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A Model Proposed for the Prediction of Future Sustainable Residence Specifications Using Analytical Network Process

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Abstract

In Egypt, people are unable to determine the qualities of appropriate residence that achieves quality and occupant satisfaction, and contributes to sustainability of residential conglomerations. In general, developing countries lack housing information which can be used to enhance quality of residence. Also, the methods of assessing and identifying the appropriate criteria for future residence quality remain traditional ones that cannot address the multiple, conflicting, overlapping aspects to reach a good decision. This calls for using the Analytical Network Process (ANP), an effective tool for specifying the relative importance of all factors impacting a specific issue for making an appropriate residential decision. In addition, this method provides results for the decision element impacts network within the decision structure; thus contributing to more understanding of the mechanisms and requirements of residence selection. The proposed decision structure comprises a two-level network: main clusters, main elements, and sub-elements included in the demographic characteristics group, the residence criteria group, the demand parameters group, the supply parameters group, the residence specifications group, and the alternatives group which representing, in total, the decision and specifying the percentage needed for each housing level. Results of the model showed complete capacity in smoothly addressing complexities and overlapping in the decision structure. The decision structure showed that 52% chose luxury residence, 28% chose middle-class residence, and 19.5% chose the economic residence. Mechanisms of decision making were analyzed; particularly in terms of relationship to demographic characteristics and residence specifications. Also, the importance and impact of demand / supply parameters in reaching decision were analyzed.

Keywords

Sustainable Residence Specifications - Supply/ Demand - Decision Making - Prediction - Analytical Network Process (ANP)

1. Introduction

Residence type and nature are crucial in specific lives of individuals at any community; highly impacting the general condition of satisfaction and the quality of life (Zebardast, 2009; Das, 2008). In Egypt, people are unable to determine the qualities of appropriate residence that achieves quality and occupant satisfaction. This is clear in cases of occupants' modifications to residence whether by adding to spaces or canceling some (Eraqi, 2016). This is common for all occupant levels; from low-income to luxury housing.

Regardless of the economic and social development level of a society, it is still essential for meeting human needs, as well as the quality and cost for achieving quality of life to individuals (Jiboye D., 2010B). Also, satisfaction with

the residence condition is highly related to satisfaction with the residential district condition (Das, 2008; Eraqi, 2016). Residence variables explain largely the variation in satisfaction with life (Oswald, Wahl, Mollenkopf & Schilling, 2003).

Due to domestic variations in the quantitative and qualitative dimenstions of the residence quality concept, it would be difficult to specify one group of criteria and indicators that apply to all regions at all times. Contrary to the developed countries, developing countries lack documented housing information in real estate activities to be used effectively in assessing residence quality (Rindfuss, Piotrowski, Thongthai, & Prasartkul, 2007).

Various quality of life indices were developed. (Kurian & Thampuran, 2011) developed a methodology for assessing residence quality using requirements given by residents. They identified a number of indices such as (location, building design, building materials and technologies, aesthetics, etc.) that contributed to establishing correlation among the type of residence, resident requirements, and their relative weights. This helped in studying the relationship among different factors and indices. Also, objective measures were used in the housing quality index to assess physical features, amenities, services, and the environment of the dwelling units (Fiadzo, Houston & Godwin, 2001). Yet, these objective measurements were criticized for failing to explain the psychological and social aspects of residence satisfaction (Mohit, Ibrahim, & Rashid, 2010).

Yet, these methods still depend on simplified measures which do not address the issues of appropriate decision and overlap of parameters needed for reach decision. Therefore, the Multi-criteria Decision Analysis (MCDA) which can conduct assessment, correlation, and comparison among a huge number of variables to give the optimum alternative (Natividade, Piantanakulchai & Antunes, 2007) is used; one of these is the ANP, an analysis method that provides an effective tool for specifying the relative importance of all parameters impacting the identified problem decision/assessment.

This paper focuses on predicting the desired residence level, and attempts to recognize the mechanisms and parameters of resident attitudes to determine the specifications of the residence that achieves residence quality and occupant satisfaction to them; as well as the influence of demographic characteristics on the decision in light of different economic conditions, intermingling of parameters impacting demand and supply, and the variation and overlap of decision makers influencing such mechanisms. This makes determining residence specifications complicated if traditional methods are used, and calls for using an analytical method such as the ANP.

2. The literature and techniques

Because the ANP gives the best results when the system is fully represented, it is necessary to collect as much of the relevant data as possible to provide a realistic representation of the monitored networks. (Saaty, 2016, p. 163). So, we will review the critical information for building a good decision structure.

2.1. Parameters impacting the housing system

Residence sustainability depends largely on achieving occupant satisfaction requirements by the residence (Eraqi, 2016). This is reflected in residence appropriateness for requirements of residents, and the quality of its internal and external elements which meet residents' needs and provide them tranquility. All such factors were introduced as indices representing criteria for the quality of residence. Such indices should specify priorities of residents (Meng & Hall, 2006). Sustainability is influenced by stability in the housing market system and relevant factors. This requires a universal understanding of surrounding changes and their corresponding impact on the housing market, particularly on residence, to be able to accomplish the state of sustainable residence.

The housing market is influenced by the economy, interest rates, true incomes, changes in housing volume, and demand parameters. Demand is influenced by a number of factors such as the economic growth which is reflected in people's incomes and, consequently, increased demand. Also, unemployment – or even fear of the same – impacts buying residence. Interest rates also matter; the more the interest rate on mortgaging, the more the pressure on family income is and, hence, reduced demand, real estate recession, as well as drastic fall of real estate prices as in a previous case in Britain. Also, consumers trust specify the potential of bearing mortgage risks; when individuals fear price falls they delay purchase decisions. Another factor is the availability of mortgaging. The more mortgages are facilitated

by banks, the more the purchasing power of families and increased demand for real states are. This was globally down with the 2007 mortgage crisis. Supply impacts demand. Shortage in supply pushes prices high, and vice versa. The capacity for bearing costs is essential in demand; the less the house price to income is, the more demand grows. Location is a major factor in determining price of a house; the more excellent is location and its features (near schools, services, railways), the more the value of residence is and the less demand by families becomes (Pettinger, 2017). The level of management impacts residence quality assessment (Meng & Hall, 2006).

2.2. The housing status in Egypt

Egypt signed the International Covenant on Economic, Social, and Cultural Rights. In its 11th article the Covenant states the right of families to adequate housing detailed in seven points: Legal security of tenure; Affordability; Habitability; Availability of services, materials, facilities and infrastructure; Accessibility; Location, to benefit from all types of services; and Cultural adequacy connected with the expression of cultural identity and life styles (ESCR-Net; Human Rights). The last point is a major reason for the inability to meet family needs, particularly the low-income who are forced to live in certain styles imposed by the government; such styles do not consider diverse needs, requirements, and lifestyles which express diversity of cultural identity. This is reflected in lack of sustainable residence, and conducting many modifications to residence by users to fit their needs.

The housing sector in Egypt faces many challenges; particularly in low-income housing, with economic pressures on real estate prices resulting from economic reform decisions and subsequent raises in real estate prices. The Central Bank of Egypt reacted by providing a package of funding incentives to the housing sector at low interest rates to encourage funding housing for low and middle income categories, particularly as the cost of official housing is beyond the reach of most families. Yet the level of mortgage funding is still the lowest in the region (1%) (World Bank, 2014, p2).

The value of mortgaging in Egypt is 0.36% of the GDP; much below the global average (60-80%). Developing mortgaging for 30 years of interest rates would enable many people to obtain a residence (BRG, 2019).

The auction policy adopted by the government for land plots led to increasing costs of owning residence and, consequently, less demand (Jaap & Michael, 2018, p 24). The high level of speculations in Egypt leads to increasing real estate prices and, thus, lack of houses at reasonable prices. Investment in speculations focused on main locations, city centers, and new residential conglomerations. This led to turning to luxury housing, and reduced supply of low and middle-income houses (Hassan, 2019). There is not much data available for measuring the influence of increasing land prices on residence prices in Egypt (World Bank, 2009). Speculations account for 25-30% of real estate transactions in Egypt (Shawkat, 2015). This is reflected in the residents 'decisions to purchase housing.

The slow real estate growth in Egypt is attributed to legislative barriers and funding obstacles. Also, the current governmental programs cannot be afforded by the low and middle-income categories (BRG, 2019). Wrong selection of new residential conglomerations locations, being remote from employment opportunities and social facilities without sufficient transportation, contributes to increased vacant units in such areas and looking for informal areas to achieve the proximity required by the income of these families (The World Bank 2014, p 3).

2.3. The Analytical Network Process (ANP):

The ANP is a developed version of the MCDA. Thomas Saaty, author of the AHP, proposed the ANP to allow for more interaction among complex and interconnected system elements (decision problem), and make relationships and reactions among such elements and, thus, reach a smooth solution for the decision problem (Hsu & Kuo, 2011). The AHP adopts a multi-level hierarchy for reaching a decision (Saaty & Vargas, 2006). It is a top-down process. Meanwhile, in the ANP, feedback is for the elements making the system in different levels of the hierarchy and inside levels in the so called network (Eraqi, Issa, & Elminiawy,2019). Decision elements are organized in Networks, groups called Clusters, and elements called Nodes (Adams, Saaty, & Saaty, 2003). The ANP allows for interaction and feedback among and within clusters. The first is called outer dependence, whereas the second is called inner dependence. The decision is based on criteria in a hierarchy, and also depends on each other (inner dependence).

Also, criteria depend on other criteria (outer dependence), which make prediction more accurate and capable of addressing complex problems in the human society. (Eraqi, Issa, & Elminiawy, 2016).

Because problems cannot usually be designed in a hierarchical manner; as they include interaction and dependence among elements in the top hierarchical level with those in the bottom level, and independence of elements is practically rare in the working life; they are represented by a network in the ANP instead of the hierarchy and are not organized in levels as is real life situations. Also, the one-way relationship in the AHP is replaced by an action-reaction one in the ANP; which makes the latter more powerful in decision making (Saaty & Vargas, 2006).

The ANP uses the Super Decision program for performing calculations. It can be used in a simple network of one-level relationships, or complex networks of two or more levels, starting by the main network, then one or more subnetworks for reaching a decision (Eraqi ،Issa ،Elminiawy ،Supporting a Decision for Informal Settlements Development using the Analytical Network Process ،2019).

ANP adopts pair comparison of decision nodes and clusters of control criteria for obtaining the relative weights. This is done by a 1-9 scale assessment for comparing two nodes, Fig (1), (Issa, Ahmed & Ugai, 2014). The consistency ratio (CR) of the pairs comparison matrix must be less than 0.1 to be accepted (Satty, 1980). The program results consist of three matrices (Saaty R.W., 2016):

- Unweighted Super Matrix – contains all the local priority vectors of the comparison groups in the network .
- Weighted Super Matrix – the cluster weights have been multiplied times the local priority vectors in the unweighted supermatrix to make each column stochastic (that is, sum to 1).
- Limit Matrix – the weighted super matrix has been raised to powers until it stabilizes - that is, all the columns in the matrix have the same values .

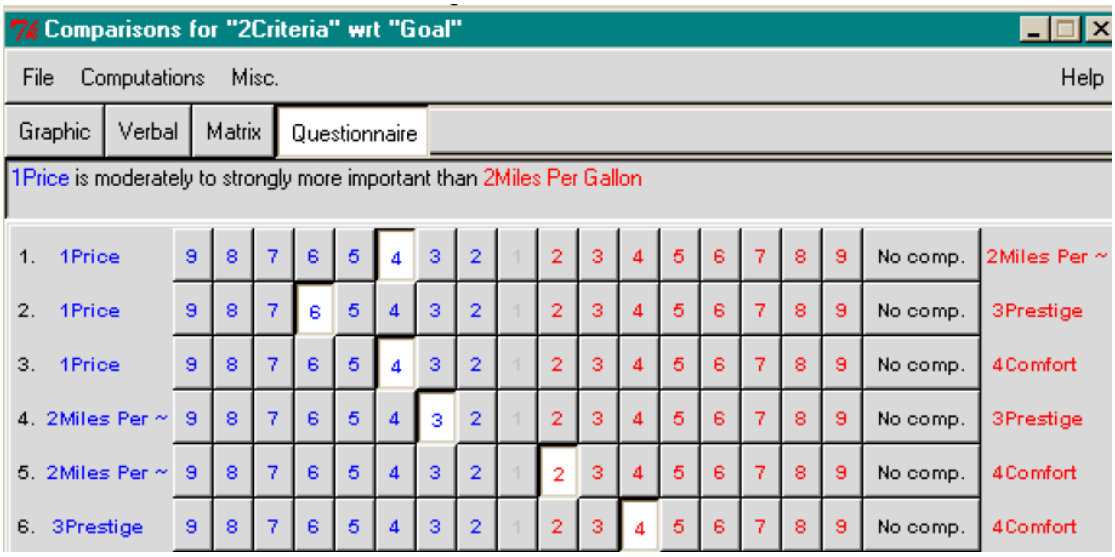

Figure 1. Scale assessment for comparing two nodes

The Computations Synthesize command displays the results of the alternatives in three ways: as Ideal, Normal and Raw. Smart means using Raw numbers if the network has more than one network; use ideal numbers if the network is either a network with a lower level or a network with rankings. (Saaty, 2016, p. 105).

Sabri & Yaakup (2008) conducted a comparison to evaluate urban extension. They concluded that ANP results are more realistic than AHP. The ANP approach was applied in selecting optimum locations, roads, construction planning, and project selection (Cheng & Li, 2005; Bottero & Lami , 2010; Banar, Kose, Ozkan, & Acar, 2007). It was used in other studies as a tool for making prediction in light of uncertainty (limited data) (Banai, 2010). It was used in the quantitative assessment of residential communities urban development and future planning orientation projects (Wang, Lee & Chang, 2010). It was also used in assessing housing quality in Ghana (Hussey, 2014). Further, it was used to establish an indices-system for assessing the construction of sustainable communities (Zon, Su & Wang, 2018).

3. Defining model criteria

Predicting the characteristics and specifications of a residence required for a target category depends on an intermingled, interrelated, complex set of nodes which – in their interrelation – specify an appropriate residence that achieves sustainability required for future urban conglomerations. Such nodes are connected to decision makers, characteristics of target residents, parameters influencing their residence demand, specifications of sustainable residence, and the variables of residence properties.

3.1. Demographic features criterion

Despite residence differences in terms of type, size, and design; measuring occupant satisfaction with residence quality remains connected to demographic features of residents (Mohit, Ibrahim, & Rashid, 2010). This was confirmed by a study conducted by Eraqi (2016), as the influence of such characteristics was reflected on all criteria related to resident decisions for identifying urban development priorities; age, income, education, and tenure status impact quality assessment (Ibem, 2012). Also, the social status and household composition impact residence quality assessment (Spain, 1990). The cultural background, family level, and ethnic/tribal origins impact residence quality assessment, too (Meng & Hall, 2006; Mohit, Ibrahim, & Rashid, 2010).

Criteria of residence quality vary from urban to rural areas, and rich and poor districts. Hence, the spatial pattern and demographic characteristics are essential parameters in selecting the optimum alternative for a sustainable residence that meets satisfaction and quality desired by occupants.

3.2. The criterion of residence

Residence quality indicators can be merged in four main criteria: (Hussey, 2014, p 30)

The economic criterion: This criterion examines the income-rent relationship (Jiboye D.A., 2010 A); and the residence cost burden, and residence value and uniqueness (Hussey, 2014); and access to work and affordability (Kutty, 1999).

The social Criterion: This criterion includes the degree of crowdedness (Jiboye D. A., 2010A); the cultural level (Meng & Hall, 2006); housing & room intensity (Kutty, 1999); tenure (Hussey, 2014), the level of privacy (Jiboye A. D., 2007); and residents' homogeneity (Eraqi, 2016).

The physical criterion: This one focuses on physical sustainability, such as integrity of residence (design, appearance, equipment) (Jiboye D. A., 2010A); structural adequacy: infrastructures (internal facilities and residence services) such as water, electricity, solid/liquid waste treatment. The criterion includes sustainability of building design (the number of floors, integrity of building elements such as wall/floor materials (Hussey, 2014); the type and security of the district, and the level of public facilities and public services provided (Kutty, 1999); residence features (number of rooms, kitchen size, room area, natural ventilation/daylighting) (Amao, 2010).

The environmental criterion: This one reflects the environmental quality of the district such as location, utilities (transportation, children playgrounds, educational and health facilities) (Ibem, 2012), access to services (Schools, markets ….etc.); the external environment of the residence, landscaping, and uniqueness of the district (Amao, 2010).

4. Criteria of controlling the housing market

Mechanisms of selecting specifications of the appropriate residence, of a housing project, are controlled tools of supply and demand that regulate the housing market in general. Supply is linked generally to impacts beyond residents' control extent, whereas demand represents the power of residents to deal with the offered housing projects. Supply and demand cluster nodes can be referred to as follows:

4.1. Parameters influencing demand

Demand is affected by the poor selection of the new residential blocks that are far away from job opportunities and social facilities (the World Bank, 2014, p. 3). The low income and the inability to afford the costs of borrowing lead to decreased demand for the housing sector (Pettinger, 2017; Wolrd Bank, 2014).

Demand in the housing market is affected also by changes of the size of housing and the ratio of the supply, ratio of unemployment, rate of mortgage interest; the customers' trust, and location characteristics that increase demand and the price of the residence (Pettinger, 2017).

4.2. Parameters influencing supply

Supply in the housing sector is influenced by the economic conditions and the stresses (The World Bank, 2014, p2). The wrong housing policies can lead to low demand which is reflected in decreased supply. Rates of speculations affect the housing supply and patterns. Orientations of the real estate investment influence the housing production (Hassan, 2019). Moreover, supply also is affected by the legislative barriers and funding obstacles (BRG, 2019).

5. Developing the proposed model and selecting criteria

The proposed model has been developed using the technique of Network Analysis Process (ANP). The research background revealed that there are many correlations between parameters of decision and the intermingling and overlapping of effects. The model consists of three phases. The first phase represents the targeted sample, its characteristics, and decisions weights related to the same. The second phase represents control and decision-influencing parameters; and the third phase represents the decision and characteristics of the future residence.

The brainstorming strategy has been used as an acknowledged scientific approach to extract and authenticate information (Issa, Ahmed, & Ugai, 2014; Alwetaishi, Gadi, & Issa, 2017). The held Sessions of brain storming consisted of a group of five experts in the sector of housing; three of them are academic and two members are real estate developers. A proposal of criteria was presented according to what has been identified in the research background. A structure, of the network of correlations between the nodes and clusters in the main network of the structure of decision and the sub-networks, was introduced. After three sessions, experts confirmed some nodes in the main and sub- network, and excluded some other poor nodes as to reduce number of comparisons in the proposed model to reduce the size of the evaluating questionnaire by populations or experts. After approving the proposed model of the decision structure that consisted of a two-level complex network; main and sub-networks, clusters and nodes that will be assessed by the experts and others will be evaluated by the residents have been determined, Fig (2).

Evaluations were done through questionnaires. A random sample; consisting of 200 targeted populations; in New Minia city, evaluated nodes of (parameters influencing the demand), (residence criteria) and (residence specifications) according to the correlation method shown in the Fig (2). Ten experts assessed the correlation between the clusters of (influencing demand) and (influencing supply), as they are the most specialized and informed of the complexities of correlation between the nodes of the two clusters. The structure of the model can be illustrated as follows, Fig (2):

- Clusters of the targeted sample: consisting of two clusters:
    - **Cluster of (demographical characteristics):** pairs of nodes of this cluster are compared to the nodes of (parameters influencing demand), (residence criteria) and (residence specifications) and (outer dependence). This cluster consists of the following nodes: age category, educational level, income level, ethnic origins, and household composition. This cluster correlates to (inner dependence). Each node includes sub-networks to compare pairs of the subsidiary nodes, and influencing parameters recognized by experts. These influencing parameters are: affordability, the residential quality, and the residential satisfaction; to evaluate the contribution of the sub- nodes in determining the relative weight of the main nodes of the cluster, that plays a role in the final decision of selecting the alternative.
    - **Cluster of (residence criteria):** It represents some criteria identified by the experts, related to the residential quality, and the residential satisfaction, pairs of nodes of this cluster was compared to the nodes of (parameters influencing the demand), with a feedback. Pairs of nodes of this cluster were compared to the nodes of (residence specifications) and (parameters influencing the demand). This cluster consists of main nodes: social characteristics, economic characteristics, environmental characteristics, and physical characteristics. Each node includes a subnetowrk representing the subsidiary nodes that determine the relative weights of the main nodes of the cluster that plays a role in the final decision of selecting the alternative. Comparison is done between the sub-nodes with inner dependence.

- **Clusters of decision control:** these are criteria controlling and affecting the orientation of decisions. This cluster includes (parameters influencing demand) and (parameters influencing supply). Pairs of nodes of each cluster were compared with internal **dependence**. Pairs of nodes of the two clusters are compared with a feedback to assess the role of each node of the clusters in the final decision. Pairs of nodes of this cluster are compared to the nodes of residence specifications as (outer dependence). This cluster includes the following two clusters:
    - **(Parameters influencing demand) cluster:** it consists of five nodes: affordability, the interest rate, the uniqueness of the residence, the customers' trust, and characteristics of the district.
    - **-(Parameters influencing the demand) cluster:** it consists of five nodes : legislations, economic changes, political changes, real estate investment, and speculation.
- **Clusters of making decisions:** It includes two clusters through which a decision can be made: the (residential specifications) cluster and (the alternatives) cluster that represents the required ratio of each housing level according to the impact of the higher levels on the decision structure. These sub- clusters are as follows:
    - **The residence specifications cluster:** it represents the required specifications of the residence. Pairs of nodes of the cluster are compared to the cluster of (the alternatives) with a feedback. Each node includes a subnetwork to compare pairs of the sub- nodes to influencing parameters identified earlier by the experts according to the Fig (2). This cluster consists of four major nodes: the nature of the residence, the nature of the community, the area of the unit, the residential-unit floor.

Table 1. Clusters, Nodes and Subnodes of decision structure

Cluster	Nodes	Sub-nodes	Criteria of controlling the subnetwork
Demographical Characteristics	Ethnic Origins	Urban origins	Residence Quality- Affordability- residential Satisfaction
		Rural origins	
		Bedouin origins	
	Family pattern	Nuclear family	
		Extended Family	
		Compound Family	
	Educational Level	High	
		Medium	
		No qualifications	
	Income Categories	<2000	
		2000- 5000	
		5001- 15000	
		>15000	
	Age Category	20- 35	
		36- 50	
		>50	

Table 1 continued

Residence Criteria	physical Characteristics	District type	Internal feedback
		Residence properties	
		Residence integrity	
		Building sustainability	
		District security	
		Structural efficacy	
	Economic Characteristics	Residence uniqueness	
		Residence burden	
		Access to work	
	Social Characteristics	Tenure type	
		Residence intensity	
		Privacy	
		homogeneity	
	Environmental Characteristics	Access to services	
		District location	
		landscaping	
		District uniqueness	
		External environment	
Parameters Influencing demand	District properties		
	Consumers' trust		
	Location uniqueness		
	Affordability		
	Interest rates		
Parameters influencing supply	Real estate speculation		
	Political changes		
	Economic changes		
	legislations		
	Real estate investment		

Table 1 continued

Residence specifications	Residence nature	Independent residence	Ethnic origins - Affordability
		Mixed residence (in a building)	
		Family residence	
	Community nature	Gated community	
		New community (new cities)	
		Traditional community (existing)	
	Residence area	< 100 m2	
		100-120 m2	
		121-150 m2	
		> 150 m2	
	Residence floor	Ground floor	Ethnic origins – Age category
		First floor	
		Second floor	
		Third floor	
		+ 3rd floor	

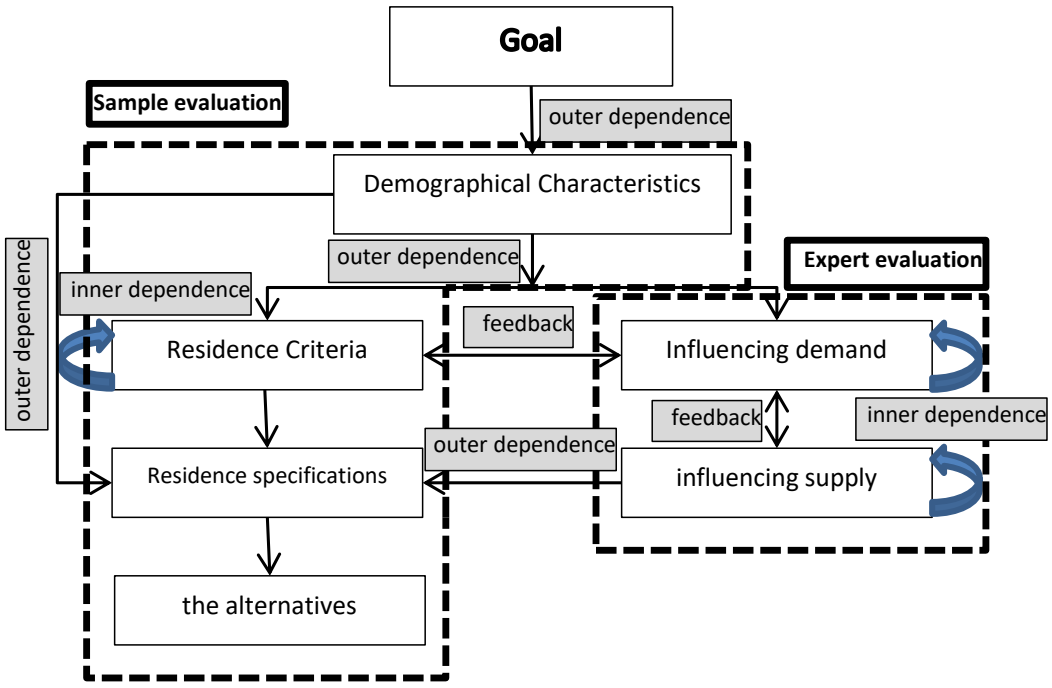

Figure 2: The proposed decision structure

6. Results

Results of pairs comparison normalized by cluster that 52.38% preferred luxury residences, whereas 28.02 chose middle-income residences, and 19.58% chose economic residences, Table (2).

Table 2. Results of decision structure alternatives

Name	Normalized By Cluster	Limiting
Economic residence	0.19589	0.026517
Luxury residence	0.52389	0.070919
Middle-income residence	0.28022	0.037933

Result analysis in weight supermatrix shows that priority in economic residence specifications was given to floor (53.96%), followed by residence nature (25%), community nature (14.28%), and area (10.94%). The priority of residence specifications in luxury residence was given to area (58.15%), followed by community nature (57.14%), floor (16.34%), and the nature of residence (5%). Priority in middle-income residence was given to area (30.9%), followed by floor (29.69%), community nature (28.57%), and residence nature (25%), Table(3).

Table 3. Priorities of residence specifications for each residential level

		Floor	Community nature	Residence nature	Area
Residence level	Economic	0.539615	0.142857	0.25	0.109452
	Luxury	0.163424	0.571429	0.5	0.581552
	Middle	0.296961	0.285714	0.25	0.308996

Table 4. Priorities of decision nodes in the proposed model

Name	Normalized By Cluster	Limiting
Interest rate	0.20409	0.061855
Affordability	0.22602	0.068503
Location uniqueness	0.18322	0.055531
Consumers' trust	0.14021	0.042495
District properties	0.24646	0.074697
Real estate investment	0.18675	0.058209
Legislations	0.17548	0.054698
Economic changes	0.27727	0.086424
Political changes	0.19821	0.061782
Real estate speculation	0.1623	0.050588
Social characteristics	0.15402	0.020455

Table 4 continued

Economic characteristics	**0.24869**	**0.033027**
Environmental characteristics	0.26724	0.035491
Physical characteristics	0.33005	0.043833
Residence floor	0.07202	0.008429
Community nature	0.50033	0.058561
Residence nature	0.27567	0.032266
Residence area	0.15198	0.017788

As for nodes priority, the highest impact was for economic changes (8.64%), followed by district characteristics (7.46%), affordability (6.85%), interest rate (6.18%), political changes (6.17%), and community nature (5.85%). The lowest impact was for area (1.7%), followed by social characteristics (2.04%), and residence nature (3.22%). Table (4)

Adding limited priorities of cluster nodes to identify the relative weights of cluster in the decision structure shows that the biggest weight was given to residence criteria (quality of residence) (52.73%), followed by supply parameters (31.17%), demand parameters (30.30%), and residence specifications (11.70%). Table (5)

As for nods priorities normalized by cluster, it can be seen that the highest impact within the residence criteria cluster was for physical characteristics (33%), with the least being social characteristics (15.40%). In supply parameters, the highest impact was for economic changes (27.27%), with the least being real estate speculation (16.23%). In the residence specifications cluster, the highest impact was for community nature, with the least being residence floor (7.20%). Table (4)

Table 5. Priorities of cluster

cluster PERIORITIES2	
Name	Limiting
Residence criteria	0.527303
Demand parameters	0.303.81
Supply parameters	0.311701
Residence specifications	0.117044

Fig (3) shows the relationship among relative weights of nodes impacting residence specifications. Results show that the highest impact over community nature is location uniqueness (0.148), followed by district properties (0.139), and interest rates (0.126). the least impact was for household composition (0.615), followed by age (0.543).

As for the nature of residence, the highest impacting nodes are: consumers' trust (0.803), followed by education (0.787), and ethnic origins (0.769). The lowest were age and economic properties; 0.313 and 0.477, respectively.

As for residence area, the highest impacting nodes were: household composition (0.615), followed by location uniqueness (0.492), and income and economic characteristics (0.477). the least were ethnic origins and age; 0.174 and 0.167, respectively.

As for residence floor, the highest impacting nodes were: age (0.965), followed by consumers' trust (0.401), and ethnic origin (0.285). The least were location uniqueness and social characteristics with zero for both.

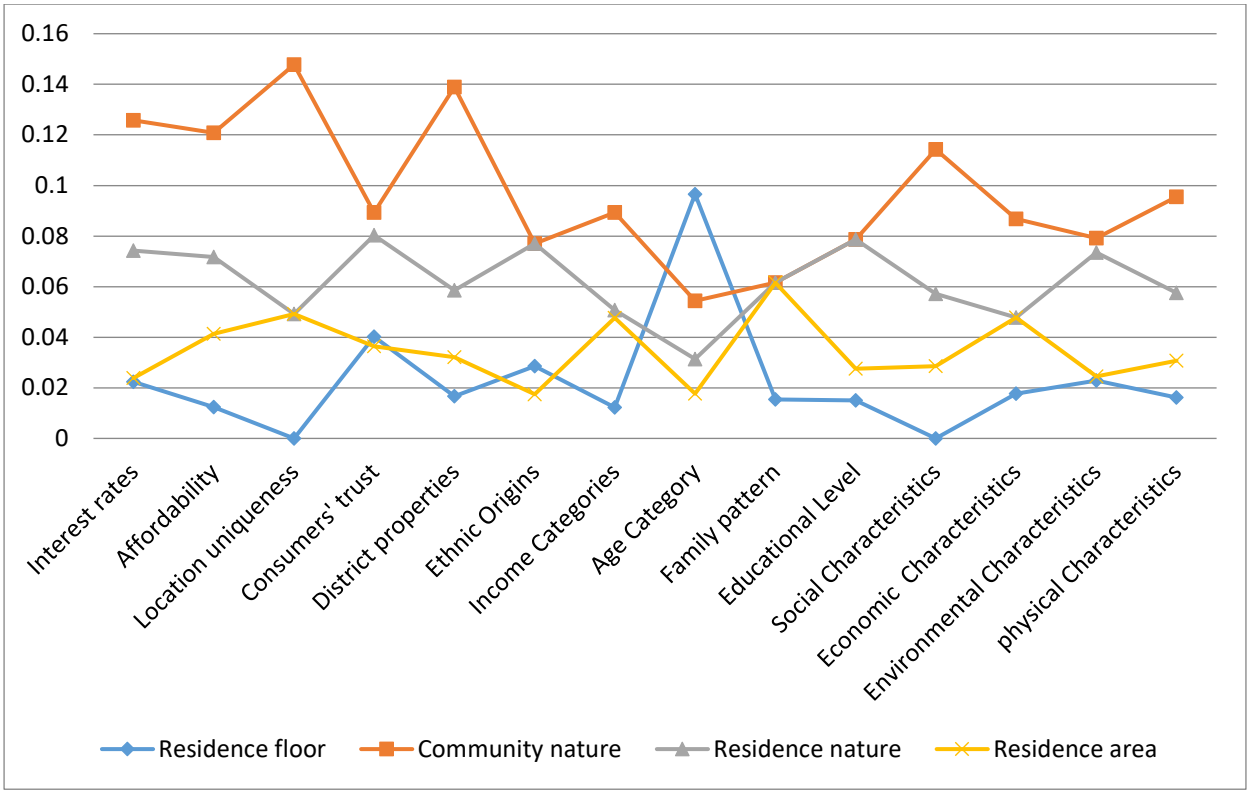

Figure 3. relationship among relative weights of nodes impacting residence specifications

Fig (4) shows the results of the pairs comparison between the demand and supply nodes. Comparison reveals that the highest influencing parameter on interest value is economic changes, whereas the least is real estate speculation. The highest parameter influencing real estate investment is affordability and the least is legislations. Location uniqueness is highly influenced by speculation, and is least influenced by economic changes. The highest parameter in consumers' trust is legislations and the least is speculation. District properties are highly influenced by speculation, and least influenced by political changes.

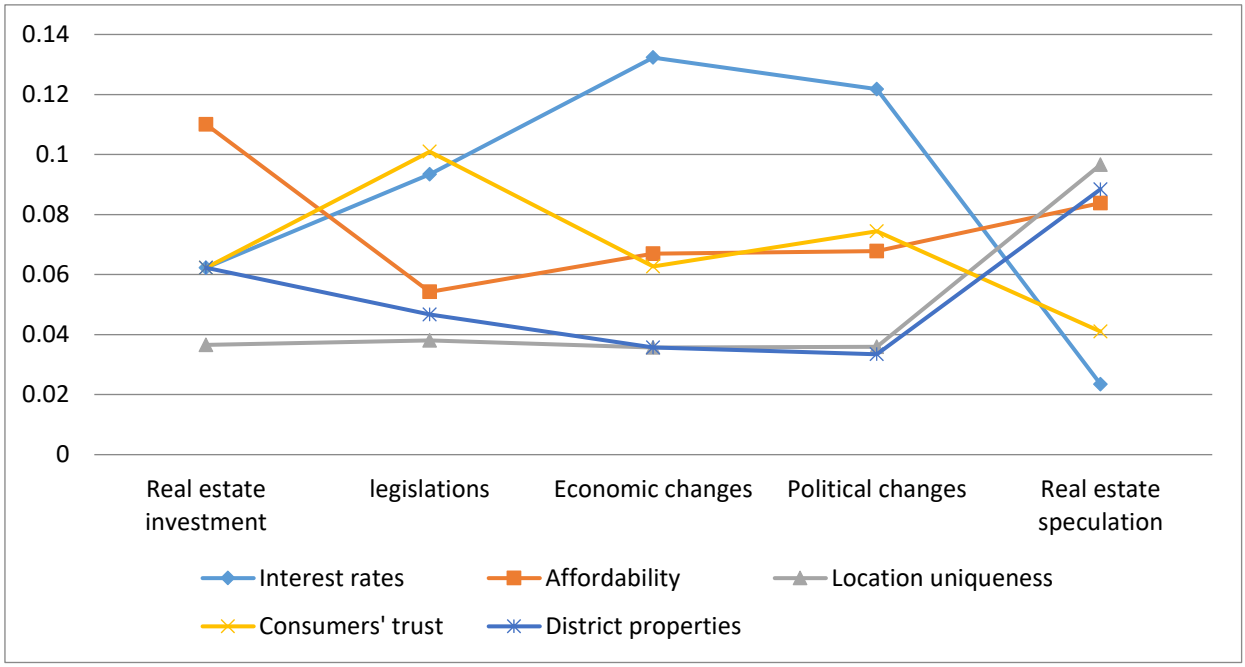

Figure 4. The results of the pairs comparison between the demand and supply nodes

6.1. Results of relevant subnetworks

As for the subnetworks, it can be seen that for the overall synthesized priorities for alternative, using normal results, priorities of sub-nods of residence nature were: family residence (0.14), followed by independent residence (0.11), and mixed residence (0.034). As for community nature the priorities were: gated community (0.25), followed by the new community (0.13), and the traditional community (0.035). As for residence floor, priorities were: higher than 3rd floor (0.037), and the ground floor (0.032), with the least being the first floor (0.019). As for residence area, priorities were as follows: <100 m^2 (0.077), with the least being >150 m^2 (0.006). Fig (5)

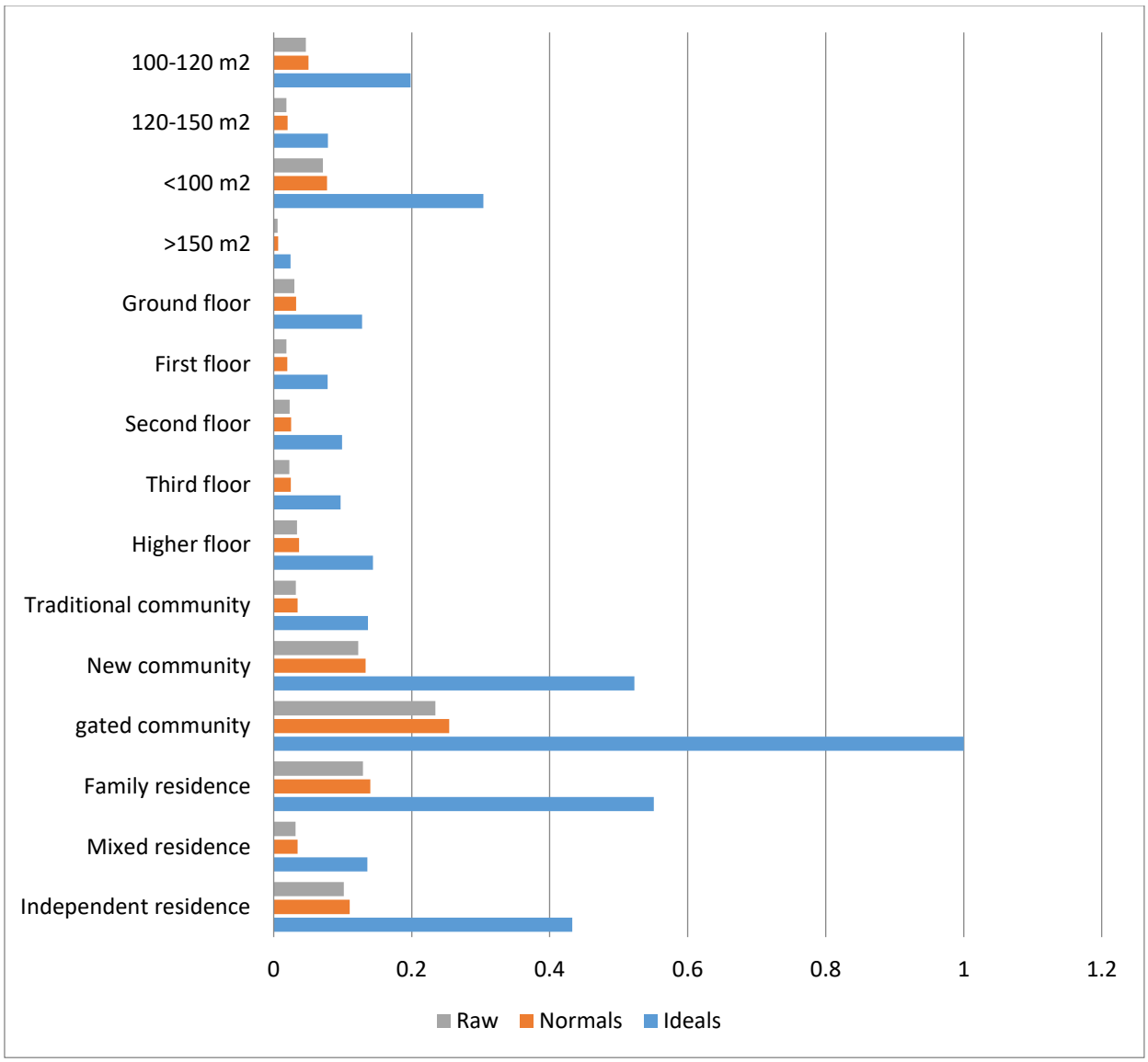

Figure 5. The overall synthesized priorities for alternatives

Subnetworks results for demographic characteristics show that the highest impact of residence satisfaction , within each main nods, was for without qualification people and extended families, age >50, income >15000, and rural origins. As for affordability, the highest impact was for the without qualification, nucleus families, age 20-35, income <2000, and rural origins. As for residence quality, the highest impact was for high qualification, compound families, age > 50, income > 15000, and urban origins. Fig (6)

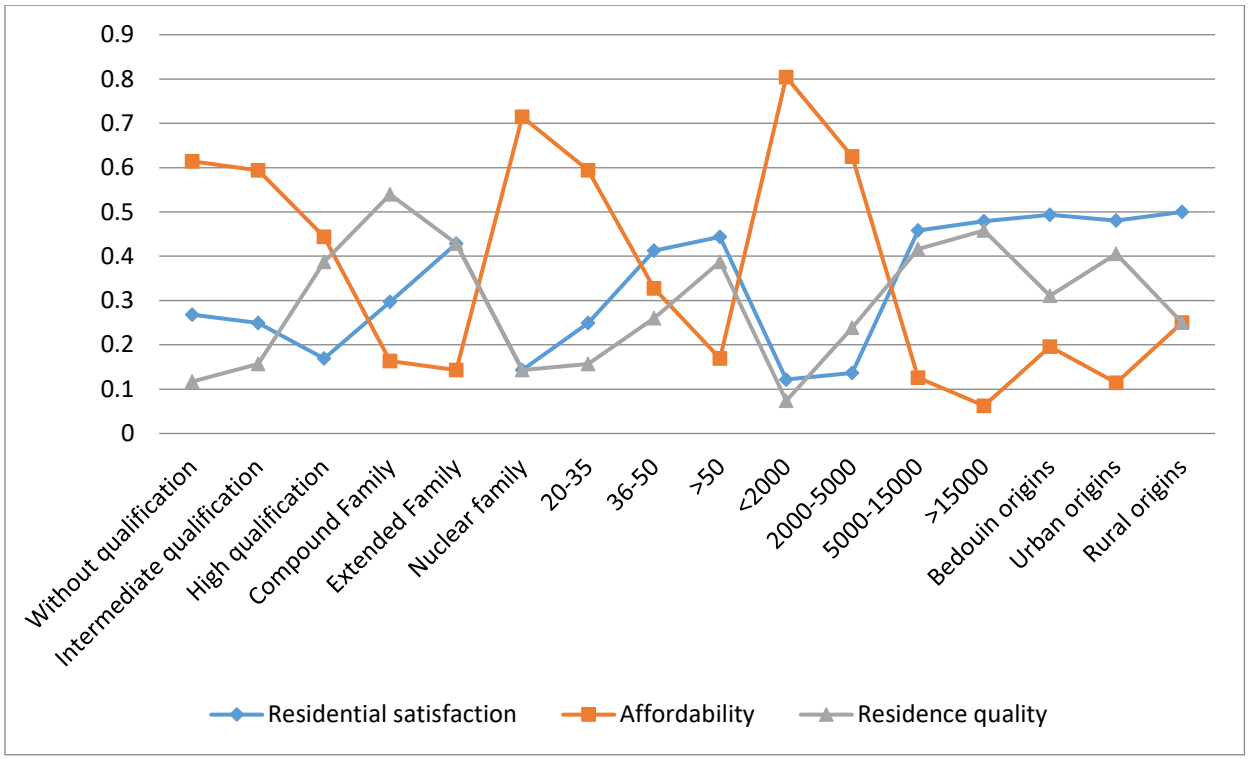

Figure 6. Subnetworks results for demographic characteristics

Fig (7) shows sub-results for each node of the residence criteria cluster. The highest in social haracteristics is tenure type, whereas the lowest is homogeneity. The highest in economic characteristics is residence burden, whereas the least is access to work. As for the environmental characteristics, the highest is access to services, whereas the least is landscaping. As for physical characteristics, the highest was district type, whereas the lowest was residence integrity.

In this paper, the model validity was checked for ensuring accuracy of results in two ways. The first adopts logical connections among model structures nodes based on data, research backgrounds, and expert help in specifying structure nodes and parameters. The second test was two five-expert sessions for discussing and analyzing model results and checking the validity and logic of results. Experts agreed that results are representative and logical in sequence and interconnection in mean results up to final results.

7. Discussion and conclusions

Results showed capacity of the model to give clear results for residence alternatives, with the required percentage for each alternative. This was done in a manner that does not rely on direct alternative assessment by targeted individuals. Rather, it was done by connecting them to variables controlling/influencing the percentage of such decision. Also, participation by experts in some decision structure phases and levels, which need cumulative experiences, affected balance of final model results. Model construction by linking decision making complexities and overlaps affected the ability to analyze results at all levels and increasing knowledge of demographic properties impacts in residents' selection of nodes within decision cluster as a whole or even their deep impacts on relative weights of prioritizing residence quality, satisfaction, or affordability as influencing parameters selected from the demographic characteristics cluster, in decision making at the higher levels up to selecting the desired residence. Also, the relationship among decision control clusters was analyzed for more knowledge of external effects on the housing market. Although results cannot be generalized to the small sample size and randomized selection, they represent a successful testing of the model efficacy and credibility.

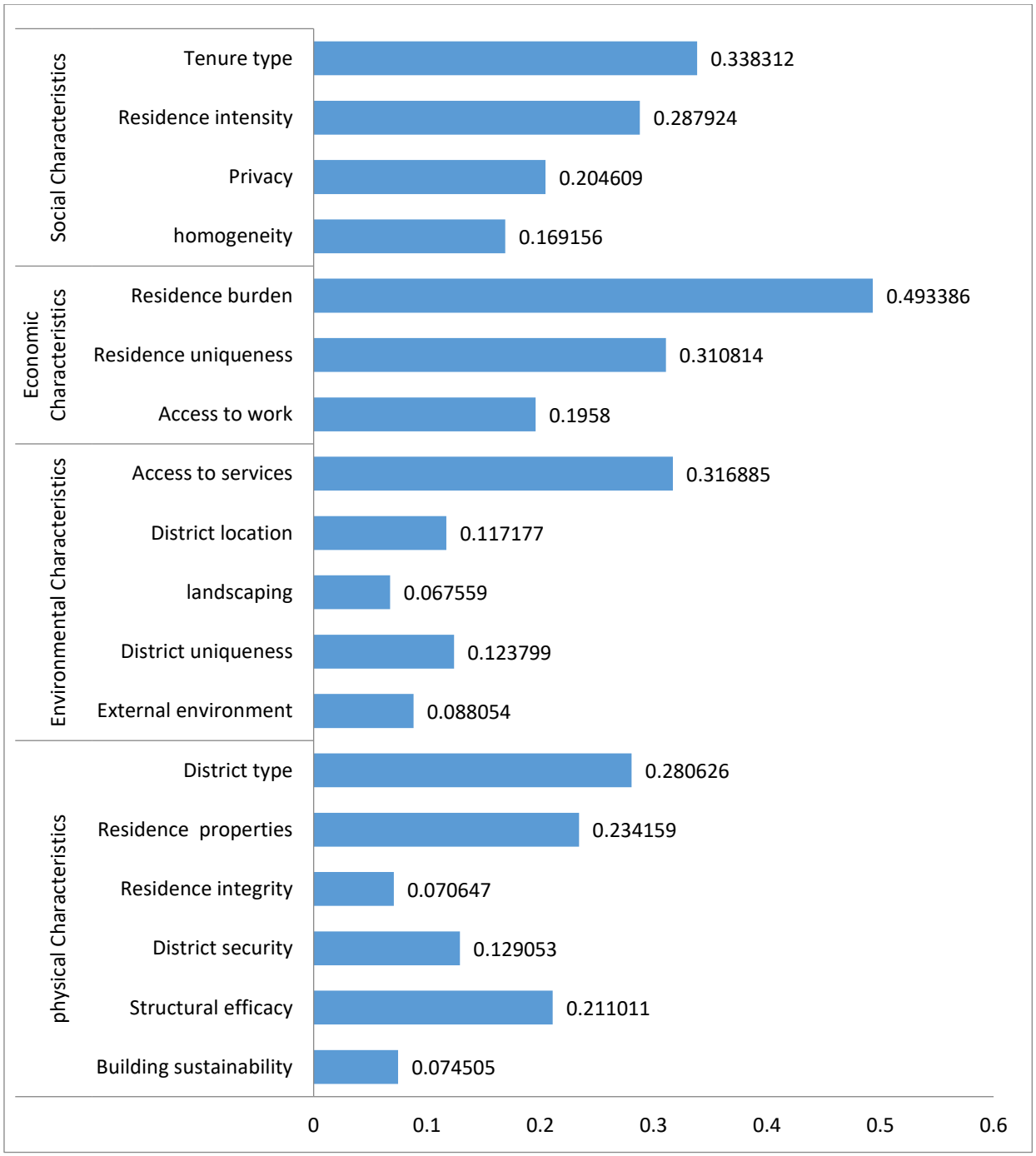

Figure 7. sub-results for each node of the residence criteria cluster

Final results showed that the majority of subjects selected luxury residence. This can be attributed to the high-income of most sample individuals, as confirmed by results analysis of network nodes. It was reflected, as in Fig (5), in a significant increase of the relative weight of enclosed community under the community nature node. It was accompanied by an increase in the relative weight of family and independent residence, as well as +3rd /ground floor; usually the closest to high-income selections. It was even at the cost of area; by selecting the highest area as <100m^2, followed by 100-120m^2, at the cost of >150m^2 which is supposed to be the most wanted by luxury level. This means that many luxury residence seekers turned to less areas to maintain luxury for a price they can afford for the desired residence.

Analysis of decision nodes priorities within the model structure for selecting an alternative, Table (4), shows that the highest impacting are economic changes, followed by affordability, interest rate, political changes, and real estate investment. This is seen from the relative weights of nodes considered by the model as model structure controlling

criteria for selecting the alternative; as such nodes are in the demand and supply clusters. This, again, confirms success of the model structure and nodes interconnecting network.

Analyzing the demographic characteristics results and their correlation with other results, Fig (6), it is found that affordability was the least influential for people from urban origins and those with >15000 income, >50 years old; who are supposed to have saved some money and have more money, extended families of more than two generations and higher economic condition, and university graduates who occupy positions that provide relatively stable financial status. These results conform to reduced interest of these clusters with the affordability node, and their focus on the other two nodes – residence quality and residential satisfaction – which express more affluence. This is confirmed by an opposing result of the increased impact of affordability for people with rural origins, people with <2000 L.E. income, youth between 20 and 35 who have less savings and job stability, nucleus families with reduced financial capabilities, the low-educated, and irregular workers. Such categories focus mainly on residence satisfaction in return for much less interest in residence quality which would increase cost.

Analyzing the impact of nodes of this cluster on residence selection specifications, Fig (3) , it can be seen that age impacts floor selection with less impact in other specifications. This is logical, as the elderly select lower floors in general to enjoy proximity to gardens or due to their health conditions. The education node focuses more on the nature of community and the nature of residence due to lifestyle and its social, cultural, and cognitive interconnections. Income is obviously important in selecting the nature of community, with much less impact in selecting the nature of residence which is clearly more impacted by ethnic origins that focus equally on the nature of community. Household composition had the largest impact in selecting residence area, as a result of household pattern impact on area.

Upon moving to analysis of residence criteria cluster, the highest cluster in decision structure according to relative weights of cluster in the structure, Table (4) shows – in the subnetwork of social characteristics – that privacy and social homogeneity did not have the highest impact, perhaps because the majority of sample individuals selected luxury residence in which the importance of such parameters diminishes relatively. This was accompanied by a clear priority given to tenure type. In the subnetwork, economic characteristics, residence burden had the highest weight. The lowest weight was given to access to work, perhaps due to high level of most of the sample individuals who can have a car to go easily to work – especially that the sample was selected in a new urban community. Access to district services and facilities had the highest impact in environmental characteristics; a result conforming to reality. Meanwhile, district location and district uniqueness came second in importance; being a major parameter – according to research background – in maintaining value of the residence commodity, which is considered according to the Egyptian style of real estate saving a method for increasing the value of savings. In terms of physical characteristics, the type of district had the highest impact, followed by residence features, and structural efficacy. This, too, confirms the above mentioned principle of achieving a safe economic residence value in addition to the required welfare.

In general, the impact of cluster nodes on selecting residence specification, Fig (3), shows that social and physical characteristics had the highest influence in community nature selection, the environmental characteristics had the highest influence in selecting the nature of residence, and the economic characteristics had the highest impact in determining residence area.

As for the analysis of decision control criteria, Fig (4), the demand cluster and the supply cluster, for which experts assessed node pairs, it can be seen that economic and political changes were the most influential on interest; being reflected on target groups ability to meet the requirements of buying residence with the help of mortgage. Meanwhile, legislations were the most influential in consumers' trust for spending their savings on purchasing a residence; perhaps due to legislative fluctuations accompanying political and economic turbulences in lasting for some time in Egypt and the corresponding changes of interest rates or residence purchase burdens such as real estate taxes, etc. Also, it was found that affordability is largely influenced by the size of economic investment and real estate speculation. Increasing the former leads to abundance in supply; thus reducing prices and raising the purchasing power of residents. Meanwhile, increasing speculation leads to the contrary; increasing real estate prices, followed by reduced purchasing power of residents. Also, results show that real estate speculation had a significant impact in selecting district properties and location uniqueness as developers interest in speculation is much higher when district properties and location uniqueness are higher; increasing the value of residence in a district and impacting the purchasing power

negatively and positively, as well as the purpose of purchasing – use or investment as is common in the Egyptian real estate market.

Analysis of the supply cluster nodes impact (the model did not specify direct correlation for pairs comparison among the nodes of demand impact and residence specifications clusters) on selecting residence specification, Fig (3), shows that district properties, location uniqueness, interest rates, and affordability are the highest impacting selection of district nature; in decision structure in general or within the cluster. This confirms, as previously indicated, the strength of the cluster in specifying the alternative in the decision structure. Also, consumers' trust had a high impact on determining the nature of residence, both in decision structure or within the cluster. Meanwhile, location uniqueness was the highest node within the cluster in terms of residence area determination.

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