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Qualitative Method by Points Applied to Determine the Localization of Housing of Social Interest - Case of Estudio Cuenca, Ecuador

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Abstract. Currently in Latin America the qualitative and quantitative deficit of low-income housing is high, due to multiple factors, social, political, economic, among them is the lack of urban land suitable for housing projects of this nature, then, the high costs of urban land, lack of provision of basic services, low density regulations in large areas, among other variables make it impossible to obtain adequate land, which makes it impossible to provide decent housing for the lower income class. Considering that in urban planning the option to sectorize and define the use of residential land, responds to the analysis of variables and territorial constants that enable decision making in benefit and safety of a population served, it must be choose the appropriate tools and methodology for guarantee an urban planning according to the reality and needs of each territory. There are many methods to analyze the relationship between the variables and constants, however, not all of them allow us to correctly define the right place to locate a housing project of social interest, therefore, through this research we intend to provide technical and methodological recommendations to determine the convenient location, considering as a case study the city of Cuenca, Ecuador. The qualitative method by points is applied in the case study, considering the variables; cost of land, proximity to the city center, availability of basic services, provision of equipment, road conditions, local restrictions and environmental factors, managing to reduce from the universe of 21 rural parishes to six potential sectors and then to a specific sector suitable for receiving and strengthen social housing due to its social and economic affordability. The method of analysis used, although it is simple and fast in its application, is effective for its objectivity and analytical system of variables, which allows to cross information from basic level to systematic information or meta-analysis, which guarantees the reliability of the expected results. Through the proposed methodological analysis is provided with basic urban planning strategies for the benefit of the neediest sectors which makes it possible to cover the qualitative and quantitative deficit of low-income housing in the city of Cuenca.

1. Introduction

The problems related to the qualitative and quantitative deficit of social interest housing in Latin America is worrisome, the lack of access to basic infrastructure services afflicts many families in the region: 21% lack electricity and sanitary facilities. 12% of homes are inadequate construction materials, while 6% have dirt floors or overcrowded conditions, which are harmful to health [1]. The economic reforms oriented to the market and the private sector that have been implemented in Latin America and the Caribbean in recent decades have brought with it important redefinitions in housing policies for



lower income households. These policies have shown that they can considerably expand the supply of social housing and reduce housing deficits. However, they have also paid insufficient attention to the qualitative deficit, the cost of land and the secondary market of these dwellings [2].

The Plan of Development and Territorial Ordering of Cuenca (PDOT) of 2011 indicated that the percentage of vacant lots in the city was high, and stated that the occupation of these sites should be promoted, as a measure tending to stop the disorderly growth of the city and tend to a uniform densification. These lots are mostly still close to the urban limits, adjacent to the main access roads, which has led to the creation of growth corridors [3]. The 2015 development plan states that the provision of services, infrastructure, equipment and others should focus on areas of the canton that present adequate conditions for densification, but excluding areas with environmental, forestry, conservation, productive, risk among others, and not only concentrate in the urban area nor occupy all the cantonal territory, because this would make it highly expensive, unsustainable and inefficient; then it argues that the settlement model should be based on strengthening certain parish headers and peri-urban areas through its vocation and the generation of several centralities, generating a network of hierarchical, articulated settlements, with services, infrastructure, equipment deconcentrated but compact in its morphology [4].

Taking as a basis this form of growth that the municipality has considered as a guideline, the sectors of urban expansion are analysed, establishing the most convenient method by applying the qualitative method by points.

2. Methodological strategies

There are several methods to analyse see Figure 1 the ideal location of a site within a project, however, not all of them contribute to obtain reliable results due to several parameters, among the most important are considered, the level of data analysed, ease of methodological application, easy interpretation results and relationship between variables. After the comparison of the advantages and disadvantages between the different methods, by experts in the economic and urban area it is established that the most reliable method to apply in the present case study is the qualitative method by points.

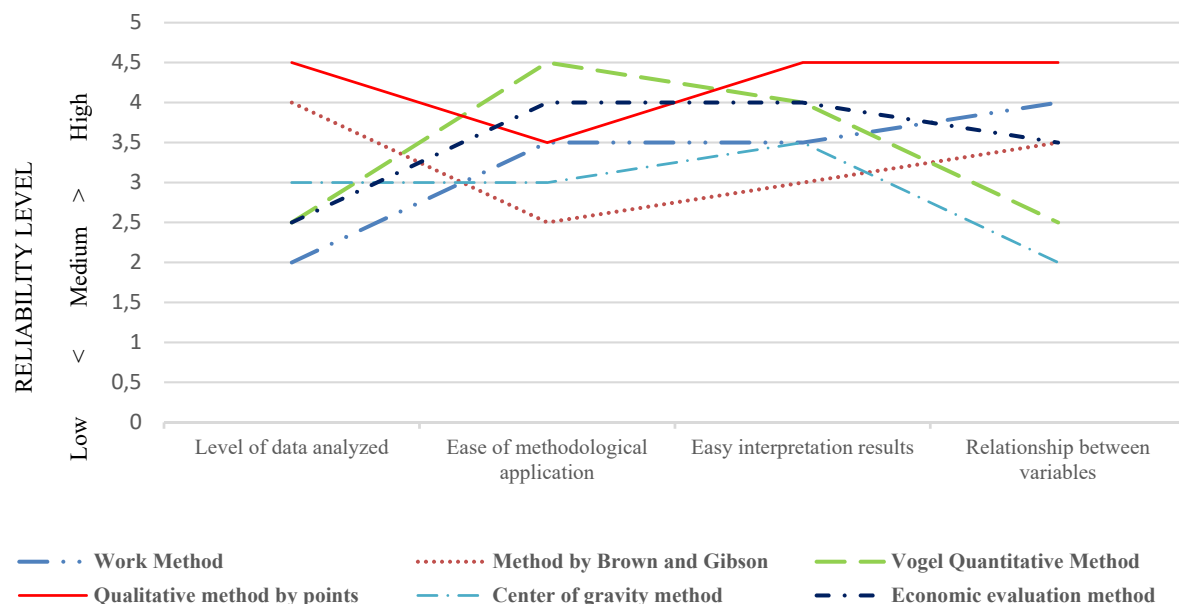


Figure 1. Reliability analysis of site location methods

2.1. Method of analysis

The qualitative method by points defined in the previous section, consists of establishing the main variables that determine the location of the site and assign weighted values of relative weight to each of them according to the importance attributed to them. The sum of the weighted scores with the highest score determines the most convenient option [5].

Before applying the method, it is necessary to determine the sectors to be intervened which were defined through the analysis of bibliographic documentation from the Development and Territorial Planning Plans of the city of Cuenca of this last decade.

2.2. Determination of the sectors to analyse

The canton Cuenca is divided into 15 urban parishes and 21 rural parishes are represented by the Parish Councils before the Municipality of Cuenca. In the PDOT 2009 diagnosis of the 21 rural parishes, the sectors of Challuabamba, Chiquintad, Ricaurte, San Joaquín and Sayausí were considered as consolidated or in expansion processes, where they are recommended as the most appropriate for the location of low-income housing programs, other sectors were not considered, such as the Cuenca-El Valle corridor for presenting an accelerated consolidation process since the PDOT proposal focused on reducing this trend, mainly due to topographical characteristics, road accessibility and high costs for the provision of infrastructure in these sectors [6].

In 2011 there is another PDOT where a model of polycentric settlements is proposed, which is conceived as the set of populated centres, of different sizes, complementary to each other, that share one or several economic - productive activities and that achieve a social cohesion, economic and territorial. In the application of this model, areas of development and articulation nodes of different levels have been identified [3]. The nodes of articulation are defined by the parishes of El Valle, Ricaurte, Baños, Tarqui and Sinincay.

In the PDOT 2015, Challuabamba is eliminated as an expansion zone because it became an urban area. Parishes such as Baños and Tarqui have a tourism and cattle-raising vocation respectively, so it is considered advisable not to favour larger settlements, leaving the urban parish areas of Sinincay, Chiquintad, The Valley, San Joaquín, Sayausí and Ricaurte, as an area of expansion conducive to becoming growth nodes with efficient settlements and less dependent on the city, for this reason these sectors of urban expansion are taken as a starting point for the analysis of location for social housing in the city of Cuenca.

2.3. Site location variables

The variables of location for a project vary depending on the objective pursued, for this case to be implementation of low-cost housing and to promote sustainable projects are analysed aspects; economic, social and environmental which have been prioritized to apply the selected methodology and establish the location of the appropriate site in the city of Cuenca. The variables inherent in the aspects mentioned are the following:

2.3.1. Transport: Mobility is related to the ease that a person must have to go from one place to another, to develop their activities, at appropriate times and using means of mobilization according to the design of the accessibility system of the territory and the cities. Mobility can be pedestrian, by motor vehicle or other alternative forms of transport [7].

The diagnosis made in the 2011 PDOT of Cuenca indicates that the greatest mobility that takes place internally in the canton of Cuenca, are the displacements from the city to the parishes and vice versa, it is 82.69%, while mobility external generates 17.31% of displacements. Internal mobility originates mainly by work and services, while external mobility, by services. The main routes for external mobility are the Cuenca Azogues, Cuenca - Molleturo and Cuenca - Tarqui routes, through which there is a passenger displacement of 72.47%, 10.06% and 17.47% respectively. In terms of internal mobility, the main displacement routes are: Cuenca-El Valle with 15.65%, Cuenca-Molleturo with 16.85%, Cuenca-

Baños with 12.40%. %, Cuenca-Checa with 24.75%, Cuenca-Llacao with 6.54% and others with the remaining 1.69%.

The Integrated Transport System that the Municipality has been working on since 2011 has created two transfer stations whose purpose is to integrate the most frequent routes with the origin and destination of greatest demand; By acting as a filter that reduces the number of trips to areas of greater road conflict, the inhabitants carry out their activities in optimal times, saving resources.

Additionally, it is proposed to implement a third transfer station on the Cuenca-El Valle route, on which there is an internal traffic of 15.65%. The UMT (Municipal Transport Unit) is in charge of controlling and regulating public transportation comprising 8 modes: conventional taxi, school and institutional transport, freight and tourism, mixed transport, light freight, heavy freight, urban bus, microregional and interparroquial. Currently the city has a qualified fleet and in good condition that covers the demand for almost all the transport in the urban and rural area of Cuenca, therefore the sectors established for the analysis all have an adequate service according to the demand, so this parameter, which is fundamental in the analysis of the location of a project, has not been taken into account for the assessment of the sectors, as it does not constitute a factor of imbalance.

2.3.2. Cost of land: The analysis of the cost of land is undoubtedly a basic factor for a social housing project, as this determines a greater or lesser cost of the building [8]. In Cuenca, land values are very variable, in one of the leading portals in real estate in Ecuador [9]. A reference of the cost of land in the analysis sectors has been found, which has allowed to value this factor see table 2.

2.3.3. Proximity to roads: This factor is important when choosing a land, but in this case, it does not apply because it is analysing sectors endowed with several roads.

2.3.4. Conditions of urban roads and roads: Regarding the road aspect, the information has been taken from the diagnosis of the roads in the rural area of Canton Cuenca, carried out in the thesis "La Ordenación de la Red Vial del Cantón Cuenca", [10] to qualify the state in each sector, the results can be seen in table 2.

2.3.5. Closeness to the centre of the city: The distance of a sector to the city's management centre is an important parameter to evaluate the location of a project, due to the high percentage of displacement registered from the parishes to the city indicated in the PDOT, in the case that concerns us. distances vary from 6 to 12Km., the obtained valuation is indicated in table 2.

2.3.6. Availability of basic services: The potable water service provided by the company ETAPA is considered one of the best in the country, according to the databases available according to the Population and Housing Census [7] the best equipped area in terms of basic services networks is the city of Cuenca, 89.26% of housing in the urban area has all the basic services, this is potable water, sewage, garbage collection, electricity and fixed telephony. In the rural area is where the largest deficit in terms of the availability of these services, the parishes best served are the parishes that are in the periphery. While the most distant as Santa Ana, Quingeo, Molleturo, Chaucha are the most disadvantaged. Consequently, any of the established sectors chosen for the location of the project have infrastructure and basic services.

According to data from the Central South Regional Electricity Company (EERCS), the electricity coverage of the canton of Cuenca is 98.43%, with the highest coverage of the urban area of the city with 99.64%. While rural parishes have less coverage. The information for the assessment of the sectors under analysis is indicated in table 1.

2.3.7. Equipment: The urban equipment is the set of buildings and spaces, predominantly for public use, where complementary activities are carried out to those of room and work, which provide the population with social welfare services and support for economic, social activities, cultural and recreational [11], [12]. Cuenca being the third city in the country, it concentrates equipment of different types, education,

health, management, cultural, provisioning, among others, many of which with a coverage radius with regional connotations.

- *Educational Equipment*: according to what is determined by the Education Law, education equipment is classified into 5 groups: Initial, Basic, Baccalaureate, University and Special. According to this classification, Canton Cuenca has a total of 544 facilities, of which 194 are located in the urban area and 350 are distributed in rural areas.
- *Health equipment*: in the city of Cuenca the health service is covered by entities such as: The Ministry of Public Health (MSP), The Ministry of Social Welfare (MBS), The Ecuadorian Institute of Social Security (IESS), The Illustrious Municipality of Cuenca, The Armed Forces, some foundations and public entities. The city is served by: Mobile Units, Health Posts, Subcentres of Health, Health Centres, Clinics and Hospital.
- *Social Welfare*: Social Welfare Equipment is divided into 7 types, according to the function, coverage and attention to various social aspects. These are: Children's nurseries. Child Development Centre (CNH). Home, Shelter or Shelter. Residence for the elderly. Centres of social reintegration. Special education centre. Health centres for people with disabilities and high risk. Cemetery

Among others of the important equipment's are those of security, recreation, cultural, provisioning, administration and management; The percentage of the provision of service equipment in the sectors analysed is shown in table 1.

2.3.8. Local restrictions:

- *Flood risk*: The information to assess this factor is taken from the 2015 PDOT where the risks of flooding in the different sectors of the canton are indicated on a map, classifying them at zero, low, medium, high and very high risk.
- *Landslide risk*: Information is obtained from the National Secretariat for Risk Management (SNGR), which identifies landslide hazard zones.
- *Municipal Protected Areas*: The Environmental Management Commission (CGA) of the Municipality of Cuenca through a consultancy that ended in 2014 (considering the classification of land use and coverage, the Forest Areas and Protective Vegetation administered by the Ministry of the Environment and aerial photographs) determined 10 areas that have the potential to be declared as Municipal Protected Areas (APM), these spaces are key to the conservation and sustainable development of the canton. With this information, the sectors where settlements can be supported without the subsequent risk of affecting or losing these areas are valued with higher scores.

2.3.9. Environmental factors:

- *Assessment of the landscape*: The 2015 POT considers the assessment of the landscape as the scenic interest of a site that presents the aspects of structure, texture, colour, smell, natural and anthropic elements, and values them as follows: Very high; High mountain structures and lagoons, texture with zones of uniform vegetation, green colours, smells to environmental freshness, domain of natural landscape. It also includes the Historic Centre of Cuenca for its value of built landscape. High; Structure of high and steep areas, variable texture, colour and variable smell, natural landscape characterized by hills. Sites of historical and cultural anthropic origin. Medium; Upland areas mainly dominated by a type of vegetation, green and brown colours, smell of freshness and humidity, areas with patches of forest, lagoons, wetlands and streams, in this class the city of Cuenca is

incorporated because its configuration includes rivers, parks and green areas. Medium Low; Areas of low height, medium grain with mixtures of crops, intense green colours, mixtures of livestock, natural and urban smells. Low; Plain topography, grain texture of monocultures, green colour, smells characteristic of agricultural areas This assessment is expressed in a map by colours that covers the entire canton of Cuenca and therefore the study sectors of this research, with this information we proceed to evaluate the sector.

- *Air quality*: In the 2015 POT it is indicated that in the canton of Cuenca the atmospheric contamination is not worrisome according to the Ecuadorian norm, however at the level of population centres if there are health conditions due to this cause, above all to the respiratory system. An air quality report carried out by the Mobility, Transit and Transportation Company (EMOV EP), indicates that the emission of fine particulate matter (PM10) such as dust, soot and smoke that damages air quality, in 2015 was of 39.9 $\mu\text{g} / \text{m}^3$, an index that, although they do not exceed the limits established by the Ecuadorian standard of air quality, 50.0 $\mu\text{g} / \text{m}^3$, grows permanently. The main source of pollution is the vehicular traffic that contributes with 75% of the emissions evaluated. The map of air pollution that includes the PDOT 2015 shows the areas where the emission of pollutants is high over time and constitutes a possible risk to the health of the population, the marked areas are established by threats and vulnerabilities where the threat constitutes the zones with high emission of pollutants, while the vulnerability is established by the presence of population settlements and characteristics of their population. The dispersion of pollutants at the cantonal level is given by the topography of the area and by the characteristics of the emission sources, the area of greatest risk is set in the city of Cuenca. The parish headers that also present problems of air pollution are: Turi, Sayausí, San Joaquín, Tarqui, Chaucha and Molleturo, of which Turi would be supporting the pollution that occurs in the city of Cuenca.
- *Green spaces*: Green areas are usually located according to the availability of sites within the urban boundary, do not keep any planning according to population requirements and determinations of use of the sectors, it is important to highlight that approximately 30% of the green areas of the city are integrated by margins of protection of rivers, spaces that in their majority should be constituted in zones of native vegetation for the ecological stability of the river. For the rest, there is no green network connectivity. With the index of green area by parish of the canton Cuenca, the sectors in analysis are valued.

3. Presentation of results

In the study, it has been considered that all variables are equally important, so it is not weighted, we proceed to assign a rating to each of them according to a predetermined scale of one to five based on the data obtained in the information collection. The sum of the ratings allows selecting the location that accumulates the highest score. The consolidated information of the location variables for each sector according to the information obtained and explained is indicated below in table 1.

Table 1. Values obtained from location variables by sector

VARIABLES		SECTORS					
		Sinincay	Chiquintad	El Valle	San Joaquin	Sayausí	Ricaurte
Cost of land	Average cost of land (dollars / m ²)	81.81	12.29	57.56	133.85	84.82	141.82
Closeness to the centre of the city	Distance from Cuenca to the parish seat (km.)	12	14	10	6	8	6
Availability of basic services	Drinking water coverage by public network	85.90%	67.50%	75.20%	68.10%	54.60%	94.20%
	Coverage of sewer system systems	44.90%	23.10%	31.10%	41.40%	36.60%	66.30%
	Garbage collection service coverage	55.00%	65.00%	78.00%	81.00%	80.00%	83.00%
	Fixed telephone service coverage	39.60%	51.10%	42.70%	47.40%	47.70%	49.60%
	Electric power service coverage	97.50%	97.90%	97.00%	97.40%	97.60%	98.30%
Equipment provision	Education	50.54%	73.33%	47.13%	67.06%	67.66%	43.23%
	Health	100.00%	100.00%	76.85%	76.13%	74.20%	32.45%
	Social welfare	77.28%	75.00%	76.13%	75.00%	98.93%	77.96%
	Security	83.33%	83.33%	74.20%	83.33%	83.33%	59.96%
	Recreation	46.77%	46.61%	32.45%	59.96%	45.03%	44.55%
	Culture	72.80%	100.00%	22.60%	99.32%	88.10%	64.78%
	Provisioning	74.27%	66.67%	70.43%	66.67%	79.37%	76.25%
Conditions of urban roads and roads	Administration and management	60.00%	40.00%	58.00%	40.00%	40.00%	60.00%
	Road service level / 100 points	66	80	78	83	85	78
Local restrictions	Flood risk	Low	Low	Medium	Medium	Medium	Medium
	Landslide risks	Low	Medium	Medium	Medium	Medium	Low
	Municipal protected areas	Does not have	Does not have	668.71 Ha	Does not have	1694.39 Ha	Does not have
Environmental factors	Assessment Landscaping	Medium Low	High	Medium	Very high	Very high	Medium
	Risk of air pollution	High	Low	High	Medium	Medium	High
	Green area index m ² / ha	3.3	0.2	3.5	0.2	0.4	2.8

Source: Bibliographic and field consultations

According to the methodology explained, the score was assigned in the scale from 1 to 5 for each variable, where 5 is the score for the best conditions, the ranges for the score were defined based on the data obtained for each sector between the maximum and minimum values, or of the twenty-one parishes when the values did not allow establishing an appropriate range, this is expressed in table 2.

Table 2. Valuation of the variables for the analysis of the sectors

VARIABLES		SCORE				
		5	4	3	2	1
Cost of land	Average cost of land (dollars / m ²)	up to \$30	from \$31 to \$60	from \$61 to \$100	from \$101 to \$140	more than \$140
Closeness to the centre of the city	Distance from Cuenca to the parish seat (km.)	up to 5 Km	from 6 Km to 10 km	from 11 Km to 15 Km	from 16 Km to 20 Km	more than 21 Km
Availability of basic services	Drinking water coverage by public network	more than 90%	from 81% to 90%	from 71% to 80%	from 61% to 70%	less than 60%
	Coverage of sewer system systems	more than 90%	from 81% to 90%	from 71% to 80%	from 61% to 70%	less than 60%
	Garbage collection service coverage	more than 90%	from 81% to 90%	from 71% to 80%	from 61% to 70%	less than 60%
	Fixed telephone service coverage	more than 90%	from 81% to 90%	from 71% to 80%	from 61% to 70%	less than 60%
	Electric power service coverage	more than 90%	from 81% to 90%	from 71% to 80%	from 61% to 70%	less than 60%
Equipment provision	Education	more than 90%	from 81% to 90%	from 71% to 80%	from 61% to 70%	less than 60%
	Health	more than 90%	from 81% to 90%	from 71% to 80%	from 61% to 70%	less than 60%
	Social welfare	more than 90%	from 81% to 90%	from 71% to 80%	from 61% to 70%	less than 60%
	Security	more than 90%	from 81% to 90%	from 71% to 80%	from 61% to 70%	less than 60%
	Recreation	more than 90%	from 81% to 90%	from 71% to 80%	from 61% to 70%	less than 60%
	Culture	more than 90%	from 81% to 90%	from 71% to 80%	from 61% to 70%	less than 60%
	Provisioning	more than 90%	from 81% to 90%	from 71% to 80%	from 61% to 70%	less than 60%
	Administration and management	more than 90%	from 81% to 90%	from 71% to 80%	from 61% to 70%	less than 60%
Conditions of urban roads and roads	Road service level / 100 points	more than 90%	de 81 a 90	de 71 a 80	de 61 a 70	less than 60%
Local restrictions	Flood risk	Null	Low	Medium	High	Very high
	Landslide risks	Null	Low	Medium	High	Very high
	Municipal protected areas	Does not have	from 1 ha to 500 ha	from 501 ha to 1000 ha	from 1001 ha to 1500 ha	more than 1501 ha
Environmental factors	Assessment Landscaping	Low	Medium Low	Medium	High	Very high
	Risk of air pollution	Does not have	Low	Medium	High	Very high
	Green area index m ² / ha	more than 3	from 2 to 3	from 1 to 2	from 0.6 to 1	Less than 0,5

Source: Bibliographic and field consultations

According to the predetermined scale in table 2, each variable is qualified for each analysis sector. The total result from the summation of the scores is indicated at the end of table 3.

Table 3. Qualification of location factors for each sector

VARIABLES		SECTORS					
		Sinincay	Chiquintad	El Valle	San Joaquín	Sayausí	Ricaurte
Cost of land	Average cost of land (dollars / m ²)	3	5	4	2	3	1
Closeness to the centre of the city	Distance from Cuenca to the parish seat (km.)	3	3	4	4	4	4
Availability of basic services	Drinking water coverage by public network.	4	2	3	2	1	5
	Coverage of sewer system systems	1	1	1	1	1	2
	Garbage collection service coverage	1	2	3	4	3	4
	Fixed telephone service coverage	1	1	1	1	1	1
	Electric power service coverage	5	5	5	5	5	5
Equipment provision	Education	1	3	1	2	2	1
	Health	5	5	3	3	3	1
	Social welfare	3	3	3	3	5	3
	Security	4	4	3	4	4	1
	Recreation	1	1	1	1	1	1
	Culture	3	5	1	5	4	2
	Provisioning	3	2	2	2	3	3
	Administration and management	1	1	1	1	1	1
Conditions of urban roads and roads	Road service level / 100 points	2	3	3	4	4	3
Local restrictions	Flood risk	4	4	3	3	3	3
	Landslide risks	4	3	3	3	3	4
	Municipal protected areas	5	5	3	5	1	5
Environmental factors	Assessment Landscaping	3	2	4	1	1	4
	Risk of air pollution	2	4	2	3	3	2
	Green area index m ² / ha	5	1	5	1	1	4
TOTAL SCORE		64.00	65.00	59.00	60.00	57.00	60.00

Source: Bibliographic and field consultations

4. Discussion of results

From the analysis of the location factors by the quantitative method by points, the sectors of Chiquintad and Sinincay turn out to be the most convenient, followed by San Joaquín and Ricaurte, then the Valley and finally Sayausí, of the first two that obtain 65 and 64 points respectively, the relevant variables favourable to Sinincay are: a greater water coverage and the green area index, while a lower cost of land, greater provision of educational and cultural equipment and a lower degree of environmental pollution of the Chiquintad stand out. sector.

In addition to having Chiquintad four of six variables in its favour, considering that the location of the site is for social housing, therefore directed to a human group of scarce resources, it is important to reduce costs in the building and one of the factors that influence The cost of a project is undoubtedly the value of the land, a problem that is precisely the city of Cuenca with the exaggerated value of the land, from this perspective as can be seen in table 1, the average cost of land in Chiquintad is Six times lower

than in Sinincay, for this circumstance it is considered that the best option for locating housing programs of social interest is the Chiquintad sector.

5. Conclusions

In the analysis of the location of projects, the specialized literatures define variables for macro and micro localization according to their context and the objective to be achieved, in the present research those that favour the development of sustainable housing projects of social interest are needed.

The method of analysis used, although it is simple and fast in its application, is effective for its objectivity and analytical system of variables, which allows to cross information from basic level to systematic information or meta - analysis, which guarantees the reliability of the expected results. The qualitative method by points is applied in the case study, considering the variables; cost of land, proximity to the city centre, availability of basic services, provision of equipment, road conditions, local restrictions and environmental factors, managing to reduce from the universe of 21 rural parishes to six potential sectors and then to a specific sector suitable for receive and strengthen social housing due to its social and economic affordability.

Through the application of the methodology it is possible to determine the rural parish of Chiquintad as the best option for the settlement of social housing for the benefits both in terms of infrastructure, equipment, cost of land, distance to the city centre, local restrictions and environmental factors, determined in the evaluation matrix of the location variables.

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