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Decision Support system to Maximize Profit Using Integer programming Comparing with other Techniques

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Abstract*:* I have written this paper to my confidence that decision support systems and technologies can help traders and business owners in develop their business especially in making decisions related with investments. The paper give readers overview on techniques used in business and especially those they work in medium institution and those they interested in investment decisions. The results of research illustrate the best techniques can use in investments decisions and the best ways to use every technique. The scope of the work was in one of medium size enterprise, i use their data for the year of 2016 and make the study on this data. In this research, I argue that the use of scientific methods is better than relying on traditional methods such as the experience of people and others. In particular, I believe that the use of linear programming method is the best way to make investment decisions. The experiments in the research on two methods assuming stability of sold quantities in 2017 as 2016 and the second method by forecast o sold quantities in 2017 after studying time series of every item. The techniques that we use are traditional method as experience of persons our case study use it, data calculations but not rely on scientific method, linear programming and ABC XYZ analyse. The way the experiments were conducted was to focus on the highest return on profitability, taking into account the available financial resources of the institution as well as the expected period of return of profits.

Keywords: Decision support system, linear programming, medium sized enterprise, investment decisions

I. INTRODUCTION

Decision support systems are modern technological systems used for developing an environment of decisions making. Decision support system depends on processing and analysing data to get best results and select best decisions. In business environments, they are always look for enhancing and developing performance, so they need the decision support systems constantly. The uses of decision support systems are not limited only one field contrariwise they are diverse. Health services, education, trading and other fields use decision support system. Government and nongovernment organizations also profit and non-profit organizations do not overlook on using decision support system. The history of decision support systems nearly started since the 1950s only in theoretically, but on the technical using it started after 1960s. There are many of studies were written in decision support systems and also many of researchers have written on DSS for the purpose of developing and to increase the benefit of return on international organizations in the areas of research and application.

This research aims is extending the benefits of DSS to cover medium-sized enterprises. Medium- sized enterprises as another profit enterprises seeking to maximizing profit. Consequently, I will make a case study on one of medium size enterprise to see if we can get good results by using DSS to access to highest possible profit. Precisely the research introduces some of different methods that are used for making the investment decisions and make a comparison between them. The research supposes that DSS using linear programming will give best results and decisions.

The main problem is the lack of benefit from the technological boom that has become widely available to all in business, especially when making investment decisions in medium-sized enterprises.

As we know, the fundamental aim in business is gaining highest profits in the shortest possible time. Some of the goods may trick even experts in their business. Sometimes investors look only for profit with ignoring other sides like product lifecycle. In another hand, high demand on a special product or quick life cycle also can trick owner of business even if this product returns the small profit. Actually, profit with slow product lifecycle is not desirable. Also, speed product lifecycle with low small profits also not desirable. For example, table 1 explores how high profitable product can trick investors.

Table 1: HOW PROFIT TRICK INVESTORS

Product name	Profit	Quantity sold
X	1000	1 pcs per 3 months
Y	100	4 pcs per month

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In the previous table, with a quick look we think x product is better to invest a budget in, but if we analysed and compared between X and Y we can see that Y is better from X:
X annual profit is 4000.
Y annual profit is 4800.

Important questions remain when making any investment decision:
What are the right items for investment now?
What is the appropriate quantity of investment of each type?
What are the items that bring us the highest possible profit?
The answer to these questions helps to get rid of many of the problems that occur in the business.

The scope of time will be for 12 months and we can use less or more 12 months but will extract data for 12 months as a standard between 1/1/2016 until 31/12/2016. The aim is not innovation new rule or approach, but it is a try seeks to applying and utilizing business methodologies as linear programming and ABC XYZ analysis combined with modern technologies as excel and mat lab in traditional business environment.

II. LITERATURE REVIEW

In the literature review, I try to focus on previous studies in decision support system and linear programming and their using in maximizing profit. The temporal boundaries in research were between 1975 to 2016. The words I used in research are decision support system, linear programming, decision making, investment decision support system, and decision support system in medium sized enterprises. I used Google scholar and infomine as scientific research engines. I used also scientific journals like IEEE, Springer, and science direct. English were the main language in research but I also used Arabic on a small scale.

Decision support system has different definitions and conceptions like using computer systems and technologies as intermediates for managers to help them in achieving and support decisions in work. Another definition is excellence design strategy in business based on evaluation techniques (Keen P. G., 1980). The studies on decision support systems have expanded in the seventies. (Studer, 1979) He is cussed the features of decision support system which were used with applications of database management systems. Only experience or programming specialists used the applications of database management systems but in the seventies, the users of these systems changed to be easier to use with no specialists. Some of the features had become available for users to apply their functions. Decision support systems were one of the importance applications used by users to develop technical or commercial areas.(Macedo, Camargo, Oliveira, Silva , & Salgado, 2013) in their paper noticed cautious of people to invest in the stock market and some other people who have the lake of knowledge in the stock market. They think that can prevent the good return and financial gain. So they invented a hybrid system that introduces heuristic rules and to give investors higher gain using forecasting techniques. The decision support system uses different kinds of means such as data, models, methods, knowledge and tools. Agents in the systems mean a component that contact with another component in another environment to achieve specific tasks. Decision support systems have (MAS) multi-agent systems that contact together and coordinate among themselves to help in decision making (Ruixue, Chaofeng , Ming, & Zhanhong , 2008).

The linear programming is a mathematical operation used in cases need to maximize or minimize something. Minimizing cost or time also to maximizing profit prices. In linear programming, there is a goal either maximize or minimize and there is constraints cannot be ignored. To solve the problem of linear programming there are different methods like geometric method and simplex method. The geometric method is used with only problems with two variables. The simplex method is used to solve problems with more than two variables (Wallis, 2012). Researchers have used linear programming in a variety of work environments. In energy sources (Torres, Crichigno , Padilla, & Rivera, 2014) have used linear programming to maximize profit. Their optimization model is used to schedule energy sources to meet the need of clients. The model combined between energy sources together (conventional, renewable and battery storage) then schedule them to clients to satisfy them and gain maximum profit. (موسى, 2012) Built a model can solve the problem of a lake of profit in vegetable oils factory using branch and bound method. The branch and bound method are one of the famous methods, which depend on simplex method. In his module, he used 20 variables and 5 constraints to achieve objective function.

III. DECISION SUPPORT SYSTEM

There are two types of decisions, fist one is qualitative decisions that do not rely on numbers and data. Second one is quantitative decisions that rely on numbers and data.

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Table 2 :Difference between qualitative and quantitative method.

	Input	Process	Output
Qualitative decision	Depend on theoretic and opinions	Expectations and experience	Not easy to measurable
Quantitative decision	Depend on data and numbers	Statistical and calculations	Easy to measurable

The decisions in organizations and business are not same, there are some difference between them. The difference between decisions can be measured by the impacts of every decision on other levels of the organization and the execution time of the decisions is also important.
Decisions are taken by three different levels in the organization that are top, middle and low level. The period also consist of three type's long, medium and short time.

There are three types of business decisions strategic, tactical and operational.

A. Strategic decision

Strategic decisions are the decision that plan the goals and future of company. The period of these decisions usually take a long term to implementation like semester and years. The level of management they always do strategic decision are a top level of management. The impact of strategic decisions effect on all levels of organizations. Strategic decision consider as unstructured decision.

B. Tactical decision

Tactical decisions are the decisions that taken by a middle level of management to support execution of decision made by top level. The period of these decisions usually tale medium term like months. The impacts of tactical decisions effect on medium and low level of organization. Tactical decision consider as semi structure decision.

C. Operational decision

Operational decisions are the decisions that execute daily operations in organization. These decisions are complement to achieve goals planned by top and medium levels. The period of operational decisions always take a short period of time days and weeks. Operational decisions are taken by low level of management. Operational decisions consider as structure decisions.
The difference between business decisions in three main points are the period of time, level of management and structure or not. All types of business decisions work together to access the goals of organization. All decision in any level has an important to be supported by data, information and knowledge. Decision support system must be available in any level of management to help decisions makers choosing optimum decision.

IV. LINEAR AND INTEGER PROGRAMMING

Linear or integer programming is a kind of research process that deals with the real problems in life, using scientific methods and then provides several solutions suitable for this problem and then choose the best solution within the solutions available, taking into account the constraints and resources available to solve the problem. Operations research in general aims to reach the optimal solution of the problem with the maximum profits possible and the lowest costs and has many applications in various fields of life such as industry, trade, transportation, military and other fields. The scientific methods on which operation researches depends on statistical analysis and linear and integer programming that we will explain detailed and other scientific methods.
Linear programming is a type of mathematical programming and may be the most applied in the business environment. Its idea is to find the best possible results whether it is the question of finding the greatest value or finding the least value under the available resources only. Software availability has contributed to the spread and application of this method in various areas. One example used to solve linear programming problems is the graph. Another method is the simplex method, which is more prevalent than its counterpart because it can solve problems with a large number of variables.
Integer programming is similar to linear programming, but the values of variables in linear programming can be integers or fractions. However, in the integer programming, the values of the resulting variables should be only integer numbers. For example, in determining the appropriate quantity to invest in certain items, it is not possible for the quantities to be fractional numbers.
Any question in linear programming consists of three basic elements:

A. Decision variables and constants

The variables can be defined as the unknown values that are determined after solving the problem, meaning that they are the results of the solution such as determining the quantities to be invested in certain varieties or determining the quantities to be produced from different products. The constants are defined as the fixed and known values on which variables are known such as the cost of the product or the number of hours of production and others.

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B. Constraints

Constraints are the possible limits of decision variables or issue outputs since output values must be in line with these constraints and are subject to available resources such as a factory-specific budget to produce a product, outputs cannot exceed these constraints.

C. Object function

In any problem or issue there is a goal to solve the issue, this goal defined by by the decision-maker may be the goal of obtaining a profit or the reduce budget of production and express this goal is called an object function and result represents the optimum solution whether the goal was maximizing the value of profit or other, result of the function is the value of the highest profit possible through the available resources or constraints, or in other situation the goal is less value such as reducing the value of production, the value of the function is the lowest possible value of production under existing resources or constraints.

Based on the above elements, linear programming issues are mathematically formulated in the following form:

$$Maxmize\ or\ Minimize\ Y = \sum_{i=1}^{n} ci * xi$$

$$subject\ to:$$

$$\sum_{i=1}^{n} a_{ji} * X_i \geq \leq b_j \qquad for\ j = 1,2,3....., n$$

$$X_i \geq 0 \quad for \quad i = 1,2,3....., n$$

Y = It is an object function is considered as output, since its value is the result of solving the equation, in the question of this research is the highest possible profit value.

C = It is considered an input, and in this research it expresses the profit value of each item separately.

X = these are the search variables which are the result of the solution. In this research, it expresses the quantities to be invested in each item.

a = It is an input of the issue and expresses the values of the left-limit variables of the constraints, the question of this research reflects the cost of each item.

b = Which is the input determined by the decision maker and express the highest or lowest possible value, in this research reflect the highest possible value of the cost of investment in the sense that the total quantities should not exceed the cost of this value

Linear programming problems are often solved using the graph method if the issue contains only two variables. If the question contains more than two variables, the simplification method will be the optimal method. In a simplistic way, not all possible solutions are calculated, but they depend on the transition from a solution to a better solution until reach to the optimal solution.

The use of linear programming in the business environment often contains many variables and several solutions are available. It is difficult to compare and search for the best solution among the solutions available only depending on the human effort. For the importance of operation researches methods in the various daily life, including the linear programming approach, computer companies interested in this science have developed many programs that solve the problems of linear programming and other operation researches issues, thus contributing to the widespread use of linear programming.

V. ABC XYZ ANALYSE

In analysing ABC XYZ, at first we execute ABC analysis and then we take the most important items, which are in the category of A, and we analyse them by XYZ analyse to determine the stability of the demand for them. The items that are classified A and X are the most important and stable items and the degree of reliability in the stability of demand and investment in it has a high profit return. In the following table, we illustrate the types of varieties according to the analysis ABC XYZ and importance of each type.

Table 3 : Types of ABC XYZ analyze

	X	Y	Z
A	High profit	High profit	High profit
	Stability in sales	Low change in sales	High change in sales
B	Medium profit	Medium profit	Medium profit
	Stability in sales	Low change in sales	High change in sales
C	Few profit	Few profit	Few profit
	Stability in sales	Low change in sales	High change in sales

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A. ABC analyse

This analysis is the classification of the best stock in the company and consists of two analyses, and each analysis is concerned with certain aspects are analysed for each item. ABC analyses and classifies a group of elements according to the degree of importance, whether these elements are customers or categories or branches of shops or others, and are classified into three categories, A are the most important items at all, B important items but less than the importance of A and finally class C and contains Non-important items. This analysis is based largely on the famous Pareto analysis, which says that 80% of the results come from 20% of the items. For example, 80% of the profits come from 20% of the items or 80% of the time goes out in 20% of the tasks and other examples in the areas of life. The percentages vary sometimes, some scientists disagree with Pareto, one of them says that 70% of the results come from 30% of items and there are also different percentages.

B. XYZ analysis

XYZ analysis is used to classify stock goods based on the fluctuation of demand for these goods and are classified as follows:

X: Items under this type have a stable demand and little change during periods, making it easier to predict the future demand of these varieties and to be closer to health and reliability.

Y: Items under this type are not as stable as the first type but their variability is often medium and in known seasons, and their quantities can be predicted to some degree.

Z: Items under this type is very variable and the quantity of demand is very difficult to predict of future demand. In the following, I will include graphical examples of variability and difference of the demand for one item in category X, and another item of category Y, and item of category Z to indicate the extent of variation.

VI. METHODOLOGY

The aim of this research is discussion issue of unstudied decisions or decisions that only depend on personal knowledge or experience without giving any attention for available and related real information with this decision that can give a good view of for decisions making. Our philosophy in this research has based on a methodology of decision support systems that use data analysing tools to support decisions in a non-routine ways by using real information.

The case study in this research will be a medium size enterprise that has a sales application contain historical data for every product. The theoretical dimension in this case study is decision support system by linear programming to choose most return on investment from existing products in the case study. Studying this type of enterprise can help us to generalization results for other medium-sized enterprises.

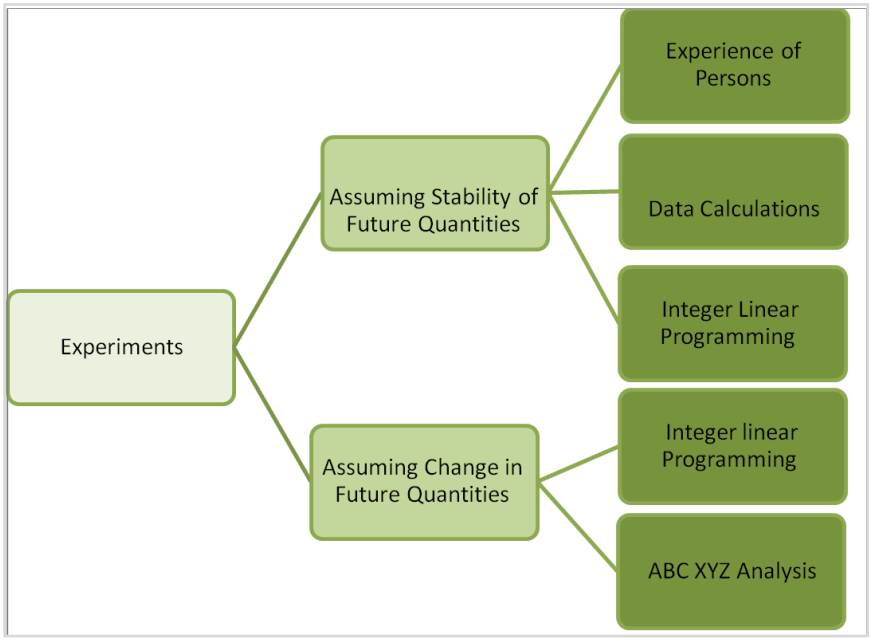

Figure 1: Types of Experiments

A. Assuming stability of future sales quantities

Data I used was for 2016 (12 months) and invested amount we put it =100000(one hundred thousand)

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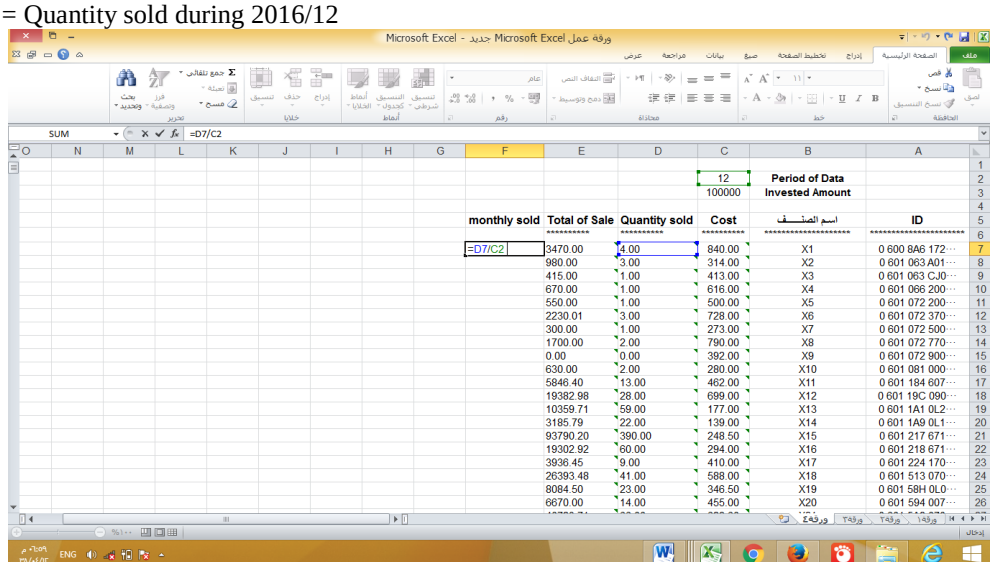
1) Data calculations
In this type, I have done some of calculations on data as follow:
Monthly sold = Quantity sold during 2016/12

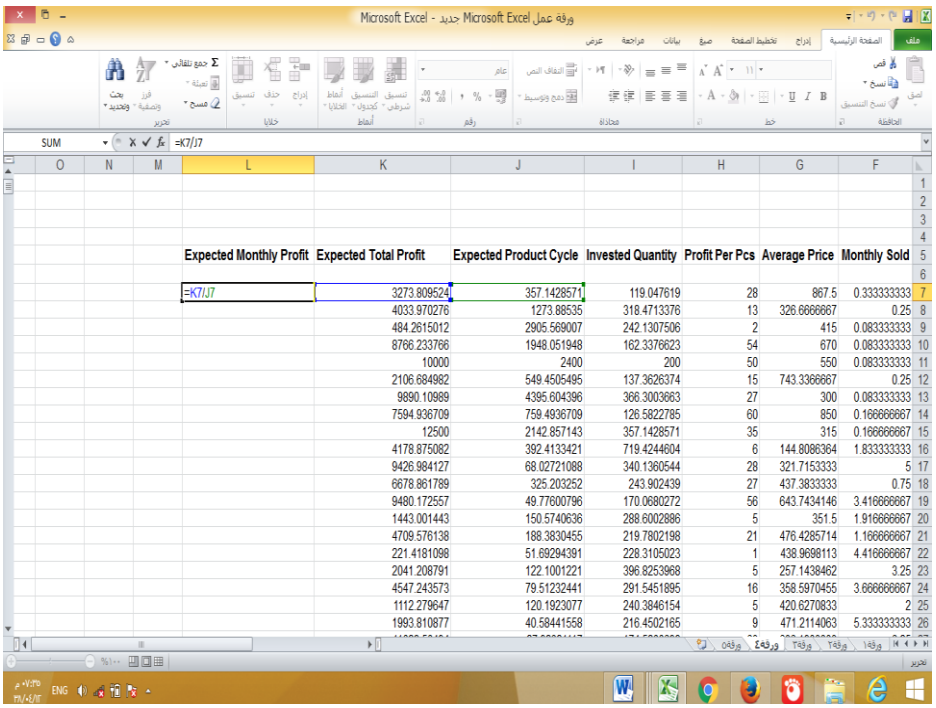


			12	Period of Data	
			100000	Invested Amount	
monthly sold	Total of Sale	Quantity sold	Cost	اسم الصنف	ID
=D7/C2	3470.00	4.00	840.00	X1	0 600 8A6 172···
	980.00	3.00	314.00	X2	0 601 063 A01···
	415.00	1.00	413.00	X3	0 601 063 CJ0···
	670.00	1.00	616.00	X4	0 601 066 200···
	550.00	1.00	500.00	X5	0 601 072 200···
	2230.01	3.00	728.00	X6	0 601 072 370···
	300.00	1.00	273.00	X7	0 601 072 500···
	1700.00	2.00	790.00	X8	0 601 072 770···
	0.00	0.00	392.00	X9	0 601 072 900···
	630.00	2.00	280.00	X10	0 601 081 000···
	5846.40	13.00	462.00	X11	0 601 184 607···
	19382.98	28.00	699.00	X12	0 601 19C 090···
	10359.71	59.00	177.00	X13	0 601 1A1 0L2···
	3185.79	22.00	139.00	X14	0 601 1A9 0L1···
	93790.20	390.00	248.50	X15	0 601 217 671···
	19302.92	60.00	294.00	X16	0 601 218 671···
	3936.45	9.00	410.00	X17	0 601 224 170···
	26393.48	41.00	588.00	X18	0 601 513 070···
	8084.50	23.00	346.50	X19	0 601 58H 0L0···
	6670.00	14.00	455.00	X20	0 601 594 007···

Figure 2: Monthly sold

I also calculated
Average price= Total of sale/ Quantity sold
Profit per pcs= Average price- cost

After I analysed historical data I am going to expect future calculate future sales as follow:
Invested quantity= invested amount/cost
Expected product cycle = invested quantity /quantity sold per month
Expected total profit = profit per pcs * invested quantity
Expected monthly profit = expected total profit / expected product cycle



Expected Monthly Profit	Expected Total Profit	Expected Product Cycle	Invested Quantity	Profit Per Pcs	Average Price	Monthly Sold
=K7/J7	3273.809524	357.1428571	119.047619	28	867.5	0.333333333
	4033.970276	1273.88535	318.4713376	13	326.6666667	0.25
	484.2615012	2905.569007	242.1307506	2	415	0.083333333
	8766.233766	1948.051948	162.3376623	54	670	0.083333333
	10000	2400	200	50	550	0.083333333
	2106.684982	549.4505495	137.3626374	15	743.3666667	0.25
	9890.10989	4395.604396	366.3003663	27	300	0.083333333
	7594.936709	759.4936709	126.5822785	60	850	0.166666667
	12500	2142.857143	357.1428571	35	315	0.166666667
	4178.875082	392.4133421	719.4244604	6	144.8086364	1.833333333
	9426.984127	68.02721088	340.1360544	28	321.7153333	5
	6678.861789	325.203252	243.902439	27	437.3833333	0.75
	9480.172557	49.77600796	170.0680272	56	643.7434146	3.416666667
	1443.001443	150.5740636	288.6002886	5	351.5	1.916666667
	4709.576138	188.3830455	219.7802198	21	476.4285714	1.166666667
	221.4181098	51.69294391	228.3105023	1	438.9698113	4.416666667
	2041.208791	122.1001221	396.8253968	5	257.1438462	3.25
	4547.243573	79.51232441	291.5451895	16	358.5970455	3.666666667
	1112.279647	120.1923077	240.3846154	5	420.6270833	2
	1993.810877	40.58441558	216.4502165	9	471.2114063	5.333333333

Figure 3: Expected monthly profit

Depend on expected monthly profit I am going to arrange items from up to down, items with highest expected monthly profit are the most important than other.

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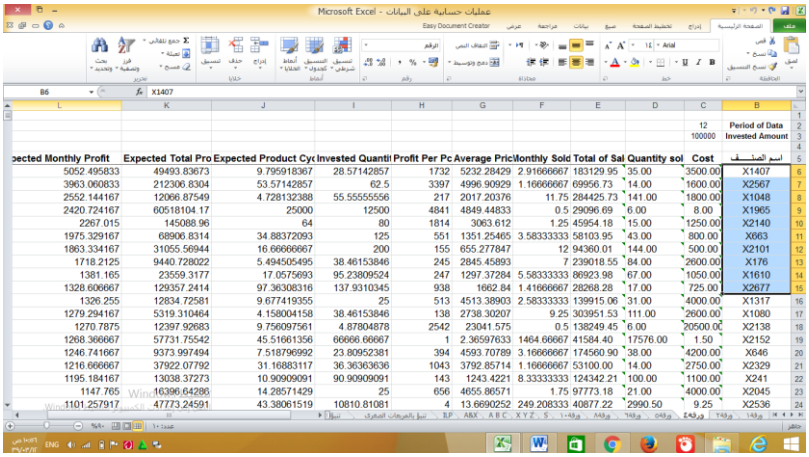
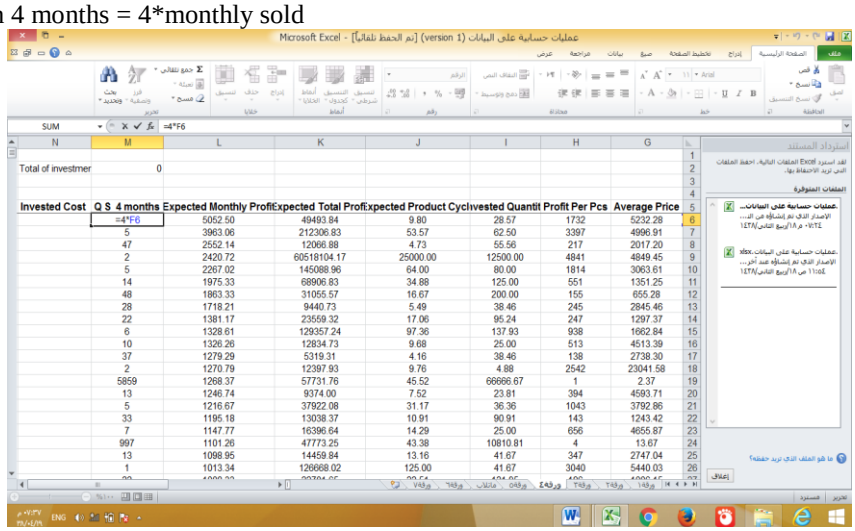


Period of Data	Invested Amount	Cost	اسم الصنف	Quantity sol	Total of Sal	Monthly Sold	Average Pric	Profit Per Pc	Invested Quanti	Expected Product Cyc	Expected Total Pro	Expected Monthly Profit
12	100000											
		3500.00	X1407	35.00	183129.95	2.91666667	5232.28429	1732	28.57142857	9.795918367	49493.83673	5052.495833
		1600.00	X2567	14.00	69956.73	1.16666667	4996.90929	3397	62.5	53.57142857	212306.8304	3963.060833
		1800.00	X1048	141.00	284425.73	11.75	2017.20376	217	55.55555556	4.728132388	12066.87549	2552.144167
		8.00	X1965	6.00	29096.69	0.5	4849.44833	4841	12500	25000	60518104.17	2420.724167
		1250.00	X2140	15.00	45954.18	1.25	3063.612	1814	80	64	145088.96	2267.015
		800.00	X663	43.00	58103.95	3.58333333	1351.25465	551	125	34.88372093	68906.8314	1975.329167
		500.00	X2101	144.00	94360.01	12	655.277847	155	200	16.66666667	31055.56944	1863.334167
		2600.00	X176	84.00	239018.55	7	2845.45893	245	38.46153846	5.494505495	9440.728022	1718.2125
		1050.00	X1610	67.00	98923.98	5.58333333	1297.37284	247	95.23809524	17.0575693	23559.3177	1381.165
		725.00	X2677	17.00	28268.28	1.41666667	1662.84	938	137.9310345	97.36308316	129357.2414	1328.606667
		4000.00	X1317	31.00	139915.06	2.58333333	4513.38903	513	25	9.677419355	12834.72581	1326.255
		2600.00	X1080	111.00	303951.53	9.25	2738.30207	138	38.46153846	4.158004158	5319.310464	1279.294167
		20500.00	X2138	6.00	138249.45	0.5	23041.575	2542	4.87804878	9.756097561	12397.92683	1270.7875
		1.50	X2152	17576.00	41584.40	1464.66667	2.36597633	1	66666.66667	45.51661356	57731.75542	1268.366667
		4200.00	X646	38.00	174560.90	3.16666667	4593.70789	394	23.80952381	7.518796992	9373.997494	1246.741667
		2750.00	X2329	14.00	53100.00	1.16666667	3792.85714	1043	36.36363636	31.16883117	37922.07792	1216.666667
		1100.00	X241	100.00	124342.21	8.33333333	1243.4221	143	90.90909091	10.90909091	13038.37273	1195.184167
		4000.00	X2045	21.00	97773.18	1.75	4655.86571	656	25	14.28571429	16396.64286	1147.765
		9.25	X2536	2990.50	40877.22	249.208333	13.6690252	4	10810.81081	43.38061519	47773.24591	1101.257917

Figure 4:After arrange items depending on monthly profit

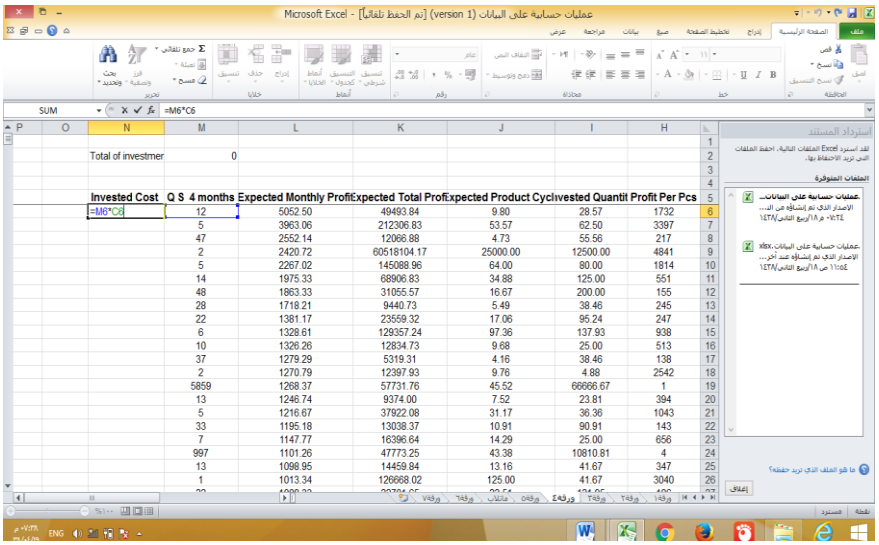
To distribute the budget on items within constraints 4 months and 100000 I am going to calculate quantity sold for every items through 4 months:
Quantity sold within 4 months = 4*monthly sold



Total of investmer	0						
Invested Cost	Q S 4 months	Expected Monthly Profit	Expected Total Profit	expected Product Cycl	vested Quantit	Profit Per Pcs	Average Price
	=4*F6	5052.50	49493.84	9.80	28.57	1732	5232.28
5		3963.06	212306.83	53.57	62.50	3397	4996.91
47		2552.14	12066.88	4.73	55.56	217	2017.20
2		2420.72	60518104.17	25000.00	12500.00	4841	4849.45
5		2267.02	145088.96	64.00	80.00	1814	3063.61
14		1975.33	68906.83	34.88	125.00	551	1351.25
48		1863.33	31055.57	16.67	200.00	155	655.28
28		1718.21	9440.73	5.49	38.46	245	2845.46
22		1381.17	23559.32	17.06	95.24	247	1297.37
6		1328.61	129357.24	97.36	137.93	938	1662.84
10		1326.26	12834.73	9.68	25.00	513	4513.39
37		1279.29	5319.31	4.16	38.46	138	2738.30
2		1270.79	12397.93	9.76	4.88	2542	23041.58
5859		1268.37	57731.76	45.52	66666.67	1	2.37
13		1246.74	9374.00	7.52	23.81	394	4593.71
5		1216.67	37922.08	31.17	36.36	1043	3792.86
33		1195.18	13038.37	10.91	90.91	143	1243.42
7		1147.77	16396.64	14.29	25.00	656	4655.87
997		1101.26	47773.25	43.38	10810.81	4	13.67
13		1098.95	14459.84	13.16	41.67	347	2747.04
1		1013.34	126668.02	125.00	41.67	3040	5440.03

Figure 5: Expected monthly sold during 4 months

After that, I am going to invest budget in items that return maximum profit from up do down until our budget finish.
M2=sum (N6:N3038) When the total reach to 100000 we will stop investment.



Total of investmer	0					
Invested Cost	Q S 4 months	Expected Monthly Profit	Expected Total Profit	expected Product Cycl	vested Quantit	Profit Per Pcs
=M6*C6	12	5052.50	49493.84	9.80	28.57	1732
5		3963.06	212306.83	53.57	62.50	3397
47		2552.14	12066.88	4.73	55.56	217
2		2420.72	60518104.17	25000.00	12500.00	4841
5		2267.02	145088.96	64.00	80.00	1814
14		1975.33	68906.83	34.88	125.00	551
48		1863.33	31055.57	16.67	200.00	155
28		1718.21	9440.73	5.49	38.46	245
22		1381.17	23559.32	17.06	95.24	247
6		1328.61	129357.24	97.36	137.93	938
10		1326.26	12834.73	9.68	25.00	513
37		1279.29	5319.31	4.16	38.46	138
2		1270.79	12397.93	9.76	4.88	2542
5859		1268.37	57731.76	45.52	66666.67	1
13		1246.74	9374.00	7.52	23.81	394
5		1216.67	37922.08	31.17	36.36	1043
33		1195.18	13038.37	10.91	90.91	143
7		1147.77	16396.64	14.29	25.00	656
997		1101.26	47773.25	43.38	10810.81	4
13		1098.95	14459.84	13.16	41.67	347
1		1013.34	126668.02	125.00	41.67	3040

Figure 6: Calculate invested cost for every item

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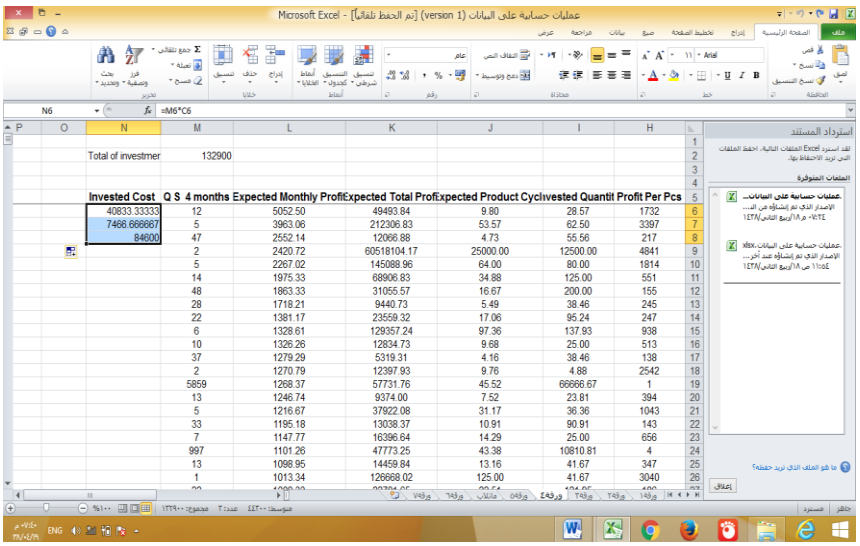

Figure 7: Invested cost for third item

When I arrived at third items, the budget went up until 132900, so I must change quantity to reach to 100000.

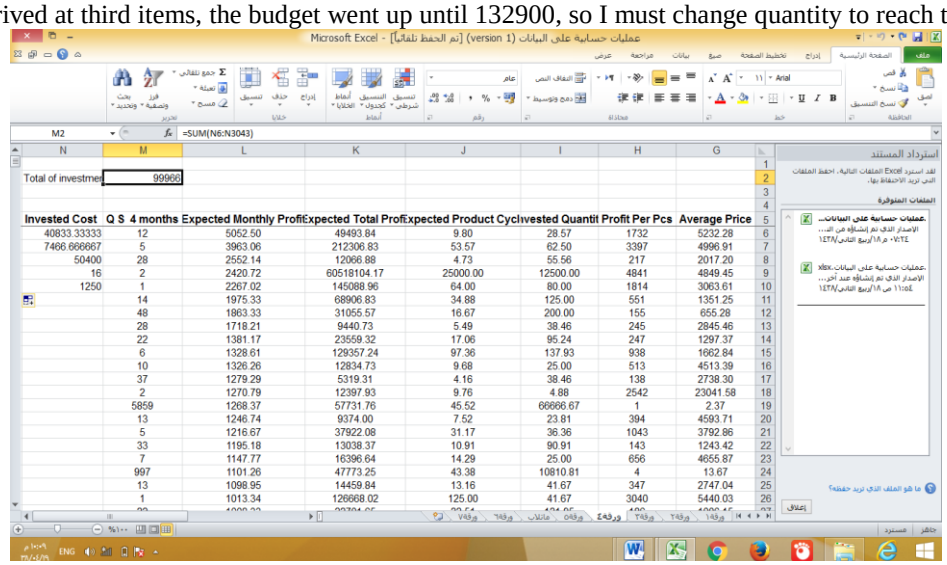

Figure 8:Total invested amount

After changing quantities within constraints, I will calculate the profit.

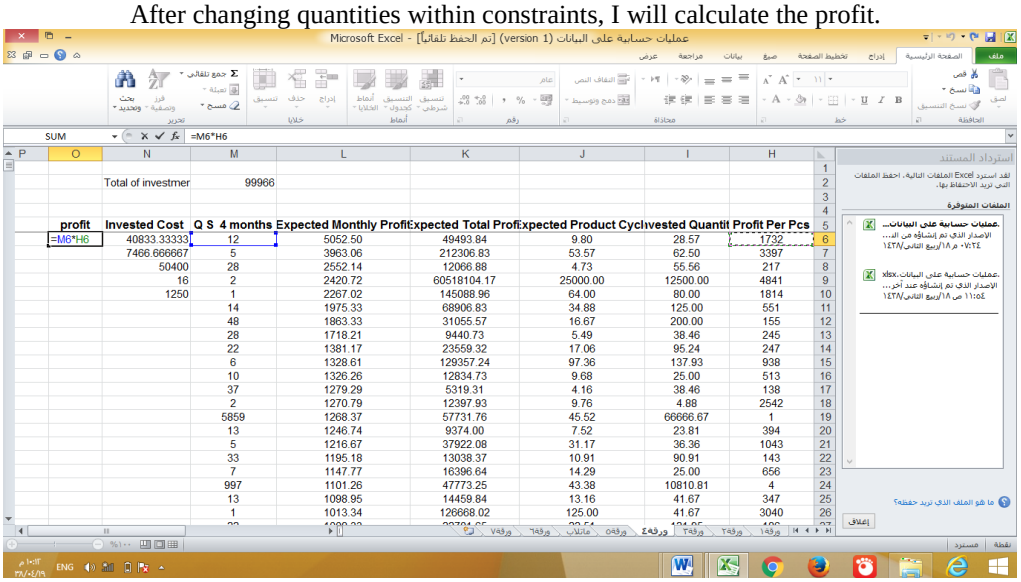

Figure 9: Calculate profit

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Profit = Quantity sold within 4 months or less* profit per pcs

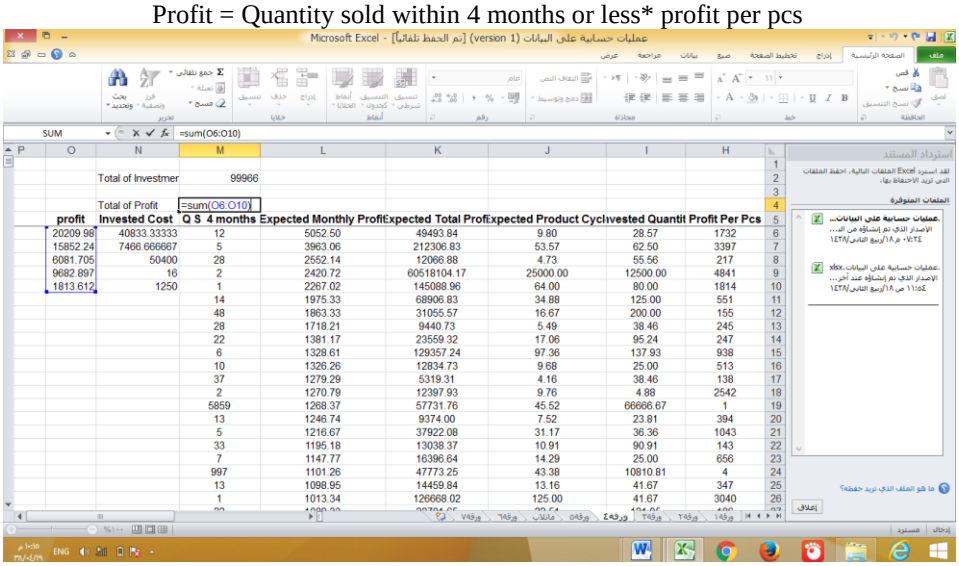

Figure 10:Sum of profit

Total of profit= 53640

2) Integer linear programming

I will use mat lab program to execute integer linear programming

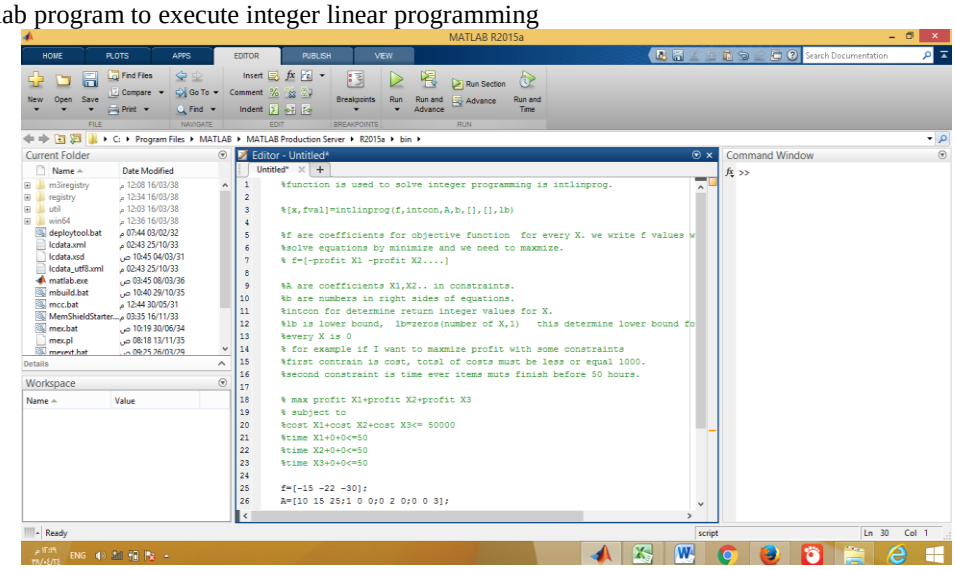

Figure 11: Explain the formula of linear programming in Mat lab

We want to maximize our profit within two constraints:

1- Budget less than 100000.

2- Hours must be less than 832(4 months* 26 days * 8 hours per day)

At first, I am going to calculate the number of hours the enterprise needs to sell one piece of each item.

Hours per pcs = working hours during the year (12 months*26 day*8 hours) / Quantity sold per year.

Hours per pcs = 2496/Quantity sold per year

For example:

The enterprise sold 4 pieces of X1 during 2016 and 3 pieces of X2 during 2016 X1=2496/4=624 hours

X2=2496/3=832 hours

Every 624 hours enterprise will sell one piece of X1 and every 832 hours sell on piece of X2.

After obtaining the hours required by the enterprise to sell one piece of each item, we will transfer data from Excel to Mat lab. We will use the Mat lab function to solve this type of questions (integer linear programming). The function is intlinprog.

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[x,fval]=intlinprog (f,intcon,A,b,lb)
Where F is the values that we want to maximize, and in our experience this is the amount of profit in each piece. Intcon indicate that the values of the X result of the equation solution must be integer. A is the coefficients values of the constraints in question for each element and the constraints in this question are the cost and the number of hours. B represents values of limitations in our experiment there are two limitations cost and number of hours.
We will solve this issue according to the following formula:
Max Profit X1+ profit X2+ profit X3+ profit X4….
Adjust to:
1- Cost X1* invested quantity of X1+ cost X2 * invested quantity of X2 + cost X3 * invested quantity of X3 + cost X4 * invested quantity of X4 <=100000
2- Hours to sell on pcs of X1<=832 hours (4 moths)
3- Ours to sell on pcs of X2 <= 832
4- Hours to sell on pcs of X3 <= 832
Every X has constraint from X1 to X3038 every X must finish before 832 hours. That mean the hours enterprise need to finish invested quantity of every X must be equal or less of 832 working hours (4 months). Total cost must be 100000 or less.
After using mat lab, I moved results to excel and arranged it from upper quantity to down to validate of results I am going to calculate cost and hours for every variable.
Invested amount = quantity by integer LP* cost

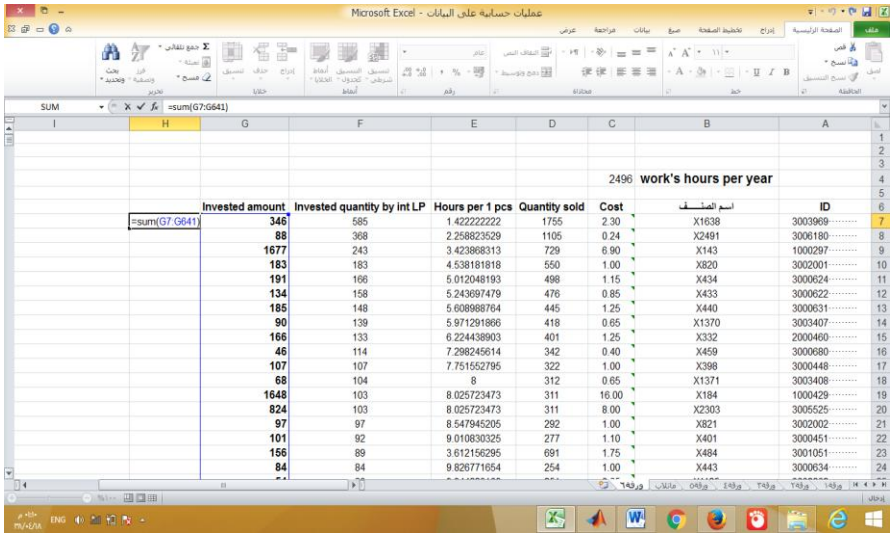

Figure 12: Calculate total of invested amount

Total is exactly 100000 that mean first condition is validate
After that, I am going to validate from second constraint, quantity for every X must finish before 4 months (832 hours)
Hours to finish quantity=invested quantity*hours per 1 pcs

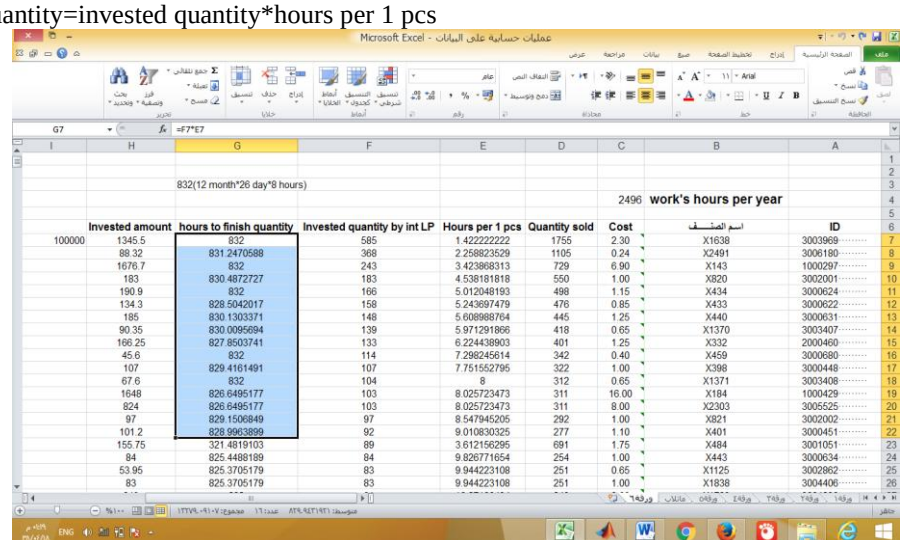

Figure 13: Number of hours to finish invested quantity of every item

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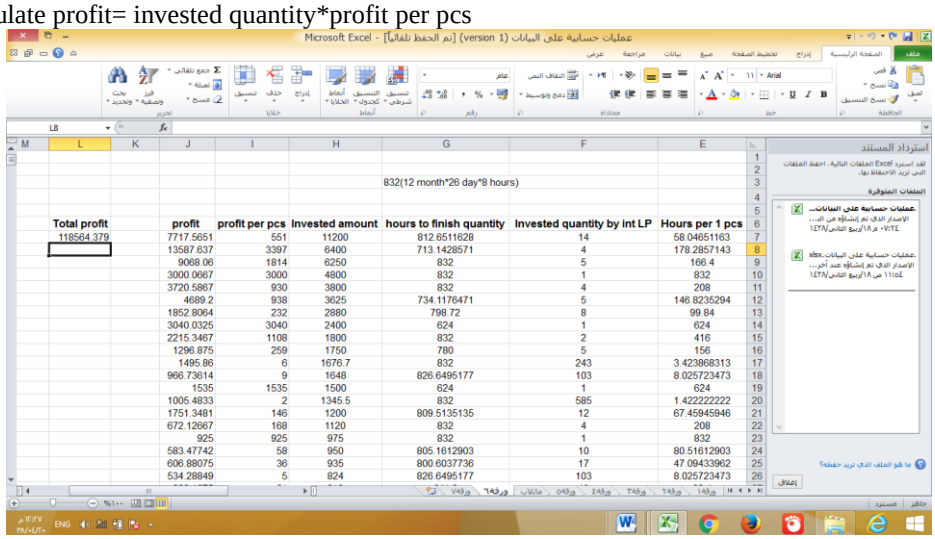
Second constraint is also validate every X finish before 832 hours.
After that, I arranged variables from high-invested amount to low
Then I will calculate profit= invested quantity*profit per pcs



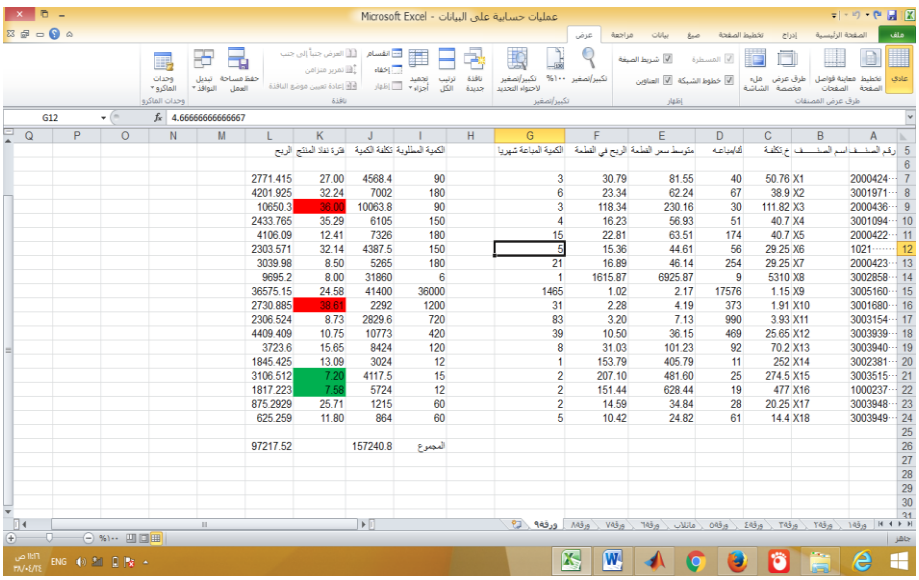
832(12 month*26 day*8 hours)

Total profit	profit	profit per pcs	Invested amount	hours to finish quantity	Invested quantity by int LP	Hours per 1 pcs
118564.379	7717.5651	551	11200	812.6511628	14	58.04651163
	13587.637	3397	6400	713.1428571	4	178.2857143
	9068.06	1814	6250	832	5	166.4
	3000.0667	3000	4800	832	1	832
	3720.5867	930	3800	832	4	208
	4689.2	938	3625	734.1176471	5	146.8235294
	1852.8064	232	2880	798.72	8	99.84
	3040.0325	3040	2400	624	1	624
	2215.3467	1108	1800	832	2	416
	1296.875	259	1750	780	5	156
	1495.86	6	1676.7	832	243	3.423868313
	966.73614	9	1648	826.6495177	103	8.025723473
	1535	1535	1500	624	1	624
	1005.4833	2	1345.5	832	585	1.422222222
	1751.3481	146	1200	809.5135135	12	67.45945946
	672.12667	168	1120	832	4	208
	925	925	975	832	1	832
	583.47742	58	950	805.1612903	10	80.51612903
	606.88075	36	935	800.6037736	17	47.09433962
	534.28849	5	824	826.6495177	103	8.025723473

Figure 14:Total of ILP profit

Total profit in integer linear programming is 118564 and in heuristic method was 53640.

3) Comparing between qualitative method and quantitative method using integer linear programming.
In this section, I will compare the most profitable method of quantitative methods, the linear programming method with the currently used method of investment in the enterprise, a qualitative method that is based only on experience without using any kind of quantitative methods or decision support systems.
The comparison method will be by reviewing one of the recent investments of the institution in which the traditional method, the qualitative method based on experience, was used to determine the quantities purchased from each item. At January 2016, the institute has invested 157240 SR in 18 items. The expected profit was 97217 and the cost was 157240. The product expiration cycle is uneven between items, some items finish through 7 months and others need 38 months. This mean the profit will return after 38 months, also this difference between items is a negative point. When quantities finish quickly is better because this give an opportunity to invest again. Also, when quantities still long time this may cause damage and lose money. The gap between expected periods of product expiration is to long as we can see in figure down some items in red colour need 36, 38 months to finish and some items need only 7 months. This discrepancy is often due to the method of non-studied investments and is not based on an analysis of the sales data of the items.



رقم الصنف	اسم الصنف	ح تكلفة	كمية	متوسط سعر الطلبة	الربح في الطلبة	الكمية المباعة شهريا	الكمية المطلوبة	تكلفة الكمية	فترة نفاذ المنتج	الربح
2000424	X1	50.76	40	81.55	30.79	3	90	4568.4	27.00	2771.415
3001971	X2	38.9	67	62.24	23.34	6	180	7002	32.24	4201.925
2000436	X3	111.82	30	230.16	118.34	3	90	10063.8	36.00	10650.3
3001094	X4	40.7	51	56.93	16.23	4	150	6105	35.29	2433.765
2000422	X5	40.7	174	63.51	22.81	15	180	7326	12.41	4106.09
1021	X6	29.25	56	44.61	15.36	5	150	4387.5	32.14	2303.571
2000423	X7	29.25	254	46.14	16.89	21	180	5265	8.50	3039.98
3002858	X8	5310	9	6925.87	1615.87	1	6	31860	8.00	9695.2
3005160	X9	1.15	17576	2.17	1.02	1465	36000	41400	24.58	36575.15
3001680	X10	1.91	373	4.19	2.28	31	1200	2292	38.61	2730.885
3003154	X11	3.93	990	7.13	3.20	83	720	2829.6	8.73	2306.524
3003939	X12	25.65	469	36.15	10.50	39	420	10773	10.75	4409.409
3003940	X13	70.2	92	101.23	31.03	8	120	8424	15.65	3723.6
3002381	X14	252	11	405.79	153.79	1	12	3024	13.09	1845.425
3003515	X15	274.5	25	481.60	207.10	2	15	4117.5	7.20	3106.512
1000237	X16	477	19	628.44	151.44	2	12	5724	7.58	1817.223
3003948	X17	20.25	28	34.84	14.59	2	60	1215	25.71	875.2929
3003949	X18	14.4	61	24.82	10.42	5	60	864	11.80	625.259
							المجموع	157240.8		97217.52

Figure 15: Data of investment process conducted by enterprise
After I used mat lab for calculate Integer linear programming for those 18 items.

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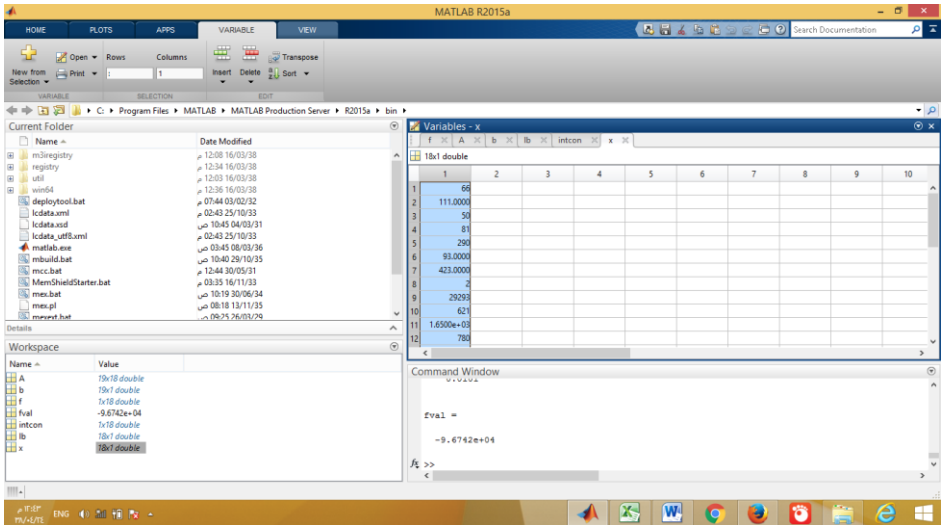

Figure 16: The number of recommended quantities for each type of investment and the profit yield for 20 months

Table 3:Comparing between qualitative and ILP

	Cost	Profit	Duration
Qualitative method	157240 SR	97217 SR	38 months
Integer linear programming	157232 SR	96742 SR	20 months

As in the table, integer linear programming return nearly same profit that qualitative method return in 38 months but in only 20 months. This give opportunity to reinvestment budget again.
When we increase constraint to 38 months as order of enterprise, the profit go up until 124960

Table 4: Comparing between three types

	Cost	Profit	Duration
Qualitative method	157240 SR	97217 SR	38 months
Integer linear programming	157232 SR	96742 SR	20 months
Integer linear programming	157235 SR	124960 SR	38 months

B. Assuming Change of future sales quantities

At first, I am going to predict future sales for every item during Jan and Feb of 2017 by using weighted moving average depending on time series of sales through 2016. Weighted moving average give extra importance for recent periods and less importance for old periods. In this situation, I divided year to six periods each one consist of two months(1,2),(3,4),(5,6),(7,8),(9,10),(11,12). Weighted moving gives different weigh for each period with a note that recent periods have more weight than old periods. In this situation, we have six periods so I need to six weights arranged from high to low.

Total of weighs is = 1

Weight = W Quantity Sold= QS Period= P

P1 = Jan+Veb P2= March+April P3= May+June

P4 = July+Aug P5= Sep+Oct P6= Nov+Dec

W6= 1/3 W5= 1/4 W4= 1/6 W3= 1/10 W2= 1/12 W1= 1/14

Weighted Moving Average =(QS of P1* W1)+ (QS of P2* W2)+ (QS of P3* W3)+ ……(QS of P6* W6)+/Total of weighs

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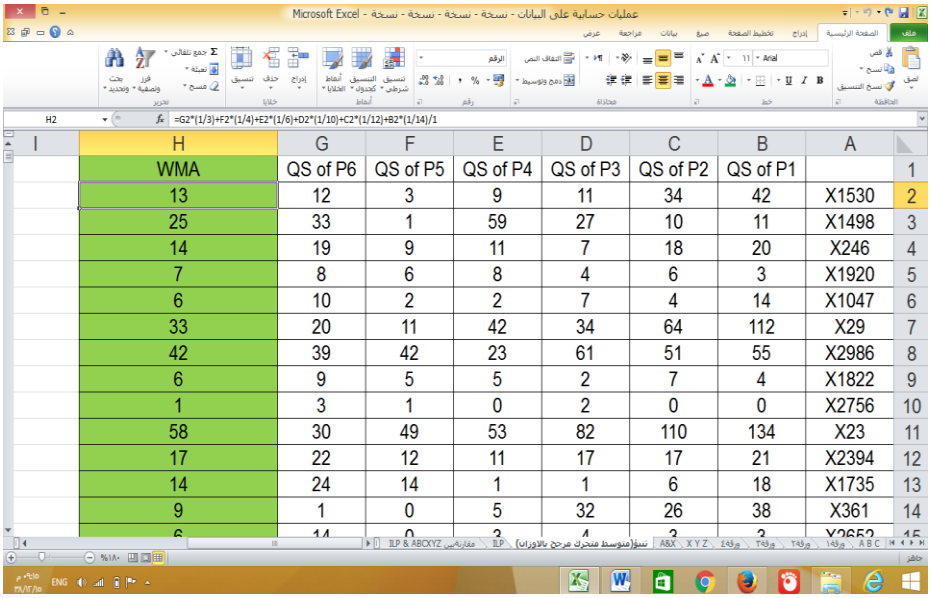


WMA	QS of P6	QS of P5	QS of P4	QS of P3	QS of P2	QS of P1	
13	12	3	9	11	34	42	X1530
25	33	1	59	27	10	11	X1498
14	19	9	11	7	18	20	X246
7	8	6	8	4	6	3	X1920
6	10	2	2	7	4	14	X1047
33	20	11	42	34	64	112	X29
42	39	42	23	61	51	55	X2986
6	9	5	5	2	7	4	X1822
1	3	1	0	2	0	0	X2756
58	30	49	53	82	110	134	X23
17	22	12	11	17	17	21	X2394
14	24	14	1	1	6	18	X1735
9	1	0	5	32	26	38	X361

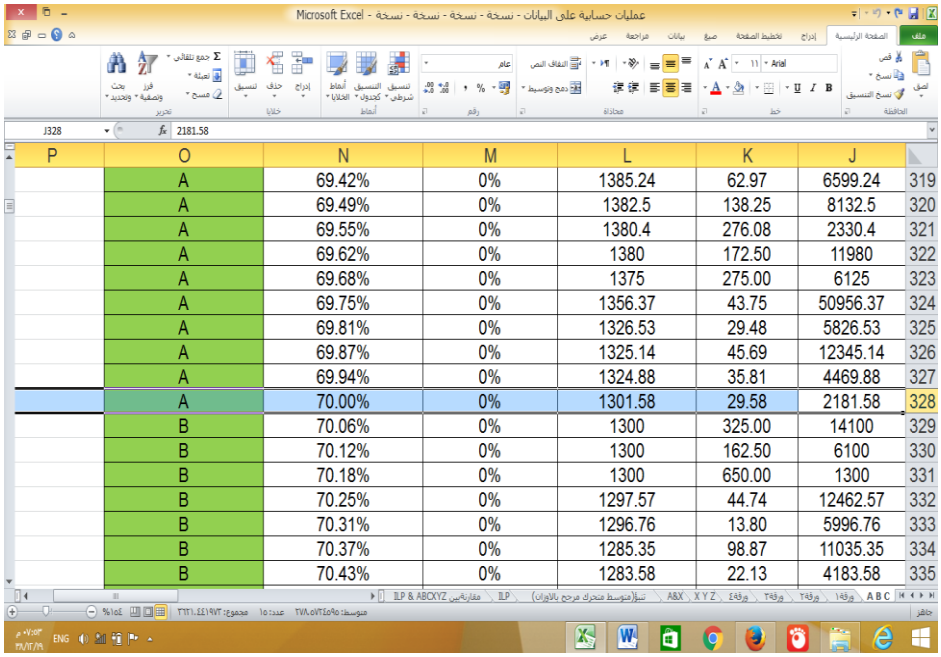
Figure 17: Calculate WMA

WMA represents predicted quantity sales for first two months of new year of 2017.

A. ABC & XYZ Analyse:

ABC XYZ analysis data to segment it to different parts based on it's importance and stability of importance, that means importance is not mutation but it is constant and continuous.

In our situation, ABC analyse divide data to three parts A, B and C. I will divided data based on profit ratio, firs part items that return until to 70% of total profit which rank it as A part. Second part items that return from 71% to 90% of total profit and that ranked as B part. Final part is C that represent lowest ratio from 91% to 100%.



A	69.42%	0%	1385.24	62.97	6599.24	319
A	69.49%	0%	1382.5	138.25	8132.5	320
A	69.55%	0%	1380.4	276.08	2330.4	321
A	69.62%	0%	1380	172.50	11980	322
A	69.68%	0%	1375	275.00	6125	323
A	69.75%	0%	1356.37	43.75	50956.37	324
A	69.81%	0%	1326.53	29.48	5826.53	325
A	69.87%	0%	1325.14	45.69	12345.14	326
A	69.94%	0%	1324.88	35.81	4469.88	327
A	70.00%	0%	1301.58	29.58	2181.58	328
B	70.06%	0%	1300	325.00	14100	329
B	70.12%	0%	1300	162.50	6100	330
B	70.18%	0%	1300	650.00	1300	331
B	70.25%	0%	1297.57	44.74	12462.57	332
B	70.31%	0%	1296.76	13.80	5996.76	333
B	70.37%	0%	1285.35	98.87	11035.35	334
B	70.43%	0%	1283.58	22.13	4183.58	335

Figure 18: Items ranked as A

Items that ranked as A are the most important items because they represents around only 9% of items and return 70% of profit. The rest items represents around 91% of items and return only 30% of profit.

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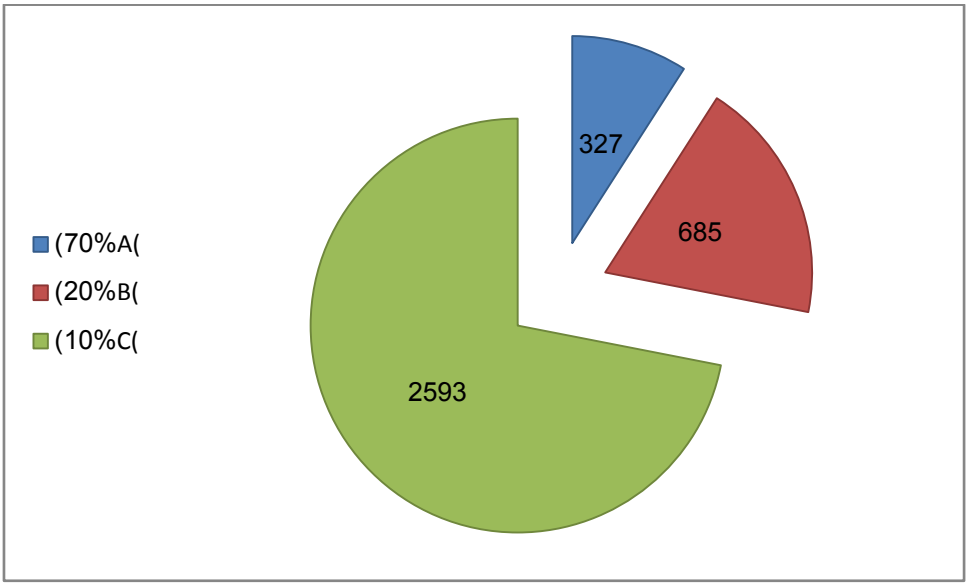
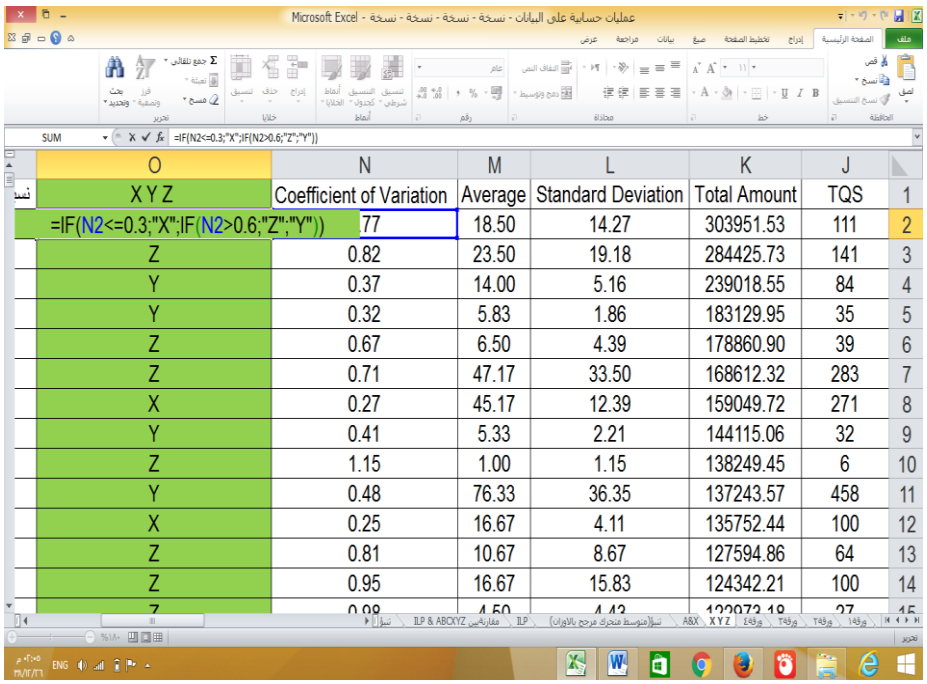


Figure 19: Profit Rate of each type

In previous figure, we see that only 327 items nearly around 9% of items return 70%of profit, and 685 items nearly around 19% of items return 20% of profit and 2593 items nearly around 72% of items return only 10% of profit.
X Y Z measure and divide coefficient of variation to three parts by calculating standard deviation around the average in different periods of dates.
In our situation, XYZ analyse data to three parts X,Y and Z. I will divided data based on value of Coefficient of Variation, firs part items that have coefficient of variation less than 0.3 which rank as X part. Second part items that have coefficient of variation between 0.3 and 0.6 and that ranked as Y part. Final part is Z that have coefficient of variation more than 0.6.



	O	N	M	L	K	J	
نسخ	X Y Z	Coefficient of Variation	Average	Standard Deviation	Total Amount	TQS	1
	=IF(N2<=0.3;"X";IF(N2>0.6;"Z";"Y"))	77	18.50	14.27	303951.53	111	2
	Z	0.82	23.50	19.18	284425.73	141	3
	Y	0.37	14.00	5.16	239018.55	84	4
	Y	0.32	5.83	1.86	183129.95	35	5
	Z	0.67	6.50	4.39	178860.90	39	6
	Z	0.71	47.17	33.50	168612.32	283	7
	X	0.27	45.17	12.39	159049.72	271	8
	Y	0.41	5.33	2.21	144115.06	32	9
	Z	1.15	1.00	1.15	138249.45	6	10
	Y	0.48	76.33	36.35	137243.57	458	11
	X	0.25	16.67	4.11	135752.44	100	12
	Z	0.81	10.67	8.67	127594.86	64	13
	Z	0.95	16.67	15.83	124342.21	100	14

Figure 20: Ranking X, Y, Z

Type X are the items that have low coefficient of variation in sales during the all six period in year less than 0.3. In the sense that the average quantity of sales a few changes during the period of year, which means that they are desirable for investment because it is safer and stable in sales.

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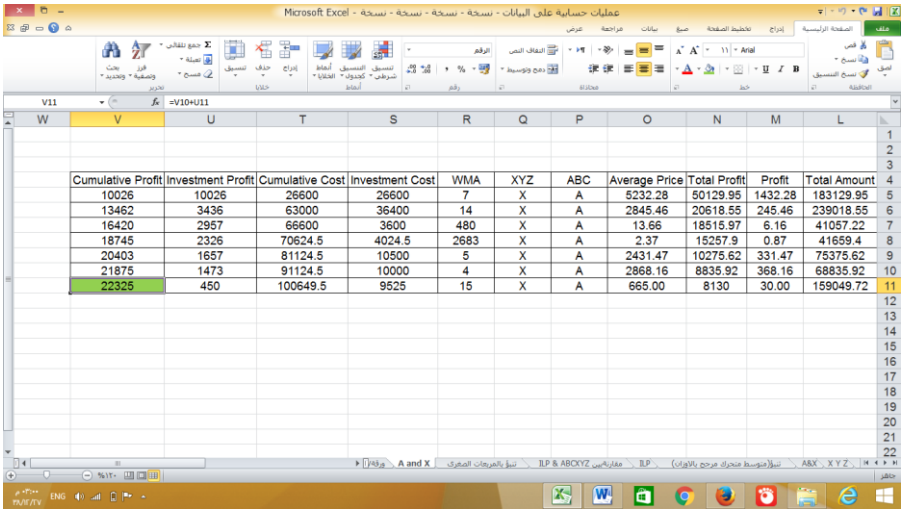
Table 5: ABC XYZ analyse

	X	Y	Z
A	High profit Stability in sales	High profit Low change in sales	High profit High change in sales
B	Medium profit Stability in sales	Medium profit Low change in sales	Medium profit High change in sales
C	Few profit Stability in sales	Few profit Low change in sales	Few profit High change in sales

After that, I will combine the first items to be included in the type A that represents about 70% of the profits as well as within the type X whose sales quantity is stable throughout the year. This ensures high profits with a lower risk of investment. Then, I am going to calculate the profit yield from investing in these items within the required investment limit, budget not more of 100000 and the quantities of the forecast by weighted moving average (WMA) to forecast the quantities sold of each item in the first two months of 2017.



Cumulative Profit	Investment Profit	Cumulative Cost	Investment Cost	WMA	XYZ	ABC	Average Price	Total Profit	Profit	Total Amount
10026	10026	26600	26600	7	X	A	5232.28	50129.95	1432.28	183129.95
13462	3436	63000	36400	14	X	A	2845.46	20618.55	245.46	239018.55
16420	2957	66600	3600	480	X	A	13.66	18515.97	6.16	41057.22
18745	2326	70624.5	4024.5	2683	X	A	2.37	15257.9	0.87	41659.4
20403	1657	81124.5	10500	5	X	A	2431.47	10275.62	331.47	75375.62
21875	1473	91124.5	10000	4	X	A	2868.16	8835.92	368.16	68835.92
22325	450	100649.5	9525	15	X	A	665.00	8130	30.00	159049.72

Figure 21: Profit of ABC XYZ analyse

Total profit was only 22295 as we see in previous image.

B. Integer linear programming

I am going to solve equation with take care of constraints 100000 and only two months by using formula in mat lab:
[x,fval]=intlinprog(f,intcon,A,b,{},{},lb)
The results of quantities shown in in next figure value of X of each item and total profit that was 74486

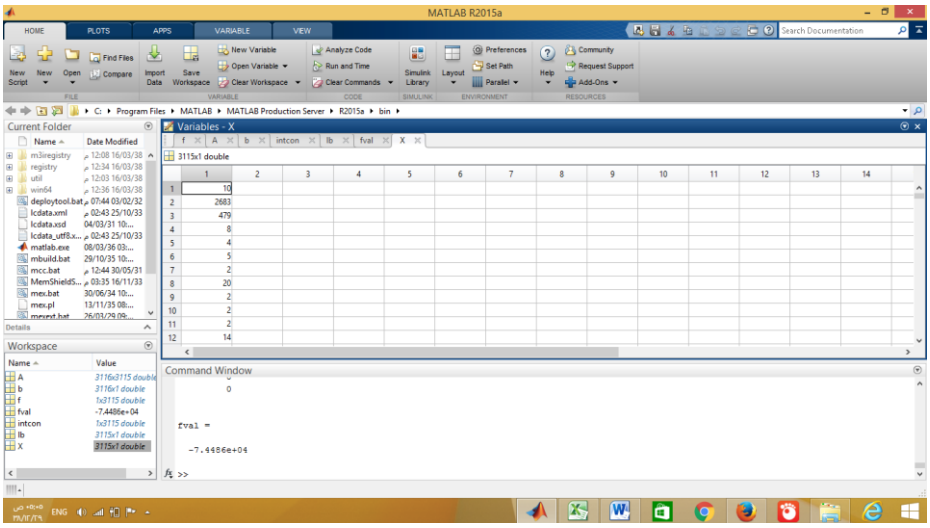


Figure 22: X "Invested quantity for every item and total profit (fval)

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C. Comparing between ABC XYZ and Integer linear programming:

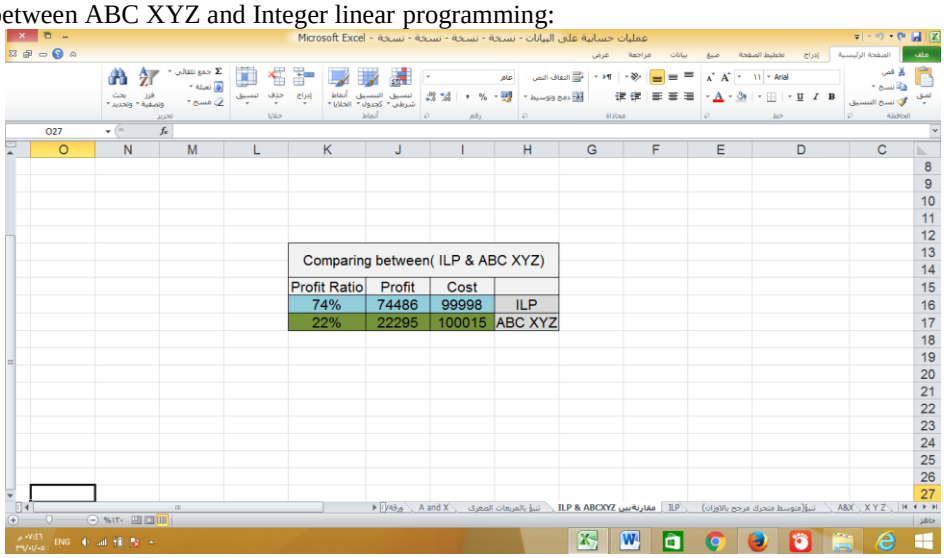

Figure 23: Comparing between ILP and ABC XYZ analyses

VII. CONCLUSION

In this research, we have concluded many different results in the use of scientific methods in general and decision support systems in particular in contributing to investment decision-making processes. We hope that these results will contribute to increasing the use of modern technology and scientific methods in the medium business environment. Many goals we extracted from this research, there are many methods that can be used by owners of medium enterprises to help them in the development and progress of their work The most important of these models, which we used in this research decision support systems in different forms, methods of quantitative prediction of future sales and types such as time series, moving average, weighted average, linear regression, etc., methods of organizing and classifying stock items according to importance and stability in demand like ABC XYZ analyze, Finally, the linear programming methods and the integer programming that are used to achieve the greatest goals of achieving the maximum profit or reduction as much as possible, according to resources available from time, budget or other. The uses of these scientific methods vary according to the objectives that are used for, such as the classification of important product, we can use ABC XYZ analyze, or search for the best products for investment that return the highest profit possible, we can use linear programming or predict future quantities of sales and others we can use time series analyses.

From the results of this research we found that the use of decision support systems in investment decisions is of great importance, as it contributes significantly to the adoption of investment decisions very effective as we can use the methods we mentioned in the search for the implementation of investment decisions are very successful using a set of scientific methods in one investment decision as follows: first we use ABC XYZ analysis to identify important products with high sales and have stability in the quantity of demand.

Then we forecast future sales for the next period of these products by analyzing previous sales periods using one of the time series analyses.

Finally, according to the forecast of the quantity of demand for each of the important and stable goods, we use the linear programming method to make an investment decision according to our resources available from a limited investment budget or other to know the products and the quantity of each product to bring us the highest possible return on profit.

One of the results we found in this research is that investment decisions that rely on scientific methods are more useful and useful than investment decisions based on salespersons' experience. For example, when we compared one of the investment decisions of the institution, we found that they invested in products with varying quantities and when we predicted the cycle of ending these quantities in their decisions, we found that some products may expire within 3 months and some within 10 months and some of them up to 38 months and that means that profits and capital back after a period Long plus some products that expire quickly have a request and are not available until the next investment date. When we used the same budget that they used and with the same products using linear programming we were able to get the same profit curves and product cycles for each category not more than 4 months only. This was one of the most important results of the research that linear programming is the best methods that contribute to maximize profits in business, after comparison with different methods in this area, including the ABC XYZ analyse and another method which depend on the experience of sales men.

The use of scientific methods and modern techniques in business, despite the importance of it, but it is not widespread or non-existent in medium enterprises. From the results of this research, we found that its use is very suitable for

medium-sized enterprises, because of its great benefits in achieving the objectives of the commercial institutions in easy and simple ways, as these scientific methods many of them are easy to implement and do not require the implementation of great knowledge of computer programs and high amounts. On the contrary, many scientific methods can be implemented with Excel and other free programs. Therefore, we advise managers of medium sized enterprises to take advantage of these possibilities in developing their business in scientific ways that are well studied and successful. We also recommend that researchers in these areas to research scientific applications that are suitable for application through medium commercial enterprises to contribute to the development of their business and also benefit the development of the general economic index.

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