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Business Case: Illumination Quality

Support to Safety Retrofits and Environmental Upgrades in the Bangladeshi Ready-Made Garment (RMG) Sector

Enhancing the Illumination Quality and Intensity is a Good Investment

In the textile industries as well as all other industries lighting is an essential factor for achieving quality performance. To provide adequate lighting, textile factories usually require 3 to 4% of the total power consumed. Therefore, the implementation of energy efficient lighting solutions offers significant saving potentials[1,2]. Providing workers with sufficient light to perform the required visual tasks not only maximises the accuracy speed and production, but also reduces material wastage and time consumed.[3]

Besides savings through energy efficiency, and enhanced work performance, lighting can also improve the job satisfaction and reduces loss and compensation payments due to accidents in the industry.

Advantages of improved illumination at a glance:

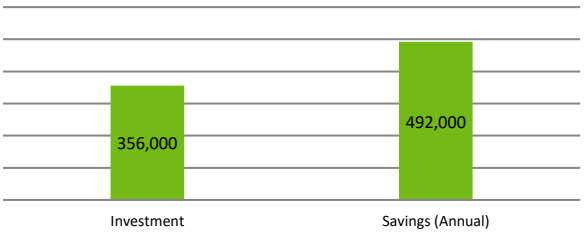
- Increased productivity
- Enhanced product quality
- Reduced accidents, including a reduction in compensation costs
- Protecting health, eyes and nervous system of workers
- Improved safety and security
- Reduced workers fatigue
- Improved satisfaction and morale of employees

Although lighting is one of the most important influencing factors on human performance in a working environment, the investment needed for its improvement is minimal. This is mostly because lighting improvement does not necessarily require the installation of more lights which would result in an increased demand for electricity. In many cases the illumination quality can already be improved by[4]:

- Making better use of existing lights
- Replacing old lights with new energy efficient lights
- Making sure that all lights are clean and in good condition
- Ensuring that lights are positioned correctly for each task
- Making the best use of natural light
- Using pale colour instead of shiny, glossy paint to avoid harmful glare

Given the low cost of improving the lighting conditions and the high benefits from energy savings, increased productivity and the reduced rate of errors, expected direct in indirect benefits outweigh the estimated costs of the investment. The average payback period of such investments is between6and12months[5].

Investment Cost and Annual Benefits (BDT)



Case study result from Bottom Gallery Pvt Ltd

Detailed information about the cost and benefits of improved lighting conditions can be found on the next page, followed by data from a case study example on page 3. Technical details on the installation and implementation process as well as legal requirements and possible means of financing can be found on pages 4 to 5.

[1]Devan and Uttam (2015). Lighting in the textile industry. International Journal of Advanced Research Engineering and Applied Sciences, Vol. 4, No. 2

[2] Hasan beige, Ali (2010). Energy-Efficiency Improvement Opportunities for the Textile Industry

[3]Mahatab Hossain & Khandaker Shabbir Ahmed (2012). Illumination Condition and Work Efficiency in the Tropics: Study on production spaces of Ready-made garments factories in Dhaka

[4]ILO (n.d.). Physical Hazards Indoor Workplace Lighting.

[5]Case Study: Bottom Gallery Pvt Ltd

Improved Illumination Equals Higher Productivity and Lower Costs

Beyond the financial gains that may be achieved through improved lighting efficiency, there are broader business benefits available from improved illumination quality and intensity.

Benefits

Financial gains through improved energy efficiency	Lighting typically accounts for around 3% of the total energy used in a spinning plant, or about 4% of the total electricity use in a composite textile plant (plant with spinning, weaving, and wet processing). Improving the energy efficiency of lighting will therefore lead to significant savings in electricity costs. A list of selected measures for energy efficient lighting can be found on page 5.
Improved product quality/ reduced error rate	Improved levels of workplace illumination lead to significantly reduced error rates. A study on the influence of illumination conditions in production spaces of ready-made garments factories in Dhaka shows that error rates can be reduced by approximately 5% to 10%[6].
Longer life expectancy and reduced maintenance costs	Regular light globes and Quartz Halogen lamps have a relatively low life expectancy (1000h – 3000h). Replacing them with fluorescent tube lights, compact fluorescent lights (6000h – 8000h) or LEDs (>20000h) can significantly reduce maintenance cost for the factory lighting.[7]
Improved colour rendering	Objects can appear different colours under different lights. Particularly products in the textile and sewing industry require accurate colour rendering, making the selection of the right light source an important consideration.

Indirect Benefits

Improved Productivity	The ability of the human eye to manipulate objects efficiently is influenced by illumination levels. High-efficiency lighting may allow businesses such as those that rely on manual handling to increase the level of illumination without financial impact. The ILO Manual "Improving Working Conditions and Productivity in the Garment Industry" indicates that improved lighting in factories resulted in a 10% increase in productivity and a 30% reduction in errors[8, 9].
Reduced risks of fatalities and injuries to staff/workers on-site	Proper lighting levels can make possible hazards more easily visible. This will reduce the probability of people getting injured resulting in lower risk of payment of compensations and medical costs. Furthermore, issues such as eyestrain can be addressed.

[6] Mahatab Hossain & Khandaker Shabbir Ahmed (2012). Illumination Condition and Work Efficiency in the Tropics: Study on production spaces of Ready-made garments factories in Dhaka

[7] Sustainability Victoria (2009). Energy Efficiency Best Practice Guide Lighting

[8] Ebd.

[9] ILO (1998). Improving working conditions and productivity in the garment industry

Calculating the Cost of Improved Illumination

The cost of improving the illumination quality within a factory depends on several factors, such as the required illumination level of each area or the ready availability of daylight. A factory case study from Bangladesh shows that retrofitting T-8 light tubes with LEDs in a factory with 6,700 m^2 and 1800 employees require an investment of approximately BDT 3.56 lakh[10].

Possible investments for improved illumination quality:

Type of Investment	Average Cost per 1 Unit
Skylight prismatic UV cut 8' x 4'	~ 15000 BDT
Normal transparent sheets 6'x 3'	~ 1000BDT
T8-4ft tube light with ballast	400 to 800BDT
LED 12 W	~1000 BDT
Total Costs and net present value	**n. a.**
Estimated payback period	**6 – 12 Month**

[10] Case Study: Bottom Gallery Pvt. Ltd.

Case Study Spotlight: Bottom Gallery Pvt Ltd, Dhaka, Bangladesh

Description of the Factory

Bottom Gallery Pvt Ltd is an export-oriented readymade Garments manufacturer, located in Chandana, Gazipur. Cutting, Sewing, Finishing, QC and packing are the major processes carried out in this factory and the production capacity sums up to about18,000 pieces per day. The Facility spreads over 6,700m^{2}with 1,800 employees working in the company.

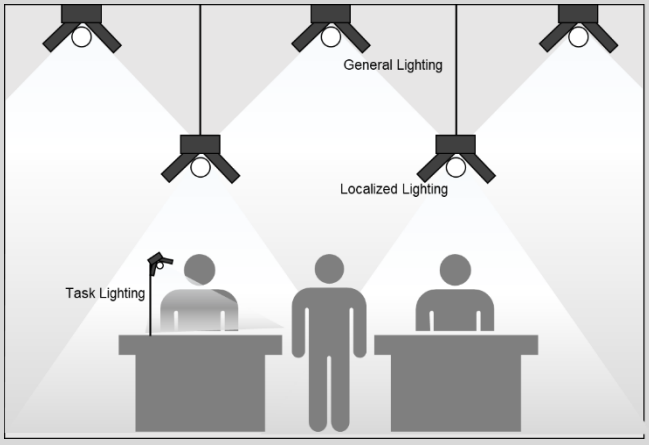
Implemented Measures

Use of proper lighting in workplace is important both for the workers and the manufacturer. Poor lighting at workplace leads to eyestrain, fatigues and accidents, and too much light causes safety and health issues like glare related headaches and stress. But both these scenarios lead to more errors hence more reworks, poor quality and low productivity. Moreover, electric lighting is usually responsible for over one quarter of the energy used in commercial buildings.

Originally Bottom Gallery Pvt Ltd.'s factory floor was illuminated by suspend mounted 4' tube fluorescent lamp (T8) fittings, surface mounted 2' tube fluorescent lamp (T8) fittings and occasionally LED fittings. Altogether Bottom Gallery Pvt Ltd.'s was equipped with 1,326 T8 fittings and 428 LED fittings, which were installed close to the ceiling at 3.6 m above floor level. Due to the magnetic ballasts usually used in T8 tube lights these bulbs consume more energy while also cause uneven lighting.

The total electrical demand for lighting was 70 kW while the average lighting power density was 10.3 W/m^2, providing an average lighting level of only 446 lux.

To make use of more energy efficient technologies available in the market as well as to provide a safe working environment for their employees the management of Bottom Gallery Pvt Ltd. decided to invest in upgrading their lighting systems. To equip the production floor with the best possible illumination quality Bottom Gallery Pvt replaced 655 T8 lamp fittings with 1,047 LED lamps. Simultaneously, the level of the light fitting was brought down by about 1.2 meter, locating the fittings much closer to the workstations.



After the successful implementation the average lighting level in the factory's production floors was improved to 473 lux. At the same time the demand for electricity attributed to the lighting system was reduced to 59 kW while the average lighting power density could be reduced to 8.7 W/m^2.

Investments and Savings

Bottom Gallery Pvt invested BDT 3.56 lakh for replacing T8 lamps with LEDs. The overall energy consumption for the lighting sector was reduced from 5,021 kWh to 5,011 kWh per month, saving a total of BDT 41,000 per month in energy costs. Thus, the payback period was only 9 months. The reduced maintenance costs of LEDs based on their longer lifespan are an additional benefit for the factory

Description	Before	After	Units
Total Area	6,780		m^2
T8 fittings	1326	671	No's
LED fittings	428	1475	No's
Lighting Power	70	59	kW
Light Level	446	473	Lux
Energy Consumption	31,315	26,294	kWh/month

Key Performance Measures

Before exchanging the T8 light tubes for LEDs the specific lighting energy consumption was 0,060kWh/pc, which could be reduced to 0.051 kWh/pc after upgrading the lighting system. This corresponds to energy savings of 0.009 kWH/pc.

However, installing the LED lights instead of the T8 light tubes not only resulted in energy savings, but actually increased the quality of lighting significantly from 445 lux to 473 lux on average.

Using natural and LED improves the overall illumination of the factory floor at Bottom Gallery Pvt. Ltd. Dhaka

Features of Best Practice Illumination

Good illumination practice considers the quality as well as quantity of the lighting. Particularly, in the production area (sewing, cutting, dyeing and finishing operations), where illumination conditions are very important, the total luminous environment usually varies with the type of lighting sources and location of the sources. Poorly designed and maintained lighting can result in glare and flicker that may cause vision problems for the workers. When the lighting meets both quantity and quality needs, it enhances working performance and productivity. Therefore, appropriate illumination condition should be maintained not only for the visual comfort but also for facilitating the meeting of production targets.

Legal and other References in Bangladesh

Although there are no binding legal references for textile/garment process specific illumination levels in Bangladesh yet, international good practice recommends certain levels of illumination at the workplace. The illuminance required for particular task depends on visual requirements of the job, satisfaction of the user, practical experience and cost-effective use of energy**.** The table below gives the recommended luminance range for different areas, tasks and activities[11]:

Area/Task/Process	Recommended Illuminance Level (lux)
General Industries	
Exterior circulating, walkways, stores, main entrances and exit roads, car parking, internal factory roads etc.	20-50
Boiler house, transformer yards, furnace-rooms, entrances, corridors, stairs etc.	70-100
Circulation areas in industry, stores and stock rooms, canteen	100-150
Coarse work	200-300
Medium work	300-500
Fine work	500-1500
Very fine minute and precise work	1500-3000
Cotton Textile Mills	
Bale breaking, washing, Stock dyeing, tinting, Mixing, Blowing	200-300
Carding, drawing, roving	300-500
Spinning, doubling, reeling, winding	300-750
Warping	300-400
Sizing	400-500
Weaving	200-1000
Knitting	300-750
Dyeing	200-450
Calendaring, chemical treatment	300-750
Grey cloth inspection	700-1000
Final inspection	1000-2000

[11] Devan and Uttam (2015). Lighting in the textile industry. International Journal of Advanced Research Engineering and Applied Sciences, Vol. 4, No. 2

Key Steps Required for Implementation

As per experience, lightning installation along with improving the overall illumination quality and intensity within a factory will approximately take 6 months (including planning and design).

To improve the lighting situation within your premises the following steps can help you to decide what measures have to be taken. A lighting professional can assist in this process:

- Determine the purpose the lighting has to fulfil in each area. Typical purposes of lighting include the illumination during work activities such as sewing (task lighting) or the provision of general lighting to a room or space (ambient lighting)
- Determine the operational characteristics the lighting should be able to provide. This includes the ability of the light to accurately render colour or the level of illumination required to properly execute the respective task
- Assess the physical environment, including existing windows, light reflection from the walls or heat sensitivity of the space
- Assess the financial requirements of different illumination options
- Audit the existing lights on your premises. This will include tasks such as mapping the area, showing the type and location of each light in the room. To measure and record illumination levels at key points in each area a calibrated light meter should be used
- Rank available lighting options by taking into account both the necessary requirements and the as-is situation
- Implement preferred options. The implementation of the preferred lighting system requires good planning and management. Large projects may require the involvement of professional engineers and/or contractors
- Assess the effectiveness of the illumination improvement by measuring the lighting levels of the new system with a calibrated light meter and comparing them to those prior to the lighting retrofit. Monitoring lighting levels throughout the year will ensure the ongoing effectiveness of the lighting system
- Maintain and clean the lighting system on a regular base to reduce possible illumination efficiency losses. Cleaning lamps, luminaires, and surfaces can increase light output by 20%, which may avoid the need for a light upgrade

Energy-Efficiency Opportunities

There are several measures which can help you increase the energy efficiency of your lighting system. A list of selected measures is shown below[12]:

Installation of Lighting Controls

The light that uses the least power is the one that is switched off. Automatic control of lighting such as occupancy sensors shut of lighting during non-working hours or whenever space is not occupied. In smaller spaces, automatic sensors can be complemented by manual controls enabling workers to switch of lighting by themselves when it's no longer needed. The payback period for lighting control systems is generally less than 2 years[13].

Replacement of T-12 tubes by T-8 tubes

The textile industry typically uses T-12 tubes which do have a high initial light output but also a very high energy consumption, poor efficiency lamp life, lumen depreciation, and colour rendering index, leading to high energy and maintenance costs. Replacing T-12 lamps with T-8 lamps approximately doubles the efficacy of the former and thereby saves electricity. Studies show that the replacement of approximately 1000 T-12 tube lights with T-8 tubes results in a 114 - 150 MWh/year electricity saving.

Replacement of magnetic ballasts with electronic ballasts

A ballast is a mechanism that regulates the amount of electricity required to start a lighting fixture and maintain a steady output of light. Electronic ballasts save 12 – 25% of electricity use compared to magnetic ballast. Experiences from textile plants in India suggest possible energy savings of 936 kWh/ballast/year with the implementation of this measure. The cost of the retrofit was about BDT 670 per ballast.

Installation of high windows and skylights

Many plants do not use natural sunlight to an optimum level. In addition to optimizing the size of the windows, skylights can be installed at the roof in order to allow more sunlight to penetrate into the production area, reducing the need for lighting during the day. Experiences from Indian factories show that the efficient use of sunlight results in energy savings of 1 – 11.5 MWh/year.

Availability of materials in Bangladesh

All the required materials can be sourced from local suppliers. For specific recommendations, please contact Bottom Gallery Pvt Ltd.

Nature of Services Required to Support the Implementation

- Assessment of the lighting situation within the different sections of the factory. To determine the illumination quality a lux-level assessment is necessary, which can be carried out by trained internal staff or external service providers.
- Installation and maintenance of new lighting solutions can be carried out by internal staff.
- Worker training to create awareness on the importance of illumination, adjust local light sources (to optimise the use of illumination sources and to avoid glare) as well as to report problems and malfunctions.

Sources of technical support/expertise used

For further technical details and guidance regarding illumination quality the following resources can be used:

- Devan and Uttam (2015). Lighting in the textile industry. International Journal of Advanced Research Engineering and Applied Sciences, Vol. 4, No. 2
- Sustainability Victoria (2009). Energy Efficiency Best Practice Guide Lighting
- Hasan beige, Ali (2010). Energy-Efficiency Improvement Opportunities for the Textile Industry
- ILO (1998). Improving working conditions and productivity in the garment industry

Possible Sources for Financing

SREUP credit line could be a good source of financing for such an investment.

Main Feature of SREUP Credit Line	
Loan Type	Normally Term Loan
Discount	Provision and possibility of 10% discount from loaned amount
Loan Tenure	3-5 years in general and in special case up to 7 years
Loan Limit	Normally up to 1 Million Euro and can be increased up to 3 Million Euro in special cases
Interest Rate	7% p.a. (maximum)
Grace period. Debt: Equity Ratio. Repayment	All issues are subject to agreement between borrower and lender

Good illumination enhance better work performance and productivity

[12] From: Hasan beige, Ali (2010). Energy-Efficiency Improvement Opportunities for the Textile Industry

[13] Ebd.

Photos (All): Factory floors of Bottom Gallery Pvt Ltd. Dhaka.

Use of LED light helps to improve the overall illumination of the factory floor