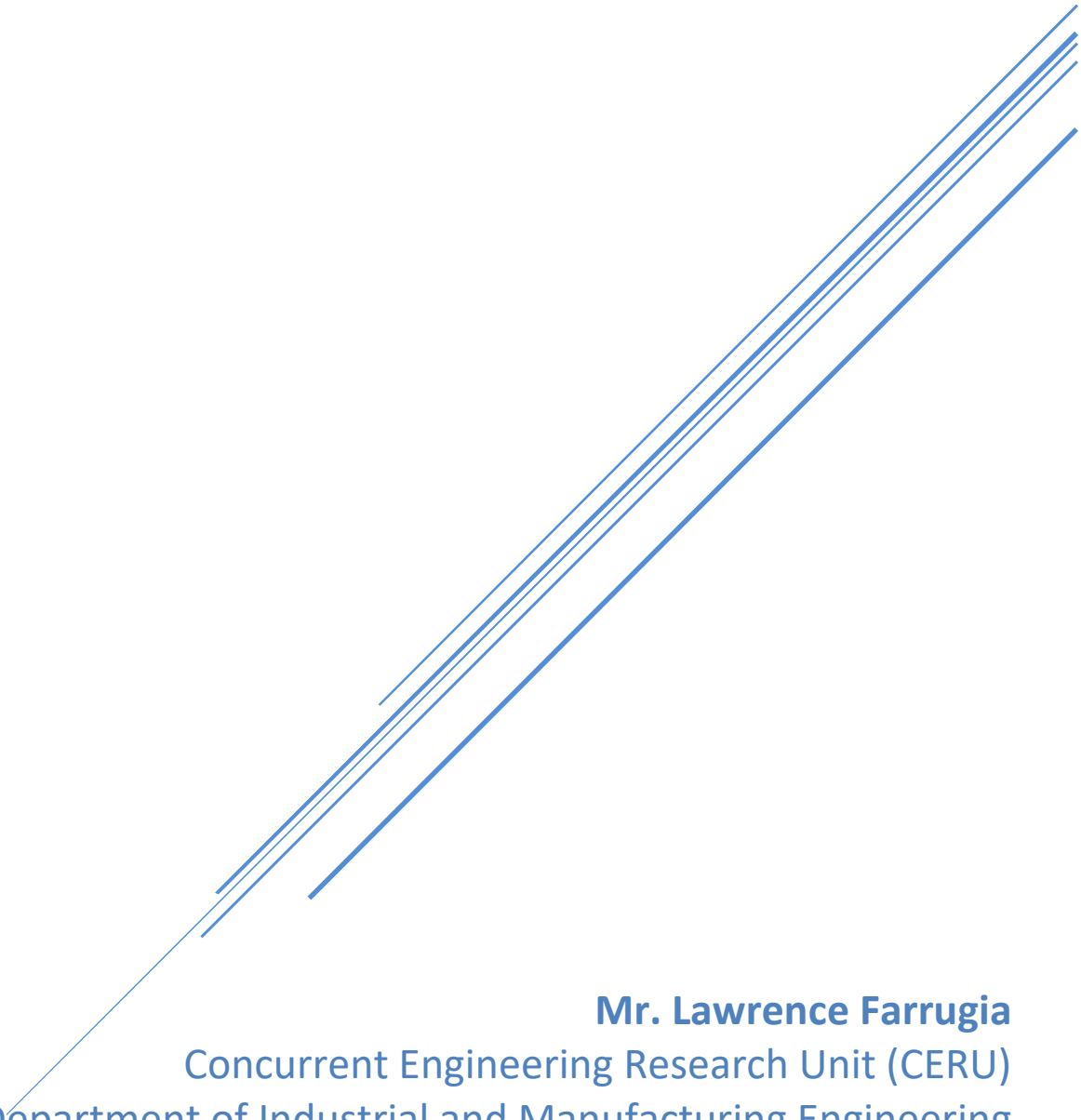
IDENTIFYING SOURCES OF EMOTIONS IN PRODUCT DEVELOPMET

CERU/PHD/ITR/01/2016



Mr. Lawrence Farrugia
Concurrent Engineering Research Unit (CERU)
Department of Industrial and Manufacturing Engineering
Faculty of Engineering

Contents

1. Introduction

This document reports the results and conclusion from an investigation which goal was to identify source of emotions in product development. Section 2 explains how emotions are experienced by individuals and the factors that shape the emotional experience. Furthermore this section also describes why the consideration of emotions elicited from factory operators can be of relevance to the success of a product development project. Section 3 presents the method and results of the investigation that was carried out for identifying the sources responsible for the elicitation of emotions experienced by factory operators. The conclusions of this chapter are presented in section 4.

2. Human Emotions and Behaviour

Ordinary people have all at one time or another experienced fear, anger, happiness or sadness. This section aims to address the question: "What is the underlying process behind the elicitation of a human emotion?"

For many years it emotions were considered to be an and irrational (Young, 1961) response to a stimulus, without an underlying process (Watson, 1919). The *behaviourist view* considered emotions to be response which is predicated *solely* by the characteristics of the stimulus itself. Yet this view has been greatly contented in the last 60 years, particularly in view of evidence indicating that:

Individuals subject to the same situation or stimulus, show significant difference in their emotional reactions (Beck, 1976; Horowitz, 1986; Smith & Ellsworth, 1987) as illustrated in Figure 1.

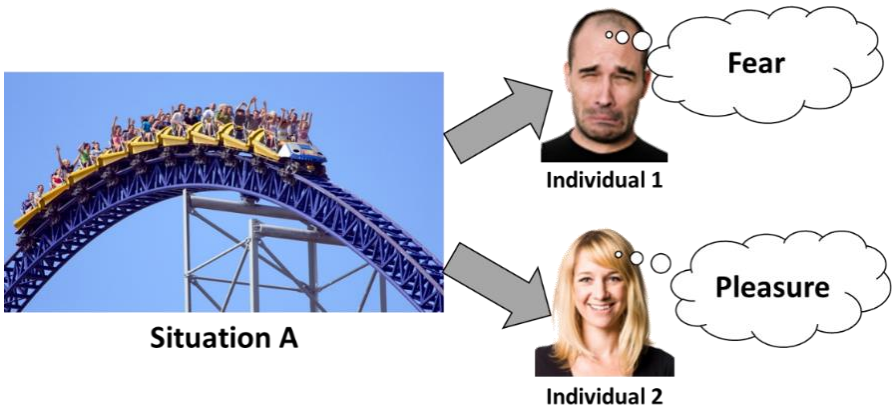


Figure 1 - Identical situation causes different emotional responses

Scherer (2015) argues that in response to the end of a romantic relationship, some individuals experience sadness, other anger while others relief. Researchers have also demonstrated that the same emotions are evoked from different situations as shown in Figure 2.

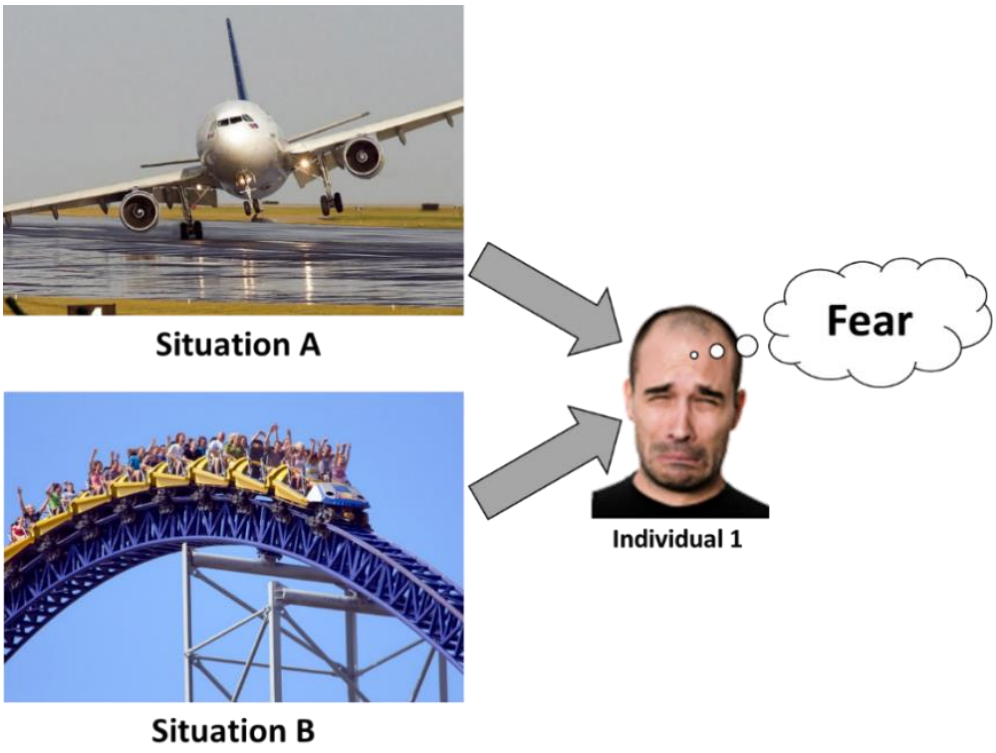


Figure 2 - Distinct situations causing the same emotional response.

For example sadness can be evoked by the death of a parent (Boucher & Brandt, 1981), divorce(Richards, Hardy, & Wadsworth, 1997) or declining sensory capacity (Kalayam, Alexopoulos, Merrell, & Young, 1991). This means that the stimulus does not uniquely determine the emotion evoked from the individual.

2.1. Cognitive Appraisal: The Process behind Human Emotion Elicitation

Cognitive appraisal theory (Lazarus & Folkman, 1984; K. Scherer, Schorr, & Johnstone, 2001) was proposed in order to explain the process through which emotions are elicited. The underlying concept of this theory is that an appraisal process causes an emotional reaction such as anger or fear. According to Lazarus & Folkman (1984) there are two elements that contribute to shape this process, hence determine the emotional reaction of the individual. These are the:

- the stimulus being appraised
- the human individual who evaluates the stimulus.

The cognitive appraisal reflects the relationship that exists between a person who has certain concerns and the stimulus which characteristics must be evaluated and interpreted. Lazarus and Folkman (Lazarus & Folkman, 1984) also draw a distinction between *primary* and *secondary* appraisal.

Primary appraisal is an assessment a stimulus in terms of its *relevance to the concerns* of the individual. The term 'concern' describes individual's goals, commitments and beliefs. Only stimuli that are of relevance to the individual have a capacity to elicit emotions. Furthermore, primary appraisal determines whether relevant stimuli present a threat, benefit or a challenge to the individual.

The scope of the secondary appraisal is to determine *what can be done*, about the relevant situation. During secondary appraisal the individual evaluates the coping potential and the likelihood of success of

the chosen coping option. The example in Figure 3 illustrates an individual interacting with a printer which is in a fault state. The goal/concern of the user is to print the important document.

Figure 3 - Human individual appraising the stimulus with respect to his concern

During primary appraisal, the individual evaluates the degree of relevance and the significance which the state of the printer has on the goal of the user. In this example the state of the printer is of relevance and presents a potential threat to the user's goal. A possible coping strategy would be to attempt to solve the fault in the printer. During secondary appraisal the individual also evaluates what is the probability of success associated with the particular chosen strategy.

The combined outcome from the primary and secondary appraisal processes determines the type of emotion which is elicited from the individual. For example, frustration may be elicited in the case where the stimulus (e.g. faulty printer) is considered to pose a serious threat to the concern of the human individual (e.g. print an important document), and the degree of success of solving the fault is very low. On the other hand pride would be experienced by the user if he manages to successfully address the fault in the printer.

The theory by Lazarus and Folkman (1984) does not explicitly describe how different emotion concepts result from the primary and secondary appraisals. In view of this limitation Scherer (2001) proposed the sequential check theory of emotion differentiation. According to this theory, a stimulus is evaluated with respect to four appraisal objectives: relevance, implication, coping potential and normative significance.

Table 3. 1 compares the theory proposed by Lazarus & Folkman (2006) to the sequential check theory (K. R. Scherer, 2001). The first two appraisal objectives are analogous to primary appraisal, while the third and fourth objectives correspond to secondary appraisal.

Table 3. 1 - Human individual appraising the stimulus with respect to his concern.

Lazarus and Folkman	**Klaus Scherer**	
Appraisal Stage	***Appraisal Objectives***	***Appraisal Checks***
Primary Appraisal	Relevance of stimulus	Novelty
		Intrinsic pleasantness
		Goal/need relevance
	Implication	Cause
		Outcome probability
		Discrepancy from expectation
		Conduciveness
		Urgency
Secondary Appraisal	Coping Potential	Control
		Power
		Adjustment
	Normative Significance	Internal standards compatibility
		External standards compatibility

Scherer also decomposes each appraisal objective into several evaluation criteria, which are termed sequential appraisal checks *(SACs)*. For instance, the appraisal objective of relevance, evaluates the stimulus in terms of three SACs: degree of novelty, intrinsic pleasantness and the relevance of the stimulus to the concerns of the individual. The manner in which the stimulus is evaluated with respect to the SACs determines the type of emotion that will be experienced by the individual. For example, fear is experienced when encountering a stimulus which is novel, intrinsically unpleasant and of high relevance to the goals of the individual. Scherer (2001) defines 14 emotion concepts in terms of these SACs.

A similar appraisal model was proposed Roseman (2001) used to predict 17 distinct emotion concepts and associated changes in facial expressions and behaviour. In order to determine the type of emotion, the stimulus is evaluated with respect to seven criteria (appraisal registers). For example the emotion frustration results from a stimulus which is appraised to be inconsistent with the goals of the individual, yet the person has a high degree of control over the stimulus. The model proposed by Roseman (2001) also describes the changes in facial expression and behaviour that accompany each emotion concept. For example frustration results in raising of eyebrows and the individual is likely to exert effort in order to attempt to overcome the situation.

This model underlines the relation between emotions and behaviour. The next section presents research work that has been carried out in order to establish the nature of this relation. Furthermore this section argues why the consideration of worker emotions is important.

2.2. The Impact of Worker Emotions on their Performance

Throughout the years, researchers have attempted to define the relationship between the emotional state of workers and their performance. The happy-productive worker thesis this states that workers who are happier and satisfied will perform better. This thesis was confirmed by several studies (Boucher & Brandt, 1981; Cropanzano & Wright, 2001; Madjar, Oldham, & Pratt, 2002; Staw & Barsade, 1993;

Zelenski, Murphy, & Jenkins, 2008) which demonstrated that there is a positive correlation between workers' positive emotional state (e.g. happiness) and their performance.

Other researchers have investigated the influence of negative emotions on the behaviour of workers. Yang and Diefendorff (2009), conducted a study involving the participation of 231 individuals. The scope of the study was to identify the sources responsible for the elicitation of negative emotions and the relationship between negative emotions and work behaviour. The evidence from this study (Yang & Diefendorff, 2009) showed that sources such as perceived ambiguity and interpersonal injustice contributed to the elicitation of negative emotions. The evidence presented in this study also showed that the experience of negative emotions was correlated to counterproductive work behaviour (CWB) towards individuals within the organization and the organization itself. The observed CWB included taking excessively long breaks, intentionally working slow and showing aggression towards a fellow co-worker.

Unfair treatment (Fitness, 2000; Skarlicki & Folger, 1997) , job incompetence (Fitness, 2000), high ambient temperatures (Anderson, Deuser, & DeNeve, 1995) and odours (Asmus & Bell, 1999) are other sources are also responsible for the elicitation of negative emotions. Yet these studies do not outline the effect that elicited negative emotions have on the performance of workers.

The search for the nature of relation between job performance and the emotional state of the individual has been referred to as the 'holy grail' (Wright, Cropanzano, Denney, & Moline, 2002) of research into organizational psychology. While many studies are in agreement with the happy-productive worker thesis, this nature of this relation is no ubiquitous.

This is because several studies demonstrated that negative emotions contribute to increase the attention towards details (Schwarz & Clore, 1993) and boost creativity (George & Zhou, 2002) of workers. Another reason for the scepticism towards the 'happy-productive' worker, stems from the fact that the reviewed studies do not provide an adequate definition of the terms productivity and performance (Tangen, 2005). Wright and Cropanzano (2002) also argue that studies on the relation between worker productivity and happiness, have operationalized happiness in terms of job satisfaction. Similarly Zelenski et al. (2008) argue that measures such as job satisfaction do not necessarily reflect into happiness:

"Despite the emotional flavour of lay conception of 'happiness', job satisfaction scales do not typically focus on emotions, instead asking employees to rate their satisfaction with pay, working conduction, job as a whole etc." (Zelenski et al., 2008).

None of the studies presented in this section consider the effect of emotions on the performance of factory operators. Furthermore, despite this lack of evidence, there has been a substantial number of studies that investigated the direct influence of environmental stressors such as temperature (Daanen, 2009), ambient illumination (Akbari, Dehghan, Azmoon, & Forouharmajd, 2013; Juslén, 2007) and humidity (Suhu, Terhadap, & Pekerja, 2013) on the productivity of factory operators as illustrated in Figure 4.

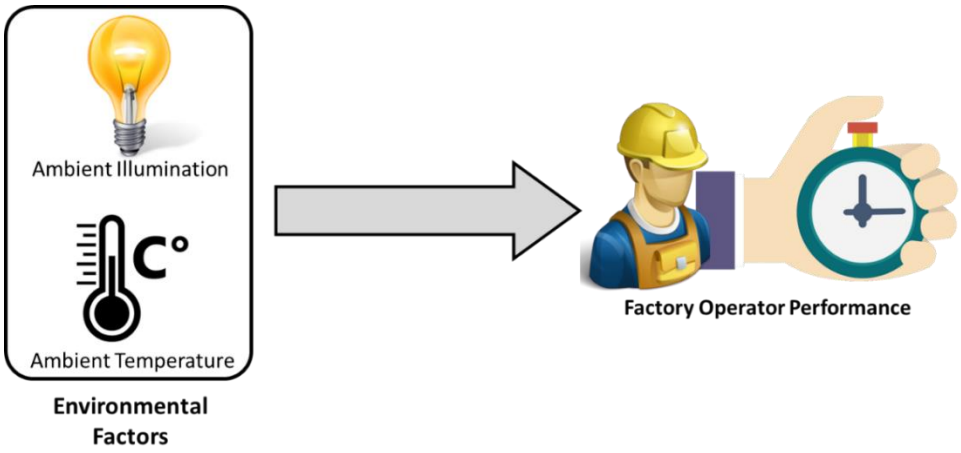


Figure 4 - The direct influence of stimuli on factory operator performance

Yet these studies *do not* consider emotion elicitation as a mediating process that contributes to influence the productivity of factory operators In view of this limitation, it was deemed necessary to investigate the role of emotions as mediators between the stimuli such as the environment and the product and performance of factory operators, as shown in Figure 5.

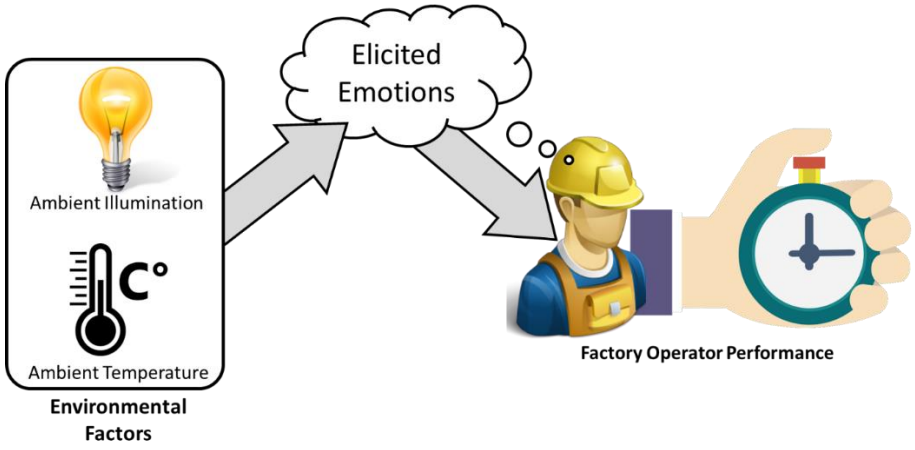


Figure 5 - Emotions mediating the relation between product development decisions and factory operator performance

The lack of evidence on the effect that emotions experienced by factory operators have on their performance, made it difficult to characterize further the product development problem. The next section discloses the study that was

3. Identifying Sources of Emotions in Product Development

A preliminary exploratory investigation was carried out in order to provide an indication of the typical concerns shared among factory operators. Furthermore this investigation also served to outline the sources that are responsible for eliciting emotions from factory operators. The outcomes from the preliminary are described in section 3.1. The results were knowledge that was obtained from the preliminary evaluation results was used as a basis for asking questions in the main investigation which is presented in section 3.2.

3.1. Preliminary Investigation

The objective of this study was to gain a better insight of the sources and typical concerns of factory operators. The factory operators (N_{PRE} = 6) who participated in a one-to-one interview with the doctoral candidate. A first version of the questionnaire was used as a means for collecting the responses from participants during interview. Furthermore the questionnaire served to provide a structure to the interview (Mitchell & J.Jolley, 2010; Nicholas Walliman, 2001). In addition to the items in the questionnaire, the doctoral candidate also asked questions whenever this was required. Participants were also encouraged to elaborate about certain aspects they considered to influence their emotional state.

For example two of the participants underlined the effect of luminance of the physical work environment on their emotional state. Poor luminance was considered to be conducive to negative emotions. Another two participants also mentioned that the lack of physical workspace contributes to render their tasks more tedious. While being preliminary, this investigation outlined that emotions are elicited as a result of the interaction with certain properties (e.g. luminance, limited physical workspace) that are responsible for the elicitation of emotions. Furthermore the preliminary study served to underline concerns such as that about the comfort and that of having tools and resources that are reliable and adequate for the task being carried out.

3.2. Main Investigation

The main investigation involved the participation of 60 (N_{MAIN} = 60) operators from four distinct firms (A, B, C and D) who were individually interviewed by the doctoral candidate. It should be noted that the actives in firms A, C and D were engaged in the manufacturing of products. The activities in firm B were related to the disposal and recycling of products at the end of their life cycle.

Each subject participated in a one-to-one interview with the doctoral candidate which lasted an average of 25 minutes. The interview session was divided into two parts. In the first part the interviewer introduced himself and delivered a brief presentation. The objective of this presentation was provide some background about the research work being carried out and explain scope and structure of the interview. In the next part of the session, each participant was presented with the survey questionnaire which is located in Appendix A. This questionnaire was divided into three parts and participants were asked to answer in writing to all the items presented in the questionnaire. The doctoral candidate asked the question and if necessary clarified any queries that emerged during the interview. The questionnaire was filled out by the participants, except in cases were subjects were unable to read and/or write.

Out of the 60 participants, 28 were male and 32 were female. The largest age group was between 30 and 40 years old. Further details describing the demographic data of the participants can be referred to in Appendix B.1.

Part 1: Ranking of Concerns

The scope of the first part of the questionnaire was to investigate which concerns (HC) are evaluated to be most important to the sample of factory operators. The survey questionnaire contained a list of 8 statements describing a variety of concerns. Each subject was asked to uniquely rank every statement in terms of its relative importance. The most important concern was allocated a rank score equal to 1, while the least important concern was given a rank score equal to 8.

Various sources of literature were used in order to define each statement. Furthermore, comments that made by participants during the preliminary study were also used as a source for defining these

statements. Appendix B.2 presents a summary of the sources used to define each statement listed in the questionnaire.

Part 2: Technical Systems

In the second part of the interview, subjects were presented with three separate lists describing various properties of the evolving product being transformed, machine systems and the physical work environment. Each subject was asked to rate each item in the questionnaire in terms of its effectiveness in eliciting negatively toned emotions such as anger or frustration. A 5 point Likert scale ranging from 'Very Ineffective' up to 'Very Effective' was used in order to measure the degree of influence.

Part 3: Perceived influence of emotions on worker performance

During the third and last part of the interview, subjects were asked to rate the extent to which they considered the elicitation of emotions (Lazarus, 2006) to influence their performance. The performance was defined in terms of two factors:

1. Productivity, which refers to the rate at which tasks are completed.

2. Quality of work carried out, denoted by the number of mistakes made throughout each task.

The purpose of this last part was to provide an *indication* as to whether or not emotions have a capacity to influence the performance of the factory operators experiencing them.

3.3. Key Results

The results showing the average rank score obtained from factory operators from each firm is presented in Table 1 and shown by the horizontal bar chart in Figure 6. This chart shows that the concern about personal health and safety (HC1) was consistently ranked as the most important by operators in all four firms. Having adequate work resources (HC2) and performing tasks correctly (HC3) ranked in second and third place respectively. The concern regarding the comfort and appeal of the work environment ranked in the fourth place (HC4). The shape of the bar chart in Figure 6 shows that there is a common hierarchy denoting the relative importance of concerns. However since the ranking scores between firms were not identical it was deemed necessary to determine if these difference were statistically significant.

In order to determine if the differences in the ranking score allocated by each of the four groups was statistically significant, a one-way ANOVA test was performed. The reason for choosing this test is that it identifies statistically significant differences in means between *two or more groups*. The result of the one-way ANOVA is tabulated in Appendix B.3. These results show that the differences between the ranking scores among the four firms were significant in the case of the concerns HC1, HC4, HC5, HC6 and HC7.

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Table 1 - Ranking of factory concerns

HC ID	Concern	Firm	Mean	Std. Deviation	Std. Error
HC1	My personal health and safety	Firm A	1.62	1.24	0.27
		Firm B	1.06	0.24	0.06
		Firm C	1.00	0.00	0.00
		Firm D	2.38	1.12	0.31
HC2	Having adequate tools and resources	Firm A	3.29	1.49	0.32
		Firm B	2.88	0.78	0.19
		Firm C	3.22	1.39	0.46
		Firm D	3.23	1.09	0.30
HC3	Perform work which meets quality standards	Firm A	3.10	1.37	0.30
		Firm B	4.00	0.87	0.21
		Firm C	2.56	0.73	0.24
		Firm D	2.92	2.18	0.60
HC4	The comfort of the physical environment	Firm A	4.48	1.36	0.30
		Firm B	2.76	1.25	0.30
		Firm C	5.00	1.50	0.50
		Firm D	3.38	1.61	0.45
HC5	Building strong positive relationships	Firm A	3.33	1.49	0.33
		Firm B	5.65	1.73	0.42
		Firm C	5.11	1.54	0.51
		Firm D	4.85	1.72	0.48
HC6	Minimize work overload	Firm A	6.00	0.95	0.21
		Firm B	7.06	0.83	0.20
		Firm C	4.89	1.54	0.51
		Firm D	5.38	1.94	0.54
HC7	Being very productive, irrespective of the quality.	Firm A	7.19	1.17	0.25
		Firm B	5.65	1.50	0.36
		Firm C	6.78	1.20	0.40
		Firm D	7.23	1.54	0.43
HC8	Spend time away from work	Firm A	7.00	1.34	0.29
		Firm B	6.94	0.90	0.22
		Firm C	7.11	0.78	0.26
		Firm D	6.62	1.45	0.40

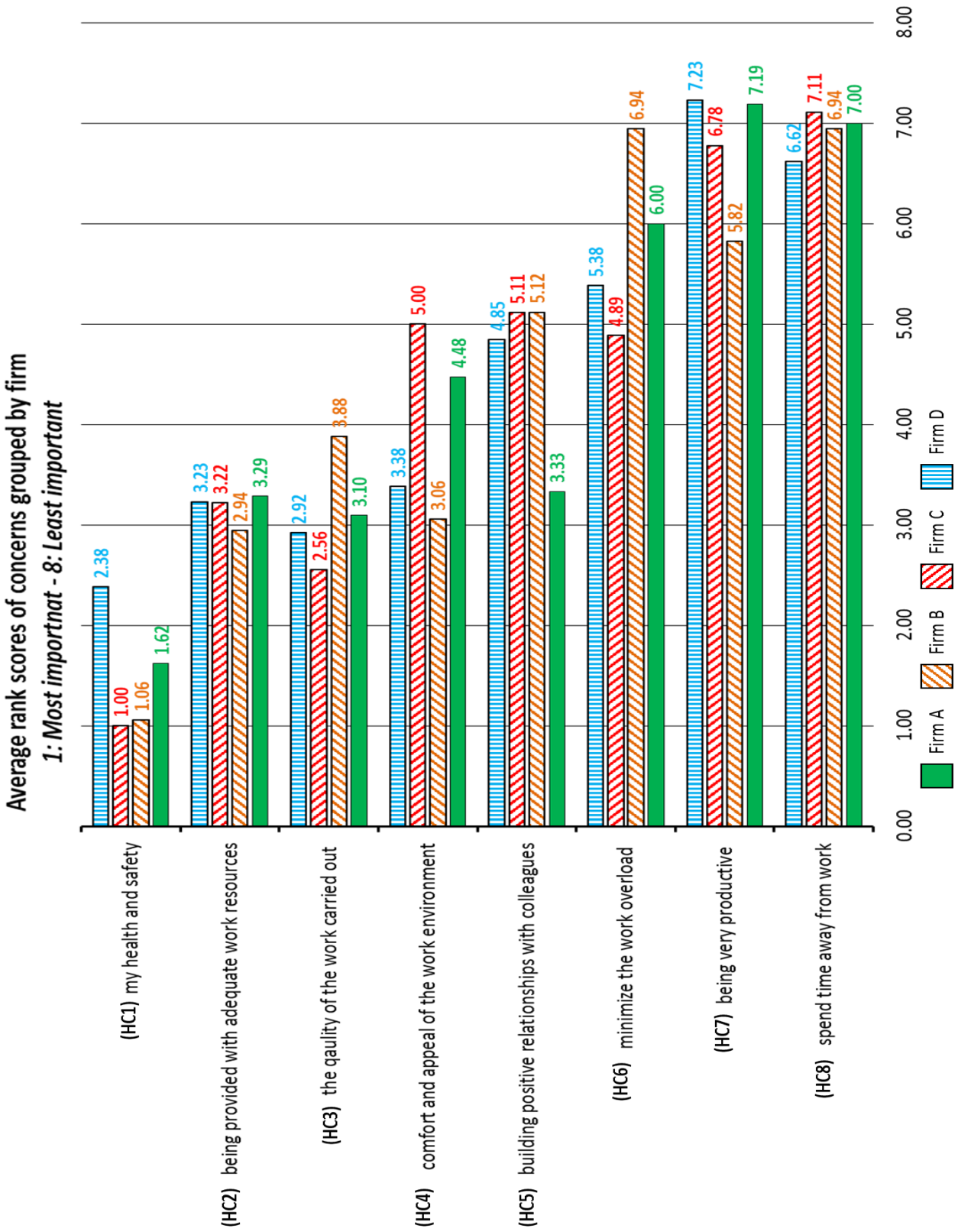

Figure 6 – Bar chart showing ranking of factory operator concerns from 4 firms

The one-way ANOVA test does not provide an indication of *which* of the groups' responses are statistically different from each other. The Tukey Honest Significant Difference (HSD) was carried out in post hoc, in order to identify the groups with statistically significant different ranking scores. The results of the Tukey HSD test presented in Appendix B.4 shows that out of the 30 comparisons made, only 9 of them resulted in statistically significant differences among groups. Furthermore the results show that out of the 9 statistically significant comparisons, 8 of these involved firm B. For example in the case of the concern HC1 there was only one significant difference, that is between firm B and D. The cases where there was a statistically significant difference between firms are marked in an asterisk.

This shows that the majority of the statistically significant differences in the ranking of concerns were between factory operators from the manufacturing life phase and those from the disposal life phase. This shows that operators from different life phases have a different hierarchies of concerns. The results from the Tukey test provide a level of confidence towards substantiating the claim that the concerns of factory operators in the manufacturing life phase are structured in a common hierarchy. The evidence presented in this first part of the study is also in agreement with the theory (K. R. Scherer, 2001) that subjects tend to have their goals organized in a *hierarchical structure*.

In the second part of the questionnaire, subjects were asked to rate 8 machine properties, in terms of their effectiveness in eliciting negative emotions. The horizontal bar chart in Figure 7 shows that the reliability (*mean*: 4.550, *st.dev*: 0.723), the luminance provided (*mean*: 4.450, *st.dev*: 0.723) and the temperature generated by the machine system (*mean*: 4.383, *st.dev*: 0.922) were among the properties considered to be the most effective at eliciting negative emotions. The data used to plot the results in Figure 7 is located in AppendixB.5.

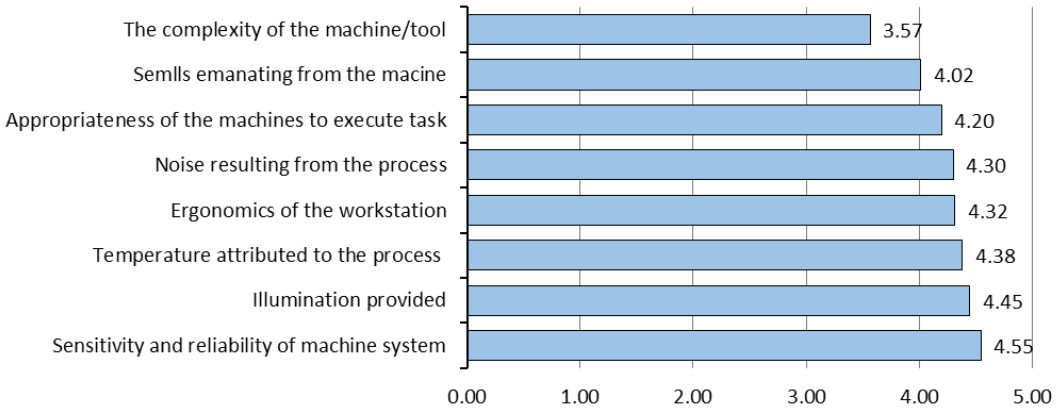

Figure 7 - Effectiveness of machine properties in eliciting negative factory operator emotions

Furthermore participants were also asked to rate 9 product properties in terms of its effectiveness to elicit negative emotions. The horizontal bar chart in Figure 8 shows that way different machine properties were rated in terms of their effectiveness in eliciting negative emotions from factory operators.

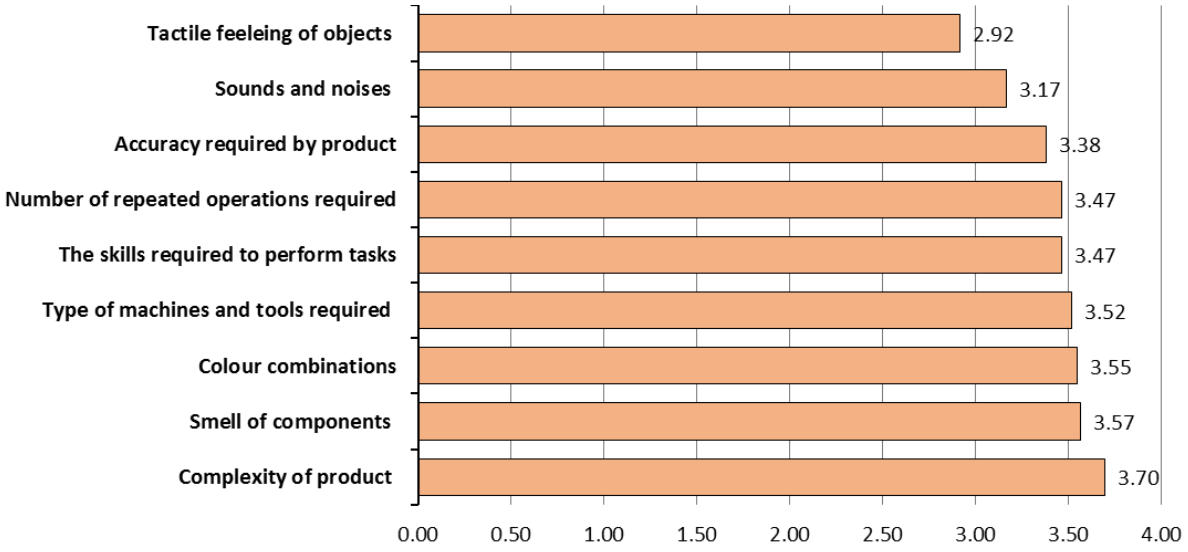

Figure 8 - Effectiveness of evolving product properties in eliciting negative factory operator emotions

The data used to plot this bar chart is located in Appendix B.6. The results show that the complexity of the product in terms of number of components required and their form (*mean*: 3.70, *st.dev*: 0.941) was rated as the most effective in eliciting negatively toned emotions. The odours emanating from product components (*mean*: 3.57, *st.dev*: 0.890) and the combinations of different colours *(mean: 3.55, st.dev: 1.10)* were also highly ranked in terms of their ability to effect the emotional state of factory operators.

Subjects were also asked to rate 15 properties describing different aspects of the work environment. The responses recorded from the factory operators are presented is summarized in **Error! Reference source not found.**. The data used to generate this horizontal bar chart is located in Appendix B.7.

The results show that the lack of space or the utilisation of space (*mean*: 4.567, *st.dev:* 0.789), unpleasant odours (*mean:* 4.433, *st.dev:* 0.810) and the lack of adequate temperature (*mean:* 4.417, *st.dev:* 0.766) were among the highest rated properties that are able to influence the emotional state of factory operators. An interesting result is that these properties all related to *physical* properties of the work environment

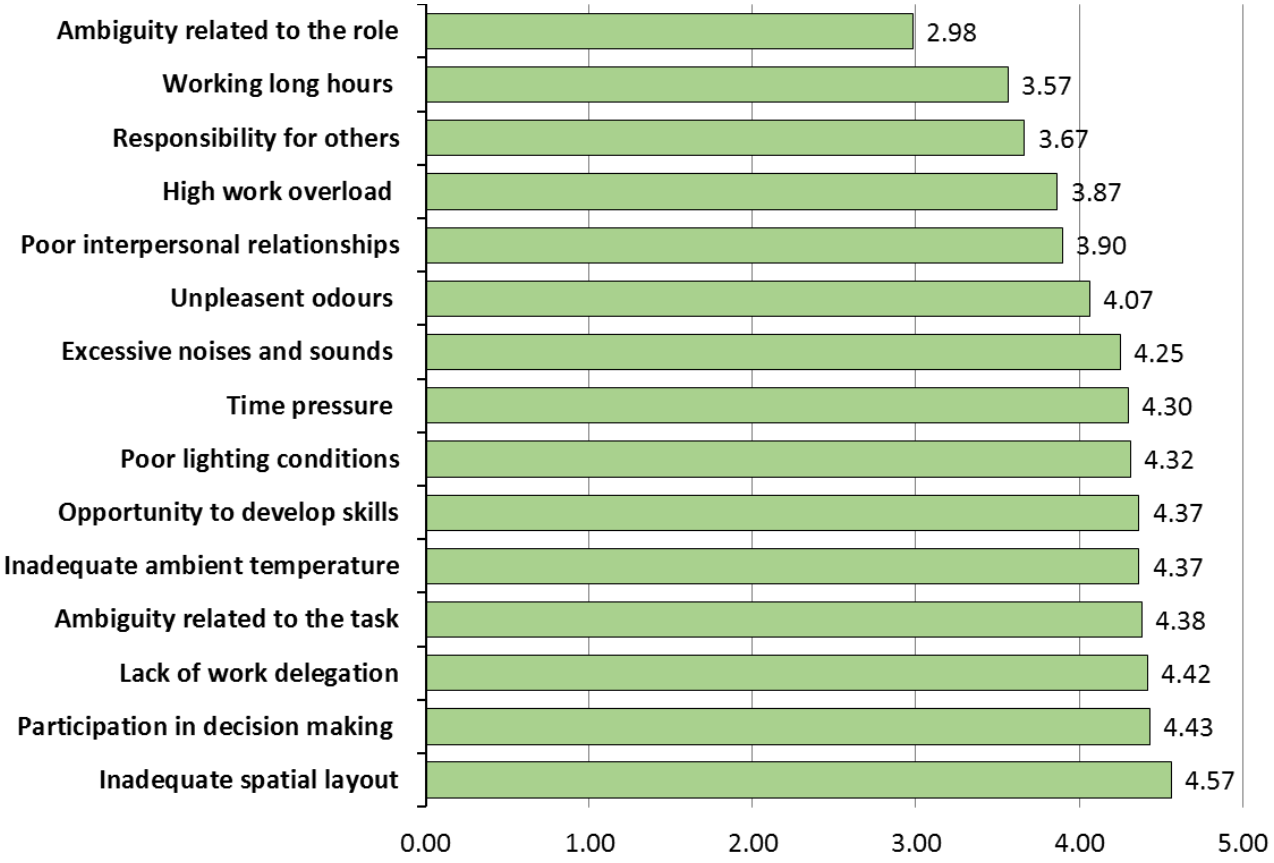

Figure 9 - Effectiveness of work environment properties in eliciting negative factory operator emotions

During the third part of the interview, subjects were asked to rate the interview participants were also asked to rate the extent to which they considered their experience of an emotion to influence their productivity. The results in Appendix B.8 show that 92% of the participants consider the experience of an emotion to have a *significant* impact on their productivity. Furthermore, the participants were asked to rate the extent to which they consider an emotional experience to influence the number of mistakes made during a particular task. The plot Appendix B.8 shows that 75% of the participants consider the experience of an emotion to have a significant influence over the number of mistakes made.

4. Conclusion

The investigation presented in this chapter was motivated by the limited research on the sources of emotions in manufacturing. By utilizing cognitive appraisal as a foundation the study presented in this chapter investigated *both* human and technical life phase system factors that contribute to the elicitation of emotion.

This investigation showed that not all concerns are of equal importance to factory operators. In fact the investigation result showed that there is indeed a hierarchy of concerns which describes their relative importance. Furthermore the results have shown that there were statistically significant differences in the ranking of concerns between operators from the manufacturing life phase compared to those interacting with the product during the end of its life cycle.

The results from the investigation also served to identify the *three* sources which were considered to be responsible for eliciting emotions from factory operators. These are the *product* which is being

transformed, the *machine system* used to support the transformation process and the *environment* in which work is carried out. More specifically the results enable the research to identify the *key properties* such as luminance, product form complexity and physical space provided that were collectively considered to be responsible for the elicitation of negative emotions.

As part of the investigation subject were also asked to self-asses the extent they consider their emotional experience influence their performance. While being highly subject, the responses motivated the doctoral candidate to investigate further the effect of factory operators' emotions on their performance. The next chapter discloses and experiment that was carried out in order to investigate the impact of factory operators' emotions on their performance.

5. Reference

Adaramola, S. S. (2012). Job stress and productivity increase. *Work (Reading, Mass.)*, *41 Suppl 1*, 2955–8. http://doi.org/10.3233/WOR-2012-0547-2955

Akbari, J., Dehghan, H., Azmoon, H., & Forouharmajd, F. (2013). Relationship between lighting and noise levels and productivity of the occupants in automotive assembly industry. *Journal of Environmental and Public Health*, *2013*, 1–5. Retrieved from http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3819755&tool=pmcentrez&rendertype=abstract

Anderson, C., Deuser, W. E., & DeNeve, K. M. (1995). Hot Temperatures, Hostile Affect, Hostile Cognition, and Arousal: Tests of a General Model of Affective Aggression. *Personality and Social Psychology Bulletin*, *21*(5), 434–448. http://doi.org/10.1177/0146167295215002

Asmus, C. L., & Bell, P. A. (1999). Effects of environmental odor and coping style on negative affect, anger, arousal, and escape. *Journal of Applied Social Psychology*, *29*(2), 245–260. http://doi.org/10.1111/j.1559-1816.1999.tb01384.x

Beck, A. T. (1976). *Cognitive therapy and the emotional disorders*. *Cognitive therapy and the emotional disorders* (Vol. 8). http://doi.org/10.1016/S0005-7894(77)80293-1

Boucher, J. D., & Brandt, M. E. (1981). Judgement of emotion: American and MAlay antecedents. *Journal of Cross-Cultural Psychology*, *12*, 272–283.

Chang, K., & Lu, L. (2007). Characteristics of organizational culture, stressors and wellbeing: The case of Taiwanese organizations. *Journal of Managerial Psychology*, *22*(6), 549–568. http://doi.org/10.1108/02683940710778431

Cropanzano, R., & Wright, T. A. (2001). When a “happy” worker is really a “productive” worker: A review and further refinement of the happy-productive worker thesis. *Consulting Psychology Journal: Practice and Research*. http://doi.org/10.1037//1061-4087.53.3.182

Daanen, H. A. M. M. (2009). Manual performance deterioration in the cold estimated using the wind chill equivalent temperature. *Industrial Health*, *47*(3), 262–270. http://doi.org/10.2486/indhealth.47.262

Fitness, J. (2000). Anger in the workplace : an emotion script approach to anger episodes between workers and their superiors , co-workers and subordinates, *162*, 147–163.

George, J. M., & Zhou, J. (2002). Understanding when bad moods foster creativity and good ones don’t: The role of context and clarity of feelings. *Journal of Applied Psychology*, *87*(4), 687–697. http://doi.org/10.1037/0021-9010.87.4.687

Horowitz, M. J. (1986). Stress-response syndromes: *Hospital & Community Psychiatry*, *37*.

Jo, M., & Bitner, M. J. (1992). Servicescapes : The Impact of Physical Surroundings on Customers and Employees. *Journal of Marketing*, *56*(2), 57–71. http://doi.org/10.2307/1252042

Juslén, H. (2007). *Lighting , Productivity and Preferred Illuminances - Field Studies in the Industrial Environment*. *Field Studies*.

Kahya, E. (2007). The effects of job characteristics and working conditions on job performance.

International Journal of Industrial Ergonomics, *37*(6), 515–523. http://doi.org/10.1016/j.ergon.2007.02.006

Kalayam, B., Alexopoulos, G. S., Merrell, H. B., & Young, R. C. (1991). Patterns of hearing loss in psychiatric morbidity in elderly patients attending a hearing clinic. *Intertnational Journal of Geriatric Psychiatry*, *6*, 131–136.

Karasek, R., Brisson, C., Houtman, I., Bongers, P., & Amick, B. (1998). The Job Content Questionnaire (JCQ): An Instrument for Internationally Comparative Assessments of Psychosocial Job Characteristics, *3*(4), 322–355.

Lazarus, R. S. (2006). *Stress and emotion: A new synthesis*. Springer Publishing Company, NY.

Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping*. Springer Publishing Company, NY.

Madjar, N., Oldham, G. R., & Pratt, M. G. (2002). There ' S No Place Like Home ? the Contributions of Work and Nonwork Creativity Support To Employees ' Creative Performance. *Academy of Management Journal*, *45*(4), 757–767. http://doi.org/10.2307/3069309

Mitchell, M., & J.Jolley. (2010). Survey Research. In *Research Design Explained* (pp. 253–303).

Nicholas Walliman. (2001). Your Research Project: a step by step guide for the first time researcher, 329.

Qureshi, M. I., Iftikhar, M., & Abbas, S. G. (2013). Relationship Between Job Stress , Workload , Environment and Employees Turnover Intentions : What We Know , What Should We Know. *World Applied Sciences Journal*, *23*(6), 764–770.

Richards, M., Hardy, R., & Wadsworth, M. (1997). The effects of divorce and separation on mental health in a national UK birth cohort. *Psychological Medicine*, *27*(5), 1121–1128. http://doi.org/10.1017/S003329179700559X

Roseman, I. J. (2001). A Model of Appraisal in the Emotion System. In *Appraisal Process in Emotion* (pp. 68–106). New York, USA: Oxford University Press.

Scherer, K. R. (2001). Appraisal Cnsidered as a PRocess of Multilevel Sequential Checking. In *Appraisal Process in Emotion* (pp. 92–120). New York, USA: Oxford University Press.

Scherer, K., Schorr, A., & Johnstone, T. (2001). *Appraisal Processes in Emotions - Theory , Methods, Research*. Oxford University Press.

Schuman, V., & Scherer, K. R. (2015). Emotions , Psychological Structure of. In J. D. Wright (Ed.), *International Encyclopedia of the Social & Behavioral Sciences* (Vol. 7, pp. 526–533). Elsevier.

Schwarz, N. N., & Clore, G. L. (1993). The use of emotion as information. In *The nature of emotion: Fundamental questions*.

Skarlicki, D. P., & Folger, R. (1997). Retaliation in the workplace: The roles of distributive, procedural, and interactional justice. *Journal of Applied Psychology*, *82*(3), 434–443. http://doi.org/10.1037/0021-9010.82.3.434

Smith, C. A., & Ellsworth, P. C. (1987). Patterns of appraisal and emotion related to taking an exam. *Journal of Personality and Social Psychology*, *52*(3), 475–488. http://doi.org/10.1037/0022-3514.52.3.475

Staw, B., & Barsade, S. (1993). Affect and managerial performance: A test of the sadder-but-wiser vs. happier-and-smarter hypotheses. *Administrative Science Quarterly*, *38*(2), 304–331. http://doi.org/10.2307/2393415

Suhu, K., Terhadap, P., & Pekerja, P. (2013). Effect of Temperature , Humidity and Illuminance Towards Worker ' s Performance in Automotive Industry, *42*(12), 1815–1818.

Tangen, S. (2005). Demystifying productivity and performance. *International Journal of Productivity and Performance Management*, *54*(1), 34–46. http://doi.org/10.1108/17410400510571437

Watson, J. B. (1919). *Psychology from the standpoint of a behaviourist*. Philadelphia:Lippincott.

Williams, L. J., & Anderson, S. E. (1991). Job satisfaction and organizational commitment as predictors of organizational citizenship and in-role behaviors. *Journal of Management*. http://doi.org/10.1177/014920639101700305

Wright, T. A., Cropanzano, R., Denney, P. J., & Moline, G. L. (2002). When a happy worker is a productive worker: A preliminary examination of three models. *Canadian Journal of Behavioural Science*, *34*(3), 146–150. http://doi.org/10.1037/h0087165

Yang, J., & Diefendorff, J. M. J. J. M. (2009). The relations of daily counterproductive workplace behavior with emotions, situational antecedents, and personality moderators: A diary study in Hong Kong. *Personnel Psychology*, *62*(2), 259–295. http://doi.org/10.1111/j.1744-6570.2009.01138.x

Young, P. T. (1961). *Motivation and emotion: A survey of the determinants of human and animal activity*. New York, USA: Wiley & Sons.

Zelenski, J. M., Murphy, S. A., & Jenkins, D. A. (2008). The Happy-Productive Worker Thesis Revisited. *Journal of Happiness Studies*, *9*(4), 521–537. http://doi.org/10.1007/s10902-008-9087-4

Appendix A

HUMAN EMOTIONS IN PRODUCT DEVELOPMENT

The objective of this survey questionnaire is to understand the main concerns and stressors which cause stress-emotions at work. To this end, you are kindly being requested to complete this survey questionnaire. Do not hesitate to ask questions if in need of assistance.

Section 1 – General Questions

Q1. What is the type of environment in which you perform work?

- ❍ Shop floor (e.g. factory production line, assembly, maintenance workshop)
- ❍ Office (e.g. clerical, receptionist, design suite etc.)
- ❍ Mobile (e.g. traveling sales person etc.)
- ❍ Services (e.g. hotel, restaurant, grocery store etc.)
- ❍ Other (please specify)

Warehouse supervisor.

Q2. Kindly rank the following statements according to the relative importance
1 = Most Important, 8 = Least Important

		Rank Order
While at work, I am concerned about…	minimizing the work overload on myself and/or my colleagues.	4
	the appearance, comfort and appeal of the work environment.	6
	my health and the safety of the work environment.	1
	being very productive, even if it means performing work of poor quality.	7
	spending as much time as possible away from work.	8
	having the right tools and resources to execute work.	5
	ensuring that the work I execute is of good quality.	2
	building strong positive relationships with my colleagues.	3

1

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Section 2 – Questions about work-related stress

Q3.To what extent do you find the following factors pertaining to the ***task/process***, for which you are responsible, to be effective in eliciting negative **stress-emotions**?

(tick one box for each row where necessary)

	Very Effective	Effective	Neither effective nor ineffective	Ineffective	Very Ineffective
The complexity of the machine/tool (e.g. need for technical skills)			✓		
Ergonomics of the workstation (e.g. the layout of objects in the workstation, proper posture etc.)			✓		
Illumination provided for the process		✓			
Temperature attributed to the process			✓		
Noise resulting from the process (noises which are generated by the tools or machines)	✓				
Smells which result from the machine (e.g. smell of lubricants and oils)		✓			
Sensitivity and overall reliability of the tools/machine			✓		
The lack of appropriate tools and/or machines to execute the required task			✓		
Other (please specify)					

2

PhD Research by Lawrence Farrugia

Q4. To what extent do you find characteristics pertaining to the ***product/object of work*** to be effective in eliciting negative **stress-emotions**?

(tick one box for each row where necessary)

	Very Effective	Effective	Neither effective nor ineffective	Ineffective	Very Ineffective
The complexity of the product (the number of individual components and their spatial layout)				✓	
The skills required to perform tasks on the product (e.g. dexterity, average size of components)				✓	
Colour combinations of the product				✓	
Smell of components produced by the product (e.g. smell of plastic pellets)		✓			
Tactile feeling of the object(s)				✓	
Sounds and noises produced by the object or object elements		✓			
Number of repeated operations required to complete the object				✓	
Accuracy required in performing operations on the product				✓	
The kind of processes/machines/tools required to perform work on the object		✓			
Other (please specify)					

3

PhD Research by Lawrence Farrugia

Q5. To what extent do you find characteristics pertaining to the ***work environment*** to be effective in eliciting negative **stress-emotions**? *(tick one box for each row where necessary)*

	Very Effective	Effective	Neither effective nor ineffective	Ineffective	Very Ineffective
Lack of appropriate/ adequate light conditions	✓				
Excessive noises and sounds		✓			
Inadequate ambient temperature	✓				
Unpleasant odours		✓			
Inadequate spatial layout	✓				
High work overload		✓			
Working long hours			✓		
Time pressure			✓		
Responsibility for others	✓				
Ambiguity related to the task (lack of information/direction)		✓			
Ambiguity related to the role (unclear role within the organization)			✓		
Opportunity to develop skills (e.g. provision of training)			✓		
Participation in decision making	✓				
Lack of work delegation		✓			
Poor interpersonal relationships	✓				
Other (please specify)					

4

PhD Research by Lawrence Farrugia

Q6. To what extent do you consider work related stress to influence:

	Very Significant	Significant	Neutral	Insignificant	Very Insignificant
The productivity of work output			✓		
The quality of work produced (e.g. higher rejection of work)			✓		
Other:					

Q7. How do you cope with work-related stress? What do you do when experiencing a high degree of work-related stress?

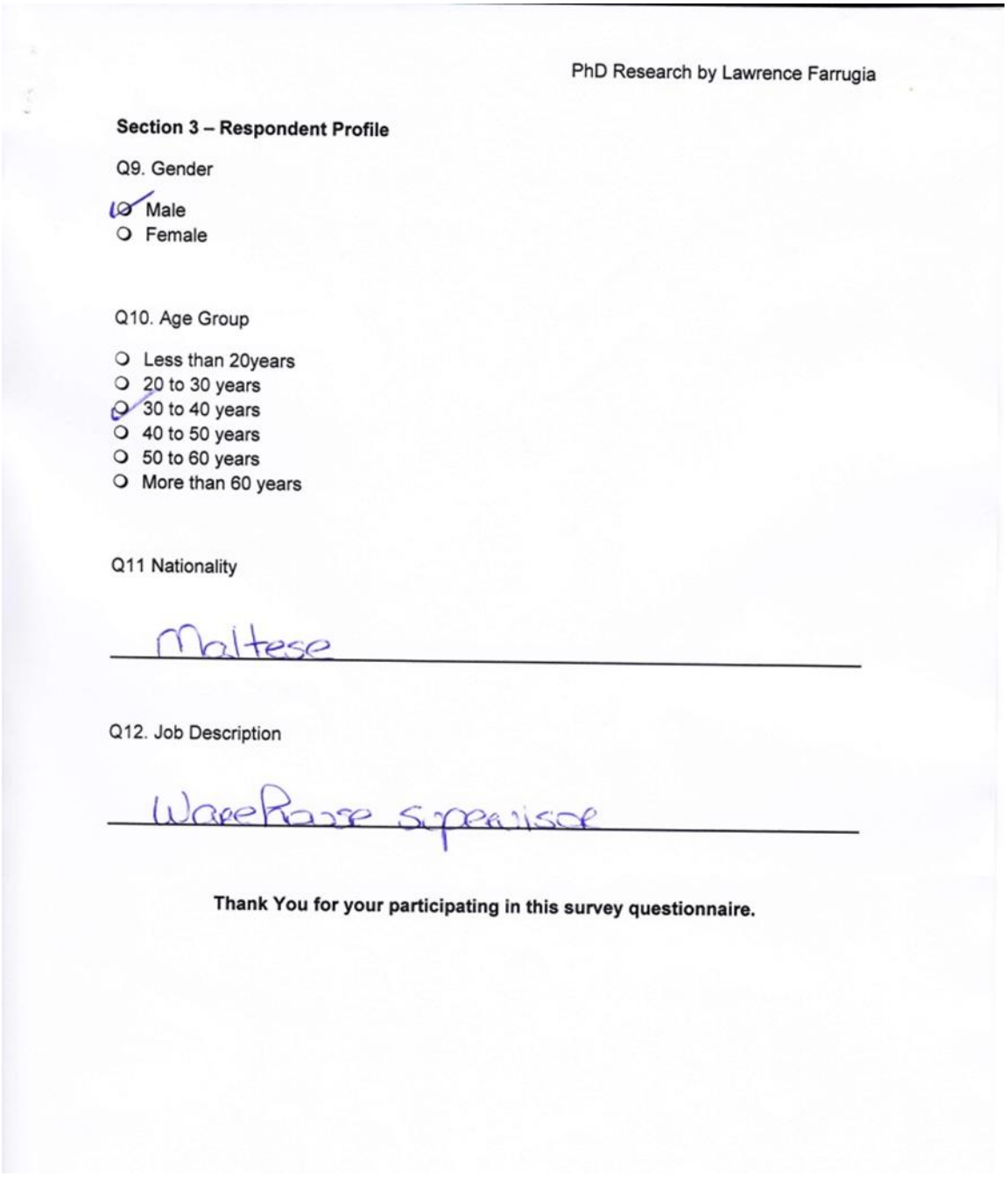
a. At Work

go smoking

b. Away from work

Q8. Other Comments

5



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Section 3 – Respondent Profile

Q9. Gender

- [x] Male
- [ ] Female

Q10. Age Group

- [ ] Less than 20years
- [ ] 20 to 30 years
- [x] 30 to 40 years
- [ ] 40 to 50 years
- [ ] 50 to 60 years
- [ ] More than 60 years

Q11 Nationality

Maltese

Q12. Job Description

Warehouse Supervisor

Thank You for your participating in this survey questionnaire.

Appendix B

B.1 - Demographic Data of Participants

	N	Gender Frequency		Age Group Frequencies				
		Male	Female	Less than 20 years	20 to 30 years	30 to 40 years	40 to 50 years	50 to 60 years
Firm A	21	5	16	1	9	9	2	0
Firm B	17	17	0	1	2	4	3	7
Firm C	9	4	5	0	2	7	0	0
Firm D	13	2	11	2	5	2	3	1

B.2 – Sources of Concerns

Concern ID	Concern	Source identified in literature	Source identified through preliminary investigation
HC1	My health and safety	✘	✓
HC3	Performing tasks which meet the expected quality standards	✘	✓
HC2	Having the right tools and resources necessary to execute work related tasks.	✓ (Jo & Bitner, 1992)	✓
HC7	Being extremely productive, irrespective of the quality of the work	✘	✓
HC6	Minimize work overload on myself and colleagues	✓ (Adaramola, 2012; Williams & Anderson, 1991)	✓
HC8	Spending as much time as possible away from work.	✘	✓
HC4	The appearance and comfort of the physical work environment	✓ (Asmus & Bell, 1999; Jo & Bitner, 1992; Kahya, 2007; Qureshi, Iftikhar, & Abbas, 2013; Williams & Anderson, 1991)	✓
HC5	Building and maintaining good work relationships with colleagues	✓ (Chang & Lu, 2007; Fitness, 2000; Karasek, Brisson, Houtman, Bongers, & Amick, 1998)	✓

B.3 – One Way Anova

Concern ID			df	F	Sig.
HC1	**My personal health and safety**	Between Groups	3	6.344	.001
		Within Groups	56		
HC2	**Having adequate tools and resources**	Between Groups	3	.386	.763
		Within Groups	56		
HC3	**Perform work which meets quality standards**	Between Groups	3	2.655	.057
		Within Groups	56		
HC4	**The comfort and appeal of the physical work environment**	Between Groups	3	7.200	.000
		Within Groups	56		
HC5	**Building strong positive relationships**	Between Groups	3	7.035	.000
		Within Groups	56		
HC6	**Minimize work overload**	Between Groups	3	7.051	.000
		Within Groups	56		
HC7	**Being very productive, irrespective of the quality.**	Between Groups	3	5.006	.004
		Within Groups	56		
HC8	**Spend time away from work**	Between Groups	3	.397	.756
		Within Groups	56		

-

B.4 – Tukey HSD Test

Concern ID	Human Concern – Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.
HC1	My personal health and safety	Firm A	Firm B	0.560	.29880	0.250
			Firm C	0.619	.36488	0.335
			Firm D	-0.766	.32320	0.095
		Firm B	Firm C	0.059	.37754	0.999
			Firm D	-1.326	.33743	**0.001***
		Firm C	Firm D	-1.385	.39713	0.005
HC4	The comfort and appeal of the physical work environment	Firm A	Firm B	1.711	.46010	**0.002***
			Firm C	-0.524	.56186	0.788
			Firm D	1.092	.49769	0.138
		Firm B	Firm C	-2.235	.58135	**0.002***
			Firm D	-0.620	.51959	0.634
		Firm C	Firm D	1.615	.61153	0.051
HC5	Building strong positive relationships	Firm A	Firm B	-2.313	.52883	**0.000***
			Firm C	-1.777	.64578	**0.039***
			Firm D	-1.513	.57203	0.050
		Firm B	Firm C	0.536	.66819	0.853
			Firm D	0.801	.59720	0.541
		Firm C	Firm D	0.265	0.702	0.982
HC6	Minimize work overload	Firm A	Firm B	-1.059	0.420	0.068
			Firm C	1.111	0.513	0.146
			Firm D	0.615	0.455	0.533
		Firm B	Firm C	2.169	0.530	**0.001***
			Firm D	1.674	0.474	**0.005***
		Firm C	Firm D	-0.496	0.558	0.811
HC7	Being very productive, irrespective of the quality.	Firm A	Firm B	1.543	0.442	**0.005***
			Firm C	0.413	0.540	0.870
			Firm D	-0.040	0.478	1.000
		Firm B	Firm C	-1.131	0.559	0.192
			Firm D	-1.583	0.499	**0.013***
		Firm C	Firm D	-0.453	0.588	0.867

*** The mean difference is significant at the 0.05 level.**

B.5 – Rating of Machine Properties by Interviewed Subjects

Machine System Properties	Average	Std. Deviation
Sensitivity and reliability of the tools/machine	4.55	0.87
Illumination[1] provided for the process	4.45	0.72
Temperature[2] attributed to the process	4.38	0.92
Ergonomics of the workstation (e.g. layout of object and posture)	4.32	0.89
Noise resulting from the process	4.30	1.01
Appropriateness of the machines to execute task	4.20	0.84
Smells[3] which result from the machine	4.02	1.07
The complexity of the machine/tool	3.57	0.93

B.6 – Rating of Evolving Product Properties by Interviewed Subjects

Evolving Product Properties	Average	Std. Deviation
Complexity[4] of product	3.70	0.94
Smell of components	3.57	0.89
Colour combinations	3.55	1.10
Type of machines and tools required	3.52	1.14
The skills required to perform tasks	3.47	1.17
Number of repeated operations required	3.47	1.01
Accuracy required by product	3.38	1.11
Sounds and noises	3.17	0.98
Tactile feeling of objects	2.92	0.94

B.7 – Rating of Work Environment Properties by Participants

Work Environment Properties	Average	Std. Deviation

[1] This term refers to the localized luminance.

[2] This is the localized temperature attributed to the operation of machines systems such as welding and casting.

[3] These are smells that result from the use of material such as lubricants and coolants that ensure proper machine operation

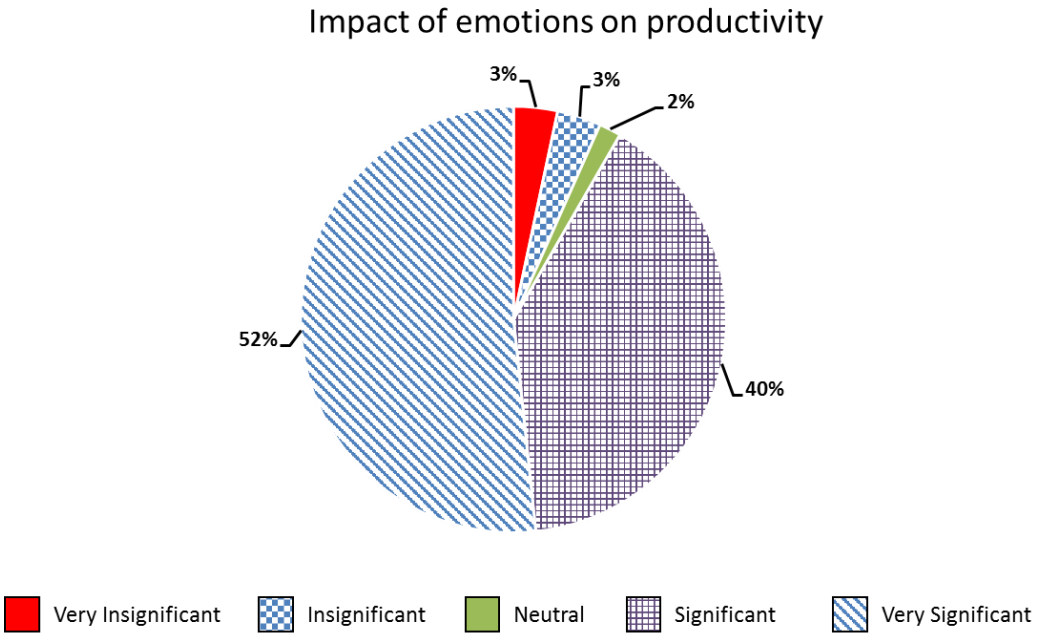
[4] Number of individual components and their spatial layout

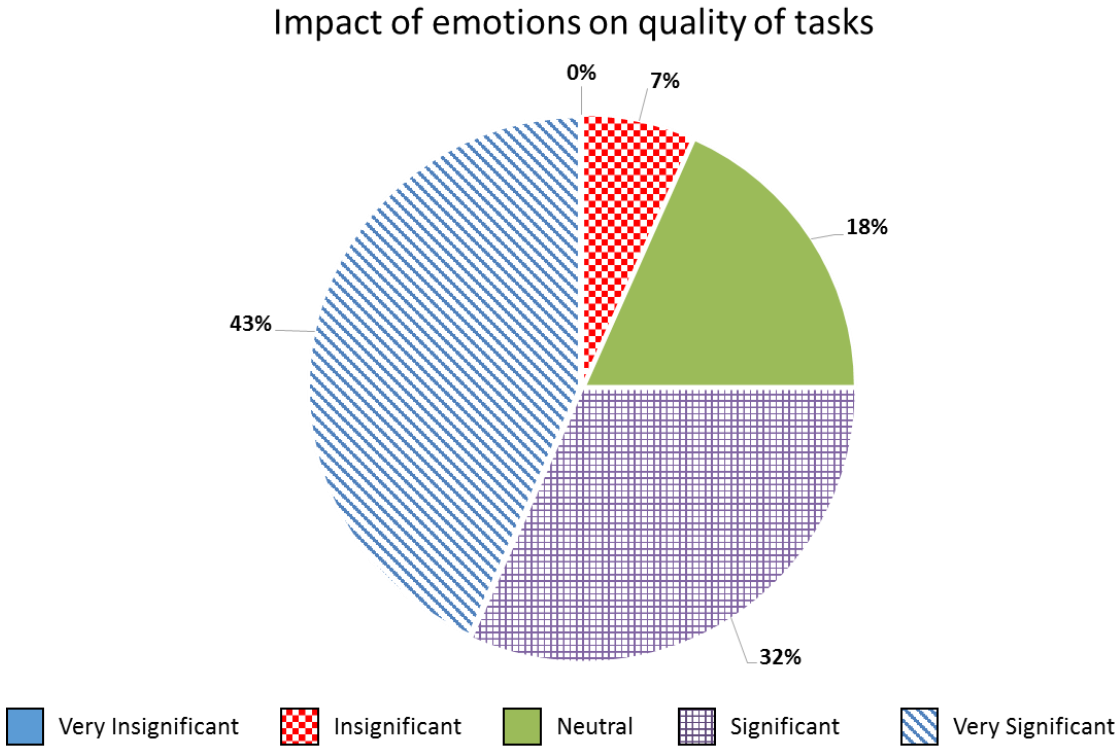
Inadequate spatial layout[5]	4.57	0.79
Participation in decision making	4.43	0.81
Lack of work delegation	4.42	0.77
Ambiguity related to the task	4.38	0.78
Inadequate ambient temperature	4.37	0.94
Opportunity to develop skills	4.37	0.76
Poor lighting conditions	4.32	0.79
Time pressure	4.30	0.79
Excessive noises and sounds	4.25	0.70
Unpleasant odours	4.07	0.90
Poor interpersonal relationships	3.90	0.80
High work overload	3.87	0.91
Responsibility for others	3.67	1.27
Working long hours	3.57	0.96
Ambiguity related to the role	2.98	1.33

[5] Refers to the physical space provided

B.8 – Perceived Impact of Emotions on Productivity

Impact of emotions on:	N	Very Insignificant	Insignificant	Neural	Significant	Very Significant
Productivity	60	2	2	1	24	31
Quality	60	0	4	11	19	26





Appendix C

EXG003/2016

To be completed by Faculty Research Ethics Committee

We have examined the above proposal and advise

Acceptance ✓ **Refusal** **Conditional acceptance**

For the following reason/s:

Signature [signature] Date 17/3/2016

To be completed by University Research Ethics Committee

We have examined the above proposal and grant

Acceptance **Refusal** **Conditional acceptance**

For the following reason/s:

Signature [signature] Date 11/8/2016