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Comparative Analysis of Prioritization Model Between AHP (Analytic Hierarchy Process) and ANP (Analytic Network Process) for Project Portfolio Management SI/IT Surabaya City Government

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Abstract

The rapid development of technology to meet the growing demands of projects, particularly in public administration organizations like e-government, faces various resource constraints. Selecting among dozens or even hundreds of alternative projects and portfolios, while aligning with organizational priorities, presents a complex multi-criteria decision-making challenge. This study explores the use of previous research and IS/IT portfolio management techniques to examine project prioritization practices and methods within successful city-level applications. The study further develops a prioritization model by comparing the Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP) methods. The priority levels of nodes (elements) and clusters obtained from the AHP and ANP analyses show relatively insignificant differences; however, the normalized values (eigenvectors) derived from the ANP approach more realistically reflect existing realities. The ANP model offers the advantage of building connections between elements and clusters, enabling feedback analysis, and is considered more effective in bridging the gap between the model and real-world decision-making.

I. INTRODUCTION

The development of information and communication technology (ICT) has become a global trend whose impact extends to almost all areas of people's lives in the world. One form of positive impact from the development of ICT is the emergence of internal digitalization systems administration of government known as Electronic Government (e-Government). Based on data from the Ministry of Communication and Information website, it is known that of the 32 Provinces which oversee 439 District or City Governments, there are 225 regional government Websites (48% of the total Regional Government) and 200 active Sites (89% of the Total Sites [1]. This e-Government can encourage easy access to information by the public to government services, as well as increasing transparency and accountability of institutions in the public sector [2]. From several previous studies, one of the results of implementing E-Government is improving

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the quality and accessibility of public services through administering public services online. Every citizen can easily access and request public services through an online-based application that is connected to the internal system of the relevant agency.

II. RELATED WORKS

Review of Previous Research

According to Simon, the APM (Application Portfolio Management) framework can reduce the level of complexity of application landscapes. From the processes included in the APM it is possible to provide space to handle modified assessment techniques. According to Maya Previana Syafitri, based on the results of the proposed online-based public service application portfolio management flow, there are 3 processes, namely: data collection, selection and prioritization and execution and supervision. The selection and prioritization methods are supported by assessment tools, namely strategic aspect assessment tools and technical aspect assessment tools. According to Soetjipto, the results of completing the weighting of criteria for assessing public service applications using the AHP method. Based on this research, there is a preparation of analysis in a conceptual model by filtering public services and producing an assessment of prioritized services.

According to Tantri, decision making on priority development regarding recommendations for administrative public service assessment tools is carried out by a combination of three aspects (Regional Head, Bappeko and Dinkominfo). Completion of prioritization using the QSPM (Quantitative Strategic Planning Matrix) method. Then the results of each prioritization will be compared. However, QSPM has weaknesses in the form of dependence on intuitive judgment and expert assumptions.

Assessment Framework using AHP and ANP Methods

The ANP is a general theory of relative measures used to derive joint priority relationships from individual proportional scales that reflect the relative size of the influence of interacting elements on control criteria [3]. ANP is a mathematical theory that can be used to realize dependency and feedback systems that can capture and relate tangible and intangible factors (Aziz, 2003).

The seven main pillars of AHP are: (1) comparative scaling, (2) pairwise scaling, (3) conditional sensitivity of eigenvectors, (4) group similarity and data clustering, (5) synthesis, (6) order reversal and immutability, and (7) consideration from the group. These seven pillars of AHP are the starting point of ANP. ANP provides a general framework for decision processing without making assumptions about the independence of higher level elements [3]. Considerations with ANP require a model that represents the relationship between criteria and their subcriteria. There are two control elements to consider when modeling a system whose weights must be known. The first control is a hierarchical control that shows the relationship between conditions and their subconditions. This control does not require a hierarchical structure like the AHP method.

Prof. Thomas Lorie Saaty from Wharston Business School has developed the Analytic Hierarchy Process (AHP) method to find the ranking or priority order of various ways to solve problems. A person always has to make different choices in his daily life, it is necessary to set priorities and test the consistency of the choices made. Making decisions in difficult situations is not influenced by a single factor, but by several factors, and involves different levels and interests.

Basically, AHP is a general measurement theory used to find a good ratio scale for discrete, and not continuous, pairwise comparisons. These comparisons can be made from basic scales reflecting the relative strength of emotions and preferences or from actual measurements.

AHP pays close attention to consistency, measurement, and reliability deviations within and outside a group of structural elements. Analytical Hierarchy Process (AHP) has an axiomatic foundation consisting of:

1. Reciprocal comparison, meaning that the pairwise comparison matrix formed must be reversed. For example, if A is k times more important than B, then B is 1/k times more important than A.
2. Homogeneity, meaning similarity in making comparisons. For example, a volleyball ball is not comparable to a watermelon in terms of taste, but it will be more important in terms of weight.

3. Dependency, meaning that each level has a relationship (complete hierarchy), even though the relationship may not be perfect (incomplete hierarchy).
4. Expectations, which means emphasizing important expectations and preferences. Evaluation can take the form of quantitative and qualitative information.

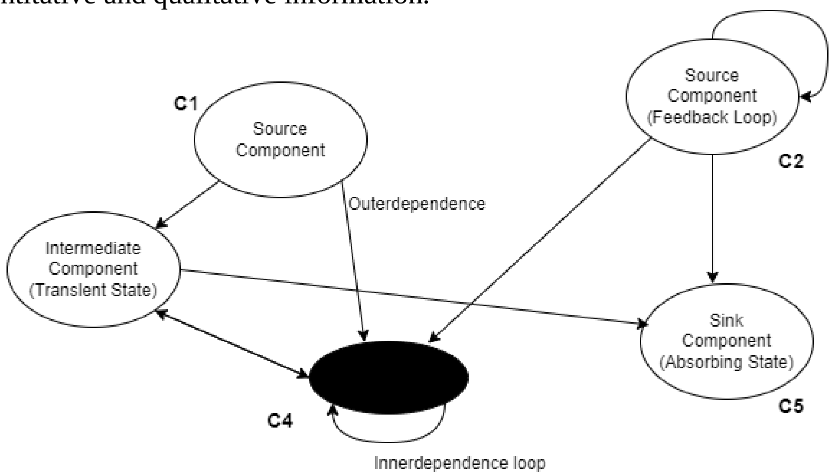

Figure 1. Analytic Network Process (ANP) Framework

III. METHODS

Research Questions

Based on the gap that is the background of the research, the big question that wants to be answered through this research is "what kind of application of e-government standards is needed for prioritization and development sequence that makes the e-government system at the city regional government level successful?" To clarify in more detail, the formulation of the problem in this research is described as follows:

RQ1: What are the factors considered in prioritization to determine the appropriate criteria for the application of government information system technology (E-Government) at the successful city level in Surabaya?

RQ2: How to develop a more effective and efficient generic prioritization model to prioritize government applications (E-Government) at the successful city level in Surabaya?

AHP and ANP are decision support methods developed by Thomas L Saaty [5]. ANP is a system with a feedback approach used to evaluate dynamic multidirectional relationships between decision attributes. ANP is a solution to overcome the limitations of the previous method, namely AHP (Analytical Hierarchy Process). ANP has advantages related to not all problems that can be prioritized due to dependencies (internal/external), as well as interactions between and within clusters (criteria and alternatives) [6] [7].

Design of AHP and ANP Structure Models

In this study, AHP and ANP are designed in three steps, namely: (i) defining the relationship in the Linear Hierarchy in Figure 2(a) and the Feedback Network in Figure 2(b), (ii) creating a pairwise comparison matrix between criteria; and (iii) developing a solution algorithm by synthesizing between criteria, subcriteria and alternatives. Specifically, the solution algorithm in ANP consists of: (a) creating an unweighted supermatrix by entering all the relative importance weights resulting from pairwise comparisons (eigenvectors) into a supermatrix; (b) adjusting the values in the weighted supermatrix so that a stochastic column is achieved (weighted supermatrix), and (c) creating a limiting supermatrix by continuously squaring the supermatrix until the numbers in each column in one row are the same (stable), then the limiting supermatrix is normalized to obtain the final value of the criteria being compared. The paired comparison scale in AHP and ANP is carried out following the provisions as presented in Table 1. [6]

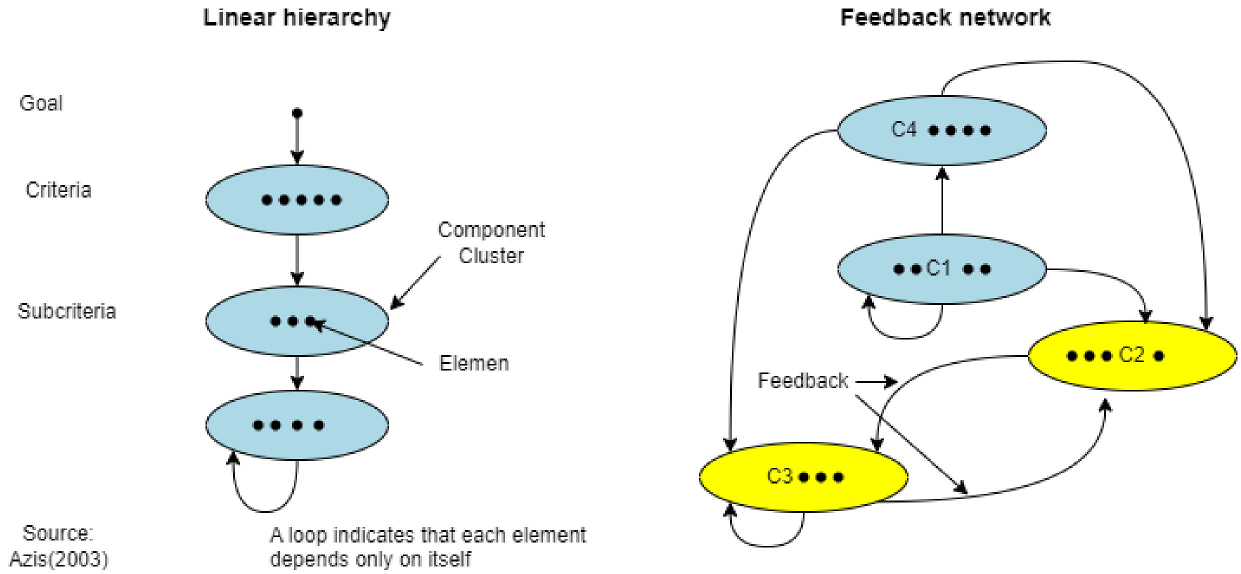

Figure 2. AHP (a) and ANP (b) structural models

Implementation of Modeling with the AHP Method

The following is the calculation of the AHP algorithm method to determine the Priority of Public Service Applications involving 10 criteria of Determining Factors with 21 Subcriteria and 7 Alternative Application Identity Groups:

1. Criteria of Determining Factors (JPA: Type of Application Development, JPL: Number of Service Users, KDPP: Compliance with the Central Government, KDPPK: Compliance with City Development Priorities, KPA: Complexity of Application Development, KSTSPL: Availability of IT Human Resources of SKPD Service Providers, KTYD: Availability of Required Technology, MA: Application Benefits, PIDES: Potential Integration with Existing System, RTP: Public Relations)
2. Subcriteria consist of: JPA (New, Update), JPL (Low, Medium, High), KDPP (No, Appropriate), KPA (Low, Medium, High), KSTSPL (None, Available), KTYD (Not Yet, Available), MA (Less, Somewhat, Very), PIDES (Not Yet, Ready), RTP (G2B, G2C).
3. Alternative Application Groups (IS: Infrastructure, KSM: Community Social Welfare, PK: Health Services, PLH: Environmental Management, PP: Education Services, RB&PLP: Bureaucratic Reform & Public Service Improvement, LP: Licensing Services).

This information is then modeled to form a multilevel tree as in Figure 3, then processed to determine the relative ranking of the existing alternative choices. Criteria of qualitative and quantitative types can be compared using informed judgment to calculate weights and priorities. From the data provided by [6] the weights and priorities of the Determining Factors are already known, so a questionnaire is made by referring to the results that have been obtained, to verify the results by conducting interviews. The following is a multilevel tree consisting of GOAL, CRITERIA, SUB-CRITERIA and ALTERNATIVES, as in Figure 3. The relative importance of the existing criteria can be determined, especially by determining the ranking of the criteria that will be carried out by evaluating the criteria. In an AHP-based system, this judgment is given by the system user and is carried out when the user intends to carry out the AHP process and see recommendations. For example, to determine the level of importance of the determining factors:

1. JPL (Type of Application Development) is EXTREMELY important than JPA (Number of Service Users).

2. KDPP (Compliance with Central Regulations) is QUITE important than JPA (Number of Service Users).
3. RTP (Public Relations) is VERY important than KPA (Complexity of Application Development)

Furthermore, with pairwise comparison, the level of importance of one criterion compared to another can be expressed, as in the example in Table 1. From the judgment above, Table 2 can be made for pairwise comparison by giving values 1 to 9 as follows:
1: Same; 3: Somewhat; 5: Very; 7: Extra; 9: Super
With values 2, 4, 6, 8 being intermediate values, and values 1/3, 1/5, 1/7, 1/9 being opposite values, and ½, ¼, 1/6, 1/8 being intermediate values.

Table 1. Criteria, Subcriteria and Application Prioritization Alternatives

Number	*Determining Factor Criteria*	*Sub Criteria*	*Alternative*
1	JPA	1. Baru, 2. Pembaruan	1. IS
2	JPL	1. Low, 2. Medium, 3. High	2. KSM
3	KDPP	1. Sesuai, 2. Tidak	3. LP
4	KDPPK	-	4. PK
5	KPA	1. Rendah, 2. Sedang, 3. Tinggi	5. PLH
6	KSTSPL	1. Ada, 2. Tidak Ada	6. PP
7	KTYD	1. Belum, 2. Tersedia	7. RBDPLP
8	MA	1. Agak, 2. Kurang, 3. Sangat	
9	PIDES	1. Belum Ada, 2. Siap	
10	RTP	1. G2B, 2. G2C	

Table 2. Questionnaire Results on JPA Factors

Pairwise Comparison of JPA Factors																		
Object A	9	8	7	6	5	4	3	2	1	½	1/3	¼	1/5	1/6	1/7	1/8	1/9	Object B
														V				JPA
											V							KDPP
													V					KDPPK
JPA										V								KPA
						V												KSTSP
																		L
							V											KTYD
															V			MA
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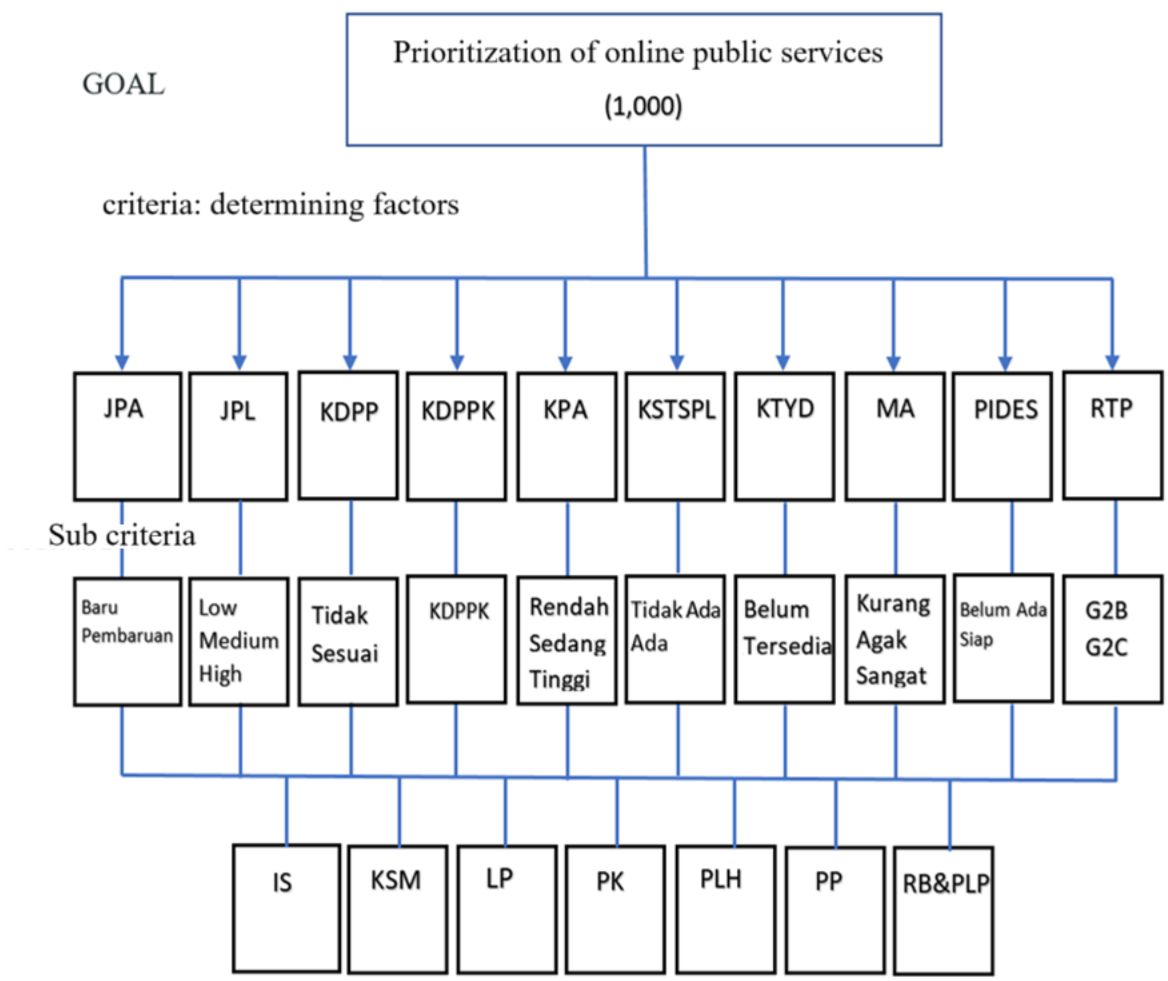

Figure 3. Multilevel Tree with Criteria, Subcriteria and Alternatives

The assignment of values from this paired comparison is left to the respondents to give their opinions, but if the values given by the respondents are inconsistent, then these values are corrected so that the inconsistency parameter is below 10% so that it can be said that the value data is consistent for further processing.

IV. RESULTS AND DISCUSSIONS

The results of this study include the results of each component of the criteria in AHP and ANP as well as the results of prioritization of online public service applications. Public service assessment is carried out using a public service assessment tool. The assessment tool is a tool used at this stage. The assessment tool that is compiled consists of assessment criteria and assessment entry categories. The assessment criteria used in compiling the assessment tool are criteria from the results of mapping the criteria in previous studies and are adjusted to the conditions of the case study. Each assessment criterion has a weight and assessment indicators. The weight of each criterion is determined using the AHP and ANP methods [9] [12] [13]. From the results of the priority calculations above, both using the AHP and ANP methods, a comparison table can be made of the two methods, to see the comparison of the weights produced by the two methods, thus proving that both have different calculations in their weights, but still show the same priority order results as shown in Table 3 and Table 4 below.

Table 3. Comparison of the results of the priority of the Determining Factors with AHP and ANP

Number	AHP Method Factors Name	Weight	Number	ANP Method Factors Name	Weight
1	MA	0.2820	1	MA	0.2240
2	JPL	0.1953	2	JPL	0.1662
3	KDPPK	0.1440	3	KDPPK	0.1260
4	KDPP	0.1155	4	KDPP	0.1130
5	RTP	0.1240	5	RTP	0.0979
6	KPA	0.0488	6	KPA	0.0686
7	JPA	0.0342	7	JPA	0.0588
8	PIDES	0.0244	8	PIDES	0.0523
9	KTYD	0.0178	9	KTYD	0.0479
10	KSTSPL	0.0139	10	KSTSPL	0.0453

Table 4. Comparison of the results of the priority of the Applications with AHP and ANP

Number	AHP Method Application Name	Weight	Number	ANP Method Application Name	Weight
1	PP	0.2466	1	PP	0.3219
2	PK	0.2127	2	PK	0.2404
3	KSM	0.1915	3	KSM	0.1644
4	RB&PLP	0.1264	4	RB&PLP	0.1079
5	LP	0.0882	5	LP	0.0643
6	IS	0.0845	6	IS	0.0631
7	PLH	0.0502	7	PLH	0.0380

V. CONCLUSIONS AND RECOMMENDATIONS

The The priority levels of nodes (elements) and clusters obtained from the results of the AHP and ANP analyses are relatively insignificant between the two, however, the normalization value (eigenvector) of the ANP approach is more realistic with the existing reality, because the model provides opportunities to build connections between elements with clusters and conduct feedback analysis. Therefore, the ANP method is considered capable of bridging the gap between the model and the reality encountered in the decision-making process. Cluster/criteria comparison the results of the pairwise comparison analysis using the AHP approach showed that the most dominant criteria considered in the application priority were the Application Benefits (MA) and Number of Service Users (JPL) criteria with weights of 0.2820 and 0.1953. Cluster/criteria comparison the results of the pairwise comparison analysis using the ANP approach showed that the most dominant criteria considered in the priority of the Determining Factors were the Application Benefits (MA) and Number of Service Users (JPL) criteria with weights of 0.2240 and 0.1662.

VI. ACKNOWLEDGMENTS

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