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# Role of Human Computer Interaction (HCI) factors as moderators of Occupational Stress and Work Exhaustion

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**ABSTRACT:**

Software professionals perform boundary-spanning activities and hence need strong interpersonal, technical and organizational knowledge to be professionally competent. But participation in professional development activities is voluntary and software professionals have to be intrinsically motivated to maintain professional competence. This intrinsic motivation is reflected in the number of hours they spend on the actual job, their depth and variety of knowledge, their confidence in use of software technologies and innovative use of software. These activities involve Human-Computer Interaction (HCI). Individuals vary in their HCI behavior. This is akin to individual variations in personality. This paper deals with theoretical issues relating to HCI and investigates if HCI factors moderate the relationship between occupational stress and work exhaustion.

**Keywords:**

Stress, computer self-efficacy, intrinsic motivation, control over technology, work exhaustion, moderators

## INTRODUCTION

Individuals need to possess competencies that enable organizations to compete in the forefront of technology curve (ITAA, 1999). Software professionals perform various roles in the process of software development (Rajeswari and Anantharaman, 2003). Hence they need strong interpersonal, technical and organizational knowledge to be professionally competent. But software professionals have to be intrinsically motivated to maintain a high level of professional competence (Schambach and Blanton, 2002).

Intrinsic motivation in the current context of the study refers to the interest that software professionals have in performing tasks related to software development activities without expectations of rewards. This is possibly reflected in the number of hours they spend on the actual job, their approach concerning innovative use of software, the depth and variety of knowledge that they acquire across domains and technology. These activities involve Human-Computer Interaction (HCI). Individuals vary in their HCI behavior. This is akin to individual variations in personality. A number of studies (Jex and Gudanowski, 1992; Jex and Bliese, 1999; Schaubroeck *et al.,* 2000) have explored the role of individual differences in personality (self efficacy beliefs, collective efficacy beliefs etc.) as moderators of occupational stress. It is therefore worthwhile to explore if individual differences in HCI can moderate the relationship between occupational stress and work exhaustion (which is a constituent of burnout) among software professionals.

This paper deals with the theoretical background on issues related to HCI, existing measures of HCI, development of scales to measure various dimensions of HCI relevant to context of the study, and data analysis pertaining to scale development as well as to investigate the moderating effects of HCI variables in the relationship between occupational stress and work exhaustion.

* This study is a part of the research conducted by the first author as a Ph D student at Indian Institute of Technology Madras under the guidance of the second author.

## THEORETICAL BACKGROUND

Several studies have pointed out that individual differences, particularly individual talent and skill predict project performance (Curtis *et al*., 1988; Rasch, 1989). Long-term productivity is dependent on hiring and retaining talented software professionals. Retention of software professionals is dependent upon increasing favorable factors at work and decreasing unfavorable conditions that induce intent to turnover. Occupational stress is identified as one of the factors that influence intent to turnover (Moore, 2000).

The key stressors for software professionals are fear of obsolescence, individual team interaction, client interaction, work-family interface, role overload, work culture, technical constraints, lack of family support, workload and technical risk propensity (Rajeswari and Anantharaman, 2003). A careful analysis of the above mentioned stressors reveals that sources of stress exist across two basic dimensions – one dimension deals with soft skills and people competencies and other dimension deals with software skills and technical competencies. But both the dimensions are inter–linked with each other as stress permeates from one dimension to another and vice-versa. Repercussions of stress felt by individuals are manifold and also have spillover effects. The focus of this paper is to explore the moderating role of HCI factors in the relationship between occupational stress and work exhaustion.

Further analysis of stress related to technology usage reveals that fear of obsolescence is a key source of stress. Hence 'keeping up' with emerging IT has been identified as a critical issue in Canada (Carey, 1992) and United States (Schambach and Blanton, 2002). Technical constraints in the job and technical risk propensity are also stressors that are related to the use of technology. Therefore it is possible that individual variations in HCI factors such as beliefs in computer skills (computer self-efficacy), intrinsic motivation and training efficacy play a key role in enabling software professionals to handle stress at work.

### Computer Self Efficacy

Increased usage of computers and software enhances an individual's familiarity with the system and the confidence of the individual in using the computer or software. This concept is brought out in the construct of Computer Self-Efficacy (CSE). CSE reflects an individual's perception of his or her ability to use computers in the accomplishment of a task (Compeau and Higgins, 1995). In the context of the current study, the task refers to software development. CSE has three inter related but distinct dimensions, namely, strength, magnitude and generalizability. There are several scales to measure CSE (Marakas *et al.,* 1998). Of these scales, the one developed by Compeau and Higgins (1995a) is found to be more suitable, even though it is directed towards novice users. Therefore, for the purposes of the current study, the preface to the instrument given by Compeau and Higgins (1995a) has been modified to address experienced software professionals. In addition, two more items that depict various situations at work (typically expected to be present in software companies), when confidence in computing can be measured were added to the existing 10 items. They depict confidence in completing a program / design using a new software technology/ package / language *if there was someone giving step-by-step instructions* and *in excelling at the use of the new technology*. The resultant scale with 12 items is used in the current study. Computer self-efficacy is found to moderate the relationship between demands and work exhaustion (Salanova *et al.*, 2002) among IT end-users. It therefore remains to be explored if computer self-efficacy moderates the impact of occupational stress among software professionals.

### Intrinsic Motivation

Intrinsic motivation refers to the pleasure and inherent satisfaction derived from a specific activity (Vallerand, 2000). Intrinsic motivation is defined as the desire to work on a task for its own sake, because the work itself is enjoyable, satisfying and or challenging. In the context of computer usage, intrinsic motivation has been measured using the construct of computer playfulness (Venkatesh, 2000). The characteristics of an individual with playful dispositions is described as follows (Webster and Martocchio, 1992):

> "Individuals with playful dispositions are said to be guided by internal motivation, an orientation toward process with self–imposed goals, a tendency to attribute their own meanings to objects or behaviors (that is, to not be dominated by a stimulus), a focus on pretense and nonliterality, a freedom from externally imposed rules, and active involvement".

Playfulness is a manifestation of cognitive spontaneity, which reveals itself as curiosity and inventiveness. In the context of human-computer interaction, this trait enables an individual to try out different patterns of behavior of the software technology / package under various conditions. This familiarity gets transformed into mastery, with great ease (in course of time and with practice). In order to denote this process Webster and Martocchio (1992) developed the construct called 'micro computer playfulness'. It is defined as "the degree of cognitive spontaneity in microcomputer (in the context of this study computer) interactions"

Computer playfulness has been studied typically in the context of Theory of Planned Behavior (TPB) and Technology Acceptance Model (TAM) as a predictor for ease of use and intention to use in the case of both MIS professionals as well as end-users. It is found to be positively related to computer efficacy beliefs and training outcomes (Webster and Martocchio, 1992). Hence it is expected that intrinsic motivation will also be a concomitant moderator of occupational stress in the current study. The seven-item computer playfulness scale of Webster and Martocchio (1992) has been used to measure intrinsic motivation.

### Technology Training Efficacy

In the context of software professionals, technology training is of a continuous nature that equips them with the latest skills in the field of computing. Training includes formal classroom training as well informal training and self-learning. Existing scales measure the training efficacy of software professionals on a particular technology/ operating system/ language at the end of a training program. These are incapable of measuring the confidence in the training that software professionals have accumulated over the years. The level of confidence in the training of software professionals is reflected in the belief that people have in their ability to transfer their knowledge to others through training. Research regarding self-efficacy judgments regarding computers has focused on novice computer users and introductory applications (Potosky, 2002). There are hardly any studies involving training and efficacy judgments over complex computer related applications and technology usage as in the process of software development. Hence a three-item scale has been developed in the study to measure technology–training efficacy. Technology-training efficacy can be defined as the belief that people have in the training that they have received.

Several studies have shown that training increases self-efficacy and that self-efficacy is related to performance (Gist, 1989; Gist *et al.*, 1989; Martocchio and Webster, 1992 and Saks, 1994). In addition, self-efficacy is related to technology acceptance (Hill *et al.*, 1987; Gist *et al.*, 1989; Martocchio and Webster, 1992) and performance in software training sessions (Gist *et al.*, 1989; and Webster and Martocchio, 1992; Compeau and Higgins, 1995b). Since self-efficacy moderates the impact of occupational stress, it is expected that technology-training efficacy can also act as moderator of occupational stress especially among software professionals.

### Perceived Control over Technology

Perceived behavioral control is defined as "…the individual's perception of the ease or difficulty of performing the behavior of interest (Ajzen, 1991). Taylor and Todd (1995) related this construct to the perceived difficulty in technology usage. The ease or difficulty of performing a behavior is a function of knowledge or skills possessed by a person. It is also dependent on the availability of resources at the disposal of the individual, in addition to the autonomy of choice, regarding software technology that can be used most successfully to achieve a goal. It is often used as an anchor in the context of Theory of Planned Behavior (Ajzen, 1991).

Perceived behavior control refers to individual's perceptions regarding their capability to perform a given behavior based on the extent to which they have requisite knowledge and resources and control at work. In the current context of the study perceived behavior control is used in the specific context of software professionals to determine control over technology. The measure of control over technology has been used to measure the autonomy related to technology usage available to the individual in the work environment. In general, perception of control also reflects the autonomy in the organizational environment in relation to the use of specific system (Venkatesh, 2000). This measure has been enhanced to encompass control over technical resource availability and usage.

## MOTIVATION FOR THE CURRENT WORK

- Role of CSE appears not to have been examined in the context of software professionals. Also, there is a need to modify the existing measure of Computer self-efficacy to suit the current context of the study.

- The role of training efficacy (especially with reference to overall technology training) has not been examined in the context of occupational stress. This creates a need to define technology training efficacy and also develop a scale to measure the same.

- Intrinsic motivation using computer playfulness, has not been studied in the context of occupational stress even though motivation as intrinsic motivation (task based) and extrinsic motivation (reward based) has been examined extensively in psychological literature.

- The overall relationship among variables has also not been examined.

## HYPOTHESES

The **main objective** is to measure the **concomitant role of the HCI variables** such as Computer Self Efficacy, technology training efficacy, perceived control over technology and intrinsic motivation **as moderators in the relationship between occupational stress and work exhaustion** among software professionals.

The other objectives are

a) to modify the scale of CSE developed by Compeau and Higgins (1995a) to suit the current context of the study and determine its reliability and validity of the scale

b) to develop a scale for technology training efficacy and determine its reliability and validity,

c) to develop a scale for perceived control over technology,

d) to check the reliability and unidimensionality of the scale for computer playfulness in the current context of the study and

e) to examine the relationship between stress, HCI variables and outcome variables.

The following hypotheses are framed in order to examine the moderating role of HCI variables in the relationship between occupational stress and work exhaustion

H 1a Stress is negatively associated with all HCI variables.

H 2a Stress and HCI variables have main (additive) effects on work exhaustion

H 2b Stress and HCI variables have an interaction effect on work exhaustion

## SCALE DEVELOPMENT

### Modification of the Computer Self-Efficacy Scale

The Computer Self Efficacy Scale developed by Compeau and Higgins (1995a) is identified for use in this study. This measure is task-focused. It has incorporated elements of task difficulty and captured differences in self efficacy magnitude (Compeau and Higgins, 1995a) as well. Even though it is found to capture all the aspects concerning use of computing technologies, it has failed to cover multiple software applications. Hence the preface of the scale is modified to include various types of software technologies. This scale is modified to include items that measure the confidence to perform when step-by-step assistance from someone is available and to measure the confidence in achieving excellence in the use of a new software package for software development. The respondents have been asked to respond to their level of confidence in the use of a new software/ technology/ package during the course of software project development and indicate the same on a seven point scale, where '1' indicates 'Not at all confident' and '7' indicates 'Absolutely confident'.

### Development of the Technology Training Efficacy Scale

Three items have been framed to measure the technology training efficacy scale. They include the ability to train oneself, which reflects the confidence that one has already accumulated a good training. The second item reflects the readiness and

interest to receive further training. Third item reflects the confidence of software professionals to impart training to others. It is difficult to train others when one is not sure of oneself. This item therefore measures the confidence that one has acquired and also conveys the readiness to impart training to others. Face validity and content validity of the instrument has been established using the opinions of experts.

#### Scale to Measure Perceived Control over Technology

Two items were constructed to capture the autonomy that software professionals enjoy at work with respect to the choice of technology for any given project. The first item depicts the autonomy aspect of control. The second item captures the knowledge pertaining to decision-making with regard to choice of technology. This encompasses the aspects of individual capability as well as availability of resources. Face validity and content validity have been incorporated in the questionnaire development process by using expert opinions.

## DATA COLLECTION

The current study has adopted a cross sectional design and survey methodology. Respondents of the study are software professionals who develop customized software for end users. They are located at two cosmopolitan cities of Chennai and Bangalore, in South India. Convenient sampling is used in the study due to resource constraints and operational constraints. Personal interviews and email have been used to obtain responses. A total of 700 questionnaires were distributed and 156 valid responses were obtained. Twenty-two software companies have participated in the study. They include large multinational software companies as well as medium and small software companies.

#### Sample Profile

Analysis of the sample reveals the following key features. Eighty percent of the respondents are male. Eighty four percent of the respondents are in the age group of 22-30. The mean age of the respondents falls between 26 and 30. Thirty one percent of the respondents are married and the rest are unmarried. Seventy one percent of the respondents have undergraduate qualification in engineering. Fifty three percent of the respondents have undergone software-training courses from private institutes. Seventy five percent of the respondents work more than eight hours a day.

## STATISTICAL ANALYSIS

#### Factor Analysis and Reliability of the HCI Variables

Factor analysis has been conducted for the scales of Computer self-efficacy, technology training efficacy and perceived control over technology in order to determine their unidimensionality. The 12 items of the modified computer self-efficacy scale has been factor analyzed by using principal component method and varimax rotation to arrive at the loadings. The 12 items loaded as two factors. One set of items pertain to situations that do not involve any form of help is termed "*Self Dependent CSE*" (with a reliability of Alpha = 0.85) and the other set of items that deal with situations that involves seeking help from various sources is termed as "*Support Dependent CSE*" (with a reliability of Alpha = 0.91). These two factors explain 71% of the total variance. Factor analysis of perceived control over technology and technology training efficacy have yielded single factors showing that they are unidimensional in nature. Cronbach's alpha has been found to be 0.6 in both the cases. Factor analysis has revealed that the scale of computer playfulness is also unidimensional. Its reliability is found to be 0.8.

#### Descriptives and Correlation Analysis

Descriptive statistics reveal that intrinsic motivation, technology-training efficacy and Support-dependent CSE are high among software professionals (See Table 1). The mean values of Self-dependent CSE and perceived control over technology are not as high as the other HCI variables.

Bivariate correlation has been conducted to ascertain the relationship between stress, HCI variables and outcome variables (Table 2). Results indicate that:

- Stress is significantly negatively related to self-dependent CSE and support dependent CSE. None of the other HCI variables is related to stress.

- Self-dependent CSE is significantly positively related to the other HCI variables such as intrinsic motivation, technology training efficacy and control over technology.
- Support dependent CSE is positively related to intrinsic motivation and technology training efficacy, but it is not related to control over technology.
- Technology training efficacy and perceived control over technology are significantly positively related to intrinsic motivation

| HCI Variables | Mean | Std Deviation | Range |
|---|---|---|---|
| Intrinsic motivation | 5.116 | 0.823 | 3.28 |
| Technology training efficacy | 5.388 | 0.854 | 4.33 |
| Perceived control over technology | 4.512 | 1.180 | 6.00 |
| Self dependent computer self efficacy | 4.254 | 1.154 | 5.66 |
| Support dependent computer self efficacy | 5.519 | 1.013 | 5.00 |

**Table 1. Measures of Central Tendency and Dispersion of HCI Variables**

The results reveal that Hypothesis (H 1a) is partially proved. HCI variables are negatively related to stress. But the relationship is significant only in the case of self-dependent and support dependent CSE. The results suggest that intrinsic motivation and technology training efficacy can help in the development of support dependent computer self-efficacy. And support dependent computer self-efficacy in combination with perceived control over technology can establish self-dependent computer self-efficacy. There is a significant negative relationship between self-dependent CSE and work exhaustion. Challenging environment and innovative projects help software professionals to develop self-dependent computer efficacy beliefs by means of providing adequate opportunities to control technology. Self-dependent CSE can be strengthened among software professionals by motivating them to acquire necessary training and enabling them to take control over technology so that they can prevent work exhaustion.

#### Hierarchical Moderated Multiple Regression

Hierarchical multiple moderated regression has been performed to identify the possible additive and interaction effects of stress, self dependent CSE, control over technology and technology training efficacy on work exhaustion. The concept of support dependent CSE is enveloped in the concept of self dependent CSE. Moreover intrinsic motivation is also reflected in the self dependent CSE and hence only self dependent CSE is used in the hierarchical moderated regression analysis along with technology training efficacy and perceived control over technology.

Predictors and moderators are jointly entered in Step I, and the interaction terms are entered in Step II. Regression coefficients for the main effects of predictor variables are obtained in Step I of each analysis, whereas the coefficients for interaction terms are obtained in Step II. F-values illustrate the significance of incremental $R^2$ at each step of the equation (Cohen and Cohen, 1983).

| | Stress | WE | SCSE | SuCSE | IM | TTE | CoT |
|---|---|---|---|---|---|---|---|
| Stress | 1 | | | | | | |
| WE | 0.457*** | 1 | | | | | |
| SCSE | -0.174* | -0.168* | 1 | | | | |
| SuCSE | -0.168* | -0.065 | 0.659*** | 1 | | | |
| IM | -0.070 | -0.112 | 0.600*** | 0.59*** | 1 | | |
| TTE | -0.188 | -0.073 | 0.371** | 0.422*** | 0.459*** | 1 | |
| CoT | -0.038 | -0.008 | 0.245** | 0.092 | 0.372*** | 0.277*** | 1 |

*** p< 0.001 ** p< 0.01 * p< 0.05

WE : Work Exhaustion

SCSE : Self-dependent Computer Self-Efficacy

SuCSE : Support dependent Computer Self-Efficacy

IM : Intrinsic Motivation

TTE : Technology Training Efficacy

CoT : Control over Technology

**Table 2. Relationship between Stress, HCI Variables and Work Exhaustion**

## RESULTS AND DISCUSSION

In order to test the hypotheses H 2a and H 2b, hierarchical multiple moderated regression is performed with work exhaustion as the dependent variable. The results of the regression are given in Table 3. A significant F value is found in the cases of both main (additive) effects as well as interaction effects. Despite the F values being significant, the incremental change in F value corresponding to the increase in $R^2$ value is not significant. Hence the data supports hypothesis H 2a and does not support hypothesis H 2b. Therefore hypothesis H 2a is accepted, and H 2b is rejected.

The results in Table 3 indicate that there is a significant relationship between occupational stress and work exhaustion. The regression coefficient of the significant interaction effect of (stress x control over technology) reveals a negative sign. Therefore for lower values of control over technology, work exhaustion will be higher (by signed coefficient rule of Mossholder *et al.,* 1990). This gives an important finding that if control over technology can be enhanced, work exhaustion can be reduced for software professionals.

| Predictors | $R^2$ | F | $\Delta R^2$ | Sig. of F change | B value | Sig. |
|---|---|---|---|---|---|---|
| Model 1 | | | | | | |
| Constant | 0.220 | 10.644*** | 0.219 | 0.000 | -0.074 | -.097 |
| Stress | | | | | 0.672*** | 6.067 |
| Control over Technology | | | | | 0.026 | .315 |
| Technology Training Efficacy | | | | | 0.070 | .583 |
| Self-Dependent Computer Self-Efficacy | | | | | -0.126 | -1.434 |
| Model 2 | | | | | | |
| Constant | 0.251 | 7.103*** | 0.031 | 0.105 | -2.10 | -.943 |
| Stress | | | | | 1.517 | 1.909 |
| Control over Technology | | | | | 0.643* | 2.300 |
| Technology Training Efficacy | | | | | -0.144 | -.312 |
| Self-Dependent Computer Self-Efficacy | | | | | -0.016 | -.058 |
| Stress x Technology Training Efficacy | | | | | 0.080 | .492 |
| Stress x Control over Technology | | | | | -0.238* | -2.330 |
| Stress x Self-Dependent Computer Self-Efficacy | | | | | -0.053 | -.507 |

***p< 0.001 **p<0.01 *p< 0.05

**Table 3. HCI Variables as Moderators in the Relationship Between Stress and Work Exhaustion**

There are only few studies that have explored the moderating role of computer self-efficacy in the relationship between stress and burnout (e.g. Salanova *et al.*, 2002). These studies dealt with users of information technology and not with software professionals. The current study is perhaps the first one in respect of software professionals in which the variables of self dependent CSE, technology training efficacy and control over technology have been concomitantly considered because confidence in training leads to confidence in doing software development by oneself which is due to control over technology gained in the process of software development.

The results imply that HCI variables have main effects, but no interaction (moderating) effects in the relationship between occupational stress and work exhaustion. Control over technology has significant interaction effect on work exhaustion. Hence efforts can be taken to empower software professionals with adequate control over technology to prevent work exhaustion.

## IMPLICATIONS

Self-dependent CSE, intrinsic motivation and technology training efficacy influences control over technology. Therefore, enhancing the above mentioned aspects would empower software professionals with control over technology. In order to achieve this, software companies have to provide adequate information and resources for learning. Further, organizations can provide opportunities for peer learning as well as encourage communities of practice for sharing knowledge. This provides stability and security in the face of changing technological environment and enables software professionals to perceive greater control over technology. Enabling control over technology can help software professionals to deal with stress and work exhaustion. Enhancing control over technology of software professionals may also enable software companies to move up the value chain and sustain themselves in the competitive market.

## CONCLUSION

To summarize, the objective of this paper has been to assess if HCI factors moderate the relationship between occupational stress and work exhaustion. In this process, this paper has also dealt with the modification of computer self-efficacy scale and the development of scales to measure technology training efficacy and perceived control over technology. The results indicate that HCI factors have main effects in the relationship between stress and work exhaustion, but do not moderate the relationship. The findings suggest that training in technical skills can increase the perceived control over technology that will mitigate the negative consequences of stress, particularly work exhaustion.

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