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Supporting a Decision for Informal Settlements Development using the Analytical Network Process

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ABSTRACT

Developing informal settlements has become an important issue for improving urban structures in developing countries. An Informal Settlements Development Fund (ISDF) was presented to Egypt for supporting urban, economic, social and environmental plans. Development plans do not clearly take into account population priorities or satisfaction criteria. Furthermore, evaluating several alternatives was based on usual statistical methods that cannot deal with multiple criteria or complex problems, leading to imprecise results. Nowadays, adding value to the developed area, restoring cost, and studying social and economic plan impacts on the population, represent high priorities. In this study, a model concerns the optimal decision evaluation for multi-criteria in informal settlements development was proposed. Five clusters (criteria) were identified and included the efficiencies of urban structure, economic, social, and environmental, in addition to population satisfaction. Twenty one internal factors represented in nods were categorized under the five clusters and affecting proposed four alternatives. The model depended on the Analytic Network Process (ANP) technique which is used to support multi-criteria decision making. ANP was selected for its capability to deal with complex problems, create dependencies and feedbacks as well as use the relative weights of all interactions. This technique confirms a logical decision and accurate prediction amongst numerous alternatives. The model was validated and applied to an informal settlements area as a case study in Egypt. The results supported to use first alternative by 38.20%, while the ISDF results selected the third alternative. Moreover, the detailed analysis emphasized that the first alternative was more balanced between the social elements and the direct economic requirements of the population, while the third alternative tended to achieve restoring cost despite its negative social effects. Lastly, the proposed model can be used appropriately in similar cases to improve informal settlements.

Keywords : Informal Settlements, Decision Making, ANP

I. INTRODUCTION

Various developing countries seek to improve informal built environments through development projects based on specific criteria. Egypt has prepared plans for addressing informal settlements since the early 1990s. The plan includes setting project priorities, work approaches, providing funds and, then, establishing schedules [1]. In general, criteria for addressing informal settlements are based on

complete elimination when the slum is small with low population intensity, and investment potentials and economic return to the city. On the other hand, as the area becomes larger, with a higher population intensity, and marginal effect on the city performance; the trend is development [1]. Although informal settlements vary in terms of location, area, and population size; they have common problems suffered by all: the difficulty of providing utilities and basic services, the domination of environmental pollution, high population intensity with a low-profile population, and the lack of an interconnected road network [1].

The Informal Settlements Development Fund (ISDF) was established by a presidential decree No. 305 of 2008, after the Dweika rock collapse. It is a fund directly supervised by the Prime Minister. The fund aims at listing and developing informal settlements, and setting plans for their urban planning, as well as supplying basic utilities (water, sanitation, electricity). The informal settlements development fund established a framework for the development strategies in which the end, objectives, development approach with its major outcomes, are set. The strategies entail an overview of development, whether by the population intensification mechanism, moving, replacement, or a mix of these. In addition, the strategy entails specifying alternatives of granting vacant plots for building; a concept of accommodating residents during development (if necessary); plans for economic, social, and institutional development; a plan for area plots protection; and a plan for building maintenance during and after development. The strategy also entails the project management view (whether an administration will be established, or the competent authority will take over management: governorate body, a university, an NGO) [2].

In recent researches, many frameworks concern informal settlements developments were established such as a framework based on a simple typology of spatial visibility [3]. Another frame work was introduced and coupling the concepts of disaster hazards, vulnerability and informal settlement characteristics such as (demographic, financial, social/poetical and locational/environmental" [4]. A methodology was developed to define and validate a set of indicators to evaluate sustainability in informal settlements [5].

Assessment of alternatives and selection of the best one in informal settlements development project adopt old statistical methods that cannot process multiple criteria and complex problems needed for making a correct decision and, hence, results are inaccurate. So, new techniques emerged based on the interrelationship between different criteria and their relationship with the alternatives. Thus, a more accurate decision can be obtained. These techniques include the Analytical Network Process (ANP).

II. METHODOLOGY

To come up with results, the following steps were executed:

a- Research background, drawing the major and minor criteria influencing decision making were collected. Aid of specialists, experts and researchers was sought to endorse the same using collective brainstorming were conducted.
b- Setting and developing a decision-making model for selecting the best alternative for developing a slum, depending on the ANP method for resolving problems of decision, overlapping of effects and variation of their relative weights.
c- Selecting a relatively small slum for ease of application, with a plan previously prepared by the ISDF.
d- Applying the proposed model to the case study, comparing the result of the model with the development project of the Fund, and discussion and analysis.

III. THE ANALYTICAL NETWORK PROCESS (ANP)

The Analytical Network Process (ANP) is considered a multiple-criteria decision-making support method, dealing with dependencies and feedback. It is a mathematical theory developed by Thomas L. Saaty. It is an extension of the Analytical Hierarchy Process (AHP) for decision making established by. This technique entails dividing a problem into decision elements and arranging the same in a hierarchical structure, setting the relative importance of element pairs and combining results [6].

In the AHP technique, the process is a top-down one, whereas in ANP, the feedback forms elements of the system in different levels of the hierarchy, as well as in the same level in the so-called network. Decision elements are organized in networks of clusters and nodes [6]. The ANP approach consists of interrelationships among clusters, and interconnections among elements. Dependencies and feedback in the hierarchical system allow for drawing priority of relative weights of elements [7].

The strength of the ANP lies in interconnection among decision merits and allowing for analysing more than one methodology. It allows for inserting all relevant elements; tangible (material), and intangible (moral), as well as objective and subjective ones which help reach the optimum decision using relative weights of all interactions and accurate expectations [8].

The ANP approach allows for interaction and feedback among and inside different clusters. The first is called external dependency, and the second is called internal dependency. Here, alternatives depend hierarchically on criteria and well as depending on each other. Also, criteria themselves depend on other criteria and on each other. This makes prediction more accurate and more capable on addressing complex problems in the human society. Hence, it is an analytical systematic approach for processing a large number of parameters instead of depending on sense for assessment [9].

Recent researchers were tackled and applied the ANP in supporting many decisions in engineering problems. The ANP multi-criteria methodology was applied as a useful prioritization tool of rural development strategies in protected areas [10]. The ANP was also employed to find out the key factors of sustainable rural built-up landscapes in the decision-making procedure of rural planning [11]. An integrated approach was developed based on ANP to evaluate the impacts of lean and green practices on organizational performance and prioritize improvements in the system [12]. A novel integrated structure was provided for assessing green buildings realistically based on stakeholders' fuzzy preferences and ANP to evaluate the correlation matrices in a quality function deployment framework [13]. The ANP approach was used to support decisions in risk management and risk mitigation [14,15]. By conducting a strength, weakness, opportunity, and threat (SWOT) analysis, the status of the building mode, energy service companies in China was presented and alternative strategies utilizing ANP as a conventional multi-criteria decision-making were proposed [16].

An ANP and genetic algorithm methodology were integrated to select the optimum mixture of Rammed earth material containing cement, expanded polystyrene and phase change materials with different moisture content [17]. The critical factors of the application of nanotechnology in construction were identified and evaluated in order to concentrate on the most critical factors using ANP technique based on multi-criteria decision making methods [18]. An integrated balanced scorecard-ANP approach was proposed for selection of the best outsourcing strategy (insourcing, outsourcing, and strategic alliance) for

operational activities of the coal mining organization [19].

Each network within this hierarchy connects to three matrices: The Unweighted Supermatrix, containing priorities drawn from comparing pairs all over the network; the Weighted Supermatrix, produced from multiplying all elements comprising the previous matrix by the weight of the opposite matrix; and the Limits Supermatrix, whose values are the priority needed for objective-relevant elements.

A. Steps of the ANP

There are four ANP application stages [7]:

1. Establishing decision structure: where the aim of decision-making is specified. The aim is divided into clusters and elements, representing criteria and alternatives. Then, relationships among different parts in the network are determined in terms of dependence and feedback.
2. Pairwise Comparison and estimation of relative weights: pairs of decision elements are compared in terms of control criteria. Pairs are also compared for all components, in terms of their weight in achieving the aim. A preference scale is used for this purpose. Decision makers are required to respond to a series of pair comparisons for two elements or two components at the same time, in terms of how they contribute to achieving the criterion. The value of the relative importance is determined on a 1-9 scale; where 1 represents equal importance for both elements, while 9 represents maximum importance of one element against the other. The consistency ratio (CR) for the pairs comparison matrix must be ≤ 0.1 to be accepted [20]. Pairs of elements are compared in each level in terms of their relative importance in the direction of criteria/cluster control. Pairs are compared at the element and the cluster levels.
3. Supermatrix Determination: The Supermatrix concept is similar to that of the Markov Chain. Priorities are obtained from the interconnected internal dependence effects by inserting Priority vectors into the right columns of the Supermatrix. As a result the matrix is divided; with each part representing the relationship between two clusters in the network [21].

   The relative importance of matrix clusters is determined with the cluster column as being the independent component. Non-Zero row components are compared to the column field according to their influence on the column field components by the pairs' comparison matrix, which links row components to column components; thus obtaining the Eigenvector. The Eigenvector is obtained for each field in the column by multiplying the first entry of the Eigenvector by each element in the first field of the column, and multiplying the second entry by all elements in the second field of the column, etc. The field in all matrix columns has weight. As a result of the previous process, a Weighted Supermatrix forms [8].
4. Combining criteria and alternatives (priorities and selection of the best alternative): Weight priority for criteria and alternatives can be obtained in the final step by elevating the Limiting Matrix to obtain the final priority vectors. Alternative weight priority can be found in the alternatives column of the Normalized Matrix. The matrix consists of interconnected components only. Additional calculations must lead to obtaining total priorities of alternatives and provide to Supermatrix.

B. Super Decision

ANP approach uses the Super Decision software developed by William J. Adams of Embry Riddle Aeronautical, under the supervision of the Creative Decisions Foundation established by Thomas L. Saaty [22].

The software prepares calculations of ANP to obtain the best alternative. It can be used in simple applications consisting of one network; or complex applications, consisting of a major network and two or more subnetworks. The software consists of [22]:

1. Simple Network: such as the Hamburger Model, in which all clusters and their nodes are in one window. The same network is the decision network, because it contains the clusters group which act as decision alternatives.
2. Two-level Network: in purchasing a BCR car, there is a top-level network, with merit nodes such as benefits, opportunities, costs, and risks. Each has a subnetwork containing a number of alternatives. Subnetworks are the decision networks because the contain alternatives.
3. Complex Network: such as the National Missile Defense Model, where there is a major network of merit nodes such as benefits, opportunities, costs, and risks. Each has a subnetwork containing other nodes acting as control criteria. Nodes allocated for acting as control criteria, Top priority network nodes, contain decision networks including alternatives linked to them. In practice, this is the most complex system. There are no limits to the number of subnetworks levels.

IV. Constructing the proposed model and criteria selection

To ensure success of deteriorated districts upgrading projects, and ensure achieving sustainability; management systems of such districts must be developed [23]. The return of urban development of deteriorated areas is recognized to be: environmental development for providing a healthy safe environment; economic development to ensure stability and eliminate financial support of such districts; and social development to ensure reducing crime levels, children labor, and illegal activities [23]. Hence, these points are the basis of assessing the success of alternatives introduced for implementing informal settlements development projects.

Planning alternatives assessment criteria fall under four major categories: the urban criterion, which includes uses, services, road network, etc.; the social criterion, which includes population density, education, social engagement, etc.; the economic criterion, which includes the economic value of the area and the properties, economic activities, etc.; and the environmental criterion, which includes pollution, waste, etc. [24]. These are almost the same major criteria adopted by the informal settlements development planning criteria by official authorities of the state [1].

The Informal settlements Development Fund used the development Environmental Impact Assessment in its universal concept (economic, social, and environmental) to introduce drivers and benefits of development in general, and the strategy adopted in particular, including economic and social opportunities of selecting the final location from the available alternatives (if more than one exist), the degree of environmental improvement expected from development, the expected social return particularly on women and the youth, and the expected development in domestic institutions capacities [2].

The state cannot meet essential needs of residents [25], and cannot achieve sufficient urban environment sustainability. This is attributed mainly to the inability to meet residents' priorities sufficiently, leading to reducing general satisfaction among residents [26]. It is reflected upon the dynamics of movement among urban conglomerations, particularly unofficial ones, and insufficient success of development programs.

Successful performance of urban environments depends on expecting and assessing their performance after development [26]. Experts stated that the main indicator of measuring success of the urban

environment is the Neighborhood Satisfaction Index [27,28].

A residential satisfaction model for the low-income was developed [26]. The model consists of the following criteria: residence, district, economy and services, society, management and participation. As a whole, these criteria comprise an index for predicting neighbourhood satisfaction in low-income districts; suitable for consideration in informal settlements.

As a first stage, the author drew a number of planning alternatives assessment criteria for informal settlements development based on the previous research background; particularly the trials and reports of unofficial districts development in Egypt (reports). The criteria were classified as major and minor. In the second stage, the brainstorming method was used as one of the most common means for data collection and assurance [29,30], to emphasize the main criteria and arrange/classify the sub-criteria, add and exclude as necessary. Over a period of time, several brainstorming sessions were organized. Sessions were attended by two experts in unofficial districts development, two engineers from the unofficial district development unit in Minia Governorate, and four architectural researchers.

These meetings produced five main criteria, theoretically deemed the basis of the proposed model for assessing informal settlements development decision alternatives. Under each criterion, there are a number of sub-criteria. Sub-criteria were limited to 20, found to be the most important ones influencing informal settlements. These criteria are:

A. Efficiency of the Urban Structure

Success of development projects depends largely on the merits of urban structure development; including four sub-criteria: The **Urban fabric** in terms of upgrading efficiency, the ability of the development project to restore balance of the developed area, increasing homogeneity among different parts of the area, and efficiency of linking to the surroundings; **Uses**, their clarity, upgrading, and integration and balance among different uses; **Services**, the efficiency of their distribution, grading, and ease of access; and **the Road Network**, its grading, efficiency of distribution, clarity, and linking capacity.

B. The Economic Efficiency

This depends on **utilizing location advantages** in terms of the availability of vacant plots, its importance and relationship to the city, and the uniqueness of its location within the city; **investment activities** which can be implemented to utilize location advantages and make economic returns to the residents; **redeemed revenue** resulting from the difference between the cost of development and the added value of investment sales returns in the area; **economic empowerment** of youth through training and employment to increase their skills and qualify them for work or increasing their income; and providing **economic activities** for youth to practice small crafts inside/outside the area to reduce unemployment.

C. The Social Efficiency

The social efficiency depends on assessing unbalance of **social inclusion** in the area by the development project, among different levels of residents particularly via elimination, eviction, or changing demographic characteristics in the area; the ability to provide **community services** needed for treating unbalance observed in the area; the degree of **social participation** by local residents in implementing the development project through its phases from the very beginning of setting criteria, making decisions, and execution management and follow-up; and **social development projects** introduced such as sustainer women's care and training, and removing illiteracy.

D. The Environmental Efficiency

This depends on assessing impacts of the development project: whether the positive/negative **economic impact** on the area and its residents; the positive/negative **social impact** on residents; or the **environmental impact** resulting from reducing sources of air/network pollution, and removing and recycling waste.

E. Satisfaction of Residents

Assessing satisfaction of residents has five aspects: The degree of **residential satisfaction** by residents with residence introduced by the development project inside/outside the area; **the urban satisfaction** of residents with the axis of urban structure development in the area; **social satisfaction** of residents with the economic aspect of the development project; and **the administrative satisfaction** of residents with different aspects of the development project.

V. Case Study

The research will apply the proposed model to one of the projects of the Informal settlements Development Fund, a subsidiary of the Prime Minister's Office in Egypt. The project is Al-Ashraf district development project, Mallawi, Minia Governorate. In the following we present the main points of the report about the case study area, and the best alternative of the district development strategy according to the report; followed by reselecting the best alternative using the proposed model; and analysis, and comparison of results and reasons of variation of the alternative, if any. The following is an overview of the main report points [31]:

A. District Description

Al-Ashraf district is located in the old core region within the administrative borders of Mallawi City, Minia Governorate. Mallawi is 45 km south of Minia, capital of the governorate; and 292 km south of Cairo, capital of Egypt, Fig1. The area of the district is about 1.4 acres, with 220 residential units and 709 people comprising 133 families. It is located in the west part of the urban mass of, adjacent to the regional transport network (the regional agricultural road Cairo- Aswan), the main railroad, and Ibrahemia Canal.

The structural layout of Mallawi was prepared in 1999, under the development policies of the city. The district must go through gradual replacement. Al-Ashraf District, according to the Informal settlements Development Fund Classification, is an insecure, unplanned district.

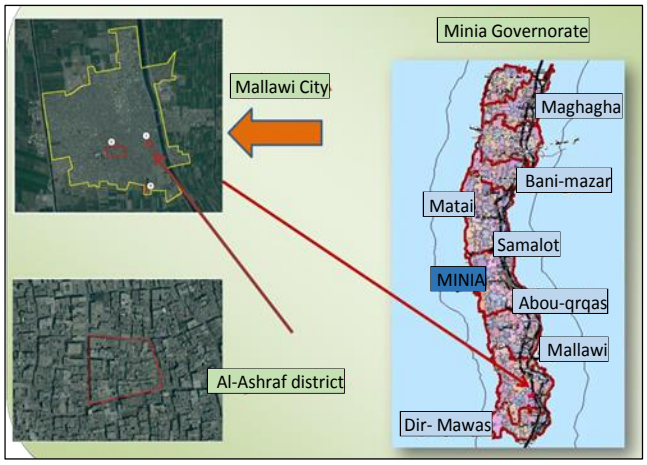

Figure 1: Location of Al-Ashraf district, Mallawi City

A.1 Land Possession and Tenure

Some surrounding areas were added to Al-Ashraf to be used in the development project, to increase the total area of the study district to 2.19 acres (9198.08 m^2) including inter-spaces and surrounding roads. Properties were various, not including inter-spaces and road, with residents' properties of 0.53 acres (2226.77 m^2) inside the district (35.43% of Al-Ashraf total area). Residents own 0.43 acres (1787.76 m^2) in the surrounding area (61.37% of the total area of the surrounding area). The Egyptian Endowments Authority has 0.474 acres (1989.36 m^2) inside the district; representing 31.65% of the total district area;

and 0.043 acres (181.17 m^2); representing 6.22% of the total area of the surrounding area.

A.2 Uses

The prevailing use is residential, 42.49% of the total uses. The total number of residential plots is 85 out of 106 plots, 709 people, and 220 residential units, Table1.

A.3 Condition of Infrastructure Networks

Since the study district is located in the old residential mass, infrastructure exists. The electrical network is working properly. The telecommunications network exists, but needs enhancing as per the telecommunications company plan. As for the water network, it is good and was recently renewed. The main supply lines to the district need to be replaced and renewed. As for the sanitation network, the replacement and renewal plan was completed in 2010.

Table 1: Al-Ashraf district use distribution

Land uses	Number of plots	Area (m^2)	Percentage %
Vacant plots	3	428.71	4.66
Social	1	479.31	5.21
Commercial	2	102.85	1.12
Religious	5	567.02	6.16
Residential	85	3908.13	42.49
Residential commercial	6	565.61	6.15
Residential occupational	1	58.44	0.64
Residential professional	1	66.36	0.72
Utilities	2	8.62	0.09
Total built mass	**106**	**6185.05**	**67.24**
Total area of roads and inter-spaces		3012.82	32.76
Total area of the district (including roads)		**9198.08**	**100.00**

A.4 Vacant Plots and Spaces

The study district contains three vacant plot with a total area of 428.71m^2, representing 4.66% of the district area. The total area of roads and inter-spaces is 3012.82 m^2, representing 32.76% of the district area, Table2.

B. Urban Characteristics

The majority of buildings are one to two floors high (70%), 21% are three floors high, and 10% are four to five floors high. As for building conditions; 61% are in bad condition, whereas 59% are in good shape. As for the adjacent area; 90% are bad to medium. Hence, most of the buildings owned by the Endowments Authority need to be replaced and renewed. Most cases of demolishing were applied to bad cases. Some valuable religious buildings were maintained, in addition to buildings in good shape.

Table 2: Number of plots, people, and residential units in Al-Ashraf District

Land uses		Number of plots	Number of families	Number of residents	Number of residential units
Endowments Authority properties inside the district		48	40.00	187.00	62.00
Residents properties inside the district		25	55.00	295.00	81.00
Total area of the district including roads and inter-spaces		**73**	**95.00**	**482.00**	**143.00**
Plots adjacent to Al-Ashraf district	Endowment Authority properties	4	3.00	21.00	3.00
	Residents' properties	29	35.00	206.00	74.00
Total area of plots adjacent to Al-Ashraf		**33**	**38.00**	**227.00**	**77.00**
Total area including roads and inter-spaces		**106**	**133.00**	**709.00**	**220.00**

C. The Economic and Social Characteristics

The district is characterized by a high rate of illiteracy and unemployment. Labor is limited to some commercial activities and handicrafts. Population density is high inside houses. Not all services are available. There are many environmental problems in the district; causing spread of diseases. Residents' needs are sanitary drainage, improving

communication services, supplying water to needy units, solving the problem of groundwater in some ground floors, facilitating access of emergency services in narrow streets, and the lack of necessary services (bathroom, kitchen) in some units.

D. Proposed Strategic Alternatives for the Development Project

The main proposals of the project focus on demolishing 91 units in a very bad condition, in addition to societal development steps which include: economic empowerment, youth employment, healthcare, as well as other societal development tasks. Alternatives meet in attempting to achieve balance between cost and making an added value out of the proposed investment activities in the development district; and the ability to make revenues of the difference between cost and the added value of the development district. The development project set four development alternatives with the following main aspects:

D.1 The First Alternative

This alternative includes re-planning of the existing road network, maintaining valuable buildings and those in good condition, full replacement of deteriorated residential buildings, gradual resettling of residents in five residential blocks with 100 residential units, adding areas necessary for green and open spaces for meeting the planning rates (1/3 of the total area), using added areas which were provided to introduce a building for residential activities and one for occupational activities to make for activities removed and offering the same for investment. The alternative proposed increasing building heights above the legal height to cover the development cost. The expected alternative cost is 8824886 L.E., The added value is 10058242 L.E. Hence, the alternative made a revenue of 1233355 L.E.

D.2 The Second Alternative

This alternative is different from the first one in that it proposes transferring residents suffering from staying in deteriorated building at the study district into another alternative location out of the district after building five residential blocks providing 100 residential units. The proposal includes re-planning the district to make maximum use, and adding another area in the middle of the development district to establish investment projects and payback cost, Fig2. The expected cost of the alternative is 19209198 L.E., with an added value of 43539232 L.E. Hence, the alternative makes a revenue of 24330033 L.E

Figure 2: location of the proposed alternative (aerial view of Mallawi)

D.3 The Third Alternative

This alternative focuses on compensating residents by granting each family a sum of fifty thousand pounds for relocating at any other district they wish, provided the district is planned over for use in investment projects to redeem cost and use the central location of the district within the city to make benefit for the city according to its strategic plan. The expected cost of executing the alternative is 16462224 L.E., with an added value of 43147170 L.E. Hence, the alternative makes a revenue of 26684946 L.E.

D.4 The Fourth Alternative

This one agrees in general with the third, but differs in establishing the value of compensation to the number of unit rooms; dividing compensations into three categories: one-room unit, two-room unit, and three-room unit. Compensation sums are 15 thousands, 30 thousands, and 45 thousands, respectively. The expected cost of executing the alternative is 14207224 L.E. with an added value of 43147170 L.E. Hence, this alternative makes a revenue of 28931899 L.E.; the highest revenue of all four alternatives.

VI. Developing and applying the proposed model

To select the best alternative, using ANP, a questionnaire representing the proposed model of decision making was prepared, by comparing pairs to determine the relative weights of all model levels and, then make a decision of the best alternative. The model consists of five main criteria and twenty sub-criteria. The questionnaire was introduced to ten experts; academia, executives, and informal settlements development decision makers.

A. Structure of the Proposed Model

The decision structure for selecting the best alternative for the study district consists of, three clusters: the aim cluster, with the best alternative; the criteria cluster, with 20 sub-criteria under five main ones; and the alternatives cluster which has four alternatives. External dependence is between the aim and the criteria clusters. Internal dependence is among the elements of these criteria. Feedback is between the criteria cluster and the alternatives, Fig3. Pairs were compared, using the questionnaire, among the assessment criteria to obtain the relative weights of clusters and elements.

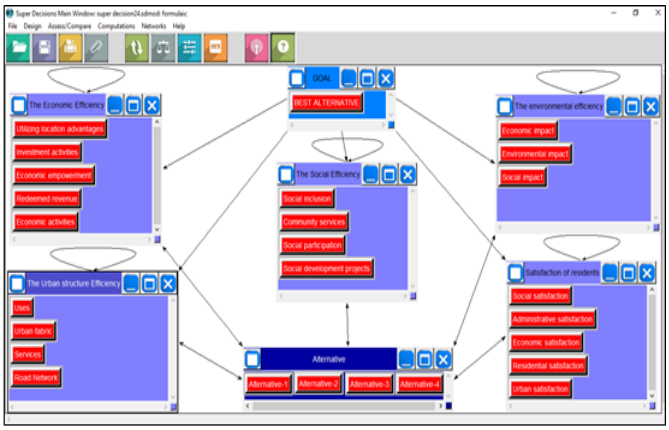

Figure 3: Decision structure for selecting the best alternative form various levels.

Results of clusters relative weights showed that neighbourhood satisfaction came first with 30.37%, followed by the environmental efficiency with 29.66%, then social efficiency with 14.94%, urban structure with 13.72%, and at last the economic efficacy with 11.28%, Fig.4. Meanwhile, results of the relative weight of elements in the entire decision showed that the social impact came first with 7.1%, followed by the economic impact with 5.2%, social satisfaction with 4.3%, environmental impact 4.2%, and at last the residential satisfaction with 3.7%. The reliability of the criteria questionnaire was 4.417% Fig.5.

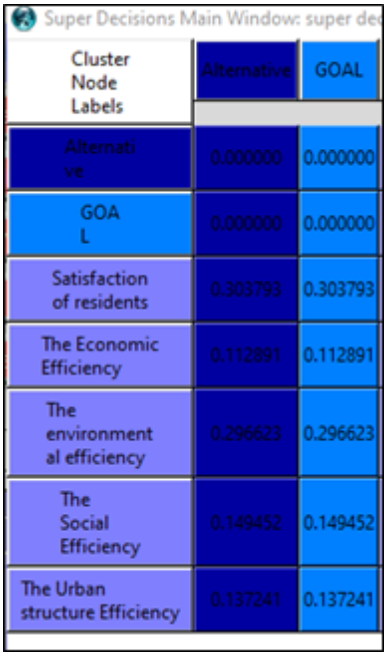

Figure 4: results of decision clusters

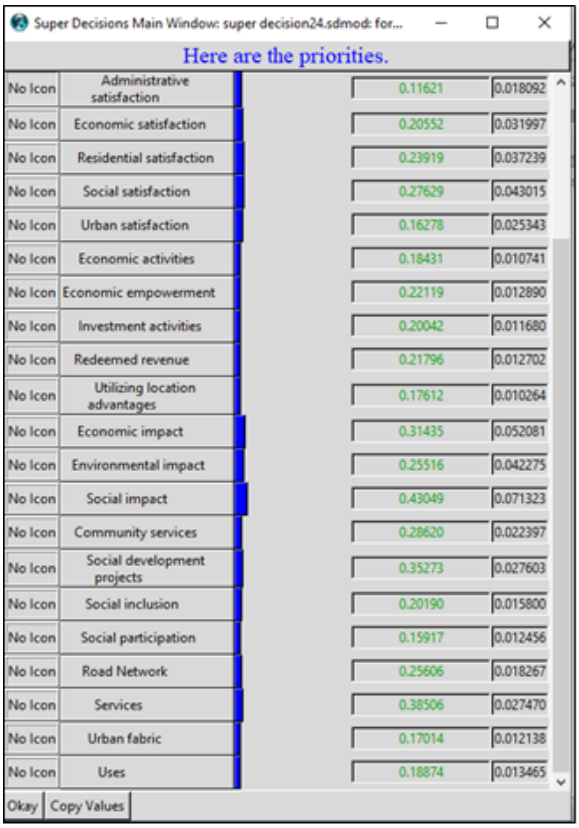

Figure 5: Relative weights and priorities of decision elements

The highest weight of elements in the neighbourhood satisfaction cluster was social satisfaction with 27.6%, followed by the residential satisfaction with 23.9%, then the economic satisfaction with 20.5%. on the other hand, The highest elements in the social efficiency cluster were: societal development projects with 35.2%, followed by social services with 28.6%, and social inclusion with 20.1%.

In the economic efficiency, the highest element was economic empowerment with 22.1%, followed by the redeemed revenue with 21.7%, and the investment activities with 20.04%. The highest elements in the environmental efficiency cluster were: the social impact with 43.04%, followed by the economic impact with 31.4%, and the environmental impact with 25.5%. As for the urban structure, the highest elements were: services (38.5%), followed by road network (25.6%), and uses (18.8%).

Results, depending on relative weights of decision clusters and elements, showed that the best alternative was the first one by (38.20%), followed by the second alternative by (24.57%), then the third one by (18.76%), and at last was the fourth by (18.46%) as shown in Fig.6.

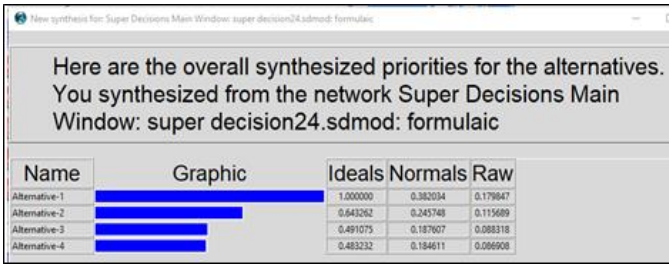

Figure 6: Order of alternatives and selection of the best one.

Table 3. shows results of elements in each alternative. The satisfaction of residents cluster shows that social and residential satisfaction elements are higher in alternative-1 than other alternatives. Economic satisfaction was highest in alternative-3. Social inclusion was highest in alternative-1. Alternative-2 was highest in societal development projects. Results of the economic efficiency cluster show that alternative-3 is the best in utilizing site advantages and investment activities. Alternative-1 appears first in economic empowerment and lowest in investment activities. In the environmental efficiency cluster, alternative-2 seems the best in economic impact, whereas alternative-1 seems highest in social impact and lowest in economic impact. In the urban structure cluster, alternative-1 was the highest in uses and services, and the lowest in urban formation and road network. Alternative-2 was highest in urban formation.

The model validity is tested by conducting a brainstorming session for discussing the model results and five specialists were invited to evaluate and identify whether the results is valid or not. The specialists decided that the results are valid and well accepted.

Table 3: Relative weights of elements in different decision alternatives

		Alternatives			
		Alternative 1	Alternative 2	Alternative 3	Alternative 4
Satisfaction of Residents	Administrative satisfaction	0.026084	0.027894	0.056729	0.022958
	Economic satisfaction	0.041883	0.055789	0.100285	0.068873
	Residential satisfaction	0.075084	0.074859	0.056729	0.079359
	Social satisfaction	0.117181	0.096834	0.033321	0.053244
	Urban satisfaction	0.043561	0.048417	0.056729	0.079359
The Economic Efficiency	Economic activities	0.022578	0.013784	0.013916	0.029614
	Economic empowerment	0.045156	0.008388	0.012907	0.015825
	Investment activities	0.011289	0.028392	0.030403	0.027578
	Redeemed revenue	0.011289	0.037662	0.027832	0.029614
	Utilizing location advantages	0.022578	0.024665	0.027832	0.01026
environmental efficiency	Economic impact	0.036194	0.207925	0.176603	0.06812
	Environmental impact	0.06812	0.057213	0.081972	0.036194
	Social impact	0.192309	0.031485	0.038048	0.192309
The Social Efficiency	Community services	0.024909	0.056852	0.054234	0.045066
	Social development projects	0.049817	0.060946	0.048733	0.053564
	Social inclusion	0.049817	0.016418	0.022118	0.034383
	Social participation	0.024909	0.015236	0.024366	0.016438
The Urban structure Efficiency	Road Network	0.016571	0.039212	0.048918	0.04816
	Services	0.069817	0.039212	0.044703	0.04816
	Urban fabric	0.01418	0.039212	0.017053	0.014975
	Uses	0.036674	0.019606	0.026567	0.025947

VII. Conclusions and discussion

Results showed that experts assessed the relative weight of the social aspect in the study district as being high; both in clusters and elements; as one of the influential assessment factors in low-income districts. This was reflected in enhancing the neighbourhood cluster and the appearance of social impact and social satisfaction on top of the relative weights of elements. Meanwhile, the economic efficiency came, unexpectedly, last for clusters. Yet, the economic impact came first in decision elements. This reflects clearly that experts tend to give more weight to elements that enhance residents' economic powers directly and resolves their economic problems during application to low-income districts more than focusing on economic elements which would make profits to increase the state's revenues out of utilizing the economic potentials of the district without directly influencing the economic status of residents.

Comparison of relative weights of elements for each alternative shows that the first alternative was the most balanced between social elements and the direct economic needs of residents. This was reflected by selecting this alternative by experts as the best alternative to focus on the social and economic impact on low-income residents. This, in turn, made it the least profiting alternative for the state. The third alternative was shown to be more directed to achieve economic returns from the development project at the cost of its negative social impacts; particularly as it adopts evicting residents and reinvesting location advantages to make huge revenues for the state. This is almost the same as the fourth alternative, which was selected by the ISDF as the best alternative. Hence, the main conclusions to be drawn are:

1- Network Analysis is a new approach for assessing planning alternatives. It can handle numerous decision criteria, with their corresponding complexities, intermingling, and network sequence; and provides accurate realistic results with little effort, money, and complexities.
2- The Network Analysis gives relative weights for each variable/criterion according to pairs' comparison, and gives the percentage of each variable/criterion in every planning alternative.
3- The Network Analysis adopts indirect alternatives' assessment over stages. Stages start by finding weights of variables/criteria by experts; comparing pairs for variables; and then obtaining the Eigen Vector.
4- Experts selected alternative 1, using Network Analysis, as the most balanced one in terms of economic and social elements. This was contrary to ISDF report which selected alternative 4 that gave priority to the economic return over the social aspect; demonstrating that it is the alternative achieving sustainability most.

This shows the need for re-assessing ISDF projects of settlements development using ANP to select alternatives, to provide more realistic and more sustainable decisions for the low-income districts.

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