventions and managers' current positions. As can be seen from Figure 14, most of the owners (75%) have not attended any conferences, meetings, and conventions related to HF/E. However, a huge number of lower-level managers (58.1 %) attended these meetings. Hence, the interpretation that lower-level managers paid more attention than owners would not be wrong.

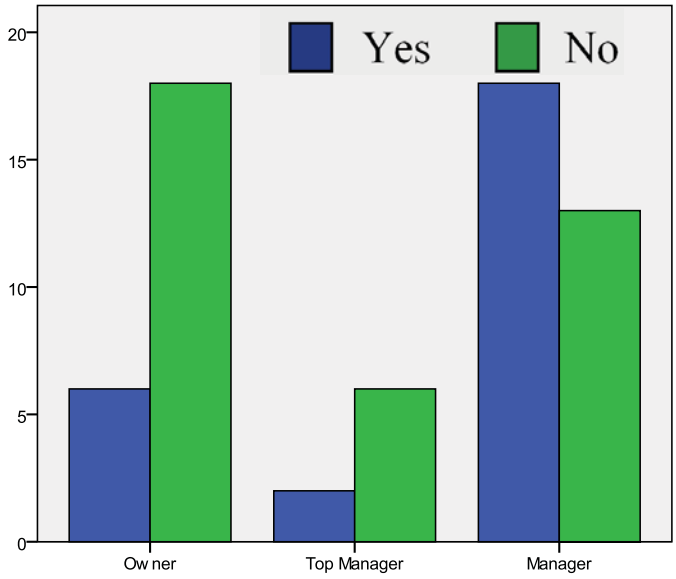

Figure 14 Conference, meeting and convention attendance of managers from different positions

The subsector of industry is also a factor of awareness about information resources related to HF/E (Figure 15). Managers in the subsectors of the Household and Institutional Furniture, Kitchen Cabinet Manufacturing (NAICS 3371), and the Office Furniture (including Fixtures) Manufacturing (NAICS 3372) expressed that they were not aware of any information resources related to HF/E. On the other hand, managers who were working in the Other Furniture Related Product Manufacturing (NAICS 3379)

subsector showed more awareness of information resources. This relationship is significantly found in the Chi-square test ($p \leq 0.037$). Because other relationships were not significantly important, they are not presented here.

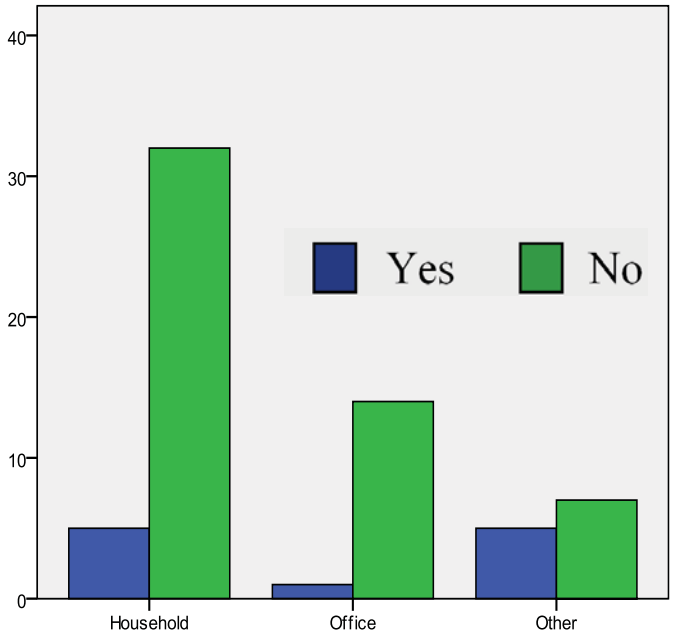

Figure 15 Awareness of information resources of managers from different industry subsectors

Managers' Opinion on Likely Benefits and Disadvantages of Human Factors and Ergonomics

Likely Benefits of Human Factors and Ergonomics

There is no doubt that HF/E has a myriad of advantages for both employees and organizations. Hendrick (1996b) shortly expresses the advantages of HF/E programs in his comprehensive literature review titled "*Good Ergonomics is Good Economics*." He explained the advantages of HF/E by saying, "*a wonderful common ground for labor and*

management collaboration, for invariably both can benefit – managers, in terms of reduced costs and improved productivity, employees in terms of improved safety, health, comfort, usability of tools and equipment, including software, and improved quality of work" (Hendrick 1996b). However, the problem is whether managers are aware of these advantages or not.

To mention some current literature for the benefits of HF/E would be beneficial before sharing the result of the survey. The advantages of HF/E can be given in two chapters: advantages to workers and advantages to the organization.

Advantages of Human Factors and Ergonomics to Workers

Many researchers agree that HF/E interventions result in an increase in productivity (Pulat and Alexander 1991; Sundstrom 2000; Hendrick and Kleiner 2002; Beevis and Slade 2003; Douphrate and Rosecrance 2004; Mirka 2005; Goggins *et al.* 2008). A research found that five years after a HF/E program was initiated in one company, productivity more than doubled (MacLeod and Morris 1996).

Improved workers' well-being (Michael and Wiedenbeck 2004), reduced work-related injuries (MacLeod and Morris 1996; AFMA and NCDOL 2003; Goggins *et al.* 2008), increased worker's safety (MWCC 2008), improved quality of work life (Goggins *et al.* 2008), more satisfied workers (Schneider 1985; Sundstrom 2000; Hendrick and Kleiner 2002), improved worker morale (Michael and Wiedenbeck 2004), increased worker comfort (MacLeod and Morris 1996), less absenteeism (Schneider 1985; Douphrate and Rosecrance 2004; Michael and Wiedenbeck 2004; Goggins *et al.* 2008),

and more energetic workers (Michael and Wiedenbeck 2004) are some other advantages of HF/E for workers.

Advantages of Human Factors and Ergonomics to the Organization

In addition to aiding workers, HF/E has many other advantages for companies, such as increased system productivity (Pulat and Alexander 1991; MacLeod 1995; Michael and Wiedenbeck 2004), less disruption on the system, less employee turnover (Schneider 1985; Douphrate and Rosecrance 2004; Michael and Wiedenbeck 2004; Goggins *et al.* 2008), reduced labor costs (Pulat and Alexander 1991; Douphrate and Rosecrance 2004; Goggins *et al.* 2008; MWCC 2008), reduced workers' compensation costs (Pulat and Alexander 1991; MacLeod 1995; Hendrick and Kleiner 2002; AFMA and NCDOL 2003; Beevis and Slade 2003; Douphrate and Rosecrance 2004; Goggins *et al.* 2008; Kim *et al.* 2008; MWCC 2008), improvements in the working environment (Beevis and Slade 2003), reduced maintenance personnel and materials (Hendrick and Kleiner 2002; Hendrick 2003), and reduced training time for employees.

Occupational injuries and illnesses are unappreciated contributors to the total burden of health care costs in the U.S. (Leigh *et al.* 1997). If companies reduced costs with the help of HF/E, they could allocate resources to designing new products to be brought to market (Douphrate and Rosecrance 2004). Therefore, the reduction in costs could result in high competitiveness ability for companies. Piegorsch (1994) found that a 20-30 percent reduction in furniture manufacturing costs can be obtained by only redesigning work processes. It is obvious that reducing costs also results in increasing the ability of survival in the business world. Likewise, HF/E programs can result in a positive

return on investment (Michael and Wiedenbeck 2004; Goggins *et al.* 2008) because of reduced workers compensation cost savings (MacLeod and Morris 1996), improvements in productivity (Schneider 1985; MacLeod and Morris 1996), reduced maintenance errors, and increased safety (Robertson 2001).

There are several studies indicating that the quality of the product is fairly influenced by HF/E (Dul and Neumann; Pulat and Alexander 1991; Eklund 1995; Drury 2000; Hendrick and Kleiner 2002; Douphrate and Rosecrance 2004; Michael and Wiedenbeck 2004; Goggins *et al.* 2008). This can be caused from high job satisfaction in workplaces. Eklund (1995) emphasizes the relationship between job satisfaction and high quality task performance.

In this thesis, managers were asked to check whether they were aware of the advantages of HF/E. The managers' responses are given in the Figure 16 by the order of frequency.

Over seventy five percent of managers believed that HF/E has an impact on increasing workers' performance (90.6%), reducing occupational injuries (87.5%), decreasing worker's compensation costs (75%), and improving work place quality (75%). More than seventy percent of managers thought that HF/E also has an impact on increasing satisfied workers (71.9%), worker safety (71.9%), and worker comfort (70.3%). Less absenteeism (68.8%), cost savings (65.6%), higher morale (64.1%), increased system productivity (57.8%), and better product quality (56.3%) were marked by more than half of the managers. Less than half of the managers believed that HF/E has positive impacts on higher competitiveness (42.4%), long-term company survival

(42.4%), and reducing illnesses (40.6%) and fatalities (37.5%). On the other hand, one manager mentioned that there were no benefits to HF/E.

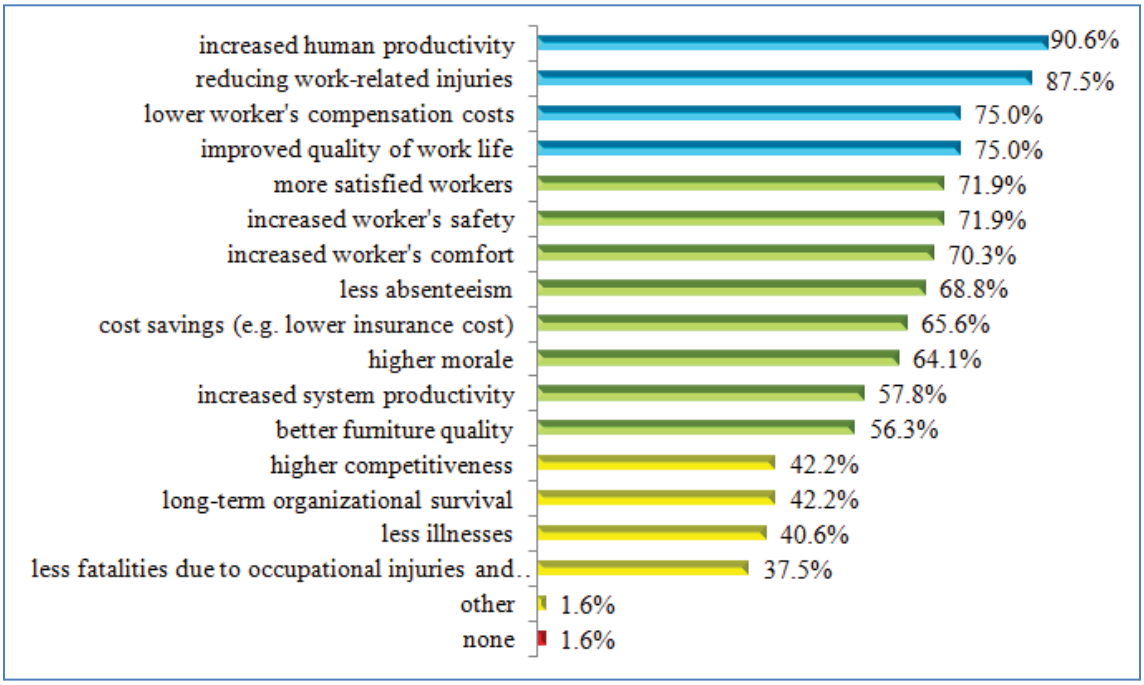

Figure 16 Likely benefits of human factors and ergonomics

For the aim of finding significant relationships between managers' demographic profiles and managers' opinions about the likely advantages of HF/E, a Chi-square statistical test was performed. The results of this statistical test are given in Table 12.

Table 12 Statistical analysis of managers' demographic properties and opinions regarding the likely advantages of human factors and ergonomics

		State	Education	NAICS	Employees	Experience in FI	Position	Experience in P
Human Productivity	χ^2	2.676	0.537	4.264	3.531	3.935	2.930	1.955
	p	0.102	0.764	0.119	0.171	0.140	0.231	0.376
System productivity	χ^2	0.298	1.175	1.599	0.841	2.862	1.230	5.361
	p	0.585	0.556	0.450	0.657	0.239	0.541	0.069
Reduced injuries	χ^2	4.728	1.109	2.277	3.619	5.435	2.524	2.699
	p	***0.030****	0.574	0.320	0.164	0.066	0.283	0.259
Less illnesses	χ^2	0.043	1.335	3.061	0.178	3.457	0.826	0.719
	p	0.836	0.513	0.216	0.915	0.178	0.662	0.698
Less absenteeism	χ^2	3.960	4.325	0.094	2.851	2.583	2.799	3.898
	p	0.047	0.115	0.954	0.240	0.275	0.247	0.142
Lower compensation	χ^2	4.692	1.925	4.930	7.563	5.179	10.394	0.672
	p	0.030	0.382	0.085	***0.023****	0.075	***0.006****	0.715
Cost saving	χ^2	8.873	0.395	4.921	6.009	1.036	7.240	2.116
	p	0.003	0.821	0.085	***0.050****	0.596	***0.027****	0.347
Satisfied workers	χ^2	2.288	0.095	0.281	1.037	0.900	0.433	0.218
	p	0.130	0.954	0.869	0.595	0.638	0.805	0.897
Higher morale	χ^2	1.245	0.097	0.789	0.077	2.018	1.344	1.378
	p	0.264	0.953	0.674	0.962	0.365	0.511	0.502
Quality of work life	χ^2	2.523	1.354	0.653	0.452	0.810	1.184	0.828
	p	0.112	0.508	0.721	0.798	0.667	0.553	0.661

A * indicates a significant relationship between managers' demographic properties and their answers at $p \leq 0.05$.
χ^2 : Chi-square value,
p: p-value (The level of statistical significance).

Table 12 (continued)

		State	Education	NAICS	Employees	Experience in FI	Position	Experience in P
Workers comfort	χ^2	0.434	1.366	2.880	0.052	1.524	2.349	1.114
	p	0.510	0.505	0.237	0.975	0.467	0.309	0.573
Worker safety	χ^2	2.288	1.257	6.681	3.676	2.073	5.906	0.477
	p	0.130	0.533	***0.035****	0.159	0.355	0.052	0.788
Less fatalities	χ^2	1.506	5.366	2.906	0.646	0.115	1.469	1.860
	p	0.220	0.068	0.234	0.724	0.944	0.480	0.395
Furniture quality	χ^2	5.292	2.010	0.179	0.429	0.039	0.535	1.122
	p	***0.021****	0.366	0.914	0.807	0.981	0.765	0.571
Competitiveness	χ^2	3.945	1.937	0.048	1.838	1.978	3.748	1.103
	p	***0.047****	0.380	0.976	0.399	0.372	0.154	0.576
Survive	χ^2	3.945	0.661	0.799	1.251	5.082	2.974	5.854
	p	***0.047****	0.719	0.671	0.535	0.079	0.226	0.054
No benefits	χ^2	0.954	5.985	4.402	3.048	3.985	1.049	2.080
	p	0.329	***0.050****	0.111	0.218	0.136	0.592	0.353

A * indicates a significant relationship between managers' demographic properties and their answers at $p \leq 0.05$.
χ^2 : Chi-square value, p: p-value (The level of statistical significance).

According to the results of the statistical test, there were significant relationships between the state where companies are located and managers' opinion that HF/E has an impact on injury reduction ($p \leq 0.030$), increased furniture quality ($p \leq 0.021$), increased company competitiveness ($p \leq 0.047$), and ensuring longer survival ($p \leq 0.047$). The 87.5 percent of managers who believed that HF/E does not have an impact on occupational injury reduction were from other states, while the other 12.5 percent were from Mississippi (Figure 17). In the same way, managers from other states believed less than

managers from Mississippi that HF/E results in increased furniture quality (Figure 18), higher competitiveness (Figure 19), and longer survival time (Figure 20).

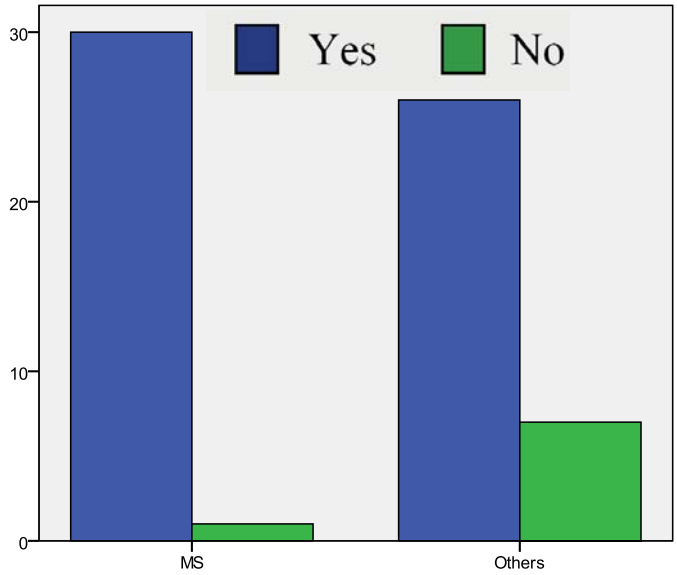

Figure 17 Mississippi vs. other states on managers' opinions about reduced injury benefits

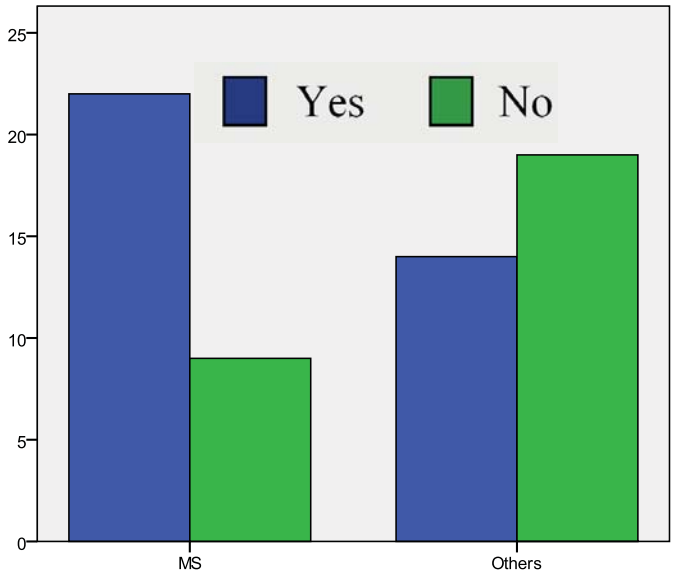

Figure 18 Mississippi vs. other states on managers' opinions about product quality benefits

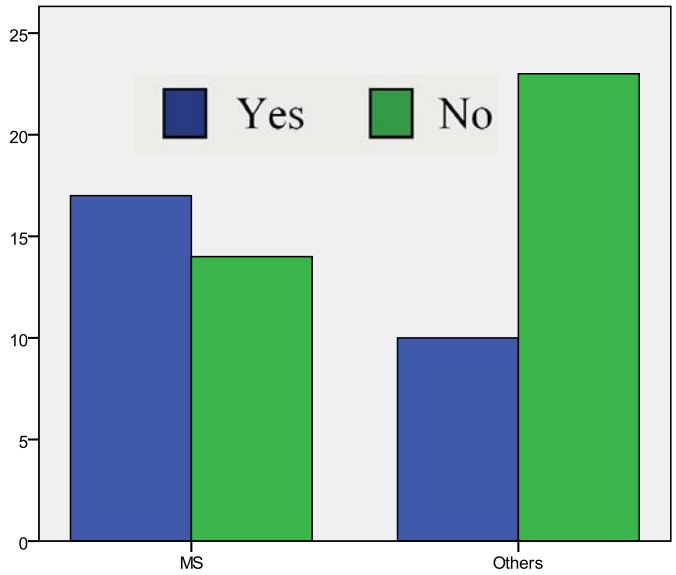

Figure 19 Mississippi vs. other states on managers' opinions about increased competitiveness benefits

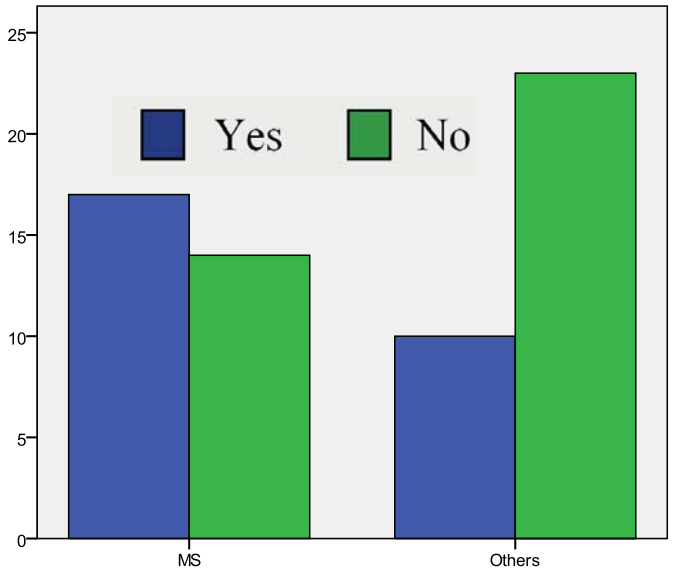

Figure 20 Mississippi vs. other states on managers' opinions about increased survival time

Because only one person mentioned that there is no advantage of HF/E, the interpretation will not be meaningful even though the relationship was statistically meaningful ($p \leq 0.050$).

There was a significant relationship ($p \leq 0.035$) between the sector and the opinion of increased worker safety. Managers from the Other Furniture Related Products Manufacturing (NAICS Code 3379) subsector thought that HF/E does not have any advantages on increased worker safety (Figure 21).

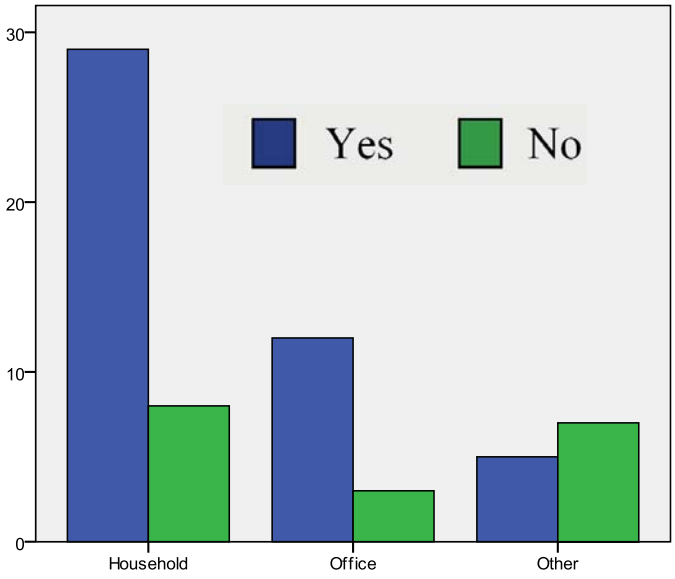

Figure 21 Sector and opinions on worker safety

Employee number or the size of company also has an impact on managers' opinions relating to the advantages of HF/E. In comparison, managers working in small companies believed much less that HF/E can reduce compensation costs ($p \leq 0.023$) (Figure 22) and result in cost savings (e.g. lower insurance cost) ($p \leq 0.050$) (Figure 23).

Likewise, owners and top-level managers believed less that HF/E can reduce compensation costs ($p \leq 0.006$) (Figure 24) and result in cost savings (e.g. lower insurance cost) ($p \leq 0.027$) (Figure 25) than their lower-level counterparts.

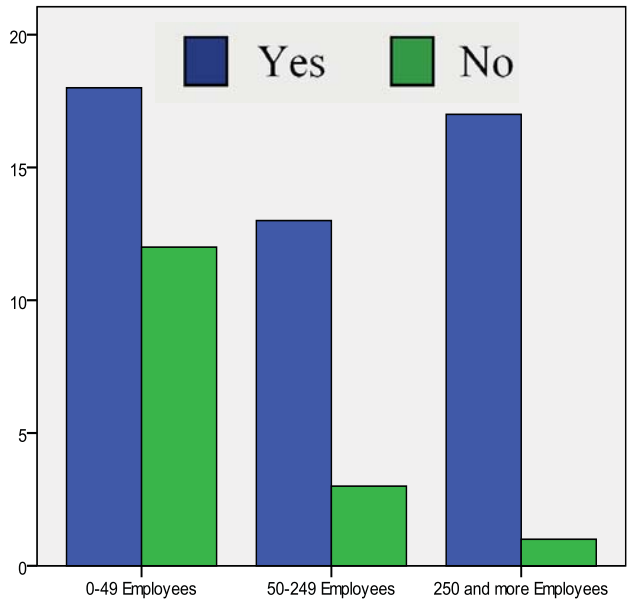

Figure 22 Company size and managers' opinions about worker's compensation

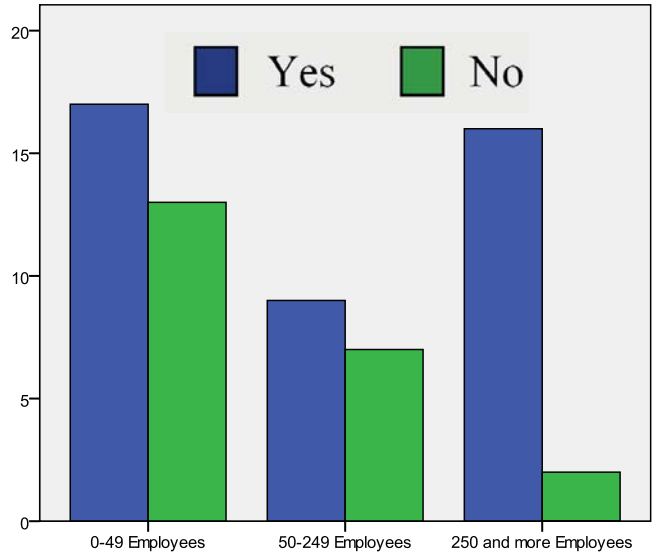

Figure 23 Company size and managers' opinions about cost savings

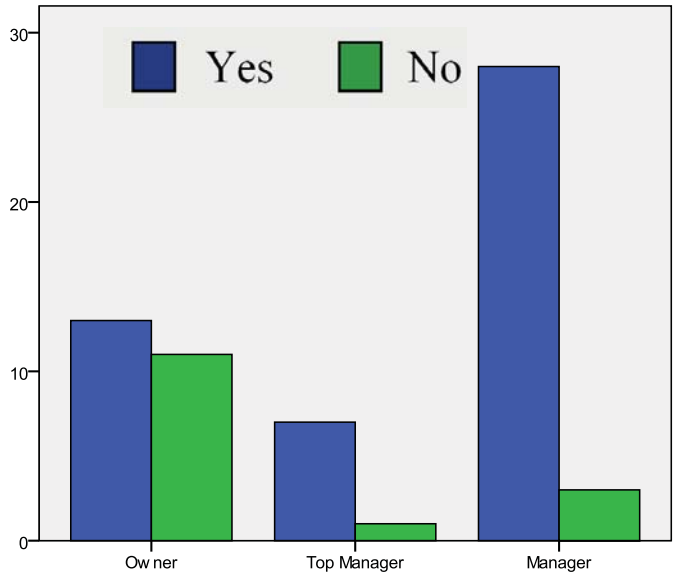

Figure 24 Managers' positions and its affect on their opinion about reduced compensation

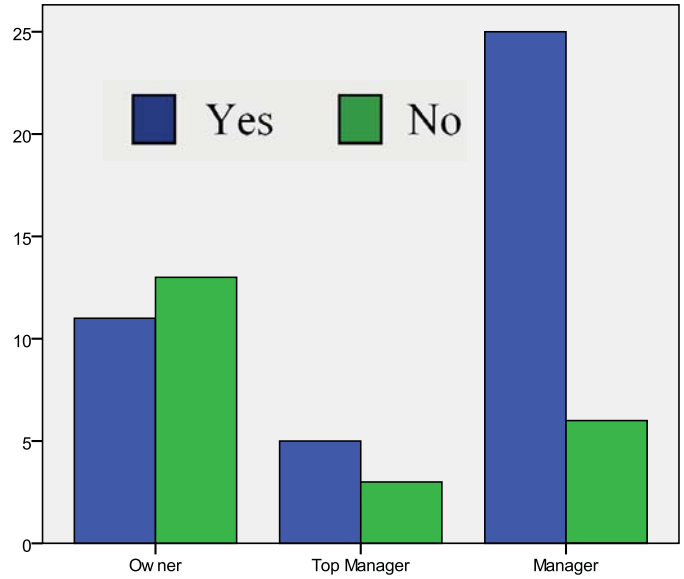

Figure 25 Managers' positions and its affect on their opinion about cost savings

Likely Disadvantages of Human Factors and Ergonomics

Likewise, managers were asked whether there were any disadvantages of HF/E. Managers' responses are given in Figure 26 by the order of frequency.

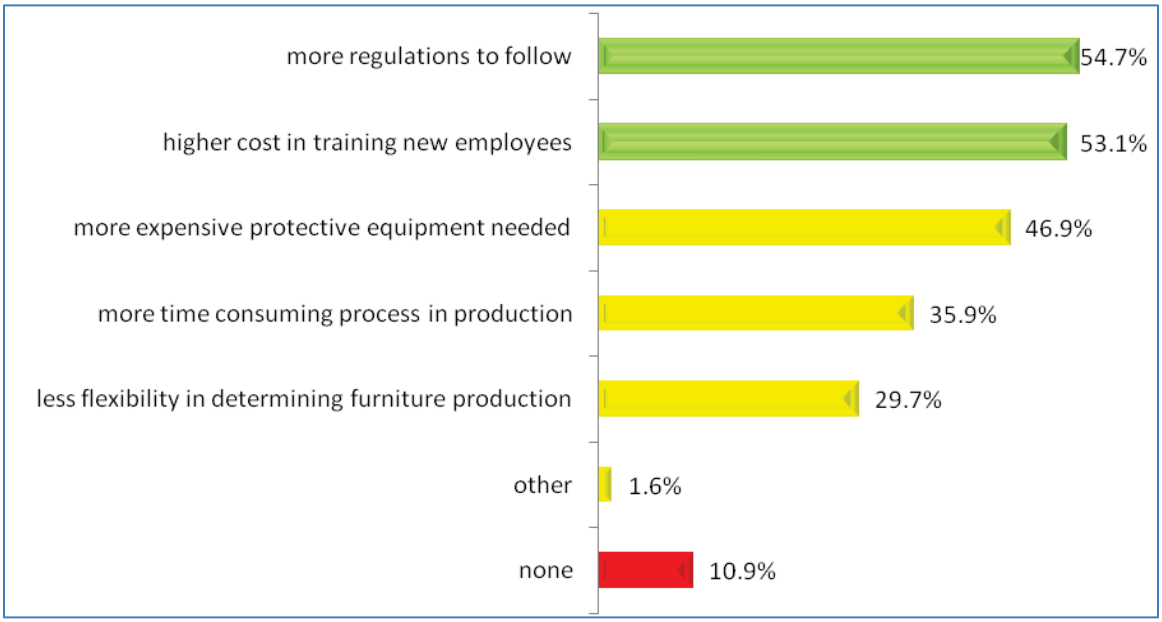

Figure 26 Likely disadvantages of human factors and ergonomics

Over half of the managers believed that HF/E resulted in more regulations to follow (54.7%) and higher cost in training new employees (53.1%). Less than half of the managers believed that HF/E has some disadvantages such as more expensive protective equipment needed (46.9%), more time-consuming process in production (35.9%), and less flexibility in determining furniture production (29.7%). Seven managers (10.9%) believed that there were no disadvantages of HF/E at all.

After performing statistical analysis to determine relationships between managers' demographic profiles and managers' opinions about the likely disadvantages of HF/E, the results are given in Table 13.

Table 13 Statistical analysis of managers' demographic properties and opinions regarding the likely disadvantages of human factors and ergonomics

		State	Education	NAICS	Employees	Experience in FI	Position	Experience in P
More regulation to fallow	χ^2	2.202	2.556	0.872	1.204	0.480	0.764	2.619
	p	0.138	0.279	0.647	0.548	0.787	0.683	0.270
Higher training costs	χ^2	3.133	0.564	0.060	2.895	1.823	1.359	1.155
	p	0.077	0.754	0.970	0.235	0.402	0.507	0.561
Time consuming	χ^2	0.939	1.749	2.041	2.158	10.510	3.550	11.115
	p	0.332	0.417	0.360	0.340	***0.005****	0.170	***0.004****
Expensive equipment	χ^2	0.589	5.344	3.620	0.106	1.117	4.589	3.410
	p	0.443	0.069	0.164	0.948	0.572	0.101	0.182
Less flexibility	χ^2	3.075	0.946	0.222	0.052	1.275	1.124	3.150
	p	0.080	0.623	0.895	0.975	0.529	0.570	0.207
No disadvantages	χ^2	0.098	1.362	0.797	0.752	2.006	2.291	4.722
	p	0.754	0.506	0.671	0.687	0.367	0.318	0.094

A * indicates a significant relationship between managers' demographic properties and their answers at $p \leq 0.05$.
χ^2 : Chi-square value,
p: p-value (The level of statistical significance).

The results of the statistical test showed that HF/E was considered as a more-time consuming process in production by managers experienced in the furniture industry ($p \leq 0.005$) (Figure 27) and experienced in the position ($p \leq 0.004$) (Figure 28). Therefore, it can be said that younger managers or less-experienced managers in either industry or in their position believed that HF/E was beneficial and did not cause time consuming processes in production.

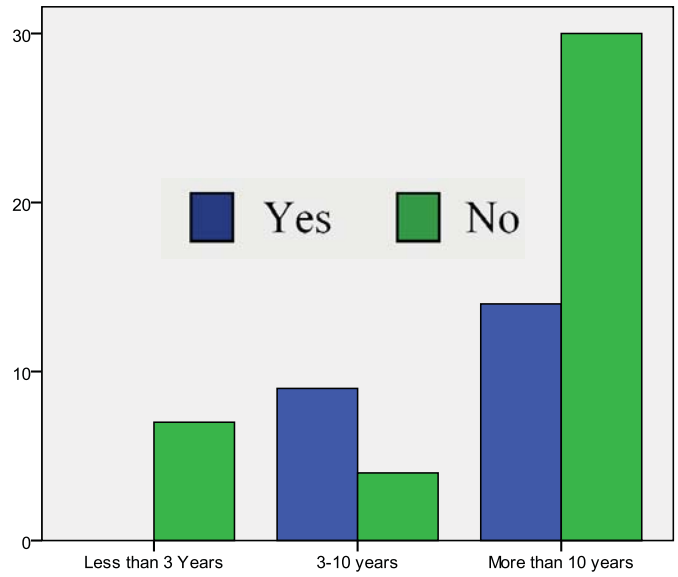

Figure 27 Managers' experience in furniture industry and its affect on their opinion about time consumption

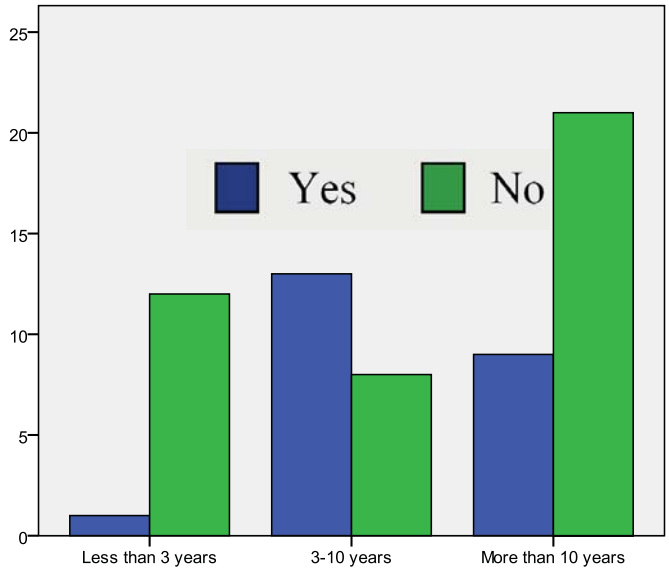

Figure 28 Managers' experience in their current position and its affect on their opinion about time consumption

A similar question was asked by Kim and his colleagues (Kim *et al.* 2008). Their aim was to determine current knowledge and opinions of twelve panel designers on the

subject of workers' ergonomic risks. This aim was shared in this thesis as well. Both researches were conducted to better understand the knowledge and opinions of decision makers regarding HF/E. The results of both researched are shown in Figure 29. In the figure, bars with light color are results of the study conducted by Kim *et al.* (2008), and bars with dark color are results obtained in this research. Initials after the answers can help to understand the figure. The initial of (K) was used to address the questions asked by Kim and his colleagues, and (G) was used to address the questions asked by the author of this thesis, Gungor.

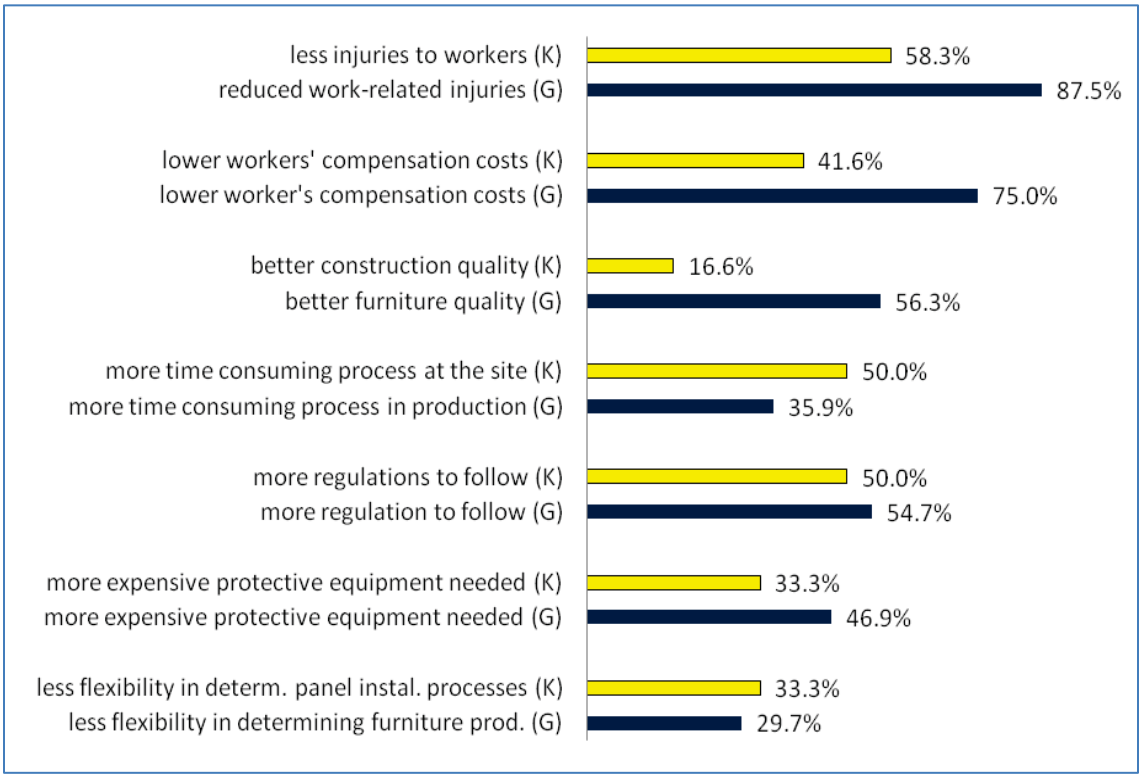

Figure 29 Comparison of the result of this thesis with the results of Kim *et al.* (2008)

In comparison, managers in the furniture industry believed more than panel designers that HF/E has some advantages such as: less occupational injuries, lower

worker's compensation costs, and better product quality. Likewise, panel designers believed more than furniture manufacturer managers that HF/E caused some problems such as: more time-consuming processes in production, more regulations to follow, more expensive protection equipment, and less flexibility in determining the production process. As a whole, furniture manufacturer managers were more aware of the advantages HF/E rather than panel designers. They were also less concerned with the possibilities of increased production time, cost, and decreased flexibility in production when they were compared to panel designers.

Managers' Agreement with Some Statements Concerning Human Factors and Ergonomics

To better understand the knowledge and opinions of managers, they were asked to rate their attitudes toward some statements. They rated the questions with a five-point scale ranging from strong disagreement to strong agreement. The distribution of the responses is given in Table 14.

Scientific data about a discipline may be considered too complex or hard to understand and apply in an industry if a person is not familiar with the scientific aspects, but the discipline of HF/E is not one of these types of disciplines. Participants in the survey believed so as well. Only 12.5 percent of managers agreed with the statement that scientific data about HF/E was too complex to understand and apply. The average of rating was 2.45. Namely, managers, in general, did not agree with the statement.

Table 14 Managers' agreement with some statements concerning human factors and ergonomics

Questions	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Rating Average	Total Respond
	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)		
Scientific data about HF/E is too complex to understand and apply.	10	15.6	25	39.1	21	32.8	6	9.4	2	3.1	**2.45**	64
HF/E causes more expenses than the benefits returned.	14	21.9	24	37.5	16	25	8	12.5	2	3.1	**2.38**	64
Small changes in environmental factors in workplaces can have a considerable impact on worker's productivity, comfort, health, and safety.	4	6.3	6	9.4	10	15.6	23	35.9	21	32.8	**3.80**	64
Workers in your factory can understand what HF/E deal with.	15	23.4	23	35.9	15	23.4	9	14.1	2	3.1	**2.38**	64
Using personal protective equipment can prevent occupational injuries and illnesses.	2	3.1	4	6.3	3	4.7	21	32.8	34	53.1	**4.27**	64
Working posture can cause or prevent musculoskeletal injuries.	1	1.6	5	7.8	5	7.8	18	28.1	35	54.7	**4.27**	64

In the same way, furniture manufacturing managers replied that HF/E did not cause more expenses than the benefits returned. The rating average was 2.38 for the question. The percentage of managers who had the opinion that HF/E causes more expenses than benefits was 15.6 in total.

Another question was asked whether small changes in environmental factors in the workplace could have a considerable impact on worker productivity, comfort, health, and safety. Managers took a neutral stance (15.6%) or a positive stance (68.7%) towards this statement. Managers' opinion showed that they were aware of the advantages of making changes in environmental factors in workplaces.

However, managers believed that workers in their factory could not understand what HF/E dealt with. The percentage of managers who thought so was 59.3 in total, while 23.4 percent of managers took a neutral stance. The rest, 17.2 percent of managers, mentioned that their workers were able to understand what HF/E dealt with.

Most of the managers fortunately showed that they were aware of the advantages of using personal protective equipment in workplaces to prevent occupational injuries and illnesses. The ratio of these managers was 85.9 percent. This is a very high ratio, and it shows that managers actually were aware of the importance of using personal protective equipment in workplaces.

Another high ratio was obtained from the question related to the importance of working posture; 82.8 percent of managers believed that good working posture could prevent musculoskeletal injuries or bad working posture could cause musculoskeletal injuries.

The statistical analysis of managers' opinions on these questions was performed, and the results of the analysis are given in Table 15.

Table 15 Statistical analysis of managers' demographic properties and managers' agreement with some statements concerning human factors and ergonomics

		State	Education	NAICS	Employees	Experience in FI	Position	Experience in P
Scientific data	χ^2	5.657	4.238	9.136	4.776	3.411	6.841	4.356
	p	0.226	0.835	0.331	0.781	0.906	0.554	0.824
More expense	χ^2	2.893	5.930	10.295	4.707	5.663	2.390	9.903
	p	0.576	0.655	0.245	0.788	0.685	0.967	0.272
Environmental changes	χ^2	3.980	9.374	6.330	6.562	5.884	6.673	7.115
	p	0.409	0.312	0.610	0.585	0.660	0.572	0.524
Worker understand	χ^2	3.429	8.442	19.751	3.707	7.443	6.941	14.277
	p	0.489	0.392	***0.011****	0.883	0.490	0.543	0.075
Using PPE	χ^2	1.934	15.816	8.781	4.208	3.606	3.725	8.811
	p	0.748	***0.045****	0.361	0.838	0.891	0.881	0.358
Posture	χ^2	6.401	8.134	18.598	6.739	4.557	8.167	3.958
	p	0.171	0.421	***0.017****	0.565	0.804	0.417	0.861

A * indicates a significant relationship between managers' demographic properties and their answers at $p \leq 0.05$.
χ^2 : Chi-square value, p: p-value (The level of statistical significance).

The relationship between education and the opinion that using personal protective equipment can prevent occupational injuries and illnesses was significant ($p \leq 0.045$). There were also significant relationships between the sector and worker understanding HF/E ($p \leq 0.011$) and the opinion that working posture could cause or prevent musculoskeletal injuries in work places ($p \leq 0.017$). Managers in the Office Furniture (Including Fixtures) Manufacturing (NAICS Code 3372) subsector agreed more than other subsectors with the statement that workers could understand what HF/E dealt with.

The Frequency of Inspections of Companies for

Human Factors and Ergonomic Problems

Inspection for HF/E is an important management control method to prevent occupational injuries and illnesses in work places. In the questionnaire survey, managers were asked the frequency of inspection done in workplaces. The distribution of responses is given in Figure 30.

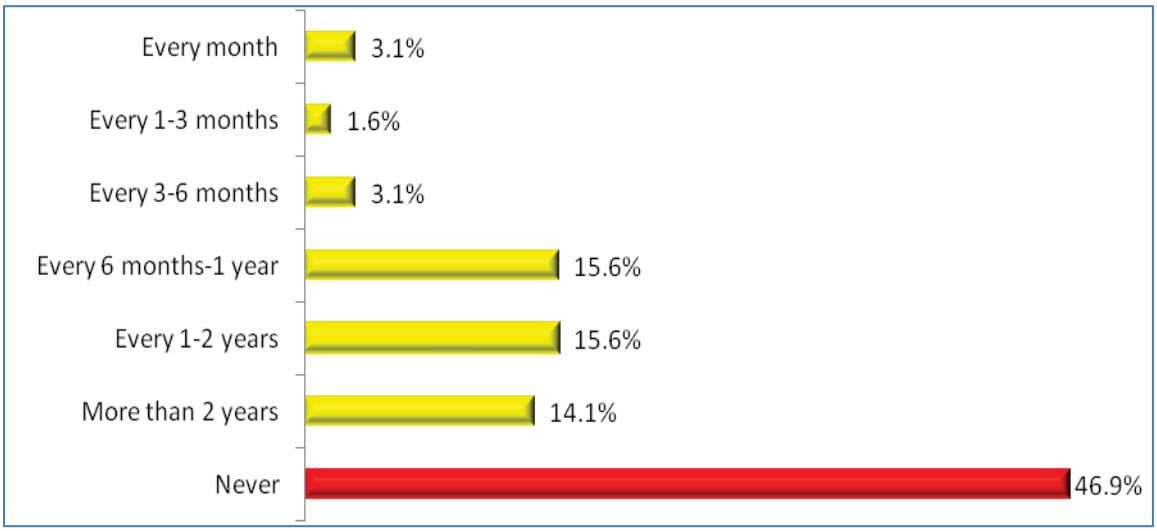

Figure 30 The frequency of inspections for human factors and ergonomics problems

In order to perform statistical analysis, the answers were combined in three categories because the observed values of cells were too small for good analysis. The new distribution is given in Table 16. After the categorization, statistical analysis was performed (Table 17).

Table 16 The frequency of inspections for human factors and ergonomics problems

Inspection Frequency	**Number**	**Percentage**	**Cumulative Percentage**
Every mounth-1 year	14	21.9	21.9
More than 1 year	20	31.3	53.1
Never	30	46.9	**100**
Total	**64**	**100**	

Table 17 Statistical analysis of the frequency of inspections for human factors and ergonomics problems

		State	Education	NAICS	Employees	Experience in FI	Position	Experience in P
Inspection	χ^2	2.016	4.551	1.029	20.761	5.481	5.891	3.061
	p	0.365	0.337	0.905	***0.000****	0.241	0.207	0.548

A * indicates a significant relationship between managers' demographic properties and their answers at $p \leq 0.05$.
χ^2 : Chi-square value,
p: p-value (The level of statistical significance).

The size of company and the frequency of inspection for HF/E were significantly ($p \leq 0.000$) related to each other. Some of small companies (66.7%) had never been inspected (Figure 31). On the other hand, 55.6 percent of large size companies had been inspected on an annual basis.

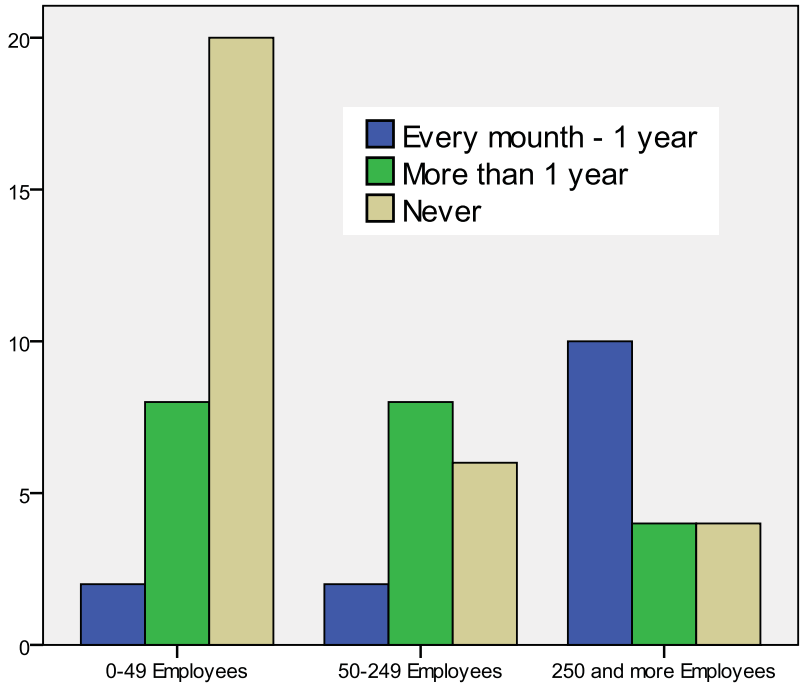

Figure 31 Company size and inspection frequency

Employees' Familiarity with Human Factors and Ergonomics

In addition to managers' familiarity, it is vital that employees be familiar with HF/E for the success in prevention of occupational injuries and illnesses. These programs improve employees' understanding and identification of occupational injury and illness risk factors. Educational programs should focus on increasing employee knowledge and awareness regarding HF/E in their work. These programs also encourage workers to actively participate in HF/E interventions (Pehkonen *et al.* 2009).

A study for evaluating a proactive ergonomic control program in three secondary wood processing companies was conducted by Gazo *et al.* in 2000 and 2001. The aim was to help employees to understand the causes, symptoms, treatment, and prevention of musculoskeletal disorders. The results of the study showed some improvements such as

reduced occupational injuries and illnesses, reduced absenteeism, improved employee health, improved manufacturing productivity, and higher product quality (Gazo *et al.* 2002).

Another example for the success of an HF/E program in the furniture industry was revealed by OSHA in 2002. An office furniture manufacturing company with 9,000 employees started an employee-focused workplace ergonomics program aiming to reduce the unacceptable back injury rate. After a few years, the back injury incidence rate lowered by 50 percent (OSHA 2002).

In this survey, managers were asked two questions to learn more about their workers and about general knowledge of their companies. The first question was whether there was a team or department in their factories to find and correct ergonomics problems (Table 18). Unfortunately, 56.3 percent of managers expressed that there was no team or department for HF/E interventions. In 9.4 percent of the companies, managers were not sure if there were any. For the second question, 40.6 percent of managers noted that their workers received training programs for HF/E.

Table 18 Employees' familiarity with human factors and ergonomics

Questions	**Yes**		**No**		**Not sure**		**Total**
	(N)	**(%)**	**(N)**	**(%)**	**(N)**	**(%)**	**(N)**
Is there a team or department in your factory that finds and corrects ergonomics problems?	22	34.4	36	56.3	6	9.4	64
Do your workers receive training for human factors and ergonomics?	26	40.6	29	45.3	9	14.1	64

Statistical analysis was performed to understand relationships between managers' demographic features and the existence of a team/department or the providing of a training program related to HF/E. Chi-square results of this analysis are given in Table 19.

Table 19 Statistical analysis of managers' demographic properties and the existence of a team/department and/or a training program

		State	Education	NAICS	Employees	Experience in FI	Position	Experience in P
Having a team	χ^2	3.355	5.234	1.651	13.601	1.337	6.748	1.425
	P	0.187	0.264	0.800	***0.009****	0.855	0.150	0.840
Workers receive training	χ^2	4.350	2.297	1.296	14.856	3.055	7.068	1.762
	P	0.114	0.681	0.862	***0.005****	0.549	0.132	0.779

A * indicates a significant relationship between managers' demographic properties and their answers at $p \leq 0.05$.
χ^2 : Chi-square value,
p: p-value (The level of statistical significance).

The analysis showed that there was a significant relationship ($p \leq 0.009$) between company size and the existence of a team or department in factories to find and correct ergonomics problems. The relationship can be seen in Figure 32 that only 16.7 percent of small companies, unfortunately, had a team or department for ergonomics problems. On the other hand, 56.3 percent of middle size companies and 44.4 percent of large size companies had teams or departments for handling HF/E related problems. Of all the managers, 9.4 percent were not sure whether a team or department existed.

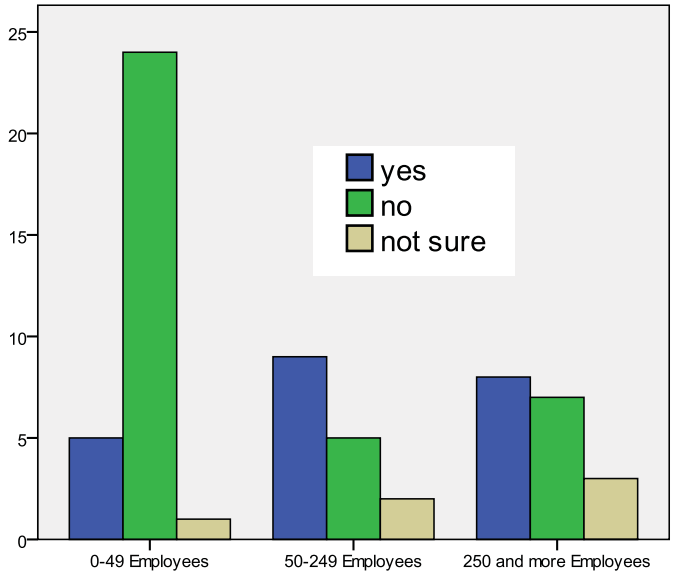

Figure 32 Company size and the existence of a team or department for ergonomics problems

Another significant relationship was related to the company size as well. Because middle and large size companies have had more opportunities to provide training to their employees, a statistical test was found significant for company size and workers receiving training ($p \leq 0.005$). Only 20 percent of small companies could provide training to their employees while 62.5 percent of middle size companies and 55.6 percent of large size companies provided training for their workers in HF/E issues (Figure 33). There were 14.1 percent of managers who were not sure about the existence of any training programs for their employees.

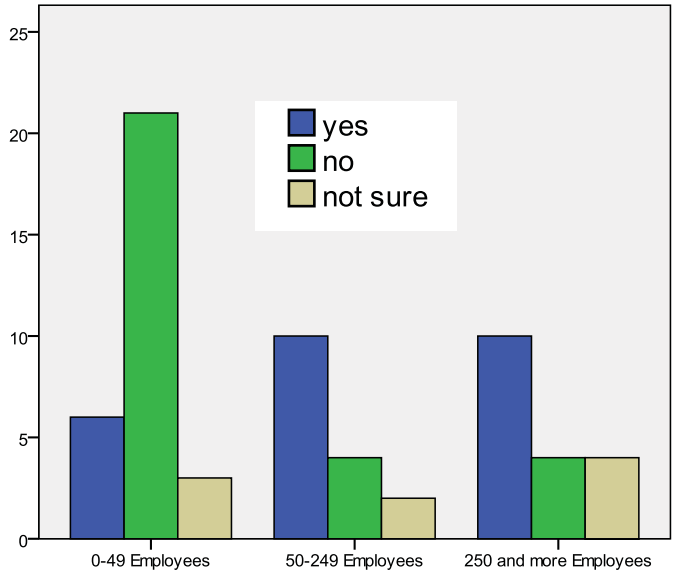

Figure 33 Company size and the existence of training programs for workers

Managers' Preference for Ergonomically Designed Equipment and Availability of Resources for Human Factors and Ergonomics Interventions

Furniture manufacturer managers were asked a critical question. The question focused on determining the level of managers' commitment to HF/E. The question was whether managers prefer ergonomically designed equipment to decrease the risk of occupational injuries and illnesses even if the equipment was more costly rather than conventional equipment. This issue has been a controversial issue for a long time. Managers have faced this dilemma. Some managers can allocate their resources to obtain ergonomically designed equipment even if it is expensive. However, the heavy financial burden of this equipment may compel others to prefer traditional and cheap equipment. The responders' distribution to this question is given in Table 20.

Table 20 Preference of ergonomically designed equipment and the availability of sufficient resources

Questions	Yes		No		Not sure		Total
	(N)	(%)	(N)	(%)	(N)	(%)	(N)
Do you prefer "*ergonomically designed*" equipment to reduce occupational hazards and accidents even if they are more expensive than regular equipment?	37	57.8	11	17.2	16	25	64
Are sufficient resources available in your company to enhance or improve ergonomics activities?	21	32.8	30	46.9	13	20.3	64

Fortunately, 57.8 percent of managers expressed that they would prefer user-friendly equipment even if it will bring some financial burden to the company. On the other hand, 17.2 percent of managers expressed that they would not prefer expensive equipment even though it is ergonomically designed. The ratio of managers who were in a dilemma about this was 25 percent.

Preference of ergonomically designed equipment depends on the availability of sufficient resources in the company. Only 32.8 percent of managers mentioned that they had sufficient resources to allocate ergonomics interventions. About half of the managers complained about the financial bottle necks.

The difference between the managers working in financially available companies (32.8%) and the managers preferring ergonomically designed equipment even if equipment is more expensive than conventional ones (57.8%) was 25 percent. Therefore, it can be said that at least a quarter of the managers expressed that they would prefer

ergonomically designed equipment even though they do not have sufficient resources to afford them.

The statistical analysis (Table 21) showed that there was a significant relationship ($p \leq 0.050$) between the state and preference of ergonomically designed equipment. Seventy-one percent of Mississippi managers expressed that they would prefer ergonomically designed equipment (Figure 34). 22.6 percent of Mississippi managers were unsure and only 6.5 percent of them took a negative stance toward ergonomically designed equipment if they were more expensive than conventional equipment.

Table 21 Statistical analysis of managers' demographic properties and preference of ergonomically designed equipment and the availability of sufficient resources

		State	Education	NAICS	Employees	Experience in FI	Position	Experience in P
Ergonomically equipment	χ^2	5.972	1.500	1.124	2.576	6.736	3.191	5.828
	p	***0.050****	0.827	0.890	0.631	0.151	0.526	0.212
Sufficient resources	χ^2	3.341	0.949	0.734	10.437	2.693	6.591	10.116
	p	0.188	0.917	0.947	***0.034****	0.610	0.159	***0.039****

A * indicates a significant relationship between managers' demographic properties and their answers at $p \leq 0.05$.
χ^2 : Chi-square value,
p: p-value (The level of statistical significance).

There was some significant relationship between managers' demographic properties and the availability of sufficient resources. Small company managers mentioned that they did not have sufficient resources to allocate HF/E interventions ($p \leq 0.034$) (Figure 35). Moreover, managers who had 3-10 year experience in their positions expressed that they had sufficient resources for HF/E issues ($p \leq 0.039$) (Figure 36).

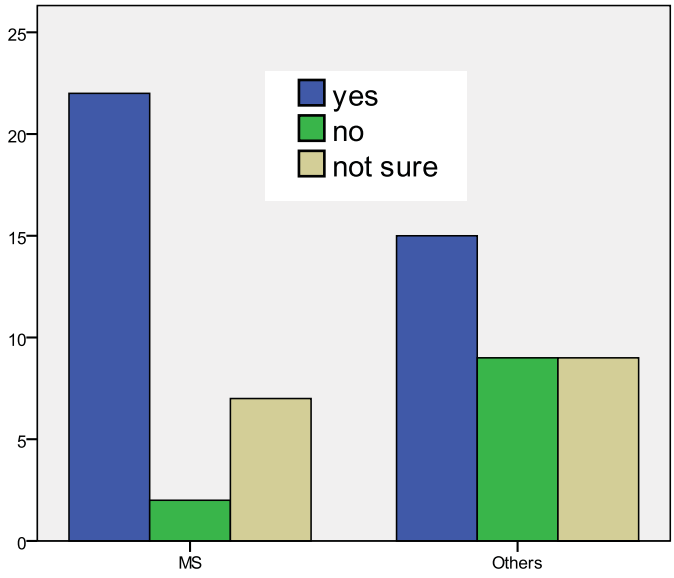

Figure 34 Mississippi vs. other states regarding the preference of ergonomically designed equipment

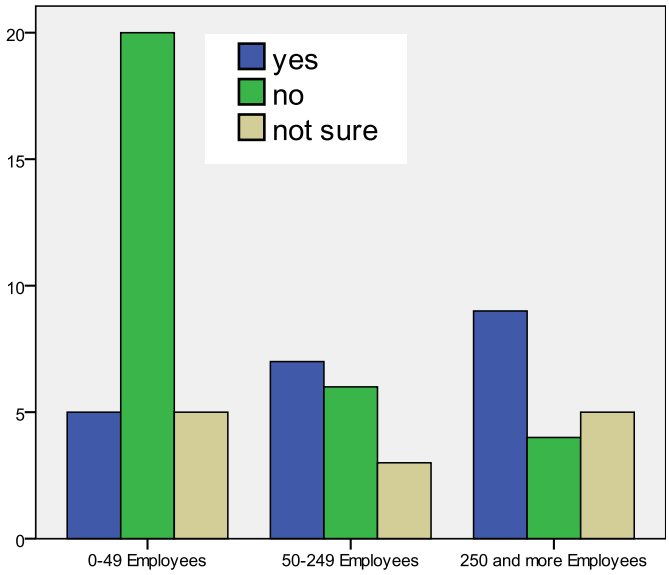

Figure 35 Company size and effect on answer for resource availability

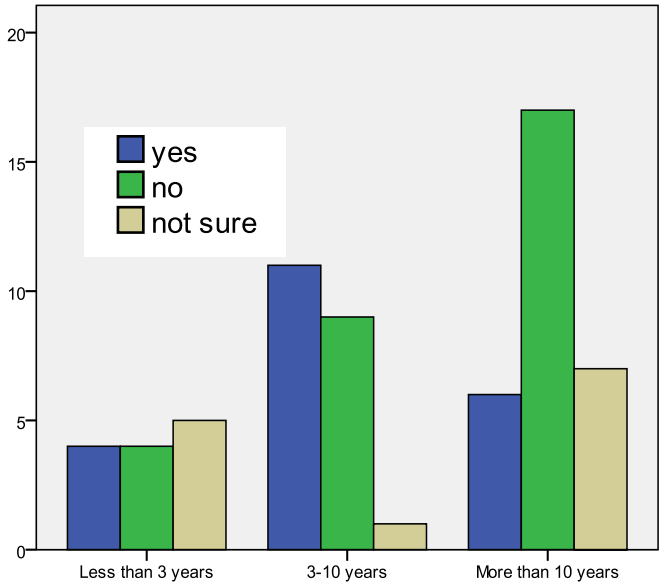

Figure 36 Managers' experience in current position and possible effect on answer for availability of sufficient resources

Managers' Opinions about the Necessities for

Human Factors and Ergonomic Sources

The managers were asked to rate their thoughts about the necessity of HF/E sources on a five-point scale ranging from "*not necessary at all*" to "*strongly necessary.*" The data distribution of the managers' opinions about necessities was obtained (Table 22).

The mean of the respondents' scores for the necessity of scientific data about HF/E was 3.00. This means managers, in general, took a neutral stance on the scientific data's necessity. Certainly, scientific data and knowledge is tremendously necessary to solve problems and create better working environments. This neutral stance could be caused from the complexity of data and knowledge in HF/E. If the 11th question of this survey is checked again, it could be seen that 45.3 percent of managers were neutral or in

agreement that scientific data about HF/E was too complex to understand and apply. Thus, there is a possibility that managers may think the scientific data is not necessary because they have a difficult time understanding and applying the complex data.

Because human factors specialists or ergonomists have an active role in initiating and continuing an HF/E program, employing a human factor specialist(s) or an ergonomist(s), particularly at the start of a program, is a necessity (Pehkonen *et al.* 2009). Even though participants generally agreed with the importance of HF/E, only 12.5 percent of them considered employing a human factor specialist(s) or an ergonomist(s) in their organizations. The rest of the participants probably had the opinion that HF/E issues were the issues should be addressed, but not the issues were necessary to address.

Table 22 Managers' opinion about the necessities for human factors and ergonomic sources

Questions	Not necessary at all		Not necessary		Neutral		Necessary		Strongly Necessary		Rating Average	Total Respond
	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)		
Scientific data about human factors and ergonomics	7	10.9	12	18.8	23	35.9	18	28.1	4	6.3	3.00	64
Employing an ergonomist(s) or a human factors' professional(s)	23	35.9	20	31.3	13	20.3	7	10.9	1	1.6	2.11	64
A team or department to handle HF/E problems	18	28.1	16	25	13	20.3	14	21.9	3	4.7	2.50	64
Training workers for human factors and ergonomics	6	9.5	5	7.9	19	30.2	23	36.5	10	15.9	3.41	64
Training management for human factors and ergonomics	8	12.5	7	10.9	15	23.4	21	32.8	13	20.3	3.38	64
Resources for HF/E issues	6	9.4	10	15.6	16	25	25	39.1	7	10.9	3.27	64

A team or department that is supported by professional human factors specialists or ergonomists can bring success. A total of 26.6 percent of mangers expressed that a team or department is necessary to handle HF/E problems. Up to 53.1 percent of managers, on the other hand, expressed that a team or department to handle HF/E problems is not a necessity. Because of this thinking, managers did not establish a team or department. The 13th question confirmed this interpretation. The 13th question asked whether there was a team or department for ergonomic problems. Of the participants, 56.3 percent mentioned there was no team or department in their organizations. As a result of the statistical test (Table 23), there were significant differences between the thinking that a team or department is necessary, the state where managers were from ($p \leq 0.004$) and managers' positions ($p \leq 0.022$).

There were 69.7 percent of managers from other states who believed that a team or department was not necessary while 35.5 percent of Mississippian managers believed so (Figure 37).

Small company managers also had a negative stance about the necessity of a team or department for finding and correcting HF/E problems (Figure 38). The significant level of this statistical relationship was 0.004.

When the relationship between managers' position and the necessity of a team or department was investigated, it could be interpreted that owners (62.5%) believed that a team or department was not necessary (Figure 39). However, the percentage of lower-level managers was lower than owners (42.0%).

Table 23 Statistical analysis of managers' demographic properties and managers' opinion about the necessities for human factors and ergonomic sources

		State	Education	NAICS	Employees	Experience in FI	Position	Experience in P
Scientific data	χ^2	6.781	8.604	8.059	14.731	10.161	10.366	8.615
	p	0.148	0.377	0.428	0.065	0.254	0.240	0.376
Human factors specialist and ergonomists	χ^2	7.841	5.964	9.560	15.308	5.529	7.187	8.407
	p	0.098	0.651	0.297	0.053	0.700	0.517	0.395
A HF/E team or department	χ^2	15.601	3.427	10.324	22.258	3.118	17.860	10.371
	p	***0.004****	0.905	0.243	***0.004****	0.927	***0.022****	0.240
Training employees	χ^2	12.683	11.406	25.514	10.686	12.541	8.153	15.752
	p	***0.013****	0.180	***0.001****	0.220	0.129	0.419	***0.046****
Training managers	χ^2	12.538	7.571	14.635	9.168	8.996	8.192	9.616
	p	***0.014****	0.476	0.067	0.328	0.343	0.415	0.293
Resources	χ^2	6.746	11.027	17.465	12.651	5.502	9.081	10.216
	p	0.150	0.200	***0.026****	0.124	0.703	0.336	0.250

A * indicates a significant relationship between managers' demographic properties and their answers at $p \leq 0.05$.
χ^2 : Chi-square value,
p: p-value (The level of statistical significance).

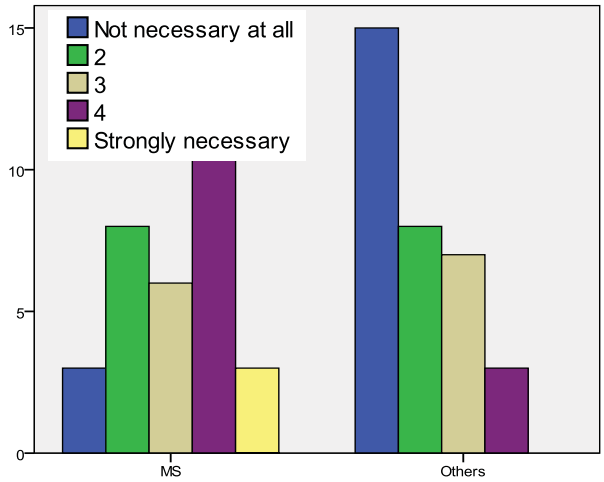

Figure 37 Mississippi vs. other states concerning the necessity of a team or department for human factors and ergonomics problems

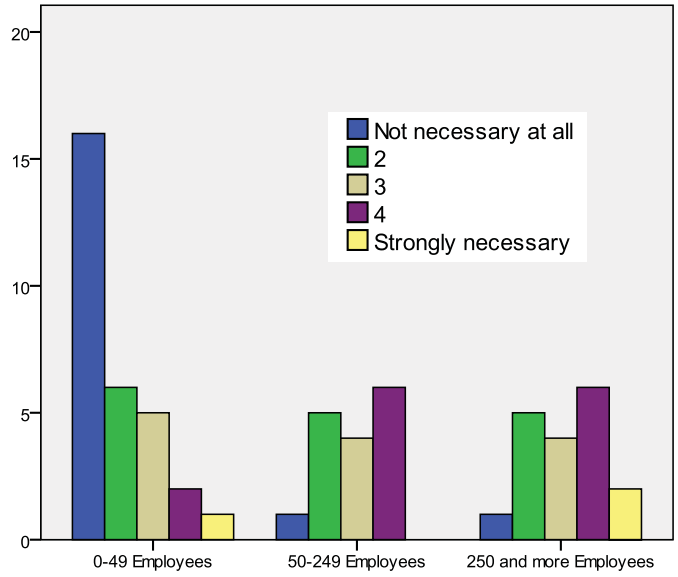

Figure 38 Company size and the necessity of a team or department for human factors and ergonomics problems

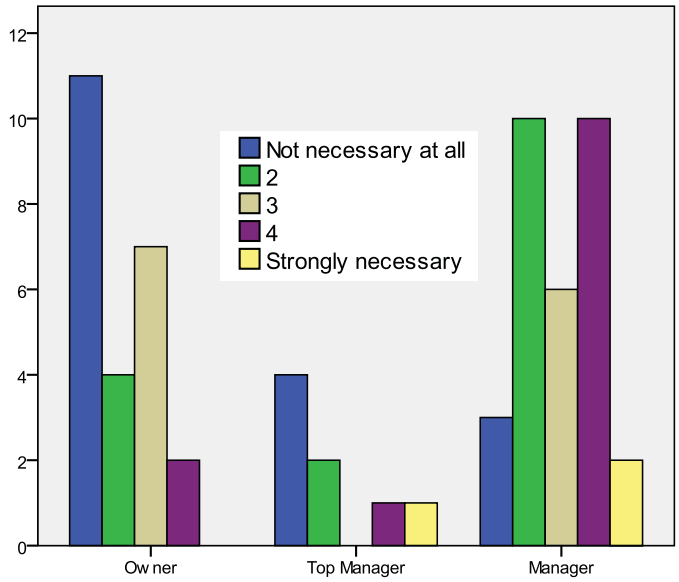

Figure 39 Manager's current position and its affect of their opinion on the necessity of a team or department for human factors and ergonomics problems

Fortunately, the percentage of managers who believed that training workers for HF/E was not necessary was not high (totally 17.4). The rest of managers took a neutral

(30.2%) or positive stance (52.4%) toward the necessity of employee training. Training employees can help to (1) obtain the ability to identify HF/E problems, (2) report problems early so that they can be solved before they become chronic and costly, (3) increase employee awareness, and (4) have the employees equipped with the tools necessary for problem solving (AFMA and NCDOL 2003). Managers from Mississippi (Figure 40) working in the Household furniture subsector (Figure 41) believed that training employees was necessary while managers from other states working in other furniture related subsectors believed the opposite way. Their significant levels of relationships were 0.013 and 0.001, respectively. The relationship between managers' experiences and the thinking of the necessity of a team or department for HF/E problems was significant as well (0.046). Managers with over 10 years experience took a neutral stance toward the necessity of training employees for HF/E interventions (Figure 42).

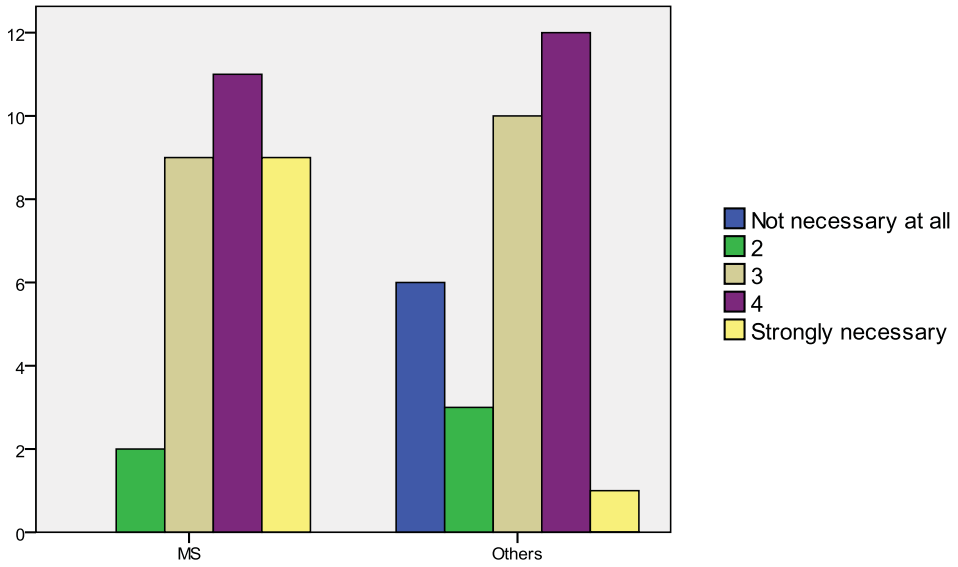

Figure 40 Mississippi vs. other states concerning the necessity of training workers

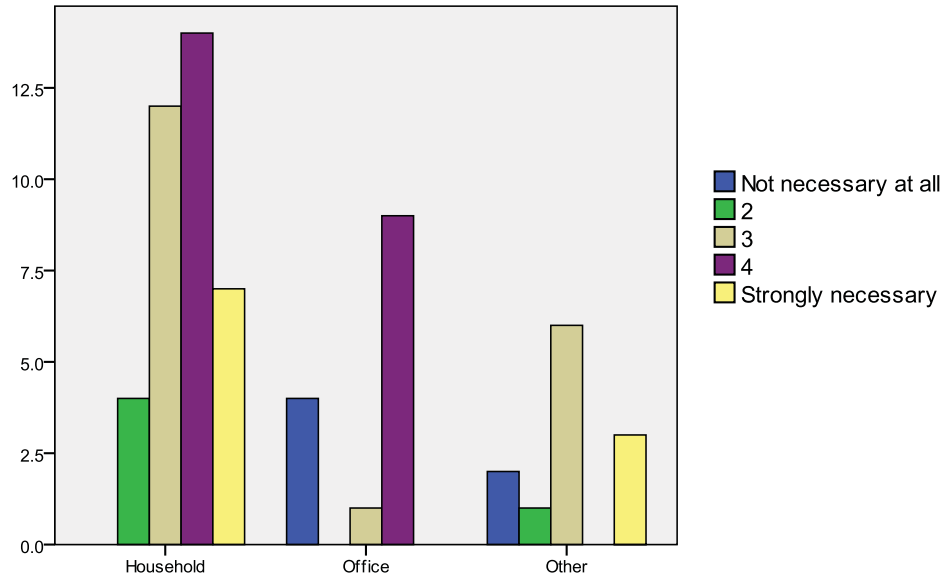

Figure 41 Sector and its affect on the necessity of training workers

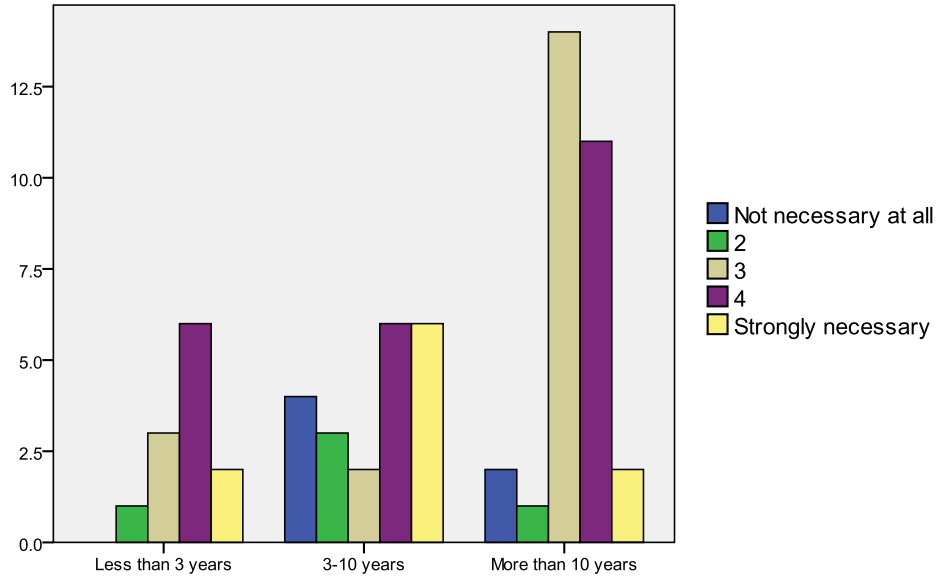

Figure 42 Managers' experience in their current position and its affect on the necessity of training workers

Likewise, training managers for HF/E was, in general, believed to be necessary (51.1%). Management training can provide better understanding of how problems

develop, how problems can be avoided, and solidification of management's commitment to the ergonomics process (AFMA and NCDOL 2003). Only 23.4 percent of managers believed training was not necessary for them. The results of statistic analysis showed that Mississippi furniture manufacturer managers took a positive stance toward training for themselves ($p \leq 0.014$) (Figure 43).

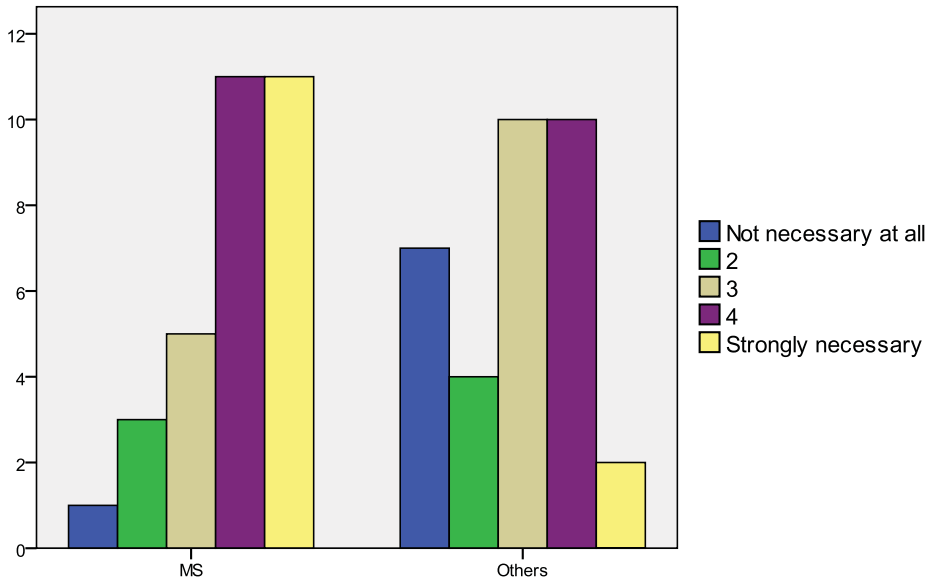

Figure 43 Mississippi vs. other states concerning the necessity of training managers

Lastly, managers were asked to rate the level of necessity of resources for HF/E issues. The mean of the respondents' scores for the necessity of resources for HF/E was 3.27.

Managers' Opinions on the Likely Causes of Occupational Injuries, Accidents, and Illnesses

Before being given the results of this survey, providing a comprehensive literature review can support broad perspective occupational risk factors in the furniture

manufacturing industry. Physical factors such as cold, heat, lighting, and noise in manufacturing work environments can directly influence worker comfort, efficiency, and productivity, while increasing the risk of injuries and illnesses. However, research and surveys generally have not been conducted considering the dimension of psychological and social factors. The result of a survey with a high number of Sweden participants suggests that psychosocial dimension of the work environment should be given greater attention (Andersson 2008). The National Institute of Occupational Safety and Health (NIOSH) revealed that psychosocial factors are as important as physical factors at workplaces (Rooney *et al.* 1993). However, here, literature will be provided with stress resources and types of injuries and illnesses rather than separating them into whether they are physical or physiological stressors.

Manager's Opinions on the Risk Factors for Occupational Injuries in the Furniture Manufacturing Industry

Environmental conditions such as noise, lighting, extreme temperatures, and vibration in the furniture manufacturing industry have an impact on worker well-being. Some research and investigations were performed to determine the quality of workplaces and to determine occupational stressors, if there were any, in workplaces. Research in Poland demonstrated that environmental conditions were stressful in the furniture industry (Bielski *et al.* 1976). For example, the noise level at all locations exceeded 90 dB (A), which is OSHA's current permissible exposure limit for workplace noise, code 29 CFR 1910.95 (OSHA Standards). Excessive noise exposure adversely affects employees' health. Temporary or permanent hearing loss, interference with

communication and performance, speech, audible warning signals, and other physical and psychological effects such as fatigue, irritability, muscle tension, increased blood pressure, ulcers, stress, and anxiety are some effects of excessive noise exposure (Keller 2008). Gradual hearing loss occurs when an individual is exposed to intense noise repeatedly and for a long time. To control noise in workplaces, engineering controls (replacement or isolation of the source of noise, increasing the distance from the noise, and sound swallowing ceilings) and administrative and work practice controls (reducing the exposure time, shift employees, and providing personal protective equipment) should be made available if the solution is effective, practical, and affordable (Keller 2008). The same Polish research also found that lighting in the furniture facilities was inadequate (Bielski *et al.* 1976).

Another environmental condition that seriously affects workers safety, productivity, and efficiency is extreme temperatures. Hot workplaces can cause heatstroke, sunstroke, heat exhaustion, harmful heat stress related illnesses, increased possibility of injuries, and decreased productivity (Beevis and Slade 2003; Keller 2008; BLS 2008). Furniture manufacturer workers, particularly ones close to heat radiating machines, will be exposed to high temperatures. The other extreme temperature is cold, but cold conditions are not commonly found in the furniture manufacturing industry. It is known that cold temperatures cause frequent accidents, skin burns and pains, tingling and itching, snow blindness, freezing, and frostbite (Keller 2008; BLS 2008). Engineering controls, good work practices, and managerial controls can prevent extreme temperature

stresses. The simple intervention for workplaces in extreme temperatures is either to wear proper clothes or acclimatize the workplaces.

Another occupational risk factor in the furniture manufacturing industry is vibration caused from moving vehicles, machinery, and hand-held power tools. As a result of the excessive exposure to vibration, vascular, neurological, and musculoskeletal disorders are widely experienced among workers. For example, the prevalence of soft-tissue disorders in the upper limbs is significantly greater among furniture manufacturer workers than among the rest of the population (Bovenzi *et al.* 2005). Severe vibration exposure causes a variety of adversely effects such as discomfort, chest pain, abdominal pain, increased pulse rate or respiratory rate, low back pain, Raynaud's phenomena (white fingers), and more. The effects depend on the body part exposed (whole-body or segmental exposure), the characteristic of the vibration (magnitude, frequency, and direction), and the duration of exposure. Control and prevention techniques have a significant impact on reducing occupational risks in the furniture manufacturing industries. For example, a research to evaluate and design an orbital sander showed a reduction in risk factors when the sander was designed to reduce exposure to vibration (Smith *et al.* 2000). Because sanders are widely used in the furniture manufacturing industry, they should be taken into consideration to control and prevent hand-transmitted vibration.

The task itself causes occupational injuries and illnesses. Exposure to repetitive motions, forceful exertion, contact stresses, vibrations, or awkward postures over a period of time results in musculoskeletal disorders (AFMA and NCDOL 2003; Keller 2008).

Musculoskeletal disorders (MSDs) can be called cumulative trauma disorders because repeated mechanical stresses on a particular body result in microtraumas which develop gradually over a period of time. Musculoskeletal disorders are related to injuries or traumas that affect soft tissues of the body. Soft tissues of the body are muscles, nerves, tendons, tendon sheaths, and ligaments of the upper extremities (hands, wrists, and elbows) and lower extremities (hip, thigh, knee, and ankle), shoulders, necks, and upper backs and lower backs (waists) (Guo *et al.* 2004; Keller 2008).

The most common occupational MSDs are tendon disorders (tendonitis, tenosynovitis, bursitis, DeQuervain's disease, trigger finger, tennis elbow, golfer's elbow, rotator cuff injuries, and ganglionic cysts), nerve disorders (carpal tunnel syndrome), and neurovascular disorders (Raynaud's syndrome or white finger). Musculoskeletal disorders alone are the most expensive work-related health problem (Leigh *et al.* 1997). According to the Swedish Union for technical and clerical employees and the salaried employees' union, over half of the members of these unions were suffering from pain in backs, necks, shoulders, and joints (Andersson 2008). The furniture industry is one of the industries that is at risk in terms of occupational injuries (Christensen *et al.* 1995; Paskiewicz and Fathallah 2003; Bovenzi *et al.* 2005; Ferguson *et al.* 2008). After conducting a country wide survey in Taiwan with a total of 18,942 participants, Guo *et al*. (2004) indicated that furniture industries and fixture manufacturing and wood and bamboo products were in the group of industries with high prevalence of musculoskeletal type injuries. Ergonomics is an effective approach to reducing the number and severity of MSDs. Ergonomics programs, when all levels and functions are involved in their

implementation, can be very effective in reducing MSDs (AFMA and NCDOL 2003). Some possible effective control and prevention techniques for the reduction of MSDs among workers in the furniture manufacturing industry are to eliminate or reduce:

- excessive or repetitive bending, twisting, and reaching,
- pulling, pushing, lifting, holding, and carrying too heavy and too large loads,
- awkward, poor, and static postures,
- vibrations, and
- poor environmental conditions (cold temperature, etc.).

Managers' Opinions on the Risk Factors for Occupational Illnesses in the Furniture Manufacturing Industry

Air contaminants are occupational illness risk factors for the furniture manufacturing workers. Airborne contaminants such as dusts, gases, fumes, hazardous biological agents, and vapors can be taken into the body by inhalation, which may result in occupational illnesses if they exceed the permissible exposure limits (Keller 2008). After investigation case reports and epidemiological studies related to the furniture and cabinet making industries, the International Agency for Research on Cancer (IARC) indicated "*Furniture and cabinet-making are carcinogenic to human*" (IARC 1987). Exposure to dusts, particularly wood dusts, is fairly excessive in the furniture manufacturing industry, which generates occupational health risks for workers (Scheeper *et al.* 1995; Schlunssen *et al.* 2001; Vinzents *et al.* 2001; Mikkelsen *et al.* 2002; Kauppinen *et al.* 2006; Kalliny *et al.* 2008; Scarselli *et al.* 2008).

There are several epidemiological studies which indicate that some hardwoods such as oak, beech, birch, elm, ash, walnut, and mahogany are associated with cancer risk, generally nasal cancer risk (Scarselli *et al.* 2008). However, this association is still

controversial among scientists because many researchers have failed to find this association. For example, a study was conducted by Rang and Acheson (1981) with 5,371 workers worked in furniture factories in Buckinghamshire, UK, so as to determine the incidence of cancer and the mortality from cancer. Researchers found a significant relationship between the incidence of the tumor nasal adenocarcinoma and the high exposure to wood dust: the incidence of tumors among workers in the furniture industry was about one hundred times higher than the incidence of tumors among the local population. However, the same relationship between wood dust exposure and the incidence of other cancer types including bronchial cancer was not significant (Rang and Acheson 1981). Another research in 25 European Union member countries showed that about 3.6 million workers (700,000 workers in the furniture industry) were exposed to wood dust in their workplaces in 2001-2002 (Kauppinen *et al.* 2006). This number is two percent of the total employees in these 25 countries. Thus, the furniture industry is, unfortunately, one of the highest exposure level industries in which most factories may exceed the recommended exposure limit (Kauppinen *et al.* 2006). As mentioned before, even though woodworking is considered as associated with cancer, there is no strong evidence to show a relationship between the exposure to wood dust and respiratory health effects among furniture workers (Goldsmith and Shy 1988).

The type of work activity determines the dust content in the environment. For example, the sanding process and surface cleaning are the most dust producing tasks (Scheeper *et al.* 1995). However, all employees, not just those responsible for sanding, are exposed the high amount of wood dust (Scheeper *et al.* 1995). Employees in sawing

and milling departments can be considered to be exposed in intermediate level wood dust (Kalliny *et al.* 2008).

In addition to the task type, worker sensitivity is important for evaluation. Some workers can be sensitive to some specific woods. For instance, a Danish research found that some workers in the furniture industry were sensitized against pine wood dust (Skovsted *et al.* 2003).

Besides wood dust, there are some other stressors for occupational illnesses in the furniture manufacturing industry. Breathing biological agents, chemicals, gases, vapors from organic solvents, or fumes is one of the common stressors in the furniture manufacturing workplaces. Resins and varnishes are highly used in the furniture industry. Because of the chemical structure of resins and varnishes, they can cause occupational illnesses. Adhesives or resins such as melamine-formaldehyde resins (Aalto-Korte *et al.* 2003) and epoxy resins (Rademaker 2000) have been studied to determine the significant relationship between the exposure to adhesives and the prevalence of occupational illnesses. After the exposure to a glue containing 1-bromopropane, employees had severe illness symptoms and abnormal findings like high urinary arsenic concentrations (Raymond and Ford 2007). Formaldehyde, also highly used in the furniture industry, is classified as probably carcinogenic to human beings (Gichner 1995). Research in Turkey to determine the relationship of exposure to polyester resin (styrene monomer: a potential carcinogen and mutagen) and genotoxic damage was performed on 53 employees in a furniture manufacturing company, and the results emphasized the possibility of genotoxic damage (Karakaya *et al.* 1997).

Another potential occupational risk factor for illnesses is carcinogenic solvents. Research in Poland conducted by Posniak *et al.* (2005) found that the exposure to organic solvents in the furniture manufacturing industry, particularly in the tasks of varnishing and cleaning, was pretty high, even higher than normal limits, which can be harmful to employees' health. Methylene chloride, another type of solvent, is highly exposed to employees stripping furniture (Estill and Spencer 1996). Acrylate varnishes, highly used in the furniture manufacturing industry, make acute toxic skin reactions more severe among exposed individuals (Voog and Jansson 1992). Pinter *et al.* (2003) conducted research to determine the effect of the occupation on colorectal cancer, and they found no evidence that occupational exposure to asbestos, EMF, formaldehyde, lead, or solvents were associated with colorectal cancer risk.

Exposure to airborne contaminants in the furniture manufacturing workplace not only results in cancers but also other illnesses. Sneezing and eye irritation (Goldsmith and Shy 1988), skin problems (Surakka *et al.* 2001; Shao *et al.* 2001), poisoning, and respiratory problems such as asthma (Balmes *et al.* 2003; Tomioka *et al.* 2006; Koh *et al.* 2008) can be significantly correlated with wood dust exposure.

Risk factors or stressors can be divided to two parts: occupational stressors and organizational stressors. Occupational (also known as physical, traditional, or task related) stressors are called micro stressors while organizational stressors are called macro stressors.

1. Occupational (micro) stressors include, but are not limited to;

- Force (mechanical compression and shear forces) and moments
- Awkward and heavy loads (lifting and lowering heavy loads, tools, equipment)
- Awkward and static working body posture
- The frequency and duration of exposure to stressors
    - Repetition (repetitive tasks)
    - Overexertion
- Contact stress (soft tissue contact stressors)
- Worker related stressors
    - Fatigue
    - Strength
    - Endurance
    - Previous injury and illness history
- Environmental factors
    - Extreme temperatures
    - Humidity
    - Noise
    - Lighting (glare, inadequate lighting, poor lighting)
    - Vibration (whole body and segmental vibration)
- Change itself
    - Changes in workplaces (tasks, equipment, tools, scheduling)
    - Changes in the environment

2. Organizational (macro) stressors include, but are not limited to;

- Organizational limitations
    - Insufficient financial resources
    - Staff shortage
    - Poor scheduling (excessive overtime, inadequate resting time, and faster deadlines)
    - Lack of worker motivation
- Inadequate or lack of proper personal protective equipment and clothing
- Job related stressors
    - Improper management for job rotation, job enlargement, and job enrichment
    - Awkward work processing methods
- Lack of individual and group trainings
- Organization's environment related external stressors
    - Technological changes in the industry
    - Political and regulatory considerations (e.g., OSHA regulations)
    - Economic factors (e.g., global competition)
- Other social and psychosocial issues

The most reliable and desirable intervention method to avoid occupational stressors is engineering design and controls. Engineers are responsible for adjusting the work and the environment to the workers' capabilities in order to arrange for a proper match between demands and capabilities (Black and Hunter 2003; Goggins *et al.* 2008).

On the other hand, organizational stressors can be reduced by applying administrative design and controls. For example, worker rotation, frequent rest breaks, and training are some good administrative controls. Training alone can prevent even 20 percent of occupational injuries and illnesses (Oxenburgh 1991).

In the questionnaire, participants were asked about the likely causes of occupational injuries, accidents, and illnesses in order to better understand the knowledge and opinions of managers. Managers' responses are given in Figure 44 from the highest to the lowest percentages.

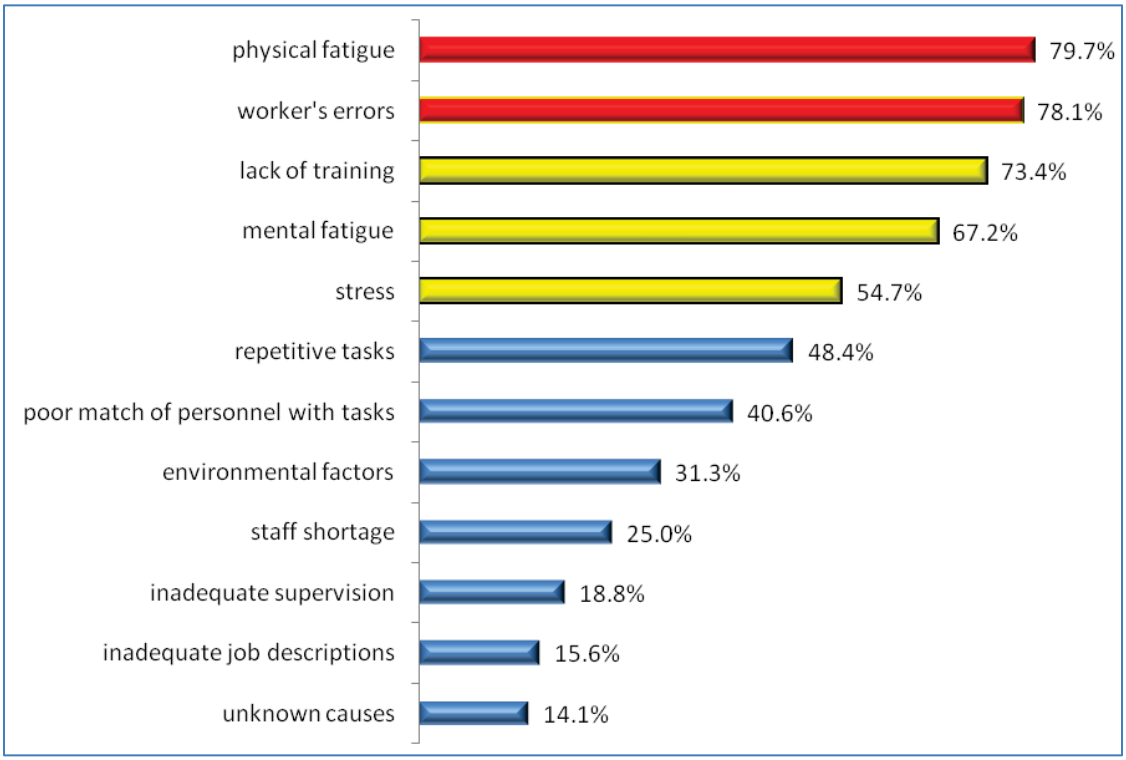

Figure 44 Managers' opinions on the likely causes of occupational injuries, accidents, and illnesses

Over seventy percent of managers replied that physical fatigue (79.7%) and worker errors (78.1%) were the main causes of all occupational injuries, accidents, and illnesses. Likewise, over half of the managers believed that occupational injuries, accidents, and illnesses were caused from lack of training for the employees (73.4%), mental fatigue (67.2%), and stress (54.7%). Other causes were expressed by less than half of the managers.

Heavy and repetitive tasks, awkward or static body postures, vibration, contact stress, and uncomfortable environments are common stress factors in the furniture industry that can directly cause the worker be exhausted both physically and mentally and can indirectly influence risk of occupational injuries and illnesses. One of the objectives of this question was to address some stress factors in the American furniture manufacturing industry regarding occupational safety and health issues.

There were some statistically significant relationships between managers' demographic properties and their opinions about the possible causes of occupational injuries, accidents, and illnesses (Table 24).

Of the managers from other states, 78. 8 percent significantly ($p \leq 0.041$) expressed that mental fatigue caused occupational injuries and illnesses (Figure 45). Managers with high school degrees believed ($p \leq 0.043$) that stress was a risk factor while managers with graduate school degrees did not believe so (Figure 46). Managers from Office Furniture (including Fixtures) Manufacturing and Other Furniture Related Product Manufacturing subsectors replied ($p \leq 0.040$) that repetitive tasks caused occupational injuries and illnesses (Figure 47). None of managers with less than 3 years

Table 24 Statistical analysis of managers' demographic properties and managers' opinion about the possible causes of occupational injuries and illnesses

		State	Education	NAICS	Employees	Experience in FI	Position	Experience in P
Stress	χ^2	0.229	6.301	5.126	1.120	1.428	3.573	3.023
	P	0.632	***0.043****	0.077	0.571	0.490	0.168	0.221
Mental fatigue	χ^2	4.159	0.738	4.740	0.975	1.320	8.782	0.398
	P	***0.041****	0.691	0.093	0.614	0.517	***0.012****	0.820
Physical fatigue	χ^2	0.034	4.833	1.433	2.126	0.491	5.818	0.702
	P	0.854	0.089	0.489	0.345	0.782	0.055	0.704
Lack of training	χ^2	1.601	0.122	1.818	2.341	1.540	2.634	5.392
	P	0.206	0.941	0.403	0.310	0.463	0.268	0.067
Repetitive task	χ^2	2.231	2.168	6.454	3.613	2.120	0.517	2.825
	P	0.135	0.338	***0.040****	0.164	0.346	0.772	0.244
Environmental factors	χ^2	0.829	5.049	2.510	1.034	0.500	0.442	2.262
	P	0.362	0.080	0.285	0.596	0.779	0.802	0.323
Worker error	χ^2	2.832	0.017	0.393	0.130	0.808	1.371	1.122
	P	0.092	0.992	0.821	0.937	0.668	0.504	0.571
Being understaffed	χ^2	1.022	1.533	2.530	4.178	0.073	0.005	1.698
	P	0.312	0.465	0.282	0.124	0.964	0.997	0.428
Poor match	χ^2	0.513	0.781	0.559	0.092	0.041	0.054	1.193
	P	0.474	0.677	0.756	0.955	0.980	0.973	0.551
Job description	χ^2	0.634	2.117	0.079	1.801	6.348	0.554	6.455
	P	0.426	0.347	0.961	0.406	***0.042****	0.758	***0.040****
Supervision	χ^2	0.014	3.186	2.357	1.130	3.000	2.436	1.593
	P	0.904	0.203	0.308	0.568	0.223	0.296	0.451
Unknown	χ^2	0.067	1.899	0.829	2.123	2.745	1.506	1.670
	P	0.796	0.387	0.661	0.346	0.253	0.471	0.434

A * indicates a significant relationship between managers' demographic properties and their answers at $p \leq 0.05$.
χ^2 : Chi-square value, p: p-value (The level of statistical significance).

experience managers with 3-10 years experience in the furniture industry ($p \leq 0.042$) (Figure 48) and in the current position ($p \leq 0.040$) (Figure 49) thought that inadequate job descriptions could cause occupational injuries and illnesses.

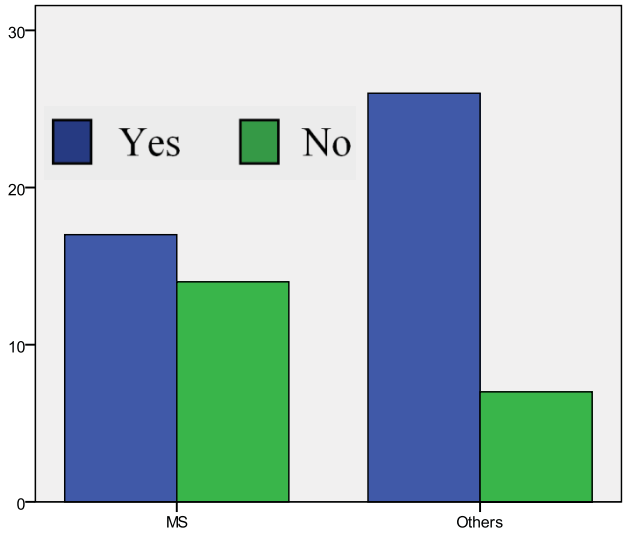

Figure 45 Mississippi vs. other states concerning managers' opinions about likely causes of mental fatigue

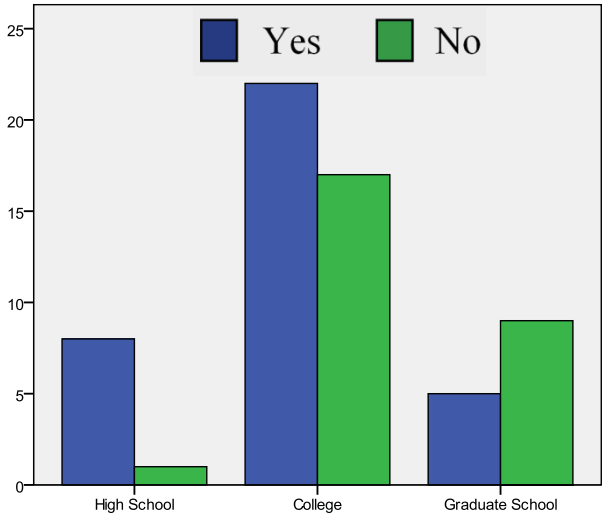

Figure 46 Manager's education level, and its affect on their opinion about the likely causes of stress

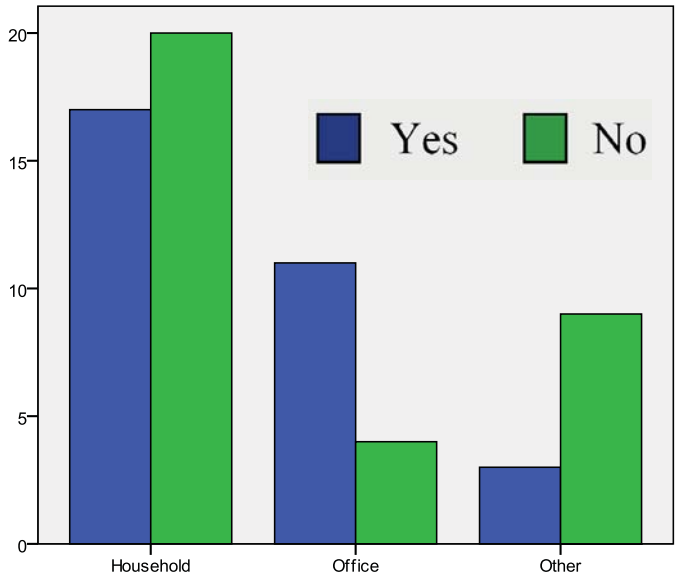

Figure 47 Sector and its affect on manager opinion about the likely causes of repetitive tasks

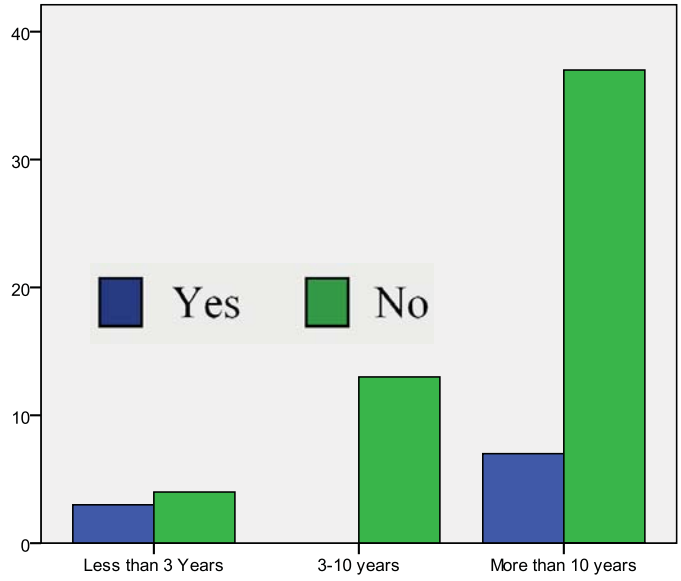

Figure 48 Managers' experience in the furniture industry and its affect on their opinion about inadequate job description

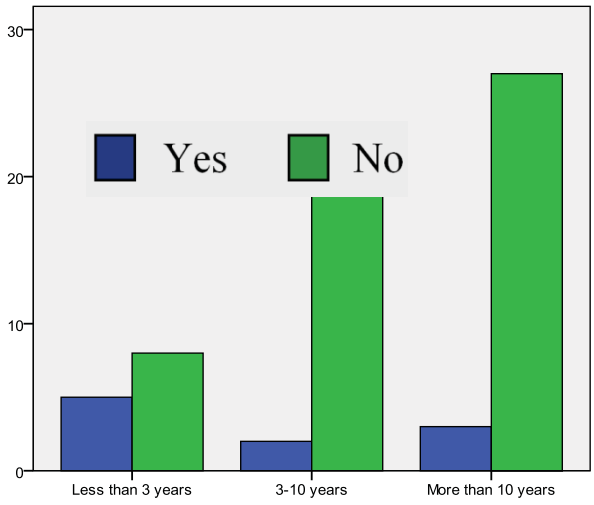

Figure 49 Experience in current position and its affect on their opinion about the likely causes inadequate job description

The last significant relationship ($p \leq 0.012$) was between the current position and the opinion that mental fatigue causes occupational injuries and illnesses. Owners believed that mental fatigue was a risk factor for occupational injuries and illnesses while lower-level managers did not believe so (Figure 50).

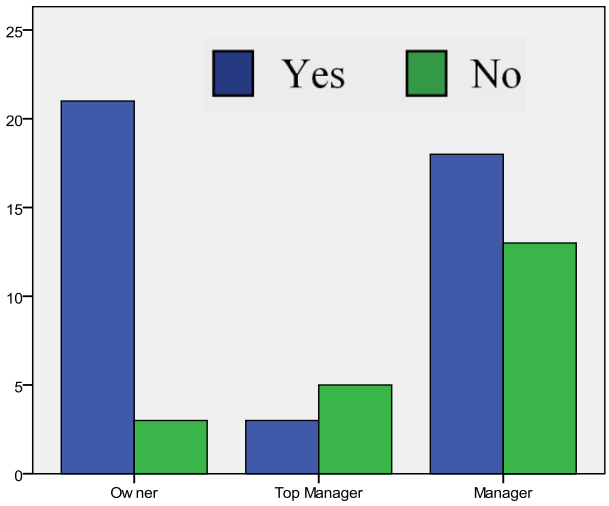

Figure 50 Managers' position and its affect on their opinion about the likely causes of mental fatigue

Managers' Opinions about Responsibility Levels

Furniture manufacturer managers were asked to rate the level of responsibilities for themselves, engineers, and employees in their companies, the company as a whole, employees' families, consumers of the company's products, and the government. The distribution of responses is given in Table 25.

Managers gave their company the highest responsibility and gave consumers the least amount of responsibility. In addition to the company (3.05 rating average), lower-level managers (2.98 rating average), workers (2.92 rating average), top-level managers (2.89 rating average), and owners (2.73 rating average) were considered as responsible for HF/E issues. Engineers (2.31 rating average), technicians (2.16 average rating), and the government (2.05 rating average) were rated as somewhat responsible. Workers' families (1.41 rating average) and consumers (1.34 rating average) were thought of as not responsible for any HF/E related problems.

A few of the managers did not answer the responsibility level for workers' families, consumers, and the government. It may be caused from not understanding the interaction. They could not associate families, consumers, and the government with responsibility. It may be considered that there is no responsibility of these people. However, researchers did not combine the answers. The result of statistical analysis is given in Table 26.

Table 25 Managers' opinions about responsibility levels

	Not Responsible		Somewhat Responsible		Responsible		Highly Responsible		Total Score	Rating Average	Total Respond
	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)			
Company	2	3.2	12	19	30	47.6	19	30.2	**192**	3.05	63
Lower-level managers	2	3.2	14	22.2	30	47.6	17	27	**188**	2.98	63
Workers	3	4.8	13	20.6	33	52.4	14	22.2	**184**	2.92	63
Top-level managers	3	4.8	14	22.2	33	52.4	13	20.6	**182**	2.89	63
Owner	5	7.9	16	25.4	33	52.4	9	14.3	**172**	2.73	63
Engineer	14	22.6	23	37.1	17	27.4	8	12.9	**143**	2.31	62
Technician	15	24.2	26	41.9	17	27.4	4	6.5	**134**	2.16	62
Government	21	34.4	21	34.4	14	23	5	8.2	**125**	2.05	61
Worker's families	40	65.6	18	29.5	2	3.3	1	1.6	**86**	1.41	61
Consumers	43	70.5	16	26.2	1	1.6	1	1.6	**82**	1.34	61

Rating score: 1: Not responsible, 2: Somewhat responsible, 3: Responsible, 4: Highly responsible

Table 26 Statistical analysis of managers' demographic properties and managers' opinions about responsibilities

		State	Education	NAICS	Employees	Experience in FI	Position	Experience in P
Company	χ^2	1.200	7.478	4.073	3.742	3.084	3.556	4.489
	P	0.753	0.279	0.667	0.712	0.798	0.737	0.611
Owner	χ^2	0.923	8.616	6.170	2.637	5.656	2.247	8.745
	P	0.819	0.196	0.404	0.853	0.463	0.896	0.188
Top-level managers	χ^2	1.930	9.920	2.502	1.873	6.067	7.615	9.388
	P	0.587	0.128	0.868	0.931	0.416	0.268	0.153
Lower-level managers	χ^2	2.820	16.072	4.551	4.502	7.241	4.023	5.624
	P	0.420	***0.013****	0.603	0.609	0.299	0.674	0.467
Engineer	χ^2	2.441	11.780	4.329	2.673	4.103	3.152	1.236
	P	0.486	0.067	0.632	0.849	0.663	0.789	0.975
Technician	χ^2	1.489	9.823	8.447	7.625	9.689	6.792	4.134
	P	0.685	0.132	0.207	0.267	0.138	0.340	0.659
Workers	χ^2	7.482	3.549	6.020	9.754	4.685	7.569	2.833
	P	0.058	0.738	0.421	0.135	0.585	0.271	0.829
Family	χ^2	2.960	4.506	5.523	5.948	7.915	6.574	3.732
	P	0.398	0.608	0.479	0.429	0.244	0.362	0.713
Consumers	χ^2	2.440	5.480	6.285	8.072	5.598	4.827	4.358
	P	0.486	0.484	0.392	0.233	0.470	0.306	0.628
Government	χ^2	1.580	6.302	4.413	5.019	3.703	7.688	5.581
	P	0.664	0.390	0.621	0.541	0.717	0.262	0.472

A * indicates a significant relationship between managers' demographic properties and their answers at $p \leq 0.05$.
χ^2 : Chi-square value,
p: p-value (The level of statistical significance).

The only significant relationship was found between education and the responsibility level of lower-level managers ($p \leq 0.013$). Managers with a high school level education rated less than the rest of the managers for responsibility (Figure 51).

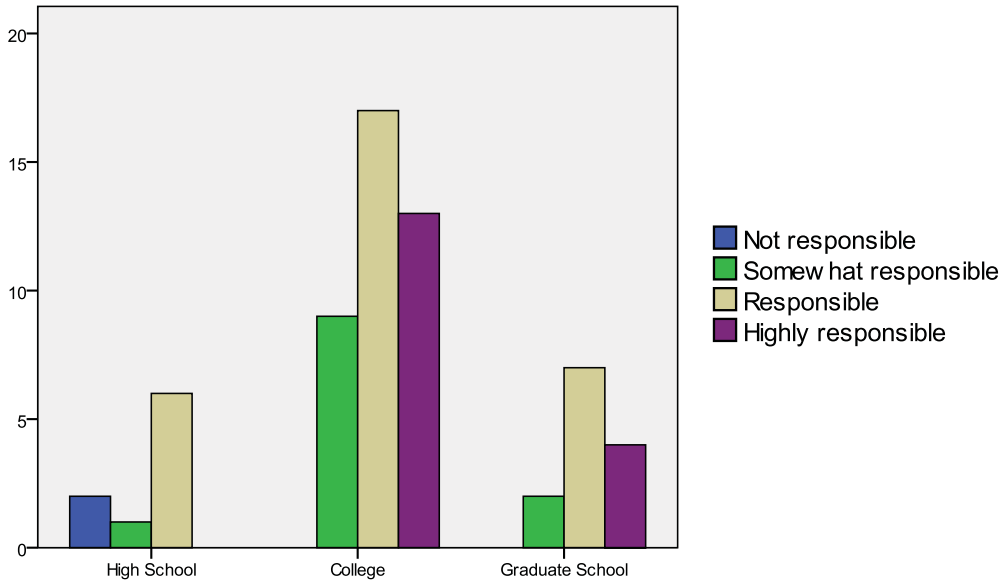

Figure 51 Managers' education and its affect on their opinion about the level of responsibility

Because of the small response number in each cell in Table 26, responses were combined in two categories. The first two categories, not responsible and somewhat responsible, were combined as "*not responsible*", and the other categories, responsible and highly responsible, were combined as "*responsible*." Even through this categorization, no more significant relationships among demographic properties and responsibilities could be found.

The analysis of how owners, top level- and lower level-mangers rated themselves in the responsibility rating scale can be beneficial to better understanding their

commitments to HF/E. The average ratings are given in Table 27. The average rating was 2.73 for owners; however, the average of the owners' rating themselves was 2.61. It means they believed they had less responsibility than the others' thoughts. However, top- and lower-level managers thought themselves more responsible than the average ratings.

Twenty three owners rated them the least responsible among owners, top- and lower-level managers. On the other hand, top-level managers rated themselves as the most responsible person for human factors problems among themselves, owners, and lower-level managers. Lower-level managers also gave themselves the highest responsibility.

Table 27 Managers' average responsibility ratings for themselves

	Responsible		
	Owner	Top-level manager	Lower-level managers
Owner (23)	2.61	2.74	2.78
Top-level manager (8)	3.00	3.38	3.13
Lower-level manager (31)	2.81	2.97	3.13
Average	2.73	2.89	2.98

Rating score:
1: Not responsible, 2: Somewhat responsible, 3: Responsible, 4: Highly responsible

Managers' Opinions about Benefit Levels

Managers were asked to rate the benefit levels for themselves, engineers, employees, companies, employees' families, consumers, and the government considering HF/E. The distribution of responses is given in Table 28.

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Table 28 Managers' opinions about benefits levels

	No Benefit		Little Benefit		Much Benefit		Most Benefit		Total Score	Rating Average	Total Respond
	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)			
Workers	0	0	2	3.2	21	33.9	39	62.9	223	3.60	62
Company	0	0	0	0	32	50.8	31	49.2	220	3.49	63
Lower-level managers	0	0	8	12.9	30	48.4	24	38.7	202	3.26	62
Owner	0	0	10	15.9	31	49.2	22	34.9	201	3.19	63
Top-level managers	0	0	10	16.1	32	51.6	20	32.3	196	3.16	62
Worker's families	4	6.3	11	17.5	27	42.9	21	33.3	191	3.03	63
Government	10	15.9	17	27	21	33.3	15	23.8	167	2.65	63
Engineer	10	16.1	16	25.8	23	37.1	13	21	163	2.63	62
Technician	11	17.7	16	25.8	22	35.5	13	21	161	2.60	62
Consumers	19	30.2	15	23.8	17	27	12	19	148	2.35	63

Rating score:
1: No benefit, 2: Little benefit, 3: Much benefit, 4: Most benefit

Table 29 Statistical analysis of managers' demographic properties and managers' opinion about benefits levels

		State	Education	NAICS	Employees	Experience in FI	Position	Experience in P
Company	χ^2	2.670	0.197	0.384	0.406	1.929	1.893	2.647
	P	0.102	0.906	0.825	0.816	0.381	0.388	0.266
Owner	χ^2	1.795	0.768	1.231	1.992	6.994	1.465	1.296
	P	0.408	0.943	0.873	0.737	0.136	0.833	0.862
General manager	χ^2	3.739	3.867	1.144	0.765	7.929	1.035	1.481
	P	0.154	0.424	0.887	0.943	0.094	0.904	0.830
Production manager	χ^2	5.241	2.287	1.954	4.153	4.011	0.179	0.732
	P	0.073	0.683	0.744	0.386	0.404	0.996	0.947
Engineer	χ^2	6.580	1.164	6.518	1.045	4.406	2.516	2.111
	P	0.087	0.979	0.368	0.984	0.622	0.867	0.909
Technician	χ^2	2.262	2.666	8.497	0.655	4.580	0.992	0.963
	P	0.520	0.849	0.204	0.995	0.599	0.986	0.987
Workers	χ^2	3.771	14.185	3.905	1.205	1.827	0.457	1.554
	P	0.152	***0.007****	0.419	0.877	0.768	0.978	0.817
Family	χ^2	0.924	3.669	4.092	2.967	2.172	0.894	3.307
	P	0.820	0.721	0.664	0.813	0.903	0.989	0.769
Consumers	χ^2	1.635	4.795	9.216	5.715	4.952	7.235	6.102
	P	0.651	0.570	0.162	0.456	0.550	0.300	0.412
Government	χ^2	4.797	11.214	6.392	4.055	1.350	10.644	5.631
	P	0.187	0.082	0.381	0.669	0.969	0.100	0.466

A * indicates a significant relationship between managers' demographic properties and their answers at $p \leq 0.05$.
χ^2 : Chi-square value,
p: p-value (The level of statistical significance).

Managers believed that workers would get the most benefits (3.60 rating average) from HF/E interventions. Companies (3.49 rating average), lower-level managers (3.26 rating average), owners (3.19 rating average), top-level managers (3.16 rating average) workers' families (3.03 rating average), the government (2.65 rating average), engineers (2.63 rating average), and technicians (2.60 rating average) were believed to get a great deal of benefit from HF/E. Consumers, who were rated as not responsible for HF/E problems, were also believed to get the least benefits from HF/E (2.35 rating scale). The result of statistical analysis is given Table 29. The only significant relationship was found between education and the benefit level of workers ($p \leq 0.007$).

Self evaluation of managers was also performed (Table 30). In general, managers rated the benefits for themselves as the others rated. Owners rated themselves the person who would get the most benefit from HF/E. Both top- and lower-level managers believed that lower-level managers would get the most benefit.

Table 30 Managers' average benefit ratings for themselves

	HF/E will Benefit:		
	Owner	Top-level manager	Lower-level Managers
Owner (23)	3.30	3.18	3.22
Top-level manager (8)	3.00	3.13	3.25
Lower-level manager (31)	3.16	3.16	3.27
Average	3.19	3.16	3.26

Rating score: 1: No benefits, 2: Little benefit, 3: Much benefit, 4: Most benefit

Rating averages of both the responsibility level and the benefit level are given in one figure (Figure 52). In the chart, bars with light color are the level of responsibility in HF/E interventions, and bars with dark color are the benefits level from HF/E

interventions. Therefore, managers, in general, believed that HF/E was beneficial, especially for workers. Besides, companies and lower-level managers were the most responsible for HF/E interventions.

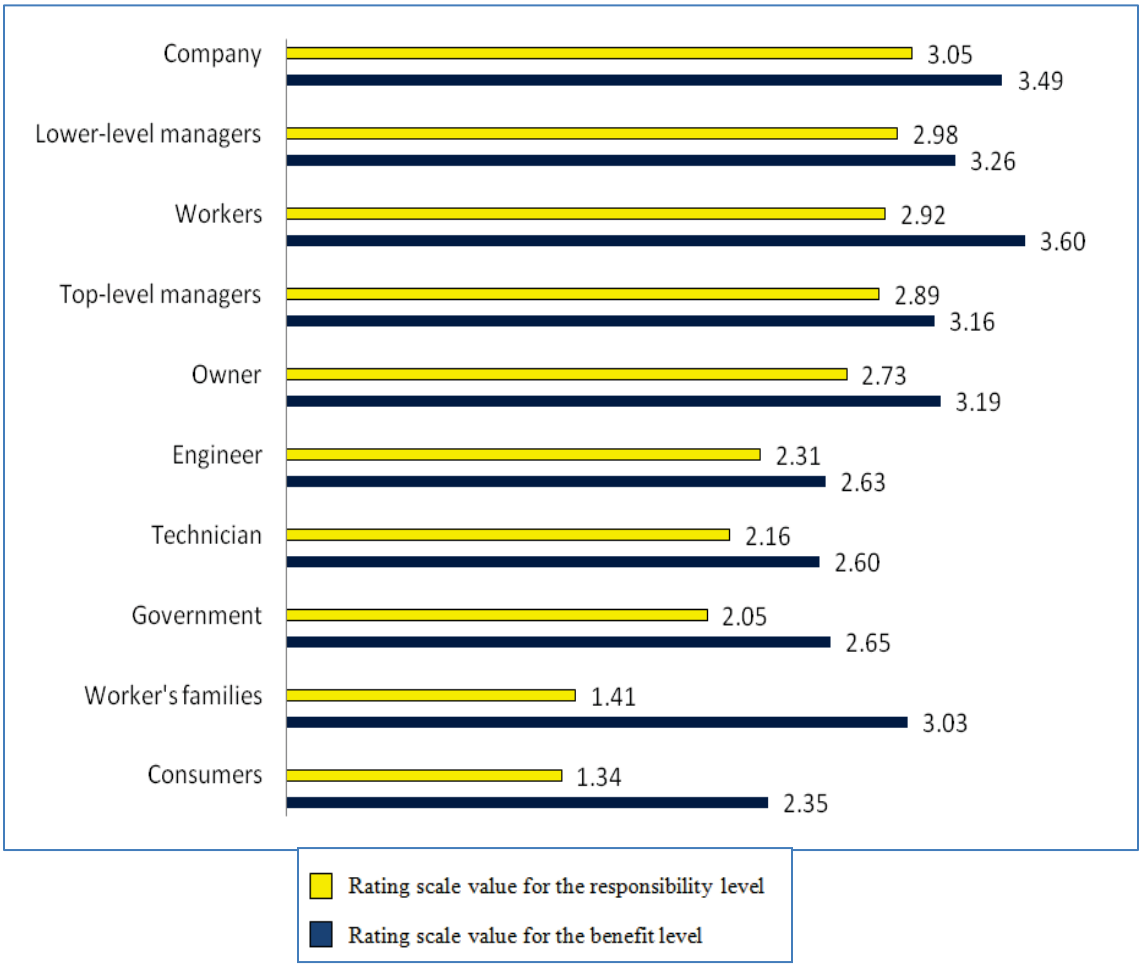

Figure 52 Rating averages of responsibilities and benefits

CHAPTER V

CONCLUSIONS & RECOMMENDATIONS

Conclusions

This study sought to explore the degree of manager awareness of HF/E in the American furniture industry and whether there was a relationship between managers' demographic properties and their awareness. The study aimed to act as a catalyst for manager awareness about HF/E in the furniture manufacturing industry. The familiarity of managers with HF/E increases the success of managers in handling problems resulting from poorly designed systems. The study also aimed to provide managers with some knowledge in order to evaluate their systems in terms of HF/E issues. The study introduces some advantages of HF/E programs and interventions to managers. For example, managers are provided the information about how beneficial an HF/E program could be. There is no doubt that HF/E programs result in financial benefits for a company. Besides financial benefits, prevention or reducing occupational injuries and illnesses is the ethical thing for companies to do; "*Ergonomics is good economics, and should be justified from both a humanitarian and an economic standpoint*" (Douphrate and Rosecrance 2004).

With the aim of better understanding of managers' awareness through HF/E, a web-based questionnfaire survey was used as the experimental instrument. Sixty-four

managers from the American furniture manufacturing industry participated in the survey. After the data collection process, statistical analyses were performed.

Mirka (2005) stated, "*Many companies in the furniture manufacturing industry have been keenly aware of the importance of ergonomics and the positive impact that ergonomics can have both in terms of loss prevention and productivity.*" Even though the results of this study often comply with Mirka's statement, there were some contrasts to the statement. In general, managers were unaware of some aspects related to HF/E. The worst result was that some of the managers did not want to allocate their resources to HF/E issues. Without managers' support, all endeavors are useless and the real achievement is not reachable. The awareness level of managers depended on some manager demographic profiles and company characteristics. The important findings will be given below.

First of all, to remind the demographic properties of managers and the characteristics of their companies can help better judge the results. Thirty-one of sixty-four managers were from Mississippi and the others were from different states in the U.S. Half of the managers were lower-level managers (49.2%), the other half of the managers were owners (38.1%) and top-level managers (12.7%). Most of the managers had college degrees (62.9%). About seventy percent of the managers had more than 10 years of experience in the furniture manufacturing industry (68.8%), and about half of the managers had worked in the same position for more than 10 years (46.9%). Half of the managers had worked in the Household and Institutional Furniture and Kitchen Cabinet Manufacturing (NAICS 3371) subsector. As for company characteristics, about half of

the managers were from small companies (46.9%), and the rest of the managers were from middle size (25%) and large size (28.1%) companies.

Company size is one of the factors that affects managers' awareness level in HF/E. Anderson (2008) points out the strong correlation between company size and HF/E interventions by saying "*the larger the company, the better the work environment*" (Andersson 2008).

Most of managers (71.4%) had not attended a formal training program in HF/E. Particularly, managers from states other than Mississippi and from small companies showed lower participation ratios for training programs. It can be a consequence of economic status of companies. Small companies might not be able to afford the cost of training programs. Owners preferred attending training programs less than top- and lower-level managers did.

Analyses showed that large companies had more opportunity to provide opportunities for (1) training programs for both managers and employees and (2) attending conferences, meetings, and conventions. Training programs in general help to prevent occupational injuries and illnesses. If the industry statistics are investigated (see Chapter 2), it can be seen that the rate of occupational injuries and illnesses was higher in small companies in 2007. The higher ratio can be the result of a lack of training programs. Therefore, small companies should be provided more training programs.

Unfortunately, there were no managers in the survey who had a certification in HF/E. In general, lower-level managers pay more attention than owners, so they attend conferences, meetings, and conventions relating to HF/E more than owners.

Managers rated their knowledge on HF/E as close to average. Most of managers (75%) rated their knowledge level as poor, fair, or average.

Reading hardcopies (e.g. books, journals, newspapers, and magazines) and searching on the Internet were the most preferred information resources. About twenty percent of the managers were, unfortunately, not aware of information resources about HF/E. Mississippi managers preferred attending conferences, meetings, and conventions and consulting an expert more than the managers from other states. Larger companies could afford to send their managers to conferences, meetings, and conventions relating to HF/E. Generally, lower-level managers attend conferences, meetings, and conventions more than owners. The Other Furniture Related Product Manufacturing (NAICS 3379) subsector showed more awareness on information resources than the other two subsectors. To sum up, because reading books, journals, newspapers, and magazines and using the Internet were the more preferred information resources, they were preferred as the media of information resource.

When the likely advantages of HF/E were asked, increasing worker performance (90.6%), reducing occupational injuries (87.5%), decreasing worker compensation costs (75%), and improving the quality in work places (75%) were the most preferred answers. More regulations to follow (54.7%) and higher cost in training new employees (53.1%) were most the preferred answers for the likely disadvantages of HF/E.

Most of the responders (87.5%) that believed that HF/E does not have an impact on reducing occupational injuries were from other states. Mississippi managers believed more than other states' managers that HF/E can increase furniture quality, enhance

competitiveness, and ensure longer survival time. Managers from the Other Furniture Related Products Manufacturing (NAICS 3379) subsector believed that HF/E does not increase worker's safety. Managers working in middle and large companies believed more than small companies that HF/E can reduce compensation costs and can cause other cost savings (e.g. lower insurance cost). Lower-level managers believed more than top-level managers and owners that HF/E can reduce compensation costs and can cause other cost savings (e.g. lower insurance cost).

More experienced managers in both the industry and the position believed that HF/E results in more time consuming processes in production. When managers in the furniture industry were compared to panel designers, furniture manufacturing managers were more aware of the advantages of HF/E and less concerned about the disadvantages. That is, managers in the furniture manufacturing industry accepted HF/E as a beneficial tool rather than panel designers.

Most managers agreed that scientific data about HF/E was not too complex to understand and apply (87.5%); HF/E did not cause more expenses than the benefits returned (84.4%); small changes in environmental factors in workplaces could have a considerable impact on worker's productivity, comfort, health, and safety (68.7%); workers could understand what HF/E deal with (17.2%); using personal protective equipment could prevent occupational injuries and illnesses (85.9%); and working posture can cause or prevent musculoskeletal injuries (82.9%). Managers in the Office Furniture (Including Fixtures) Manufacturing (NAICS Code 3372) subsector agreed more than other subsectors that their workers could understand what HF/E dealt with.

Unfortunately, about half of the managers mentioned that their companies had never been inspected for HF/E problems (46.9%). A large amount of these companies were small companies (66.7%).

Only 34.4 percent of companies had a team or department for HF/E interventions. The ratio was lower in small companies (16.7%). Forty percent of managers expressed that workers in their factories received training for HF/E. Only 20 percent of small companies trained their employees.

Seventeen percent of managers mentioned that they did not prefer ergonomically designed equipment even if it might help to reduce occupational hazards and accidents. Mississippi manager were more willing to use ergonomically designed equipment than the managers from other states.

Thirty percent of managers mentioned that they had sufficient resources to allocate ergonomics interventions. Small companies did not have sufficient resources for HF/E interventions. Managers with 3-10 years of experience in their positions mentioned they had sufficient resources.

Managers rated the necessities of resources for HF/E. They believed that employing an ergonomist(s) or a human factors' professional(s) was not necessary. Likewise, a team or department to handle HF/E problems was rated as not necessary. Managers took a neutral stance toward the necessity of scientific data, employees' training, managers' training, and allocation resources to HF/E. Fortunately, a small percent of managers believed that training workers for HF/E was not necessary (17.4%). Managers from other states, managers from small companies, managers from the Office

Furniture (Including Fixtures) Manufacturing (NAICS 3372) subsector, managers with more than 10 years experience, and managers with the position of owner believed that a team or department was not necessary. Mississippi managers took a positive stance toward training management.

Physical fatigue (79.7%) and worker errors (78.1%) were rated as the major causes of occupational injuries, accidents, and illness. Managers from other states believed that mental fatigue causes occupational injuries and illnesses. Repetitive tasks were rated by managers from the Office Furniture (including Fixtures) Manufacturing (NAICS 3372) and the Other Furniture Related Product Manufacturing (NAICS 3379) subsectors as a risk factor for occupational injuries and illnesses.

Managers with 3-10 years of experience in the furniture industry and managers with less than 3 years of experience in their position did not believe that inadequate job descriptions could cause occupational injuries and illnesses. Owners more rated mental fatigue as a risk factor than other managers did.

Managers gave the company, lower-level managers, and workers the highest responsibility for HF/E problems. Owners rated themselves as the least responsible, and lower- and top-level managers rated themselves as the most responsible for HF/E problems.

Managers believed that workers, companies, and lower-level managers would get the most benefits from HF/E interventions. Owners believed that they would get the most benefit among top- and lower-level managers, but top- and lower-level managers believed that lower-level managers would get the most benefit.

Recommendations

The furniture manufacturing industry is one of the industries where workers are at risk in terms of occupational injuries and illnesses. Managers in the furniture industry should understand the importance of HF/E to prevent or reduce these injuries and illnesses. For example, lifting or lowering heavy and awkward furniture occurs all the time. Managers should be able to find solutions for these risk factors. They should be familiar with assistive devices for manual handling tasks or with the knowledge of the advantages of team lifting. Most of the occupational injury problems can be solved by simple engineering solutions.

Managers should be patient with the results of HF/E interventions. Unfortunately, financial advantages of these solutions may not be immediately obtained. Management commitment and employee involvement are the most important factors for the success of HF/E programs. Managers should institute practical HF/E programs whether or not OSHA promulgates some regulation on related issues.

Scientists can be recommended to better document their research. Little research has been done on the topic of HF/E in the furniture manufacturing industry, and the benefits of HF/E were not well documented in these researches. This has resulted in poor support by the leaders of the business and government. Research should be documented in terms of business points of view. The cost-benefit analysis should be shared with other colleagues, scientists, and the other members of furniture manufacturing communities by publishing in journals, magazines, and on the Internet. To conclude, scientists should

introduce good examples of how a simple and inexpensive solution can result in very high cost–benefit effectiveness.

This thesis will close with a quote from one of authors of the first HF/E text book which should give the actual problems that should be dealt with, which is that human properties are various and complex; Chapanis emphasized "*these are not problems of man versus machine, but rather of man versus man - man, the user and operator of machines, versus man, the designer of them*" (Chapanis 1965).

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APPENDIX A

CORRESPONDENCE TABLES:2002 THE NORTH AMERICAN INDUSTRY CLASSIFICATION SYSTEM (NAICS) MATCHED TO 1987 THE U.S. STANDARD INDUSTRIAL CLASSIFICATION (SIC) SYSTEM

Table 31 Correspondence Tables: 2002 The North American Industry Classification System (NAICS) Matched to 1987 the U.S. Standard Industrial Classification (SIC) System

2002 NAICS	2002 NAICS U.S. Description (with link to definition)	Com-para-bility	1987 SIC	1987 U.S. SIC Description (with link to definition)
337110	Wood Kitchen Cabinet and Countertop Manufacturing			
			2434	Wood Kitchen Cabinets
			2541	Wood Office and Store Fixtures, Partitions, Shelving, and Lockers (Counter tops)
			5712	Furniture Stores (Custom wood cabinets)
337121	Upholstered Household Furniture Manufacturing			
			2512	Wood Household Furniture, Upholstered
			2514	Metal Household Furniture (Upholstered)
			2515	Mattresses, Foundations, and Convertible Beds (Convertible beds)
			5712	Furniture Stores (Custom made upholstered household furniture)
337122	Nonupholstered Wood Household Furniture Manufacturing			
			2511	Wood Household Furniture, Except Upholstered (Except wood box spring frames)
			5712	Furniture Stores (Custom made nonupholstered wood household furniture except cabinets)
337124	Metal Household Furniture Manufacturing		2514	Metal Household Furniture (Except upholstered metal furniture and metal box spring frames)
337125	Household Furniture (except Wood and Metal) Manufacturing			
			2499	Wood Products, NEC (Laundry hampers of reed, rattan, and willow)
			2519	Household Furniture, NEC
337127	Institutional Furniture Manufacturing			
			2531	Public Building and Related Furniture (Except motor vehicle seats and blackboards)
			2541	Wood Office and Store Fixtures, Partitions, Shelving, and Lockers (Wood lunchroom tables and chairs)
			2542	Office and Store Fixtures, Partitions, Shelving, and Lockers, Except Wood (Lunchroom tables and chairs)
			2599	Furniture and Fixtures, NEC (Except hospital beds)
			3952	Lead Pencils, Crayons, and Artists' Materials (Drafting tables and boards)
			3999	Manufacturing Industries, NEC (Beauty and barber chairs)

Table 31 (continued)

337129	Wood Television, Radio, and Sewing Machine Cabinet Manufacturing		2517	Wood Television, Radio, Phonograph, and Sewing Machine Cabinets
337211	Wood Office Furniture Manufacturing		2521	Wood Office Furniture
337212	Custom Architectural Woodwork and Millwork Manufacturing		2541	Wood Office and Store Fixtures, Partitions, Shelving, and Lockers (custom architectural millwork)
337214	Office Furniture (except Wood) Manufacturing		2522	Office Furniture, Except Wood
337215	Showcase, Partition, Shelving, and Locker Manufacturing			
			2426	Hardwood Dimension and Flooring Mills (Wood furniture frames and finished furniture parts)
			2511	Wood Household Furniture, Except Upholstered (Wood box spring frames(parts))
			2514	Metal Household Furniture (Metal box spring frames)
			2541	Wood Office and Store Fixtures, Partitions, Shelving, and Lockers (Except custom architectural millwork, counter tops, and lunchroom tables and chairs)
			2542	Office and Store Fixtures, Partitions, Shelving, and Lockers, Except Wood (Except lunchroom tables and chairs)
			3089	Plastics Products, NEC (Finished plastic furniture parts)
			3429	Hardware, NEC (Sleep sofa mechanisms and chair glides)
			3499	Fabricated Metal Products, NEC (Metal furniture frames)
337910	Mattress Manufacturing		2515	Mattresses, Foundations, and Convertible Beds (Mattresses and foundations)
337920	Blind and Shade Manufacturing		2591	Drapery Hardware and Window Blinds and Shades

Comparability Symbols link to the Bridge Between NAICS and SIC, 1997

(Bridge complete.)	Comparable	NAICS derivable from SIC data.
(Drawbridge slightly open.)	Almost comparable	Sales or receipts from SIC are within 3% of NAICS sales or receipts.
(Drawbridge open.)	Not comparable	NAICS sales or receipts cannot be estimated within 3% from SIC data.

Resource: Census Bureau (2002), Retrieved April 1, 2009, from http://www.census.gov/epcd/naics02/N2SIC33C.HTM#N33712

APPENDIX B

INSTRUMENT: HUMAN FACTORS AND ERGONOMICS

AWARENESS QUESTIONNAIRE

Human Factors and Ergonomic Awareness Survey

Password

ENTER YOUR PASSWORD then click "next": (If you do not have a password, enter "visitor".)

Human Factors and Ergonomic Awareness Survey

The Informed Consent

This is a questionnaire survey the aim of which is to better understand human factors and ergonomics through the knowledge and opinions of managers in the furniture industry and to document the results. The information gained from the survey may help managers, scientist, engineers, and systems designers in the industry to design more productive, safer and healthier tasks and workplaces.

This research project has been approved by the Institutional Review Board at Mississippi State University for projects involving human participants. The IRB approval number is 08-196.

The questionnaire survey should take approximately ten minutes. It consists of 18 questions. The first six questions are for demographic analysis. The others are for your background and opinions on human factors and ergonomics.

We maintain the confidentiality of data; hence the questionnaire does not have any direct identifying information on it such as your name, address, phone number, etc. However, the password provided to you in the recruitment e-mail to begin the questionnaire is linked to your identity. This is to keep track of which participants have completed the questionnaire and also to make sure that only the recruited individuals take the survey. The list of passwords and corresponding identities will be kept as a separate file in a password-protected drive other than the one containing completed questionnaires and will be deleted so as to maintain the confidentiality of data when the data collection process is completed. This password is assigned for you and assures that no one will start the questionnaire on behalf of you and no one will see your responses. If there is a breach of confidentiality of the research data, there could be a risk to you depending on your responses, in terms of your reputation and/or liability concerns. However, we will take the steps mentioned above to minimize this risk. There is the possibility for identification of respondents in two ways (1) through the assigned password and/or (2) through indirect identifiers collected through the survey, such as the state, NAICS code, size of company, etc.

There are no direct benefits to you associated with this survey. However, it may benefit you and other managers in the American Furniture Industry to gain knowledge about human factors and ergonomics after it is published. Participation is voluntary and refusal to participate involves no loss of benefits or negative consequences. You may discontinue this survey at any time. You can choose not to answer specific questions or to stop participating at any time. This will not affect you in any way.

There are two choices below. Clicking the choice of "I admit" indicates you accept all the risks and you volunteer to participate. Clicking to the choice of "I admit" also indicates that you have read the description of the study, understand the nature of the research, are 18 years old or older, and accept the above conditions.

If you do not want to be a part of this survey, click the choice of "I decline".

Human Factors and Ergonomic Awareness Survey

If you have any questions about this research project, please feel free to contact Celal Gungor* and Dr. Steve L. Hunter± at 662-325-8344. For additional information regarding your rights as a research subject, please feel free to contact the MSU Regulatory Compliance Office at 662-325-2238.

* Graduate Student, Franklin Furniture Center, Department of Forest Products, Mississippi State University, MS cg282@msstate.edu
± Associate Professor, Franklin Furniture Center, Department of Forest Products, Mississippi State University, MS shunter@cfr.msstate.edu

*** participation**

◯ I admit ◯ I decline

Human Factors and Ergonomic Awareness Survey

Managers' Demographic Profiles and Company Characteristics

1. Demographic properties

	State	Your education
Select one		

2. What is your factory's North American Industry Classification System (NAICS) code?

NAICS code

3. How many employees work in your factory?

- ◯ 0-19 employees
- ◯ 20-49 employees
- ◯ 50-99 employees
- ◯ 100-249 employees
- ◯ 250-499 employees
- ◯ 500-999 employees
- ◯ 1000 empolyees or more

4. How long have you worked in the furniture industry?

- ◯ less than 1 year
- ◯ 1-3 years
- ◯ 4-10 years
- ◯ more than 10 years

5. What is your current position?

- ◯ Owner
- ◯ General Manager / CEO / President
- ◯ Production Manager / Director of Manufacturing / Plant Manager / Vice Manager / Human Resources Manager
- ◯ Engineer
- ◯ Technician

Human Factors and Ergonomic Awareness Survey

6. How long have you worked in this position?

- ◯ less than 1 year
- ◯ 1-3 years
- ◯ 4-10 years
- ◯ more than 10 years

Human Factors and Ergonomic Awareness Survey

Definition of Human Factors and Ergonomics

Twelve questions left.

Before starting these questions, it will be beneficial to remember what human factors and ergonomics are.

The International Ergonomics Association (IEA) defines human factors and ergonomics as: "Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system. The profession applies theory, principles, data and methods to the design of systems, for example, workplace, tasks, processes, in order to optimize human well-being and overall system performance."
http://www.iea.cc/browse.php?contID=what_is_ergonomics

PLEASE, NOTE THAT HUMAN FACTORS AND ERGONOMICS ARE USED SYNONYMOUSLY IN THIS SURVEY.

Human Factors and Ergonomic Awareness Survey

Managers' Familiarity, Knowledge, and Information Resources

7. Please check yes or no on the following questions.

	Yes	No
Have you ever attended a formal training program in human factors and ergonomics?	○	○
Do you have any certification in human factors and ergonomics?	○	○

8. To what level do you rate your knowledge on human factors and ergonomics?

	Poor				Excellent
Your knowledge on Human Factors & Ergonomics	○	○	○	○	○

9. How do you get information concerning human factors and ergonomics? (Check all that apply)

- ☐ read books, journals, newspapers, magazines
- ☐ attending conferences, meetings, conventions
- ☐ internet
- ☐ consulting an expert
- ☐ computer software
- ☐ I am not aware of information sources about human factors and ergonomics.
- ☐ other (please specify)

Human Factors and Ergonomic Awareness Survey

Likely advantages and Disadvantages of Human Factors and Ergonomics

10. In your opinion, what are the likely benefits and disadvantages of human factors and ergonomics activities? (Check all that apply)

Likely benefits;

- [ ] increased human productivity
- [ ] increased system productivity
- [ ] reducing work-related injuries
- [ ] less illnesses
- [ ] less absenteeism
- [ ] lower worker's compensation costs
- [ ] cost savings (e.g. lower insurance cost)
- [ ] more satisfied workers
- [ ] higher morale
- [ ] improved quality of work life
- [ ] increased worker's comfort
- [ ] increased worker's safety
- [ ] less fatalities due to occupational injuries and illnesses
- [ ] better furniture quality
- [ ] higher competitiveness
- [ ] long-term organizational survival
- [ ] There is no benefits of human factors and ergonomics
- [ ] other (please specify)

Human Factors and Ergonomic Awareness Survey

Likely disadvantages;

- [ ] more regulations to follow
- [ ] higher cost in training new employees
- [ ] more time consuming process in production
- [ ] more expensive protective equipment needed
- [ ] less flexibility in determining furniture production
- [ ] There is no disadvantages of human factors and ergonomics
- [ ] Other (please specify)

Human Factors and Ergonomic Awareness Survey

Managers' Agreements with Some Statements

11. To what level do you agree with these statements?

	Strongly disagree				Strongly agree
Scientific data about human factors and ergonomics is too complex to understand and apply.	○	○	○	○	○
Human factors and ergonomics causes more expenses than the benefits returned.	○	○	○	○	○
Small changes in environmental factors in workplaces can have a considerable impact on worker's productivity, comfort, health and safety.	○	○	○	○	○
Workers in your factory understand what human factors and ergonomics deal with.	○	○	○	○	○
Using personal protective equipment (hardhat, goggle, earplug, gloves, earmuff, respirator, safety shield) has an impact to prevent work-related injuries and illnesses.	○	○	○	○	○
Working posture can cause or prevent musculoskeletal injuries.	○	○	○	○	○

Human Factors and Ergonomic Awareness Survey

The Frequency of Inspections for Human Factors and Ergonomic Problems

12. How often is your factory inspected for ergonomic problems by a human factors' specialist(s) or an ergonomist(s) with respect to using ergonomics guidelines (NIOSH lifting equation, specific checklists, etc.)?

- ◯ Every month
- ◯ Every 1-3 months
- ◯ Every 3-6 months
- ◯ Every 6 months-1 year
- ◯ Every 1-2 years
- ◯ More than 2 years
- ◯ Never

Human Factors and Ergonomic Awareness Survey

Employees' Familiarity and Preference and Availability of Resources

13. Please check yes, no, or not sure on the following questions.

	Yes	No	Not sure
Is there a team or department in your factory that finds and corrects ergonomics problems?	○	○	○
Do your workers receive training for human factors and ergonomics?	○	○	○

14. Please check yes, no, or not sure on the following questions.

	Yes	No	Not sure
Do you prefer "ergonomically designed" equipment to reduce occupational hazards and accidents even if they are more expensive than regular equipment?	○	○	○
Are sufficient resources available in your company to enhance or improve ergonomics activities?	○	○	○

Human Factors and Ergonomic Awareness Survey

Importance of Human Factors and Ergonomics Sources

15. How important do you find these human factors and ergonomics sources for your factory?

	Not necessary at all				Strongly necessary
Scientific data about human factors and ergonomics	○	○	○	○	○
Employing an ergonomist(s) or a human factors' professional(s)	○	○	○	○	○
A team or department to handle human factors and ergonomics problems	○	○	○	○	○
Training workers for human factors and ergonomics	○	○	○	○	○
Training managers for human factors and ergonomics	○	○	○	○	○
Resources for human factors and ergonomics issues	○	○	○	○	○

Human Factors and Ergonomic Awareness Survey

Likely Causes of Occupational Injuries, Accidents, and Illnesses

16. In your opinion, what are the main causes of occupational accidents, injuries, and illnesses? (Check all that apply)

- [ ] stress
- [ ] mental fatigue
- [ ] physical fatigue
- [ ] lack of training
- [ ] repetitive tasks
- [ ] environmental factors (hot, cold, wind, bacteria, etc.)
- [ ] worker's errors
- [ ] staff shortage
- [ ] poor match of personnel with tasks to be performed
- [ ] inadequate job descriptions
- [ ] inadequate supervision
- [ ] unknown causes
- [ ] other (please specify)

Human Factors and Ergonomic Awareness Survey

Responsibility Levels

17. Who do you think is responsible for human factors and ergonomics problems?

	Not responsible	Somewhat responsible	Responsible	Highly responsible
Company	○	○	○	○
Owner	○	○	○	○
General Manager / CEO / President	○	○	○	○
Production Manager / Director of Manufacturing / Plant Manager / Human Resources Manager	○	○	○	○
Engineer	○	○	○	○
Technician	○	○	○	○
Workers	○	○	○	○
Worker's families	○	○	○	○
Consumers	○	○	○	○
Government	○	○	○	○

Human Factors and Ergonomic Awareness Survey

Benefit Levels

18. Please rate how each of the following would benefit from considering human factors and ergonomics?

	No Benefit	Little Benefit	Much Benefit	Most Benefit
Company	○	○	○	○
Owner	○	○	○	○
General Manager / CEO / President	○	○	○	○
Production Manager / Director of Manufacturing / Plant Manager / Human Resources Manager	○	○	○	○
Engineer	○	○	○	○
Technician	○	○	○	○
Workers	○	○	○	○
Worker's families	○	○	○	○
Consumers	○	○	○	○
Government	○	○	○	○

Human Factors and Ergonomic Awareness Survey

Appreciation

Thanks for participating in this survey.
If you would like to conduct us about your feedback or provide additional thoughts and comments, please feel free to contact us.

If you would like to contact us for further information regarding this survey and rights of research subjects:

Celal Gungor,
Franklin Furniture Center,
Department of Forest Products,
Mississippi State University, MS
cg282@msstate.edu

Dr. Steve L. Hunter,
Associate Professor,
Franklin Furniture Center,
Department of Forest Products,
Mississippi State University, MS
shunter@cfr.msstate.edu
Phone : 662-325-8344

APPENDIX C

INSTITUTIONAL REVIEW BOARD (IRB) APPROVAL: # 08-196,

MISSISSIPPI STATE UNIVERSITY

Mississippi State UNIVERSITY

September 3, 2008

Celal Gungor
Forest Products
Mail Stop 9820

RE: IRB Study #08-196 An Awareness Survey Study of Professional Personnel in the American Furniture Industry

Dear Mr. Gungor:

The above referenced project was reviewed and approved via expedited review for a period of 9/3/2008 through 8/15/2009 in accordance with 45 CFR 46.110 #7 Please note the expiration date for approval of this project is 8/15/2009 If additional time is needed to complete the project, you will need to submit a Continuing Review Request form 30 days prior to the date of expiration. Any modifications made to this project must be submitted for approval prior to implementation Forms for both Continuing Review and Modifications are located on our website at http://www.orc.msstate.edu

Any failure to adhere to the approved protocol could result in suspension or termination of your project. Please note that the IRB reserves the right, at anytime, to observe you and any associated researchers as they conduct the project and audit research records associated with this project.

Please note that the MSU IRB is in the process of seeking accreditation for our human subjects protection program. As a result of these efforts, you will likely notice many changes in the IRB's policies and procedures in the coming months. These changes will be posted online at http://www.orc.msstate.edu/human/aahrpp.php

Please refer to your docket number (#08-196) when contacting our office regarding this project.

We wish you the very best of luck in your research and look forward to working with you again. If you have questions or concerns, please contact Jonathan Miller at jmiller@research.msstate.edu or call 662-325-2238

Sincerely,

Jonathan Miller, CIP
IRB Officer and Assistant Director

cc: Dr. Steve Hunter

Office for Regulatory Compliance
P. O. Box 6223 • 70 Morgan Avenue • Mailstop 9563 • Mississippi State, MS 39762 • (662) 325-3294 • FAX (662) 325-8776

APPENDIX D

SAMPLE INVITATION E-MAIL

Subject: a survey on human factors and ergonomics in the furniture industry- MSU
From: cg282@msstate.edu
To: shunter@cfr.msstate.edu

Dear **Mr. Steve L. Hunter**,

We are conducting a survey on human factors and ergonomics in the furniture industry and would appreciate your response.

Participation involves a web based questionnaire and may take 5-10 minutes to complete. By participating in this study, you will help us to better understand human factors and ergonomics through the knowledge and opinions of managers in the furniture industry.

Your password to login and begin questionnaire: SLH01

To complete the questionnaire, go to:
http://www.surveymonkey.com/s.aspx?sm=utQ4xicsVLlXlL1zzW5AyA_3d_3d
or visit the Department of Forest Products, Mississippi State University:
http://www.cfr.msstate.edu/forestp/furniture_survey.asp
or visit Franklin Furniture Institute: http://www.ffi.msstate.edu/

We have received IRB approval to conduct this study. The information you provide by means of the questionnaire will remain confidential. We will destroy all individual information once the study is complete. No one at Mississippi State University (or anywhere else) will have access to individual information not already available to the public. All information you provide will be used only for research purposes by researchers. If you have any questions about this research project, please feel free to contact Celal Gungor and Dr. Steve L. Hunter at 662-325-8344.

Steve L. Hunter,
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