JOURNAL OF MARITIME RESEARCH

Vol XXII. No. II (2025) pp 239–246

ISSN: 1697-4840, www.jmr.unican.es

Cost-benefit Analysis of Replacing Traditional Lights to Light Emitting Diode (LED) Lights for Industrial Fishing Vessels of Bangladesh

Md. Mostahidur Rahman[1], Muhammad Mahdi Marzan[2,*], Md. Reaz Hasan Khondoker[3], Mohammad Mahabbat Ali[4]

ARTICLE INFO

Article history:
Received 04 Oct 2024;
in revised from 11 Oct 2024;
accepted 15 Nov 2024.

Keywords:
Cost-benefit, LED, Industrial Fishing, Bangladesh.

ABSTRACT

Light Emitting Diode (LED) lights require less energy to produce one kilowatt of light than incandescent, halogen, mercury and fluorescent lights, leading to a decrease in fuel consumption and carbon dioxide gas emissions. The study found that LED lighting uses, on average, 40% less energy than fluorescent lighting and 80% less energy than incandescent lighting to provide the same amount of light.

In the present study, the economic and material performance of two Bangladeshi commercial fishing vessels, F.T. Agro Food 2 and F.T. Agro Food 3, were evaluated using light emitting diode (LED) lamps instead of the old lighting system. The results demonstrate that, compared to conventional lighting systems, LED lamps consume less fuel – specifically 16 tonnes less annually for F.T. Agro Food 2 and 18 tonnes less annually for F.T. Agro Food 3. Also, due to their better material specifications, LED lighting systems offer a longer lifespan, a relatively reduced explosion risk i.e. less heat dissipation, and are more eco-friendly. Therefore, this study recommends the prospective decision makers of the fishing vessel industry to recognize the advantages of energy saving technologies, such as LEDs, and implement such measures to enhance energy efficiency.

1. Introduction.

Coastal and marine areas of Bangladesh attract a warm tropical climate, blissful rainfall, and nutrients, which have created some of the richest and most productive ecosystems in the world. In the highest echelons of the Bangladeshi government, the role of marine resources in the development process –specifically in terms of wealth generation and employment– has been adequately recognized. To over a 100 million coastal fishing households, marine fisheries provide a vital source of food.

These households also diversify into other multiplier jobs within supporting industries, such as seafood processing and marketing.

In Bangladesh, a 710-kilometer-long coastal belt runs from the southeasternmost point of Teknaf to the southwestern part of Satkhira (DoF, 2019). The International Tribunal for the Law of the Sea, along with the ruling of the International Court of Arbitration in the historic maritime territorial dispute between Bangladesh, India, and Myanmar, affirmed Bangladesh's sovereign rights to exploit and manage both living and non-living resources of the Bay of Bengal within its Exclusive Economic Zone of 118,813 square kilometers (MoFA, 2014). Of the total 24,500 square kilometers of coastal waters, about 24,000 square kilometers have a water depth of less than 10 meters (DoF, 2019).

[1]Graduate Student, Department of Maritime Science, Maritime University, Bangladesh, Plot#14/06-14/23, Pallabi, Mirpur-12, Dhaka-1216, Bangladesh, E-mail Address: mostahid1625@gmail.com.

[2]Student, Sunnydale School, Plot # 19A, Road # 13, Block G, Bashundhara, Dhaka-1229, Bangladesh, E-mail Address: mahdimarzan16@outlook.com.

[3]Adjunct Faculty, Maritime University, Bangladesh, Plot#14/06-14/23, Pallabi, Mirpur-12, Dhaka-1216, Bangladesh, E-mail Address: mr9hasan@gmail.com.

[4]Dean, Faculty of Shipping Administration, Maritime University, Bangladesh, Plot#14/06-14/23, Pallabi, Mirpur-12, Dhaka-1216, Bangladesh, E-mail Address: dean.fsa@bsmrmu.edu.bd.

[*]Corresponding author: Muhammad Mahdi Marzan. E-mail Address: mahdimarzan16@outlook.com.

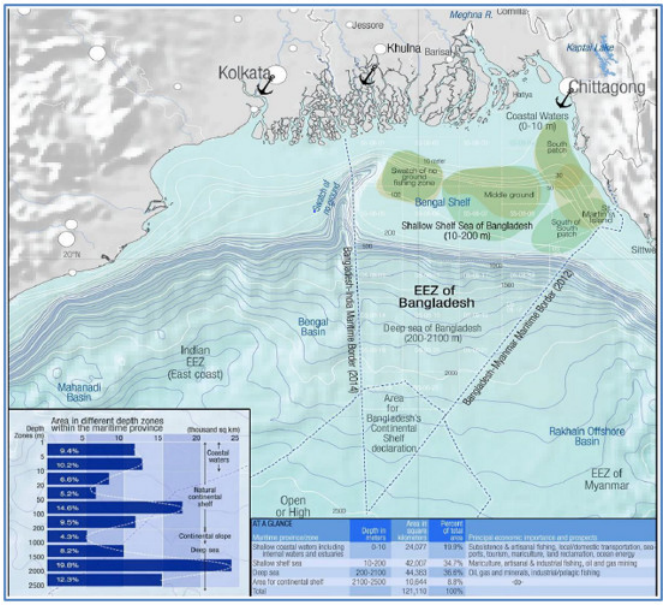
Bangladesh is the fourth-largest producer of fish in the world. The annual fish production in the 2015–16 cycle (DoF) was 0.6 million tonnes, with marine fisheries contributing about 20% to this volume. The fishing industry represents 3.69% of the GDP, while the agricultural sector is higher at 23.12%. Marine fishing also provides employment for 5 million people in Bangladesh.

The World Bank (2008) reports that 41 million people worked full-time or part-time directly in fishing and fish farming, fish processing, and fishery support services worldwide. Another 123 million people were involved in various secondary activities related to the industry (World Bank, 2008). According to the FAO, the fishing sector feeds over 8% of the world's population. Currently, Asia alone hosts about 86% of the fishers and fish farmers globally, while approximately 70% of the engine-powered fishing vessels are in this region (FAO, 2008). In general, employment in fisheries is on an ascending trend in most low- and middle-income countries like Bangladesh. In proportion to the growth of the fishing sector, a higher percentage of job increase is being experienced (FAO, 2008).

Bangladesh's maritime capture fisheries are complex and multispecies in nature. Despite a significant marine and brackish water region falling within the Exclusive Economic Zone (EEZ), this sector contributes only 15.31% of Bangladesh's total fish production (DoF, 2019). Figure 1 illustrates the coastal and marine fishing zones of Bangladesh.

There are two sub-sectors within Bangladesh's marine fishing industry: industrial and artisanal. The fishing fleet off Bangladesh consists of 67,669 mechanized and non-mechanized vessels and 232 industrial trawlers (DoF, 2024).

Figure 1: Fishing zones in the coastal and marine area of Bangladesh.



Source: Chowdhury, 2014.

In Bangladesh's Exclusive Economic Zone (EEZ), the two different types of industrial trawlers used for fishing are freezer trawlers and iced (wooden body) trawlers. Fish and prawn trawlers are the two different types of freezer trawlers, while demersal and mid-water trawlers are the two different types of wooden body trawlers. For the preservation of the collected fish, nearly all steel hull and wooden body trawlers have freezing capabilities. Table 1 represents the number of fishing vessels operating in the Bay of Bengal by gear type and size.

Table 1: Number of fishing vessels operating in the Bay of Bengal by gear type and size.

Type of Fishing Vessel	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
Shrimp Trawler	37	37	30	37	34	33
Demersal Trawler & Mid water trawler	216	218	190	184	202	199
Total	**253**	**255**	**220**	**221**	**236**	**232**
Mechanized boat (MB)	32859	32859	32859	32859	32859	32859
Non-Mechanized boat (NMB)	34810	34810	34810	34810	34810	34810
Total	**67669**	**67669**	**67669**	**67669**	**67669**	**67669**
Gill net	115028	119958	37190	37190	37190	37190
Set Bag net (SBN)	40824	40824	20750	20750	20750	20750
Long line	11863	11863	3225	3225	3225	3225
Trammel net	422	422	131	131	131	131
Other gear	15640	15640	6373	6373	6373	6373
Total	**183777**	**188707**	**67669**	**67669**	**67669**	**67669**

Source: DoF, 2019 and DoF, 2024.

The size of the industrial fishing fleet ranges from 251 to 668 metric tons for steel-hull trawlers and from 56 to 148 metric tons for wooden body trawlers. Wooden-hulled trawlers typically measure between 18.5 and 26.5 meters in length, while steel-hull trawlers range from 34 to 54 meters in length. The engines typically have a power output of 450 to 1,850 brake horsepower; for wooden-hulled trawlers, this can range from 420 to 600 brake horsepower, while for steel-hull trawlers, it ranges from 700 to 1,850 brake horsepower. The main catch for these industrial trawlers includes demersal fish and prawns, although some trawlers are now targeting pelagic species. Most mid-water trawlers use high-opening bottom trawls from the back of the boat, with a mesh size of 60 millimeters.

The head-rope length of the fish trawler fleet ranges from 18 to 32 meters. Almost all fishing vessels are outfitted with cutting-edge communication, navigation, and fish-finding technology. By regulation, trawl fishing is not permitted beyond the 40-meter depth contour. A typical voyage for steel-hulled ships lasts 30 days, compared to 14 days for smaller wooden trawlers. They often finish 5–6 hauls per day, with each haul requiring 3–3.5 hours (Barua et al. 2014). Table 2 shows the industrial fishing fleet of Bangladesh.

At present, most of the industrial fishing vessels of Bangladesh use incandescent, halogen, mercury and fluorescent lights. These lights consume significant amount of energy and therefore contribute to greenhouse gas emissions. In the present study, the economic and material performance of two Bangladeshi commercial fishing vessels, F.T. Agro Food 2 and F.T. Agro Food 3, were evaluated using light emitting diode (LED) lamps instead of the old lighting system.

Table 2: Industrial fishing fleet of Bangladesh.

Vessel type	No.	Gear used	Length Overall meter	Engine Power (BHP)	Hull Type
Shrimp trawler	33	Shrimp trawl	30.00 ~ 43.00	450~750	Steel hull
Demersal fishing trawler	49	Bottom trawl	18.50 ~ 54.00	420~1450	Steel and wooden hull
Mid water fishing trawler	112	Mid water trawl	36.00 ~ 45 .00	1050~1850	Steel hull
On Trial Demersal trawler & Mid water trawler	38	Bottom trawl & Mid water trawl	34.00 ~54.00	700~1850	Steel hull

Source: DoF, 2019; DoF, 2024 and Barua et al. 2014.

2. LED over traditional lamps.

LED lights are more environmentally friendly than traditional lighting systems for several reasons: they are energy-efficient, lead to lower carbon dioxide emissions, and are 100% recyclable. It requires less energy to produce one kilowatt of light by an LED light compared to incandescent, halogen, mercury, and fluorescent lights. The use of LED lights in place of other traditional types also result in lower energy reiquirement to reach target efficiency since LED lights not only match but often exceed the lumen output of conventional lighting. The increased efficiency leads to reduced fuel consumption and lower carbon dioxide emissions. Carbon dioxide is one of the key contributors to greenhouse gas emissions, which cause global warming and adverse climate conditions.

Furthermore, LED lights have a longer lifespan than traditional lighting systems, meaning they need not be replaced frequently since they serve to illuminate for much longer periods than other types. An additional factor in reducing the secondary carbon footprint by the use of LED lights is that companies producing them assert that 100% of the materials used are recyclable. This means that LED bulbs can be recycled rather than disposed of at the end of their useful lives.

All of these underlying features of LED lights have the potential to significantly reduce shipboard energy use and adverse effects on the environment.

Table 3: Principal particulars of the industrial fishing vessels.

Item	F.T. Agro Food 2	F.T.Agro Food 3	Unit
Length Overall	41.00	42.00	[meter]
Breadth	9.00	11.00	[meter]
Depth	4.90	4.70	[meter]
Draft	3.32	4.40	[meter]
DWT	495.3	310	[ton]
Speed	11	10	[kn]
GT	386	560	[ton]
Main engine	1300	1850	[bhp]
Generator	438	438	[kw]

Source: Authors.

3. Particulars of the Fishing Trawlers.

In the present study, a cost benefit analysis of the switch from conventional incandescent lamps, halogen lights, mercury lamps and fluorescent lamps to new generation LED lamps was conducted for two Bangladeshi fishing vessels named F.T. Agro Food 2 and F.T. Agro Food 3. The particulars of the vessels are shown in Table 3.

4. Results and discussions.

TThis study assessed the feasibility of replacing traditional lamps with LEDs to enhance energy efficiency and reduce fuel consumption in the two aforementioned vessels using real data. Information about the different lamps used on board the sample vessels were collected. Based on entries from the engine room's official logbook, a calculation of the total power consumed by the sets of lights at various vessel positions (at the fishing ground, way to the fishing ground, way to the port, and at discharge port), the total cost incurred for vessel illumination, and the potential reduction of power consumption and cost savings through the switch to LEDs have all been completed for each of the relevant vessels.

Calculations for daily, monthly, and annual cost savings were also performed to determine the potential annual fuel savings for switching from conventional lighting to LEDs.

The price of fuel i.e. diesel oil was obtained from the Bangladesh Bunker price (dated August 20, 2023) and used to calculate the cost per unit of power consumption.

Tables 4 and 5 show the cost incurred for vessel illumination and calculation of power consumption for F.T. Agro Food 2.

Table 4: Cost incurred for vessel illumination of F.T. Agro Food 2.

Position	Avg. Gen. Load (KW)	Operating our/Day	KW-Hr/ Day	Avg. Fuel Cons./ Day (Kg)	Cons./KW-Hr (Kg)	Fuel Price/Kg (USD)	Cost/ KW-Hr (USD)	Avg. KW-Hr/Day (For Lighting)	Total Cost/ Day (USD)
At Fishing Ground (While Fishing)	320	24	7680	1700	0.221	0.993	0.21945	168.72	37.02
Way to Fishing Ground	180	24	4320	960	0.222	0.993	0.22044	168.72	37.19
Way to Port	280	24	6720	1500	0.223	0.993	0.22143	168.72	37.36
At Discharge Port	250	24	6000	1340	0.223	0.993	0.22143	234.72	51.9

Source: Authors.

Table 6 displays the cost savings associated with switching to LED lighting for F.T. Agro Food 2. As shown in Table 6, the daily cost savings for illuminating F.T. Agro Food 2 are $31.49 when the vessel is at sea, on its way to sea, or at the discharge port and $43.60 when it is at port.

Table 7 presents the fuel savings and associated cost reductions for F.T. Agro Food 2. As shown in Table 7, switching from traditional lights to LEDs can significantly decrease the vessel's fuel consumption by 11.4 tonnes and 15.81 tonnes annually, resulting in a reduction of 37.5 to 40 tonnes of CO2 emissions while the vessel is either at sea or in port, respectively. It is important to note that the CO2 emission calculations were conducted using the carbon calculator available at https://sustainability.crownoil.co.uk/carbon-calculator/.

Table 5: Calculation of power consumption for F.T. Agro Food 2.

						Lighting Avg. Running Hr /Day		Daily Avg. Power Cons. By Lighting (Kw-Hr/Day)	
Sl. No.	Name of Lamp	Type of Lamp	In Use	Unit Power (W)	Total Power (KW) Of Lighting	At Sea/Way to Sea/Way to Port	At Port	At Sea/Way to Sea/Way to Port	At Port
1	Halogen Projector	Maker's Standard	4	300	1.2	0	12	0	14.4
2	Incandescent Projector	P-571/580	4	400	1.6	0	12	0	19.2
3	Incandescent Projector	P-571/580	4	500	2	0	12	0	24
4	Ballast Resistance	C-810/813	3	400	1.2	0	12	0	14.4
5	Pendant Light	I-123-1	2	60	0.12	24	24	2.88	2.88
6	Fluorescent Lamp	Maker's Standard	2	20	0.04	24	24	0.96	0.96
7	Mast Light	60W	2	60	0.12	24	24	2.88	2.88
8	Side Light	60W	2	60	0.12	24	24	2.88	2.88
9	Stern Light	40W	2	40	0.08	24	24	1.92	1.92
10	Mercury Lamp	P-520/524	10	400	4	12	12	48	48
11	Fluorescent Ceiling Lamp	40W	20	40	0.8	24	24	19.2	19.2
12	Fluorescent Ceiling Lamp	20W	10	20	0.2	24	24	4.8	4.8
13	Steering Light	20W	4	20	0.08	24	24	1.92	1.92
14	Search Light	1000W	1	1000	1	6	0	6	0
15	Pendent Light	100W	10	100	1	24	24	24	24
16	Fluorescent Wall Light	Maker's Standard	15	20	0.3	24	24	7.2	7.2
17	Fluorescent Mirror Light	Maker's Standard	15	20	0.3	24	24	7.2	7.2
18	Incandescent Wall Light	Maker's Standard	15	60	0.9	24	24	21.6	21.6
19	Flame Proof Ceiling Lamp	I-141	12	60	0.72	24	24	17.28	17.28
				Total Power	**15.78**	**Avg. Power Cons./Day(Kw-Hr)**		**168.72**	**234.72**

Source: Authors.

Table 6: Calculation of cost savings for switching over to LED for F.T. Agro Food 2.

Sl. No.	Name of Lamp	In Use	Unit Power (W)	Total Power (W)	For LED (W)	Total LED Power (W)	Group Saving (W)	Lighting Avg. Running Hr /Day		Power Cons. For Lighting (KW-Hr/Day		KW-Hr Savings/Day (For Lighting)		Cost Saving/Day (for Lighting) in USD	
								At Sea /Way to Sea/Way to Port	At Port	At Sea /Way to Sea/Way to Port	At Port	At Sea /Way to Sea/Way to Port	At Port	At Sea /Way to Sea/Way to Port	At Port
1	Halogen Projector	4	300	1200	50	200	1000	0	12	0.00	14.40	0.00	12.00	0.00	2.65
2	Incandescent Projector	4	400	1600	80	320	1280	0	12	0.00	19.20	0.00	15.36	0.00	3.39
3	Incandescent Projector	4	500	2000	100	400	1600	0	12	0.00	24.00	0.00	19.20	0.00	4.24
4	Ballast Resistance	3	400	1200	80	240	960	0	12	0.00	14.40	0.00	11.52	0.00	2.55
5	Pendant Light	2	60	120	7	14	106	24	24	2.88	2.88	2.54	2.54	0.56	0.56
6	Fluorescent Lamp	2	20	40	3	6	34	24	24	0.96	0.96	0.82	0.82	0.18	0.18
7	Mast Light	2	60	120	7	14	106	24	24	2.88	2.88	2.54	2.54	0.56	0.56
8	Side Light	2	60	120	7	14	106	24	24	2.88	2.88	2.54	2.54	0.56	0.56
9	Stern Light	2	40	80	5	10	70	24	24	1.92	1.92	1.68	1.68	0.37	0.37
10	Mercury Lamp	10	400	4000	80	800	3200	12	12	48.00	48.00	38.40	38.40	8.41	8.49
11	Fluorescent Ceiling Lamp	20	40	800	5	100	700	24	24	19.20	19.20	16.80	16.80	3.68	3.71
12	Fluorescent Ceiling Lamp	10	20	200	3	30	170	24	24	4.80	4.80	4.08	4.08	0.89	0.90
13	Steering Light	4	20	80	3	12	68	24	24	1.92	1.92	1.63	1.63	0.36	0.36
14	Search Light	1	1000	1000	280	280	720	6	0	6.00	0.00	4.32	0.00	0.95	0.00
15	Pandent Light	10	100	1000	10	100	900	24	24	24.00	24.00	21.60	21.60	4.73	4.77
16	Fluorescent Wall Light	15	20	300	3	45	255	24	24	7.20	7.20	6.12	6.12	1.34	1.35
17	Fluorescent Mirror Light	15	20	300	3	45	255	24	24	7.20	7.20	6.12	6.12	1.34	1.35
18	Incandescent Wall Light	15	60	900	7	105	795	24	24	21.60	21.60	19.08	19.08	4.18	4.22
19	Flame Proof Ceiling Lamp	12	60	720	7	84	636	24	24	17.28	17.28	15.26	15.26	3.34	3.37
		Total Power		**15780**	**Total Power (LED)**	**2819**	**12961**			**Total Saving**		**143.544**	**197.304**	**31.44**	**43.60**

Source: Authors.

Table 7: Calculation of fuel savings & cost saving of F.T. Agro Food 2.

Position	Daily Cost Saving (USD)	Monthly Cost Saving (USD)	Annual Cost Saving (USD)	Annual Fuel Saving (Tonnes)
At Fishing Ground (While Fishing)	31.44	943.2	11318.4	11.39
Way to Fishing Ground	31.44	943.2	11318.4	11.39
Way to Port	31.44	943.2	11318.4	11.39
At Discharge Port	43.6	1308	15696	15.80

Source: Authors.

Table 8: Comparison of different parameters of LED lamp over incandescent, halogen and CFL lights of F.T. Agro Food 2.

Comparison Parameters	Incandescent Lamp	Halogen	CFL	LED
Watts Used	60W	43W	14W	7W
Projected lifespan	1200 hrs	985-1250 hrs	10000 hrs	25000 hrs
Bulbs needed for 25,000 hours of use	21 pcs	23 pcs	2.5 pcs	1 pc
Average Cost per bulb	1 USD	2 USD	2 USD	5 USD
Equivalent bulb cost for 25,000 hours	21 USD	46 USD	5 USD	5 USD
kWh of electricity used over 25,000 hours	1,500 KWh	1,075 KWh	350 KWh	175 KWh
Cost of electricity (at 0.220 $ per kWh)	330 USD	236.5 USD	77 USD	38.5 USD
Total Cost incurred for 25,000 hours uses	351 USD	282.5 USD	82 USD	43.5 USD
Total cost for 100 bulbs	35,100 USD	28,250 USD	8,200 USD	4,350 USD
Savings by switching from incandescent lamp	0 USD	6,850 USD	26,900 USD	**30,750** USD

Source: Authors.

Table 9: Cost calculation of F.T. Agro Food 3.

Position	Gen. Load (KW)	Operating Hour	KW-Hr	Avg. Fuel Cons./ Day (Kg)	Cons./KW-Hr (Kg)	Fuel Price/Kg (USD)	Cost/KW-Hr (USD)	Avg. KW-Hr/Day (For Lighting)	Total Cost/ Day (USD)
At Fishing Ground (While Fishing)	380	24	9120	2000	0.219	0.993	0.217	256.08	55.764
Way to Fishing Ground	220	24	5280	1200	0.227	0.993	0.225	256.08	57.792
Way to Port	320	24	7680	1700	0.221	0.993	0.219	256.08	56.287
At Discharge Port	300	24	7200	1600	0.222	0.993	0.220	267.6	59.050

Source: Authors.

Table 10: Calculation of cost savings for switching over to LEDs for F.T. Agro Food 3.

Sl. No.	Name of Lamp	In Use	Unit Power (W)	Total Power (W)	For LED (W)	Total LED Power (W)	Group Saving (W)	Lighting Avg. Running Hr /Day		Power Cons. For Lighting (KW-Hr/Day		KW-Hr Savings/Day (For Lighting)		Cost Saving/Day (for Lighting) in USD	
								At Sea /Way to Sea/Way to Port	At Port	At Sea /Way to Sea/Way to Port	At Port	At Sea /Way to Sea/Way to Port	At Port	At Sea /Way to Sea/Way to Port	At Port
1	Incandescent Lamp	12	60	720	7	84	636	0	12	0.00	8.64	0.00	7.63	0.00	1.68
2	Incandescent Projector	4	400	1600	80	320	1280	0	12	0.00	19.20	0.00	15.36	0.00	3.39
3	Incandescent Lamp	4	60	240	7	28	212	0	12	0.00	2.88	0.00	2.54	0.00	0.56
4	Incandescent Lamp	35	60	2100	7	245	1855	0	12	0.00	25.20	0.00	22.26	0.00	4.91
5	Pendant Light	2	60	120	7	14	106	24	24	2.88	2.88	2.54	2.54	0.55	0.56
6	Fluorescent Lamp	2	20	40	3	6	34	24	24	0.96	0.96	0.82	0.82	0.18	0.18
7	Mast Light	2	60	120	7	14	106	24	24	2.88	2.88	2.54	2.54	0.55	0.56
8	Side Light	2	60	120	7	14	106	24	24	2.88	2.88	2.54	2.54	0.55	0.56
9	Mercury Lamp	14	400	5600	80	1120	4480	12	12	67.20	67.20	53.76	53.76	11.71	11.86
10	Fluorescent Ceiling Lamp	40	40	1600	5	200	1400	24	24	38.40	38.40	33.60	33.60	7.32	7.41
11	Fluorescent Ceiling Lamp	25	20	500	3	75	425	24	24	12.00	12.00	10.20	10.20	2.22	2.25
12	Search Light	1	1000	1000	280	280	720	6	0	6.00	0.00	4.32	0.00	0.94	0.00
13	Fluorescent Wall Light	15	20	300	3	45	255	24	24	7.20	7.20	6.12	6.12	1.33	1.35
14	Mercury Lamp	8	400	3200	80	640	2560	24	12	76.80	38.40	61.44	30.72	13.38	6.78
15	Incandescent Wall Light	15	60	900	7	105	795	24	24	21.60	21.60	19.08	19.08	4.15	4.21
16	Flame Proof Ceiling Lamp	12	60	720	7	84	636	24	24	17.28	17.28	15.26	15.26	3.32	3.37
			Total Power	**18880**	**Total Power (LED)**	**3274**	**15606**	**Total Saving**				**212.23**	**224.99**	**46.22**	**49.65**

Source: Authors.

Table 11: Calculation of annual fuel and cost savings of F.T. Agro Food 3.

Sl. No.	Position	Daily Cost Saving (USD)	Monthly Cost Saving (USD)	Annual Cost Saving (USD)	Annual Fuel Saving (Tonnes)
1	At Fishing Ground (While Fishing)	46.22	1386.6	16639.2	16.75
2	Way to Fishing Ground	46.22	1386.6	16639.2	16.75
3	Way to Port	46.22	1386.6	16639.2	16.75
4	At Discharge Port	49.63	1488.9	17866.8	17.99

Source: Authors.

Table 8 compares various parameters between LED lamps, incandescent, halogen, and CFL lights used on F.T. Agro Food 2. As shown in Table 8, using 100 pieces of LED lights instead of 60-watt incandescent lights available on board F.T. Agro Food 2 could potentially yield an economic benefit of USD 30,750 over 25,000 operating hours (equivalent to 5.7 years at 12 hours of usage per day).

Table 10 displays the LEDs that are scheduled to be put in place of the current lighting sources. These LEDs were chosen from the literature. The shipboard brightness of the LED lamps can be as brilliant as or brighter than that of traditional lamps, and their considerably lower power consumption can increase energy efficiency.

The preceding estimate, based on data from F.T. Agro Food 3 as shown in Table 11, indicates that switching to LED lighting may save up to 18 tonnes of fuel, which could subsequently reduce CO2 emissions by up to 45 tonnes and result in annual savings of USD 17,867. If a long period of service is considered, this will undoubtedly be a major accomplishment for the vessel and its owner, allowing them to attain higher environmental compliance without suffering any financial setbacks. Rather, they would benefit from the reduced fuel and equipment costs, as demonstrated in Table 8.

5. Survey Analysis.

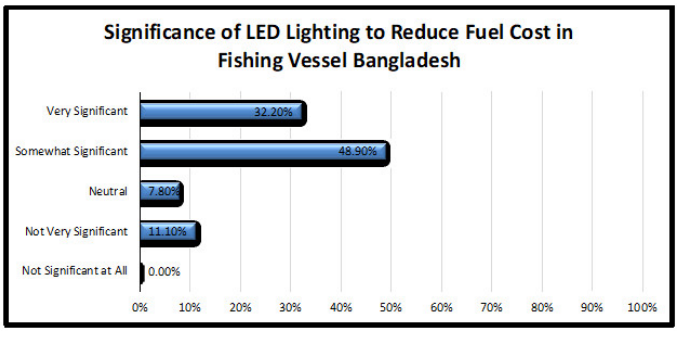
To understand the effectiveness of LED lamps over traditional lights commonly used onboard fishing ships, an online survey form was designed under "Google Forms" for a pilot survey among various stakeholders of the fishing vessel industry in domestic arena. They were asked to present their respective views on following subject matters:

1. Use of LED lights can cause a significant change in energy efficiency by minimizing fuel consumption in fishing vessels.

2. Under cost benefit analysis, if LED lights prevail over traditional lamps, vessel-owners should invest on existing vessels for the replacement of conventional lights with LED lights, and this would be cost worthy in long term.

The survey results are illustrated in Figures 2 ~ 3.

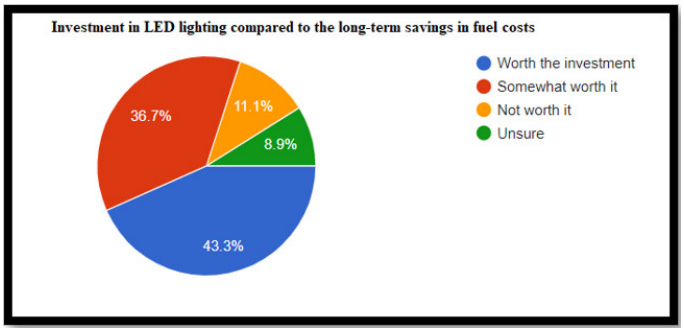
Figure 2: LEDs can play significant role on minimizing fuel cost in fishing vessel.



Source: Authors.

The online survey analysis asked respondents, "How significant do you believe the reduction in fuel costs would be if fluorescent and other lighting systems were switched to LED lights on board fishing vessels in Bangladesh?" Approximately 48.90% of respondents somewhat agreed with the statement, while 32.20% strongly agreed, and about 7.8% remained neutral.

Figure 3: Investment in LED lighting compared to the long-term savings in fuel costs .



Source: Authors.

In another question, respondents were asked, "How do you view the initial investment in LED lighting compared to the long-term savings in fuel costs and maintenance?" Approximately 43.3% of respondents indicated that it was worth the investment, while 36.7% considered it somewhat worth it. About 8.9% were not sure, and only 11.1% thought it was not worth the investment.

Based on the findings of the survey mentioned above, it can be concluded that the use of LEDs on board is acceptable to a wide range of stakeholders. As a result, the fishing industry can promote this technology to enhance energy efficiency and reduce fuel costs and consumption.

Conclusions.

LED lights requires less energy to produce one kilowatt of light than incandescent, halogen, mercury and fluorescent lights. The fact that these lights provide not just the same lumen outputs with each use, but actually improved lumen outputs means that less energy is needed to reach target efficiency, which leads to a decrease in fuel consumption and CO2 gas emissions.

This study successfully evaluated the economic, environmental, and material performance of two Bangladeshi commercial fishing vessels named F.T. Agro Food 2 and F.T. Agro Food 3 using light emitting diode (LED) lamps in place of the old lighting system. The outcome shows that as compared to conventional lighting systems, energy-efficient lighting systems (LEDs) consume less fuel 16 tonnes annually and 18 tonnes annually for F.T. Agro Food 2 and F.T. Agro Food 3 respectively. Also, based on the findings of the survey in present research, it may be said that using LEDs onboard is acceptable to a wide range of stakeholders.

References.

Barua, S., E. Karim, and N.M. Humayun. 2014. Present status and species composition of commercially important finfish in landed trawl catch from Bangladesh marine waters. International Journal of Pure and Applied Zoology 2(2): 150-159.) https://www.researchgate.net/publication/277250346_PRESENT_STATUS_AND_SPECIES_COMPOSITION_OF_COMMERCIALLY_IMPORTANT_FINFISH_IN_LANDED_TRAWL_CATCH_FROM_BANGLADESH_MARINE_WATERS

Chowdhury, 2014. Maritime Province of Bangladesh (map). University of Chittagong, Bangladesh. https://www.researchgate.net/figure/Marin-Province-of-Bangladesh-Chowdhury- 2014_fig4_348248949.

Department of Fishing (DoF), 2024. Yearbook of Fisheries Statistics of Bangladesh 2022-2023. http://fisheries.portal.gov.bd/sites/default/files/files/fisheries.portal.gov.bd/download/668-35738_1def_4eb0_8028_cb70be103f6f/2024-07-08-03-59-c335-f1d6908e7427417e8bc610142b63.pdf.

Department of Fishing (DoF), 2022. Annual Report 2021-2022. https://fisheries.gov.bd/site/view/annual_reports/Annual-Report.

Department of Fishing (DoF), 2021. Annual Report 2020-2021. https://fisheries.gov.bd/site/view/annual_reports/Annual-Report.

Department of Fishing (DoF), 2019. Compendium: National Fish Week 2019. https://www.researchgate.net/publication/351624930_Report_prepared.

Department of Fishing (DoF), 2017. Yearbook of Fisheries Statistics of Bangladesh, 2016-17. Fisheries Resources Survey System (FRSS), Department of Fisheries, Bangladesh, 34, 129. http://fisheries. portal.gov.bd/sites/default/files/files/fisheries.-portal.gov.bd/page/4cfbb3cc_c0c4_4f25_be21_b91f84bdc45c/ -Fisheries%20Statistical%20Yearboook%202016-17_Final.pdf.

FAO, 2009. Aquaculture Department Food and Agriculture Organization of the United Nations, The state of world fisheries and aquaculture 2008. https://openknowledge.fao.org/server/-api/core/bitstreams/32c821d8-2b82-4f23-8460-7b3fd83a2d97/-content.

MoFA, (2014). Press Release: Press statement of the Hon'-ble Foreign Minister on the verdict of the Arbitral Tribunal/PCA. Dhaka, 08 July 2014. (Ministry of Foreign Affairs)

Mohiuddin, K., Ahmed, S., Uddin, M.S. et al, 2024. Emissions estimation of offshore fishing vessel: Evidence from real-time voyage data. Environ Dev Sustain (2024). https://doi.org/-10.1007/s10668-024-04967-x.

World Bank, 2008. The World Bank annual report 2008. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/452391468323718231/the-world-bank- -annual-report-2008-year-in-review.