# An Investigation into Laptop Triple Bottom Line

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# APSC 262 Project Report:
# An Investigation into Laptop Triple Bottom Line

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**ABSTRACT**

This term, projects in APSC 262 focused on using the Triple Bottom Line assessment to improve the sustainability of the UBC campus in various aspects. One of the sustainability concerns is the large and increasing number of electronics used by the UBC population. UBC promotes products that outcomes from resource management, where conservation goals and equity in social outcomes are maximized while overall costs are minimized. This project focuses on assessing laptops, as the first step, to develop a TBL for evaluating electronics in this manner.

A three-star rating system is recommended to evaluate the three aspects of the TBL: financial, environmental, and social. Each aspect consists of three indicators used to grade the TBL of the product and is given a star when the requirement of an indicator is met. Since the TBL assessment method is a new approach to evaluate electronics, a survey was done to collect primary resources to determine the requirements of each indicator and the significance of the financial, environmental, and social aspects of the TBL in the perspective of laptop consumers. Satisfying consumers is a primary goal for electronics companies and, thus, the consumers' outlooks provide a very important indication for when requirements are met.

Data collected from this survey has been interpreted to weigh the financial, environmental, and social aspect of the laptop TBL with 50%, 35%, and 15% of the overall three-star evaluation of the product. Not only will this weighed-overall rating allow consumers to assess each aspect separately but it will allow companies to increase their competitive edge in the aspects that are important to their consumers.

It is also recommended that UBC collaborate with organizations such as RCBC to set up a few recycling posts dedicated to electronics around campus. This will raise awareness to students and staff at UBC on the electronic products that can be recycled; promote the act of recycling electronics; and also provide a convenience to the people that want to contribute into making their electronics' LCA more eco-friendly.

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## GLOSSARY

**Performance to Price ratio:**

How well the laptop performs in respect to its competition in the same price range.

**Profit Margin Ratio per unit:**

The ratio of the profit divided by the production cost of the product for every unit sold.

## LIST OF ABBREVIATIONS

| | |
|---|---|
| **LCA** | Life Cycle Assessment |
| **PCF** | Product Carbon Footprint |
| **RCBC** | Recycling Council of British Columbia |
| **TBL** | Triple Bottom Line |
| **UBC** | University of British Columbia |

## 1.0 INTRODUCTION

As environmental and social issues are being equally viewed as financial aspects of a product, the use of the triple bottom line (TBL) is becoming more popular in assessing the impacts and returns from research and development programs in terms of sustainability. However, the TBL has not been used to assess electronic products. For the purpose of this project, the focus is to introduce a triple bottom line assessment to evaluate laptops.

Only around 40% of laptops are recycled (EPA, 2010) and for every laptop that is not recycled precious metals, such as, copper, silver and gold are being wasted. Through the development of the laptop TBL, the social and environmental impact of laptops will be brought to the attention of consumers and assist them in purchasing the product that best suits their values.

This report outlines a three-star rating system that consists of three indicators for each of the financial, environmental, and social aspect of the TBL to assess the impact of a laptop. A star is given when the requirements for an indicator is met, out of a total of three stars for each aspect. Requirements for satisfying each indicator are decided by consumers, determined through a survey conducted on laptop consumers. Through the same survey, the significance of each aspect in respective to the overall evaluation of the laptop is calculated. The final TBL evaluation is determined 50%, 35%, and 15% by financial, environmental, and social aspect of the laptop respectively.

The indicators will assist laptop companies and consumers to:

- Manage and evaluate the impact of a laptop's life cycle
- Report performance of laptops as a legitimate assessment
- Establish the basis for targets and goals when producing/purchasing a laptop

## 2.0 ECONOMIC INDICATORS

The Suggested indicators to measure the economic aspect of Laptop TBL are:

- performance to price ratio
- cost of production
- marketability

These indicators will be part of the 3 star system that we designed to help laptop producers evaluate the economic aspect of the target laptop.

## 2.1 PERFORMANCE TO PRICE RATIO

The price is an important factor for the consumers looking to buy a new laptop. But just how important is it, would someone be willing to pay more for a higher performance laptop if it is worth the price? From the survey we conducted, results showed that price alone can not be the deciding factor on whether or not someone buys a specific laptop, it is the performance to price ratio that does. The performance to price ratio is how well the laptop performs in respect to other laptops in its price range. To find out about what the consumers are willing to pay for laptops of different performance levels, we included a question in the survey that asks the subjects to give the reasonable price they are willing to pay for a laptop of different level of performance capabilities. For this question we are excluding the difference between the ram, GPU, of the laptops etc. and only taking the difference in CPU into consideration. The results are as follows:

“Considering only Intel processors, what is the reasonable price for each of the following? (I-3,I-5,I-7)”

- The average price of a CPU I-3 laptop would be around $430
- The average price of a CPU I-5 laptop would be around $580
- The average price of a CPU I-7 laptop would be around $770

If the price range of the specific laptop being evaluated is under the average price levels of the respective performance level of the laptop we obtained from the survey, the laptop is awarded the first out of three stars.

## 2.2 COST OF PRODUCTION AND PROFIT MARGIN RATIOS

One of the ways to maximize profit is by decreasing the production cost, thus increasing the profit margin ratio of the laptop. The profit margin ratio of a product is the ratio of the profit divided by the production cost of the product for every unit sold. For this particular subject, we conducted a research on what the profit margin ratio is for major laptop companies such as Apple and Lenovo, and match it against the profit margin ratio of the subject laptop.

Below is a list of the profit margin ratios of 6 major laptop companies.
Apple: 20% (Keizer, 2010, para. 1)
Lenovo: 12.8% (Lenovo, 2014)
HP: 7.21% (Hughes, 2011, para. 3)
Acer: Approximately 1% (Hughes, 2011, para. 3)
Asus: Approximately 4.5% (Hughes, 2011, para. 3)
Dell: 4% (Hughes, 2011, para. 3)

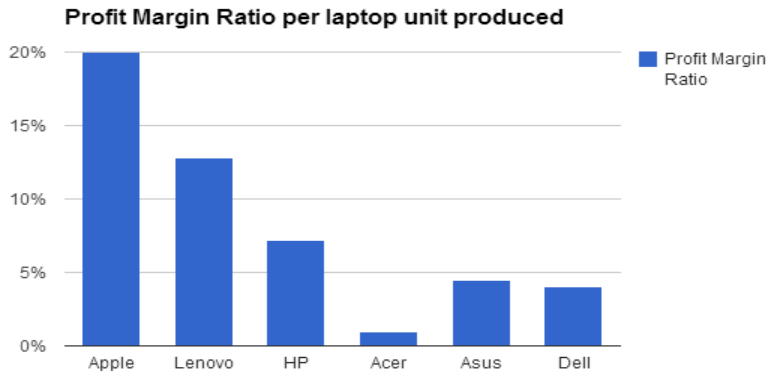


**Figure 1.** Profit Margin Ratio per laptop unit produced graph

From the data acquired, it shows that the range of the profit margins for different laptop manufacturers is very wide, from as high as 20% (Apple) to as low as 1%(Acer). To find the average profit margin, we've omitted the extreme cases (Apple and Acer) to find the appropriate average of the remaining 4 companies to be 7.13%. On the second indicator of the economic aspect of the laptop TBL, a star is awarded if the laptop's profit margin ratio per unit sold is over 7.13%.

## 2.3 MARKETABILITY

According to our survey, brand recognition and pop culture relevance will add to the appeal of the laptop. Over 70% of the people we surveyed answered yes to the question: "Would you choose a laptop with a brand name that you recognize over something that you don't when the price and performance of the two laptops are comparably similar?", while 55% answered yes to the question: "Would you choose a laptop that is endorsed by a celebrity that you recognize over another laptop that is not, if the price and performance of the two laptops are comparably similar ?". This shows that the consumers will trust something that they already know rather than taking a risk on something that is unknown to them, and that money on advertising and marketing is money worth spending.

For the third test and final star for this aspect of the laptop TBL, we will conduct a survey asking the consumers whether or not they recognize the brand of the subject, if over 50% of the surveys answer yes, then the third star will be awarded.

## 3.0 ENVIRONMENTAL INDICATORS

The demand for higher performance allows the newer laptop models to become obsolete. This causes the older models to simply end up in landfills. Laptops contain dangerous lead in their batteries as well as polyvinyl chloride (PVC) in wire coating which can emit toxic dioxin if burned. The toxic lead from the batteries can also leach out in water supplies.

Several methods can be implemented in order to promote recycling and reuse of laptops. Marketing schemes should be implemented for upgradable products. Laptop parts should be evaluated in terms of durability instead of profits during the manufacturing stage. Laptop parts must not be down-cycled until all possibilities of reuse are exhausted. Standards must be set for reused parts in order to assure the buyer that the parts meet all the basic quality criteria. Universality in the design is also very important as it allows parts to be used in several different models. Both the embedded energy and the energy in production needs to be minimized for environmental benefits.

Some of the parameters that should be considered for the environmental assessment of laptops are:

- Product carbon footprint
- Energy consumption

## 3.1 PRODUCT CARBON FOOTPRINT

Product Carbon footprint assesses the life cycle green house gas emissions that are released as part of the processes of creating modifying, transporting, using, recycling or disposing of goods and services. In order to assess the product carbon footprint of a laptop impacts from transportation, on-board components, life cycle assessment and recyclability of the laptop can be considered.

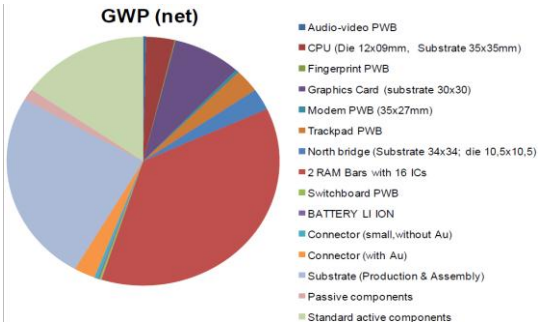


**Figure 2.** Carbon footprint contributions from components of the motherboard

In a study conducted on a Dell laptop, it was found that the motherboard components and air transport contribute significantly to the product carbon footprint.

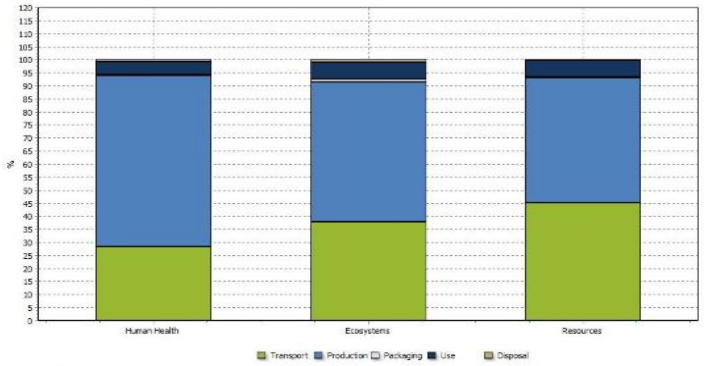


**Figure 3.** Impact on PCF

## 3.2 ENERGY CONSUMPTION

It seems like the processing speed of laptops generally doubles after every new generation. However, one must make a tradeoff between processing speed and power efficiency of a laptop. Inefficient or high power consumption laptops have a devastating impact on our environment. Inefficient laptops end up emitting far more greenhouse gases. Certain companies, like Dell are starting to take actions against this and are trying to improve the power efficiency. If the industry adopted a lower power consumption architecture, energy usage would go down considerably and battery life for the laptops would increase.

## 4.0 SOCIAL INDICATORS

Social indicators provide a measure of the impacts of a laptop to the society and to the local communities where the laptop is manufactured.

For the social aspect, our team examined case studies and LCAs of laptops, such as Elisabeth Ekener-Petersona's and Goran Finnveden's "Potential Hotspots Identified by Social LCA-Part 1: a Case Study of a Laptop Computer". We found out that these case studies identify workers and the local community as the stakeholders that are most at risk of negative social impacts. Thus, our suggested indicators to measure the social aspect of Laptop TBL are:

- The Laptop Manufacture Workers' Wage
- The Working Environments of the Laptop Factories
- Impacts to the Local Communities

With the survey that our team conducted, the weight ratio of the social indicators, in comparison to the other two aspects of the TBL, is suggested to be 15%. How we determine the weight ratio of social aspects is through the questions that focused on if the conditions of underpaid workers, bad working environments and negative impacts to the local communities of where the laptop is manufactured were acceptable or not. One example of the questions of the social aspect was asking if people would still purchase their laptops knowing that their laptops were manufactured by underpaid labours. Out of 69 surveys that we collected, 57 would still purchase the laptops. This results shows that 82% of people do not care if their laptop computers were manufactured by underpaid labours. Combining with the data of other "social questions" in our survey, we obtain an average percentage from these data and come up with a weighted-overall rating of 85%. The significance is that the social aspect of Laptop TBL should be weighted less than the other two aspects, and in fact, it should be weighted as 15% comparing to the other two aspects.

## 4.1 WORKERS' WAGE

As the assessments on the social life cycle of laptops, and the survey we conducted suggest, our first social indicator is the manufacture workers' wage. A laptop has production phases of resource extraction, refining and processing of raw materials, manufacturing and assembly, marketing and sales, use, and finally, the recycling and disposal phase. Through these production phases, studies show that during the manufacturing phase, the workers are at most risk of negative impacts, and the most obvious reason is that they are at the very bottom of the supply chain.

Like many other products, companies usually have factories placed in developing countries to reduce the costs of their products. A laptop consists of 1800~2000 parts, and most of them are manufactured in the developing countries, such as China (Ekener-Petersen & Finnveden, 2012). Even if in countries like Taiwan or South Korea that have become developing countries, the issues of underpaid workers still exist.

In our survey, we collected people's point of views of how much more than their local minimum wage the manufacture workers should be paid if their increase was reflected onto the price of the laptop (percentage-wise). The average result of 69 people was approximately 10%. To implement this with our 3-star rating, if a laptop is to be assessed with our 3-star rating, if the company are paying 10% or above more than the local minimum wage for their workers is considered to be socially sustainable to a level.

## 4.2 FACTORY WORKING ENVIRONMENT

The second indicator is the condition of the manufacture workers' working environment. Since manufacture workers are at the bottom of the supply chain, companies care more about the profits than the social aspect of the TBL; companies have their manufacture workers to work in bad or hazardous environment. Many of the factories manufacturing parts of the laptop may be placed in countries or territories that have armed conflicts, such as Saudi Arabia and Thailand. Also, some of the laptop's parts may require workers to use toxin in the factories. Due to all these factors, we also collected people's

opinions concerning the factories' working environment.

The result shows that people think the most unacceptable working environment includes the following: factories without proper fire exists, factories in the territories with armed force, using toxin in factory, and hazardous machinery. Therefore, in our 3 star- rating system, if a company factories producing their laptop in such working environments, the laptop concerning the working environment is also considered to be sustainable to a level in the social aspect.

### 4.3 IMPACTS ON LOCAL COMMUNITIES

Impacts that the laptop factories have to the local communities is also another important concern in the social aspect of Laptop TBL. Danger like explosion when manufacturing or toxic materials that affect the safe and healthy living conditions of the local communities may be involved. Furthermore, the job opportunities that the laptop company can provide to the local residents are also a factor. Basically the main concern is basically indicating if whether a laptop company has a good enough community engagement with the local residents (Ekener-Petersen & Finnveden, 2012).

The main concerns that people doing the survey have towards the impacts to local communities are the following: does the companies care about the safe and healthy living of the local community or not? ; do the companies pay injury compensation fairly or not? ; does the companies respect for the indigenous rights or not? ; does the company have their workers work for reasonable hours of shift? If the company is having their laptop assessed through our 3-star rating system, its laptop is considered to be socially sustainable if the answers to all the above questions are positive.

## 5.0 CONCLUSIONS AND RECOMMENDATIONS

For this project we have resorted to a three-star rating system to evaluate the financial, environmental and social aspect of the laptop TBL. Each aspect consists of three indicators and a star is given when the requirements for an indicator is met. A survey was conducted on laptop consumers to determine the conditions for satisfying each indicator and the significance of each aspect in respective to the overall TBL evaluation ( 50% - financial, 35% - environmental, 15% - social).

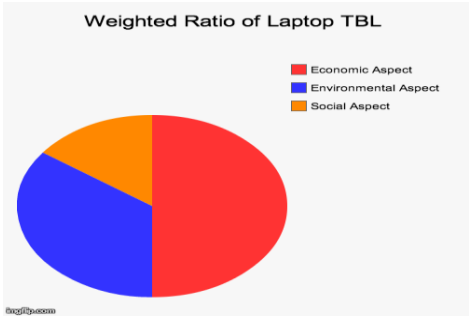


**Figure 4.** Pie Chart of the Weight Ratio of Laptop TBL

From an economic aspect, we believe it is in the producers' best interest to focus on improving the performance of the laptop rather than adjusting the price, for the consumers don't necessarily want to buy something that is cheap, but to get the most performance out of the money they are paying.

From an environmental aspect, we suggest that companies produce components of the laptop with recyclable material. We also suggest that companies make it noticed and promote laptops that are expected to have a better LCA.

From the social aspect, we believe it is best that companies examine their laptop with the 3 indicators: the workers' minimum wage, the working environment of the factories, and the factories' impacts to the local communities. If the laptop satisfies all three of the suggested social indicators, it is considered to be a socially sustainable laptop.

Hopefully these indicators will assists laptop companies and consumers to manage and evaluate the impact of a laptop's life cycle; report performance of laptops as a legitimate assessment; and establish the basis for targets and goals when producing/purchasing a laptop. As an additional recommendation, we suggest UBC to collaborate with RCBC to set up a few recycling posts dedicated to electronics around campus. This will:

- Raise awareness to students and staff at UBC on the electronic products that can be recycled.
- Provide convenience to the people that want to contribute by improving the LCA of their unwanted electronics
- Promote the act of recycling electronics

**REFERENCES**


Claerr, J. (2011, May 23). The 5 Best Green Laptop and Desktop Computers. *Bright Hub*. Retrieved February 28, 2014, from http://www.brighthub.com/environment/green-living/articles/50259.aspx

Colón-Jiménez, E. X. (2010). *$CO_2$ price impact on dell's supply chain : A framework for carbon footprint economic analysis.* (Masters Dissertation, Massachusetts Institute of Technology). , 9-81.

Deng, L., Babbitt, C. W., & Williams, E. D. (2011). Economic-balance hybrid LCA extended with uncertainty analysis: case study of a laptop computer. *Journal of Cleaner Production*, 19(11), 1198 - 1206. doi:10.1016/j.jclepro.2011.03.004

Ekener-Petersen, E.,& Finnveden, G. (2013). Potential hotspots identified by social LCA—part 1: a case study of a laptop computer. *The International Journal of Life Cycle Assessment*, 18(1), 127 - 143.

ELECTRONIC PRODUCT ENVIRONMENTAL ASSESSMENT TOOL. (n.d.). *Zero Waste Alliance*. Retrieved February 27, 2014, from http://www.zerowaste.org/epeat_devel/files/EPEAT%20Summary%20060113.pdf

Guide to Greener Electronics. (n.d.). *GREENPEACE*. Retrieved February 27, 2014, from

http://www.greenpeace.org/international/Global/international/publications/climate/2012/GuideGreenerElectronics/Guide-Ranking-Criteria-v18.pdf

Hughes, N. (2011, August 18). HP's PC sales lead industry but 5.7% operating margins dwarfed by Apple. *Appleinsider*. Retrieved April 11, 2014, from http://appleinsider.com/articles/11/08/18/hps_pc_sales_lead_industry_but_5_7_operating_margins_are_dwarfed_by_apple

Keizer, G. (2010, October 22). MacBook Air more profitable than other Apple laptops, says analyst. *Computerworld*. Retrieved April 11, 2014, from http://www.computerworld.com/s/article/9192618/MacBook_Air_more_profitable_than_other_Apple_laptops_says_analyst

Kondoh, S., & Mishima, N. (2010). Strategic decision-making method for eco-business planning. *CIRP Annals - Manufacturing Technology*, 59(1), 41-44.

Kuklinksi G. (2010, October 22). Screening life cycle assessment of a laptop used in Poland. Retrieved January 05 2010, from http://greendelta.com/uploads/media/SocialLCAParisOECD_final.pdf

Lenovo. (2013, March 14). *LENOVO REPORTS STRONG FOURTH QUARTER AND FULL YEAR 2012/13 RESULTS*. Retrieved April 11, 2014, from https://www.lenovo.com/news/sa/en/2013/05/lenovo_results.html

Shrivastava, P., Zhang H. C., Li J., & Whitely A. (2005). Evaluating obsolete electronic products for disassembly, material recovery and environmental impact through a decision support system, 221-225. doi:10.1109/ISEE.2005.1437029

Stutz, M. (2011). Product carbon footprint (PCF) assessment of a dell OptiPlex 780 desktop – results and recommendations. In M. Finkbeiner (Ed.), *Towards life cycle sustainability management* (pp. 495-500). London, New York: Springer Netherlands. doi:10.1007/978-94-007-1899-9_48

Ciroth, A. (2010, October 22). Social and environmental life cycle assessment of a laptop. Retrieved October 18, 2010, from http://greendelta.com/uploads/media/SocialLCAParisOECD_final.pdf