Effectiveness of Push-Pull Method in a Hydraulic Sales Environment

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Abstract *– In today industry of sales, the main activity is to manage inventory in the fastest way possible. In the same way a warehouse main activity is to move the inventory from point a to point b in the fastest way without ever being out of stock. In a combine environment dedicate to store and sale products, these two expectations are meet and combine. Here the application of a push and pull system is dedicated to combining a forecast and Kanban to predict and establish a new sale pattern and to reduce the amount of stock at the same time. The work must important venue is the application of a percentage value while calculating the seasonal value to permit the process to have an expectancy of growth assume by the company predictive guidance. The final forecast done well document the futuristic of the present atmosphere and can be adjust with a minimal arrange of the expected growth in the future and if there is a case where handling of a product go beyond expectance there is the Kanban to sort the problem out and recheck the company situation at the moment. In the future it is recommend to have a research on the effect of having one cargo ship to attend the need of an entire population such as Puerto Rico.*

Key terms *– Deseasonal and Seasonal Value, Forecast, Kanban, Percentage of Growth, Push/Pull.*

INTRODUCTION

During recent years the companies in the world have become more competitive, making the industrial world more efficient and resolved. As this goes on, some companies have rearrange themselves and the company structure, others have change the process of production or displacement. This has helped them improve in some ways to achieve efficiency and reliability. It can be said that one of the biggest improvements are based on the ideas of the great master of industrialization Dr. Shingeo Shingo, who has given the world the Toyota Production System (TPS) and more. During his life time he developed some of the best modern ideas and some of the best guidance of how to reduce company inventory and still develop products on time.

His idea of having the less amount of raw material helped companies around the world develop more space for finish goods and have the on hand raw material to maintain a healthy production line. To the point that by his guidance, Toyota industries became one of the world's leading automotive corporations.

Following his teaching, many have made adaptations that help improve different enterprises. This research is going to be based on some of Dr Shingo ideas and some implementations done to, Toyota industries that have make a significant influential performance in the enhancement of the working environment as well as the production time.

The company at hand is a warehouse that have over 300 different hydraulic products, some products need to be assemble in a production line, others can be sold separately and some are to be sold in groups. Questions to be answered in this research are can it be possible to make the stock lower, can the company reduce stock and elaborate a new production line, can it continue to growth with this new ideas?

Six Sigma was developed in the mid 1980's at Motorola. Over the last few years it has received recognition and many companies such as General Motors, Ford, GE and Honeywell, adopted it in order to achieve their goals. Six Sigma is a business strategy that provides businesses with the proper tools to improve the capability of their business processes. The purpose of process improvement is to increase a process performance and decrease its variation. This will lead to a reduction in defects and

improvements in profits, organizational culture, product quality and business excellence.

Problem

At the moment the company necessity is to maintain a useful amount of stock of products. In this case, as the company has base in Puerto Rico, they are in needs of having the lowest amount of stock, do to in part by government taxation and by the situation of being an island. Products stock at the company are sold randomly throughout the year and some are sold in a daily base. The mayor stock analysis is base in two standard points of view:

1. Replenish every year at the beginning of the year;
2. Replenish when the product stock is low or zero.

Additional to all this, the company is rearranging a production line.

The situation with item 1 is that;

- It is sold daily,
- It is used in production line, and
- It is sold to suppliers and sold in batches.

The item 2 has a different situation;

- It is sold randomly, and
- Could be used on the production line when the item 1 is sold out.

Objectives

The purpose of this research is to create a better way to manage stock flow to be used in none predictable items. Primarily the situations is to create a mathematical way to calculate how many stock it is need of a none predictable item and how often it is need to replenish its stock. At the same time it is important to predict the future needs of each product and to acknowledge the previews tendencies the products may have. A sub-objective is to reduce unnecessary stock, to prevent been out of stock and to reduce errors in stock flow.

Contributions

Research in this area may help and represent a major group of companies all over Puerto Rico and the world. The impact or contribution given to the warehouse a lesser amount of stock for any particular product is that the warehouse may re use this available new space. Allowing a used spot to be free may help the company to bring a new product, may permit the rearrangement of all company product and could even bring a new production line to existent. Thru the knowledge of a futuristic consumption output of the product can help the company to create a sales strategy that can beneficiate the company. It can also help the company to work with their employees so everyone can work in unison. Another aspect that is being impacted is the financial system of the company. In this case, first there is the taxation. In Puerto Rico there is a law that affect companies that have store product for over a year they have to pay taxes for them. In the same line there is the fact that the company does not have to buy unnecessary amount of stock, which may help increment the economic value of their stock.

RESEARCH

Before starting to analyzing any data collected for this research it is important to know the mathematical accomplishment that have happened in the past. All corporation need to have products in stock to supply the needs of the customer and to supply other companies with new merchandise. Due to the corporation needs, research have been driven by three areas; supply chain, managing of stock and stock flow. Impacts in this areas are based on work studies that have been done in the applications of systems like Poke-A-Joke, Just in Time, Supply Chain Management, system transportation analysis, and others. Some works that have been studied, will not be mentioned in this research this can be because their use may help more but time, changes and applicability may compromised their implementation and they will be refer for future studies. Software integration is always a plus, but the company already have one that it is not an option. It is important that the research is concentrated in the following problems; the cost of having or not having stock, the unreliability of the supplier and the effect

that may happened if the cargo is stopped by the Transportation Agency and the fact that the company is not changing suppliers.

Literature Review

The researcher investigation went in the search of the best Just in Time (JIT) process that could be applied in this situation as the items to be study have random attributes. Understanding the definition of JIT as, *in a flow process, the right parts needed in the assembly reach the assembly line at the time they are needed and only in the amount needed.* [1] Let's define what was just read. First the parts need to be in the warehouse, this can be done by having the part with easy access when they are going to be use or next to the area of use if is in the assembly line. However, the second part said the *only amount needed,* here comes a situation for the warehouse is not near the production of the item and the acquisition of the item may take between three to four weeks. To cope with this definition the company must reduce the amount of stock to have the necessary parts of the initiative of this project.

Kanban

As it is said by Ichiro Majima in one of his books that *every company establishes production plan based on customer demand* [2]. Kanbans are ideal pulling systems that elaborate the ideal amount of stock to have, see Equation 1.

$$\text{Number of kanbans} = \frac{\text{demand in the cycle}}{\text{size of each container}}$$

$$K = \frac{D \times (TP + TD)}{C} \tag{1}$$

This equation represents the basic starting point of this research. In here it is note that the quantity of stock is going to be determine by the correlation of the time it takes to transport it and to the time it takes to be sold out. A margin of error is proposed, to identify the minimum amount of stock before asking for more. This is completely ideal because you cannot identify shipment problem, unreliability of the supplier or random stock flow or problems that happens. It is ideal because the amount of uncertainties that can affect the use of the item is driven by the demand of the product.

Forecasting

In an ideal world in the Kanban process a person may only need to ask in this case for stock when the stock is low, as the Kanban create a minimum amount of product to have in stock. However in reality we need help from the Material Requirement Planning (MRP), a computer software that help in production planning and Inventory schedules. *MRP is an inventory planning technique that computes the future requirements for subcomponents of an end product.* [3]

It can be said that forecasting is a develop part of this process. Forecast is a trend that used data to checked, in this case the warehouse data, to create a futuristic outcome. As forecasting use real base data it can be arrange in different forms by the user, application and product demand.

Forecasting Conditions

Forecasts are done based on past data and are created to simulate a pattern for the future. Therefore there are some conditions that have to be achieve first. There are the four principles of forecasting [4];

1. *Forecasts are usually wrong,* due to the fact that they look to map future events without considering future casualties, life changes and life cycles.
2. *Every forecast should include an estimate error,* it is important to establish this percent because it is expected to have an error and by having this expectancy one can arrange to have a minor effect in the final countdown.
3. *Forecast are more accurate for families or groups,* it is more accurate to follow a group than an individual because the information gather for a group is more richer than that of a simple individual where any particular event can cause a different outcome.
4. *Forecast are more accurate for near time periods,* reducing the time period helps to have

less uncertainty of the future and can help reduce the percentage of error.

One of the most important parts of Forecasting is the data collection this can help reduce the effect of the estimate error and can prevent future probabilistic problems. Thus, it is imperative to have a good control of the data recollection and in some ways creating a pattern may help future works and forecasts. In the book *Introduction to Materials Management* [4] they establish the fallowing principles;

1. Record data in the same terms as needed for the forecast;
2. Record the circumstances related to the data;
3. Record the demand separately for different customer groups.

These three principle that are proposed can vary from author to author but in a manner are the same. Having these guidelines may help future forecast and will create a good, organized and efficient way to analyze information.

Forecasting Elements

In the Book *Inventory Control and Management* [5], the authors present four different types of forecasting;

1. *Forecast*, which predicts future circumstance.
2. *Judgment forecast*, which are based on opinion.
3. *Casual forecast*, which use relationships between variables to forecast.
4. *Projective forecast*, which project past patterns into the future.

In the book *Introduction to Material Management* [4] forecasting can be categories in three stages; *Qualitative, Extrinsic and Intrinsic*. Qualitative goes to define the ones that project the future by means of judgment or intuition. This method is usually used by individuals with more knowledge in the work area and does not have have a mathematical approach. It is based more in experience and knowledge of the events than in the mathematical outpost of previews years.

Extrinsic forecasting can observe to be the one where the data comes from outsource information rather than the company logs, it contains a mathematical input and output. Mathematical input are based on the information of an outside source. For example, what kind of population will use our product in the future? The basic group of study is an outside source while the object to study is and inside object. The last one is the intrinsic a technic that used past data of an item to see how well it can be used in the future or in other words use historical data to plan ahead.

Table 1
Item 1 Data

Month	Quantity (Year 2)	Quantity (Year 3)
1	213	467
2	445	406
3	204	412
4	427	621
5	452	286
6	406	492
7	542	550
8	378	
9	474	
10	328	
11	179	
12	176	

METHODOLOGY

The company facilitate the data of two complete years and half of the third year in a table. That data came with the amount of sold items per day and hour. They also include the day the company restock the merchandise and the amount of merchandized that was restock. From that data it was decide to eliminate the entire first year because the data did not had enough values to procure a forecast. Table 1 and Table 2 show the representing data of each item. The

third year for each product is at a half because the data was collected in mid-year.

Table 2
Item 2 Data

Month	Quantity (Year 2)	Quantity (Year 3)
1	19	14
2	35	7
3	59	27
4	17	162
5	21	35
6	11	51
7	14	72
8	4	
9	2	
10	36	
11	22	
12	1	

To understand the data of each item it is important to have the following information. During the mid of the third month the company started to do a change in the production line. In this case item 2 became part of the production time. During the end of the second year the company quoted a special project. That project was worked in the fourth month of the third year. As it is a special project is important because the effect elevated the amount of sold items from 62 to 162. Situations that can cause a big discrepancy in ways of elaborating the forecast.

When the company order, new merchandise it usually takes around two weeks to get to the company premises. At the end of the second year this time became different due to the fact that one of the shipping companies shot off the route and the other reduced the shipping routes. The time change cause the shipment time to extended from a two weeks to a three weeks period. In the company, the shipment that comes in has an entire week where it is checked, analyzed and stock in its proper area. This situation added one week lead-time converting the total lead-time of the process to be of 4 weeks or an entire month.

With the information of these two products it was determined to implement a push-pull system. The Table 3 is the configuration used to further study this process. The implementation of Quarters was use because of the period of time it take to get the merchandise to do travel and refitting stock process. The yellow mark represent the real demand in the second year of the study. The deseasonilezed values represent the future value to be sold and the seasonal index represent the value of correlation between the demand and this value.

In this case, the equation for seasonal index got altered to affect a problematic occurrence in the data normally the equation is use as follows in Equation 2.

$$S = \frac{D}{D_d} \tag{2}$$

This form is used to evaluate the seasonal index of the first year. In it D represents the seasonal value and Dd the deseasonalized value. After that it is change to Equation 3.

$$S = \frac{\sum s}{n} \tag{3}$$

Where s represents the values of the preview year and the n represent the amount of month use to calculate s. In this case Equation 3 got alter to add a percentage value that is representative of the uncertainty growth that products must have in this period of time. This is shown in Equation 4 below.

$$S = \frac{\sum s}{n} + i \tag{4}$$

Table 3
Forecast table of Product 2

Month	Quarter	Demand	Deseasonalized value	Seasonal Index	Forecast
1	4	19	32	0.59	
2	3	35	30	1.17	
3	2	59	27	2.19	
4	1	17	25	0.68	
5	4	21	23	0.91	
6	3	11	21	0.52	
7	2	14	19	0.74	
8	1	4	17	0.24	
9	4	2	15	0.13	
10	3	36	13	2.77	
11	2	22	11	2.00	
12	1	1	9	0.11	
1	4	14	32	1.30	42
2	3	7	30	2.26	68
3	2	27	27	2.40	65
4	1	62	25	1.09	27
5	4	35	23	1.53	35
6	3	51	21	2.62	55
7	2	72	19	2.48	47
8	1		17	1.23	21
9	4		15	1.74	26
10	3		13	3.32	43
11	2		11	3.07	34
12	1		9	1.56	14
AVG	20.08				
a	-2.0944	Lead Time	1.0		
b	33.697	Container Size	25		
Order time in weeks	4	Kanban	15		

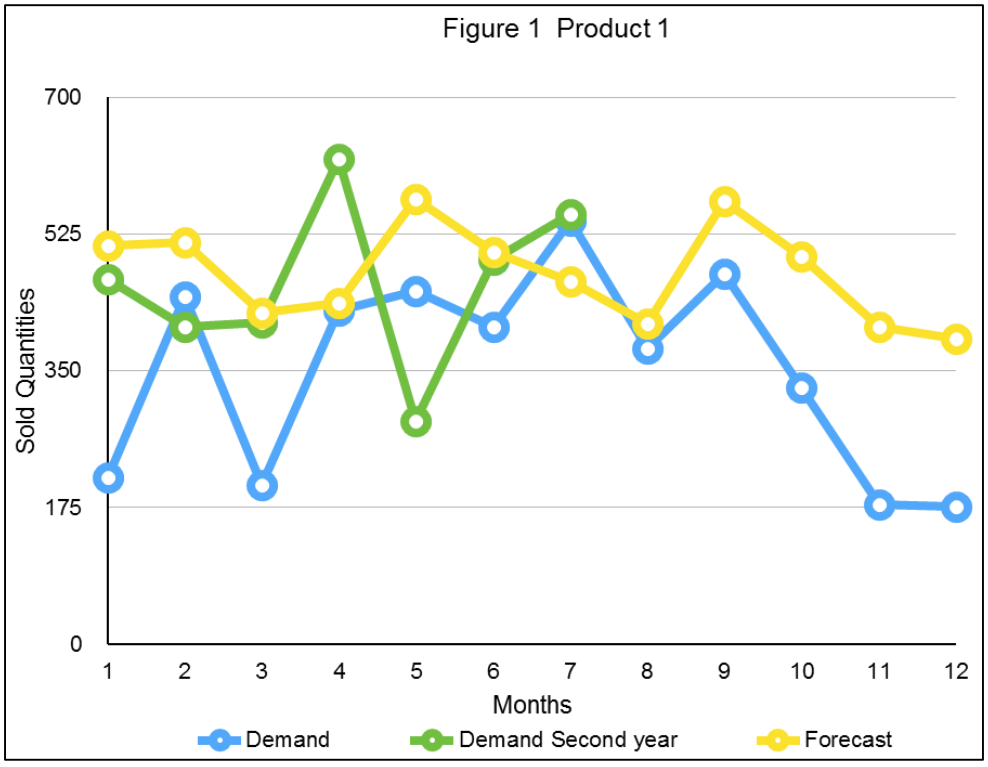

Figure 1
Forecast of Product 1

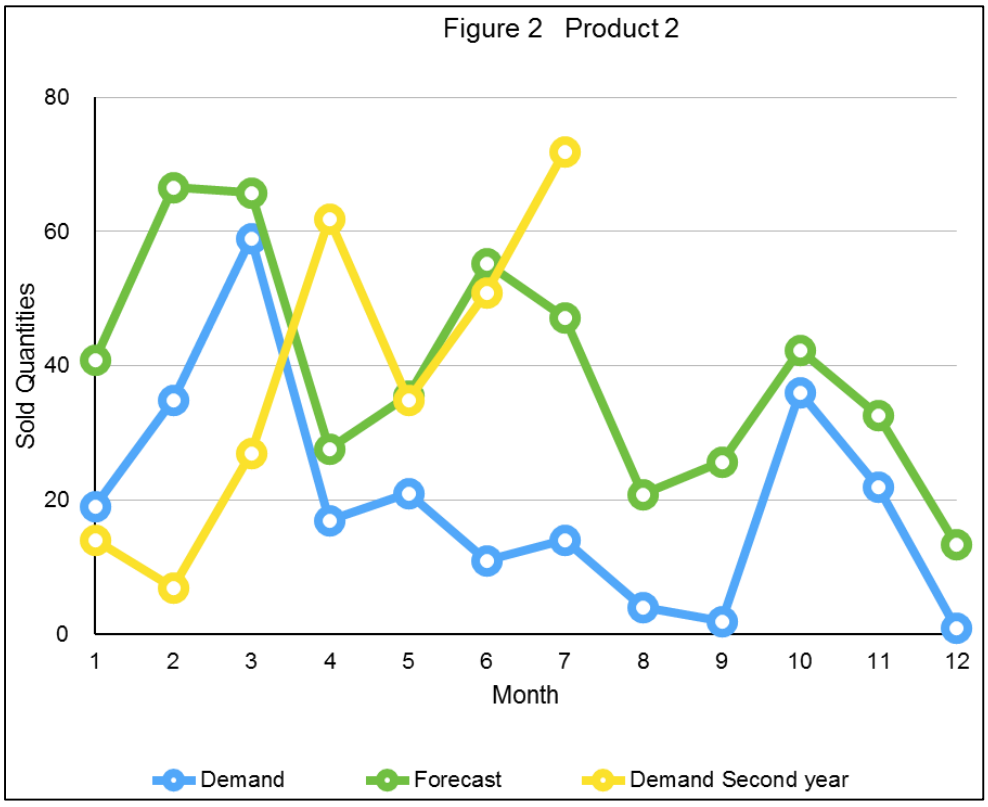

Figure 2
Forecast of Product 2

After calculating these values the process went to create a visual representation of the information in a way that could be understand. Figure 1 and Figure 2 show the values for each product. In each there is a representation of demand per year and a forecast for an entire year.

RESULTS

Product 1 calculation lead to a 10 Kanban minimum per month. This can be translated to 350 pieces to sale per month as the reality grew the results recommendation to 13 Kanban minimum per month for this product. Which represent a growth of 455 or 30% increase that do to the analysis of the first three month of the current year.

Product 2 calculations brought a 1 Kanban per month which would be acceptable if the product would have continue it's their course. Do the changes in the product usages, the recommendation for this product is that the Kanban to be 2 per month. This represent an increase of 100 %, from 25 pieces to 50 pieces per month.

The forecast for product 1 has an anticipate expectation from the company to increase value. This product increase is a relative small one. For consideration it was applied in the seasonal index, where it got a 25 % increase added to the original value. The forecast for product 2 is a different. The company expects a double increment in this product, in other words the expectation is to sale twice as more product than its preview year. Do to this fact, the seasonal index was altered but do to the reality of the situation the index increase was of 75%. The thing is that for every percentage it increase, the product expectation per month went to high and it became unrealistic. At some point the increment went over board and at other it went insufficient does the best quantity outcome came from a 75% increase.

CONCLUSION & RECOMMENDATION

The application of a push and pull system represent a way to managed inventory in a more adequate way. The stock flow of the company is way more accurate now and can be understood more, which let the company on making works on the ways they market their product. At the same time planning the future or knowing the possible future of the product allows the company work in a manner where the company knows how to alter their stock by month and when it is on the limits of his stock. As this is being applied the company has now a better understanding of their product and this help the industry get to their ideal point of view.

The following are some recommendation that are thought to be ideal to follow:

- A research on the applicability of this work in another type of industry or enterprise.
- It is recommend an investigation in the transportation system.
- A search investigation in new ways to reduce the inefficiency of our transportation system.
- Search if transportation efficiency can be improved by the incorporation with more ships, routes of transport and the effect in economic value of this new situations.
- Research can be done in the way the stock is reincorporated to reduce time and increase efficiency.

There are a lot of areas where another person can investigate, not all are mentioned. In Puerto Rico supply chain has a lot of places where it can grow and there are a lot of working environment that can grow with a better management of stock.

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