The Presentation of a Mathematical Model to Assess and Control the Inventory Control System through ABC Analysis Approach
(A Case Study of Lino Meat Products Company)

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ABSTRACT
Today, the effective inventory management plays an important role in the success of the organizations in the new business environment. It is not clearly possible for the organizations that store hundreds of inventory items to economically design an inventory management policy for each inventory item separately. Moreover, various inventory items may play quite different roles in the business of the organization. Hence, the managers need to classify these items in order to control each inventory category properly based on its importance rating. This research is composed of the following sections: In the first section, the criteria affecting the evaluation of the inventory control system of the studied factory and the priority of each one of them will be identified, in the second section, the priority of each criterion in each inventory category (A, B, C) is calculated using the analytical hierarchy process, in the third section, a mathematical model will be presented to evaluate the inventory control system using the regression, in the fourth section, based on the categories defined for inventory items; the model sensitivity analysis is used to determine the significance of each criterion for each inventory category.

The overall result obtained from this study shows that by entering any new inventory to the inventory control system of the studied factory, the inventory control managers will be able to determine the importance of each identified criteria affecting that inventory by using a presented mathematical model, which will improve the inventory control system.

Keywords
Inventory, Inventory management, ABC analysis, the regression model

1. INTRODUCTION
Given that at present, all the organizations maintain thousands different types of inventory, it is likely to lose the effective inventory management. Therefore, it is particularly important for all the organizations to establish the appropriate inventory control systems or to evaluate and improve the existing inventory control systems. Because on the one hand, the organization encounters the inventory-related costs, including Cost of Holding, Cost of Ordering, Cost of Shortage the increase of each one due to the lack of a suitable inventory control system will have negative effects on the profitability of the organization. On the other hand, since the number of inventory items is largely increasing due to the increase of the customers' demands for different products, the organizations should have a quick and effective

response to the customers' demands to survive and maintain their competitive advantage. The establishment or improvement of an appropriate inventory control system can lead the organization in this path. Considering that today, the organizations save a large percentage of their total investment in the inventories, it has become of a special importance to all organizations to properly manage the inventory and establish a proper inventory control system. According to what was mentioned, all the organizations need an appropriate inventory control and planning system in order to effectively manage their resources and inventories. In fact, this system should be able to make a balance in two opposite directions. On the one hand, this system should support the organization regarding issues such as warehouses not being out of stock, machinery stops, and timely delivery of the products to the customers. One the other hand, this system must be able to keep the cost of inventory at the lowest possible level. Now, according to what was mentioned, the question will be raised that whether a suitable inventory control system should consider separate inventory management policies separately for each inventory or it should only use one level of inventory management for all inventory items?

Various studies have shown it is not economically cost-effective for the organizations to consider a separate inventory control policy for each inventory item. On the other hand, each one of the items stored in the warehouse may play a quite different role in the organization's performance. Consequently, the organizations require different levels of inventory management, because it is not economically cost-effective for the organizations to control all inventories the same and another point is that all the organizations have limited resources especially time. As a result, the establishment of an inventory control system with common control policies for all different items inventory will lead to the additional costs and complexity of the managers' work. Therefore, in order to create a perfect inventory control system, various inventory items should be classified into the significant categories based on appropriate criteria and standards. Various models and methods have been so far presented to classify inventory among which, ABC analysis approach is one of the most common methods which is widely used for planning and inventory control (Kilgour & et al 2006). Inventory classification based on ABC analysis allows the organization to classify its inventory into the significant categories. Generally, the above approach has been formed based on the Pareto Principle which is also known as "20-80" law. Regarding the organizations' inventory, this principle will be expressed as follows: In the manufacturing organizations, there are only a few inventories which mostly contribute to the dollar value of the annual consumption of the organization's inventory system and there are only a few inventories which a little contribute to the dollar value of the annual consumption of the inventory system. Given that the primary purpose of the inventory classification based on this approach is to create appropriate control levels for each inventory category, this question will be raised that whether the inventory classification based on single criterion ABC analysis will be able to meet all the needs of the organization's inventory control system. It is obvious that considering the increase of the diversity of the inventory control characteristics in today's industrialized world, the inventory classification based on this approach will not be able to meet all needs of the organization's inventory control system and there may be other criteria in the field of management and inventory classification, the criteria including inventory usage rate, lead time, the inventory related costs and etc. and some of these criteria are likely to be more important than the mentioned criterion [11]. Consequently, it is considered critical and crucial to identify the most important parameters affecting the inventory classification in any organization. Nowadays, "multiple objective" models and "multiple criteria models" of inventory classification are widely used in order to establish an effective inventory control system and consequently, a more effective inventory management. As a result, the organizations can apply proper control policies by identifying the most effective criteria in their inventory classification. This study has also tried to present a mathematical model based on multiple criteria regression, in order to evaluate the inventory control system of the studied factory. For this purpose, first, the criteria affecting the evaluation of the inventory control system, classification of inventory and the priority of each one of the criteria in the studied factory and the priority of each one of the criteria in each inventory category (A, B, C) have been identified. The inventory control system in the studied factory can be evaluated based on the analysis of the sensitivity of the obtained regression model.

2. AN OVERVIEW OF THE RESEARCH LITERATURE

So many studies have been conducted in recent years on the inventory classification to improve inventory control system, the main part of which has been introduced in this section. In 1987, an article was presented entitled "The application of multiple criteria ABC analysis" in which the results of the use of multiple criteria ABC analysis have been provided to classify the storage inventory. The studies conducted in this paper show that the managers can use both "cost criteria" and "non-cost criteria" in the classification of warehouse inventory and formulate specific policies by using different criteria to manage warehouse inventory [5]. In 2008, an article was presented entitled "Particle Swarm Optimization" in order to classify the inventory in which an optimization approach is proposed regarding the inventory classification problems at the conditions when inventory items should be classified based on a target or multiple targets, such as minimizing costs, maximizing the rate of inventory turnover and etc.[14]. In 2007, an article was presented entitled "A simple classification for multiple criteria ABC analysis". In this paper, a simple model is proposed for multiple criteria classification of the inventory. In fact, this model covers the criteria of all the criteria in a single criterion. The study conducted in this paper shows that by appropriate conversion of the scale model of different criteria of the inventory classification, the organizations can reach some criteria of the inventory items without need for linear optimization. The model presented in this paper can be widely used by the organizations with minimum experience in the optimization. The criteria reviewed in this article include: the dollar value of the annual consumption, the average cost of each unit, and lead time [10]. In 2006, an article was presented entitled "the inventory classification based on multi criteria ABC using weighted linear optimization" [16]. In 2010, an article was presented entitled "The use of techniques based on the artificial intelligence for multiple criteria ABC analysis" by "Maine-Chun-Yu". In this paper, a study has been conducted to compare the classification techniques based on artificial intelligence and traditional classification techniques (MDA) [15]. In 2010, an article was presented entitled "Fuzzy AHP-DEA approach for inventory classification based on multiple criteria ABC approach". In this article, two approaches of Data envelopment Analysis and fuzzy analytic hierarchy process are combined for multiple criteria ABC classification of inventory [8]. In 2008, an article was presented entitled "The inventory control by combining ABC approach and fuzzy classification". The purpose of this study is to provide a new approach on the inventory control called "ABC fuzzy classification" [9]. In 2004, an article was presented entitled "multi criteria classification approach to manage the spare parts inventory". In this article, the best strategy has been reviewed to manage inventory in each category (A, B, C) (Braglia & et al, 2004). In 1992, Flores and whybark presented a two-criterion matrix approach for the inventory classification. This classification was able to control the inventory comprehensively. The approach presented by them classifies the inventory items based on the standard ABC classification by each criterion. Then, these two single criterion groups are combined through a paired matrix. One of the major disadvantages of this approach is that it becomes very complex for more than 2 or 3 criteria, and it will not be applicable (B.E Flores & et al, 1992). In 2010, "Hadi-Venche" presents a simple non-linear planning model in order to classify the inventory items. This model determines a common set of weights for all inventory items [7]. In 1981, "Chakravary" presents a dynamic model for the classification of inventory, in which the inventory are classified based on the increase of the time of each demand and cost of holding each classification. One of the main strengths of this model is to minimize total costs, and one of its main weaknesses is the length of its run time [1].

In 2006, "Ramanathan" presents a weighted linear optimization model in order to classify the inventory through multiple criteria ABC approach, which was expanded in 2007 by "Zhou Fan" [13]. In 1988, "Ernst and Cohen" used statistical clustering technique to classify the inventory items in stock through multiple criteria. Generally, this technique needs information about the inventory and at higher levels, statistical processes such as "factor analysis" are required. One of the major problems of this technique is that the organization has always new inventory in stock and by entering any new inventory item, the classification process should be repeated and there is a possibility that the items which have been previously classified will be classified again into different categories [3]. In 1993, Berton and Partovi use analytic hierarch process to classify the warehouse inventory. Principally, this type of classification considers both quantitative and non-quantitative criteria (Partovi & Berton, 1993). In 2006, "Ramanathan" and in 2008, "Ng" presented the techniques similar to the model DEA. The weakness of such models is like the statistical clustering techniques. It means that the model should be revised with any new item (Ramanathan, 2001). In 1998 "Guvenir and Erel" presented genetic algorithm GAMIC for multiple criteria inventory classification [6]. In (2002), "Partovi and Anandarajan" used BP classification and genetic algorithm based learning methods in order to develop an artificial neural network to classify inventory [11].

3. CONCEPTUAL MODEL

The conceptual model of the research is presented in figure 1.

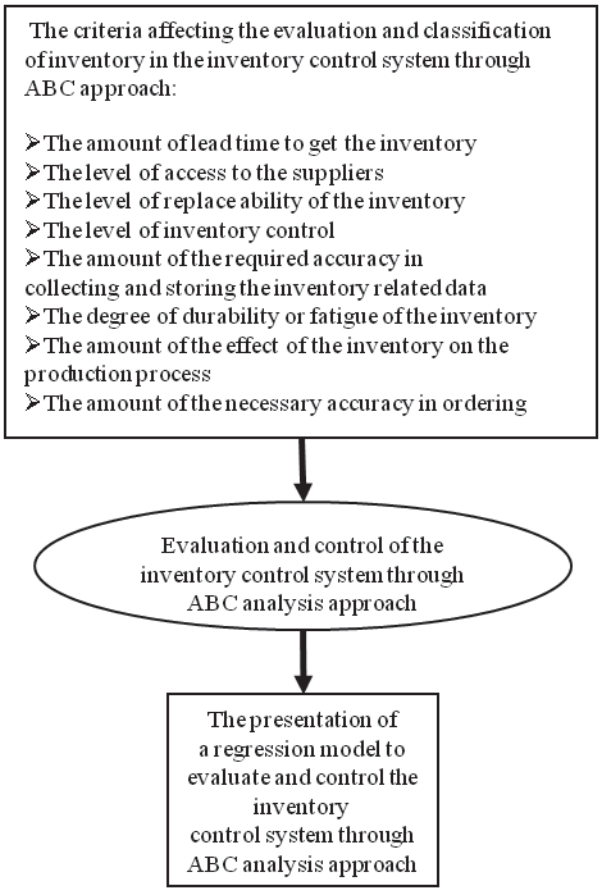


Figure 1: The conceptual model of the research

The acronyms of each criterion are presented in table 1.

4. THE RESEARCH OBJECTIVES

This study generally aims at five following objectives:

- Identifying the affective indices and the priority of each one in the evaluation of the inventory control system and the inventory classification in the inventory control system through ABC approach.
- Determining the weights of the indices in the classification A of the inventory control system through ABC approach.
- Determining the weights of the indices in the classification B of the inventory control system through ABC approach.
- Determining the weights of the indices in the classification C of the inventory control system through ABC approach.
- Presenting a mathematical model based on multiple regression analysis to evaluate and analyze the inventory control system.

Table 1: The acronyms of the criteria

Acronyms	Criteria
S1	The lead time to get the inventory
S2	The level of access to the suppliers
S4	The level of replace ability of the inventory
C1	The amount of the necessary accuracy in ordering
C3	The level of inventory control
C4	The amount of the required accuracy in collecting and storing the inventory related data
I 2	The degree of durability or fatigue of the inventory
I 6	The amount of the effect of the inventory on the production process

5. THE RESEARCH QUESTIONS

- Which are the indices affecting the evaluation of the inventory control system and the inventory classification and the priority of each one in the inventory control system through ABC approach?
- What is the weight of each index in the classification A of the inventory control system through ABC approach?
- What is the weight of each index in the classification B of the inventory control system through ABC approach?
- What is the weight of each index in the classification C of the inventory control system through ABC approach?
- Is it possible to present a mathematical model based on multiple regression analysis to evaluate and analyze the inventory control system?

6. RESEARCH HYPOTHESES

- The index of "the amount of the effect of the inventory on the production process" is a high priority among the indices affecting the evaluation of the inventory control system and the inventory classification in the inventory control system.
- The index of "the amount of the necessary accuracy in ordering" has the highest weight in the classification A of the inventory control system through ABC approach.
- The index of "the degree of durability or fatigue of the inventory" has the highest weight in the classification B of the inventory control system through ABC approach.
- The index of "the level of access to the suppliers" has the highest weight in the classification C of the inventory control system through ABC approach.
- The model presented through multiple regression approach is an appropriate model to evaluate and analyze the inventory control system.

7. THE RESEARCH METHODOLOGY AND DATA ANALYSIS

This study is an applied research with modeling process in terms of purpose and is descriptive-survey in terms of data collection. The questionnaires have been used in this study in order to collect data.

8. RESEARCH HYPOTHESES TESTING

- The first research hypothesis: The index of "the amount of the effect of the inventory on the production process" is a high priority among the indices affecting the evaluation of the inventory control system and the inventory classification in the inventory control system.

The following tests have been used to test the first statistical hypothesis:

- Delphi test
- Friedman test

Delphi test aims to access to the most reliable consensus of experts' opinion for a treatable issue which will be repeatedly performed using questionnaires and surveying experts. In the study, a questionnaire has been used in order to use this test to achieve the most reliable consensus of experts' opinion to identify the indices affecting the evaluation and classification of the inventory in the inventory control system. According to the results of the questionnaire, the above 8 criteria have been selected, because they have reached the maximum agreement:

- The amount of lead time to get the inventory
- The level of access to the suppliers
- The level of replace ability of the inventory

- The degree of durability or fatigue of the inventory
- The amount of the effect of the inventory on the production process
- The amount of the necessary accuracy in ordering
- The level of inventory control
- The amount of the required accuracy in collecting and storing the inventory related data

The Zero Hypothesis and the opposite hypothesis for the Friedman test are expressed as follows:

$$H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_8$$

$$H_1 : \beta_i \neq \beta_j$$

The Zero Hypothesis is expressed based on the principle that the effect of all eight indices in the evaluation of the inventory control system and the inventory classification is the same and are not different. In table 1, the results of the Friedman test, including statistical characteristics and statistic. As it is shown in table 1, the value of the statistic χ^2 is measured "33.986" using the Friedman test. From table χ^2, the critical value is extracted with degrees of freedom of (K-1=7) at the confidence level of 0.95 (14.0671). Since the test statistic obtained from the table 1 is greater than this value, the rejected Zero Hypothesis and H1 hypothesis will be accepted at the confidence level of 0.95.

Table 2: Friedman test output

N	10
Chi - square	33.986
D.f	7
Asymp.sig.	0.000

In this study, the eigenvector technique is used to identify the most important index and prioritize the effective indices. This step requires identifying the relative importance and relative importance of each criterion based on its degree of priority compared to the other criteria. Given that this method is based on paired comparisons and since the decision matrix is not available, paired comparisons will be performed by decision makers. The values of paired comparison matrix have been determined by 3 experts. Since the paired comparisons were performed by a group of experts, the geometric mean of the paired comparison matrix obtained from surveying three experts has been used. The consistency rate of the paired comparison matrices obtained from the geometric mean of the experts' opinion is calculated less than 0.1. Therefore, the experts' opinion is consistent and reliable. Since the respondents in the field of research, the weight of responses is considered equal and at the same level of priority. The results of the prioritization of the indices affecting the evaluation of the inventory control system and inventory classification in the inventory control system based on the eigenvector technique is shown in table 3.

The consistency rate of the above matrix is obtained 0.02. Thus, the above matrix has sufficient consistency rate. According to the results of the prioritization and the results shown in table 3, the first hypothesis of the study will be confirmed.

- The second research hypothesis: The index of "The amount of the necessary accuracy in ordering" has the highest weight in the classification A of the inventory control system through ABC approach.

Considering that the criteria affecting the inventory classification in the inventory control system, and the weight of each one of them was calculated in the previous sections, in this section, in order to test the third hypothesis of the study, the weight of each identified effective indices in each one of the inventory classifications A, B, C will be calculated

Table 3: The weight of the indices affecting the evaluation of the inventory control system and inventory classification in the inventory control system

Effective indices	S1	S2	S4	C1	C3	C4	I2	I6	Weights
S1	1	1.26	1.59	0.35	0.3	0.79	1.45	0.28	0.077
S2	0.79	1	1.26	0.3	0.28	0.79	1.14	0.23	0.065
S4	0.63	0.79	1	0.3	0.3	0.55	1.26	0.28	0.06
C1	2.86	3.33	3.33	1	1.26	1.82	2.62	0.55	0.191
C3	3.3	3.57	3.33	0.79	1	1.26	1.26	0.79	0.176
C4	1.27	1.27	1.82	0.55	0.79	1	1.82	0.38	0.105
I2	0.69	0.79	0.38	0.38	0.79	0.55	1	0.3	0.07
I6	3.57	3.57	1.82	1.82	1.27	2.63	3.33	1	0.257

based on "AHP" method. For this purpose, first, the paired comparison technique is used to form a paired comparison matrix of the different inventory categories (categories A, B, C) to each one of the identified effective criteria. To this end, questionnaires were distributed among three respective experts. The consistency rate of the paired comparison matrices obtained from the geometric mean of the experts' opinion is calculated less than "0.1". Therefore, the experts' opinion is consistent and reliable. Since the respondents in the field of research, the weight of responses is considered equal and at the same level of priority. Finally, according to the weights obtained for each one of the criteria affecting the inventory control system and the weight of each one of the classifications (A, B, C) to each one of the identified effective criteria, analytic hierarchy method is used to determine the weights of each one of the identified effective criteria. The hierarchical display of decision is shown in figure 2.

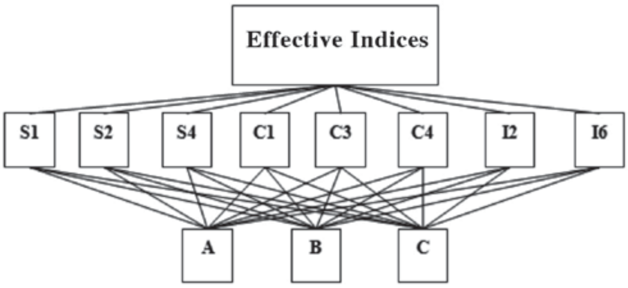


Figure 2: the hierarchical display of decision in each one of the classifications A, B, C

Table 4: The results of the paired comparisons of the index of time lead (s 1) in each one of the classifications A, B, C

(S1)The amount of lead time to get the inventory	A	B	C	weights
A	1	1.26	2.62	0.471
B	0.79	1	1.26	0.316
C	0.38	0.79	1	0.212

The consistency rate of the above decision matrix is measured 0.03 which indicates the consistency of the experts' opinions.

Table 5: The results of the paired comparisons of the index of the amount of access to the inventory suppliers (S 2) in each one of the classifications A, B, C

(S2) The amount of access to the inventory suppliers	A	B	C	weights
A	1	1.26	2.88	0.482
B	0.79	1	1.26	0.314
C	0.35	0.79	1	0.204

The consistency rate of the above decision matrix is measured 0.04 which indicates the consistency of the experts' opinions.

Table 6: The results of the paired comparisons of the index of the level of replace ability of the inventory (S4) in each one of the classifications A, B, C

(S4) The level of replaceability of the inventory (S4)	A	B	C	weights
A	1	1.82	2.62	0.52
B	0.55	1	1.26	0.273
C	0.38	0.79	1	0.207

The consistency rate of the above decision matrix is measured 0.00188 which indicates the consistency of the experts' opinions.

Table 7: The results of the paired comparisons of the index of the amount of the necessary accuracy in inventory ordering (C1) in each one of the classifications A, B, C

(C1)The amount of the necessary accuracy in inventory ordering	A	B	C	weights
A	1	3.3	3.92	0.632
B	0.3	1	2.28	0.238
C	0.26	0.44	1	0.130

The consistency rate of the above decision matrix is measured 0.05 which indicates the consistency of the experts' opinions.

Table 8: The results of the paired comparisons of the index of the level of inventory control (C3) in each one of the classifications A, B, C

(C3) The level of inventory control	A	B	C	weights
A	1	3.3	3.92	0.632
B	0.3	1	2.28	0.238
C	0.26	0.44	1	0.130

The consistency rate of the above decision matrix is measured 0.05 which indicates the consistency of the experts' opinions.

Table 9: The results of the paired comparisons of the index of the amount of the required accuracy in collecting and storing the inventory related data (C4) in each one of the classifications A, B, C

(C4) The amount of the required accuracy in collecting and storing the inventory related data	A	B	C	weights
A	1	2.1	2.62	0.538
B	0.48	1	1.26	0.257
C	0.38	0.79	1	0.205

The consistency rate of the above decision matrix is measured 0.00001 which indicates the consistency of the experts' opinions.

Table 10: The results of the paired comparisons of the index of the degree of durability or fatigue of the inventory (I2) in each one of the classifications A, B, C

(I2) The degree of durability or fatigue of the inventory	A	B	C	weights
A	1	1.82	2.82	0.528
B	0.55	1	1.26	0.271
C	0.35	0.79	1	0.201

The consistency rate of the above decision matrix is measured 0.00453 which indicates the consistency of the experts' opinions.

Table 11: The results of the paired comparisons of the index of the effect of the inventory on the production process (I6) in each one of the classifications A, B, C

(I6) The effect of the inventory on the production process	A	B	C	weights
A	1	1.26	1.82	0.429
B	0.79	1	1.26	0.325
C	0.55	0.55	1	0.246

The consistency rate of the above decision matrix is measured 0.00198 which indicates the consistency of the experts' opinions. The final weight of each criterion in each one of the classifications A, B, C is presented in table 12.

- The third research hypothesis: The index of "the degree of durability or fatigue of the inventory" has the highest weight in the classification B of the inventory control system through ABC approach.

According to the final results of the "analytical hierarchy process" and the final results given in table (12), it can be concluded that the third research hypothesis is rejected, i.e. the criterion of "the effect of the inventory on the production process" has the highest weight in the inventory classification B of the inventory control system.

- The fourth research hypothesis: The index of "the amount of access to the inventory suppliers" has the highest weight in the classification B of the inventory control system through ABC approach.

According to the final results of the "analytical hierarchy process" and the final results given in table 12, it can be concluded that the fifth research hypothesis is rejected, i.e. the criterion of "the effect of the inventory on the production process" has the highest weight in the inventory clas-

Table 12: The final weight of each criterion in each one of the inventory classifications A, B, C

Index	Index weights	Inventory class			Composite weights		
		A	B	C	A	B	C
S1	0.077	0.471	0.316	0.212	0.036	0.024	0.016
S2	0.065	0.482	0.314	0.204	0.0313	0.020	0.013
S4	0.06	0.52	0.273	0.207	0.0312	0.016	0.0124
C1	0.191	0.632	0.238	0.13	0.121	0.045	0.025
C3	0.176	0.632	0.238	0.13	0.111	0.042	0.023
C4	0.105	0.6	0.289	0.111	0.063	0.030	0.0117
I2	0.070	0.503	0.277	0.22	0.035	0.019	0.015
I6	0.257	0.429	0.325	0.246	0.110	0.084	0.063

sification B of the inventory control system.

- The fifth research hypothesis: The model presented through multiple regression approach is an appropriate model to evaluate and analyze the inventory control system.

In this section of the study, multiple-linear regression model is presented to evaluate inventory control system of the studied factory. Through regression, we intend to estimate and analyze a mathematical relation through which the value of an unknown variable can be determined using known variables. Then, through correlation, we intend to determine the relation type and the amount of the relationship which correlates the variables. This model can be stated as follows.

$$Y= B_0 + B_1X_1 + B_2X_2 + \dots + B_KX_K$$

Where, the clause X_K shows the value of the kth independent variable for the i_{th} case, and B shows the regression coefficient of the equation, i.e. the coefficient of independent variable to the dependent variable. Regression Analysis generally means the fit of a mathematical model to data, which indicates the type of relationship between variables.

The methods for selection of variables in the multiple regressions are: 1.Forward selection 2.Backward elimination and 3.Stepwise Selection. In this study, the multiple regressions is used with stepwise selection method. The obtained regression equation is as follows:

$$Y=-13.81+0.193S_1+0.085S_2-0.163S_4+0.369C_1+0.279C_3+0.095C_4+0.21I_2+0.139I_6$$

Where:

y= the importance level of the inventory

S1= the lead time to get the inventory

S2= the level of access to the inventory suppliers

S4= the level of replace ability of the inventory

C1= the amount of the necessary accuracy in the inventory ordering

C3= the level of inventory control

C4= the amount of the required accuracy in collecting and storing the inventory related data

I2= the degree of durability or fatigue of the inventory

I6= the amount of the effect of the inventory on the production process

Through stepwise analysis method and considering the table (13), the significance level (Sig) of all independent variables at the confidence level of 95% is less than 0.05%. Therefore, all eight mentioned independent variables have a significant relationship with the dependent variable and affect it.

9. ANALYSIS OF VARIANCE (ANOVA)

Analysis of variance (ANOVA) evaluates the strength of the regression line to indicate the observed values of variable of the function. The hypotheses of this test are expressed as follows:

H0: There is no regression line relationship between the dependent variable and the independent variables.

H1: There is a regression line relationship between the dependent variable and the independent variables.

The test results are given in table 14; this table includes the sum square statistics, degrees of freedom, mean squares, F statistics and significance level. Sum of square of the variance explained by the regression line is 27,865.826 and

Table 13: regression model output

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	-13.806	1.978		-6.980	0.00
S1	.193	.057	.167	3.379	.001
S2	.085	.042	.081	2.045	.045
S4	-.163	.078	-.187	-2.080	.042
C1	.369	.120	.379	3.066	.003
C3	.279	.103	.289	2.699	.009
C4	.095	.033	.066	2.852	.006
I2	.210	.037	.171	5.625	.000
I6	.139	.044	.160	3.132	.003

Sum of square of the variance not explained by the regression line is 552.085. The degree of freedom of the variance explained by the regression line is 8 and the degree of freedom of the variance not explained by the regression line is 58 and F statistics is 365.935. In the above test, the significance level rejects H0 and H1 hypothesis will be confirmed. Therefore, H0 hypothesis suggesting non-existence of regression line will be rejected at the confidence level of 95% or error level of 5%. Therefore, the above test confirms the validity of the model. The coefficient of determination of the model which shows a proportion of the explained variance to the total variance is 0.99 according to the table 15. This suggests that 0.99% of the changes in the dependent variable are explained based on the changes in the independent variables of the model. In addition, the value of statistics of "Durbin–Watson" and the significance level of F confirm this.

Table 14: The results of ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	27865,.826	8	3483.228	365.935	.000[a]
	Residual	552.085	58	9.519		
	Total	28417.910	66			

Table 15: The results of ANOVA

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
Dimension0 1	.990[a]	.981	.978	3.08523991	1.687

10. THE LINEARITY BETWEEN THE VARIABLES

Usually, there is linearity between the independent variables. But if this linearity is high, the model will be not appropriate. One of the methods to calculate the amount of dependence between variables is the calculation of the covariance between variables. Table 16 shows that the correlation between variables is not great.

11. SENSITIVITY ANALYSIS OF MODEL

This section aims to analyze and evaluate the range of changes in the independent variables based on the changes in the dependent variable of the model (the importance level of inventory) using regression analysis. The main purpose of this sensitivity analysis is that, by entering any new inventory to the inventory control system, the inventory control managers of the studied factory will be able to de-

Table 16: The results of the independence of the independent variables

Model			I6	S4	I2	S2	C3	S1	C4	C1
1.00	Correlations	I6	1.00	-0.08	-0.05	-0.32	0.15	-0.38	-0.05	-0.23
		S4	-0.08	1.00	0.43	0.06	0.30	-0.08	0.22	-0.49
		I2	-0.05	0.43	1.00	-0.08	0.36	0.05	-0.13	-0.38
		S2	-0.32	0.06	-0.08	1.00	-0.11	-0.37	0.05	0.06
		C3	0.15	0.30	0.36	-0.11	1.00	-0.10	-0.33	-0.68
		S1	-0.38	-0.08	0.05	-0.37	-0.10	1.00	-0.11	0.04
		C4	-0.05	0.22	-0.13	0.05	-0.33	-0.11	1.00	-0.37
		C1	-0.23	-0.49	-0.38	0.06	-0.68	0.04	-0.37	1.00
	Covariance's	I6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		S4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		I2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		S2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		C3	0.00	0.00	0.00	0.00	0.01	0.00	0.00	-0.01
		S1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		C4	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
		C1	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.01

termine the importance of each one of the eight identified criteria for the new inventory, according to the criterion (the importance of inventory) of the new inventory and based on the range in which the amount of new inventory is. Therefore, based on the derived regression equation, all independent variables, except one, are assumed constant thus, an equation has been obtained solving which determines the range of change of that independent variable. To determine the values of the variables, the arithmetic mean of the independent variables in each one of the five categories listed above are used and these values will be put in the formula. According to the index of the inventory importance, the intended ranges are shown in the following table.

Table 17: The considered ranges based on the importance of inventory

Class	The importance of inventory
A	80-100
B	60-80
C	40-60
D	20-40
E	0-20

Table 18: the arithmetic mean of the index of the independent variables in the category A

Index	Arithmetic mean
S1	80
S2	76.67
S4	60
C1	93.33
C3	93.33
C4	86.67
I2	63.33
I6	96.67

If a new inventory enters the inventory control system, and its importance is in the category A, the minimum importance level of the index S1 will be calculated according to the values in table 18 as follows.

$-13.81+0.193S_1+0.085S_2-0.163S_4+0.369C_1$
$+0.279C_3+0.095C_4+0.21I_2+0.139I_6 = 90$

-13.81+0.139S1+0.085*76.67 0.163*86.67+0.369*93.33+0.279*93.33+0.095*60+0.21*63.33+0.139*96.67 = 90

S1= 96

And the importance of other criteria:

S2 = 113

S4 = 68

C1 = 102

C3 = 104

C4 = 92

I2 = 78

16 = 119

If a new inventory enters the inventory control system, and its importance is in the category B, the minimum importance level of the index S1 will be calculated according to the values in table 19 as follows.

Table 19: the arithmetic mean of the independent variables in the category B

Index	Arithmetic mean
S1	56.00
S2	56.00
S4	3.336
C1	76.00
C3	72.67
C4	53.33
I2	55.33
I6	84.67

$-13.81+0.193S_1+0.085*56-69*76+0.279*72.67$
$+0.095*53.33+0.21*55.33+0.139*84.67 = 70$

S1 = 65

And the importance of other criteria:

S2 = 77

S4 = 52

C1 = 81

C3 = 79

C4 = 72

I2 = 64

16 = 98

If a new inventory enters the inventory control system, and its importance is in the category C, the minimum importance level of the index S1 will be calculated according to the values in table 20 as follows.

Table 20: the arithmetic mean of the independent vari-

ables in the category C

Index	Arithmetic mean
S1	37.50
S2	33.13
S4	48.13
C1	57.50
C3	55.00
C4	44.38
I2	48.75
I6	59.38

-13.81+0.193S1+0.085*33.13-369*57.5+0.279*55 +0.095*44.38+0.21*48.75+0.139*59.38 = 50

S1 = 50

And the importance of other criteria:

S2 = 60

S4 = 34

C1 = 64

C3 = 63

C4 = 69

I2 = 60

16 = 76

If a new inventory enters the inventory control system, and its importance is in the category D, the minimum importance level of the index S1 will be calculated according to the values in table 21 as follows.

-13.81+0.193S1+0.085*21.88-9*38.75+0.279*37.5 +0.095*42.5+0.21*36.25+0.139*38.13 = 30

S1 = 26

Table 21: the arithmetic mean of the independent variables in the category D

Index	Arithmetic mean
S1	29.38
S2	21.88
S4	28.75
C1	38.75
C3	37.5
C4	42.50
I2	36.25
I6	38.13

The importance of other criteria:

S2 = 13

S4 = 33.31

C1 = 36.75

C3 = 34.84

C4 = 34.74

I2 = 32.71

I6 = 32.81

If a new inventory enters the inventory control system, and its importance is in the category E, the minimum importance level of the index S1 will be calculated according to the values in table 22 as follows.

$-13.81+0.193S_1+0.085*15.29-0.163*14.12+0.369*27.65+0.279*24.12+0.095*48.24+0.21*23.53+0.139*30=10$

S1=22

Table 22: the arithmetic mean of the independent variables in the category E

Index	Arithmetic mean
S1	19.41
S2	15.29
S4	14.12
C1	27.65
C3	24.12
C4	48.24
I2	23.53
I6	30.00

-13.81+0.193S1+0.085*15.29-69*27.65+0.279*24.12 +0.095*48.24+0.21*23.53+0.139*30 = 30

S1 = 22

The importance of other criteria:

S2 = 25

S4 = 11

C1 = 26

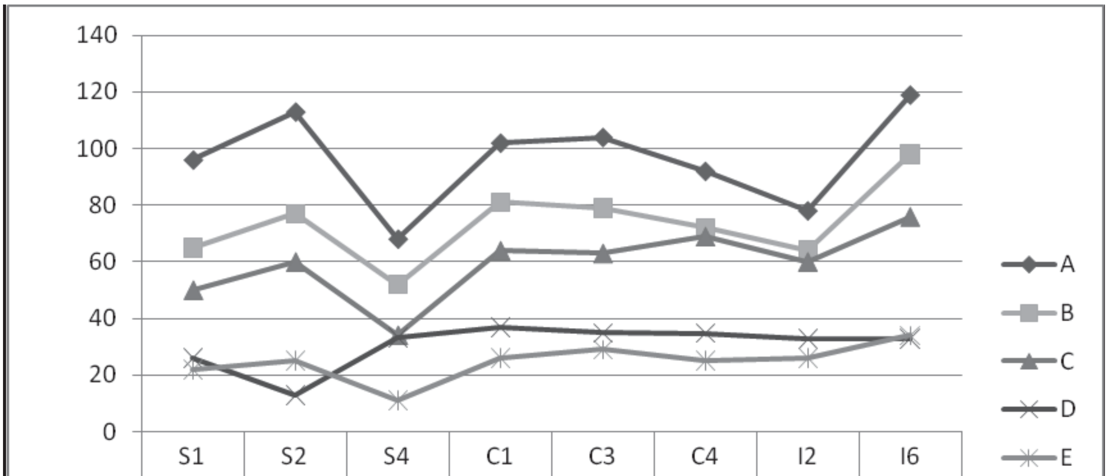
C3 = 29

C4 = 25

I2 = 26

16 = 34

The final result of the sensitivity analysis of the regression model is shown in figure 3.



	S1	S2	S4	C1	C3	C4	I2	I6
A	96	113	68	102	104	92	78	119
B	65	77	52	81	79	72	64	98
C	50	60	34	64	63	69	60	76
D	26	13	33.31	36.75	34.84	34.74	32.71	32.81
E	22	25	11	26	29	25	26	34

Figure 3: The importance level of the indices S1, S2, S4, C1, C3, C4, I2, I6 in 5 inventory categories of A, B, C, D, E

12. CONCLUSIONS AND RECOMMENDATIONS OF RESEARCH

In this study, the indices affecting the evaluation and control of the inventory control system of Lino Meat Products Factory Endo have been identified and the results of the prioritization of the effective criteria suggest that the index of "the effect of inventory on the production process" has the paramount importance among the other criteria. Also, the results of AHP suggest that this criterion of "the required accuracy in ordering" in the inventory category A and the criterion of "the effect of inventory on the production process" in the inventory categories B and C have the highest importance. The final result of the sensitivity analysis of the presented model suggests that inventory control system management of the studied factory can determine the importance of these eight criteria for each new inventory entering to the inventory control system, according to the presented model, which improves the inventory control system considering the resource limitation in the organization.

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