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Taxonomy of Factors for Lifetime Buy

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Abstract

As products become more electronically complex and component lifecycles are shortened due to rapidly changing technologies, obsolescence management has become a challenging problem associated with sustainable products. One of the most common strategies to manage obsolescence is to purchase enough components to sustain the product over its life in operation. This strategy is known as lifetime buy. Purchasing components for the life of a product depends on satisfying demand, as well as maintaining the product in the context of its use within larger complex products or systems. Firms must also consider manufacturing systems and support systems that were built for the product. Component loss due to damage or expiration in storage and scrap during manufacturing also contribute to lifetime buy quantities. Product support systems, such as warranties and product replacement programs, can consume a portion of lifetime buy reserves and lead to unsatisfied demand from customers. This paper takes on optimizing lifetime buy decisions by investigating the myriad of factors impacting total costs. A taxonomy is put forward that provides the basis for a comprehensive decision support tool, capable of assisting lifetime buy quantity decisions over the product lifecycle.

Keywords
Obsolescence, Lifetime Buy, Warranty, Final Order

1. Introduction

In 2006, the U.S. Department of Defense estimated annual cost to the U.S. government due to obsolescence and obsolescence mitigation to be $10 billion annually [1]. Components of products becoming obsolete over the product's life are some of the most costly problems and are prolific in almost all industries. Since 2006, products have only become more technologically advanced and the cost of obsolescence management is rising.

Due to the unpredictable nature of obsolescence, many firms take reactive approaches to finding solutions to problems caused by obsolescence. The most common of these approaches is lifetime buy. A lifetime buy is when a firm places a last order for the obsolete part. This order will create a stockpile that the firm will then use to continue product undisturbed. These stockpiles can be planned to last for years [2]. A lifetime buy can also occur before obsolescence occurs, even at the time of initial product launch, with the intention of assured replacement parts. Indeed, the literature shows a growing focus on calculating demand for the product, determining how long the product will be in production, and then ordering that quantity demanded for that duration of time. Additional work in this field also shows how individual factors such as warranties or counterfeiting [3, 4] can also affect order quantities during a lifetime buy. In this paper, a relational factor framework, represented in terms of a taxonomy, is presented to organize and describe how additional factors affect lifetime buy decisions.

As shown in Figure 1, factors in the framework are organized first into five key areas:

- Sales Forecasting
- Irreversible Component Damage in Supply Chain
- Supplier Problems
- Warranties and Maintenance Programs
- Economic Analysis

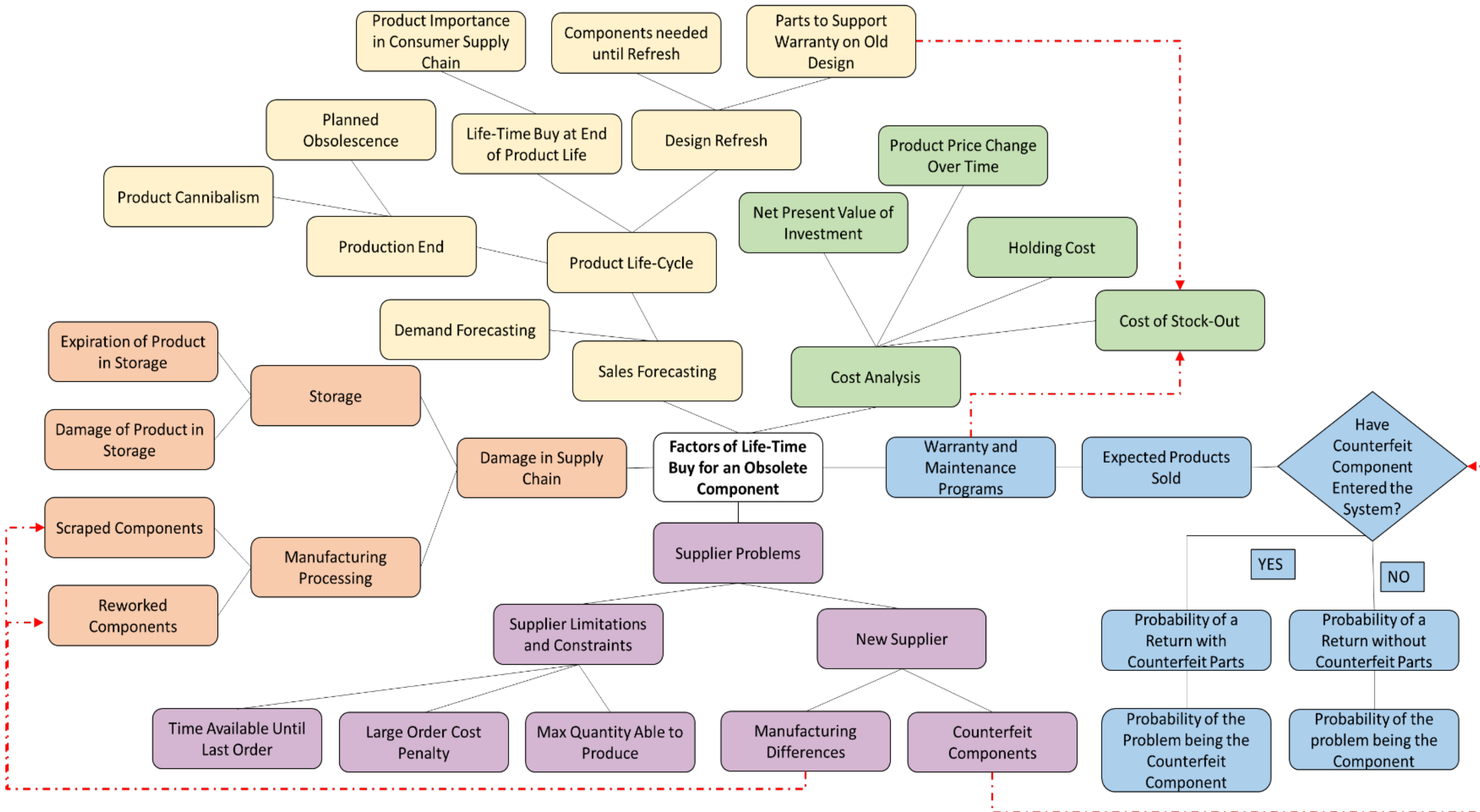

Figure 1: The Relational Factor Framework (Taxonomy)

The framework takes into account factors such as losing components in the supply chain, risk of counterfeit components from new suppliers, and the effects of counterfeit components on warranty return rates. The framework also supports the ability to perform economic analysis with insight into how lifetime buy costs propagate over time. Collectively, the five key areas enable informed decisions for firms using lifetime buy as a strategy for obsolescence management.

2. Sales Forecasting

Sales Forecasting is one of the first factors to take into account when calculating a lifetime buy quantity. Sales can be broken into two components: demand forecasting and product life cycle. Demand forecasting focuses on quantifying the consumers' want for a given product [5]. Demand forecasting and sales forecasting are not the same. Sales represents the number of products sold to satisfy consumer demand. If a firm is transitioning from an old product to a new similar product, the new product will satisfy some of the consumer demand and thus decrease sales of the older product. Purchasers of lifetime buys need to account for not only the current product but also future products still in design and how those products will fit into the business model to accurately predict sales.

2.1 Production End

The majority of obsolete component problems are caused by the upgrading of manufactured products and toward new updated, and usually more technologically advanced, products. This is caused by a drive to increase market-share and profits in order to remain competitive in an evolving market. Product cannibalism and planned obsolescence are both used by firms to keep market-share and move consumers to new products. In planning a lifetime buy, firms must not blindly buy enough components to satisfy consumer demand. Instead, firms must plan how future products will shape sales for current products. Designing another product that will cannibalize sales of the product with the obsolete component will inherently decrease sales after the new product is released; therefore needing fewer parts for the lifetime buy. In contrast, planned obsolescence of the product with the obsolete component will give firms a set duration of time to maintain obsolete components in inventory. A hard product stop production date will cause consumers that use a product as a component in their products to do a lifetime buy for the firm's soon to be obsolete product.

To account for this spike in demand at the end of the product's life cycle, firms must investigate the importance of the product against manufacturing costs, the products of the firm's customers, and the customers' ability to switch to other products. For example, many companies in the defense industry have a yearlong product testing and approval process. These companies will have to use the firm's old product that contains the obsolete part for at least a year. That year does not include the redesign time needed for a company's new product to be designed before being submitted to the year-long test [6].

When determining a lifetime buy quantity it is important to the firm's strategy for not just the product with the obsolete part but for all products. Both product cannibalism and planned obsolescence can measurably shrink the number of years that a firm is buying in a lifetime buy mode.

2.2 Design Refresh

Over a product's life cycle, numerous components can become obsolete. Maintaining obsolete parts in a product can be expensive. Firms minimize the number of obsolete components by having incremental design refreshes [7]. The newly designed product is sold as the same product, but does not use obsolete components in manufacturing. The design refresh will cause lifetime buy quantities to only last until the product's design refresh and not until the end of the product's life cycle.

3. Irreversible Component Damage in Supply Chain

After a lifetime buy is placed, the components are shipped and make their way into the firm's supply chain process. Lifetime buys can span up to 10 years, or longer, with the first stop for the majority of components being the warehouse. Warehouses can be mysterious and dangerous places. Components can be misplaced and damaged over their long stay at the warehouse. If components are sensitive to handling, temperature, or water, storing all the components safely for the life of the lifetime buy can be difficult. Also, during manufacturing processes a certain scrap rate is expected and some of the obsolete components will be reworked or salvaged from the scrapped sub-assemblies, but not all of them.

Damaging of components during the production process is important to keep in mind while computing a lifetime buy quantity. A product with high scrap rate and an obsolete component that is difficult to store will increase the number of components of the lifetime buy compared to just looking at consumer demand allow.

4. Supplier Problems

4.1 Suppliers Limitations and Constraints

The original problem triggering the lifetime buy is the suppliers' warning that production will end soon. A firm that is faced with this problem and chooses to react with a lifetime buy must first consider whether the component is custom or commercial off-the-shelf (COTS). COTS components have more suppliers and will create fewer constraints for the purchasing firm.

The first factor needed from the supplier is the time available until the firm can place their last order. The farther out the last order date, the more time the firm can find alternate and/or additional suppliers. A lifetime buy can be a reserve for numerous years. This means the order quantity will be considerably more than an ordinary order to the firm's current suppliers. These types of orders can have large transportation fees and even increased component cost if firms are bidding for the last batches of components [8]. With the firm having to place an atypically large order many suppliers alone cannot fulfill the order. This is why the time until the last order date is important because firms may have to find numerous suppliers to orchestrate the lifetime buy.

4.2 Counterfeits and Reusing Components

Procuring the quantity needed for a lifetime buy can be complex due to the possibility that the large order quantity will need to be split over numerous suppliers. But remember, the reason for the lifetime buy is there are few suppliers of the component. The lack of suppliers and access to information found on the Internet is pressuring firms to use less well-known suppliers. In some cases, this includes using eBay and other peer to peer selling sites. These practices lead to the introduction of counterfeit parts entering the supply chain. Counterfeiting covers a range of meanings; everything from selling scrapped or stolen goods to illegally manufacturing components from original molds or designs [9].

One area, counterfeiters specifically target is obsolete products or other legacy devices [10]. These counterfeit suppliers leverage the knowledge that each day the potential customer's supplier options are dwindling and has a desperate need for these parts to keep up with production. Unfortunately, these suppliers become more prevalent when it is time to make a lifetime buy. To minimize the risk of purchasing from a counterfeiter, the following advice, or rules, have been suggested [10]:

- Look at how long the supplier has been supplying the parts. New producers of an old part can be a sign of counterfeiting.
- Look for wear on the products. Salvaged items can be rebranded and sold.
- Countries with poor IP laws can be safe havens for counterfeiters.
- Check manufacture ID number against products currently owned and verified as authentic. Many counterfeiters will use other numbering systems or non-typical fonts that can give away its illegitimacy.

5. Warranties and Maintenance Programs

Firms for a myriad of reason have begun to offer warranties and maintenance programs with the purchase of their products. Many of these programs last beyond these products' production life cycle [11]. An effective lifetime buy quantity can be crucial in supporting these programs and preventing cost from expanding.

An order quantity calculation that is too small will be allocated to the most recent needs for the component and the firm will first see affect to farthest out uses of the component, most commonly, warranties and maintenance programs after production of the item has stopped. If replacing the component is the only option to fix a product still covered by a warranty and maintenance program, the company may have to replace the whole product with a new product for free. And without the component, the company must find other, sometimes costly, means to honor that contract.

The expected quantity required to cover all repairs and the expected quantity demanded to produce assemblies must be combined to fulfill all instances the component could be utilized in the future. For firms to calculate expected quantity to cover repairs, lifetime buyers can use Equation (1):

$$N * P(R) * P(C) \quad [12] \tag{1}$$

The variables in Equation (1) represent the following:

- N = Number of products sold under warranty or a maintenance program and contain the obsolete part
- P(R) = The probability a sold product is returned under the warranty or a maintenance program
- P(C) = The probability the obsolete component needs to be replaced on the returned product.

5.1 Counterfeits Components Effect on Warranties and Maintenance Programs

The probabilities used in the equation above will be reasonably calculated using data from current return rates and the maintenance logs that document the problem with the returned products. The probabilities are correct for non-counterfeit components. However the rate products are returned can increase if counterfeit components enter the supply chain due to the lifetime buy and reduce the quality of the product. This increase in defective parts will increase the lifetime buy quantity.

6. Economic Analysis

Obsolescence management is usually quantified as a cost avoidance [13]. Cost avoidance is savings from spending lower quantities sooner to avoid higher costs later [14]. After quantifying the factors, discussed previously, and calculating a prediction of how many parts the system as a whole will need, the firm must conduct an economic analysis. The economic analysis is one of the most important factors in the lifetime buy process because without one the cost avoidance precautions may become additional hidden costs.

6.1 Holding Cost and Opportunity Cost

One of the largest factors in the cost of a lifetime buy is the cost of holding the additional inventory for years. These increasing costs can cause once relatively cheap components to have a remarkably higher cost when finally produced and sold. Lifetime buys cause firms to purchase years worth of inventory at one time and use them accordingly over the following years. During an economic analysis, a firm needs to be aware of the cost of having funds tied up in capital as opposed to in research and development or another project that can generate revenue.

The graph shown in Figure 2 was created using a part cost of $100, a discount rate of 10%, and a standard annual holding cost of 20% of part cost recommended by Chase and Jacobs in Operations and Supply Chain Management [15]. The graph shows how much the original part costs ($100), the value of the part if the money had been invested at a 10% return (Opportunity Value or Net Present Cost), and the holding cost of that up until that year.

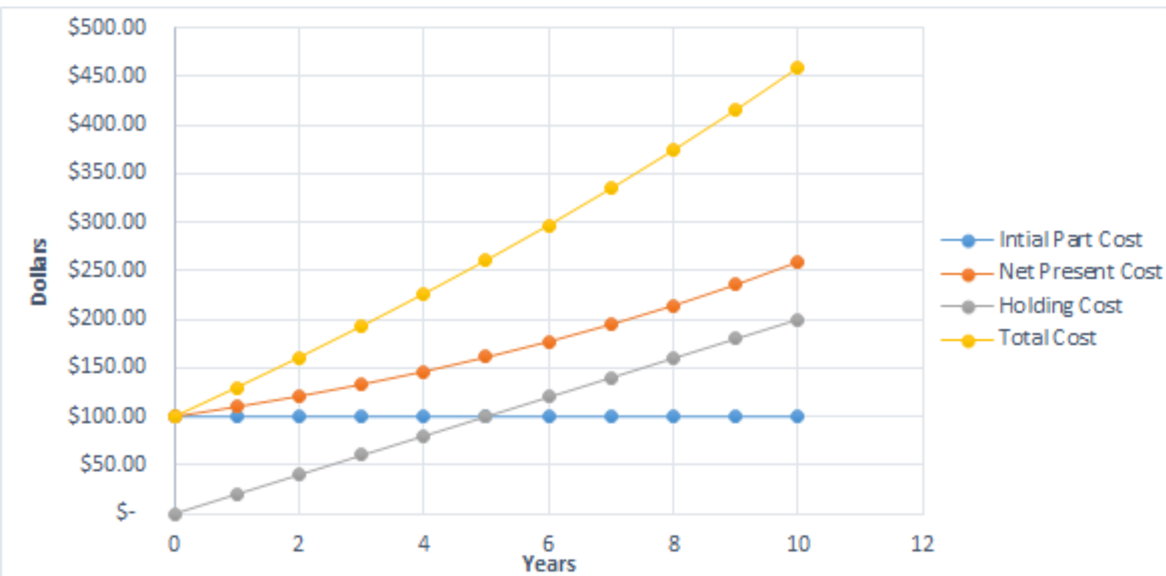

Figure 2: Lifetime Buy Costs over Time

Due to many firms' planning redesigns every five years for products with components with high obsolescence risk, lifetime buys over five years are in the minority. Because of this we will look at the cost of meeting demand five years out from the lifetime buy. These parts will have been stored in the warehouse for five years then assembled and sold in the fifth year. In this year, a part originally bought for $100 will need to make at a minimum $261 to cover the holding and opportunity cost over the five years. Both holding and opportunity cost need to be taken into account because that total number is the amount the firm would have if it did not invest in those parts and spent those funds on another project.

The longer a component is stored, the longer the firm's assets are tied up in capital; this greatly decreases margins on the product. For example if a product is manufactured using seven components all costing $100 ($700 total) at the start and the product is sold at $1000. The product has a 30% margin. Now consider that one of the components is in the third year of this lifetime buy and another is in its fifth and not have a combined holding and opportunity cost of $193 and $261, respectively. The new total cost is $954, which is only a 4.6% margin.

Albert Einstein was quoted as saying, “Compound interest is the eighth wonder of the world.” Figure 3 shows the power of compounding interest and the dangers of satisfying far future demands without taking into account the cost of tying up assets over that time. This problem only greatens as time increases. Continuing the above example of the seven component product sold at $1000, if only one of the parts is using the tenth year of lifetime buy reserves and all other parts can be bought in that year, the total cost of that one part is $459 and the total cost of the product is $1059. Due to the holding and opportunity cost, the firm now loses $59 on every sale.

The scenario of a ten year lifetime buy for a product’s life cycle may be extreme, but a production cycle of five years and then a five year warranty is highly plausible. The firm ties up capital in the warehouse for ten years so the holding and opportunity cost incurred are the same in both scenarios.

6.2 Changes in Price Over Product Life Cycle:
As products age throughout their lifetime and new products enter the market, lowering prices is a common strategy to continue regular sales levels. Firms in highly price-inelastic market (markets where a small decrease sees a huge increase in sales) will be especially at risk of the price of products lowering over time. A product with a dropping price and increasing holding costs will start cutting into its profit margins from both directions and the first time period with net negative profit is rapidly approaching. When calculating a lifetime buy quantity, firms need to account for this to prevent over ordering.

6.3 Negative Profit: A Good Business Decision:
In the previous section, the ballooning effect of costs over time was demonstrated. This section explains why business decisions that result in negative profit in the short run may be the correct business decision. Firms today sell by creating relationships with their consumers. The relationship may not be personal, but solely based on trust in a product’s integrity and faith the firm will honor and support contracts. The decision to create safety stock and over buy during a lifetime buy will increase cost. These costs might pale in comparison to the damage to the firm’s reputation and sales if production stops and warranties and maintenance programs are not honored.

7. Summary and Conclusions:

In the growing age of more electronically complex products, component lifecycles are shortened. Firms in an attempt to manage these constant changes must react with an obsolescence management strategy. Lifetime buy is one of the most common strategies. Buying components to only satisfying demand is a frequent mistake made by lifetime buy purchasers.

Understanding the relationship of the product in the suite of products the firm sells and the product’s place in the marketplace can help predict quantity of parts required to meet the firm’s future needs. The creation and maintaining of the product throughout its life cycle has additional ramifications in lifetime buy quantities. Firms with high scrape rates or high damage rates in storage need to purchase additional components to account for the expected destruction of those components. Buyers need to work with current suppliers to accommodate abnormally large orders and when current suppliers cannot complete orders, vet new suppliers for manufacturing differences and potential counterfeits. This includes understanding how warranty and maintenance programs can require additional components for longer than the product’s production life cycle and how counterfeit suppliers can effect these programs. And lastly, the importance of economic analysis in recognizing how costs affect buy quantities.

The taxonomy described lays the foundation, or framework, for further work in obsolescence management. One of the next steps should include quantifying, and sometimes, the creation of metrics for the individual factors discussed herein. The creation of mathematical models, simulations, and other tools using the newly quantified factors will enable industry to better estimate lifetime buys quantities.

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