مجلة الإدارة والاقتصاد

استخدام تحليل العاملي للتعرف على سلوك مستخدمي الأطراف الصناعية Using factor analysis to identify the behavior of prosthetics users

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الملخص

هذا البحث يهدف إلى دراسة أهم العوامل التي تؤثر على سلوك أولئك الذين يستخدمون الأطراف الاصطناعية (التعويضية). استخدمت ورقة تقنية التحليل العاملي للوصول إلى هدفها. هذه الأداة ، كما هو معروف ، هي أداة مهمة تستخدم لدراسة وتحليل العديد من الأحداث والظواهر الصحية والاقتصادية والاجتماعية والاقتصادية. لذلك ، جرى اختيار واختبار أحد عشر متغيرًا مستقلاً يؤثر على مستخدمي الأطراف الاصطناعية ، بشكل مباشر أو غير مباشر . باستخدام طربقة المركبات الرئيسة ، جرى تحديد أهم العوامل

Abstract

This paper aims to examine the most important factors affecting the behavior of those using artificial limbs (Prosthetics). The paper used the factor analysis technique to reach its goal. This tool, as it is well known, is an important one used to study and analyze many health, economic, social, and economic events and phenomena. So, eleven independent variables influence the prosthetic users, directly or indirectly, were chosen and tested. Using the principle compounds method, the most important factors were identified.

1. Theoretical Framework

1.1. Prosthetics

It can be said that the prosthesis is an alternative used by the injured when exposed to the loss of one of the limbs, whether the upper or lower, where these artificial limbs served as a replacement of the human ones. It is after the World War II when this treatment came available to those whose upper or lower limbs were imputed during military operations or among civilian affected by such military events. . Initially, the prosthetic limbs was made of timbers, then new materials, shape, and designs were changed benefiting from the new technology. In Iraq the prosthetics industry increased significantly because of the emergent violence taking place during the long Iran-Iraq war, and the occupation of Iraq in 2003. In addition, the political and security instability caused by terrorism and insurgency resulted in the terrorist bombings in several Iraqi cities, where thousands of civilians and security forces injured resulting in huge number of disabled people. For the mentioned reasons the demand for prostheses showed high increase . 1.2.Factor Analysis^{[Ali,2014:p.p 14][Saad,2003,]}

One of the most important statistical methods, which is used to identify the factors or elements that help in diognizing and explaining the complex phenomenon by analyzing the existent correlation among various variables involved in the description of the cases under study to conclude certain factors that are representing the relationships among the variables set in mentioned studies. For example, we can say that the factor analysis objective is to reduce and summarize the data by identifying a few number of factors that explain most of the

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variance in a big number of variables; so, if there are (25) variables, for example, the factor analysis reduces these variables to only (5) factors. In most cases, those values of individuals in form of psychological, social, economic or other values. The relationship between two or among few variables is explained by correlation coefficients, but this explanation of the same among large number of variables is more complicated using the same correlation coefficients. So, factor analysis helps researchers to study different variables and limit them to the most important factors that affect the phenomenon. 1-3 Factor analysis model^{[Ali,2014:p.p 19][Mohamed,2011:p.p178]}

The model (k) to translate the observed variables to be a sample size (n) based on a linear function of common factors (M), (M <K) and K of the unique factors for each variable where:

X = T $\underline{F} + \underline{U} + \underline{M}$ (1)K*M M*1 K*1 K*1 K*1 Also the model can be formulated as follows $X = \mu + TF + U$ (2)Since that : X: the random vector of n views

u: Vector means variables

T: the model matrix (factors saturation of variables), it is constant.

U: the variables random variance's vector

F: random vector of hypothetical factors

Because of the coefficients of common and special factors means are zero, according to the assumption that the variables' means vector variables is zero (the variables in the standard form), then :

$$\mathbf{E}(\underline{X}) = \underline{\mu} = \underline{0}$$

$$\mathbf{E} \begin{bmatrix} \underline{\mathbf{F}} \\ \dots \\ \underline{\mathbf{U}} \end{bmatrix} = \begin{bmatrix} \underline{\mathbf{0}} \\ \dots \\ \underline{\mathbf{0}} \end{bmatrix}$$

So, the factorial model is formulated in the following form:

 $\underline{\mathbf{A}} = \mathbf{I} \quad \underline{\mathbf{F}} + \underline{\mathbf{U}} \qquad (3)$ 1-4 The main hypotheses of the factorial analysis^{[Sawsan,2016:p.p81][Mohamed,2011:p.p173]}
Provide the factorial analysis^{[Sawsan,2016:p.p81][Mohamed,2011:p.p173]} $\underline{X} = T \underline{F} + U$

Reviewing literature on factor analysis, it is seen that all methods of the same agree on the next listed basic premises:

1. First hypothesis: There are correlation relationships among set of variables ; they are called (Intercorrelation), this internal correlation is a product of the presence of common factors affecting the phenomenon. The factor analysis seeks to give an clarification to those correlations among the variables studied, here we find three types of variance:

- **i** Common variance: it is the main part of the variance, that shows the correlation of the variable with other variables.
- ii-Specific variance: it is the amount of the variance that is not attributed to any other variable
- iii-Error variance : It is the portion of the variance taking place because of other variables not considered in the study of the phenomenon, or it comes from errors in the sample, measurement process, or other changes leading to instability.

The common (general) and special variances jointly form the dependent variance, which is reflected by the following formula :

 $1 = t_{i1}^2 + t_{i2}^2 + \ldots + t_{im}^2 + S_i^2 + E_i^2 \ldots (4)$

The square roots of the common variance ratios from 1 to t time are due to the loads (saturation) of the factors and represent the correlation amount of the variable i in each factor. 2. Second hypothesis: there is a correlation between the variables j, k ; it is calculated according to the nature and effect of the common factors' saturation.

The basic equation for the factorial analysis for independent and orthogonal factors, and using matrices technique, we put the idea in the following matrix equation:

1.5. Communalities^[Ali,2014:p.p 25] [Sawsan,2016:p.p85]

It is the sum of all the variables' contributions in the derived factors , and it is mathematically defined as the sum of the squares of the variables' saturation by the derived factor .

The communality of the variable (zi) is a value of its variance, which is interpreted by the extracted factors ; that is, the sum of the squares of saturation of that variable, symbolized by (h_i^2) can be expressed as follows:

$$h_i^2 = \sum_{p=1}^m a_{ip}^2$$
 ... (7)

The weight of a_{ip}^2 for Z_i is the coefficients of the matrix of factors F which can be represented as follows:

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One characteristic of the communality (h_i^2) , is that it is positive taking value between zero and one $0 \le h_i^2 \le 1$.

The (h_i^2) means the extent of interference among the variables and the derived factors; so :

- 1- If the value of (h_i^2) is large and is close to one, then it means that the variable interferes fully with the derived factors.
- 2- If the value of $h^2 i$ is equal to zero, then it signifies that the extracted factors could not clear any portion of the variable variance.
- **3-** If the value of $h^2 i$ between zero and one indicates that there is an overlap among variables and factors.
- 1.6. Rotation^[Ali,2014:p.p 28] [Mohamed,2014:p.p73]

Once the factors and their loads or saturations are identified, the process of rotating factors to explain them. The main objective of rotating factors is to get a proper combination of factors that can be explained.

1.6.1. Orthogonal rotation: this kind of rotation assumes that the factors are not interrelated, therefore it is relatively easy to be understood and to deal with in case of calculation and drawing.

1.6.2. Oblique rotation: this category is more convenient for the real life, because of the overlapping, interfering, and correlative attribute of variables in a single event or phenomenon and the difficulty of explaining by factors entirely independent of each other.

1.7. Eigenvalue^[Ali,2014:p.p 35] [Mohamed,2014:p.p74]

The eigenvalue measures the amount of variance in all variables related to a single factor .It is not a percentage of the variance interpretation, but a measure of the portion of the variance, normally used for comparison purposes. As Kaiser stated, the factor with an eigenvalue is greater than one is accepted, meanwhile if the same is less than one, the factor is rejected.

Eigenvalue Where the explained variance ratio of the first component= Sum Eigenvalues

1.8. Factor analysis methods:

There are several methods of factorial analysis developed over time, the most important are :

1.8.1 Principal Components Method [Mahfouz,2008:p.p67] [Sawsan,2016:p.p91]

It is the most widely used technique by researchers because its simplicity and it is most interpretable method. It is a linear structure of the dependent variables (responding variables). As we have P of the responding variables, the first basic component is expressed in the following equation :

 $Z_1 = a_{11}x_1 + a_{21}x_2 + \ldots + a_{p1}x_p$

. . . (10) a_{ii} represents the saturation of the responding variables by the first factor.

The second key component is expressed as follows:

 $Z_2 = a_{12}x_1 + a_{22}x_2 + \ldots + a_{p2}x_p$. . . (11)

The first component explains the maximum possible variance between the original variables, and the second component (not related to the first component) shows the maximum amount of residual variation ... and so on until all the variance is explained. The variance of all components is equal to the sum of the variability of the original variables, and the components can be calculated in two ways:

1- Using the common variance matrix of the responding variables. In this case, the variables are measured by deviations from the mean.

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2- Using the correlation matrix for responding variables, in this case standard variables are used, this is necessary when different units of measurement are used for the responding variables.

1.8.2. Diagonal method [Mohamed,2014:p.p69]

This method is a direct and easy way in the factorial analysis and it is used when there are a limited number of variables, it helps in extracting as many factors as possible. The mentioned method requires previous knowledge of the values of the variables' commonness, that is, without this knowledge it cannot be used. It is named as that because it is based on the use of diagonal values directly in the correlation matrix. The diagonal method begins to extract the entire value in the first factor and thus the root of this value is the saturation of the first variable on the first factor and is called the diagonal saturation and so on.

1.9. Number of factors:

There are several criteria to determine the number of significant (important) factors , the most frequently used criteria is the (Kaiser) 1960 ; it indicates that the significant factors are the factors that correspond to the distinctive roots (Eigen Value) (eigenvalue is a function of the percentage of variance to which each contributes. Morrison suggested that the factors are calculated in the way that their contribution to explain the overall variance is equal to or greater than 0.75. This paper has adopted the standard (Kaiser) to determine the significant factors.

- **2.** The Applied Study
- 2.1. the data description

The research deals with (11) indicators that affect the behavior of prosthetics users.

where the data were collected through a questionnaire and distributed to a group of auditors for the department of Industrial Parties in Wasit Governorate, and the sample size is 85 persons. The behavior of prosthetics users is one of the most important factors that affect them directly or indirectly with the methods of calculation:

- 1. Do you think that society needs to increase awareness of prosthetic users (X1)?
- 2. Do you think that the rights of users of prosthetics are fully available to (X2)?
- 3. Do you think that prosthetic users tend to be isolated most of the time (X3)?
- 4. Are jobs available in all sectors (X4)?
- 5. Do you think you have difficulty completing education and study for advanced (X5)?
- 6. Do you think that the percentage of amputees is more males than females (X6)?
- 7. If you are a healthy person do you accept marrying someone who has amputation (X7)?
- 8. Most ages range from (less than 18) (from 19 to 29) (over 30) (X8)?

9. Do you see that they are enjoying their own lives did not have to seek help most of the time (X9)?

10. Do you support the work of prosthetic users with ordinary people (X10)?

11. Do you think amputees feel unwanted when they are with normal people (X11)?

12. Behavior of prosthetic users (Y1)

• Results and Discussion

After the analysis of the variables (11) by the method of the principle compounds, it was found that there are four main factors representing the underlying root which is greater than one as shown in Table (2) below and that these values are arranged according to the importance of the influence of each factor and the explanatory capacity of these variables was (58.868) The following is an explanation of the factors through the load matrix of factors and by importance.

• The first factor

The first factor is called the main factor or a general factor. All the variables included in the analysis, or the majority of them, show significant saturation over 0.25, as in Table (1). All variables with different saturation coefficients reflect the general correlation between the variables. The first factor explained about (18.127) of the total variability between the study variables.

The second factor

The second factor as shown in Table (1) around (15.722) of the total variation and is considered second in terms of importance in the interpretation of the relationships between variables.

- The third factor
- The third factor is explained in Table (1) about (14.519) of the total variation.
- The fourth factor

This factor has been explained in table (1) about (10.500) of the total variation and is the last work in the interpretation of the importance for the other factors.

Total Variance Explained									
Rotation Sums of Squared			Extraction Sums of Squared						
Loadings			Loadings			Initial Eigenvalues			
	Aggregate	Contrast		Aggregate	Contrast		Component		
Cumulative	Contrast	explained	Cumulative	Contrast	explained	Aggregation	variation	TOTAL	Factors
%	%	%	%	%	%		%	%	
17.221	17.221	1.894	18.127	18.127	1.994	18.127	18.127	1.994	1
32.162	14.942	1.644	33.849	15.722	1.729	33.849	15.722	1.729	2
46.504	14.342	1.578	48.369	14.519	1.597	48.369	14.519	1.597	3
58.868	12.364	1.360	58.868	10.500	1.155	58.868	10.500	1.155	4
						67.496	8.628	.949	5
						75.432	7.936	.873	6
						82.595	7.163	.788	7
						88.230	5.634	.620	8
						93.830	5.600	.616	9
						97.059	3.229	.355	10
						100.000	2.941	.324	11

Table 1 the explanation for each variable and the aggregate variance

The results of the saturation matrix were extracted before recycling as shown in Table (2) according to the method of analysis of the basic components (Principal Component) and show the following: -

• Saturation of the first factor

The presence of the two most saturated variables are (do you think do they have difficulty in completing the education and study for an advanced stage (x_5), the majority of their ages range from (less than 18) (from 18 to 30) (more than 30) x_8) and saturation (0.513,0.741), respectively, as shown in table(1) (The other variable (do you think that the percentage of amputees males more than the proportion of females(X_6)) and saturation (-0.756) is negative saturation reflects the negative saturation direction of the impact of these variables among

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them in other words it is moving in the opposite direction and the increase by this The variables are accompanied by a decrease in the percentage of variables with positive saturation as shown in Figure (1).

• The second factor saturation

The most satisfactory variables in this factor are (Do you support the work of users of prosthetics with ordinary $people(X_{10})$, do you complicate that the society needs to increase awareness of the direction of users of prosthetics(X₁)) and saturation (0.629, 0.662) respectively, which is positive saturation and the value is relatively high or Variable (if you are a healthy person do you accept marrying a person with amputation(X₇)) The amount of saturation (-0.623) is negative saturation as shown in Table (2) note the decrease in the previous variable and Figure (1) shows that.

• The third factor saturation

This factor includes two variables are the most saturated contribute to the composition of this factor is (Do you see that the rights of users of prosthetics available to them to the fullest (X_2) , that most of the ages ranging between (less than 18) (from 18 to 30) (more than 30)(X_8)) and saturation (0.598 and 0). 539) respectively are two positive saturation.

• Fourth Factor Saturation

Here are two variables that are most saturated are (Are jobs available in all sectors(X_4), do you think that amputees feel unwanted when they are with ordinary people(X_{11})) and positive saturation (0.525,0.670), respectively, as shown in Table (2) Significant in the ratio of this variable.

Component Matrix							
Saturat recycli	ion of ng	factors	before		Factors		
4	3	2	1				
.083	221	.629	.391	Does it hold that society needs to raise awareness of the tendency of prosthetic users?	1		
264	.539	038	420	Do you see that the rights of users of prosthetics are available to them to the fullest	2		
.341	494	.337	024	Do you think prosthetics users tend to be isolated most of the time?	3		
.670	.287	449	007	Are jobs available to them in all sectors	4		
017	124	201	.741	Do you think you have difficulty completing education and studying for an advanced stage	5		
.214	123	144	756	Do you think that the percentage of amputees is more male than female	6		
316	113	623	.309	If you are a healthy person you will accept marriage to someone who has amputation	7		

Table (2) the saturation before recycling

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	147	.484	.175	243	Do you see that they enjoy their own lives did not have to ask for help most of the time	8
	.210	.357	.662	.002	Do you support the work of prosthetics users with ordinary people	9
	.525	.412	241	.355	Do you think amputees feel unwanted when they are with normal people?	10
	159	.598	.201	.513	Most of the ages range from (less than 18) (from 18 to 30) (more than 30)	11

Figure (1) below presents the root values of each factor on the y-axis and the component number on the x-axis.





Figure (2) below depicts the prevalence of factors within components using the box diagram. Figure (2) fund factor diagram

Component Plot in Rotated Space



The results of the saturation matrix were extracted after recycling as shown in Table (3) according to the method of analysis of the basic components (Principal Component) and show the following: -

* Saturation of the first factor after recycling

The presence of the two most saturated variables are (most of the ages ranging from (less than 18) (from 18 to 30) (more than 30) (X_8), do you think they have difficulty completing education and study (X_5)) and saturation (0.602,0.718), respectively, as shown in table (3) The other variable (do you think that the percentage of amputees male more than the proportion of females (X_6)) and saturation (-0.799) is negative saturation reflects the negative saturation direction of the impact of these variables among them in other words it is moving in the opposite direction and the increase by these variables accompanied Decrease in the percentage of variables with positive saturation.

The second factor saturation *

The most saturated (2) variables in this factor are (Do you support the work of prosthetics users with ordinary people (X10)) and saturation (0.750) which is positive saturation and its value is relatively high or variable (if you are a healthy person do you accept marriage to someone who has amputation (X7))(-0.739) It is of negative saturation as shown in Table (3) we note a decrease in the previous variable.

*The third factor saturation after recycling

This factor includes the three most saturated variables that contribute to the composition of this factor: (Do you think that the rights of users of prosthetics available to them to the fullest (X2), do you see that they enjoy their own lives did not have to ask for help most of the time (X9)) and saturation (0.533,0.715), respectively These are positive saturation and variable (do you think prosthetics users tend to be isolated most of the time (X3)) is negative (-0.571) as shown in Table 4.

*Fourth factor saturation after recycling

Here are two variables that are most saturated are (are jobs available in all sectors (X4), do you think that amputees feel unwanted when they are with ordinary people (X11)) and positive saturation (0.745, 0.837) respectively as shown in Table (3) we note an increase Significant in the ratio of these variables.



	Rotated Component Matrix ^a							
Satı	ration of recy	f factors cling	after		Factors			
4 3 2 1		1						
234	425	.483	.368	Does it hold that society needs to raise awareness of the tendency of prosthetic users?	1			
031	.715	.050	153	Do you see that the rights of users of prosthetics are available to them to the fullest	2			
089	571	.313	204	Do you think prosthetics users tend to be isolated most of the time?	3			
.837	.002	073	166	Are jobs available to them in all sectors	4			
.139	355	311	.602	Do you think you have difficulty completing education and studying for an advanced stage	5			
.056	.109	.025	799	Do you think that the percentage of amputees is more male than female	6			
.020	016	739	.224	If you are a healthy person you will accept marriage to someone who has amputation	7			
025	.533	.246	006	Do you see that they enjoy their own lives did not have to ask for help most of the time	8			
.033	.139	.750	.164	Do you support the work of prosthetics users with ordinary people	9			
.745	.008	.038	.270	Do you think amputees feel unwanted when they are with normal people?	10			
.124	.343	.193	.718	Most of the ages range from (less than 18) (from 18 to 30) (more than 30)	11			
1					11			

Table	(3)	the	saturation	before	recycling
	1		1 0		• 9

The component conversion matrix using Varimax with Kaiser Normalization refers to the strength of the relationship between factors before recycling and factors after recycling. The relationship between the first factor before and after recycling was (0.902). The relationship between the second factor before and after the recycling equals (0.884) or the relationship between the third factor before and after the recycling equals (0.82) and the relationship between the fourth factor before and after the recycling is equal to (0.783) as shown in table (4) below:

Component Transformation Matrix								
Factors								
4	3	2	1					
.161	377	132	.902	1				
427	098	.884	.164	2				
.422	.820	.239	.303	3				
.783	418	.380	259	4				

 Table (4) the relationship between factors before and after recycling

5- Conclusions

Through research and study of indicators that affect the behavior of prosthetic users, where the most important conclusions are as follows:

- 1- The results show that the most important indicators in the first factor before recycling do you have difficulty in completing education and study for an advanced stage(X5), that most of the ages ranging from (less than 18) (18 to 30) (more than 30) (X8)) and saturated (0.513,0.741) respectively note that the variable ages had a greater role in the composition of the first and third factor. the second factor before recycling Trend of users of prosthetics) and saturation (0.629, 0.662) respectively. third factor before recycling (Do you think that the rights of prosthetic users are available to them to the fullest(X2), that most of the ages (Less than 18) (18 to 30) (more than 30) (X8)) and saturated (0.539) respectively. and the fourth factor before recycling (Are jobs available to them in all sectors (X4), Do you think that amputees feel that they are undesirable when They are with normal people (X11)) and with positive saturation (0.525,0.670) respectively.
- 2- the results show that the most important indicators in the first factor after recycling (most of the ages range from (less than 18) (from 18 to 30) (more than 30) (X8), Do you think they have difficulty completing education and studying (X5) (and 0.602,0.718) respectively. the second factor after recycling (Do you support the work of prosthetics users with ordinary people (X10)) and saturation (0.750). the third factor after recycling is (Do you think that the rights of prosthetic users are available to them to the fullest (X2), do you see that they enjoy Have not had to ask for help most of the time (X9)) and saturated (0.533,0.715), respectively. and the fourth factor after recycling They are with ordinary people (X10)) and with positive saturation (0.745,0.837) respectively.

References

1- Ali .N. Nasser .(2014) "The impact of environmental pollution on the health level in Iraq" College of Management and Economics - University of Baghdad.

2- Mahfouz .J. (2008) "Statistical Analysis Using SPSS" dar wael for publishing and distribution.

3- Mohamed .H. M. Farag and Faeza M. El Hassan .(2014) "The use of factor analysis in determining the most important factors affecting the migration of Sudanese scientific competencies" Magazine Emma Rabak. Twelfth issue .page (65-84).

4- Mohamed .A. Mohamed.(2011) "The use of factor analysis from the higher grades in determining the most important factors affecting the socialization of children under the age

of six" Qadisiyah Journal of Administrative and Economic Sciences. Volume 13 Issue 4.

5- Saad.Z. Basheer (2003) "Your Guide to the SPSS Statistical Program"



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6- Sawsan .I. Omar .(2016) "Factor Analysis of the Foundations of Development in South Kordofan State Using Key Component Method". Doctoral dissertation. Sudan University of Science and Technology, College of Graduate Studies.