World Journal of Advanced Engineering Technology and Sciences
eISSN: 2582-8266
Cross Ref DOI: 10.30574/wjaets
Journal homepage: https://wjaets.com/

(RESEARCH ARTICLE)

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Effects of environmental and safety factors on productivity of RMG industry in Bangladesh: A survey-based approach

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World Journal of Advanced Engineering Technology and Sciences, 2025, 15(01), 1475-1485

Publication history: Received on 04 March 2025; revised on 14 April 2025; accepted on 16 April 2025

Article DOI: https://doi.org/10.30574/wjaets.2025.15.1.0345

Abstract

The Ready-Made Garments (RMG) industry is the only multi-billion-dollar manufacturing and export earning sector in Bangladesh. This industry contributes 83% of the country's total export earnings, which was 18% of total GDP in 2016. Productivity, which reflects the efficiency and effectiveness of an organization in transforming its inputs into outputs, is very crucial for this industry. Since most of the RMG workers have little and sometimes no formal education, productivity factors associated with environmental and safety factors gain less attention. This study focuses on assessing and quantifying the effects and relationship of Ergonomics, Health Safety & Environment (HSE), and Occupational Health & Safety (OHS) on workers' productivity in the selected RMG factories. A structural questionnaire has been used for data collection. Expected outcomes of this study are (i) Ranking of the factors by their contributions to the productivity, (ii) Individual effect of the factors on productivity, and (iii) the relationships among the factors and the productivity of RMG industry in Bangladesh. These outcomes will be helpful to concern policymaker and factory owners about the importance of Ergonomics, HSE, and OHS and to provide a sustainable safety environment to the workers for improving productivity

Keywords: Ready-Made Garments; Productivity; Safety; Ergonomics

1. Introduction

For the first time in history, the total export of Bangladesh has crossed the USD 30.18 billion mark. For the last three decades, Bangladesh has been the world's second-largest exporter of ready-made clothing items exporting to over 132 countries worldwide. From 2010 to 2015, it is estimated to double and almost triple by 2022. The RMG industry produced US$ 28.14 billion in the financial year 2016-2017, which accounted for 80.7% of total export earnings and 12.36% of GDP; the industry also adopted green manufacturing practices (Hossain et al., 2017). The RMG sector provides about 4.4 million people with direct employment, 80% of whom are women. About 20 million people depend on this sector, directly and indirectly.

To comprehend how successful a company is in its process of creating wealth, it is vital to understand the idea of productivity. Productivity can be expressed as the ratio of output to inputs used in the process of production, i.e., output per input unit. (Diewert et al., 1992) offers a concise definition of productivity as the efficiency of the inputs used to

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generate outputs. A significant aspect of productivity improvement is the growth of labor productivity, which is characterized as the number of goods and services produced by a worker in a given period of time (Al-Saleh et al., 1995).

Improving worker productivity is a major concern of industry, especially in developing countries. In order to discuss the importance of labor productivity in the context of industries in Bangladesh, it should be noted that the productivity of garment labor per hour in Bangladesh is still lower than its rivals in average output, except for Cambodia, according to the latest data. Bangladesh, being the second-largest garment exporter, is also the second-lowest in terms of productivity, which, according to the data, is valued at $3.4.On the other hand, the largest garment exporter China's per hour productivity is calculated at $11.1. The labor productivity gap between Bangladesh and China is 69 percent.

Early researchers and writers found a limited number of factors that had the most significant impact on the workforce's performance. Taylor found that four fundamental principles could be used to dramatically improve the efficiency of the workforce (Taylor et al., 1998). Taylor's principles advised managers to systematically design jobs, scientific selection, and training of the workers, close cooperation with the workers, and divide the work and responsibility equally between the worker and management (Birnbaum & Somers, 2023). Neglecting the ergonomic values provides the workplace with inefficiency and discomfort. An ergonomically deficient workplace can cause physical and emotional stress, low productivity, and poor work performance (Ayoub et al., 1990b).

According to Taiwo, A. S. (2010), about 86% of productivity problems reside in the work environment of organizations. Poor environmental conditions can cause inefficient worker productivity. Environmental factors like lighting, noise level, proper temperature conditions, and humidity have significant influences on worker productivity (sarode et al., 2012) (Li x et al., 2016).

Building an understanding of ergonomics as work culture is the first step towards improving RMG efficiency, comfort, health and safety, and increasing injury, illness, and the probability of errors (El-Tahan et al., 2014).

According to Alam & Azim, 2018, workplace conditions most significant effect on employee productivity and OSH management system & training neither positively or negatively affect on employee productivity in RMG sector in Bangladesh.

As seen from the above literature, the RMG in Bangladesh has the potential to meet the growing annual demand of Bangladesh. Also, this sector has an opportunity to enhance the global market share and earn more export revenues. However, productivity barriers in RMG industries are hampering their growth. To improve productivity, proper identification of the factors affecting the productivity of RMG industries in Bangladesh is of great importance. Besides, a systematic study identifying appropriate and significant factors affecting the productivity of RMG industries in Bangladesh is lacking. This article, therefore, aims to identify the significant factors and their relationship with/ effect on the productivity of RMG industries in Bangladesh. This study focuses on:

- Identifying environmental, ergonomic and safety factors critical to the productivity of the RMG industries in Bangladesh;
- Ranking the factors by their contributions to the productivity of the RMG industries in Bangladesh;
- Reducing observed factors into highly predictive productivity determinants of the RMG industries in Bangladesh;
- Correlation among the previously identified significant factors and the productivity of the cement industries in Bangladesh.

2. Methodology

2.1. Questionnaire Construction

Based on the critical factors reported in the relevant published literature, a structured questionnaire was prepared and later modified using experts' opinions from adroit managerial personnel and academic expert. There were two parts in the questionnaire. The first part included demographic variables like age, job responsibility, and length of service of the respondents. The second part included the factors affecting the productivity of the RMG industry in Bangladesh. A set of 30 factors was determined. As can be seen in Table 1, a set of 35 factors was determined under three broad categories, namely Work-place environmental factors, ergonomic factors, and safety factors. To rank the importance and impact of the productivity factors, a 5-point Likert scale was used and labeled as 1= very low, 2= low, 3= average, 4= high, and 5=

very high. Moreover, in this study, Cronbach's alpha was used to measure the internal consistency of the questionnaire utilized.

Their voluntary nature of participation in this study and confidentiality of responses was assured with an introductory letter. The questionnaires were sent randomly to the participants either directly or by email. The completed questionnaires collected by the authors were in ceiled. The respondents filled up the questionnaires at their workplaces. They were instructed not to consider the answers too long but always stick with the first spontaneous answer that came to their mind.

Table 1 Critical Productivity Determinants Obtained from Literature Review

Category	**Productivity Determinants**	**Source**
Work-place environmental factors	Noise level	Vandyck & Fianu, 2012
	Presence of dust particle	Samaddar, 2016
	Temperature condition	Imran Bin Hussain, 2018
	Presence of toxic substances at workplace	Ahmad, et. Al., 2013
	Proper lighting	
	Humidity level	Jafari & Singh, 2017
	Proper ventilation	Somanathan et. al., 2015
	Cleanliness of the work area	Samaranayake et al., 2013
	Vibration	Rahmi et al., 2019
	Radiation	Zaman et al., 2018
	Air quality	Joarder & Sultana, 2019
	hazardous wastes	Le & Ren 2022
	Congested work area	Qian et al., 2021
		Dabirian et al., 2023
Ergonomic factors	Ergonomic design of hand tools	Generalis & Mylonakis, 2007
	Ergonomic design of the workstation	Larson, 1998
	Proper work height	Karakolis & Callaghan, 2014
	Proper man-machine system design	El-Tahan & El-Nasr, 2014
	improper workplace design	Fahim et al., 2023
	poorly designed task	Shikdar et al., 1993
	Improper machine design	Laoha et al., 2021
Health and Safety policies/factors	Safety training	Al-Dabbagh et al., 2018
	Availability of medical facilities	Zaman et al., 2018
	Availability of lavatories and washing facilities	Sommer et al., 2016
	Availability of safe drinking water	Samaddar, 2016
	Facilities for rest and to eat meal	Uddin, 2015
	Availability and uses of Personal Protective Equipment (PPE)	Padmini & Venmathi, 2012 Kaminski, 2001
	Availability and good understanding of safety sign	Samaddar, 2016
	Established health and safety policies	Rahman & Ehasan, 2017
	Periodic hazard identification and elimination	Alam & Alias, 2016
	Physical health of workers	Ahmed & Hossain, 2009
	Accident and near-miss investigation	Alam & Azim, 2018
	Provision of Organizational Health and Safety (OHS) committee	Grimani et al., 2019
		Shikdar & Sawaqed, 2003
		Sharif et al., 2015

	Provision of Environment Health and Safety (EHS) officer on site Following safety precaution while working Safe operating procedure	Vaughn et al., 2004 Leitão et al., 2019 Hameed et al., 2021; Paul et al., 2023

2.2. Data Collection

Data were collected using the semi-structured questionnaire from eighteen different RMG industries. The respondents were from a wide occupational range engaged in productivity measurements and improvement of the RMG industries in Bangladesh. They were of general manager, engineers (production, maintenance, electrical, mechanical) and other middle managers. A total of 350 survey questionnaires were distributed. Of the 218 returned questionnaires, 202 were usable. The response rate was approximately 62.2%. These 202 useable questionnaires were used to analyze the data.

2.3. Data Analysis

After data collection, the attributes in terms of their criticality as perceived by the respondents were first ranked. In this study, before ranking, the relative importance of productivity determinants was quantified using the relative importance index (RII) method and a total of 15 factors were ranked in ascending order. While ranking the attributes, a RII value of 0.5 was taken as a cut off point. The following equation calculated RII:

$RII = \Sigma W/(A*N)$

Where

W Weight is given to each factor by the respondents

A Highest weight

N Total number of respondents

Principal components analysis (PCA) was then performed to reduce factors into highly predictive productivity determinants. In this study, components with eigenvalues of 1.00 or higher are considered worth analyzing. The components with small or negative eigenvalue were omitted due to having the lowest variance (Tabachnick and Fidell, 1996). For ease of interpretability, a suitable label was also reassigned to each of the identified principal components.

Finally, a regression equation was developed to demonstrate the causal relationship between the identified principal factors and productivity. All analysis was performed by SPSS 25.0.

3. Results and Discussions

3.1. Reliability Test

Data analysis was started with testing the validity and reliability of the questionnaire in terms of internal consistency. In this study, to test internal consistency, Cronbach's alpha (Cα) was used (Teerajetgul et al., 2009). The scale's reliability was determined through a sample of 202 respondents. Each of them answered 31 questions. The overall value of Cronbach's alpha (Cα) was 0.724, and hence, data can be analyzed further to conclude the results (Mehboob et al., 2011).

3.2. Demographics Characteristics

From the Table 2 shows the summary statistics of the demographic characteristics of the respondents, it is found that job categories of the respondents were distributed as engineering (37.9%), administrative (19%), production (15.7%), human resource (14.8), and finance (12.6%). Of 202 respondents, more than two-thirds (65.9%) were identified as early middle age (31-40 years), 15.2% as a young adult (24-30 years), and 18.9% as late middle age (41-50 years). Moreover, 74..3% of the respondents had at least five years of work experience in cement industries, while 25.7% of them were working for less than five years at the time of the study.

Table 2 Demographic characteristics of the respondents

Demographic variable	Category	%
Job category	Administrative	19.0
	Engineering	37.9
	Finance	12.6
	Human resource	14.8
	Production	15.7
Age group	24 – 30 yrs.	15.2
	31 – 35 yrs.	48.1
	36 – 40 yrs.	17.8
	41 – 50 yrs.	13.9
	Over 50 yrs.	5.0
	1 – 4 yrs.	25.7
Length of service	5 – 10 yrs.	39.4
	10 – 14 yrs.	13.9
	Over 15 yrs.	21.0

3.3. Ranking of Factors

In this study, all the identified productivity determinants were ranked using the RII method, and a total of 15 factors of productivity was sorted in descending order of RII, as can be seen in Table 3. From the table, it is evident that top seven productivity determinants were effective use of lighting (0.882653), humidity (0.854545), proper man-machine system design (0.853266), and temperature condition (0.852525) followed by noise level (0.832323), physical health of workers (0.827551) and design of workstation (0.824121). Besides, availability of medical facilities (0.754545), availability and good understanding of safety sign (0.727273), provision of Environment Health and Safety (EHS) officer on site (0.642857), availability and uses PPE (0.630303), provision of Organizational Health and Safety (OHS) (0.626531), established health and safety policies (0.619388), ergonomic design of hand tools(0.560804) and inappropriate work height (0.524623) were found to be the bottom eight-factor affecting the productivity of the RMG industries as perceived by the respondents.

Table 3 Ranking of productivity determinants of RMG industries

Factors	Mean (SD)	RII	Rank
Lighting	4.41(.796)	0.882653	1
Humidity	4.27(.865)	0.854545	2
Proper man-machine system design	4.27(.849)	0.853266	3
Temperature condition	4.26(.813)	0.852525	4
Noise level	4.16(.892)	0.832323	5
Physical health of workers	4.14(.937)	0.827551	6
Design of workstation	4.12(.891)	0.824121	7
Availability of medical facilities	3.77(1.124)	0.754545	8
Availability and good understanding of safety sign	3.64(1.099)	0.727273	9
Provision of Environment Health and Safety (EHS) officer on site	3.21(1.084)	0.642857	10

Availability and uses PPE	3.15(1.139)	0.630303	11
Provision of Organizational Health and Safety (OHS)	1.13(1.138)	0.626531	12
Established health and safety policies	3.10(1.315)	0.619388	13
Ergonomic design of hand tools	2.80(1.062)	0.560804	14
Inappropriate work height	2.62(1.065)	0.524623	15

3.4. Principal Component Analysis

Principal component analysis (PCA) – a descriptive, statistical approach to data transformation – reduces a large set of variables to a small set called principal components (PCs) while retaining most of the information in the large set (Jolliffe, 2011). The ranking of the PCs in order of their importance is designated by the eigenvalues associated with the vector for each PC. In this study, PCA was, therefore, performed to reduce factors into highly predictive productivity determinants of the RMG industries, and only components with eigenvalues of 1.00 or higher were considered worth analyzing.

Table 4 Retained principal components for productivity of RMG industries

	Eigen value	**% of variance**	**Factors**	**Factor loading**
PC1	3.192	21.283	Temperature condition	0.862
			Humidity	0.811
			Proper lighting	0.781
			Noise level	0.753
PC2	1.513	10.084	Proper man-machine system design	0.783
			Design of workstation	0.684
			Ergonomic design of hand-tools	0.481
PC3	1.300	8.668	Provision of Organizational Health and Safety (OHS)	0.641
			Provision of Environment Health and Safety (EHS) officer on site	0.639
			Established health and safety policies	0.620
PC4	1.186	7.908	Availability and uses PPE	0.756
			Availability of medical facilities	0.609
			Availability and good understanding of safety sign	0.180

As shown in Table 4, four principal components – also termed as highly predictive components – were retained in PCA for this productivity determinants analysis. Together these four principal components accounted for 47.94% of the variation in the original thirty-five variables included in this analysis. The first principal component (PC1) was heavily loaded on temperature condition, humidity, proper lighting, and noise level. The second component (PC2) was loaded heavily on proper man-machine system design, design of workstation and ergonomic design of hand-tools. The third component ((PC3) was loaded on the provision of Organizational Health and Safety (OHS), provision of Environment Health and Safety (EHS) officer on site, and established health and safety policies. Finally, the fourth component (PC4) was loaded on availability and uses PPE, availability of medical facilities and availability, and a good understanding of safety signs. For ease of interpretability, these principal components were termed as "Work-place environmental condition" (PC1), "Ergonomic condition" (PC2), "Safety arrangement and policy" (PC3), and "Provision of safety equipment and facilities" (PC4). However, it should be noted that these do not represent any categories; instead, they show the dominant indicators that define each of the four retained principal components and hence, the four distinct indicators of productivity of RMG industries in Bangladesh.

3.5. Pearson correlation

Table 5 Pearson correlation for all identified principle components with worker productivity

Principle components	Worker productivity	Sig.
PC1 (Work-place environmental condition)	0.874**	0.000
PC2 (Ergonomic condition)	0.794**	0.000
PC3 (Safety arrangement and policy)	0.754**	0.010
PC4 (Provision of safety equipment and facilities)	0.239*	0.030

**. Correlation in significant at the 0.01 level (2-tailed)

Table 5 shows Pearson correlation for all identified components with worker productivity. This analysis indicates that all Principle components- Work-place environmental condition, Ergonomic condition, Safety arrangement and policy, Provision of safety equipment, and facilities has a significant positive correlation with Worker productivity. Among all principle components, Work-place environmental condition has a most positive correlation with worker productivity (0.874**) and then followed by Ergonomic condition (0.794**), Safety arrangement and policy (0.754**) and then Provision of safety equipment and facilities (0.239*) has least correlation with worker productivity.

3.6. Recommendation

Work-place environmental condition (PC1)-composed of four factors, namely temperature condition, humidity, proper lighting, and noise level, is a very crucial factor affecting worker productivity, which is responsible for 21.283% of the variation in the original thirty-five variables included in this analysis. Table 4 also shows that Work-place environmental condition (PC1) has a high and positive significant correlation to worker productivity [r=0.874**]. Clements- (Croome et al., 2000) suggested that worker productivity could be improved by 4 to 10% by improving Work-place environmental conditions.

El-Zeiny, R. M. A. (2012) identified that workplace interior design, Proper man-machine system design, Ergonomic design of hand-tools could make a difference in worker performance, and consequently have a positive impact on the corporations' productivity.

Ashraf A. Shikdar (2003) shows that 54% of companies reported a hot environment, and 28% reported noisy (.85 dBA) conditions, which reduce worker productivity. Chowdhury. S. (2015) recommended that the comfort temperature range for the worker should be 24 -28 degrees Celsius and moderate temperature range should be 28 -32 degrees Celsius where humidity % less than 65 and mean airspeed 0.6 m/s for maximum worker productivity. Above 37 degrees Celsius, heat becomes a definite hazard if it is not maintained the body's required temperature of 37 degrees Celsius(Brooks et al., 1996). Talukdar, M. K. (2001) recommended that the maximum noise level could be 80 dBA for maximum worker productivity.

Ergonomic condition (PC2)-composed of three factors, namely Proper man-machine system design, Design of workstation, and Ergonomic design of hand-tools, is a second crucial factor affecting on worker productivity which is responsible for 10.084 % of the variation in the original thirty-five variables included in this analysis. Table 5 also shows that Ergonomic condition (PC2) has positively significant correlation to worker productivity [r=0.794**]. Jan Dula, R.B., and oth M ers, (2012) showed that whenever proper ergonomic condition does not play a role in system design, it could be lead to sub-optimal systems with quality deficits, reduced efficiency, illness, dissatisfaction, etc. whenever ergonomics can provide solutions to these problems.

Safety arrangement and policy (PC3)-composed of three factors namely Provision of Organizational Health and Safety (OHS), Provision of Environment Health and Safety (EHS) officer on site and Established health and safety policies is third crucial factor affecting on worker productivity which is responsible for 8.668 % of the variation in the original thirty-five variables included in this analysis. Table 4 also shows that Safety arrangement and policy (PC3) have a positive significant correlation to worker productivity [r=0.754**]. Mudavanhu et al., (2014) concluded that Provision of Organizational Health and Safety (OHS), Provision of Environment Health and Safety (EHS) officer on site has a significant effect on worker productivity. They also concluded that established health and safety policies might improve productivity, quality, and minimize production costs. Besides, policymakers should develop a cost-effective, simple, and easy to use regulatory OSH and EHS framework for managers to implement . Ahmed et al., 2019 also said that safety arrangement and policy has a significant influence on worker performance.

Finally Provision of safety equipment and facilities (PC4)-composed of three factors namely Availability and uses PPE, Availability of medical facilities and Availability and good understanding of safety sign is fourth and least significant factor affecting on worker productivity which is responsible for 7.908 % of the variation in the original thirty-five variables included in this analysis and it has positively significant correlation to the worker productivity [r=0.693**]. Saha et al., (2015) and Ahmed et al., (2019) identified that provision of different safety equipment and facilities has a significant influence on worker productivity in RMG sector. Increasing the provision of safety equipment and facilities improves worker performance.

4. Conclusion

The Ready-Made Garments (RMG) industry is the only multi-billion-dollar manufacturing and export earning industry in Bangladesh. In order to improve productivity, we identified the factors that have a significant impact on the productivity of the RMG industry in Bangladesh. According to Relative importance index (RII) lighting, humidity, Proper man-machine system design, temperature condition, noise level are the top five factors that mostly affected the productivity of the RMG industry in Bangladesh. Besides, principal components analysis reveals four critical factors, namely Work-place environmental condition, Ergonomic condition, Safety arrangement and policy, and Provision of safety equipment and facilities. Further, a correlation among principle components and worker productivity depicts that Work-place environmental condition has a highly positive significant effect on worker productivity in the RMG sector in Bangladesh.

4.1. Limitations of the research

- In this study, only three evaluation criteria and 30 productivity determinant factors were considered for evaluation.
- Feedbacks were collected from visiting 18 garments. It might not reveal the real picture of the whole RMG sector scenario of Bangladesh.
- The quantitative relationships among the factors and the productivity were not determined.
- The limitations can provide a new way for future research.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] Ahmad, S., Iqbal, M., Rashid, M. M., Iqbal, S. A., & Roomi, m. Productivity improvement focusing on investigation of injuries, accidents and hazards occurred in a garments manufacturing organization.

[2] Ahmed, J. U., & Hossain, T. (2009). Industrial safety in the readymade garment sector: A developing country perspective. Sri Lankan Journal of Management, 14(1), 1-13.

[3] Ahmed, S. M., Karmaker, C. L., & Ahmed, M. (2019). Assessment of safety, health and environmental risk factors in garments industries of Bangladesh. *Journal of Applied Research on Industrial Engineering*, *6*(3), 161-176.

[4] Ahmed, S. M., Karmaker, C. L., & Ahmed, M. (2019). Assessment of safety, health and environmental risk factors in garments industries of Bangladesh. *Journal of Applied Research on Industrial Engineering*, *6*(3), 161-176.

[5] Alam, M. N., & Alias, R. The mediating role of employee work motivation in the relationship between social compliance and employee productivity: A conceptual framework.

[6] Alam, M. N., Alias, R. B., & Azim, M. T. (2018). Social Compliance Factors (SCF) Affecting Employee Productivity (EP): An Empirical Study on RMG Industry in Bangladesh. *Pacific Business Review International*, *10*(8), 87-96.

[7] Alam, M. N., Alias, R. B., & Azim, M. T. (2018). Social Compliance Factors (SCF) Affecting Employee Productivity (EP): An Empirical Study on RMG Industry in Bangladesh. Pacific Business Review International, 10(8), 87-96.

[8] Al-Dabbagh, M. A., Al Daadi, S., El Nahari, G., & El Thagfi, W. Raising Productive Efficiency in Industrial Firms (Solutions & Suggestions for Clothes Industry).

[9] Al-Saleh, H.1995. Improving construction productivity in Saudia Arabia. The 4th Saudi Engineering Conference, November 1995, Saudi Arabia.

[10] Ayoub, M. A. (1990b). Ergonomic deficiencies. II. Probable causes. Journal of Occupational Medicine, 32(2), 131–136

[11] B Antoncic, RD Hisrich(2004), Corporate entrepreneurship contingencies, and organizational wealth creation. Journal of management development 23 (6):518-550.

[12] Birnbaum, D., & Somers, M. (2023). Past as prologue: Taylorism, the new scientific management and managing human capital. International journal of organizational analysis, 31(6), 2610-2622.

[13] Brooks, G. A., Fahey, T. D., & White, T. P. (1996). *Exercise physiology: Human bioenergetics and its applications* (No. Ed. 2). Mayfield publishing company.

[14] Dabirian, S., Moussazadeh, M., Khanzadi, M., & Abbaspour, S. (2023). Predicting the effects of congestion on labour productivity in construction projects using agent-based modelling. International Journal of Construction Management, 23(4), 606-618.

[15] Diewert, W.E (1992). The measurement of productivity, Bulletin of Economic Research,44(3):163-198

[16] Dul, J., Bruder, R., Buckle, P., Carayon, P., Falzon, P., Marras, W. S., ... & van der Doelen, B. (2012). A strategy for human factors/ergonomics: developing the discipline and profession. *Ergonomics*, *55*(4), 377-395

[17] El-Tahan, A., & El-Nasr, H. A. The influence of ergonomics parameters on ready-made garments industry an analytical research.

[18] El-Tahan, A., & El-Nasr, H. A. The influence of ergonomics parameters on ready-made garments industry an analytical research.

[19] El-Zeiny, R. M. A. (2012). The interior design of workplace and its impact on employees' performance: A case study of the private sector corporations in Egypt. *Procedia-Social and Behavioral Sciences*, *35*, 746-756.

[20] Fahim, I., Kalwar, S., & Fatima, S. (2023). The Impact of Workplace Design on the Productivity of Employees in Architectural Firms. Journal of Educational Research and Social Sciences Review (JERSSR), 3(1), 189-205.

[21] Generalis, G., & Mylonakis, J. (2007). Productivity and ergonomics: a strong relationship leading to best working results. Eur J Soc Sci, 5(1), 54-60.

[22] Grimani, A., Aboagye, E., & Kwak, L. (2019). The effectiveness of workplace nutrition and physical activity interventions in improving productivity, work performance and workability: a systematic review. BMC public health, 19, 1-12.

[23] Hameed, T., Bashir, E. A., Khan, A. Q., & Ahmad, M. (2021). Safety culture implications on safe work practices and work place exposure incidents in Operation Theater. Pakistan Journal of Medical Sciences, 37(2), 379.

[24] Hossain, Latifee, Md. Sajib, Enamul Hafiz (6 August 2017). "Ready-made garment industries are going green." The Financial Express. International Publications Limited.

[25] Imran Bin Hussain, M. (2018). Impact of thermal environment on occupational health at readymade garments buildings in Bangladesh.

[26] Jafari, S., & Singh, S. (2017). Designing a ready-made garment factory with ideal lighting. NIFT-Mumbai.

[27] Joarder, M. H., & Sultana, M. Hazards and Labor Productivity: A Conceptual Model from the Context of Garments Industries in Bangladesh. In MESSAGE FROM THE CONFERENCE CHAIRS (p. 555).

[28] Kaminski, M. (2001). Unintended consequences: organizational practices and their impact on workplace safety and productivity. Journal of occupational health psychology, 6(2), 127.

[29] Karakolis, T., & Callaghan, J. P. (2014). The impact of sit–stand office workstations on worker discomfort and productivity: a review. Applied ergonomics, 45(3), 799-806.

[30] Khan, M. S. I., Paul, S., & Sushil, S. (2020). Implementation of TQM Pillars in A Manufacturing Factory: An Empirical Case Study. *Journal of Management Info*, *7*(2), 119-134.

[31] Khan, S. I., Khan, J. B., Paul, S., & Prince, I. Feasibility of Green Manufacturing in Corporate Sustainability. vol, 6, 1-5.

[32] Laoha, C., Intanon, N., Saengkaw, A., & Kurakanok, O. (2021). The Design and Construction of a Machine to Improve Production Productivity. Turkish Online Journal of Qualitative Inquiry, 12(6).

[33] Larson, M. (1998). Worklife quality: Ergonomic workstations boost productivity. Quality, 37(3), 44.

[34] Le, D., Li, Y., & Ren, F. (2022). Does air quality improvement promote enterprise productivity increase? Based on the spatial spillover effect of 242 cities in China. Frontiers in Public Health, 10, 1050971.

[35] Leitão, J., Pereira, D., & Gonçalves, Â. (2019). Quality of work life and organizational performance: Workers' feelings of contributing, or not, to the organization's productivity. International journal of environmental research and public health, 16(20), 3803.

[36] Li, X., Chow, K. H., Zhu, Y., & Lin, Y. (2016). Evaluating the impacts of high-temperature outdoor working environments on construction labor productivity in China: A case study of rebar workers. *Building and environment*, *95*, 42-52.

[37] Li, X., Chow, K. H., Zhu, Y., & Lin, Y. (2016). Evaluating the impacts of high-temperature outdoor working environments on construction labor productivity in China: A case study of rebar workers. Building and environment, 95, 42-52.

[38] Mendis, M. V. S. (2016). Workplace design and job performance: A study of operational level employees in the apparel industry of sri lanka. *International Journal of Scientific and Research Publications*, *6*(12), 148-153.

[39] Mudavanhu, N., Zhou, T., & Dzomba, P. (2014). An assessment of small and medium enterprise owners' occupational safety and health efforts: the case of Southerton, Harare, Zimbabwe. *Journal of Scientific Research and Reports*, 407-418.

[40] Oxenburgh, M., Marlow, P. S., & Oxenburgh, A. (2004). Increasing productivity and profit through health and safety: The financial returns from a safe working environment. CRC Press.

[41] Padmini, D., & Venmathi, A. (2012). Unsafe work environment in garment industries, Tirupur, India. J Environ Res Dev, 7, 569-575.

[42] Paul, S., Khan, M. M. A., Khan, M. S. I., & Rahman, Q. (2023).Attributes of safety culture discrepancy among various workgroup in manufacturing industry: an empirical case study.

[43] Paul, S., Mia, T., Kamal, S. N., & Saha, S. Analysis of Overall Equipment Effectiveness in the Sewing Section of Garments Factory: A Case-Study.

[44] Qian, G., Duanmu, C., Ali, N., Khan, A., Malik, S., Yang, Y., & Bilal, M. (2021). Hazardous wastes, adverse impacts, and management strategies: a way forward to environmental sustainability. Environment, Development and Sustainability, 1-26.

[45] Rahman, M. M., & Ehasan, M. A. (2017). Public Opinion towards the Worker Dissatisfaction in Ready-Made Garment (RMG) Industry of Bangladesh. Global Journal of Management And Business Research.

[46] Rahmi, T. E., Wibowo, S. I. G. I. T., & Mukti, M. A. (2019). The effect of physical work environment, work safety, occupational health and work discipline on employee productivity. Journal of Research in Management, 1(4).

[47] Saha, P., & Mazumder, S. (2015). Impact of working environment on less productivity in RMG industries: A study on Bangladesh RMG sector. *Global Journal of Management And Business Research*.

[48] Samaddar, K. K. (2016). Occupational Health and Safety Management in RMG Sector of Bangladesh. International journal of scientific & technology research, 5(12), 176-193.

[49] Samaddar, K. K. (2016). Occupational Health and Safety Management in RMG Sector of Bangladesh. International journal of scientific & technology research, 5(12), 176-193.

[50] Samaranayake, S. U., & De Silva, S. (2013). Effect of green workplace environment on employee performance.

[51] Sarode, A. P., & Shirsath, M. (2012). The factors affecting employee work environment & it's a relation with employee productivity. *International Journal of Science and Research (IJSR)*.

[52] Sharif, P. A., Islam, M. E., & Kabir, R. A. (2015). A Study on Occupational Health & Safety Practices in RMG Factories of Bangladesh in Accordance with Compliance after Rana Plaza Incident. The International Journal of Business & Management, 3(5), 214.

[53] Shikdar, A. A., & Sawaqed, N. M. (2003). Worker productivity, and occupational health and safety issues in selected industries. Computers & industrial engineering, 45(4), 563-572.

[54] Shikdar, A., Carlopio, J., Cross, J., Stanley, P., & Gardner, D. (1993). Mechanical equipment injuries in small businesses. Ergonomics in a Changing World. Proceedings of the Ergonomics Association of Australia, Australia: Perth, 199-205

[55] Sikhdar, M. H., Sarkar, S. K., & Sadeka, S. (2014). Socio-economic conditions of the female garment workers in the capital city of Bangladesh.

[56] Somanathan, E., Somanathan, R., Sudarshan, A., & Tewari, M. (2015). The impact of temperature on productivity and labor supply: Evidence from Indian manufacturing. Indian Statistical Institute: New Delhi, India.

[57] Sommer, M., Chandraratna, S., Cavill, S., Mahon, T., & Phillips-Howard, P. (2016). Managing menstruation in the workplace: an overlooked issue in low-and middle-income countries. International journal for equity in health, 15(1), 86.

[58] Tabachnick, B. G., & Fidell, L. S. (1996). SPSS for Windows workbook to accompany large sample examples of using multivariate statistics. HarperCollins College Publishers.

[59] Taiwo, A. S. (2010). The influence of the work environment on workers productivity: A case of selected oil and gas industry in Lagos, Nigeria. *African Journal of Business Management*, *4*(3), 299-307.

[60] Talukdar, M. K. (2001). Noise pollution and its control in textile industry.

[61] Taylor, F.W.(1998). The principles of scientific management. Mineola, New York: Dover.

[62] Teerajetgul, W., Chareonngam, C., & Wethyavivorn, P. (2009). Key knowledge factors in Thai construction practice. *International Journal of project management*, *27*(8), 833-839.

[63] Uddin, A. J. (2015). Impact of the Low Wages on the Health and Nutritional Status of RMG Workers in Bangladesh. Journal of Business, 36(2).

[64] Vandyck, E., & Fianu, D. A. (2012). The work practices and ergonomic problems experienced by garment workers in Ghana. International Journal of Consumer Studies, 36(4), 486-491.

[65] Vaughn, T. E., McCoy, K. D., Beekmann, S. E., Woolson, R. F., Torner, J. C., & Doebbeling, B. N. (2004). Factors promoting consistent adherence to safe needle precautions among hospital workers. Infection Control & Hospital Epidemiology, 25(7), 548-555.

[66] Zaman, F. (2019, November). Identifying the Importance of Workplace Health and Safety Training in Bangladesh. In ECMLG 2019 15th European Conference on Management, Leadership and Governance (p. 409). Academic Conferences and publishing limited.

[67] Zaman, K. U. A. B., Arifuzzaman, M., & Trina, N. A. Working Environment Strategies and Policies to Increase the Working Efficiency of RMG Workers of Bangladesh.