Project Report

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This project can be divided into 4 parts about my recommendation:

1. Environmental impact;
2. Material use, resource cost and availability;
3. Production capacity, employees and profit;
4. Social & ethical problem.

Environmental impact

Firstly, there is a table which shows the basic information about gas emissions.

Country	CO_2 emissions (1000 tonnes/car produced)	NO_x emissions (tonnes/car produced)	Water used (m^3/car produced)
Australia	7	60	165
Bangladesh	10	68	215
Canada	6	62	150
Germany	5	63	147
United States	8	62	180

One of the main types of harmful emissions form car manufacturing is CO2. As is well-known, CO2 is one of the main contributors to the greenhouse effect. But NOx (i.e. NO and NO2) emissions are an important fact as well. These emissions have detrimental health effects and can cause inflammation of the airways. This means that the effects of NOx emissions are more localised than those of CO2 emissions, but harmful nonetheless. Finally, car factories use large amounts of water. This water cannot be used as drinking water or for irrigation purposes, for example, adding to the environmental footprint of car manufacturing.

Above table is a summary of these three components of the environmental impact of a typical car manufacturing plant in Australia, Bangladesh, Canada, Germany and the United states.

Table shows Australia and Canada perform similar emissions. And Bangladesh gets the worse emissions in every subitem.

Then the following is a detailed analysis of three countries:

Australia is a major exporter and consumer of coal, the combustion of which liberates CO2. Consequently, in 2003 Australia was the eighth highest emitter of CO2 gases per capita in the world liberating 16.5 tonnes per capital

Australia is claimed to be one of the country's most at risk from climate change according to the Stern report.

In 2005, the Australian car industry adopted voluntary targets of 222g CO_2 per km by 2010. This wasn't in line with international standards and masked the poor fuel efficiency of locally manufactured vehicles as shown in the chart below.

Average CO2 emissions (grams per kilometre) for new vehicles

	YEAR	NATIONAL AVERAGE EMISSIONS	PASSENGER VEHICLES	LIGHT COMMERCIAL VEHICLES	AUSTRALIAN CAR MANUFACTURERS	EU AVERAGE	DIFFERENCE AUSTRALIA V EU PASSENGER VEHICLES (%)
1	2010	213	205	250	**247**	146	40
2	2011	207	198	245	**219**	136	38
3	2012	199	190	238	**210**	132	37
4	2013	192	182	236	**210**	127	39
5	2014	188	177	235	**210**	123	41
6	2015	184	175	229	**208**	124	43

Source: National Transport Commission (NTC) Reports 2010–2015 Get the data

With voluntary standards, the local car industry was under no pressure from the government to improve its fleet's fuel efficiency. The Australian car industry failed to meet the target. Average emissions from cars manufactured in Australia in 2010 were 247g per km – 11% higher than the voluntary target.

In April 2012, the Australian government mandated that 100% of all Commonwealth vehicles would be Australian made. This explicitly excluded acquiring vehicles on the grounds of "environmental considerations, such as fuel efficiency".

In 2013, the government announced a Productivity Commission review of the industry that would examine international competitiveness, exports, trade barriers and long-term sustainability. At this point the local car industry announced its decision to abandon manufacturing in Australia. As a result, the commission didn't examine the impact of climate policy measures on the local car industry, although it did suggest that environmental policies could serve as a barrier to international trade.

SUMMARY OF EMISSION REQUIREMENTS FOR NEW PETROL PASSENGER CARS IN AUSTRALIA

1972 - Present

Standard[1]	*Date Introduced*[2]	*Exhaust Emission Limits (petrol vehicles)*				*Source Standard / Test Method*
		HC[3]	*CO*	*NOx*	*PM*[4]	
ADR26	1/1/72	NA	4.5% by vol	NA	NA	Idle CO test
ADR27	1/1/74	8.0 - 12.8 g/test	100 - 220 g/test & 4.5% by vol	NA	NA	ECE 'Big Bag'
ADR27A	1/7/76	2.1 g/km	24.2 g/km	1.9 g/km	NA	US '72 FTP
ADR27B	1/1/82	2.1 g/km	24.2 g/km	1.9 g/km	NA	US '72 FTP
ADR27C[5]	1/1/83	2.1 g/km	24.2 g/km	1.9 g/km	NA	US '72 FTP
ADR37/00	1/2/86	0.93 g/km	9.3 g/km	1.93 g/km	NA	US '75 FTP
ADR37/01	1/1/97 - 1/1/99	0.26 g/km	2.1 g/km	0.63 g/km	NA	US '75 FTP
ADR79/00[6]	1/1/03 – 1/1/04	0.25g/km	2.2 g/km	0.25g/km	NA	UN R83/04 (Euro 2)
ADR79/01	1/1/05 – 1/1/06	0.2 g/km	2.3 g/km	0.15 g/km	NA	UN R83/05 (Euro 3)
ADR79/02	1/7/08 – 1/7/10	0.1 g/km	1.0 g/km	0.08 g/km	NA	UN R83/05 (Euro 4)
ADR79/03[7]	1/11/13 (new models only)	0.1 g/km 0.068 g/km (NMHC)	1.0g/km	0.06 g/km	0.0045g/km	UN R83/06 (Euro 5)
ADR79/04	1/11/16	0.1 g/km 0.068 g/km (NMHC)	1.0g/km	0.06 g/km	0.0045g/km	UN R83/06 (Euro 5)

"NA" means no limit applies.

The Australian Government is currently considering the case for adopting Euro 6 through the Ministerial Forum on Vehicle Emissions. For further information, please visit https://infrastructure.gov.au/roads/environment/forum/index.aspx.

Vehicle emissions modelling is an important tool when developing strategies to manage and improve air quality. Motor vehicles are a major source of common air pollutants, including hydrocarbons (HC), volatile organic compounds (VOCs), and oxides of nitrogen (NOx). In the Sydney air shed, for example, motor vehicle exhaust emissions contribute over 71 per cent of NOx and over 38 per cent of VOCs, excluding emissions associated with refuelling. NOx and VOCS are major contributors to smog.

Vehicle Noise issue:

1. new model vehicles produced on or after 1 January 2007 with an engine that operates on diesel, liquefied petroleum gas or natural gas and with a GVM greater than 3.5 tonnes;
2. with an engine power of 150 kW (ECE) or above but less than 320 kW (ECE) Limit values [dB(A)]: 80'.
3. with an engine power of 320 kW (ECE) or above Limit values [dB(A)]: 83' is inserted after paragraph 6.2.2.1.2.2 of Appendix A.
4. with an engine power of 150 kW (ECE) or above but less than 320 kW (ECE) Limit values [dB(A)]:80'.

- In 2017 the national average carbon dioxide emissions intensity from new passenger and light commercial vehicles was 181.7 g/km. This is a 0.3 per cent reduction from 2016. This is the lowest annual reduction since records started in 2002.
- Consumer preferences are an important factor affecting the national average of carbon dioxide emissions intensity for new vehicles. If all Australians who purchased new vehicles in 2017 had purchased vehicles with best-in-class emissions, the national average carbon dioxide emissions intensity would have been reduced to 76 g/km, a 58 per cent reduction.
- About 92 per cent of all new vehicle sales in 2017 were from 15 makes. Of these 15 makes, Audi had the lowest corporate average emissions intensity (145 g/km), and Holden had the highest (219 g/km).
- Private buyers purchased vehicles with the lowest average emissions intensity

(176 g/km), followed by business buyers (186 g/km) and government buyers (199 g/km).

• There were 97 ‘green’ car models available in Australia in 2017 (compared with 51 in 2016), which represented 3.8 per cent of total sales (compared with 2.5 per cent in 2016). A ‘green’ car is defined as a vehicle with emissions intensity that does not exceed 120 g/km.

• There were 2,424 electric vehicles sold in 2017 (compared to 1,369 in 2016) which is a 77 per cent increase from 2016.

• The average emission intensity for new passenger vehicles in European countries was 118.5 g/km in 2017. In the same year, Australia’s average emissions intensity for passenger vehicles were 171.5 g/km, 45 per cent higher.

• There are many reasons why Australian light vehicle emissions intensity are higher than in Europe. Some of the reasons include:

  o Australian consumer preferences for heavier vehicles with larger and more powerful engines
  o Australia has a lower proportion of diesel-powered engines
  o Australia has fewer government incentives for lower emissions vehicles
  o relatively lower fuel prices in Australia compared with Europe.

Air pollution in **Canada** is contributed by industrial and vehicular emissions, agriculture, construction, wood burning and energy production. A recent report found that Canadian companies contributed 73% more to air pollution than companies in the United States.

While overall pollution levels have dropped, it was found that oil sands pollution has increased by 20% since 2009. According to a 2009 study, Alberta’s oil sands are one of the major causes of air pollution in Canada.

Transportation is one of the largest sources of carbon pollution in Canada. Automobiles and light trucks account for about 11 per cent of Canada's total greenhouse gas emissions.

Passenger vehicles emit various air pollutants including volatile organic compounds (VOCs), nitrogen oxides (NOx), particulate matter (PM), carbon monoxide (CO) and Sulphur oxides (SOx). Both nitrogen oxides (NOx) and volatile organic compounds (VOCs) are involved in a series of complex reactions that result in the formation of ground-level ozone, which is a respiratory irritant and one of the major components of smog. The Criteria Air Contaminants Summary presents the emission estimates of these pollutants from transportation sources in Canada. Passenger vehicles account for a considerable proportion of the total national transportation emissions including:

approximately 21 per cent of nitrogen oxide (NOx) emissions

approximately 51 per cent of volatile organic compound (VOC) emissions

approximately 4 per cent of fine particulate matter (PM 2.5) emissions

Since 1971, the federal government has adopted increasingly stringent standards for smog-forming emissions from motor vehicles. On January 1, 2004, the new On-Road Vehicle and Engine Emission Regulations (full regulation) came into effect under the Canadian Environmental Protection Act, 1999. For passenger vehicles, the regulations phase-in more stringent standards between 2004 and 2009. When these Regulations are fully phased-in, all passenger vehicles will be subject to the same set of emissions standards. These Regulations will result in a reduction of the allowable level of nitrogen oxide and volatile organic compound emissions from new vehicles by up to 95 percent and 84 percent, respectively, relative to previous requirements.

Most passenger vehicles operate using gasoline. Low levels of Sulphur in gasoline enable the effective operation of vehicle emission control technologies. As a result of the requirements of the Sulphur in Gasoline Regulations (full regulations), Sulphur levels in Canadian gasoline were reduced to an average of 30 parts per million (ppm) as of January 1, 2005. This level represents a reduction of more than 90% relative to average Sulphur levels in the 2000 timeframe.

Exposure to nitrogen oxides (NOX) and Sulphur oxides (SOX) can irritate the lungs, reduce lung function, and increase susceptibility to allergens in people with asthma. Both NOX and SOX are also precursors of fine particulate matter (PM2.5) and contribute to the formation of smog and acid rain.

Fine particulate matter and ground-level ozone (O3) are the main components of smog and they have been associated with eye, nose and throat irritations, shortness of breath, exacerbation of respiratory conditions and allergies, chronic obstructive pulmonary disease and asthma, increased risk of cardiovascular disease and premature death. The young, the elderly, those with acute illnesses and those living near cities are at greater risk.

Environmental impacts

Ground-level O3 can reduce the growth and productivity of some crops and injure flowers and shrubs and may contribute to forest decline in some parts of Canada. Ecosystem changes can also occur, as plant species that are more resistant to ground-level O3 can become more dominant than those that are less resistant.

Various particulate matter constituents taken up by plants from the soil can reduce plant growth and productivity and can cause physical damage to plant surfaces via abrasion.

Nitrogen oxides and SOX can cause or accelerate the corrosion and soiling of materials and are major contributors to acid rain. Acid rain affects soils and water bodies, and stresses both vegetation and animals. The interactions between acid rain, ultraviolet (UV) radiation and climate change can magnify the impacts of acid rain.

Emissions of mercury and other hazardous pollutants work in synergy with Sulphur dioxide (SO2) and NOX to worsen the harmful effects of acid deposition on fish and wildlife. Increasing acidity of water bodies increases the rate of conversion of mercury into toxic and bioavailable methyl mercury (MeHg).

Air pollution of **Bangladesh** is caused due to increasing population and associated motorization. Indoor air pollution is mainly associated with the use of biomass fuels during cooking with poor ventilation.

Air pollution mainly occurs due to burning of fossil fuels like coal, petroleum etc and associated black smoke. Over 99% of the brick kilns use fossil fuel but don’t comply with the “Brick Kiln Ordinance” and pollute enormous air.

One of the major sources of air pollution in urban areas of Bangladesh is due to the unburned fuel from two stroke engine vehicles. Dhaka has been rated as one of the most polluted cities of the world.

The motor vehicle usage has increased tremendously in Dhaka, and like other metropolitan cities, Dhaka is also facing a pollution problem from emissions of carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx), and particulate matter (PM). Besides this, about

451 polluting industrial plants such as tanneries, textile mills, oil refineries, distilleries, fertilizers, paint manufacture, pulp and paper factory etc. discharge highly toxic effluent directly into the river in Dhaka. In a thickly populated area like Hazaribagh, there are about 160 tanneries discharging 28 to 35 liters of waste effluent for each kilogram of hide processed which contains toxic heavy metals like chromium, arsenic, zinc etc. These run through open drains and fill the whole area with a putrid smell. About 1.3 million people in Dhaka depend on 6 x10 metric ton of wood and other non-conventional fuel in each year, which causes thick smoke from their cooking stoves. The purpose of this paper is to briefly survey the air pollution conditions in Dhaka city.

The total number of motor vehicles registered in 1988 was 270860 in the country which is not so high in comparison with the other developing countries, but, due to the higher emission percentage from the motor vehicles the city atmosphere becoming unhealthy for its people.

Material use, resource cost and availability

Amount of material used to produce each model (kg/car)	*Cubic*	*Traveller*	*Adventurer*
Steel	400	500	520
Glass	50	70	40
Rubber	70	80	150
Paint	30	40	50

Country	Steel	Glass	Rubber	Paint
Australia	0.3	1.2	2.2	23
Bangladesh	0.2	0.6	1.4	11
Canada	0.3	1.1	2.0	24

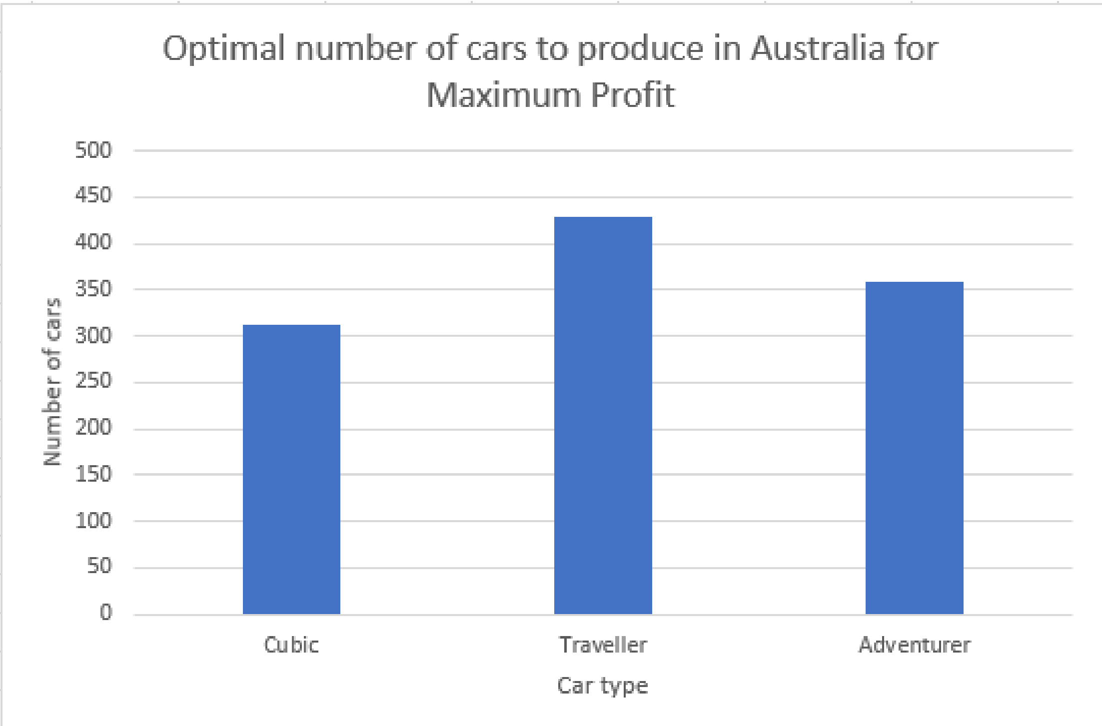
Country	Steel	Glass	Rubber	Paint
Australia	600	60	110	60
Bangladesh	800	100	140	80
Canada	600	50	120	60

These tables show Bangladesh has the most resources and the least material cost.

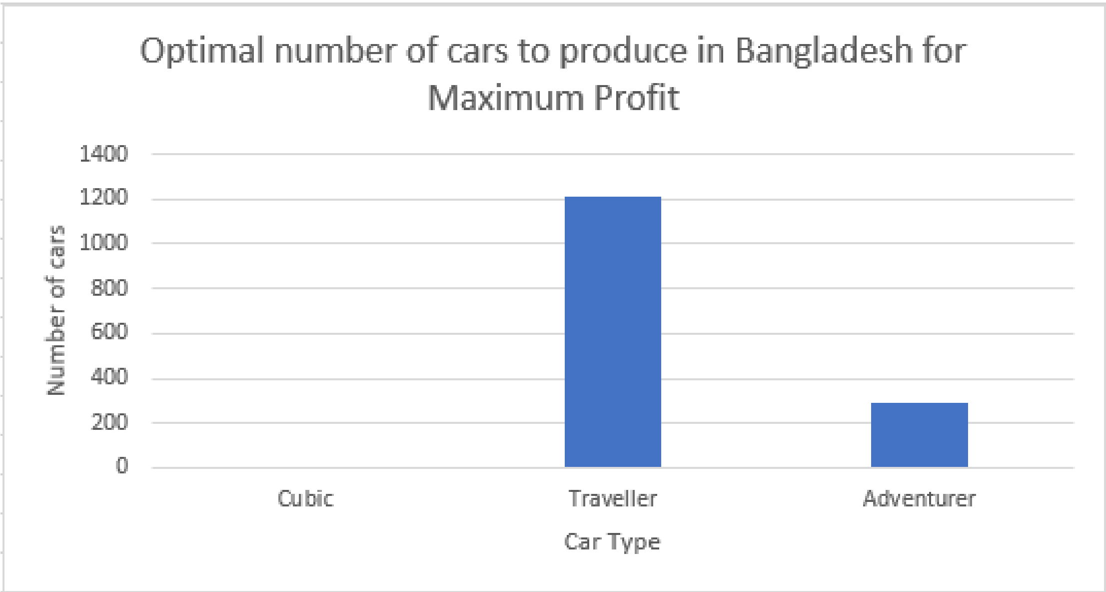
Production capacity, employees and profit

Location	Production capacity (cars/yr)	Number of Employees	Investment required (million AUD)	Labour cost per car produced (fraction of retail price ex GST)
Australia	1100	200	20	0.5
Bangladesh	1500	300	20	0.1
Canada	800 until 2021 1100 from 2022	250	20	0.45

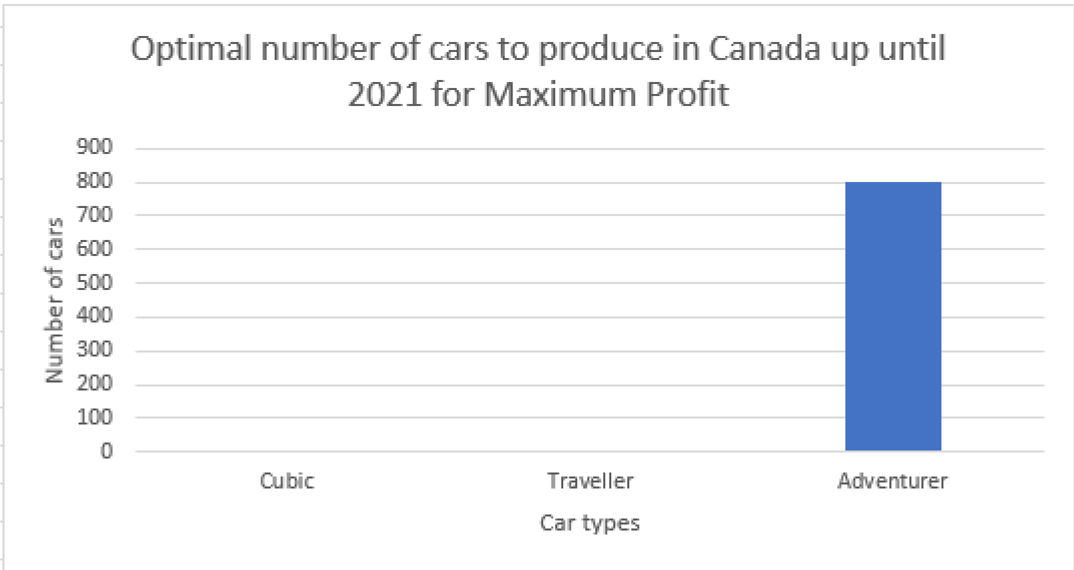
Because we already know the basic information about three countries like material & resource cost, production capacity, the number of employees and labour cost per car. We can calculate the approximate profits of them from mathematical ways.



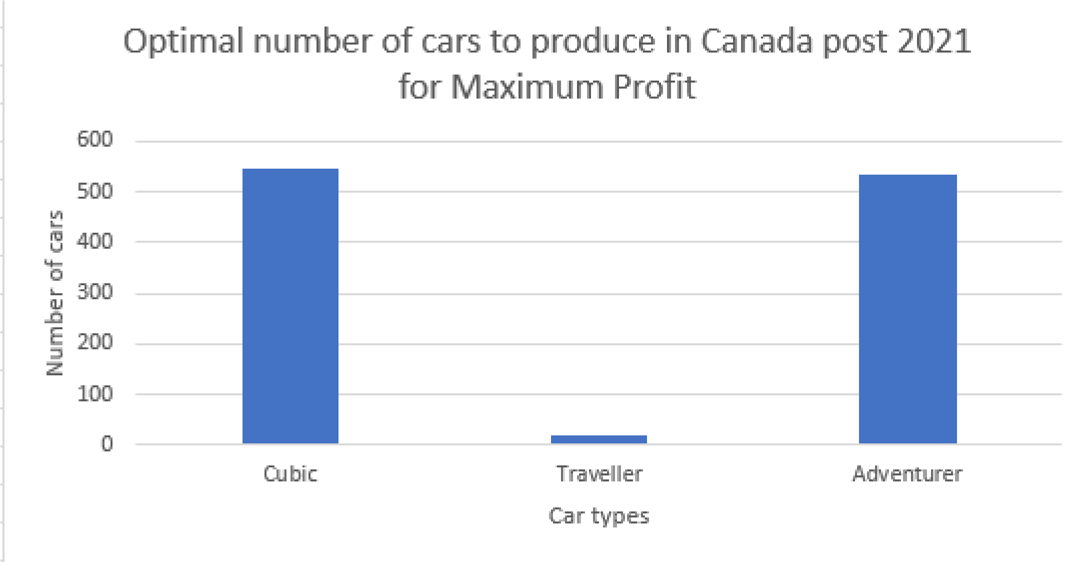
The maximum profit of Australia: $6790886



The maximum profit of Bangladesh: $10443342



The maximum profit of Canada until 2021: $6129361



The maximum profit of Canada post 2021: $7000827

Social & ethical problem

As we know, some social & ethical problems will influence the operations of the industries. Bangladesh has a problem which is Child Labour.

Child labour in Bangladeshis common, with 4.8 million or 12.6% of children aged 5 to 14 in the work force. Out of the child labourers engaged in the work force, 83% are employed in rural areas and 17% are employed in urban areas. Child labourcan be found in agriculture, poultry breeding, fish processing, the garment sector and the leather industry, as well as in shoe production. Children are involved in jute processing, the production of candles, soap and furniture. They work in the salt industry, the production of asbestos, bitumen, tiles and ship breaking. In 2006,Bangladeshpassed a Labour Law setting the minimum legal age for employment as 14. Nevertheless, the enforcement of such labour laws is virtually impossible in Bangladesh because 93% of child labourers are employed in the informal sector such as small factories and workshops, on the street, in home-based businesses and domestic employment.

Decision & Conclusion

A Wider Range of Criteria												
					Australia		**Bangladesh**		**Canada until 2021**		**Canada from 2022**	
Criteria	Rank	Weighting	Score	Weighted Score	**Score**	**Weighted Score**	**Score**	**Weighted Score**	**Score**	**Weighted Score**	**Score**	**Weighted Score**
Profit	1	0.370408163	10	3.704081633	6.7	2.481734694	10	3.704081633	6.1	2.259489796	7	2.592857143
Least Amount of Total Environmental Impact	2	0.22755102	10	2.275510204	8	1.820408163	4	0.910204082	10	2.275510204	10	2.275510204
Least Total Resource cost	3	0.156122449	10	1.56122449	5	0.780612245	10	1.56122449	6	0.936734694	6	0.936734694
Total Resource Availability	4	0.108503401	10	1.085034014	8	0.868027211	10	1.085034014	7	0.75952381	7	0.75952381
Least Failure Rate	5	0.072789116	10	0.727891157	9	0.655102041	5	0.363945578	8	0.582312925	8	0.582312925
Labour cost	6	0.044217687	10	0.442176871	5	0.221088435	10	0.442176871	6	0.265306122	6	0.265306122
Number of Employees	7	0.020408163	10	0.204081633	10	0.204081633	5	0.102040816	7.5	0.153061225	7.5	0.153061225
Number of Criteria	7	1	**70**	**9.3537415**	51.7	7.031054422	54	8.168707483	50.6	7.231938776	51.5	7.565306122

The decision is decided by decision matrix, because Bangladesh allows child labour, it is out of the decision. Then Canada has the highest scores, so Canada is an ideal choice.