An Application of the AHP to Urban Residential Upgrading in Jakarta

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Abstract
This paper presents an application of the analytic hierarchy process (AHP) in building consensus among experts on the choice of urban residential upgrading schemes in Jakarta, Indonesia. Questionnaires were administered to both international and Indonesian experts involved in residential upgrading in our study area. Given the goal of urban residential improvement, they were asked to weigh such alternatives as multi-storey housing (MS), single-detached housing (SD), and Kampung Improvement Program (KIP) based on such criteria as tenure, floor area, accessibility to work place, accessibility to transportation and lifestyle. It was found that accessibility to work place was the most important criterion while multi-storey housing was the single most preferred housing improvement scheme contrary to the popular program (KIP) promoted by international aid agencies.

Keywords: Urban Residential Upgrading; Analytic Hierarchy Process (AHP); Kampung Improvement Program (KIP)

1. Introduction
Jakarta is the capital and the largest city of Indonesia, and is the commercial and administrative center of the country with an area of about 661.52 square kilometers. The city is urbanizing very rapidly at the rate of two per cent annually (Central Bureau of Statistics, 1997). Urbanization in Jakarta is primarily a result of population, that has been growing at about two per cent (Central Bureau of Statistics, 1998) rather than technological or industrial development, with over half of the population growth due to net immigration from other parts of Indonesia. These population influxes have led to the development of low-income marginal settlements popularly referred to as kampungs.

International financial institutions such as the World Bank, the Asian Development Bank and aid agencies such as Japan International Cooperation Agency and the Japan Bank for International Cooperation in collaboration with the Government of Indonesia have been implementing urban residential upgrading schemes in Jakarta as well as in other cities in response to this problems. The focus of this assistance is the provision of both financial and technical assistance to programs aimed at improving the urban environment. Among such programmes are the construction of multi-storey housing, site and services with single-detached housing, and the Kampung Improvement Program (KIP).

Objective of the research
Given the goal of urban residential upgrading in Jakarta, a subject that has attracted the attention of researchers in recent years (Ishizaka et al., 1997, and Shibata et al. 1995), this paper examines the most viable alternatives among multi-storey housing, single-detached housing, and KIP reviewed in these studies. We also examine the most important criteria and search for both consensus and variation in judgments in both the groups of international and Indonesian experts involved in urban residential upgrading schemes in the study area. Finally, we perform a sensitivity analysis to determine how changes in our variable criteria affect the findings of our study. To this end, a multi-criteria decision-making process is employed using the Analytic Hierarchy Process (AHP) developed by the mathematician Thomas L. Saaty at the Wharton School of the
University of Pennsylvania (1980, 1996) and applied by such authors as Yin et al. (1999) and Homma et al. (1998). We believe the AHP method is appropriate for building consensus among those involved in urban residential upgrading in Jakarta.

2. Research Background

Here we examine notable urban residential upgrading schemes embarked upon by various international financial institutions and aid agencies in collaboration with the Indonesian Government in urban residential upgrading in Jakarta.

The Kampung Improvement Program (KIP)

One well-known example of such international cooperation is the Kampung Improvement Program. The indigenous residential areas known as ‘kampungs’ are an important part of the landscape of Indonesian cities. The oldest kampungs originated as “urban” villages during the colonial period when residential separation between the Indonesian and non-Indonesian residents (including Chinese populations and Dutch settlers) were the dominant feature of urban agglomerations in the country. The term refers to predominately residential areas, which were often rural villages that have been engulfed by the rapid urban expansion and incorporated within the city. These “urban villages” which include middle-income as well as low-income families, are characterized by generally inadequate physical infrastructure and social services. They are usually over-crowded neighborhoods, often on land occupied without authorized tenure, and without minimum urban infrastructure such as drainage, piped water, and accessible road network (Figure 1). Their residents are often new migrants from the rural areas engaged in the informal sector of the economy.

The DKI Jakarta had been implementing a betterment project for the deteriorated kampung using their own funds. However, the Government picked up on such a physical infrastructure improvement project as a formal system called KIP in 1969 and started giving financial support. It was an attempt to meet minimum infrastructure needs of large numbers of urban poor at low cost. Since the government was unable to provide all the resources necessary to rebuild the kampungs, it then decided to concentrate its available resources on improvement of those physical infrastructures, which the people found most difficult or impossible to organize and construct themselves. Gradual improvement of the existing settlements through the provision of basic structures and services necessary to create a pleasant and healthy urban environment was then adopted as a strategy. It involved the provision of access roads, paved footpaths, drainage, piped water, sanitation facilities and public services (such as primary schools and clinics), while keeping the current residents on the same site as much as possible (Figure 2). KIP, however, did not involve improvement in individual residential structure. This was not only to minimize the project cost, but also to encourage private self-help initiatives and avoid getting involved in the sensitive issue of land tenure. KIP was the precursor of the IUIDP (Integrated Urban Infrastructure Development Program) that involved citizens’ participation, and financial assistance among others.

The first KIP project was started in 1969, the first year of the Five-Year Development Plan of the Republic of Indonesia (PELITA I), by an initiative of the City of Jakarta. By 1973, KIP projects upgraded
areas over 2,400 hectares, thereby providing various benefits to over 1.2 million residents. The World Bank was impressed by the cost-effectiveness of KIP and from 1971 extended loans for the implementation of more KIP projects in Jakarta and elsewhere in Indonesia.

By the end of the seventies, however, the limitation of the concept of KIP began to manifest itself. It became increasingly difficult to find project sites where land could be spared for common public services such as roads and footpaths in the over-crowded neighborhoods. Also, in spite of the efforts to encourage current residents to stay in the neighborhood, there has been an influx of relatively higher income groups (gentrification) into the kampungs as the quality of its environment improved. Due to the low-cost construction work, some early project sites started to show deterioration that required costly repair.

**Single-Detached Housing (SD)**

The National Urban Development Corporation (PERUMNAS) was established in 1974 as a new government agency to manage low-cost housing development. PERUMNAS was expected to behave like a private enterprise, while also supplying socialized housing to the people. It had to apply government standards, so that the houses could be considered adequate in terms of space allocation for neighborhood services among others. The establishment of PERUMNAS boosted the supply of single-detached low cost housing.

Low cost housing is defined as a single–storey house with a maximum floor size of 70 square meters, and a plot size of 54 square meters to 200 square meters. Low cost housing consists of large, small, and very low cost type, as well as ready to develop land. The large type low cost housing has a floor size ranging from 36 square meters to 70 square meters, while the small type ranges between 21 and 36 square meters. The very low cost type has a floor area of between 21 and 36 square meters but with unit construction costs about half of the large type. It has at least a bathroom, a toilet and a multi-function room (Figure 3). Although this type of housing is popular as it allows access to the ground in a way that many Indonesians are accustomed to, it is often located in areas far away from the work place of the residents on the periphery of the city in order to avoid high land price.

Other housing types are the medium and large housing types. Medium housing is a single-storey house having a plot size of between 54 and 600 square meters while the large housing type is between 54 and 2,000 square meters. This classification is based on the guidelines of the government (Decree No. 04/KPTS/BKP4N/1995). In order to promote balanced development it required formal developers to construct units in a ratio of six low cost units and three medium size houses for every large house.

**Multi-storey Housing (MS)**

The third program is the multi-storey or flat housing which has drawn the attention of many authors (Yokobori et. al., 1998 Morishige et al., 1994 Morishige et al., 1993 and Nagasawa et al., 1993). Multi-storey housing has been implemented in Indonesia since 1980 in order to fill the shortage of housing stock for low and middle-income people, particularly in the big cities.

The decision to build multi-storey housing was based on increasing the efficiency of urban land use, in the course of urban renewal programs in the big cities. Another consideration was the poor living conditions of people in the kampungs with extreme over-crowding. Based on these considerations, the government has made efforts to improve and renew their living environment and offer people the chance to live in such houses. It was started in 1980 when PERUMNAS constructed the first walk-up flats for low-income people in Kebon Kacang in central Jakarta (Figure 4). The development of multi-storey residential buildings has since become common in many Indonesian cities. However, many Indonesians believe that their
traditional family lifestyle cannot be sustained in multi-storey housing. This belief appears strong among recent migrants from the countryside to the cities.

3. The Analytic Hierarchy Process (AHP)

We employ the AHP to determine the importance of the above three housing types and their attributes (criteria) in relation to the goal of urban residential upgrading based on the assumption of their hierarchical relationship. A hierarchical structure of our problem is therefore constructed as follows:

Level 1. goal
Level 2. actors
Level 3. criteria
Level 4. alternatives in the study area

Our overall objective (level 1) is residential upgrading as shown in Figure 5, with level 2 consisting of the actors, divided into international aid agencies (INT) and Indonesian officials (IND). The priorities of international aid agencies relative to that of the Indonesian Government in urban residential upgrading in Jakarta are computed from the pairwise comparison (A1). We identified five criteria (level 3) distilled from literature on residential upgrading (Mukoko, 1997). They are tenure (TEN), floor area (FLA), accessibility to work place (ACW), accessibility to transportation (ACT), and lifestyle (LFS). Here, tenure refers to the ownership of a property associated with a parcel of residential land or housing while floor area is the total area of rooms in a dwelling used for living, sleeping, eating, etc. Accessibility to work place is the distance from home to the place of work and accessibility to transportation is defined as access to the primary network of roads. Lifestyle refers to traditional housing taste of the people.

Pairwise comparison (B1) indicates the priorities of the criteria by the international experts and B2 by the Indonesian experts. Three residential upgrading alternatives (level 4) were identified in the study area. They are multi-storey (MS), single-detached housing (SD) and KIP. C11 in figure 5 shows the priorities of the alternatives by the international experts with respect to tenure. C12 through C15 are the priorities for the alternatives with respect to floor area, accessibility to work place, accessibility to transportation, and lifestyle. C21 through C25 are the equivalent Indonesian priorities.

The Model

The formal model can be stated as follows: Suppose $A_1, A_2, ..., A_n$ be the set of elements and $w_1, w_2, ..., w_n$ be the importance of each element with respect to some attribute. Pairwise comparison score between elements $A_i$ and $A_j, a_{ij}^*$ can be defined as $a_{ij}^* = w_i/w_j$, or in the matrix form as shown below.

$$A^* = \left( a_{ij}^* \right) = \begin{pmatrix} w_1/w_1 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \cdots & w_2/w_n \\ \vdots & \vdots & \ddots & \vdots \\ w_n/w_1 & w_n/w_2 & \cdots & w_n/w_n \end{pmatrix}$$

By multiplication of matrix $A^*$ on the right hand side by the vector, $\mathbf{w}=(w_1, w_2, ..., w_n)^T$ becomes $\mathbf{nw}$. The resulting equation is given below:

$$(A^* - nI)\mathbf{w} = \mathbf{0} \quad (2')$$

Note that equation (2) is the characteristic equation of matrix $A^*$ and $n$ is the maximum eigen value.

The importance $w_i$ is supposed to be unobservable but pairwise comparisons of elements are possible with minimum errors. In other words, we have to estimate weight vector $\mathbf{w}$ from observed pairwise comparison matrix $A$. Because observed matrix $A$ contains inconsistency, equation (2) should be rewritten in a more relaxed form as:

$$(A - \lambda_{\text{max}}I)\mathbf{w} = \mathbf{0} \quad (2'')$$

Where $\lambda_{\text{max}}$ is a maximum eigen value. The weight vector $\mathbf{w}$ is estimated as an eigenvector with respect to the maximum eigen value. The inconsistency ratio (CR) is defined as:

$$\text{CR} = \text{CI}/\text{RI} \quad \text{where} \quad \text{CI} = \lambda_{\text{max}}^2 - n \over n - 1 \quad (3)$$

RI, Random Index, is defined in Saaty (1980).

Fig.5. Hierarchy of our problem
Survey Design

Questionnaires were administered to a total of 30 experts made up of 14 international and 16 Indonesian experts involved in urban residential upgrading schemes in the study area. These experts come from diverse international and national institutions such as the World Bank, the Asian Development Bank, Japan International Cooperation Agency, Government officials, and non-profit organizations but all are involved in urban residential upgrading in Jakarta.

Each expert made pairwise comparisons among the criteria in relation to the goal and among the alternatives in relation to the criteria. These evaluations were made on a scale of 1 to 9 based on the level of importance. 1 indicates equal importance, 3 moderate, 5 strong, 7 very strong and 9 extreme while other values lie in-between. The geometric means of all the respondents with respect to each question were then computed and are presented in the appendixes in matrix form. Matrix A1 represents the combined score of the responses of the 30 experts. While B1, C11 through C15 are the combined scores of the 14 International experts, matrices B2, C21 through C25 are the scores of the 16 Indonesian experts.

We ran our model using Expert Choice for Windows (Expert Choice Inc., 1995). The results of our analysis are presented in the following section of this paper.

4. Results

The results of the pairwise comparisons by the experts and estimated weightings by criteria are shown in the appendixes. All the inconsistency ratios of our analysis were less than the acceptable level of 0.14 (Saaty, 1980) as quoted by Kinoshita (2000).

The importance of international assistance to residential upgrading in Jakarta compared to the efforts of the Indonesian Government were weighted 0.583 and 0.417 respectively, indicating that...
international assistance to urban residential upgrading in Jakarta is slightly more favorably weighted. The priority scores are normalized to make the sum equal to unity (see appendix 1).

The priorities of the criteria with respect to our goal are as follows: tenure (0.159) floor area (0.077) accessibility to work place (0.451) accessibility to transportation (0.253) and lifestyle (0.061) as shown in figure 6. Accessibility to work place followed by accessibility to transportation are the two most weighted criteria among the five. This result indicates that transportation is vital in the life of many urbanizing cities as typified in this case by Jakarta city.

Given the three alternatives in urban residential upgrading in our study area, multi-storey housing is the most favored by all the experts (0.447) followed by single-detached housing (0.386) and KIP (0.166) (Figure 7). This is expected, as multi-storey housing is closely associated with the criterion of accessibility to work place.

In searching for variations and consensus in the views expressed by the two groups of experts, we found some slight variations and major areas of agreement by them. Criteria priorities with respect to the goal from the point of view of the international experts (appendix 2, B1) are tenure (0.155), floor area (0.082), accessibility to work place (0.446), accessibility to transportation (0.257), and lifestyle (0.060). For the Indonesian experts (appendix 3, B2) they are tenure (0.165), floor area (0.069), accessibility to work place (0.457), accessibility to transportation (0.247), and lifestyle (0.062). While accessibility to work place and transportation still remain the major criteria for both groups of experts, contrary to our expectation lifestyle was weighted rather evenly (0.060 and 0.062).

Among the three alternatives concerning urban residential upgrading in our study area, there was a consensus of opinion by the two groups of experts that multi-storey housing is the most viable scheme. Figure 8 shows the relationship between the criteria and the alternatives from the point of view of the two groups. The international experts with respect to tenure, floor area, accessibility to transport and lifestyle evaluate the multi-storey higher than the Indonesian group. The Indonesian experts with respect to most criteria prefer the single-detached housing while KIP is the choice of the international group with respect to all of the criteria.

Finally we performed sensitivity analyses to investigate the sensitivity of the alternatives to changes in the priorities of the criteria (Figures 9-13). There could be changes in the order of the alternatives as the priorities of some criteria are altered. While an increase in the priorities of tenure, floor area, accessibility to transport, and lifestyle in figures 9, 10, 12 and 13 makes single-detached housing the most attractive alternative, only a decline in accessibility to work place in figure 11 produces the same result. However, with an increase in importance of accessibility to work place, KIP then becomes the second most favored alternative after multi-storey housing.

By applying the sensitive analysis we are able to visualize policy options as the priorities of the criteria change.

5. Conclusion

This paper presents a novel approach to evaluating alternative urban residential housing schemes in an attempt to upgrade the deplorable housing situation in many parts of Jakarta city. We found the methodology employed (Analytic Hierarchy Process) quite appropriate in building consensus among those involved in the conception and implementation of such schemes. It was found that accessibility to work place and multi-storey housing were the most dominant criterion and alternative respectively in the search for appropriate urban residential upgrading schemes in metropolitan Jakarta. The usefulness of this study is however limited by the fact that the questionnaires were administered to experts rather than the residents who are the direct beneficiaries of urban residential upgrading schemes; hence we suggest this approach for future research.

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Endnote
1) Single-detached housing in this paper also includes duplex and row houses.

References
1) Central Bureau of Statistics (1998) Statistical yearbook of Indonesia
2) Central Bureau of Statistics (1997) Population, Migration and Urbanization in Indonesia. Intercensal population survey of 1995. (in Indonesian)
3) Decree on Housing of Indonesia No. 04/KPTS/BKP4N/1995
4) Expert Choice Inc. (1995) Expert Choice for Windows Version 9.0. Expert Choice Inc.
5) Hooma, R., Morozumi, M., and Iki, K. (1998) On the Development of the Landscape Evaluation System by Means of AHP: The consensus decision tool on the design stage of the large-scale project. Summaries of Technical Papers of Annual Meeting of AIJ, F-1, 571-572. (in Japanese)
6) Ishizaka, K., Hasegawa, H., and Yokobori, H. (1997) Statistical Analysis on Rental Housing Situation in Jakarta metropolitan Area. Journal of Architecture, Planning and Environmental Engineering (Transactions of AIJ), No.497, 179-186. (in Japanese)
7) Kinoshita, E. (2000) AHP no riron to jissai, Nikkagiren. (in Japanese)
8) Morishige, K. et al. (1993) A Study on “Multi Storey Dwellings” in Urban Housing Renewal in Jakarta Part 3: The maintenance of multi storey dwellings and its environment managed by the association of inhabitants. Summaries of Technical Papers of Annual Meeting of AIJ, F-29-30. (in Japanese)
9) Morishige, K. et al. (1994) A Study on “Multi Storey Dwellings” in Urban Housing Renewal in Jakarta Part 2: How multi storey dwellings built by public sector are used by the inhabitants. Summaries of Technical Papers of Annual Meeting of AIJ, F-383-384. (in Japanese)
10) Mukoko, S. (1997) The role of tenure security in housing self-improvement: A case-study of Surabaya, Indonesia. Review of urban and regional development studies, 9, 37-54
11) Nagasawa, A. et al. (1993) A Study on “Multi Storey Dwellings” in Urban Housing Renewal in Jakarta Part 1: The supply of multi storey dwellings built by public sector. Summaries of Technical Papers of Annual Meeting of AIJ, F, 381-382. (in Japanese)
12) Saaty, T. (1980) The Analytic Hierarchy Process, McGraw-Hill
13) Saaty, T. (1996) Multicriteria Decision Making: The Analytic Hierarchy Process: Planning, priority setting, resource allocation. 2nd ed. RWS publications
14) Shibata, S. et al. (1995) A Study on Housing Supply for Low-income-people in Jakarta. Summaries of Technical Papers of Annual Meeting of AIJ, F-1, 865-866. (in Japanese)
15) Yin, H., Morozumi, M. et. al. (1999) Grass-Land Classification with AHP in Aso Region for Landscape Preservation. Journal of Architecture, Planning, and Environmental Engineering (Transaction of AIJ), No.524, 231-237. (in Japanese)
16) Yokobori, H., Ishizaka, K. and Hasegawa, H. (1998) Transition of Urban Housing Policy in Indonesia. City Planning Review, No.215, 93-99. (in Japanese)

Appendix 1: Pairwise comparison by both group of experts
A1: Comparison of actors in terms of goal

|    | INT | IND | Priority |
|----|-----|-----|----------|
| INT | 1   | 1.4 | 0.583    |
| IND | 1/1.4 | 1  | 0.417    |

CR = 0.0

Appendix 2: Pairwise comparisons by the international experts
B1: Comparison of criteria in terms of goal

|    | TEN | FLA | ACW | ACT | LFS | Priority |
|----|-----|-----|-----|-----|-----|----------|
| TEN | 1   | 3.5 | 1/4.8 | 1/3.0 | 3.5  | 0.155    |
| FLA | 1/3.5 | 1   | 4/4.4 | 1/3.2 | 2.2  | 0.082    |
| ACW | 4.8  | 1/4.4 | 1    | 2.3  | 4.2  | 0.446    |
| ACT | 3.0  | 3.2  | 1/2.3 | 1    | 3.4  | 0.257    |
| LFS | 1/3.5 | 1/2.2 | 1/4.2 | 1/3.4 | 1    | 0.060    |

CR = 0.08