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THE IMPORTANCE OF DEMAND FORECASTING METHOD AND MATERIAL REQUIREMENT PLANNING (MRP) FOR IN VITRO FERTILIZATION PRODUCTS : CASE STUDY OF PT XYZ

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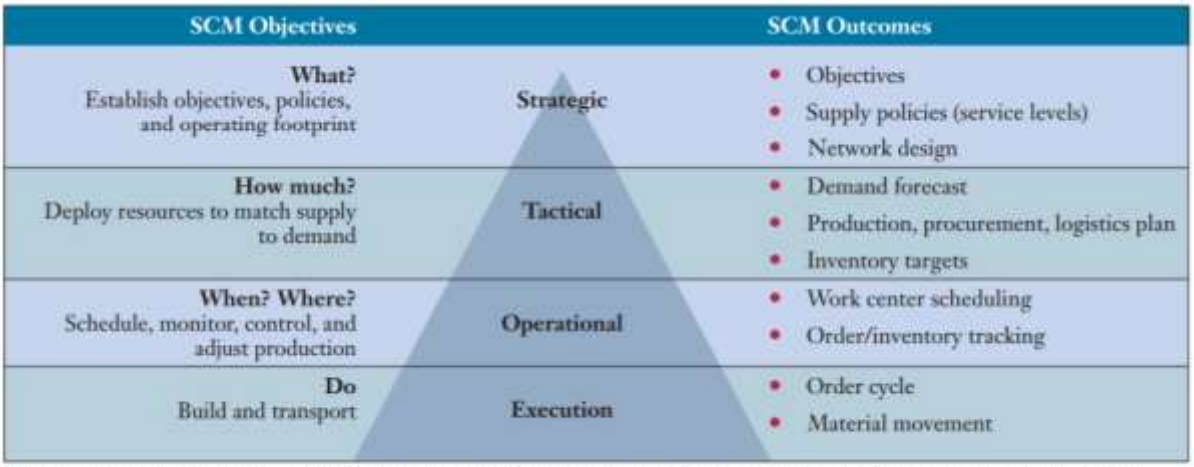
Abstract. *Having a balanced ratio between supply and demand is important in running business. Hence, to have a balanced ratio of supply and demand, a firm could control its supply input in order to adapt its supply with the demand level. When the level of mismatch between supply and demand are very high, it will create subsequent level of inventory. Which, is considered as waste in the practices of lean operations. Thus, to eliminate the over-amount of stocks or inventory, forecasting the demand level for products could be the response. However, the outcome of the forecasting method would not stand a chance minimizing all the operational obstacles of a firm if it does not have any support. Material Requirement Planning (MRP) can provide the considerations of lead time. This research conducted a case study in PT XYZ, which is a distributor of In-Vitro Fertilization (IVF) technology supplies in Indonesia. This company has experienced problems with overstocks and losses due to the problem of mismatch between supply and demand. Moreover, the firm has not applied a methodized demand forecasting system. Thus, this research's aim is to determine the suitable forecasting method for the firm. Besides the forecast method, this research also enhances the application of MRP to provide a better understanding of procurement decisions. Taking the positives from this paper will hope to add up to the learning curve of a developing company with a comparable business model in medical or other industries with similar characteristics.*

Keywords: demand forecasting, MRP, In-Vitro Fertilization, medical technology, case study.

Introduction

Business organizations, either supplier firms, manufacturer firms, or distributor firms, could be associated in a supply chain. Complementing each other when executing their business activity. Hence, making supply chain decision for each firm will affect the entire supply chain. Thus, decision making in an organization is structural and fundamental. In an organizational scope, the decision making process could be categorized in three levels. Some also adds another level to four. Pictured by O'Brien & Marakas (2011) below, this organizational decision making could as well be implemented in making supply chain decision.



Source: Adapted from Keith Oliver, Anne Chung, and Nick Samanach, "Beyond Utopia: The Realist's Guide to Internet-Enabled Supply Chain Management," *Strategy and Business*, Second Quarter, 2001, p. 99.

In a business firms, it is very important to have a balanced ratio between supply and demand. Demand is a factor that we could control less than supply. Due to demand would depend to the market of the industry. Hence, to have a balanced ratio of supply and demand, a firm could control its supply input. Controlling its supply to adapt with the demand level. These decisions of order tracking, order quantity, and procurement are in the level of tactical and operational decision, as shown above. But more importantly to adapt the level of supply to the demand, a demand forecasting holds another important role in a supply chain decision making. It would be a tactical decision by a firm to methodize its demand forecast. Which, will affect other decisions in the company that will have a more detailed effect in the business activity. For example, the outcome of the demand forecast would be taken as consideration to decide order quantity of a certain product or a raw material.

In Vitro Fertilization (IVF)

In Vitro Fertilization (IVF) is one type of Assisted Reproductive Techniques (ART). ART is a method invented by scientists to provide assistance towards a pair of man and woman to have offspring. Usually, the patient needs assistance because of their inability to execute fertilization naturally. Hence, the technique of IVF makes the fertilization happen in a laboratory, outside the female uterus. For then, the fertilized ovum, or embryo, to be inseminated back into the female uterus. In hope that the plantation is successful so the embryo could develop through its stages in becoming a baby. The simple acronym "IVF" does not reflect the complexities of the procedure itself. Invented by Edwards and Steptoe in 1978, the treatment was purposed to sidestep the tubal blockage in the female patient. Prevention of the ovulated egg traveling to the uterus and its engagement with the sperm cell, causing the failure of fertilization to happen in the uterus. The treatment could avoid the infertility cause by attaining fertilization process in laboratory (Fauser & Devroey, 2011). For then the fertilized ovum, or embryo, to be inseminated into the female uterus.

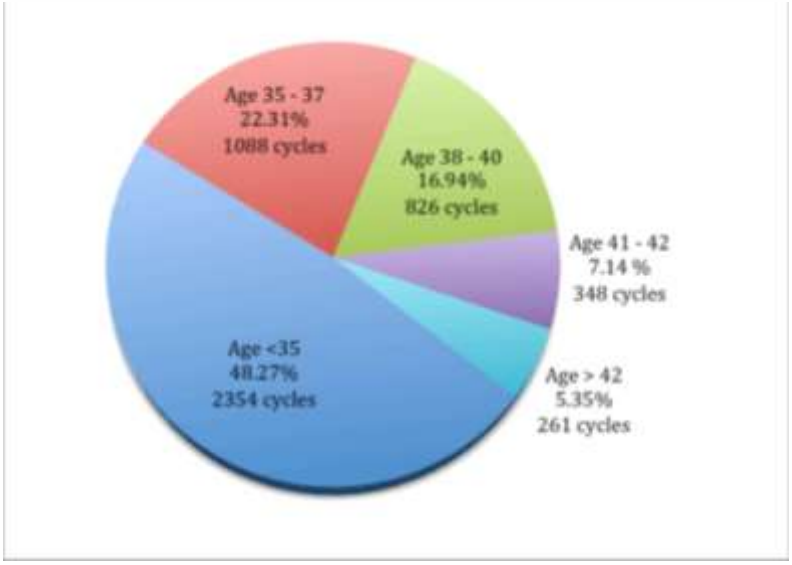
Most forms of IVF today require a drug phase of pre-treatment to 'hyper-stimulate' the ovaries to produce multiple follicles. In natural conception ovulation is triggered by a surge in luteinising hormone (LH), a reproductive hormone produced in pulses by the pituitary gland at mid-cycle. In assisted conception this same reaction is triggered by an injection of human chorionic gonadotrophin (hCG), which also triggers oocyte maturation. Egg retrieval, through the aspiration of follicular fluid, takes place 36 hours later, just before spontaneous ovulation would have occurred. But the time restriction of egg retrieval has been solved in 1982, by the development of more intelligent type of hormone to stimulate the patient (Fauser & Devroey, 2011). Although, there are some side effects caused by the hormonal treatment. Some are relatively modest, such as mood swings and bloating, but can include painful ovulation. About 5% of patients develop a complication called ovarian hyper-stimulation syndrome that in extreme cases can be fatal. Many women require repeated cycles, and doctors don't know yet what the long-term effect of multiple treatments may be (Westphal, 2005).

The products that are related to IVF are generally divided into two; mediums and devices. Mediums are the ones that are used in the procedure of IVF, such as chemicals or other substances. These are products purposed to sterilize, prepare, and also preserve the ovum cells, sperm cells, and embryo cells. These products could be furthermore categorized by its involvement in the IVF stages. The mediums products distributed by PT XYZ itself could be divided into five categories; *oocyte retrieval, sperm separation, embryo culturing and transfer, microtechniques, and cryopreservation*. Meanwhile the devices are tools such as needles, catheters, pipette, etc. These tools are available in many sizes. But commonly, the devices needed are micro-sized due to the IVF procedure which operates in a micro-sized level.

IVF Industry in Indonesia

According to the data taken in the year of 2014 by Indonesian Association for In Vitro Fertilization (IA-IVF), there are 28 clinics existed in Indonesia that can execute the Assisted Reproductive Technology (ART), which includes IVF. The term clinic could refer both to specially-dedicated fertility specialized clinic or hospitals which are capable to execute IVF procedure. Each and every clinic would need supplies of IVF products in order to execute their operations. However, only 27 out of 28 clinics submitted reported IVF procedure executions to IA-IVF to be reviewed. Hence from those clinics, it is reported that 4877 cycles of ART are executed in the year of 2014. A cycle refers to the stages between a patient started the IVF procedure until the fertilized ovum, embryo, is inseminated into the female uterus. If then the try fails and the patient decided to do the procedure again, it will be counted as another cycle. Furthermore, there are two types of cycles; fresh embryo cycle and frozen embryo cycle.

ART cycles					
Age	**< 35**	**35 – 37**	**38 – 40**	**41 – 42**	**> 42**
Total	2354	1088	826	348	261



Out of 4877 cycles executed in 2014, the patient comes from a wide range of age. As shown above, the data of the age distribution of women taking the ART procedure. It is mainly dominated by women aged below 35, with 48,27%. After then, followed respectively by women aged 35-37, 38-40, 41-42, and women over 42 years old. And out of all of those cycles, as much as 30,55% resulted to a pregnancy. In other words, 1490 out of 4877 cycles are succeeded. Below is the success rate from the age group perspective:

ART cycles by age group						
Age	<35	35-37	38-40	41-42	>42	Total
Total cycles	2354	1088	826	348	261	4877
Cycles resulted in pregnancy	887	316	199	63	25	1490

All in all, the market of IVF in Indonesia is quite segmented. The fact that the procedure is relatively uncommon and rarely known in Indonesia could explain the small number shown below if compared to the total number of total Indonesian citizen of around 250 million. The ratio is significantly minor. The limited number of capable clinics also limits the reach of IVF technology to a certain location. But most this outcome is also reasonable, because the existence of infertile person that needed the IVF procedure is also very niche. It could be summarized that the IVF market in Indonesia is very niche. However as aforementioned, the IVF procedure requires supplies which is used in the process and stages of the procedure. From one stage to another, it involves a different type of product. Moreover, in each stage, many types of products are involved. Hence, this means the IVF procedure has a long list of products required which is complimentary to the procedure itself. From those many products, each and every one of them is tagged with a significant number of price. The products ranging from about IDR 900000 to dozens of million rupiah, which not all people could afford it and could be considered expensive. Thus, the potential value that could circulate in the market is not insignificant. It has an enormous potential in terms of total value of the products.

While the In Vitro Fertilization (IVF) technology products are available all around the world, unfortunately, there is still no domestic company which is able to produce IVF products in Indonesia. Consequently, IVF products are imported into Indonesia and Origio, which originated from Denmark, is one of the available products in the Indonesian market. Based on the contract that PT XYZ has with Origio, it is stated that PT XYZ will be the sole distributor or Origio's products. Which means, there will be no other company distributing the products from Origio. Nationally, there are three international brands whom products are available in the market of Indonesia. Each are represented in Indonesia by sole distributors. Furthermore, the products available are quite similar on to another.

Besides Origio, the other IVF technology manufacturer products available in Indonesia is VitroLife and FertiPro. VitroLife originated from Sweden and is distributed in Indonesia by PT PQR. The third brand, FertiPro, originated from Belgium. It is solely represented by RS Siloam Surabaya with its leading senior fertility specialist doctor, dr Aucky Hinting. However, they do not distribute and sell the products, FertiPro is only used by RS Siloam Surabaya and its network. In other words, PT XYZ's main rival in the industry is PT PQR. This rival company had been established for many years. Their history stretches back to the 1960s. Hence the company, has a broader product line. It is a similar importer of medical products as well as PT XYZ. However, PT PQR covers more than the IVF-related products segment. The company also distributes pharmaceuticals products, consumer health products, medical equipment, and analytical laboratory supplies.

Meanwhile, the regulation of In Vitro Fertilization (IVF) procedure in Indonesia is stated in article 16, UU No. 23 Tahun 1992 regarding health. According to the regulation, it is stated that IVF is an assisted reproductive technique, an unnatural reproduction, which could be executed in the as a last attempt for a legally married couple to have a descendant. The most important thing is, stated in paragraph 2, that the procedure could only be executed by a legally married couple. Furthermore, without any third person donor nor a surrogate mother. Also, executed by healthcare skilled staffs that has been given legal authority to practice the procedure. This law was also contributed by the statement from Majelis Ulama Indonesia (MUI), an institution that regulates any practices that requires a religious view towards it, especially which concerns an Islamic law. A controversy broke out in the 1970s in Indonesia regarding the practices of IVF. Then in 1979, MUI stated that the IVF procedure, or any other assisted reproductive technique, could be considered as a form of endeavor and initiative for a married couple

to have a descendant. The principle is, that there must be no other third party involvement either in the form of a donor nor a surrogate mother. If these boundaries are breached, then the child conceived after the procedure is done is illegitimate.

Forecasting Method

Forecasting is an art and a methodized process of predicting upcoming occasions. Heizer & Render (2011) continues that forecasting may take the consideration of historical data and projecting it in the future using some sort of mathematical equation. Chopra & Meindl (2007) adds, forecasting is a basis of all supply chain planning. Both in the pull or push view of the supply chain, the first fundamental stage that a manager takes is the preparation of customer demand forecasting.

Moving Average Method

The method of moving average is the simplest of all the techniques of forecasting. The most fundamental concept of the moving average method is that the most recent observations will dictate the outcome of the value forecasted. At any time t, the average of the n most recent observations (t-1, t-2, ..., t-n) is computed, this is referred to as the moving average at time period t. (Cheng, 1987). Could be conceptualized by the following formula (Chopra & Meindl, 2007):

$$F_{t+1} = L_t$$

$$L_t = \frac{(D_t + D_{t-1} + D_{t-2} + \cdots + D_{t-N+1}}{N}$$

Lt = estimate of level at the end of period t
Ft = forecast of demand for period t
Dt = actual demand observed in period t
N = number of period in the Moving Average

Exponential Smoothing Method

This technique requires the data to be given weight, particularly the most recent data to be given greater weight. Cheng (1987) stated, the weight assigned to the past observations decrease exponentially as they become less recent. Thus, the forecasted outcome is the weighted average of all the previous data. The exponential smoothing method covers a major drawback the moving average method has, which needs to continually carry a large amount of data. In most of applications, the most recent occurrences are most indicative of the future than those in more distant past (Chase et al., 2007).Chase et al. (2007) added that the exponential smoothing technique have become well accepted for six major reasons; it is surprisingly accurate, relatively easy, the user can understand how the model works, little computation is required to use the model, small computer storage requirements, and the ease to compute accuracy tests of the model performance. Chopra & Meindl (2007), expresses the exponential smoothing method based on the following formula:

$$F_{t+1} = L_t$$

$$L_{t+1} = \alpha D_{t+1} + (1 - \alpha) L_t$$

Ft = forecast for period t
St = demand for period t
0 < alpha < 1

Holt's Model

The Holt's Model is almost the same with the exponential smoothing method. Difference is, this method has two smoothing constants, thus resulting in greater advantage in affording flexibility

(Kayande, 1999). The Holt's model calculation is based on the following formula (Chopra & Meindl, 2007):

$$F_{t+1} = L_t + T_t$$

$$L_{t+1} = \alpha D_{t+1} + (1-\alpha)(L_t + T_t)$$

$$T_{t+1} = \beta(L_{t+1} - L_t) + (1-\beta)T_t$$

L = level
T = trend
o < alpha < 1
o < beta < 1

Winter's Model

Chopra & Meindl (2007) continued that the Winter's Model method, or trend- and seasonality-corrected exponential smoothing, is appropriate when the systematic component of demand has a level, a trend, and a seasonal factor. And based as from the formula of the following:

$$F_{t+1} = (L_t + T_t)S_{t+1}$$

$$L_{t+1} = \alpha\left(\frac{D_{t+1}}{S_{t+1}}\right) + (1-\alpha)(L_t + T_t)$$

$$T_{t+1} = \beta(L_{t+1} - L_t) + (1-\beta)T_t$$

$$S_{t+p+1} = \gamma\left(\frac{D_{t+1}}{L_{t+1}}\right) + (1-\gamma)S_{t+1}$$

L = level
T = trend
S = seasonal factor
o < alpha < 1
o < beta < 1
o < gamma < 1

Error Rate Evaluation

Generally, the accuracy of any forecasting method could be measured by the difference of the forecasted values and the actual values (Heizer & Render, 2011). Three method of error measurement are popular and they could be used altogether or separately (Cheng, 1987).

Mean Squared Error (MSE)

Cheng (1987) stated that MSE is simply the sum of the squared forecast error, divided by the number of the periods in the forecast. However, it suffers from the possibility of over-emphasizing the error due to the squared item, although probably it is most commonly used.

$$MSE_n = \frac{1}{n}\sum_{t=1}^{n} {E_t}^2$$

Mean Absolute Deviation (MAD)

Represents the sum of absolute forecasting error, divided by the number of periods. This method eliminates the exaggerated effect of the Mean Squared Error (MSE) (Cheng, 1987). Chase et al. (2007)

added that MAD is the average error in the forecast, using absolute values. It is valuable because MAD, like standard deviation, measures the dispersion of some observed value from some expected value.

$$MAD_n = \frac{1}{n}\sum_{t=1}^{n}|E_t|$$

Mean Absolute Percentage Error (MAPE)
When the data illustrate large fluctuations, this method is best used because it provides a better measurement of forecast accuracy. Mathematically, MAPE relates the MAD with the actual observations by dividing it with the actual demand that particular period (Cheng, 1987). Thus, this method expresses the outcome in a percentage state.

$$MAPE_n = \frac{\sum_{t=1}^{n}\left|\frac{E_t}{D_t}\right| 100}{n}$$

Ideally, the method that has better accuracy is the one that has a smaller error outcome from the calculation of method. Moreover, this research in will be more focused on the practices of MAD and MAPE.

Material Requirement Planning (MRP)
Material Requirement Planning system is a set of techniques designed to translate a Master Production Schedule into time-phased net requirement. It recognizes that the demand for component parts is dependent on the demand for the components or products of which they are constituent parts, therefore, it generates the demand for component items from the actual forecast demand for the independent end products. After getting the gross requirement for each item, it allocates existing on-hand quantity and reevaluates the validity of the timing of any outstanding orders in determining net requirement. Then, it computes the order quantity according to one of several lot-sizing rules and establishes a schedule of planned orders for each item. From all the functionality that the system does, it has only one important objective, that is, to have the right part in the right place at the right time and in the minimum quantity to satisfy the service criteria of the business (Jamnongpipatkul, 1999).Thus, the MRP system is used calculate the net requirements of a product by considering other elements, such as inventory on hand. Furthermore, it determines how to provide the product required in bound of the time constraint and also fulfilling the minimum quantity requirements.In order for the MRP to run, there are some elements which also complements the system. According to Jamnongpipatkul (1999), the key components of the system are the Master Production Schedule (MPS), the Bills of Material (BOM), Inventory Control System, and Ordering System. Although, Chase *et al.* (2007) stated that the MRP only has three main inputs which are the MPS, BOM, and Inventory Control System.

Master Production Schedule (MPS) is the prime input on which the MRP system depends for its real effectiveness and usefulness. It is the result of balancing two sets of potentially conflicting data; demand components and supply components. A statement of requirements for end items by date (planning period) and quantity (Jamnongpipatkul, 1999). Meanwhile, Chase *et al.* (2007) stated that, the Bills of Material (BOM), or often called *product structure file* or *product tree*, contains the complete product description. Listing not only the materials, parts, and components but also the sequence of the product is created. Jamnongpipatkul (1999) continued that, inventory is a stock of goods that can be anything from raw materials, semi-finished component parts, finished component parts to subassemblies. However, what the MRP system certainly interested is in the status of the inventory.

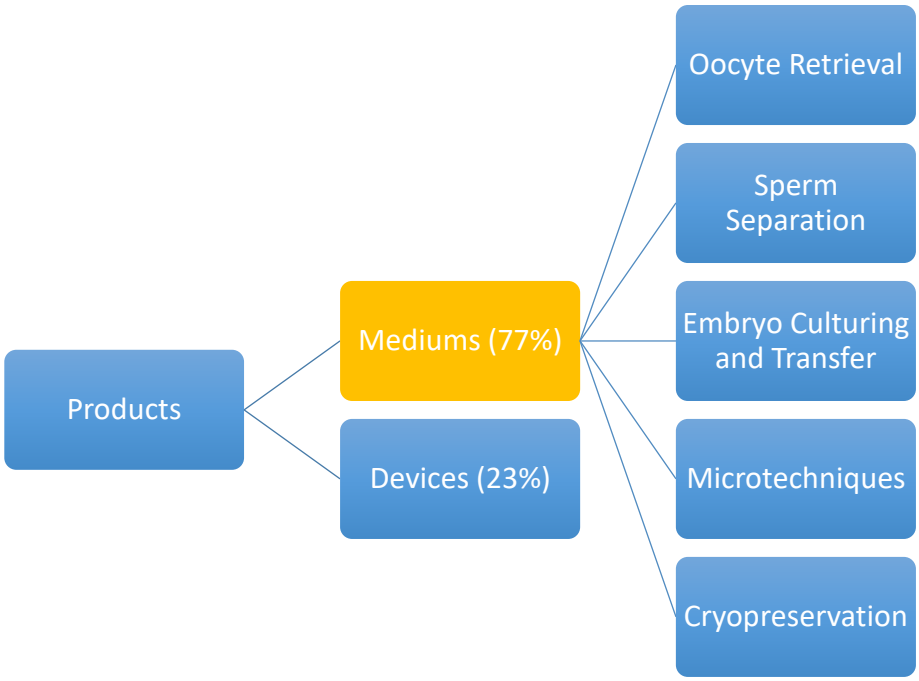
Status of the inventory which is defined as the amount of each item have on-hand, the quantity expecting to receive, and also the location of any particular item as it moves through the company.

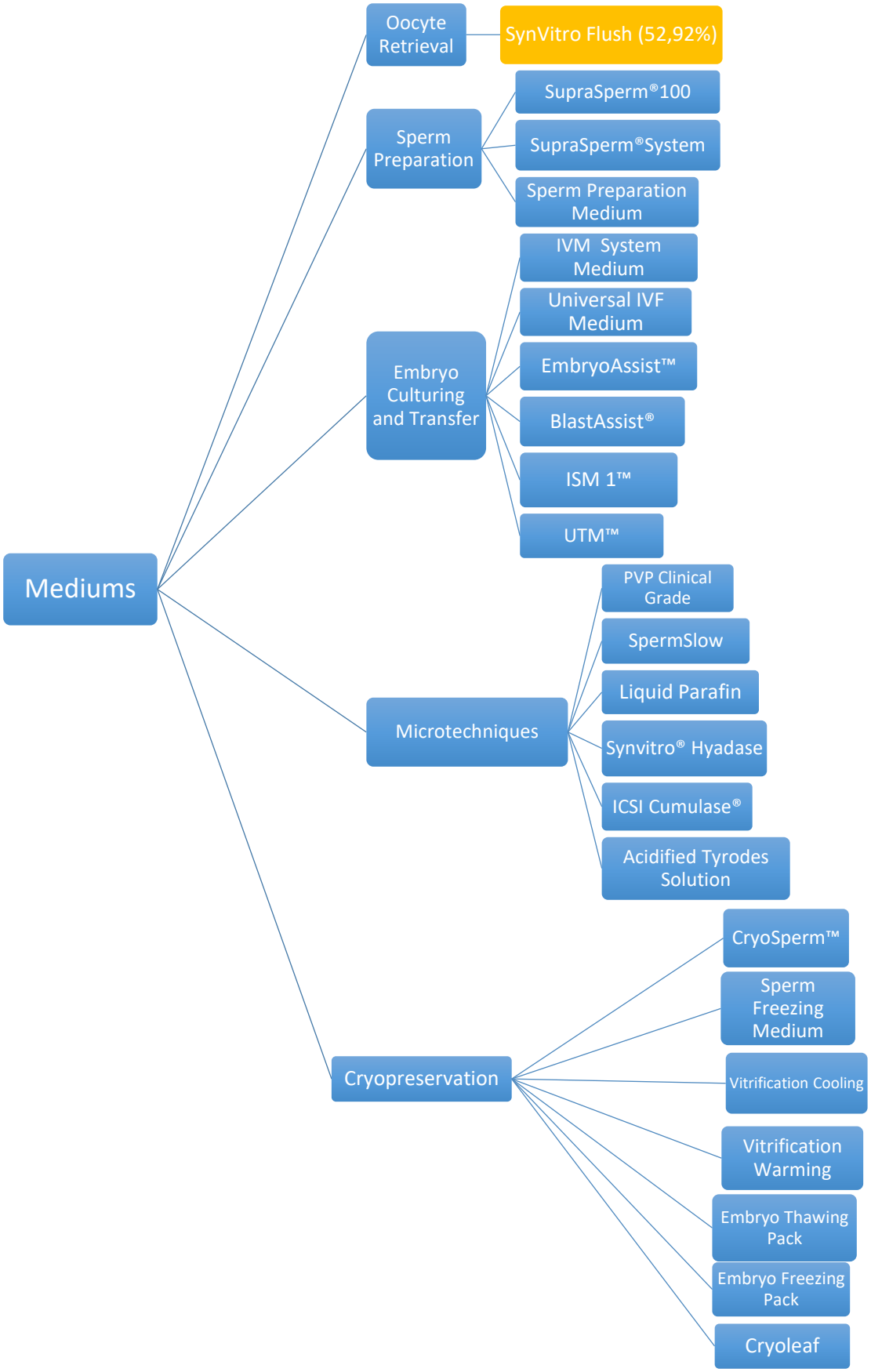
Jamnongpipatkul (1999) stated that the process of computing the demand for each components/raw materials under the MRP system can be grouped into 4 phases; determination of gross requirement, determination of net requirement, lot sizing, and offsetting. Gross requirements are the time-phased requirements of component parts needed to satisfy a master production schedule, before taking account of the stock in hand or on order. For high-level components or end product, the requirement from MPS can be used directly. However, for lower-level components, the MPS is converted into its component part content by the technique of time-phased part explosion, using a product structure defined by BOM. Meanwhile, net requirements can be defined as the time-phased requirements of component parts needed to satisfy a master production schedule, after taking into account of stock on hand and on order. After the net requirements are calculated, they are grouped into planned order receipts by a lot-sizing technique. In this research, the technique that is going to be used is the lot-for-lot method. Due to the company characteristics of executing pull demand system. After an order has been scheduled to be received at a given time period, the MRP has to do the offsetting by deducting the lead time for that order from the period that the order is due to get the period of time that the order needs to be placed.

Problem Identification

From the products detailed afore, could be summarized that the products could be categorized into two; mediums and devices. The figure below would further explain the relation between these products. The data of percentage unit sold is taken from the combined period from 2014 to 2015.

	2014		2015		2014-2015	
	Units	Value	Units	Value	Units	Value
Total	2622	Rp 7,266,180,875.00	3337	Rp 7,659,682,525.00	5959	Rp 14,925,863,400.00
Medium	2156	Rp 5,030,255,550.00	2446	Rp 6,959,986,525.00	4602	Rp 11,990,242,075.00
Device	466	Rp 2,235,925,325.00	891	Rp 699,696,000.00	1357	Rp 2,935,621,325.00
Medium/Total	82%	69%	73%	91%	77%	80%
Device/Total	18%	31%	27%	9%	23%	20%





It is shown from the figure and the table that the mediums products dominated the sales of PT XYZ in terms of unit sold. In terms of total value, it is also still in dominance compared to the device category. Therefore, to reflect a more accurate outcome of this research the topic will be focused on the mediums products.

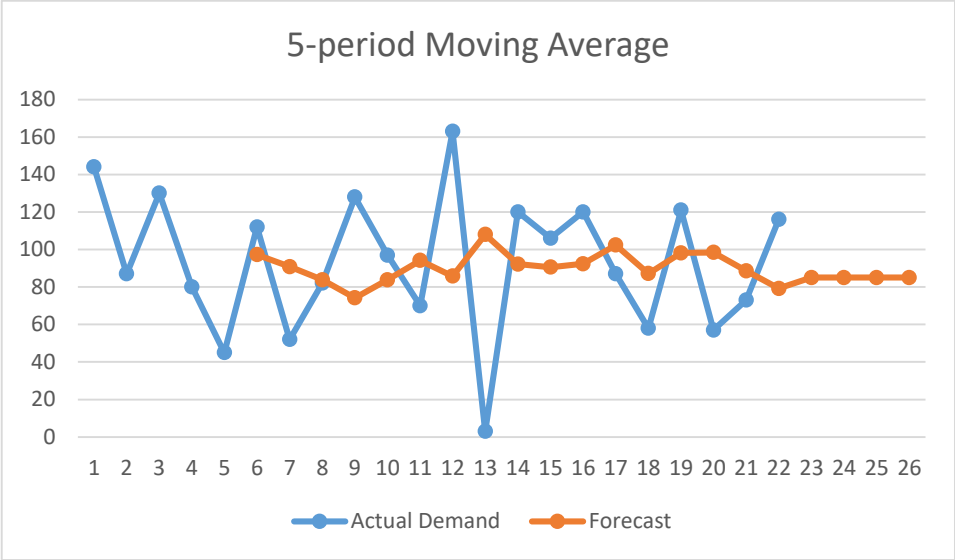
Afterwards, it is needed to specify a certain product from all the choices in the mediums category. It could be prioritized by its urgency to be solved. It could be indicated by the error or mismatch between supply and demand. Below are the calculation result of the error or mismatch of each product.

Error Summary					
No	Product		MSE	MAD	MAPE
1	SynVitro® Flush	125 ml	1366.4	27.2	30.6
2	SupraSperm®100	60 ml	0.3	0.3	20.0
		2x60 ml	0.0	0.0	0.0
3	SupraSperm®System	2x10 ml	1.1	0.7	18.3
4	Sperm Preparation Medium	60 ml	2.7	1.3	30.3
		5x60 ml	0.7	0.5	15.0
		10x10 ml	0.4	0.4	10.0
5	IVM System Medium	4 x 10 ml	0.2	0.2	10.0
6	Universal IVF Medium	60 ml	4.6	1.8	39.7
		5x60 ml	0.6	0.4	10.0
		10x10ml	0.1	0.1	0.0
7	EmbryoAssist™	10 ml	1.2	0.6	28.3
		60 ml	0.0	0.0	0.0
8	BlastAssist®	10 ml	26.0	4.0	62.7
9	ISM 1™	10 ml	7.8	2.0	67.8
		60 ml	1.5	0.9	24.2
10	UTM™	10 ml	6.1	1.5	27.7
11	PVP Clinical Grade	5x0,2 ml	1.9	0.9	43.3
12	SpermSlow	4 x 0.1 ml	0.1	0.1	10.0
13	Liquid Parafin	60 ml	2.4	1.0	23.3
		5x60 ml	97.6	8.8	63.5
14	Synvitro® Hyadase	5x1 ml	30.4	3.2	30.6
15	ICSI Cumulase®	5x0,5 ml	0.8	0.6	17.5
16	Acidified Tyrodes Solution	5x0,2 ml	0.3	0.3	20.0
17	CryoSperm™	10 ml	0.5	0.3	30.0
18	Sperm Freezing Medium	10 ml	1.3	0.7	10.0
19	Vitrification Cooling	4x1 ml	1.3	0.7	35.0
20	Vitrification Warming	5x2ml	0.5	0.3	10.0
21	Embryo Thawing Pack	4 x 10ml	0.2	0.2	10.0
22	Embryo Freezing Pack	4 x 10ml	0.3	0.3	30.0
23	Cryoleaf		0.1	0.1	0.0

In this research, the error rate parameters will be used separately, not altogether. Hence focusing on the MAD. Could be concluded from the table that the product that has the highest rate of mismatch between supply and demand is the SynVitro Flush. Even though it has not got the highest MAPE, it got the highest MAD at the level of 27,2.Besides the error consideration, the dominance of SynVitro Flush compared to the total sales is a factor also. The product sales is more than 50% of the total mediums products sales. Thus, this research will focus on the item of SynVitro Flush. In hope that in making forecast and MRP for the item can have more impact for the company compared than other products.

Results

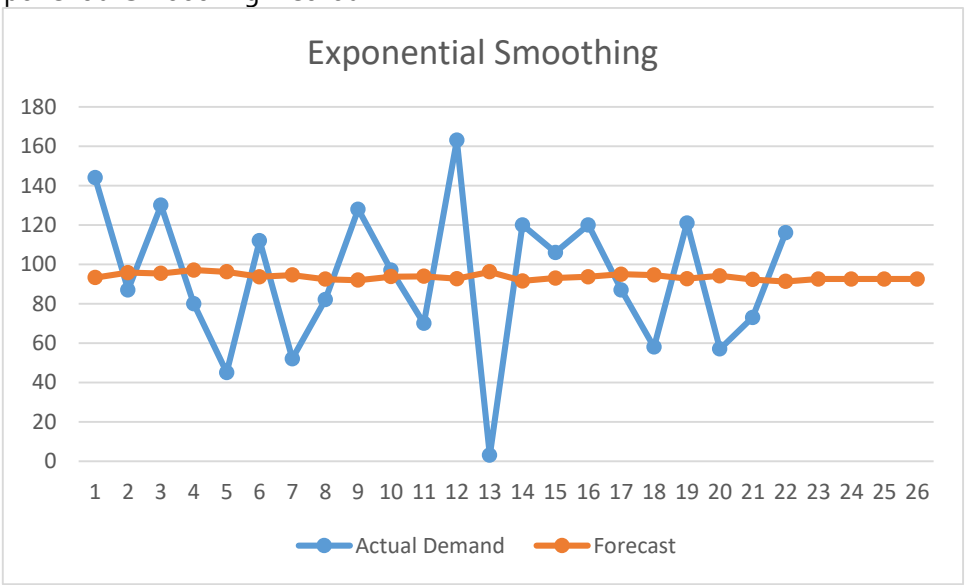
1. Moving Average Method



Above are shown the result of the method of moving average. The number of period used in the calculation is as much as 5 periods. From the calculation, the resulting error evaluation of the method will be expressed in the form of MAD and MAPE, which are:

- MAD : 33
- MAPE : 235

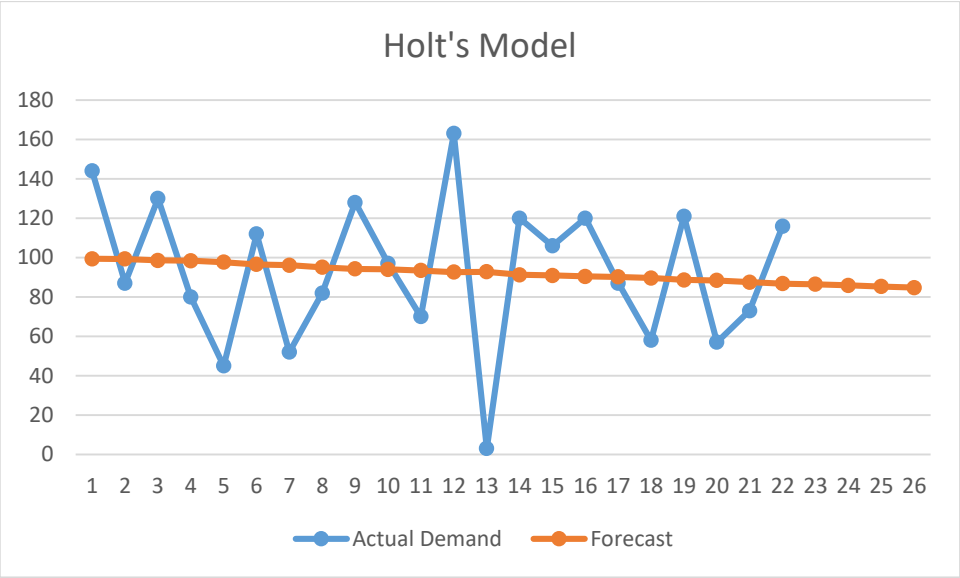
2. Exponential Smoothing Method



Above are shown the results of the method of exponential smoothing. These numbers are generated based on the data of actual demand that were aforementioned. In this method of exponential smoothing, the alpha coefficient is equal to 0,05. From the calculation, the resulting error evaluation of the method will be expressed in the form of MAD and MAPE, which are:

- MAD : 31
- MAPE : 173

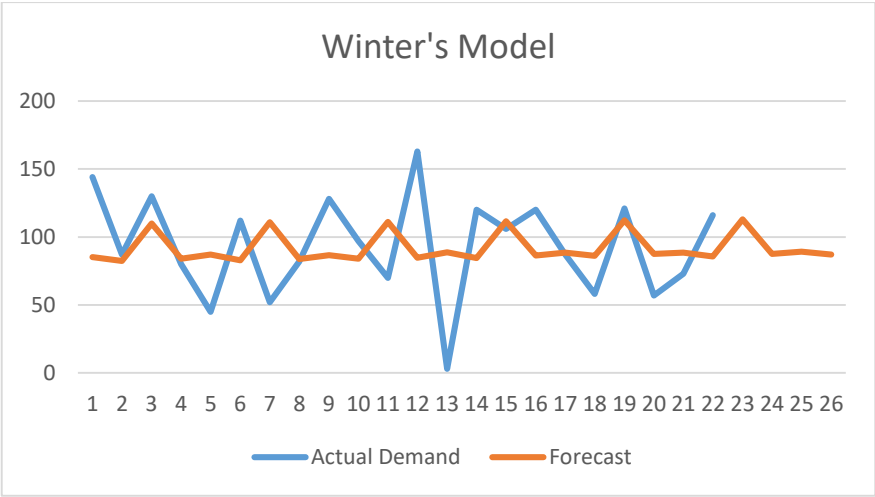
3. Holt's Model



Above are shown the results from the calculation based on the Holt's Model of forecasting method. In this calculation of Holt's Model forecasting method, there are two coefficients, alpha and beta. The alpha used is equal to 0,01 and the beta is equal to 0,08563. From the calculation, the resulting error evaluation of the method will be expressed in the form of MAD and MAPE, which are:

- MAD : 30
- MAPE : 167

4. Winter's Model



Above are shown the results of the calculation of the Winter's Model forecasting method. There are three coefficient used in the calculation of Winter's Model forecasting method, which are alpha, beta, and gamma. In this calculation the alpha is equal to 0,01; beta is equal to 0,0747; and gamma equal to 0,01. From the calculation, the resulting error evaluation of the method will be expressed in the form of MAD and MAPE, which are:

- MAD : 30
- MAPE : 161

5. Material Requirements Planning (MRP)

The method which is going to be used in the process of MRP in this research is only the lot-for-lot. The demand data taken here was the outcome from the previous method of forecasting. Which, final results saw Winter's Model that has the least error. Moreover, the simulation that is practiced in this section will represent the period time from January to April 2016, presented in a weekly view. This period of time is due to the results of the forecasting method. Below is the table that shows the process of the MRP:

	Week															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Gross requirements	0	0	113	0	0	0	88	0	0	0	89	0	0	0	87	0
Projected on hand	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Net requirements	0	0	113	0	0	0	88	0	0	0	89	0	0	0	87	0
Planned order receipts			113				88				89				87	
Planned order releases	113				88				89				87			

Conclusion

From the calculation aforementioned in the previous section, the comparison between each and every method could be evaluated by measuring the error rate of the method. The method of error evaluation used in this research is the Mean Absolute Deviation (MAD) and Mean Absolute Percentage Error (MAPE). Which, is summarized as the following:

Forecasting Method	**MAD**	**MAPE(%)**
Moving Average (5 period)	33	235
Exponential Smoothing	31	173
Holt's Model	30	167
Winter's Model	30	161

As shown above are the summary of error rate of the four methods executed in the research. It could be concluded the Winter's Model forecasting method has the smallest number of both MAD and MAPE compared to the other three method, Moving Average, Exponential Smoothing, and Holt's Model. Thus, referring to the original purpose of the research. Which, is to determine the most suitable method of forecasting for the company of PT XYZ. Moreover, in hope to overcome the problem of mismatch between supply and demand which the company faced before. The Winter's Model forecasting method is the method that has the least number of error measurement. Hence, it will give the best outcome. Afterwards, the method of Material Requirements Planning (MRP) is also complimentary to the forecasting method. It is as important also to a company. Even though if it stands itself, it wouldn't have that much of an impact. The operational decision must be made as a whole unit and complementing one another

Recommendation

Recommendations available for the company based on the research outcome would be to implement the Winter's Model forecasting method. As the method showed the least number of error rate. As before the company has not practiced the method of forecast towards their demands, applying the method to the company operations would worth the attempt and be beneficial. Goes as well as for the MRP method, even though the company is not a manufacturing company. A more basic recommendation to the company would be a more detailed documentation of the company, even though the company is still categorized as a Small and Medium Enterprises (SME). This includes the documentation of past demands, past order forms, business activities, etc. The company of PT XYZ is still at a developing stage and has not grown into its full potential. But in order to exercise it to the fullest, every single detail will always have a room for improvement. And it is these minor and detailed improvements that would be the slight edge and be the difference between the company and its competitors in the market.