

Evaluating Stretch Wrap Alternative Used in Goods Consolidation at an Electronics Manufacturing Using Triple Bottom Line

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Abstract: PT. X is an electronics manufacturing that produces various electronics product and components. The company operates three manufacturing plants and one main warehouse; they are all located in separate buildings. Material and components required for manufacturing are stored and delivered from the main warehouse; each materials and components are consolidated and put into a pallet and secured by stretch wrap first before being transported to the three manufacturing plants. The pallet movement is a closed loop, meaning the empty pallets are returned back to the main warehouse. Stretch wrap is a single-use material, once used are discarded. The use of such material is a sustainable issue. Using Triple Bottom Line approach for the sustainable problem to evaluate and produce a suitable alternative that is sustainable and doesn't burden the PT X's financials. TBL approach selects an alternative that can replace stretch wrap by evaluating and measuring how each consolidation method and tool based on factors of Economic Measure, Environmental Measure and Social & Human Measure. Resulting evaluation produces that the suggested alternative, pallet cover is a more economically viable, reusable and relatively easy to use, meaning a better solution.

Keywords: stretch wrap; sustainability; Triple Bottom Line

Introduction

PT X is part of a multinational corporation in the field of electrical manufacturing and energy management. PT. X's has three manufacturing plant and one logistic and warehouse hub. This warehouse stores and supplies materials and components used in the manufacturing process. The replenishment for production process are done through sending pallets of boxes filled with materials and components that are placed on a pallet. This load are then wrapped with stretch wrap to maintain its integrity and securing the load to the pallet. Stretch wrap as a single-use plastic material is wasteful and environmentally unfriendly procedure. This research is conducted to produce an alternative that is economically viable, sustainable and can be applied to the replenishment activity. The main underlying criteria is that the alternative must be reusable and practical, hence it is a sustainable procedure, can be used multiple times on its lifespan and can be applied directly to the replenishment process.

Evaluating the procedure are done through using the Triple Bottom Line. TBL or 3BL is a sustainability framework or theory focusing on economic prosperity, environmental quality and the element which business preferred to overlook, social justice. First coined by John Elkington in 1994, a famed British management consultant and sustainability guru, as his way of measuring performance in corporate America. TBL enables a more sensible approach in evaluating and determining a project by an entity.

Research Method

Evaluating a suitable alternative to replace stretch wrap that fulfills the need to be reusable, economically viable and easy to use, is done through using method of Triple Bottom Line.

Triple Bottom Line

Triple Bottom Line (TBL or 3BL) is a sustainability framework or theory that is focusing on economic prosperity, environmental quality, and — the element which business had preferred to overlook — social justice (Elkington [2]).The idea was that a company can be managed in a way that not only earns financial profits but which also improves people's lives and the planet (Elkington [3]).

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Figure 1. Triple bottom line diagram illustration
(A Simple Explanation of the Triple Bottom
Line: University of Wisconsin [5])

TBL focuses on three main variables that must be taken into account. Those variables are defined by Hall & Slaper [4] as:

- **Economic Measure**
Variables that ought to deal with regards to money or economic value. i.e. expenditures, taxes, employment and business diversity factors.
- **Environmental Measure**
Variables that represent measurement of natural resources and reflect potential influences to its viability.
- **Social and Human Measure**
Variables that refers to social dimensions of a community or a region and could include measurements of education, health, quality of life or etc.

Engineering Economy

In this case, the method of evaluation based on economic measure is done using Economic Engineering. Engineering Economy is techniques that simplify comparison of alternatives on an economic basis. As company makes decision on a regular basis, decision that usually involves financial and capital resources it is very important to have a fundamental understanding regarding the techniques and formulas. Since most decisions affect what is going to happen or done, the time frame of engineering economy is primarily the future. Therefore the numbers used in engineering economy are best estimates of what is expected to occur (Blank & Tarquin [1]). The estimates and the decisions usually involve four essential elements:

- Cash flows
- Times of occurrence of cash flows
- Interest rates for time value of money
- Measure of worth for selecting an alternative

The criterion used to select an alternative in engineering economy for a specific set of estimates is called a measure of worth. The measure developed are as follows:

- Present Worth
- Future Worth
- Annual Worth

Annual Worth

Annual Worth (AW) value is the equivalent uniform annual worth of all estimated receipts and disbursements during the life cycle of the project or alternative, AW is easy to understand by any individual acquainted with annual amounts, for example, dollars per year The AW value, which has the same interpretation as A used thus far, is the economic equivalent of the PW and FW values at the MARR for n years. (Blank & Tarquin [1]). The following formula expresses the method to calculate annual worth.

$$AW = PW(A/P, i, n) = FW(A/F, i, n) \quad (1)$$

$$(A / P, i, n) = \frac{i(1+i)^n}{(1+i)^n - 1} \quad (2)$$

$$(A / F, i, n) = \frac{i}{(1+i)^n - 1} \quad (3)$$

A represents the dollar value of Annual Worth. P represents the worth of money at the present or start of an investment. The span of time is represented as n . The rate set for an investment is illustrated as i .

Minimum Acceptable Rate of Return or known as MARR is minimum value of the rate of return for an alternative to be financially viable. For any investment to be profitable, the investor (corporate or individual) expects to receive more money than the amount of capital invested (Blank & Tarquin, 2018). The Minimum Attractive Rate of Return (MARR) is a reasonable rate of return established for the evaluation and selection of alternatives. A project is not economically viable unless it is expected to return at least the MARR. MARR is also referred to as the hurdle rate, cutoff rate, benchmark rate, and minimum acceptable rate of return. Most companies use a 12% hurdle rate, which is based on the fact that the S&P 500 typically yields returns somewhere between 8% and 11% (annualized).

Replacement Analysis

A replacement analysis or replacement study is usually designed to first make the economic decision to retain or replace now (Blank & Tarquin [1]). The objective is to address the question whether a currently used or owned asset or services should be kept in use or immediately replaced. The decision to do with an existing asset are as follows:

- Keep using the asset
- Abandon and do not replace the method
- Replace but keep the previous asset as backup purposes
- Augment the capacity of the asset
- Dispose of the asset and replace with another

Three reasons to consider replacing an asset are as follows, physical or deterioration impairment that may hinder the responsibility the asset needed to fulfill, changing requirements that may not suited to the currently used asset and also the introduction of new and improved technology that is readily available. Some important terms of replacement analysis that is to be taken into consideration is the life of an asset, the following are different terms that may apply:

- *Economic life*: the period of time (years) that yields the minimum equivalent uniform annual cost (EUAC) of owning and operating as asset.
- *Ownership life*: the period between acquisition and disposal by a specific owner.
- *Physical life*: period between original acquisition and final disposal over the entire life of an asset.
- *Useful life*: the time period an asset is kept in productive service (primary or backup).

Replacement studies are performed in one of two ways: without a study period specified or with one defined. A replacement analysis determines when a challenger replaces the in-place defender. If the study period is known or planned then economic service life is not performed. The AW values for the challenger and for the remaining life of the defender are not based on the economic service life; the AW is calculated over the study period only. What happens to the alternatives after the study period is not considered in the replacement analysis.

Result and Discussion

Data that shows the usage of stretch wrap is required to determine the volume of pallet movement between the main warehouse to the three manufacturing plant. Collecting the data for the overall usage in the year 2019 to show a one year habit of demand. The following table shows the 2019 data of rolls used for lot A and B respectively of the main warehouse that house multiple component and material needed for manufacturing process.

Table 1. 2019 stretch wrap monthly usage

Month	Lot A (rolls)	Lot B (rolls)
January	758	666
February	680	966
March	359	556
April	430	688
May	397	576
June	218	254
July	335	785
August	287	860
September	226	540
October	424	638
November	157	374
December	323	288

The known information regarding the stretch wrap are that each of them cost around 2.64 USD per roll. The company spend a total expenditure for the year of 2019 amounted to 32,793.88 USD. The time to wrap around a single pallet is around 60 seconds (based on foreman accounts, no supporting data collected due to COVID-19). Determining the pattern of usage of a single roll of stretch wrap to wrap a pallet ensures that pattern of habit the workers are accustomed to using the method. The following table below shows the data collected through the week of usual traffic for each lot A and B in the month of March, 2020.

Table 2. Lot A stretch wrap and pallet traffic

Date	Rolls Used	Pallets
9	21	146
10	26	140
11	24	169
12	20	154
13	21	155
15	9	43
16	13	104
17	13	108
18	11	95
TOTAL	158	1114

Table 3. Lot B stretch wrap and pallet traffic

Date	Rolls Used	Pallets
9	28	137
10	26	140
11	29	147
12	25	121
13	33	175
16	27	143
17	29	157
18	7	49
TOTAL	204	1069

Next step is to calculate the rate of roll used to wrap a single pallet to determine how many pallets are wrapped on 2019. Then using the data collected, the rate of which to wrap a single pallet on lot A is 0.14183124 roll/pallet. The rate to wrap each pallet on lot B is 0.190833 roll/pallet. Figuring the requirements of alternative to accommodate the flow of moving pallet in and out of the main warehouse, taking into account the flow in one week, the following table shows the calculation figuring the requirement itself.

Table 4. Rolls to pallet conversion

	Lot A	Lot B
Most rolls in a month	758	966
Rolls per week	190	242
Rolls per pallet	0.1418	0.1908
Most pallets a week	1340	1269
TOTAL pallets a week	2609	

The most rolls used in a month for lot A is 758 rolls on the month of January while for lot B the most is 966 rolls that occur in the month of February. Assuming there is 4 weeks in a month, it is earned that rolls per week used are 190 and 242 for lot A and B respectively. Converting to most pallets moved are using the usage rate (rolls per pallet). Hence the most pallets moved from main warehouse to each of the manufacturing plant are 1340 and 1269, totaling to 2609 pallets. The earned total is the assumed capacity of the system of moving pallets.

Triple Bottom Line Measure

The process of analyzing whether there is a more sustainable and economically sound method to use is by designing well build criteria to base the analysis and decision to be made. Considering TBL as the principle of the of this process, three main criteria are divided into three, are Economic Value, Environmental Impact and Social or Human Aspect for evaluating whether to replace or keep using stretch wrap follows Triple Bottom Line approach.

Each criteria has several key attributes that suit and relevant to the cause. The method of evaluating is by using score tables to weight on each option based on the attributes. Every attributes are weighted equally.

Economic Measure

Measuring through economic value is important; every business should ensure its responsibility in the sense of profitability to the stakeholders. Every business must manage efficiently the cost and its asset that contributes to the overall economic growth of the company. To ensure which option of potential and current asset that is being used is the best securing method possible based on economical thinking, different attributes and factors are considered.

Based on the issue at hand, whether to replace or keep an asset the best method is using replacement analysis that measures each asset based on its economic value, in this sense by weighing the each of the asset's annual worth. This to ensure which option is economically viable and in money terms which is the better candidate. Estimating whether the cost is manageable to the firm or not.

Variable cost varies due to different factors such as changing output, market condition and etc. This type of cost is hard to manage due to for the most of it is not in the controlling power of the business, varying cost may eat up the profits that the business generates over time. A more manageable cost is a fixed cost and in this sense more preferable than variable cost.

Lastly, the attribute that impacts economically is the productivity. How each subjects impacts the productivity in terms of hours spent on doing the method against the volume of work and how many manpower needed to handle it. The lesser manpower needed the better. All the factors or attributes and data collected are summarized into table to be more structured and streamline process of thinking.

Environmental Measure

Each option will be evaluated on its impact on environment based on the 3R. This allows determining the impact it gives, how bad and good the tool brings to the environment. The basic values of sustainability are to reduce our use of resources, reuse any possible material to their fullest life and recycle our waste in order to sustain the heavy burden in the cycle of material. These three basic and understandable factors are used to judge the defender and the challenger.

Wastage measures the sum of weight from each option past their useful life. This generalizes the impact of both the defender and challenger as both are mostly using similar kind of material derived from plastic. This neglects the potentially different process it took to manufacture each specific types of plastic as it lacks the ability to measure the emission and related things, also to simplify the explanation and understanding of this topic.

Other factors are the reusability and the recyclability. This directly evaluates whether the subjects have the ability to be reusable multiple times and have materials that are recyclable.

Social & Human Measure

New ideas and methods should not neglect the human part of all things. A tool should ease and improve people effort and progress. This part values how the impact of the method is used by people, as in this matter the workers who are going to use the method. This is done by evaluating the ease of use to apply the tool to wrap a loaded pallet, the safety to the physical work environment and its flexibility or effectiveness to handle the work load. The three criteria are weighted equally as every one of them are important to the whole operation in the company.

Ease of use is an important factor to consider, advantages of this introducing new method that is easy to understand and improve the time it took to do the task. The problem of flexibility speaks about how the method or tool can handle different extreme of load of boxes. The more wide range of boxes it can hold the much better application it can be. Next factor is regarding safety. Working in warehouse and transportation is a labor intensive and pose dangerous physical hazard to everyone that works around. Factoring safety, examines whether there is a safety feature that increases the strength to hold and tighten during vibration or travelling through varying terrain. This ensures that the boxes that are transferred and the inventory within it are safe. Ergonomics are not accounted, due to any constraints that hinder the attempt to observe and collect data.

Evaluation Method

Evaluating and scoring based on the information and data that is going to be listed on the table are done by giving scores ranging from the lowest 0 to highest possible; 1.

Scoring to the quantitative data is done by rating based on how the least favorable number fares

against the most favorable. If the most favorable number is a quantitatively larger number then it is given a maximum score of 1 and the lesser number is given a score based on the scale it is against the better result. While in the situation if the given better-favorable number is a quantitatively smaller value than the rest, then scoring is done through an inverse scale.

The other problem is at the non-quantitative data, the qualitative data. The method is to give a binary approach, where the most favorable attribute of the method is given a score of 1 while the least-favorable attribute is given a score of 0. Every attributes within the 3 main considerations are weighted equally as per TBL values, then each of them are averaged and scored accordingly so, resulting to a final score based on 3BL.

The values and philosophy of 3BL constitutes that the economic values, environmental impact and human aspect are valued equally. Ideally, as evaluating based on the qualitative data should be on the hands of the company, as they are the ones who are impacted directly in this matter. But the situation at the moment of writing this is not ideal for conducting the scoring based on qualitative data.

Alternative Research

Researching for a potential alternative are done through scouring the internet and company website. After finding the potentially suitable alternative, query regarding related information about the offered alternative product are done contacting directly the company or business that provide the such product. Through defining the needs and volume to earn the specification and price for the product. Underlying criteria to be regarded as an alternative are reusable and fulfill the same role of stretch wrap. Hence the acquired alternative is the pallet cover. Pallet cover is a reusable solution, that provides a method to consolidate and secure boxes unto a pallet. Consist of mesh made of fibers derived from plastic. The method of applying this pallet cover can be described as applying a corset or a belt around boxes. The following picture illustrate the tool.



Figure 2. Pallet cover

Comparing based on the acquired information can be summarized as below. The information for pallet cover is provided by Shenzhen Sunnice Textile Co.,Ltd through negotiation.

Table 5. Comparison of characteristics

Characteristics	Stretch Wrap	Pallet Cover
Price per item	2.64 USD	26 USD
Weight per item	2.8 kg	15 kg
Time to apply	~60 secs	~40 secs
Usability horizon	Single use	3-4 years
Flexibility to loads	Very flexible	Depends specs.
Sustainability	Recyclable	Recyclable & Reusable

Triple Bottom Line Analysis

Analyzing based on the created measure and the known characteristics supported by data and specifications earned through research are done.

Economic Analysis

First step is to calculate the economic valuation of stretch wrap and pallet cover. Based on the criteria created, it required 2609 items of pallet cover to handle the load of moving pallets in a single week, the number is gained from Table 4. Calculating for the annual worth as per replacement analysis basis can be seen seen at the table 9 and 10 respectively for stretch wrap and pallet cover. Assuming a 15% rate of MARR and assuming that after 3 years (worst case) the pallet covers are discarded. Based on the formula (2), resulting an annual worth value and present value as such.

PT. X spent 32,793.88 USD to procure stretch wrap on the year of 2019. That number will be made as the baseline for the annual worth value. Assuming that every year the company spends roughly that number. A study time of 3 years to convert the 32,793.88 USD to the value of present worth, earning the number of 74,868.43 USD. This number means that to provide the capital for a 3 years worth of stretch wrap based on the volume of movement on the year of 2019.

Calculating for the alternative, the pallet cover. Priced at 26 USD per unit and using the number earned from the understanding the data on table 4, with a capacity of moving pallets of roughly 2609 pallets that need to be consolidated and secured, with one pallet cover to secure one pallet. Totalling to a initial investment of 67,834 USD to procure a 3

years worth of pallet cover (worst case scenario of study time). Calculating using the calculation (2), using the initial investment as *P*, it is calculated that the annual worth for the pallet cover roughly amounting to 29,711.29 USD per year.

The calculated annual worth and the several earned information are the formulated together into the measure table at table 11. The manhour are the time spent on a single month (22 days work week) to consolidate goods unto pallets. Based on respective 60 seconds and 40 seconds time to apply for stretch wrap and pallet cover. Equating to 173.5 hours for stretch wrap and 115.6 hours for pallet cover.

Table 6. Economic measure table

	Stretch Wrap	Pallet Cover
Annual Worth	32,793.88 USD	29,711.29 USD
Cost Type	Variable Cost	Fix Cost
Manhour	173.5 hours	115.6 hours

The known values are then translated into a more equal standing and able to weigh. Converted valuation are shown at the table below.

Table 7. Economic score table

	Stretch Wrap	Pallet Cover
Annual Worth	0.91	1.00
Cost Type	0.00	1.00
Manhour	0.67	1.00
SCORE	0.53	1.00

Environmental Analysis

The environmental analysis explains the impact to the environment based on simple 3R values. Generalizing the wastage to accordance with the 'Reduce' value, the numbers are presented as the overall weight in kilogram of the total pieces from stretch wraps and pallet covers.

Stretch wraps waste using usage data collected from the year of 2019, the business used 6127 rolls of stretch wrap with each of them weighing 2.8 kg totaling to 51,466.8 kg of waste in the span of 3 years, while on the other hand with each pallet cover weighing around 15 kg, can total up 39,135 kg in the span of 3 years.

While both the stretch wrap and pallet cover are made of plastic based material that can be recycled if through a recycling process, but stretch wrap is a single use material and can be used multiple times after its initial use rendering it unable to be reuse. While the pallet covers is a more versatile product being able to be used multiple times for 3 to 4 year time. The data is shown below.

Table 8. Environmental measure table

	Stretch Wrap	Pallet Cover
Wastage	51,466.8 kg	39,135 kg
Reusability	Single use	3-4 year
Recyclability	yes	yes

The known values are then translated into a more equal standing and able to weigh. Converted valuation are shown at the table below.

Table 9. Environmental score table

	Stretch Wrap	Pallet Cover
Wastage	0.76	1.00
Reusability	0.00	1.00
Recyclability	1.00	1.00
SCORE	0.59	1.00

Social & Human Analysis

In the sense of social and human aspect that speaks about how the techniques impact the human aspect of the work environment directly. Easily translatable is speaking about how easy and quick each method or technique can be applied. Stretch wrap time to apply is around a minute while on the pallet cover it is suggested taking around 40 seconds to apply. Pallet wrap is also a relatively straight forward method to secure a load in a pallet where it can handle different loads and size of bulk of boxes or materials, an almost limitless method. Pallet cover is restricted to its specification and limitations, it couldn't handle extreme sizes and only limited to its specifications. The pallet cover is offered with security enhancing features, like hooks and straps that increases the strength to hold heavy load better and maintain a better form integrity. While the stretch wrap has no added safety features and only depends heavily on how it is applied and wrapped.

Table 10. Social & human measure table

	Stretch Wrap	Pallet Cover
Ease of use	60 seconds	40 seconds
Flexibility	Highly flexible	Restricted
Safety	None	Hooks, straps, etc

The known values are then translated into a more equal standing and able to weigh. Converted valuation are shown at the table below.

Table 11. Social & human score table

	Stretch Wrap	Pallet Cover
Ease of use	0.67	1.00
Flexibility	1.00	0.00
Safety	0.00	1.00
SCORE	0.56	0.67

Result

The score gained from the economic, environmental and social-human measure can be summarized into the table 12 below. The final score for the TBL analysis is earned from averaging the three values of TBL. The better score shows that there is a possible and viable alternative to the stretch wrap in pallet cover. Pallet cover is the overall better solution, winning on the three attributes or metrics set.

Table 12. TBL score table

	Stretch Wrap	Pallet Cover
Economic	0.53	1.00
Environmental	0.59	1.00
Social & human	0.56	0.67
SCORE	0.56	<u>0.89</u>

Attaining an average score of 0.89, pallet cover enables a cost saving in investment and a potential saving in manhour spent on the process of consolidating goods. It only struggled at the flexibility to handle . The specification restricts the varying loads it can carry, could not wrap around small loads nor larger loads. It shouldn't be a concern as there is safety precaution restriction on how large a pallet can handle on PT.X

Conclusion

Stretch wrap is a plastic based material. It is a widely used method by companies, organizations and government entity to secure, protect and consolidate boxes, materials and various items unto a pallet. While offering many upsides to businesses and firms, there is an increasing dilemma due to a severe dependent on the material that makes up stretch wrap that is a plastic derived material. Stretch wrap can be characterized as a single use item. It can only be applied once to a palletized load and can only be opened up by tearing and ripping it up to allow access to the object within it. After that the material is thrown away into dump and usually ends up in landfill or worse, especially in a region that is relatively less stringent on plastic waste and lack the infrastructure needed, like specific trash collection system and recycling center. This is a sustainability problem and an environmental nightmare for businesses, especially PT.X .

Approaching this problem should not focus only on the environmental issue but as a business there are a lot of things to consider. Here is the role of Triple Bottom Line philosophy plays into. Triple Bottom Line allows a mindset on dealing with projects or basically any sustainability issue that a business may face with a mindset that cater the need of said business and any stakeholders that is affected.

Composed of values such as Economic Value, Environmental Impact and Social Aspect, each of them are as valuable as the other and shouldn't be left out when building a sustainability and environmentally program or project.

Approaching the problem at hand with Triple Bottom Line, evaluating whether there is an alternative to stretch wrap that is a viable investment, a more environmentally friendly and sustainable method and doesn't burden the process of consolidation of goods. Through researching and browsing the internet, scouring marketplace and companies website results in a pallet cover. Pallet cover is a reusable method to secure and consolidate boxes or goods unto a pallet.

The result of the analysis shows that Pallet cover is a viable option, economic wise, sustainable and doesn't impair the process in the warehouse and logistics. It is a more attractive investment and could save the business around \$3,000 every year from using it rather than stretch wrap. It is reusable for at the least 3 years and can last longer if used accordingly. It also produces less waste in term of weight, producing a waste of 39,135 kg (assuming to last at the least, 3 years) in contrast of stretch wrap that produces waste up to around 51,466.8 kg. Pallet cover is a suitable alternative and easily recommended for business especially PT.X.

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