KANBAN system in Automobile Industries: Feasible Study

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Abstract

The current running company uses MRP system for production and inventory. The main client decided to change its ordering system to KANBAN JIT. Hence company should make decision either keep pervious system (MRP) or follow client and move to KANBAN JIT. The following report addresses the change to JIT and provide conclusion to the decision maker.

1. Introduction

Company which project has done located in Saudi Arabia. It started producing Auto parts since ten years ago when economical stimulations were given by government to produce inside country. The company produces more than eighteen group products, which include either one or more in each group. Electronic and Mechatronic are two main areas that company work on it.

Main client orders more than 95 percent of company product. The reason of that company count on one client is monopoly of products and only company that located in level one of client grading. Client has a grading system for its supplier, based on this system each supplier twice a year has audit by client in whole company area such as financial, production, supply chain, purchasing and after sell services. After audit each company based on grade that obtained divided in three levels. Level one company achieve 80 percent of client order, level two obtain 15 percent of order and level three get last 5 percent.

The company uses MRP system for production and inventory. Client decided to change its ordering system to KANBAN JIT. Hence company should make decision either keep pervious system (MRP) or follow client and move to KANBAN JIT.

2.1 Problem Statement:

Change in client ordering system that affects all suppliers responding. The decision should be to react to this change based on the capabilities and current situation in company.

2.2 Scenarios to deal with new change:

1- Follow same way as client to run KANBAN JIT system in company.

2- Keep MRP system and adjust based on new situation.

2.3 Goal of this project:

This project seeks to select one of the above two scenarios based on comparing them in all cost related on them. Moreover, after choosing the most appropriate one draw roadmap to obtain maximum efficiency.

3. Methodology:

First, negotiate with suppliers based on new ordering process and suppliers divide to two groups, follower, and not follower. Then Follower suppliers define their lead-time. KANBAN cards define based on new lead-time for follower. The suppliers who could not follow new system EOQ method use to order.

1- Predict demand for items that provide by suppliers who could not follow KANABAN system.
2- Designing the KANBAN system.

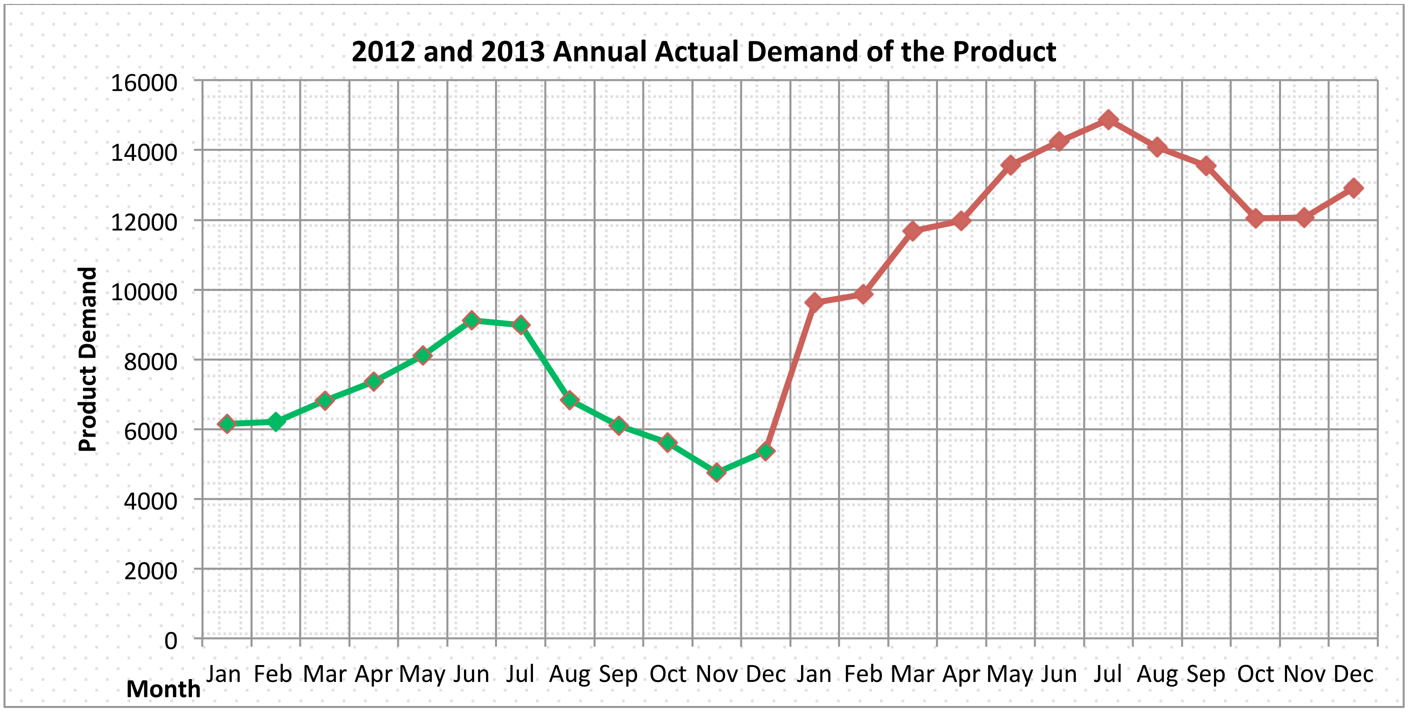
4. Forecasting the demand

Data and Analysis

4.1 Data

4.1.1 Historical Data

This project applies to the automobile industry in Saudi Arabia and I have been successful to acquire the historical demand data of the product for the preceding fiscal two years 2012 and 2013 respectively. The historical data illustration (snapshot given in Graph 1) and the detailed of the data is enclosed in Appendix 1.



Graph 1: 2012 and 2013 Annual Actual Demand of the Product

4.1.2 Analysis of the historical Data

The historical data of the product demonstrated a trend over the whole fiscal year, the historical demand commenced during the preceding two years with an approximate average of 8,000 products (the detailed data is enclosed in Appendix 1), then began experiencing upraising demand reaching an approximate average peak of 12,000 products. The trend of the historical demand gradually began from March till it ends in September (please refer to Graph 1). The trend of the demand clearly showed the peak during periods Jun/July.

The analysis of the historical demand clearly demonstrated seasonality, where the historical data series repeats itself every year.

4.2 Forecasting the future demand

4.2.1 Selection of the method to forecast future demand

In order to proceed with forecast of the future demand, first the quest was to find a forecasting model that incorporate the product trend in the market. Doing so, the forecasted figures will realistically reflect the market situation and will keep the reliability of the output data. The model chosen to forecast future demand was the Seasonal Factors for Stationary Series.

4.2.2 The method of forecasting

The seasonal Factors for Stationary Series method is a simple method of computing the seasonal factors for a time series with Seasonal variation and trend (Nahmias, 2008). The method requires minimum of two seasons of data, which I have the historical demand for 2012 and 2013.

The method simply works on computing seasonal factors of each period in the series by the following steps,

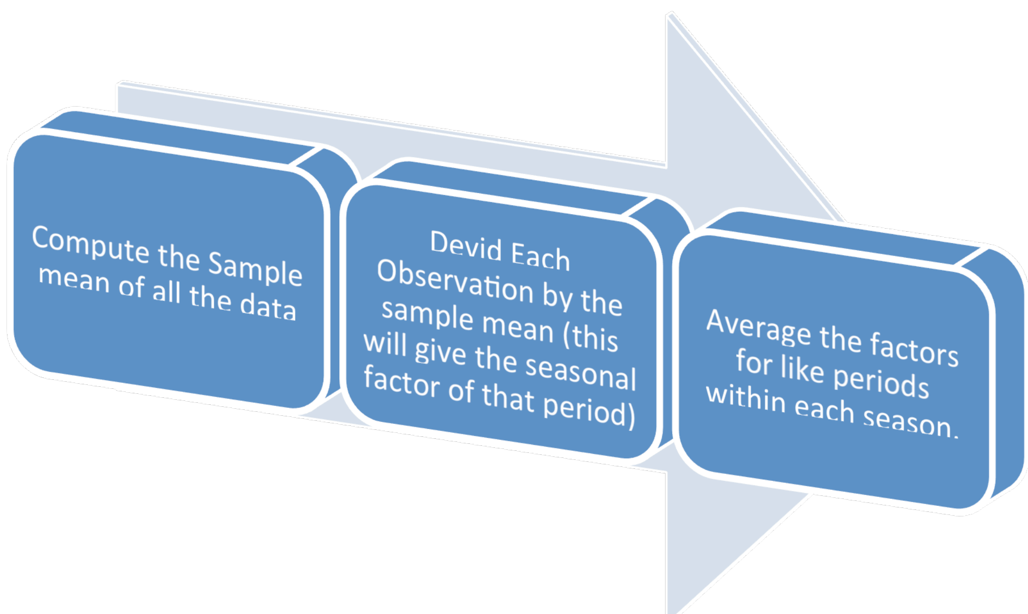
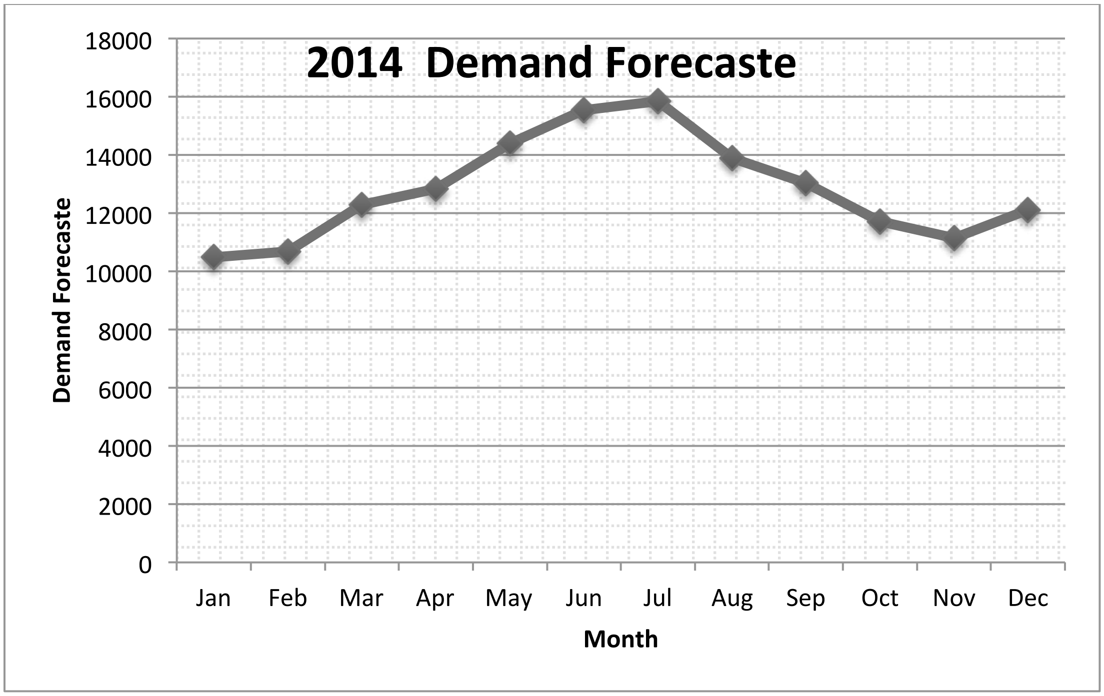


Figure 2: The steps in the method of forecasting, Seasonal Factors

4.2.3 The Results of the Forecasting Model

Now, applying this method to the set of the historical demand that I have, resulted in sample mean of all observation equals to (12833 products), then the Seasonal Factors of each period (month) of the last two years are 0.65, 0.65, 0.72, 0.78, 0.85, 0.86, 0.95, 0.72, 0.64, 0.59, 0.50, 0.56, 0.99, 1.01, 1.20, 1.23, 1.39, 1.46, 1.52, 1.44, 1.39, 1.24, 1.24 and 1.32. These factors represent the months starting from January and ending in December.
Now we average the factors for like periods, for example the seasonal factor for January 2012 is 0.65 and the one for January 2013 is 0.99; the resulted average seasonal factor for the period (January) equals to 0.82. Applying this to all the periods gives the following average seasonal factors (0.82, 0.83, 0.96, 1.00, 1.12, 1.21, 1.24, 1.08, 1.02, 0.91, 0.87 and 0.94.
Now to calculate the forecast demand for the year 2011, we multiply the average seasonal factor by the sample mean of all the historical demand. Doing so, the forecasted demand of the product for the year 2011 is as follows: 10484, 10687, 12286, 12849, 14407, 15533, 15850, 13885, 13040, 11718, 11143 and 12118 (Ragsdale, Cliff T. (2003). These factors represent the months starting from January and ending in December rounded up.
The resulted forecast is illustrated in Graph 2, and the tables are enclosed in Appendix 2.



Graph 2: Future demand forecast

4.3 Validation and substantiation

In order to validate the forecasted data using the seasonal Factors for Stationary Series methods, I have consulted the output of the method with the factory engineer. The feedback on the data and the forecast analysis was adequate and represent the real situation.

5. Designing KANBAN system

Assumptions**:**

1- One product chooses as a prototype for this project.

2- Client send its order once a day by predefine quantity (no more than one KANBAN).

3- All suppliers could not follow KANBAN either they have minimum quantity order or long lead time.

4- Suppliers who could not follow KANBAN, we keep ordering based on EOQ and storages are known as another supplier in KANBAN system with zero lead time.

5- The scope of KANBAN for this project is suppliers and fellow KANBAN cards between suppliers and manufacturing (manufacturing already has set up for KANBAN).

6- Single card is selected for this project because just suppliers are in scope, so KANBAN card for production automatically omitted and just use replenishment card (SAP AG and KANBAN website).

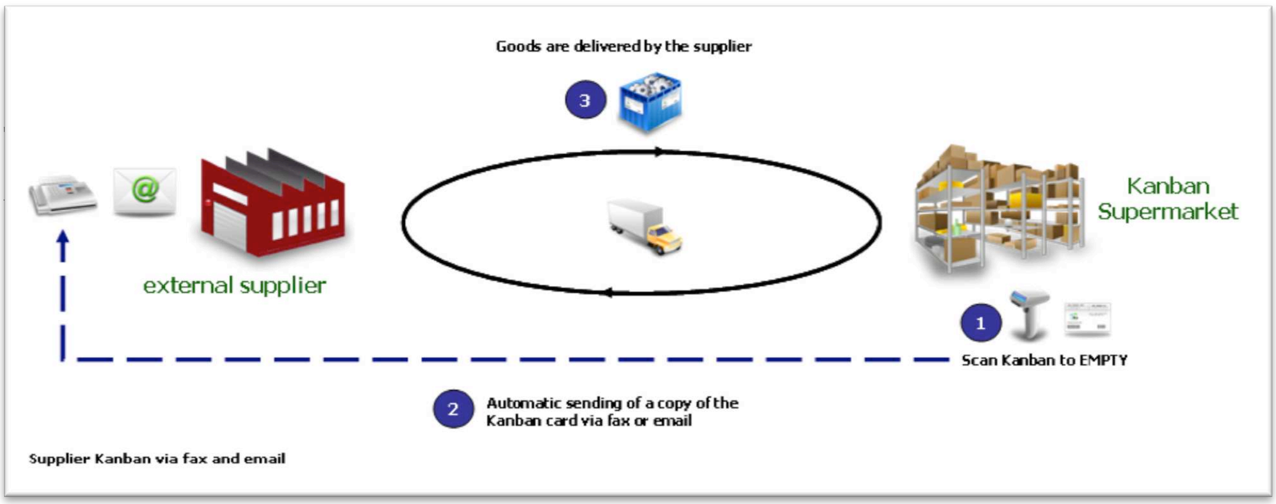


Figure 3: Snap shot of a KABAN system

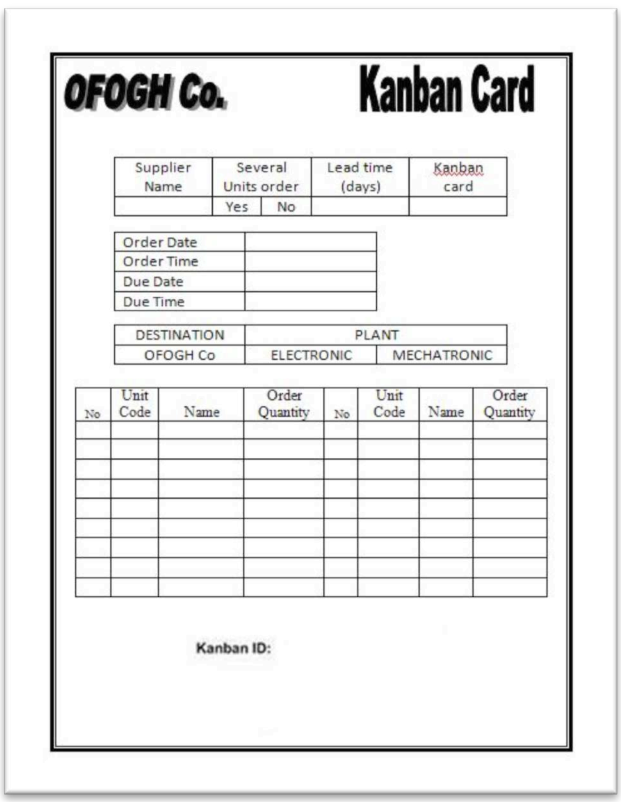
5.1 Calculate quantity KANBAN card:

Several methods were defined for calculate quantity KANBAN card (http://www.resourcesystemsconsulting.com/blog/) (http://www.kanban.com). Based on available data formula, which was selected to calculate quantity of KANBAN card is:

$$\# \textit{KANBAN cards} = (\text{Demand}*\text{Lead time})*(1+\alpha)/\text{Container Size}$$

The "α" was defined in order to accommodates the error in calculation. This error includes our error to estimate data and supplier error to respond our order, this factor accommodate for the *theft loses* in the system (α is 10% in this project).

The suppliers who follow KANBAN system provide either one item or several items. We design KANBAN card can use in both situation In order to reduce several KANBAN card sending. The KANBAN card (Appendix 5) that was design for this project has come as bellow:



OFOGH Co. Kanban Card

Supplier Name	Several Units order		Lead time (days)	Kanban card
	Yes	No		

Order Date	
Order Time	
Due Date	
Due Time	

DESTINATION	PLANT	
OFOGH Co	ELECTRONIC	MECHATRONIC

No	Unit Code	Name	Order Quantity	No	Unit Code	Name	Order Quantity

Kanban ID:

Figure 4: KANBAN Card

KANBAN card quantity calculation:

α is 10%

Unit Code	Name	EOQ	Usage rate	Lead Time (days)	Countiner (capacity)	Supplier Name (Internal)	Demand (450 per 2 days)	# KANBAN Cards (α is 10%)		
120068	Capacitor	NO	1	0.50	20,250	A	450	0.0117778	A	A=1
120076	Capacitor	NO	1	0.50	20,250	A	450	0.0116667		
120084	Capacitor	NO	2	0.50	20,250	A	900	0.0233333		
120086	Capacitor	NO	1	0.50	20,250	A	450	0.0116667		
120090	Capacitor	NO	4	0.50	20,250	A	1800	0.0466667		
110008	Capacitor	NO	3	0.50	20,250	A	1350	0.035		
110034	Capacitor	NO	1	0.50	20,250	A	450	0.0116667		
110052	Capacitor	NO	31	0.50	20,250	A	13950	0.3616667		
110054	Capacitor	NO	1	0.50	20,250	A	450	0.0116667	**0.525**	
120202	Resistor	NO	2	0.40	26,100	B	900	0.0144828	B	B=1
120208	Resistor	NO	2	0.40	26,100	B	900	0.0144828		
110212	Resistor	NO	3	0.40	26,100	B	1350	0.0217241		
110224	Resistor	NO	3	0.40	26,100	B	1350	0.0217241		
110290	Resistor	NO	4	0.40	26,100	B	1800	0.0289655		
110292	Resistor	NO	1	0.40	26,100	B	450	0.0072414		
110310	Resistor	NO	40	0.40	26,100	B	18000	0.2896552		
110320	Resistor	NO	1	0.40	26,100	B	450	0.0072414		
110328	Resistor	NO	2	0.40	26,100	B	900	0.0144828		
110336	Resistor	NO	1	0.40	26,100	B	450	0.0072414	**0.427**	
130004	Connector	NO	1	1.00	450	C	450	1.05	**1.05**	**C=2**
120254	Resistor Array	NO	2	0.45	1,800	D	900	0.23625	D	D=1
120255	Resistor Array	NO	1	0.45	1,800	D	450	0.118125		
120261	Resistor Array	NO	1	0.45	1,800	D	450	0.118125	**0.472**	

Unit Code	Nmae	EOQ	Usage rate	Lead Time (days)	Countiner (capacity)	Supplier Name(Internal)	Demand(450 per 2 days)	# KANBAN Cards (α is 10%)		
120408	**IC OpAmp**	**NO**	**1**	1.10	16,200	**E**	**450**	0.0320833		
120610	**Transistor**	**NO**	**1**	1.10	16,200	**E**	**450**	0.0320833		
120613	**Transistor**	**NO**	**1**	1.10	16,200	**E**	**450**	0.0320833		
120850	**LED**	**NO**	**1**	1.10	16,200	**E**	**450**	0.0320833		
122000	**Crystal**	**NO**	**1**	1.10	16,200	**E**	**450**	0.0320833		
110426	**IC OpAmp**	**NO**	**1**	1.10	16,200	**E**	**450**	0.0320833		
110430	**IC Shift Register**	**NO**	**2**	1.10	16,200	**E**	**900**	0.0641667		
110432	**IC Shift Register**	**NO**	**1**	1.10	16,200	**E**	**450**	0.0320833		**E=2**
110600	**Transistor**	**NO**	**10**	1.10	16,200	**E**	**4500**	0.3208333		
110604	**Transistor**	**NO**	**2**	1.10	16,200	**E**	**900**	0.0641667		
110902	**Diode**	**NO**	**4**	1.10	16,200	**E**	**1800**	0.1283333		
110904	**Diode**	**NO**	**2**	1.10	16,200	**E**	**900**	0.0641667		
110952	**Diode Supressor**	**NO**	**9**	1.10	16,200	**E**	**4050**	0.28875	**E**	
100000	**PCB**	**NO**	**1**	1.50	450	**G**	**450**	1.575	**1.15**	
110944	**Body**	**NO**	**1**	2.00	450	**I**	**450**	2.1	**1.5**	**G=2**
110912	**Packing box**	**NO**	**1**	0.60	450	**K**	**450**	0.63	**2**	**I=2**
110418	**IC Micro Controller**	**YES**	**1**						**0.6**	**K=1**
110434	**IC Sound**	**YES**	**1**							
110958	**LCD**	**YES**	**1**							
200000	**Print Screen**	**YES**	**1/10000**							

Table 1: KANBAN card quantity calculation

Flowing KANBAN cards

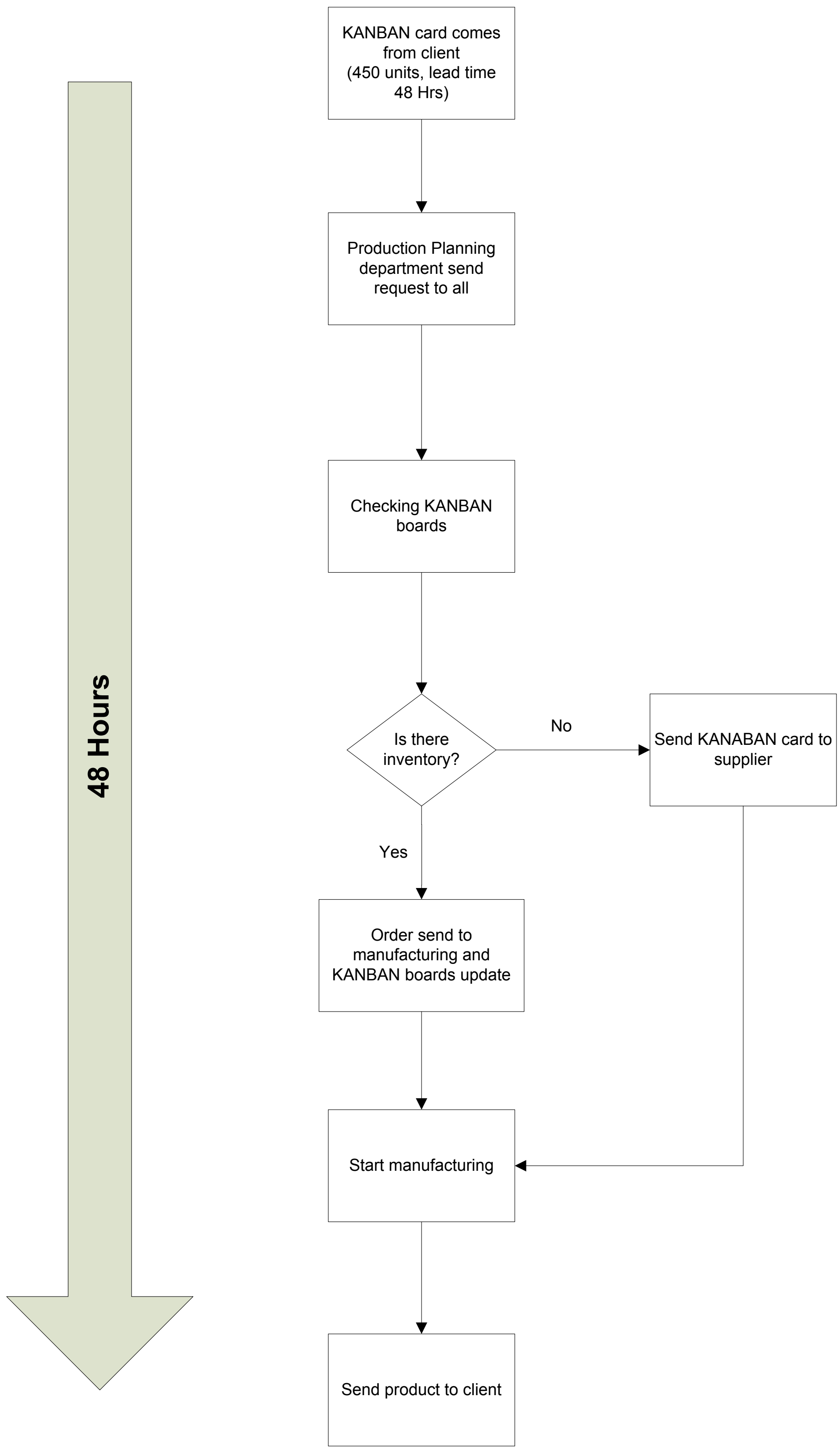


Figure 5: Flowing KANBAN Cards

6. Cost Analysis:

In order for us to evaluate and present the recommendation, I will be presenting the current ordering policy cost where Material Requirement Planning (MRP) is being used (without KANBAN implementation, I will call it the current situation) and compare it with the cost if KANBAN is applied to the factor.

6.1 The Cost of the current situation (Without KANBAN implementation).

According to the bill of material and the information provided from the factory, the list of all components that build the products is as follows; Capacitors (different Models), Resistors (Different Models), Resistors Array (Different Models), IC OpAMP (Different Models), Transistor (Different Models), LED, Crystal, IC Shift Register, Transistor, Diode (Different Models), Diode Suppressor, PCB, Body, Packing Box, IC Micro-Controller, IC Sound, LCD and Print Screen.

All of the above items have different cots, the set up cost is USD 100 per each and the holding cost is based on an annual interest rate of 40%.

The Economical Order Quantity (EOQ) is defined is as follows;

$EOQ = (2KL/h)^{1/2}$, where K is the set up cost, L is the demand and h is the holding cost based on the intrest rate (I).

The EOQ is determined for each product and is shown in Appendix 3.

The relevant set up and holding cost of this order policy is determined according to the cost function of the EOQ (KL/EOQ + EOQ*h/2) where k set up cost, L Demand & Holding Cost. The resulted total monthly cost is equal to USD 1,287,882.

6.2 The cost if KANBAN to be applied to the factory.

6.2.1 Cost resulted from the suppliers who didn't follow the KANBAN.

The supplier who didn't follow the KANBAN in this project are those supporting the factory with the following items

i. IC Micro-Controller
ii. IC Sound
iii. LCD
iv. Print Screen

The factory will continue ordering the above mentioned items directly from the suppliers, the Economic Order Quantity will be the model followed to determine the order quantity.

i. For the IC Micro-Controller, each item - according to the information provided from the factory- cost USD 6.5 and according to the forecasted demand for year 2011, the annual demand is 154000 units. From the experience and the information provided from the factory the set up cost is USD 652, the cost of this item is high due to that the supplier are all from outside Saudi Arabia. The annual interest rate was assumed 40% annually.

   Knowing that EOQ = $(2KL/h)^{1/2}$, where K is the Set Up cost, L is the demand and h is the holding cost based on the interest rate (I), I Applied the EOQ formula and results that the economic ordering quantity of the IC Micro-Controller is 8788 Units. The resulted set up and holding from this ordering policy for the IC Micro-Controller is USD 22,850. That is resulted from applying the cost formula of the holding and set up cost.

ii. For the IC Sound, the cost of each item is USD 3.5. The set up cost is USD 652, while the forecasted annual demand is 154000 units. Knowing that EOQ = $(2KL/h)^{1/2}$, where K is the Set Up cost, L is the demand and h is the holding cost based on the intrest rate (I), we apply the Economical Order Quantity (EOQ) formula results in 11,977 units.

The relevant set up and holding cost of this item's ordering policy is USD 16,767.

iii. For the LCD, the cost of each item is USD 10. The annual forecasted demand is 154000 unites. The Economical Order Quantity (EOQ= $[2KL/h]^{1/2}$) for this item is 7085 units. The related set up and holding cost is USD 28,342.

The total cost using the EOQ for the supplier who didn't follow the KANBAN system is USD 68,360.

The supported tables for the calculation of the EOQ are supported in the appendices under Appendix 4.

6.2.2 The KANBAN Cost

If company use the KANBAN, KANBAN will apply to the following [Capacitors (different Models), Resistors (Different Models), Resistors Array (Different Models), IC OpAMP (Different Models), Transistor (Different Models), LED, Crystal, IC Shift Register, Transistor, Diode (Different Models), Diode Suppressor, PCB, Body and Packing Box] each KANBAN is assumed to have 450 units, and the cost of each KANBAN card is estimated to be USD 100.

Knowing from the forecast of 2011 that the annual demand is 154000 units, we know that the number of the KANBANS that will be issued are 342 (154000/450) KANBANs. The Cost of all KANBANS is USD 34,222.

As I know from the factory that there is a 13 group of KANBANS, thus; the relevant cost of applying the KANBAN is USD 444,889.

6.3 Storage Space Cost

In order to calculate the storage space cost, we have to calculate the storage space first. Gathering some information are important to come up with final space like the standard of pallet dimension ,the final product dimension, how many pallets can we put above each other and how many rows each pallet has.

Here some data that we collected and assumptions that we assumed in order to get the final storage cost we need.

Data collection:

1- Final product dimension is 30cmX20cmX10cm
2- U.S Pallet standard Dimension is 1.2mX1mX0.15m
3-

Assumptions:

1- Only allow to put three pallets above each other.
2- Each pallet has four rows (shelves).

Therefore, each pallet can takes 80 products (5X4X4).

In addition to that, we have to know the highest monthly production to build our storage based on that capacity, adding to that plus 10% as a percentage of error. The highest monthly production is in July which is equal 15850. Therefore we have to find space for 17435 products (including 10% of error).

As we calculate above, each pallet can takes 80 products, so we need 218 pallets (17435/80) and only three pallets can we put above each other, therefore, the aggregate pallet per unit is73 pallets on the floor

(218/3). The storage is divided into two rows, each row has 37 pallets.

From this information, we can come up with the length and the width of the storage in order to get the final storage space. The length(X) is equal the length of 37 the aggregate pallets times 1.2 m (the standard pallet length dimension) which approximately equal 50 m. On the other hand, the width(Y) is equal the width of two the aggregate pallets (two rows) times 1m(the standard pallet width dimension) plus 0.5m as a space for movement which equal approximately 8m. Therefore, the total space area is 400 sq.m.

From the past data that we had, we know that the monthly rent for this space of area is $3,000. Therefore, the annually cost of storage space is $36,000.

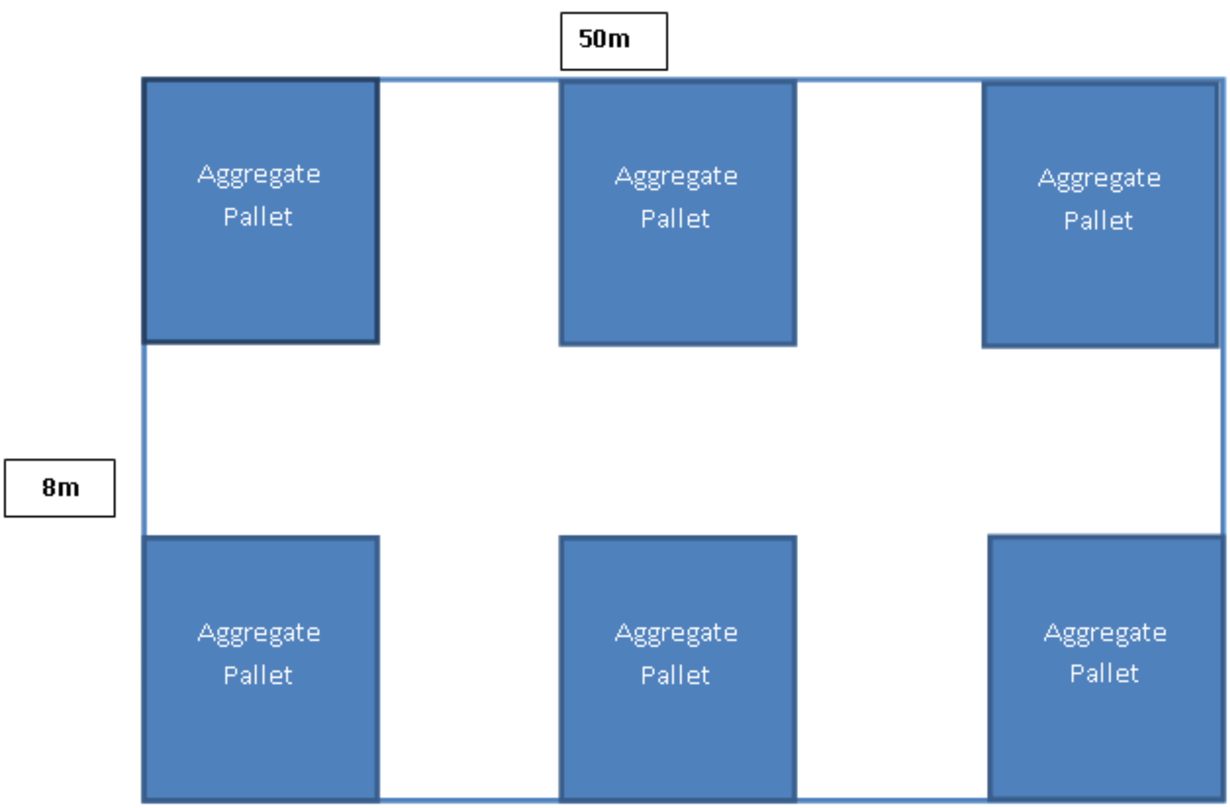


Figure (6): Storage Layout

Conclusion:

1- Based on cost analysis by using KANBAN system we have 50% decreases in average costs.
2- Based on calculation in storage space by using KANBAN system we can eliminate storage for final goods and we cut monthly rent.
3- The method used for forecasting the demand (Seasonal Factors) was representing the trend that the product is experiencing. We recommend that this method to be used for forecasting the other automobile related materials in this factory.

Recommendation:

Based on conclusion it looks scenario one is feasible but it needs follow a roadmap and specific plan.

Road map to move KANBAN JIT:

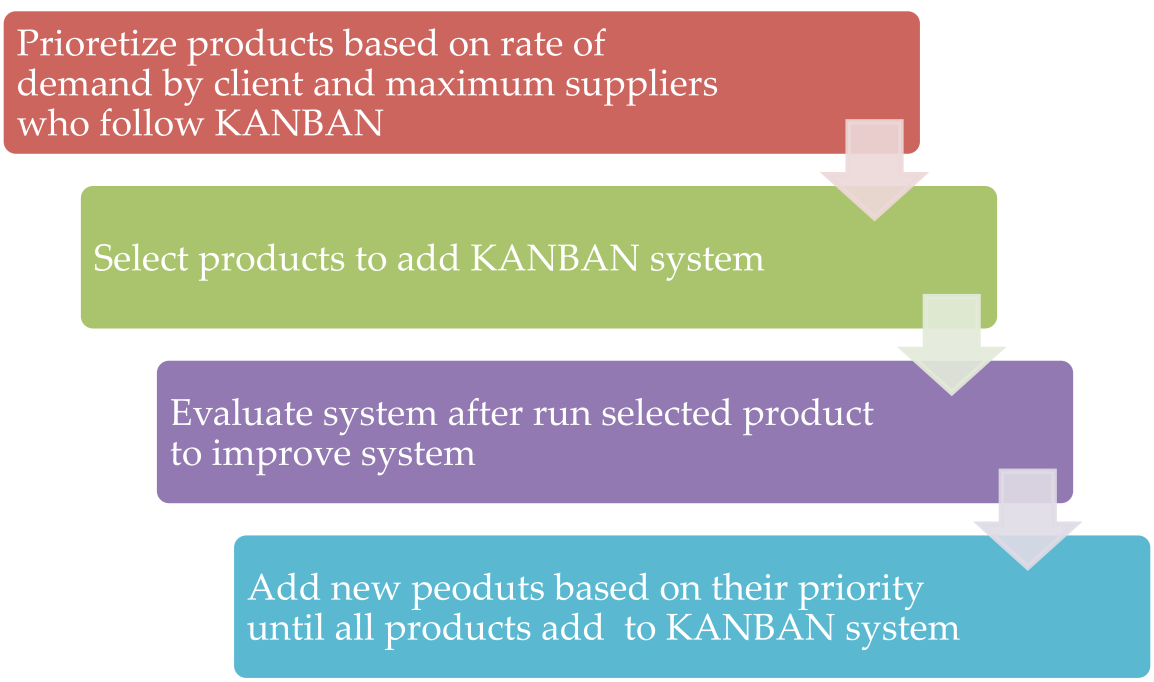


Figure 7: Road Map towards JIT.

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