The Impact of Animation Technology in Mechanical Engineering Education

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ABSTRACT

Mechanical engineering is one important area of engineering. Students of mechanical engineering require practice and live experiments on complex machines and tools. Unfortunately, certain machines are hard to purchase or to make available for learning purposes. Such situations require technology and multimedia to support its delivery of information. The final results showed that the majority of level four mechanical engineering students in the International Islamic University Malaysia agreed and preferred using animation technology in their studies. Practically, the author designed a short animated presentation of a mechanical engine that is provided in the questionnaire for the students to evaluate. Following this, the collected data is analyzed using the factor analysis method. In conclusion, it is believed that the animated presentation of each individual part of a machine, no matter how complex it may be, will enhance students learning capabilities compared to traditional methods of learning.

Keywords: animation, four-stroke petrol engine, learning, mechanical engineering, and multimedia.

1 INTRODUCTION

This paper presents the result of a number of variables used in executing statistical tests using the analytical SPSS (Statistical Package for the Social Sciences) software. This study went through two separate stages of data gathering. One is the primary (Pilot) round followed by the secondary (Final) round. There are two different methods of analysis adopted. One is the regression analysis which is used in the pilot round to test and measure the validity and reliability of the questionnaire, while the other is the factor analysis, which is used twice; once in the pilot study and second in the final round. In this paper, the author will present the factor analysis only.

Descriptive statistical analysis is adopted during the pilot and final round. William (2006) agreed that this type of statistic is usually applied to explain the fundamental specifications of the data to be tested in a certain study. Descriptive analysis offers straightforward reviews about the sample in conjunction with clear graphics analysis; they structure the base of all quantitative analysis of data.

The questionnaire was developed after a thorough review of literature. Variables such as, technology, textbooks and usability were extracted from Holzinger et al. (2008), which was chosen as the adopted method in the author's master research work. However, due to the nature of the focus of the research and in conjunction with Jakob Nielsen and Rolf Molich's (1990) ten usability heuristics that were updated and reviewed by Nielsen (2005), additional variables such as presentation, flexibility and standard were intuitively added. Those variables were added due to the relevance and to modify the previous studies' variables which were considered specific and relevant in measuring the effect of animation in mechanical engineering students' performance.

Factor analysis can be conducted for either exploring the data or confirming the data outcomes. Exploratory factor analysis mainly focuses on recognizing, explaining, and categorizing data. On the other hand, confirmatory factor analysis which is used for testing the hypothesis depends on data outcomes from other resources including exploratory factor analysis. Data related to one another is organized in one group with each group representing a factor. This method helps in identifying the degree of data fit (Child, 2006).

In this paper the factor analysis is applied firstly through the exploratory analysis in order to determine the number of essential factors and the group of variables that are listed under each factor. Secondly, the confirmatory analysis is applied in order to describe the relationship among the variables, how they are affected by one another and the most important variable that influences other variables. Field (2005) found that "in general over 300 cases for sampling analysis is probably adequate. There is universal agreement that factor analysis is inappropriate when sample size is below 50". In this study, the final round of data collection contains 106 samples therefore it is adequate and it is possible to analyze the samples collected using both factor and multiple regression analysis. The Extraction Method used in the factor analysis is Principal Component Analysis. The variables that had most influence on the study were the variables age and perceived quality of animation (PQOA), which measure the animation's evaluation section in the questionnaire.

For further understanding and extra explanation the author performed several searches in order to learn about factor analysis. The author found plenty of useful information by Field (2005-2009) pertaining to 'Research Methods II: Factor analysis on SPSS, Factor analysis Using SPSS'. The explanation and examples given were very clear. As such, Field's (2005-2009) findings and discussions are used in this paper to support the author's justification for the tables extracted. In addition, for accuracy and more detailed results in the analysis, all numerical values are rounded up to two decimal places.

2 QUESTIONNAIRE PREPARATIONS

The author evaluated the learning progress and reaction when using dynamic media such as 'Animations'. The objective of the study is to determine aspects that form dynamic demonstrations of educational tools that promote effective learning. The author designed clear and simple animation presenting the 'Four-Stroke Petrol Engine' aiming to offer the highest compatibility between the animation and the static book content which the student is accustomed to.

2.1 PARTICIPANTS

The respondents of this research were N=130 final year/ year 4 undergraduate students from the Mechanical Engineering Department of the International Islamic University Malaysia (IIUM). In total, there were 103 male and 27 female students. The average age of the respondents was 23 years. The youngest participant was 23 and the oldest 30. The pilot study was conducted with 24 participants and gathered during the last semester in December/2012. The second round (in total 106) was performed during the first semester, namely February-April/2013.

In the first round (pilot study) the respondents (24 in total) were gathered in one session. The respondents in the second round of the questionnaire were gathered in groups. The first group was from the class of Dr. Qasim Hussain Shah, Associate Professor in the Mechanical Engineering Department who teaches MEC 4865 Computer Aided Engineering, IIUM (4th level course, 22 students). The second group (in total 18 students) was from Prof. Dr. Ashraf Ali Omar's Air Craft Design Course. In the third round of finding respondents, Dr. Meftah Hrairi Associate Professor & Head of Department of Mechanical Engineering in IIUM provided the questionnaire link in one of the assignments before distributing it to students (28 respondents in total). The fourth and final stage of collecting data and finding responses was organized by Dr. Meftah in conjunction with Prof. Mohiuddin to take place in 1st April 2013 (38 respondents in total) during one of the Engine Design classes.

2.2 MATERIALS

The soft materials used to present the questionnaire content was the online survey website surveymonkey.com. The software that the author used to design the animation is Adobe Flash CS3 by using Action Script 3.0. The author prepared and printed out the survey link in order to distribute it to students for the sake of making the survey environment more accurate and organized. The computer devices that the respondents used were desktops with Microsoft Windows. The students used several available web browsers such as Firefox, Google Chrome, and Internet Explorer.

3 FACTOR ANALYSIS

3.1 PILOT ROUND

3.1.1 DESCRIPTIVE STATISTICS

Table 1 is the first output from the factor analysis which shows descriptive statistics for all the variables under examination. In general, the mean, standard deviation, and number of respondents (N) who participated in the survey are presented in this table. By looking at the mean, it is apparent that age is the most important variable that influenced students to perceive and understand the animation presentation. It has the highest mean of 1.75.

3.1.2 CORRELATION MATRIX

The next output from the analysis is the correlation coefficient. Table 2 shows the correlation matrix which is simply a rectangular array of numbers that gives the correlation coefficients between a single variable and every other variable in the study. Usually, the correlation coefficient value between a variable and itself is one. Consequently, the principal diagonal of the correlation matrix contains ones. The correlation coefficients above and below the principal diagonal are the same. The determinant of the correlation matrix is shown at the foot of the table below. In this table the value of it is 0.12 which is greater than the required value 0.00001. As a result, repeated errors are not an issue of concern for that data. In conclusion, questions used in the survey correlates reasonably to one another which mean that the questionnaire is sufficiently reliable to be used in measuring the efficiency of animation technology in mechanical engineering education.

From Table 2 it is apparent that the variable perceived animation utility is strongly significant with the variable perceived animation efficiency at (sig. 0.79) which means that they are strongly related to one another and works together to insure the animation's quality. Moreover, the variable perceived animation compatibility is moderately significant with the variable perceived quality of animation PQOA at (sig. 0.51). As a result, if the animation is compatible and well designed the quality of animation's presentation will be high and valuable. It is important to mention that in the reproduced correlations, residuals are computed between observed and reproduced correlations. There are 9 (42.0%) nonredundant residuals with absolute values greater than 0.05.

3.1.3 KMO AND BARTLETT'S TEST

In Table 3, Kaiser-Meyer-Olkin (KMO) and Bartlett's Test is used to measure the strength of the relationship among all variables. The KMO measures the sampling adequacy which should be greater than 0.5 for a satisfactory factor analysis to proceed. The KMO measure in this table is 0.5. Bartlett's test is another indication of the strength of the relationship among variables which can be used to test the null hypothesis. Bartlett's test associated probability must be less than 0.05. In Table 3, it is actually 0.002, the significance level is small enough to reject the null hypothesis. As a result, correlation matrix is not an identity matrix. Therefore, factor analysis is appropriate.

3.1.4 COMMUNALITIES

Field (2005) found that "Communalities indicate the amount of variance in each variable that is accounted for. Initial communalities are estimates of the variance in each variable accounted for by all components or factors. Extraction communalities are estimates of the variance in each variable accounted for by the factors (or components) in the factor solution. Small values indicate variables that do not fit well with the factor solution, and should possibly be dropped from the analysis". Table 4 shows how much of the variance in the variables has been accounted for by the extracted factors. For instance over 92.8% of the variance in perceived animation efficiency is accounted for while 55.8% of the variance in age is accounted for. This means that the amount of variance in the variable perceived animation efficiency can be explained by the retained factors.

3.1.5 TOTAL VARIANCE EXPLAINED

Table 5 demonstrates all the factors extractable from the analysis along with their eigenvalues, the percent of variance attributable to each factor, and the cumulative variance of the factor and the previous factors. The first factor accounts for 30.10% of the variance, the second 22.99%, and the third 20.34%. All the remaining factors are not significant.

3.1.6 SCREE PLOT

Figure 1 shows the scree plot which is a graph of the eigenvalues against all the factors. This graph is particularly helpful for determining the number of factors to be retained. The point of interest is where the curve actually starts to flatten as shown in the figure. It can be seen that the curve begins to flatten between factors 3 and 4. In addition, factor 4 has an eigenvalue of less than 1. Therefore, only three factors have been retained for this study.

3.1.7 COMPONENT (FACTOR) MATRIX

Table 6 shows the loadings of the seven variables on the three factors extracted. The concept is based on the idea that the higher the absolute value of the loading, the more the factor contributes to the variable. The empty fields shown in the table characterize loadings that are less than 0.5; this procedure makes the table clearer and easier to read. As shown in Table 6, factor 1 strongly contributes to the variable perceived animation efficiency at 0.73, the variable perceived animation utility at 0.68, and the variable age at 0.66. This means that those three variables under the first factor highly contribute together and is affected by one another in making the animation presentation reliable. Factor 2 contributes equally to the variables perceived animation efficiency, perceived animation compatibility and gender at 0.51; and strongly contributes to the variable perceived animation utility at 0.68. Factor 3 strongly contributes to the variable perceived ease of use at 0.68 and the variable perceived quality of animation PQOA at 0.60.

3.1.8 ROTATED COMPONENT MATRIX

Rotation matrix table is extracted to decrease the number of factors on which the variables under exploration have high loadings. Rotation is useful in making the explanation of the analysis easier. Table 7 shows five significant variables that had direct impact on the study. The variable perceived animation efficiency is loaded on factor 1 at 0.95 which form a very strong contribution and the variable perceived animation utility is loaded on factor 1 as well and is contributing very strongly at 0.93. Factor 2 contributes strongly to the variables perceived quality of animation PQOA at 0.84 and the variable perceived animation compatibility at 0.83. Finally, factor 3 contributes strongly to the variable perceived ease of use at 0.80. The result of this final table in factor analysis proves the study's alternative hypothesis which is perceived quality of animation has a relation with animation utility, animation compatibility, ease of use and animation efficiency. This ensures that the null hypothesis is rejected.

3.2 SECOND ROUND OF QUESTIONNAIRE

3.2.1 DESCRIPTIVE STATISTICS

Table 8 lists the first output values from the factor analysis which shows descriptive statistics for all the variables tested. Generally, the mean, standard deviation, and number of respondents (N) who participated in the survey are presented in this table. By looking at the mean, it is apparent that perceived quality of animation PQOA is the most important variable that influenced students to perceive and understand the animation presentation. It has the highest mean of 2.21.

3.2.2 CORRELATION MATRIX

Table 9 shows the correlation matrix which forms a rectangular array of numbers that gives the correlation coefficients between a single variable and every other variable in the study. The determinant of the correlation matrix shown at the foot of the table is 0.60 which is greater than the required value 0.00001. Based on that result, repeated errors are not an issue of concern for the data. In conclusion, questions used in the survey correlates reasonably to one another which means that the questionnaire is sufficiently reliable to be used in measuring the efficiency of animation technology in mechanical engineering education. Table 9 also demonstrates a moderate significant relation between the variables age and perceived animation efficiency at 0.53.

It is important to mention that in the reproduced correlations, residuals are computed between observed and reproduced correlations.

There are 13 (61.0%) nonredundant residuals with absolute values greater than 0.05. Compared with the pilot test there were 9 (42.0%) nonredundant residuals with absolute values greater than 0.05. It is obvious that the number of nonredundant residuals with absolute values greater than 0.05 has increased and actually went beyond the half. This is a sign that the data is qualified to be used in testing the quality of animation and the idea of using animation technologies for mechanical engineering education. In addition, it shows the satisfaction of users against that idea.

3.2.3 KMO AND BARTLETT'S TEST

Table 10 shows the Kaiser-Meyer-Olkin (KMO) and Bartlett's Test which measures the strength of the relationship among all variables. Sampling adequacy measured by KMO must be greater than 0.5 for a satisfactory factor analysis to proceed. The KMO measure in this table is 0.5 which is the same as the value in the pilot factor analysis outcome. Bartlett's test is also used in Table 10 to indicate the strength of the relationship among variables which can be used to test the null hypothesis. Bartlett's test associated probability must be less than 0.05. In Table 10, it is actually 0.00, the significance level is small enough to reject the null hypothesis. As a result, correlation matrix is not an identity matrix. Therefore, factor analysis is appropriate and accurate in testing this study with the sample size of 106 in the second round. Compared with the pilot test, the significance level was 0.002 which means it decreased more in the second round, which is another sign of adequacy.

3.2.4 COMMUNALITIES

Table 11 demonstrates how much of the variance in the variables has been accounted for by the extracted factors. For instance over 88.5% of the variance in perceived animation compatibility variable is accounted for while 58.9% of the variance in perceived animation utility is accounted for. This means that the amount of variance in the variable perceived animation compatibility can be explained by the retained factors.

3.2.5 TOTAL VARIANCE EXPLAINED

Table 12 shows all the factors extractable from the analysis along with their eigenvalues, the percent of variance attributable to each factor, and the cumulative variance of the factor and the previous factors. The first factor accounts for 22.95% of the variance, the second 18.15%, the third 16.56%, and the fourth 14.92. All the remaining factors are not significant.

3.2.6 SCREE PLOT

Figure 2 shows the scree plot which is a graph of the eigenvalues against all the factors. Looking at the figure, it can be seen that the curve begins to flatten between factors 4 and 5. In addition, factor 5 has an eigenvalue of less than 1; therefore, only four factors have been retained for this study in the second round of data analysis.

3.2.7 COMPONENT (FACTOR) MATRIX

Table 13 shows the loadings of the seven variables on the four factors extracted. The higher the absolute value of the loading, the more the factor will contribute to the variable. The empty fields shown in the table illustrates loadings that are less than 0.5; this procedure makes the table clearer and easier to read. As shown in Table 13, factor 1 strongly contributes to the variable age at 0.85 and the variable perceived animation efficiency at 0.85. This means that those two variables under the first factor highly contribute with each other and is affected by one another in making the animation presentation reliable and understandable by the users. Factor 2 contributes moderately to the variables perceived animation utility at 0.68 and the variable gender at 0.66. Factor 3 moderately contributes to the variable perceived quality of animation PQOA at 0.55. Finally, factor 4 contributes very strongly to the variable Perceived animation compatibility at 0.92. The overall outcomes are highly significant in conclusion and are positively affecting the presentation of the animation.

5.2.8 ROTATED COMPONENT MATRIX

Table 14 shows six significant variables that had direct impact on the study. The variable age is loaded on factor 1 at 0.87 as well as the variable perceived animation efficiency at 0.84 which forms a strong contribution. Factor 2 contributes moderately to the variables gender at 0.77 and the variable perceived animation utility at 0.72. Factor 3 contributes moderately as well to the variable perceived ease of use at 0.76. Finally, factor 4 contributes very strongly to the variable perceived animation compatibility at 0.94. The result of this final table in the second round of factor analysis shows that there is a very strong relation among variables that are directly affecting the quality of animation which insures the study's alternative hypothesis which is perceived quality of animation has relation with animation utility, animation compatibility, ease of use and animation efficiency. This indicates that the null hypothesis is rejected.

3.2.9 ANALYSIS CHARTS

Figure 3 shows the histogram and normal probability plot of the data for this study. The histogram apparently looks like a normal distribution (a bell-shaped curve). SPSS draws a curve on the histogram in order to show the shape of the distribution clearly. For the animation data, the distribution is exactly normal. The normal probability plot also shows deviations from normality. The straight line in this plot represents a normal distribution, and the points represent the observed residuals. Therefore, the data set is perfectly normally distributed because all points lie on the line.

4 CONCLUSION

Using updated technology tools in mechanical engineering education will not only help students to better understand but will also enhance lecturers performance, ease of preparing the lessons for students and ease of explaining the information to students. Mechanical engineering environments require from students to have practical skills and ability to work on live experiments. If one element of the necessary learning tools is missing, it will cause distraction. This research could have a positive impact on mechanical engineers knowledge.

Education with all its different scopes is interrelated. As such, it is important to investigate and explore other technologies around us in order to implement new things in new ways. Communication is required among people with different specialties in order to benefit from one another's to produce reliable products. Animation is a cost effective and viable option to support education that requires complex and expensive machinery. The image association and interactive format of animations ensure that students are able to have access to the components of a machine and its various operations.

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6 LIST OF TABLES

Table 1: Descriptive Statistics

	Mean	Std. Deviation	Analysis N
Age	1.7500	.44233	24
Gender	.7083	.46431	24
Perceived ease of use	1.1250	.33783	24
Perceived animation utility	1.0833	.28233	24
Perceived animation efficiency	1.1250	.33783	24
Perceived animation compatibility	1.0417	.20412	24
PQOA	1.6845	.57681	24

Table 2: Correlation Matrix[a]

		Age	Gender	Perceived ease of use	Perceived animation utility	Perceived animation efficiency	Perceived animation compatibility	PQOA
Correlation	Age	1.000	-.159	.218	.174	.218	-.361	-.323
	Gender	-.159	1.000	-.312	.193	-.035	.134	-.115
	Perceived ease of use	.218	-.312	1.000	-.114	.238	-.079	.052
	Perceived animation utility	.174	.193	-.114	1.000	.798	-.063	-.137
	Perceived animation efficiency	.218	-.035	.238	.798	1.000	-.079	-.012
	Perceived animation compatibility	-.361	.134	-.079	-.063	-.079	1.000	.512
	PQOA	-.323	-.115	.052	-.137	-.012	.512	1.000
Sig. (1-tailed)	Age		.229	.153	.208	.153	.041	.062
	Gender	.229		.069	.183	.436	.267	.296
	Perceived ease of use	.153	.069		.298	.131	.357	.405
	Perceived animation utility	.208	.183	.298		.000	.385	.262
	Perceived animation efficiency	.153	.436	.131	.000		.357	.478
	Perceived animation compatibility	.041	.267	.357	.385	.357		.005
	PQOA	.062	.296	.405	.262	.478	.005	

a. Determinant = .106

Table 3: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.468
Bartlett's Test of Sphericity	Approx. Chi-Square	44.516
	df	21
	Sig.	.002

Table 4: Communalities

	Initial	Extraction
Age	1.000	.558
Gender	1.000	.628
Perceived ease of use	1.000	.647
Perceived animation utility	1.000	.924
Perceived animation efficiency	1.000	.928
Perceived animation compatibility	1.000	.699
PQOA	1.000	.755

Extraction Method: Principal Component Analysis.

Table 5: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.107	30.102	30.102	2.107	30.102	30.102	1.847	26.387	26.387
2	1.609	22.987	53.090	1.609	22.987	53.090	1.794	25.628	52.015
3	1.424	20.337	73.427	1.424	20.337	73.427	1.499	21.412	73.427
4	.693	9.903	83.330						
5	.617	8.808	92.139						
6	.431	6.160	98.298						
7	.119	1.702	100.000						

Extraction Method: Principal Component Analysis.

Table 6: Component Matrix[a]

	Component		
	1	2	3
Perceived animation efficiency	.725	.519	
Perceived animation utility	.683	.677	
Age	.655		
Perceived animation compatibility		.512	
Perceived ease of use			.678
PQOA			.603
Gender		.508	

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

Table 7: Rotated Component Matrix[a]

	Component		
	1	2	3
Perceived animation efficiency	.945		
Perceived animation utility	.933		
PQOA		.838	
Perceived animation compatibility		.829	
Age			
Perceived ease of use			.796
Gender			

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 4 iterations.

Table 8: Descriptive Statistics

	Mean	Std. Deviation	Analysis N
Gender	.8113	.39311	106
Age	2.0755	.35719	106
Perceived ease of use	1.3962	.49144	106
Perceived animation utility	1.3302	.47252	106
Perceived animation compatibility	1.3396	.47583	106
Perceived animation efficiency	1.0094	.09713	106
PQOA	2.2089	.49317	106

Table 9: Correlation Matrix[a]

		Gender	Age	Perceived ease of use	Perceived animation utility	Perceived animation compatibility	Perceived animation efficiency	PQOA
Correlation	Gender	1.000	.102	-.102	.185	-.011	.047	-.079
	Age	.102	1.000	.099	-.093	-.040	.528	.099
	Perceived ease of use	-.102	.099	1.000	-.036	.071	.120	-.160
	Perceived animation utility	.185	-.093	-.036	1.000	.047	-.069	-.138
	Perceived animation compatibility	-.011	-.040	.071	.047	1.000	-.070	.080
	Perceived animation efficiency	.047	.528	.120	-.069	-.070	1.000	-.013

	PQOA	-.079	.099	-.160	-.138	.080	-.013	1.000
Sig. (1-tailed)	Gender		.148	.148	.029	.457	.316	.210
	Age	.148		.156	.172	.341	.000	.157
	Perceived ease of use	.148	.156		.359	.236	.109	.051
	Perceived animation utility	.029	.172	.359		.316	.243	.079
	Perceived animation compatibility	.457	.341	.236	.316		.238	.206
	Perceived animation efficiency	.316	.000	.109	.243	.238		.447
	PQOA	.210	.157	.051	.079	.206	.447	

a. Determinant = .600

Table 10: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.500
Bartlett's Test of Sphericity	Approx. Chi-Square	51.971
	df	21
	Sig.	.000

Table 11: Communalities

	Initial	Extraction
Gender	1.000	.647
Age	1.000	.765
Perceived ease of use	1.000	.735
Perceived animation utility	1.000	.589
Perceived animation compatibility	1.000	.885
Perceived animation efficiency	1.000	.726
PQOA	1.000	.734

Extraction Method: Principal Component Analysis.

Table 12: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.606	22.949	22.949	1.606	22.949	22.949	1.593	22.762	22.762
2	1.271	18.154	41.104	1.271	18.154	41.104	1.252	17.886	40.648
3	1.159	16.562	57.666	1.159	16.562	57.666	1.179	16.842	57.490
4	1.044	14.919	72.585	1.044	14.919	72.585	1.057	15.095	72.585
5	.770	10.993	83.578						
6	.696	9.947	93.525						
7	.453	6.475	100.000						

Extraction Method: Principal Component Analysis.

Table 13: Component Matrix[a]

	Component			
	1	2	3	4
Age	.853			
Perceived animation efficiency	.845			
Perceived animation utility		.682		
Gender		.660		
PQOA			.547	
Perceived ease of use				
Perceived animation compatibility				.917

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

Table 14: Rotated Component Matrix[a]

	Component			
	1	2	3	4
Age	.873			
Perceived animation efficiency	.843			
Gender		.767		
Perceived animation utility		.723		
Perceived ease of use			.755	
PQOA				
Perceived animation compatibility				.936

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 6 iterations.

7 LIST OF FIGURES

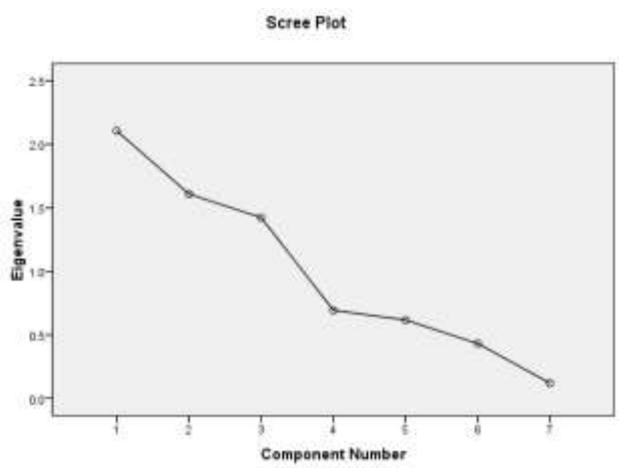

Figure 1: Pilot study scree plot

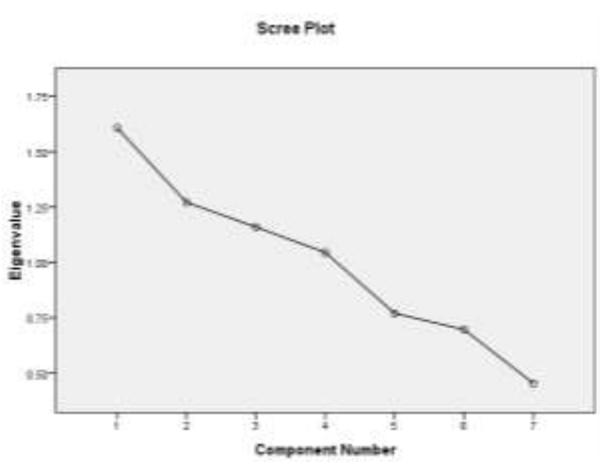

Figure 2: Second round data scree plot

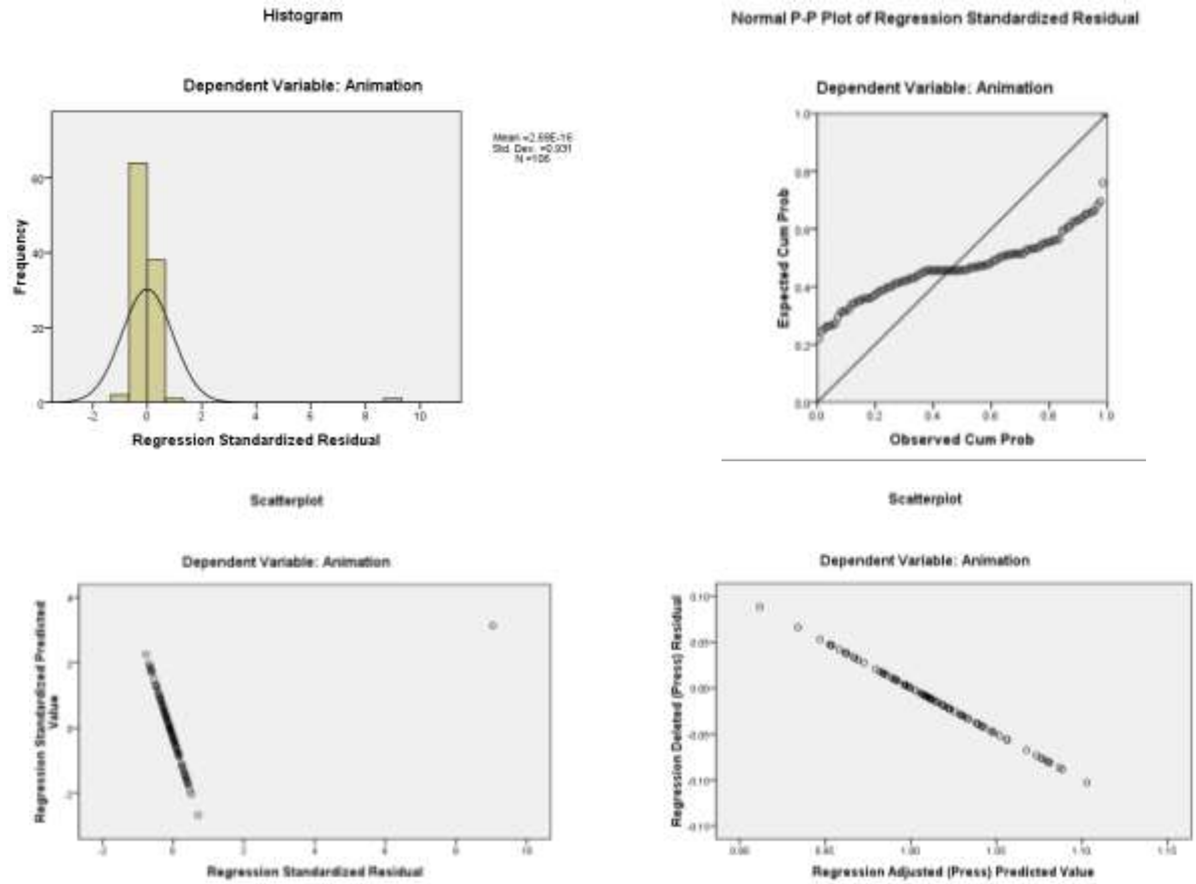

Figure 3: Histograms and normal P–P plots of normally distributed residuals