COMPUTER BASED MODEL TO CHANGE OCCUPATIONAL SAFETY & HEALTH AND ENERGY MANAGEMENT ATTITUDES OF OCCUPANTS IN THE GARMENT INDUSTRY

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ABSTRACT

Garment industry is one of the major contributors to the Sri Lankan economy. Nonetheless, productivity of the industry is crucially influenced by Occupational safety and health (OSH) and Energy management (EM) mal-behaviours. Even within the industry, behaviour of sewing machine operators are vital. It is noted that that industry is the second most contributor to the OSH accidents. Further, energy demand for the manufacturing is a major concern. In fact, it is notable that these two areas can be enriched by altering personnel attitudes, which will ultimately affect to the behavioural patterns. There are varieties of tools to change attitudes of people in order to change their behaviours. Computer models can be considered as a modern approach. Thus, this research focuses on current common behavioural issues and brings-up a computer model as a solution

Consequently, the research concludes findings obtained through preliminary investigation and a semi structured questionnaire survey that was conducted upon, behavioural issues and applicability of computer model respectively. Preliminary investigation consists of two surveys; expert opinion survey and structured questionnaire survey.

Ten number of issues were confirmed. Not wearing PPEs, poor sitting positions, removing safety devices of the machine and not switching off probe lights and machine were noted as top three significant issues. In computer model, top two accepted aspects were scoring mechanism and monitory gifts for winners.

Keywords: *Attitudes and Behaviours; Attitude Change; Computer Based Model; Energy Management; Occupational Health and Safety.*

1. INTRODUCTION

EM and OSH are two different areas that are vital for the garment manufacturing industry (Dheerasinghe, 2003). Nevertheless there are many occupational accidents in the garment manufacturing industry in Sri Lanka (Dissanyake and Fonseka, 2014). Similarly, on the other hand, ultimate product price is influenced by the energy costs (Samarasinghe *et al*., 2015). Furthermore, both of these areas are actively engaged in the production areas, where sewing works are carried-out (Dalia *et al*., 2014; Padmini and Venmathi, 2012). Hence, behaviours relating to OSH and EM are important (Dheerasinghe, 2003).

Martins *et al*., (2016) stated that computer model have a positive impact on a psychology of a person. Similarly, Orland *et al*. (2014) mentioned that people's ability to think, managerial and conceptual skills, designing, and familiarise to the environment can be improved through computer games.

Currently in Sri Lanka, younger generations are more into the computer technology (Department of Census and Statistics [DCS], 2015). This was a positive point to implement a computer model to improve behaviours by changing attitudes of a person. Therefore, comprehensive literature review was carried out in the next section followed my methodology chapter. Finally, the study presents research findings and discussion followed by conclusions and recommendations.

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2. LITERATURE FINDINGS

2.1. OCCUPATIONAL SAFETY AND HEALTH (OSH) IN GARMENT INDUSTRY

OHS is primarily concerned about refining the health of employees and ensure their protection during working hours (Goetzel *et al.*, 2008). There are around 4000 incidents in garment manufacturing industry per year resulting to lose more than 600000 working days (Dissanyake and Fonseka, 2014). OSH is vital for the reputation and product cost of a garment factory (Samarasinghe *et al.*, 2015). However poor attitudes have identified as a primary cause for accidents (Almén and Larsson, 2014). Table 1 illustrates the identified OSH related behavioural issues of workers in garment industry.

Table 1: Behavioural Issues of Workers Related to OSH

No.	Source	Issue
I1	Calvin and Joseph (2006)	Employee meet needle stick Injuries due to poor behaviours
I2	Bandara (2010)	Employee is electrocuted due to carelessness
I3	Calvin and Joseph (2006)	Employee keep objects on floor and hence slip/trip/falls
I4	Serinken *et al.* (2012)	Employee touches hot surface and get burned
I5	Serinken *et al.* (2012)	Employee get Injured due to mechanical parts of machine other than needle stick injuries
I6	Calvin and Joseph (2006)	Employee doesn't try to wear PPEs
I7	Lombardo (2012)	Employee doesn't avoid poor sitting positions
I8	Bashiri (2014)	Employee doesn't avoid high lighting levels
I9	Padmini and Venmathi (2012)	Employee doesn't avoid foreign body (Dust/Fumes)
I10	Padmini and Venmathi (2012)	Employee doesn't avoid higher noise levels
I11	Padmini and Venmathi (2012)	Employee doesn't avoid hot environment

2.2. ENERGY MANAGEMENT (EM) IN GARMENT INDUSTRY

Sri Lankan garment sector subjected to the high-power consumption which result product price goes-up (Samarasinghe *et al.*, 2015). Nevertheless, supply chain of apparel is affected with energy and other additional costs in factories (Jayawickrama and Thangavelu, 2011). However, personal behaviours are critically attributed to energy consumption patterns (Yang *et al.*, 2015). Hence attitudes of people towards EM should be changed. Table 2 illustrates the identified EM related issue list.

Table 2: Behavioural Issues of Workers Related to EM

No.	Source	Issue
I12	SLSEA (2009)	Employee do not switch off lights when leaving
I13	Padmini and Venmathi (2012)	A/C set temperature level is kept less than 25 degrees Celsius
I14	Padmini and Venmathi (2012)	Employee do not switch off A/C when leaving
I15	BOI (2011)	Requiring of excessive lighting exceeding required amount
I16	Islam (2016)	Machines are set to high RPM rates when working, by employees
I17	Darabnia and Demichela (2013)	Poor sewing machine maintenance by Employees
I18	Abdoli and Semere (2014)	Employees do not switch off machine when leave
I19	Dalia *et al.* (2014)	Removing compressed air tubes of machine for other purposes other than expected purpose; pneumatic supply for machine

2.2 CHANGE ATTITUDE TOWARDS BEHAVIOURS

Behaviour is the action of an individual may take (Coon and Mitterer, 2013). Further, attitude is a psychological propensity which is unique for each individual based upon their desires (Shook and Bratianu, 2008). Moreover, attitudes of one person are subjected to the behaviours of other people (Ajzen, 2015). One of best method to change behaviours is through administrative punishments and rewarding (Lardner, 2015). According to Ajzen (2015) sometimes past memories of people are cause for attitude changes. However Ajzen (2015) stated that self-intention is required to change attitudes. Similarly, Rogers (2003) highlighted that an innovative ideas have ability to change attitudes of a person. Motivation is also an attitude changing approach (Ajzen, 2015). These are the past attitude changing approaches that an employee may perceive.

It is apparent that number of researches have focused on different computer based models in order to change the workers attitude and behaviours towards working process. Thus, Bang *et al*., (2006) introduced a computer game, "power house" to change behavioural pattern in order to save energy. A good computer model, "Energy Chicken" were introduced by a group of people to conserve the energy pattern and got 13% of electrical consumption savings (Orland *et al*., 2014). Similarly, computer games were used to improve the OSH in industries. Guo *et al*., (2012) introduced a computer game model to improve the safety of the workers. Nevertheless, it is proved that computer games can improve the health outcomes (Primack *et al*., 2012). Hence computer game models can be used to improve either OSH or EM related behavioural issues.

Further, in Sri Lanka, employees are motivated by giving compensation, gifts, financial benefits or rewards (Pratheepkanth, 2016). However, Current overall computer literacy in Sri Lanka is 24.6% and there is a 9.8% growth compare to the year 2014 (DCS, 2015). Hence it can be clearly identified that computer literacy is improving and it ultimately result to the progress of the model.

2.3 FEATURES OF COMPUTER MODELS

Success of a game depends on the technology that used to design multimedia effects (Chen *et al*., 2005). Nevertheless, creativity of the game is immensely contributed to the success of a game (Vanhala *et al*., 2015). Chen *et al*., (2016) argued that, perceived amusement through the game is vital to attract many people. Hence it is clear that high quality graphics will render the success of a game. Moreover, there are several areas that have to be concerned. Game value motivates the players to play the game and discover game more and more (Shi and Shih, 2015). It primarily depends on the preferences of the players (Park and Lee, 2011). Game fantasy stands for the environment of a game or the background of a game (Tamborini and Skalski, 2016). Game goals are the targets of the game (Swartout and Lent, 2003). Interaction means, how the player communicates with the game and level of the communication (Shi and Shih, 2015). Game mechanism is the pathway or a technique to achieve the goal (Shi and Shih, 2015). Challenge is the test given for the player (Rieber and Noah, 2008). Multimedia effects are highly useful to achieve this target (Huang *et al*., 2013).

Computer model is driven through a score system. Score systems are described under the section 2.5.If organisation intended to raise-up its productivity, then the best option would be performance evaluation (Karuhanga, 2015). Auditing is a high quality process of detecting and reporting the data related to activities (Mohamad and Habib, 2013). According to authors audit is a method to ensure that the implemented activities or the processes work properly. Therefore, it is apparent that there are significant factors such as game value, game fantasy, game goals, game mechanism, auditing and score system to be considered when developing a computer based game model to change the attitudes of the workers in particular industry.

3 COMPUTER MODEL

Following computer model was developed based upon the findings of the literature review. This computer model does not affect to employees' day to day work routine. Supervisors evaluate whether the employees are committing an issue or not. Figure 1 present the interface of the developed computer model.

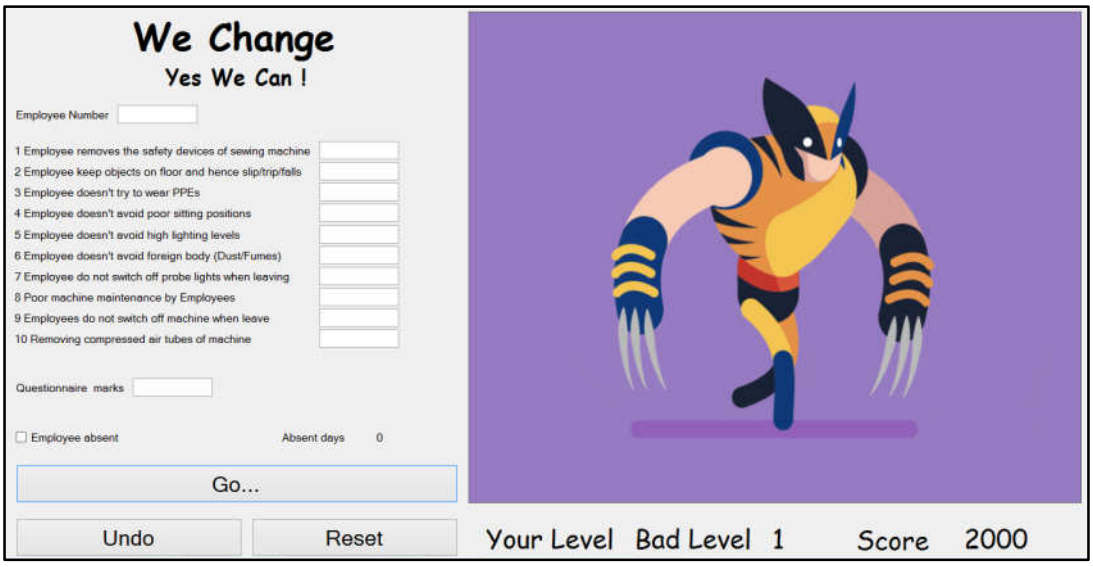


Figure 1: Interface of the Computer Model

Computer model itself provided a comprehensive OHS related issues and EM related issues frequently done by the employees. The evaluation is based on the frequency of occurrence of a particular issue by particular employee and the score system developed at the section five of the research paper.

Each user has been assigned a unique character. In the beginning, this character is appeared as good and aesthetic. When a user commits a poor behaviour, his/her total mark (2000) will begin to reduce gradually. Initially a set score of 2000 points are added to the system. These 2000 score is valid only for one month. However, these points are subjected to the poor behaviours of employees. Each behavioural issue related to OHS and EM is assigned a unique value. This unique value is obtained through the data analysis based on the questionnaire survey regarding the OHS and EM related behavioural issues. Based on the answers given by the experts, issues were prioritised according to the mean values. These values are considered as negative values. These negative values are to be added to the total score (2000).

There are four (4) levels in the game currently. These levels are named as “Bad Level”. To complete a “Bad Level”, user need to collect 200 negative points that are resulted due to the bed behaviours. When the users’ negative points increase, “Bad Level” of the character in this game will be gradually increased. Higher “Bad level” means, these users have committed numerous poor behaviours.

There are two weightages for score system. One weightage is dedicated for the type of the behavioural issue whereas the other weightage is dedicated for the character level. When user goes one “Bad Level” to another, his/her OHS and EM related behaviours are subjected to higher weightage. Hence his/her negative values will be increased though he committed the same mistake as similar to the previous levels. This feature is added to prevent doing the same mistake again and again. It is assumed that the user will not commit any more poor behaviour in order to save his/her current score. User, who achieves the highest score, as mentioned under the Eq. 1, will be awarded. Highest score can be defines as the Peron who stays in the lowest “Bad Level”. Nevertheless, ultimate score is the combination of both negative marks and initial marks (refer Eq. 3).

Employee may be absent for days. If the employee absent for more than 3 days, his/her character will be temporary disabled until the next round. For less than 3 days absentees, their total average negative points till the absent days will be added for absent day (refer equation 3).

$$\textit{Obtained total negative points (TNP)} = \sum_{i=1}^{n}\{W_i(\sum_{k=1}^{l}(N_k I_k))\} \qquad \textit{(Eq: 01)}$$

Where, W = weightage per level (level 1= 1.1, level 2= 1.2, level 3= 1.3 and level 4 = 1.4), n = number of levels, i = number of behavioural issues types (refer Figure 4), I = Negative value per type of issue (depend on garment factories), and N= count of the issue corresponding to I

$$\textit{Absent day negative score} = \textit{TNP till absent day/ worked days} \qquad \textit{(Eq: 02)}$$

$$\textit{Total Score} = 2000 + \textit{TNP} \qquad \textit{(Eq: 03)}$$

4 RESEARCH METHODOLOGY

Research can be identified as a combination of activities including investigation procedures, possible ways of happening, understanding the principle, testing and analyse the solutions (Kumar, 2011). In here, two approaches have been followed; qualitative and quantitative. Nevertheless, research process is a path which is taken by people when they got a question and how they answer it (Kumar, 2011). As the initial stage, it was stated the problem, interested areas and subject matters briefly. Secondly Literature survey was carried-out to provide framework for the research and as well as benchmarks to compare research findings. Computer model was developed by considering the facts described under literatures survey.

Preliminary investigation consists of expert survey as the first part of it. It was conducted to obtain the opinions of the experts in garment manufacturing industry regarding identified mal-behaviours. Three (3) experts were selected from the same industry for the purpose of refining the identified issues. Second part of the preliminary investigation consists of a structured questionnaire. It was used to prioritise the behavioural issues which were already refined under the expert questionnaire survey. Therefore 30 questioners were distributed among the experts and requested to mark the significance of each behavioural issue in order to rank them. A semi structured questionnaire survey was conducted to review the concept of computer based model. 30 questionnaires were distributed among the experts and requested to mark the suitability of each feature of the computer model.

Data analysis consists of three preliminary functions; data preparation, analysis and discussion of results (Kumar, 2011). Both qualitative and quantitative data were analysed. N-Vivo software was used to analyse qualitative data. Quantitative data was analysed to compute Mean and Standard deviation (STD) using Microsoft excel and IBM SPSS. Mean is the average of the responses and STD defines of how the members deviate from the mean (Kumar, 2011). Relative importance index (RII) technique was used to analyse the relative importance of the factors by cross comparing it (Muhwezi *et al*., 2014). According to authors, it is considered that issues which has got RII value greater than 0.599 (RII>0.599) are considered as significant factors whereas the rest are noted as the not significant factors

$$Mean\ (\bar{x}) = \frac{\sum x}{n} \qquad (Eq: 04)$$

Where, x = response value and b = number of responses

$$Standard\ Deviation\ (STD) = \sqrt{\frac{\sum(x-\bar{x})^2}{n-1}} \qquad (Eq: 05)$$

Where, x = response value, $\bar{x}$ = mean and b = number of responses

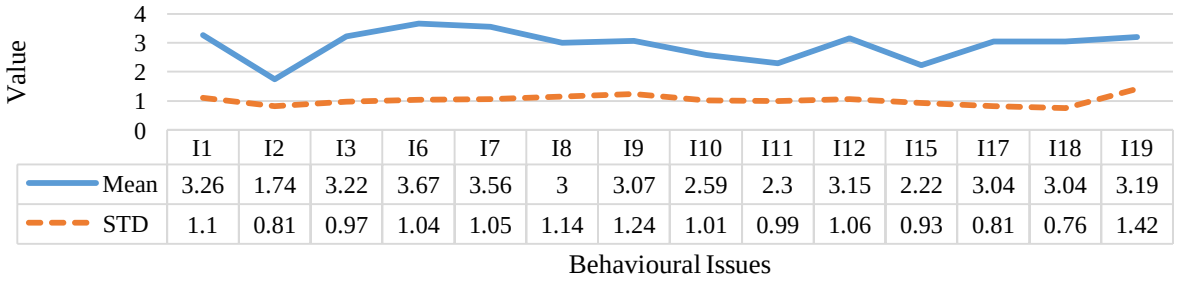
$$Relative\ Importance\ Index\ (RII) = \frac{\sum_{i=1}^{n} P_i W_i}{An} \qquad (Eq: 06)$$

Where, A = highest allocated integer weight, n = sample size, W = number or similar response on each weight class and P= weight relating to the corresponding responses (W)

5 DATA ANALYSIS

First part of the data analysis is consists of an expert opinion survey. Based on the opinion of them, I4, I5, I13, I14 and I16 were removed from the list (refer Table 2) with clear reasoning and I1 and I12 were updated. I1 was improved as employee removes the safety devices of the machine and I12 were improved as employee may no switch-off probe lights when leaves. With this survey, identified issues were refined according to the Sri Lankan context.

Structured questionnaire prioritised the refined behavioural issues. As per the RII analysis, issues that have obtained more than 0.6 were removed from the list. Therefore, I1, I3, I6, I7, I8, I9, I12, I17, I18 and I19 were regarded as critical issues. Figure 2 illustrates the analysis of Mean and STD of the structured questionnaire. Figure 3 illustrates the RII for EM and OSH related behavioural issues



	I1	I2	I3	I6	I7	I8	I9	I10	I11	I12	I15	I17	I18	I19
Mean	3.26	1.74	3.22	3.67	3.56	3	3.07	2.59	2.3	3.15	2.22	3.04	3.04	3.19
STD	1.1	0.81	0.97	1.04	1.05	1.14	1.24	1.01	0.99	1.06	0.93	0.81	0.76	1.42

Figure 2: Mean and STD of Behavioural Issues

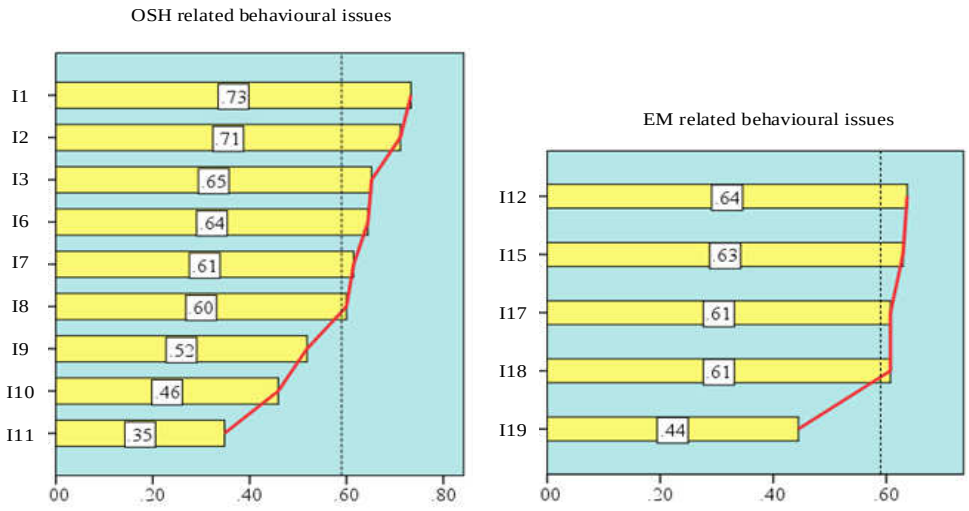
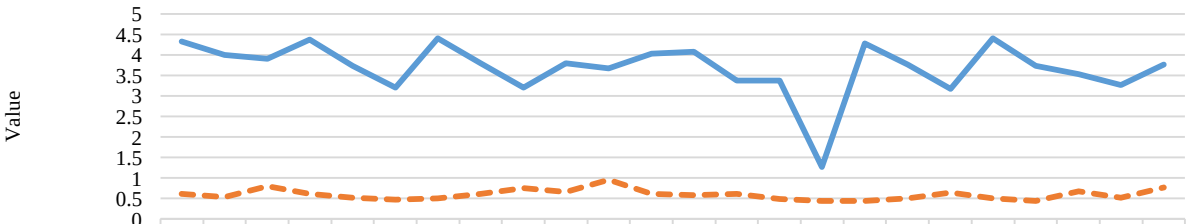


Figure 3: RII for EM and OSH Related Behavioural Issues

It can be observed that none of the issues were broadly accepted as “highly significant” by the respondents. Maximum value of recorded mean is 3.67 for I6 in OSH field and for the EM, it is recorded as 3.19 for issue I19. Respondents noted 10 issues that have got more than 3 as Mean. Only I2, I10, I11, and I15 were recorded as less than 3 for the Mean. STD of 8 issues out of 14 were recorded above 1 (STD > 1). Moreover, there are three (3) issues naming, I3, I11, and I15 were recorded above 0.9 STD (0.9 < STD < 1.0). Only STD of I18 was recorded less than 0.8 (STD < 0.8). It indicates all the issues except I3 are broadly dispersed. These facts clearly defines that the distribution of data is dispersed. Therefore, it can be understood all the issues are not equally significant for the garment factories.

STD value varies between 0.44 and 1.034. Lower STD defines that the data set is dispersed around the Mean. Therefore, the validity of the mean is comparatively higher. Mean of the data set vary from 1.27, to 4.47 on different factors. Nevertheless, respondent had noted 1.27 STD for the Q6.1. Therefore, respondents decided to reject Q6.1. Consequently, it was noted that answers of the respondents vary from “Not agreed” to the “Agreed” state. Aspects of each group were separately analysed. In fact word “employee” refers to the sewing machine operators. These facts are illustrated in Figure 4.

According to the qualitative data analysis, respondents highly noted to award many people instead of awarding only one employee (Q6.1). Rest of the aspects were approved by the respondents. However, some suggestions were made. It was suggested to, include a sector that relates to the production, improve monitoring mechanisms, more focus on low level people, improve awareness of employees, award more number of employees and introduce more negative score recovering methods.



	Q1	Q2.1	Q2.2	Q2.3	Q2.4	Q3.1	Q3.2	Q4.1	Q4.2	Q5.1	Q5.2	Q5.3	Q5.4	Q5.5	Q5.6	Q6.1	Q6.2	Q7.1	Q7.2	Q7.3	Q7.4	Q7.5	Q8	Q9
Mean	4.33	4	3.9	4.37	3.73	3.2	4.4	3.8	3.2	3.8	3.67	4.03	4.07	3.37	3.37	1.27	4.27	3.77	3.17	4.4	3.73	3.53	3.27	3.77
STD	0.61	0.53	0.8	0.61	0.52	0.48	0.5	0.61	0.76	0.66	0.96	0.61	0.58	0.61	0.49	0.45	0.45	0.5	0.65	0.5	0.45	0.68	0.52	0.77

Figure 4: Mean and STD for Aspects of the Computer Model

The concept of a computer model designed to change the attitudes and behaviours on OSH and EM activities can be effective as it forms a stage for the competitiveness in the working environment which will prove effective. However, many respondents have noted that this concept is innovative computer game was designed to improve the attitude of employees and then improve the behaviours relating to the OSH and EM. Each and every employee has to take a part in this computer game. Behavioural issues relating to OSH and EM of the employees are observed by the supervisors and marks are given based on their behaviours. This score decides the behaviour level. Each behaviour has got a unique value and similarly each level is assigned a unique weight. A character is assigned for each employee and it was assumed that employee maintain his character. Therefore, computer game defines that there is an addiction of employees and it result to change attitudes of the employees. Therefore, it is assumed that OSH and EM behavioural issues would be changed. Figure 5 illustrate the aspects of the computer game model.

ID No.	Aspects of Computer Model	ID No.	Aspects of Computer Model
Q1	Computer model as solution for EM and OSH activities	Q5.3	Weights scales for behaviours
		Q5.4	Weight scales for score levels
Q2	Characteristics of the computer model	Q5.5	Employee temporary out due to absenteeism
Q2.1	Game value	Q5.6	Score for a absent days
Q2.2	Game goal	Q6	Award mechanism of the computer model
Q2.3	Game fantasy	Q6.1	Award only one employee
Q2.4	Game mechanism	Q6.2	Monitory gifts
Q3	Supervision mechanism on employees	Q7	Addiction of employees to the computer model
Q3.1	Supervising on employees	Q7.1	Judgemental approach
Q3.2	Biasness of supervising	Q7.2	Attributional approach
Q4	Character and background of the computer model	Q7.3	Diffusion of innovative theory
Q4.1	Assigned character for employees	Q7.4	Motivational approach
Q4.2	Character change based on the user levels	Q7.5	Theory of planned behaviour
Q5	Scoring mechanism of the computer model	Q8	Suitability of the current computer model as a solution to the OSH and EM activities of sewing machine operating employees
Q5.1	Negative points for miss-behaviours		
Q5.2	Bad levels based on negative points		
Q5.3	Weights scales for behaviours	Q9	Aspiration to Implement computer model in factory

Figure 5: Mean and STD for Aspects of the Computer Model

Majority of respondents have noted that the proposed computer model in section 3 is acceptable. Many features of the computer model are recorded above 3.0 mean. Nevertheless, respondents have noted that this computer model will be successful in garment sector, but they highlighted that it is difficult to conclude an opinion before implementing it. However, majority of respondents noted that they are willing to implement the computer model.

5 SUMMARY

Attitudes of the people are vital for a better society. Proper OSH and EM behaviours related to the activities in Garment manufacturing industry is concerned as critical. Behaviours committed by sewing machine operators are concerned for this research. Behaviours can be changed by altering attitudes. Six approaches have been identified to alter the attitudes; Attribution approach, conditioning and modelling approach, judgemental approach, theory of planned behaviour, diffusion of innovative theory, motivation. Computer models can be used as solution to improve the attitudes and six approaches can be integrated with it.

Ten significant behavioural issues were identified. Six out of ten is related to the OSH and the rest is related to the EM. Most significant OSH related behaviour is, not wearing PPE by the employees. Similarly it is noted that poor sitting positions and removing of safety devices of machine are also significant issues. On the other hand, not switching off probe lights when leaving, and removing of compressed air tubes for other purposes were noted as most significant two issues related to the EM.

Developed computer model was model was accepted by the majority of respondents. Main features, score mechanism, characters were majorly accepted. However awarding only one employee was not accepted by the respondents. Finally, it can be concluded that developed model is acceptable but it can be further enhanced with the improvements.

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