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Human Factors, Ergonomics Model and Application in Automotive Industries: Focus on Job Satisfaction

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1. Introduction

Industrial work design is defined as a specification of work content, method and relationships to satisfy the requirement of the worker and the system. Industrial work design must be developed as an integrated whole, taking into consideration the interdependencies among skills, organization and technology. On the other hand, the concept of job satisfaction is typically defined as an individual's attitude about work roles and the relationship to worker motivation. There can be no job satisfaction where there is no motivation.

The most important evidence that indicates the worsening conditions of an organization is the low rate of job satisfaction. Thus job satisfaction is the key to establishing a healthy organizational environment in an organization. Nonetheless, factors related to job satisfaction are relevant in the prevention of employee frustration and low job satisfaction because employees will work harder and perform better if they are satisfied with their jobs. Many factors affect job satisfaction according to Bowen et al, 1994, DeSantis and Durst, 1996 and Gaesser and Whitbourne, 1985. Although numerous studies on the effect of job satisfaction in industries exist, findings were often specific to the particular investigation, and to date mainly consider individual components of the physical environment (Clegg et al, 1997).

Nadin et al, 2001 stated that many researchers have suggested a number of workplace design strategies to improve the quality of the workplace. In contrast, Oldham, 1996 stated that little attention is given to the actual process of workplace design. Clegg, 1995 suggested that methods should be developed to facilitate this process; and to do so, a more thorough understanding is needed about how various factors affect industrial job satisfaction. Workplace design research can make progress by applying what is already known and by asking a more comprehensive set of research questions (Holman et al, 2002). An approach to the design of workplaces that is human centered is needed. This approach should adequately incorporate factors that contribute to the effectiveness of workplace design.

2. Background materials

Ergonomically, job satisfaction can be affected by job characteristics, job environment, and job organization. The relationships between job satisfaction and these factors can be analyzed statistically using correlations to provide new insights into factors that affect job satisfaction in automotive industries. The Job Diagnostic Survey or JDS by Hackman and Oldham (1974) can be used as a tool to diagnose job characteristics, job environment and job organization.

2.1 Job characteristics

Hackman and Oldham (1974) divided job characteristics into five factors. They were skill variety, task identity, task significance, autonomy, and feedback from job.

Firstly, skill variety was defined as the degree to which a job requires a variety of different activities which involve the use of a number of different skills and talents. Secondly, the degree to which a job requires completion of a “whole” and identifiable piece of work was defined for task identity. Thirdly, task significance was defined as the degree to which a job has a substantial impact on the lives or work of other people, whether in the immediate organization or in the external environment. Fourthly, the degree to which the job provides the employee substantial freedom, independence and discretion in scheduling the work and in determining procedures to complete it was defined as autonomy. Finally, feedback from job was defined as the degree to which completing work activities required by the job results in the employee obtaining direct and clear information about the effectiveness of his or her performance.

2.2 Job environment

Air temperature, humidity, noise, and light were four environmental factors included that could influence job satisfaction. Parsons (2000) stated that environmental factors such as temperature and humidity can have important effects on psychological parameters such as level of arousal and motivation. To assess thermal comfort, JDS's questionnaire developed adopts the definitions of Parson (2000) as “the condition of mind which expresses satisfaction with the thermal environment”. The reference to “mind” indicates that satisfaction is a subjective measure. However, warmth discomfort has been shown to be related to the stickiness caused by un-evaporated perspiration. Consequently, questions regarding thermal comfort addressed satisfaction and comfort.

Noise levels can also affect worker satisfaction. The term comfort is not usually used when assessing the effect of noise on the occupants of the buildings. In practice, again according to Parsons, (2000), annoyance levels are the most useful criterion. Thus, questions regarding noise addressed annoyance and comfort.

Lastly, Parsons (2000) stated that light can cause both discomfort and positive sensations. Questions regarding light addressed satisfaction and the degree of comfort in seeing the work task.

2.3 Job organization

Das (1999) stated that the organization factors such as workers' participation in job related decision self-regulation and worker autonomy can affect job satisfaction. The questionnaire addressed respondents' perception of these factors.

De Jong (1989) classified five factors for job organization and they were job rotation, work method, training, problem solving, and goal setting. Job rotation allows workers to rotate among jobs to increase variety. This technique has been widely used to increase the competence of workers and to reduce monotony (Helander, 1995). The objective of job rotation is to broaden an employee's experience and to train backup staff to allow the company to cope with worker vacations and illnesses, and also with periods of increased production (The Ergonomics Group, 1986).

Work method describes how tasks are being organized (Rouse et al., 1991) and according to Quirk (1999), the methods could include procedures, instructions and documentation that define how manufacturing steps or processes are accomplished. Training is defined as the systematic development of worker skills. Individuals need knowledge and skills to perform adequately on a given task (Stammers and Patrick, 1975). Problem solving describes how the workers handle work related problems by giving them the resources and authority to do so (Ugboro and Obeng, 2001), whereas goal setting is the process of developing, negotiating and formalizing the targets or objectives that an employee is responsible for accomplishing (Umstod et al., 1976).

3. Case study: automotive industries in Malaysia

A survey was done to discover new insights into factors that affect job satisfaction in automotive industries in Malaysia. The primary objective of this survey was to investigate how job satisfaction is affected by job characteristics, job environment and job organization. The methods used in this survey to address the objectives include questionnaire design, observation, measurements, and data collection. The job diagnostic survey (JDS) by Hackman and Oldham (1974) was used as a tool to diagnose job characteristics, job environment and job organization. The questionnaires used consist of a set of multiple-choice items that use a seven-point Likert scale (Rodeghier, 1996). The relationships between job satisfaction and the tested factors were analyzed statistically using correlations.

3.1 The survey

The questionnaires were distributed to the subjects individually. Two automotive manufacturing industries ("Auto1" and "Auto 2") were involved in the survey; 170 male subjects (ages 18 to 40 years) completed the survey, where 120 were from Auto1 and 50 were from Auto2.

3.2 The questionnaires

The questionnaires were organized into four sections covering:

- a. General background data: age, gender, years of employment, marital status and education levels.
- b. Job characteristics factors: skill variety, task identity, task significance, autonomy and feedback from the work.
- c. Environmental factors measured at each workstation: air temperature, humidity, noise in decibels (dB) and light in lux.
- d. Job organization: job rotation, work method, training, problem solving and goal setting. This section intends to determine how the respondents felt about the tasks being organized, the type of procedures being used, and the related work being loaded.

Before initiating the questionnaire sessions and as a reference for the analysis, the management was first interviewed and a checklist was made.

3.3 The analysis

The data were analyzed for correlations using the Spearman rank order correlation. To test the reliability of each question in the survey, reliability of factors tested in the survey was quantified using Cronbach's α . This statistic is derived from the average correlations of all items on the scale, which will measure the internal consistency of the test scores. As a rule of thumb, values that are greater than 0.70 will indicate that the questions are reliable.

4. Results and discussion

The results were divided into several sections covering general background data, reliabilities measures, and correlations of job satisfaction with job characteristics, environment and job organization factors.

4.1 General background data

Eighty percent of the 170 respondents in both companies hold "Malaysian Certificate of Education" (SPM) equivalent to "O" levels; while others hold SPM certificate together with other skill certificates.

Respondents in Auto1 were older and more experienced than those in Auto2. The respondents from Auto1 were 23 to 40 years old (mean = 31.3, s.d. = 3.9; 83% \geq 26 years) with a mean of work experience of 10.6 years (s.d. = 3.8); those from Auto2 were 18 to 27 years old (mean = 22.6, s.d. = 2.1; 10% \geq 26 years) with a mean of work experience of 2.6 years (s.d. = 1.8). In Auto1, 69% were married, but in Auto2 only 13% were married. Ages were normally distributed but work experience was not.

Work experience for Auto1 was negatively skewed but work experience for Auto2 was positively skewed. At Auto1, 90% of the respondents from Auto 1 had worked for there for more than 5 years, but at Auto2, only 10% had worked there for more than 5 years. These demographic differences between the plants may occur because Auto1 was established before Auto2.

4.2 Reliabilities measure

Cronbach's α was derived from the average correlations between the Likert-scale assessments of all pairs of items (Rodeghier, 1996). Out of twenty-eight reliability measures in both companies, 18 had $\alpha > 0.7$, 9 had $0.6 < \alpha < 0.7$ and one had $\alpha = 0.5$ (Table 1). Therefore, the reliability measures were high for job factors in both companies, especially for skill, task identity, autonomy and feedback ($0.69 < \alpha < 0.88$).

4.3 The correlation coefficient

Job satisfaction was significantly ($p < 0.01$) correlated with several job characteristics, environment and job organization (Figures 1 to 3). Eight factors had strong significant correlation in with job satisfaction Auto 1: skill variety, task identity, autonomy, light, job rotation, work method, training and goal setting. Four factors had strong significant correlation with job satisfaction in Auto 2: skill variety, humidity, job rotation and work method.

Tested Factors	Auto1, n = 120	Auto2, n = 50
Job factors		
Skill	0.77	0.79
Task identity	0.76	0.69
Task significance	0.61	0.63
Autonomy	0.72	0.69
Feedback	0.86	0.88
Environmental factors		
Perception of temperature	0.72	0.69
Perception of humidity	0.64	0.86
Perception of noise	0.76	0.67
Perception of light	0.78	0.64
Job organization factors		
Job rotation	0.83	0.83
Work method	0.89	0.88
Training	0.83	0.50
Problem solving	0.69	0.79
Goal setting	0.90	0.82
Job satisfaction	0.89	0.82

Table 1. Reliability Measures (Cronbach’s α).

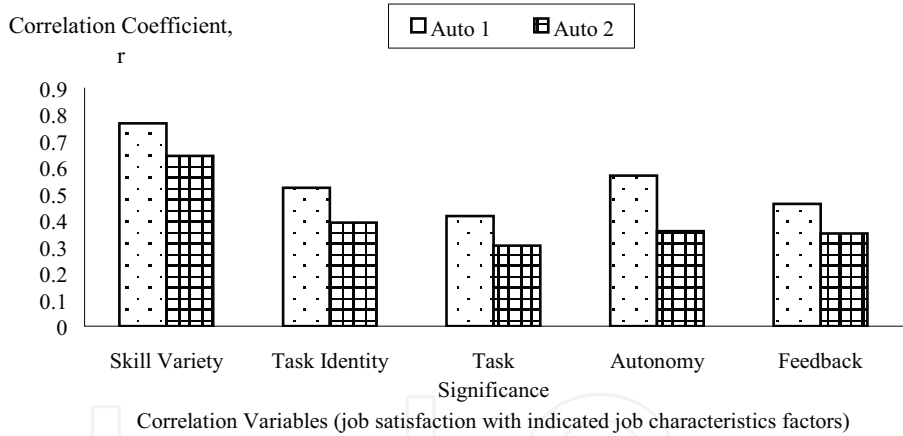


Fig. 1. Correlations of job satisfaction with five job factors

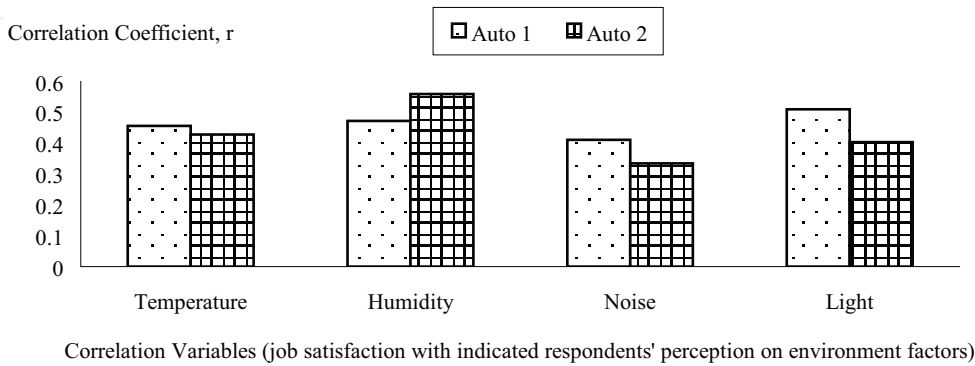


Fig. 2. Correlations of job satisfaction with four environmental factors.

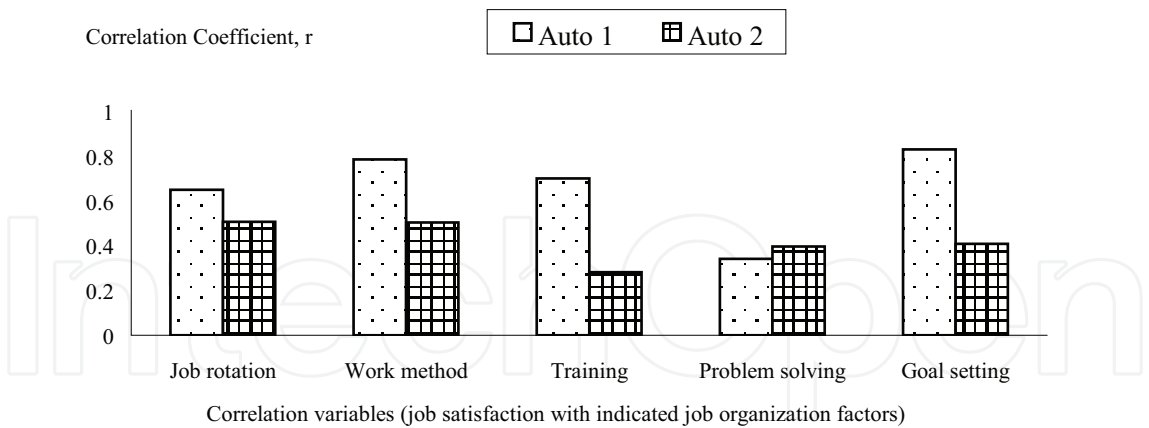


Fig. 3. Correlations of job satisfaction with job organization factors.

4.4 Effects of job characteristics, environmental factors, and job organization on job satisfaction

The study detected significant positive correlations between job satisfaction and several job characteristics. This result was in agreement with those of empirical studies by Hackman and Oldham (1974) and Umstod et al., (1976). In this study, the correlations of job satisfaction with job characteristics were stronger than those observed by Hackman and Oldham (1974), possibly because the present study considered only automotive industries. One outstanding result was that job satisfaction was significantly correlated with skill in both companies. Generally, more than 80% of respondents agreed that they utilized moderate to very much skill. Based on this finding, they tend seem to appreciate skill variety, and this variety has a greater influence on job satisfaction than other job factors. Hackman and Oldham, (1974 and 1976) stated that skill, task identity and task significance are psychological factors that help workers see their work as meaningful. However, results from this study suggest that skill variety had greater effect on that matter than did other factors. Significant positive correlations occurred between job satisfaction and perception of all environmental factors as shown in Figure 2. The outstanding correlation for Auto1 was perception of light and for Auto2 was perception of humidity. The results indicated that environment conditions, especially temperature, humidity, noise and light affect job satisfaction in automotive industries. The management of both companies should attempt to optimize temperature, humidity and noise because measurements of these factors are outside the comfortable boundary and respondents are not satisfied with them. Standard environmental conditions (including temperature, humidity, noise, and light) for automotive industries in Malaysia must be revised to maintain workers' health physically and mentally, thereby increasing productivity and job satisfaction as well as performance. Significant positive correlations were observed between job satisfaction and job organization factors. In Auto1, job satisfaction was strongly correlated with job rotation, work method, training and goal setting showed strong correlations with job satisfaction, but only intermediate correlation with problem solving. In Auto2, job satisfaction showed intermediate correlations with most job organization factors, except for the training factor, for which the correlation was low. The correlations for all factors were higher in Auto1 than Auto2. The findings indicated that job satisfaction is affected by job rotation, work method, training, goal setting and problem solving. More than 70% of the respondents in both

companies were satisfied with the implementation of job rotation, work method, problem solving and goal setting. In contrast, more than 80% of the respondents in Auto1 felt that they have moderate to adequate training and only 55% of the respondents in Auto2 felt the same way. In addition about 30% of workers in Auto2 felt that they have training opportunities, but only 5% respondents in Auto1 felt the same way. Management therefore should emphasize training opportunity, because the result reflected a decrease in job satisfaction with too training much Auto2. Moderate to adequate training will lead to higher job satisfaction (Gaziolu & Tansel, 2002).

4.5 Effects of age, work experience and marital status on job satisfaction

The correlations between job satisfaction, job characteristics and job organization factors are higher in Auto1 than in Auto2 (Figures 1 and 3). One possible explanation is that older, married and more experience workers in Auto1 were more satisfied with their work than the younger, single and less experienced workers in Auto2. Older, married and more experienced workers had higher levels of job satisfaction and are more committed than the younger, single and less experienced men; furthermore, younger, single and less experienced workers may still be deciding on a career and this may interfere with job satisfaction and organizational commitment (Bowen et al. 1994). Benin and Nienstedt (1985) found that job satisfaction influenced marital happiness and that the effects of job satisfaction and fulfillment interacted with the effects of marital happiness in producing overall happiness.

Research on relationships between work satisfaction and marital characteristics is extensive and is primarily found in literature on marital satisfaction, work identity and satisfaction, and dual-career couples (Blair 1998, Ray 1990, Gaesser & Whitbourne 1985). These studies suggested that career and family lives are mutually entangled, and that to understand strain in one domain, information on both facets of an individual's life is necessary (Ludlow & Salvat 2001). Therefore further research should be conducted into this interaction.

Job satisfaction was also correlated with worker age. Studies in five different countries prove that older workers are more satisfied than their younger counterparts (Kaya 1995). The results also supported findings by Janson and Martin (1982) and McCaslin & Mwangi (1994) who found that older employees have higher job satisfaction than younger ones, and those by Lee & Wilbur (1985) which suggested that job satisfaction increases with age. One explanation for such a finding is that older employees are more able to adjust their expectations to the characteristics of their work (DeSantis & Durst 1996). The lack of job satisfaction amongst younger workers may cause them to be more mobile and seek new jobs. If this occurs in Auto2, the plant will experience a shortage of skilled and experienced workers.

Work experience is only one of the many aspects related to length of employment that can be correlated with perceived job satisfaction. Bowen et al. (1994), McCaslin & Mwangi (1994), Manthe (1976), Boltes et al. (1995) and Bertz and Judge (1994) found that overall job satisfaction increased as the years of experience increased.

5. Conclusions

This study found that job satisfaction was significantly correlated with job characteristics, environment, and job organization. The strength of the correlation between job factors and job satisfaction was influenced by age, work experience and marital status whereas job

satisfaction was only significantly correlated with environmental and job organization factors. The environmental factors did affect job satisfaction and the strength of the correlation was influenced by the workers' surroundings, depending on the function of the building.

This study established that skill variety had an outstanding effect on job satisfaction in the automotive industries.

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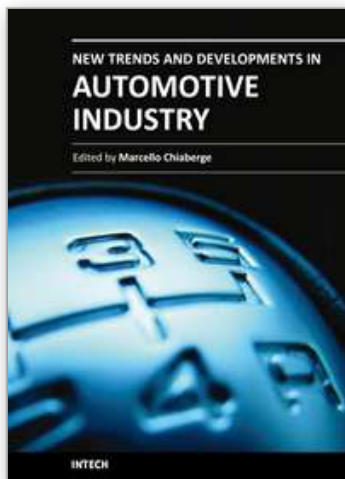
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