

CHAPTER V

IMPLEMENTATION AND SOFTWARE TESTING

5.1 Implementation

According to TechTarget (2000), *implementation is the carrying out, execution, or practice of a plan, a method, or any design for doing something.* As such, *implementation is the action that must follow any preliminary thinking in order for something to actually happen.* In an information technology context, implementation encompasses all the processes involved in getting new software or hardware operating properly in its environment, including installation, configuration, running, testing, and making necessary changes. The word deployment is sometimes used to mean the same thing.

5.1.1 Programming Language

The main programming language used for the implementation of Data Analysis software is PHP, a server-side scripting language designed for web development, utilizing Flat File as its database.

5.1.2 Hardware and Software Specifications

The hardware and software specifications used for implementation and later testing are as follows:

1. Processor Intel Core i3-2330M 2.2 GHz
2. Memory 2 GB
3. OS Linux Mint 17 "Qiana"

5.2 Software Testing

According to Pan (1999), *software testing is any activity aimed at evaluating an attribute or capability of a program or system and determining that it meets its required results.*

The process of software testing can be observed in the figures below:

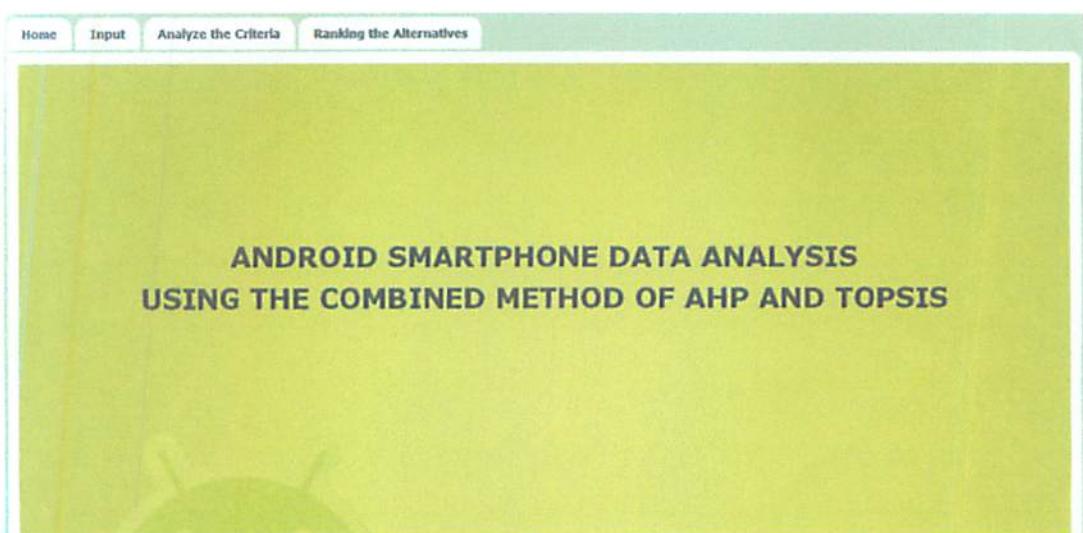


Figure 5.1 Starting Page/Home SS (Screen Shot)

When the “Input” button is pressed, the input page will be displayed as shown below:

Input

Name					
Price in Rupiah	> 3.00 million	3.51 - 3.00 million	2.61 - 2.50 million	1.51 - 2.00 million	< 1.51 million
Android OS Version	< 4.1	4.1	4.2	4.3	> 4.3
Screen	< 4.3 inches	4.3 inches	4.5 inches	4.7 inches	> 4.7 inches
Resolution	< 850x480 pixels	850x480 pixels	960x640 pixels	720x1280 pixels	> 720x1280 pixels
Primary	< 5 MP	5 - 8 MP	> 8 MP		
Secondary	none	0.3 MP (VGA)	> 0.3 MP		
Processor Cores	< 2 cores	2 cores	> 2 cores		
Memory	Internal	4 GB	0 GB	> 4 GB	
RAM	< 512 MB	512 MB	768 MB	1 GB	> 1 GB
Battery Capacity	< 1500 mAh	1500 - 1750 mAh	1751 - 2000 mAh	2001 - 2250 mAh	> 2250 mAh

ADD**EDIT****Alternative Specifications**

No	Alternative	Price	Version	Screen	Resolution	Cameras	Processor	Memory	Internal	RAM	Battery	Delete Row
1	SAMSUNG Galaxy Grand	> 3.00 million	4.1	> 4.7 inches	850x480 pixels	5 - 8 MP / > 0.3 MP	2 cores	8 GB	1 GB	2001 - 2250 mAh	DELETE	
2	LENOVO S920	> 3.00 million	4.2	> 4.7 inches	720x1280 pixels	5 - 8 MP / > 0.3 MP	> 2 cores	8 GB	1 GB	> 2250 mAh	DELETE	
3	LG G2 Mini	> 3.00 million	> 4.3	4.7 inches	960x640 pixels	5 - 8 MP / > 0.3 MP	> 2 cores	8 GB	1 GB	> 2250 mAh	DELETE	
4	X-TOUCH Octa Core	> 3.00 million	4.3	> 4.7 inches	720x1280 pixels	> 8 MP / > 0.3 MP	> 2 cores	8 GB	> 1 GB	1751 - 2000 mAh	DELETE	

Empty Database**Figure 5.2 Input SS**

Data that has been inputted will be displayed in the “Alternative Specifications” table.

“Delete” button will delete the row where the button is located while “Empty Database” button will delete the entire database.

When the “Analyze the Criteria” button clicked, the page as in the figure 5.3 below will be displayed.

Using AHP to Analyze the Criteria

After the criteria and alternatives identified, AHP will be used to analyze the criteria and determine its weight.

Create the Pairwise Comparison Matrix for the Criteria**Figure 5.3 AHP 1 SS**

Click the “Create the Pairwise Comparison Matrix for the Criteria” button to continue with the AHP method.

Home Input Analyze the Criteria Ranking the Alternatives

Shatty's 9-Point Scale

The pairwise comparison matrix in AHP uses the Shatty's 9-point scale as the fundamental scale for assigning the numerical scale values to the pairwise comparison matrix.

Criteria	1	2	3	4	5	6	7	8	9
1	None								
2	Weak Dependence	Two activities have equal contribution to the objective.							
3	Strong Dependence	Experience and judgment slightly favor one activity over another.	Experience and judgment highly favor one activity over another.						
4	Very Strong or Dominated dependence	An activity is favored very strongly over another.							
5	Extreme importance	The evidence favoring one activity over another is at the highest possible order of estimation.							
6	For comparison between the above values	Sometimes one needs to independently compare different numbers.							

Pairwise Comparison Matrix for the Criteria

The pairwise comparison matrix participants answer it through a sequence of pairwise comparisons to assign the values of numerical scale from the measurement of ratios. The criteria compared pairwise is how important is the alternative.

Criteria	Price	Version	Screen	Camera	Processor	Memory	Internal RAM	Battery	Column Sum
Price	1	3	3	5	7	9	7	3	5
Version	3	1	3	5	7	9	7	1	5
Screen	3	3	1	7	9	9	9	3	5
Resolution	5	3	0.3333	1	7	9	9	3	5
Camera	5	2	0.1429	0.1429	1	3	0.3333	0.3333	0.3333
Primary	2	0.5	0.1429	0.1429	3	1	0.3333	0.3333	0.3333
Secondary	0.5	0.2	0.3333	0.3333	0.3	1	0.1429	0.1429	0.2
Processor	0.2	0.2	0.2	0.2	1	3	7	1	5
Internal	0.2	0.2	0.2	0.2	3	1	0.3333	0.3333	0.3333
RAM	0.2	1	5	5	7	1	3	1	5
Battery	0.2	0.2	0.2	0.2	0.2	5	1	0.3333	0.3333
Column Sum	0.9526	0.33	0.12	0.1223	45.2	63	23.8225	42.4761	27.2833

Figure 5.4 AHP 2 SS

Home Input Analyze the Criteria Ranking the Alternatives

Normalized Pairwise Comparison Matrix

To normalize the pairwise comparison matrix, each element will be divided by the total value of each column of the pairwise comparison matrix table.

		Price	Version	Screen	Camera	Processor	Memory	Internal RAM	Battery	Row Sum
Criteria		Price	Version	Screen	Camera	Processor	Memory	Internal RAM	Battery	
Screen	Price	0.3337	0.4739	0.3285	0.2485	0.1548	0.1323	0.2094	0.1647	0.413
	Version	0.1112	0.1579	0.3285	0.2485	0.1548	0.1323	0.2094	0.1647	0.1376
	Size	0.1112	0.0526	0.1095	0.1493	0.1548	0.1323	0.2094	0.1647	0.1376
	Resolution	0.0667	0.0315	0.0365	0.0497	0.1548	0.1323	0.1256	0.1177	0.0275
Camera	Primary	0.0476	0.0225	0.0156	0.007	0.0221	0.0735	0.0139	0.0078	0.0196
	Secondary	0.037	0.0175	0.0121	0.0055	0.0044	0.0147	0.0083	0.0033	0.0152
	Processor	0.0667	0.0315	0.0219	0.0165	0.0663	0.0735	0.0418	0.0706	0.0458
	Internal	0.0476	0.0225	0.0156	0.0099	0.0663	0.1029	0.0139	0.0235	0.0196
Memory	RAM	0.1112	0.1579	0.1095	0.2485	0.1548	0.1323	0.1256	0.1647	0.1376
	Battery	0.0667	0.0315	0.0219	0.0165	0.0663	0.0735	0.0418	0.1177	0.0458

Figure 5.5 AHP 3 SS

The AHP method continued until the “Weight of Criteria” table obtained as shown in the figure 5.6 below.

Weight of Criteria

After each row total is obtained, the next step is to calculate the weight of each criterion by dividing each row total with the number of criteria.

$$\text{Weight of criterion } i = \frac{\text{Row Total}_i}{\text{number of criteria}}$$

Criteria	Weight
Price	0.2669
Version	0.1855
Screen	0.1431
Resolution	0.0868
Camera	0.0243
Processor	0.0126
Memory	0.0476
RAM	0.033
Battery	0.1468
	0.0523

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Figure 5.6 AHP 4 SS

When the “Ranking the Alternatives” button clicked, the page as in the figure 5.7 below will be displayed.

Using TOPSIS to Ranking the Alternatives

TOPSIS will be used to ranking the inputted alternatives.

[Determine the Criteria Score](#)

Figure 5.7 TOPSIS 1 SS

Click the “Determine the Criteria Score” button to continue with the TOPSIS method.

Criteria Score

The criteria score will be used as the reference for the conversion of the specification data into the decision matrix.

Criteria	Data Specification	Weight of Score	Explanation
Price	> 3.0 million	1	Very Poor
	2.6 - 3.0 million	2	Poor
	2.1 - 2.3 million	3	Fair
	1.6 - 2.0 million	4	Good
	< 1.6 million	5	Very Good
	< 4.1	1	Very Poor
Version	4.1	2	Poor
	4.2	3	Fair

Alternative Specifications

The identified alternative specifications that will be converted to the decision matrix.

No	Alternative		Price	Version	Screen		Camera		Memory		Battery	
No	Alternative		Price	Version	Size	Resolution	Primary	Secondary	Processor	Memory	RAM	Battery
1	SAMSUNG Galaxy Grand	> 3.0 million		4.1	> 4.7 inches	480x800 pixels	3 - 8 MP	> 0.3 MP	2 cores	8 GB	1 GB	2001 - 2250 mAh
2	LENOVO S930	> 3.0 million		4.2	> 4.7 inches	720x1280 pixels	3 - 8 MP	> 0.3 MP	> 2 cores	8 GB	1 GB	> 2250 mAh
3	LG G2 Mini	> 3.0 million		4.3	4.7 inches	540x960 pixels	3 - 8 MP	> 0.3 MP	> 2 cores	8 GB	1 GB	> 2250 mAh
4	K-TOUCH Octa Core	> 3.0 million		4.2	> 4.7 inches	720x1280 pixels	> 8 MP	> 0.3 MP	> 2 cores	> 8 GB	> 1 GB	1751 - 2000 mAh
5	LENOVO S820 8 GB	> 3.0 million		4.2	4.7 inches	720x1280 pixels	> 8 MP	> 0.3 MP	> 2 cores	8 GB	1 GB	1751 - 2000 mAh
6	SAMSUNG Galaxy Grand Neo	2.31 - 3.0 million	4.2	> 4.7 inches		480x800 pixels	3 - 8 MP	0.3 MP(VGA)	> 2 cores	8 GB	1 GB	2001 - 2250 mAh
7	SAMSUNG Galaxy S3 mini	2.31 - 3.0 million	4.1	< 4.3 inches		480x800 pixels	3 - 8 MP	0.3 MP(VGA)	2 cores	8 GB	1 GB	< 1501 mAh

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The decision matrix referring to the alternatives that is evaluated based on the criteria.

No	Alternative	Price	Version	Screen		Camera		Processor	Memory		Battery
				Size	Resolution	Primary	Secondary		Internal	RAM	
1	SAMSUNG Galaxy Grand	1	2	5	2	3	5	3	3	4	4
2	LENOVO S930	1	3	5	4	3	5	5	3	4	5
3	LG G2 Mini	1	5	4	3	3	5	5	3	4	5
4	K-TOUCH Octa Core	1	3	5	5	5	5	5	5	5	3
5	LENOVO S820 8 GB	1	3	4	4	5	5	5	3	4	3
6	SAMSUNG Galaxy Grand Neo	2	3	5	2	3	3	5	3	4	4
7	SAMSUNG Galaxy S3 mini	2	2	1	2	3	3	3	3	4	1

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Normalized Decision Matrix

The purpose of normalization of the decision matrix is to minimize the distance(range) of data, in order to facilitate the calculation of TOPSIS and save on memory usage.

No	Alternative	Price	Version	Screen Size	Resolution	Camera Primary	Camera Secondary	Processor	Memory Internal	RAM	Battery
1	SAMSUNG Galaxy Grand	0.0375	0.1098	0.2085	0.1045	0.1437	0.1818	0.1154	0.2023	0.1704	0.1754
2	LENOVO S930	0.0375	0.1646	0.2085	0.2091	0.1437	0.1818	0.1923	0.2023	0.1704	0.2193
3	LG G2 Mini	0.0375	0.2744	0.1660	0.1560	0.1437	0.1818	0.1923	0.2023	0.1704	0.2193
4	K-TOUCH Octa Core	0.0375	0.1646	0.2095	0.2614	0.2395	0.1818	0.1923	0.3371	0.2130	0.1316
5	LENOVO S620 8 GB	0.0375	0.1646	0.1665	0.2091	0.2395	0.1818	0.1923	0.2023	0.1704	0.1316
6	SAMSUNG Galaxy Grand Neo	0.0751	0.1646	0.2085	0.1045	0.1437	0.1091	0.1923	0.2023	0.1704	0.1754
7	SAMSUNG Galaxy S3 mini	0.0751	0.1098	0.0417	0.1045	0.1437	0.1091	0.1154	0.2023	0.1704	0.0439

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Figure 5.10 TOPSIS 4 SS

Weight of Criteria

TOPSIS uses the weight of criteria to calculate the weighted normalized decision matrix.

Criteria	Weight
Price	0.1669
Version	0.1639
Screen	0.1442
Resolution	0.1928
Camera Primary	0.2549
Camera Secondary	0.0118
Processor	0.2476
Memory Internal	0.0118
RAM	0.1448
Battery	0.0339

Weighted Normalized Decision Matrix

The weighted normalized decision matrix is calculated by multiplying each column of the normalized decision matrix by its associated weight and shown in the weighted normalized matrix.

No	Alternative	Price	Version	Screen	Resolution	Camera Primary	Camera Secondary	Processor	Memory Internal	RAM	Battery
1	SAMSUNG Galaxy Grand	0.0152	0.0269	0.0168	0.0091	0.0188	0.0269	0.0207	0.0269	0.0269	0.0168
2	LENOVO S930	0.0152	0.0269	0.0168	0.0091	0.0188	0.0269	0.0207	0.0269	0.0269	0.0168
3	LG G2 Mini	0.0152	0.0269	0.0168	0.0091	0.0188	0.0269	0.0207	0.0269	0.0269	0.0168
4	K-TOUCH Octa Core	0.0152	0.0269	0.0168	0.0091	0.0188	0.0269	0.0207	0.0269	0.0269	0.0168
5	LENOVO S620 8 GB	0.0152	0.0269	0.0168	0.0091	0.0188	0.0269	0.0207	0.0269	0.0269	0.0168
6	SAMSUNG Galaxy Grand Neo	0.0333	0.0269	0.0168	0.0091	0.0188	0.0269	0.0207	0.0269	0.0269	0.0168
7	SAMSUNG Galaxy S3 mini	0.0333	0.0269	0.0168	0.0091	0.0188	0.0269	0.0207	0.0269	0.0269	0.0168

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Figure 5.11 TOPSIS 5 SS

The positive and negative ideal solution are used to determine the distance between the value of each alternative.

$A^+ = \{(\max_{i \in I} v_{ij} - j \in J) (\min_{i \in I} v_{ij} - j \in J), i = 1, 2, 3, \dots, m\}$
$= \{v_1^+, v_2^+, v_3^+, \dots, v_n^+\}$
$A^- = \{(\min_{i \in I} v_{ij} - j \in J) (\max_{i \in I} v_{ij} - j \in J), i = 1, 2, 3, \dots, m\}$
$= \{v_1^-, v_2^-, v_3^-, \dots, v_n^-\}$
v_{ij} is an element of the weighted normalized decision matrix
$v_{ij}^+ \in J, i = 1, 2, 3, \dots, n$ is an element of the positive ideal solution
$v_{ij}^- \in J, i = 1, 2, 3, \dots, n$ is an element of the negative ideal solution
$J = \{j j = 1, 2, 3, \dots, n\}$ and J is a set of benefit criteria
$J^- = \{j j = 1, 2, 3, \dots, n\}$ and J^- is a set of cost criteria

Positive Ideal Solutions

Price	Version	Screen		Camera		Processor	Memory		Battery
		Size	Resolution	Primary	Secondary		Internal	RAM	
0.0501	0.0505	0.0298	0.0227	0.0058	0.0023	0.0092	0.0111	0.0313	0.0115

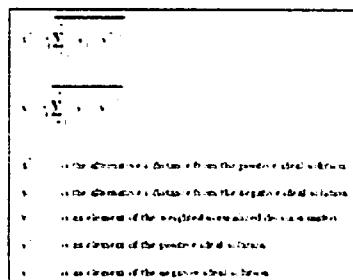
Negative Ideal Solutions

Price	Version	Screen		Camera		Processor	Memory		Battery
		Size	Resolution	Primary	Secondary		Internal	RAM	
0.0100	0.0102	0.0060	0.0043	0.0012	0.0005	0.0018	0.0022	0.0063	0.0023

Calculate the Separation Measure for Each Alternative from the Positive and Negative Ideal Solution

Figure 5.12 TOPSIS 6 SS

Separation measure is a measurement of the distance of an alternative to the ideal solution.



Separation from the Positive Ideal Solutions

No.	Alternative	Positive Separation
1	SAMSUNG Galaxy Grand	0.0352
2	LENOVO S820	0.0459
3	LG G3 mini	0.0433
4	HTC ONE M8 Corp	0.0431
5	LENOVO S820 8 GB	0.0404
6	SAMSUNG Galaxy Grand Neo	0.0397
7	SAMSUNG Galaxy S2 mini	0.0333

Separation from the Negative Ideal Solutions

No.	Alternative	Negative Separation
1	SAMSUNG Galaxy Grand	0.0337
2	LENOVO S820	0.0411
3	LG G3 mini	0.0359
4	HTC ONE M8 Corp	0.0400
5	LENOVO S820 8 GB	0.0373
6	SAMSUNG Galaxy Grand Neo	0.0365
7	SAMSUNG Galaxy S2 mini	0.0348

Figure 5.13 TOPSIS 7 SS

Relative Closeness to the Positive Ideal Solutions

$$C_i = \frac{S_i^-}{S_i^- + S_i^+}$$

C_i is the relative closeness from the alternative i to the positive ideal solution

S_i^- is the alternative-i distance from the positive ideal solution

S_i^+ is the alternative-i distance from the negative ideal solution

No.	Alternative	Relative Closeness
1	SAMSUNG Galaxy Grand	0.3888
2	LENOVO S930	0.4724
3	LG G2 Mini	0.5457
4	K-TOUCH Octa Core	0.5047
5	LENOVO S820 8 GB	0.4455
6	SAMSUNG Galaxy Grand Neo	0.5009
7	SAMSUNG Galaxy S3 mini	0.3211
8	LG G Pro Lite	0.4498
9	AXIOO Picoophone X1 GDS	0.4323

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[Ranking the Alternatives](#)

Figure 5.14 TOPSIS 8 SS

The TOPSIS method continued until the “Rank of the Alternatives” table obtained.

Rank of the Alternatives

By comparing the relative closeness values, the ranking of the alternatives are determined. The higher the value of relative closeness means the better the rank. The alternatives sorted or ranked from the closest value to 1 and in decreasing order. It means the best alternative have the shortest distance from positive ideal solution and the longest distance from the negative ideal solution.

Rank	Alternative	Relative Closeness
1	MITO A95	0.6639
2	MAXTRON Diamond	0.6445
3	K-TIO Fantasy Power A60	0.6216
4	LENOVO A659	0.6003
5	KITO A70	0.5950
6	MICRON PHONE i333	0.5770
7	SPC Mobile Arena	0.5657
8	K-TOUCH New S100	0.5597

Based on the result of combined method of TOPSIS and KETHOD, the best choice from all of identified alternatives is MITO A95.



TOPSIS is a well-known multi-criteria decision-making technique that uses the concept of relative closeness to the ideal solution to rank alternatives. It is based on the Euclidean distance between the alternatives and the positive and negative ideal solutions.

Figure 5.15 TOPSIS 9 SS

From the results shown in the “Rank of the Alternatives” table, the best choice from all of identified alternatives is MITO A95.