The Effect of IEQ Factors on Efficiency of Green Building: A Case of Sri Lankan Apparel Industry

Rupasinghe OHSN[1]
Deegahawathure MMDR[2]

ABSTRACT

This research investigates whether the effect of Indoor Environment Quality (IEQ) on factory efficiency is higher in the green buildings than the non-green buildings in the apparel industry. Since green building involves higher investment, they need higher return on investments. Factory efficiency is a key performance indicator which can be used to measure the success of the factory. Hence it is important to find out the contribution of IEQ factors to the factory efficiency. A green building and two non-green buildings were selected and five factors noise, dust, illumination, relative humidity and temperature were used to measure IEQ. Illumination and dust level directly affect the efficiency in green building, whereas temperature and noise level directly affect the efficiency in non-green buildings. These preliminary findings indicate that the relationship between factory efficiency and the IEQ factors is strong in green building than the non- green buildings.

KEY WORDS: Factory Efficiency, Green building, IEQ

INTRODUCTION

Establishment of green buildings has become a trend in business world though it is not popular in Sri Lankan context. However, there are few companies which got the initiatives and set up factory green buildings in Sri Lankan apparel industry. Though green buildings positively effect sustainability by lowering operating cost, reducing resource consumption and wastages, create a healthier working and living environment etc. (Wedding & Brown, 2007) business organizations may concern on its impact on efficiency which directly relates to business performance. Also, higher investment involved in green buildings demands favorable return on investment.

Thus, the impact of green building on efficiency may stimulate its use by business organizations. Yet, this effect is less researched.

Therefore, the relationship between green buildings and efficiency is attempted to explore. Particularly, the concern of this study is on the impact of Indoor Environment Quality (IEQ) on efficiency. IEQ consists of lighting, noise level, dust level, temperature and relative humidity.

LITERETURE REVIEW

Green building concept is focused to design and construct a building with the purpose of providing an opportunity to use resources in a more effective manner (American Chemistry Council, Inc, 2010-2015). Also, they practice to reduce or eliminate the negative impact of their developments on the environment and people (Green Building Council SA, 2007).

Green buildings only use 36% of total energy and 65% of electricity consumption. Also, they emit only 30% of greenhouse to the environment. 30% of wastage (136 million tons annually) throws away from the green houses while using 30% of raw materials. In addition to that they only consume 12% of portable water. Furthermore, occupants of green buildings enjoy healthier indoor environments and higher productivity levels (Sauve, 2012).

[1]Graduate, Department of Industrial Management, Faculty of Applied Sciences, Wayamba University of Sri Lanka.

[2]Senior Lecturer, Department of Industrial Management, Faculty of Applied Sciences, Wayamba University of Sri Lanka.

Efficiency is the comparison of what is actually produced or performed with what can be achieved with the same consumption of resources. In the apparel industry, skills and expertise of a sewing operator is introduced as "Efficiency" term. When operators work with higher efficiency, they produce more garments and manufacturing cost of the factory goes down. Not only operator efficiency, but also efficiency of a production line is important for a factory.

$$Line\ Efficiency = \frac{Total\ Minutes\ Producted\ by\ the\ Line * 100}{Total\ Minutes\ Attended\ by\ all\ Operators}$$

Equation 1: Line Efficiency

(Sarkar, 2011)

Kroll (2010) surveyed two groups of employees who had moved from conventional office buildings to LEED-certified buildings. They have found out that stress and depression is decreased by 20.21% and declined the healthy problems. Studies (Controls, 2011) show that better light and more natural light can improve office worker productivity, improve health and well-being in medical facilities.

The study, Green Buildings Driving Employee Productivity (LaSalle, 2011), has identified two links between how they might be measured and how companies can benefit from this understanding to make commercial business decisions. Similarly, it recognizes that the organizations are coming to the realization that the significant cost benefit of focusing on improvements to employee productivity can be achieved through a workplace resource policy linked to occupation of green buildings. Furthermore, the study (Building Green.Com, 2014) with data from 65 LEED-certified buildings but only those certified under LEED v2.2 or earlier concludes that workers in LEED buildings are no more satisfied with indoor environmental quality than those in non-LEED buildings.

Thus, in this research an attempt is made to identify whether the green building affects the factory efficiency than non-green building in Sri Lankan apparel industry.

METHODOLOGY

The research was designed to identify whether the green factories have higher impact on efficiency over non-green factories. Thus, a comparison between the green and non-green factories was designed.

After identifying the factors which are going with the green concept, data from one green building and two non-green buildings was collected. The study used secondary data. Monthly data for the selected factors for two years were collected. Furthermore, multiple linear regression analysis was carried out for this data.

DATA ANALYSIS AND RESULTS

Table 1: Analysis of Multiple Regression of Green Factory

R^2 Value		.516		
P Value		.015		
Model	Unstandardized coefficient B	Sig.	Collinearity Statistics	
			Tolerance	VIF
(Constant)	5.391	.896		
Noise (dBA)	.441	.263	.915	1.093
Illumination (Lux)	-.007	.029	.867	1.154
Dust (mg/m^3)	78.065	.038	.932	1.074
Relative Humidity (%)	-.145	.546	.935	1.070
Temperature (°C)	1.105	.175	.797	1.255

Since the P value is 0.015 which is less than 0.05, it can be concluded that the model is significant. Thus, there is a model

at 95% significance level which explains 51.6% of variability in green plant efficiency.

Similarly, when considering about the coefficients of the model, only illumination and dust variables have the significant values. It means that only those variables directly affected to the efficiency of green buildings.

Thus, the illumination level is negatively affected to the factory efficiency and if the illumination is increased by 1 unit of Lux level then the efficiency is decreased by 0.007 units. If the dust level is increased by 1 mg/m^3, then the efficiency is increased by 78.065 units, it affected to the factory efficiency positively. Tolerance and VIF values describe that there is no multicollinearity among the independent variables.

Table 2: Analysis of Multiple Regression of Non-Green Factory

R^2 Value		.380		
P Value		.001		
Model	Unstandardized coefficient B	Sig	Collinearity Statistics	
			Tolerance	VIF
(Constant)	244.261	.000		
Noise (dBA)	-2.722	.000	.841	1.189
Illumination (Lux)	-.003	.447	.881	1.135
Dust (mg/m^3)	9.422	.394	.641	1.561
Relative Humidity (%)	-.183	.103	.882	1.133
Temperature (^{0}C)	1.628	.011	.723	1.382

Since the P value is 0.001 which is less than 0.05, it can be concluded that the model is significant. It means that there is a model at 95% significance level which describes 38 % of variability in non-green plant efficiency.

According to the significance of coefficients, noise and temperature are the significant variables which directly affect to the factory efficiency in non-green buildings. Noise is negatively affected to the efficiency but the temperature level is positively affected.

If one unit of noise is increased then the efficiency is reduced by 2.722 units. And also, if the temperature increases by one unit then the efficiency will increase by 1.628 units. Multicollinearity among the independent variables is less in this model.

DISCUSSION

Table 3: Summary of the Regressions

Plant	R^2 Value	Significance Variables	
Green	.516	-Illumination	+Dust
Non-green	.380	-Noise	+Temperature

According to the Table 3, green factory has the highest R^2 value that is 51.6%. It means, efficiency in the green plant is described by the other independent variables less than that of non-green factory. It means that indoor environment quality of green building helps to increase the factory efficiency.

Illumination level directly affects to the efficiency in green buildings. The illumination level at the work place should be within 600-800 lux. Also, illumination level and production defects have negative linear correlations (Hossain, 2012). And also, glare from a direct light source or reflected off equipment or shiny surfaces can cause discomfort, eye strain and fatigue which cause reduction in quality and productivity. Thus in this research it was found that when illumination increases, then the efficiency is decreased.

There are some limitations in this analysis. Though some variables are significant for this model, the relationship makes some doubts regarding the model. For example, when dust level increases, the

efficiency is also increased in green building. But dust is harmful for the health and affect to the operators' productivity, thus cause to factory efficiency. Furthermore, high or lower temperature affect to the operators. But according to the analysis, when temperature increases, the efficiency is also increased. These kinds of issues arise from this research.

CONCLUSION

Followings are the conclusions of this study.

- It is identified that among the IEQ factors, dust and illumination level affect to the factory efficiency in green plant.
- In non-green factories, temperature and noise level affect to the factory efficiency.
- Finally, it can be concluded that the relationship between efficiency and IEQ factors is better in green buildings than the non- green buildings in Sri Lankan Apparel industry. Moreover, green buildings has better indoor environment quality and therefore they can increase the factory efficiency.

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