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A Multicriteria Decision analysis Model for Finding the Optimal New Bank Branch Location

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Abstract: *The development of a commercial branch network is very critical to the profitability of the business. The geographical location of a store and its significance can be confirmed by the large differences in the turnover of the stores from the same chain. In the past years, solving an optimal location problem for the establishment of bank, commercial or other branches was based particularly on empirical studies. However, many of these studies did not use quantified methods and there was no accuracy in the results. In this study, the main problem is divided into smaller problems so that the results can be presented with precision and greater detail. In this way, it is possible to study and analyze all the individual parameters and data of each smaller sub-problem. This rationalizes the decision-making process, achieving results that are not only useful for making decisions for the present but also for the future. Another new feature introduced by this study is the justification of the scores given by the researcher on the criteria and alternatives. This is succeeded by comparing the values of the measurable sizes of the alternatives. For non-measurable sizes, scoring is justified based on qualitative data. This methodology is fully in-depth and quantified using AHP method and other appropriate analytical techniques. In addition, it also offers better knowledge to entrepreneurs about the market in which they operate. It refers to the visualization, analysis and identification of markets based on geographical, economic and demographic criteria with the goal of optimal locating a business store. It can be applied in areas such as: corporate and private banking, commercial enterprises, electronics, telecommunications etc.*

Keywords*: AHP, multicriteria analysis, optimal location, Superdecisions*

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I. Introduction

The development of a business's branch network is very important for its viability. The significance of its geographical location can be confirmed by the large differences in the turnover between stores from the same chain. As for the banking sector especially, during the past few years, there have been enormous changes globally. The low cost of creating and operating support of bank branches and several new ways of banking such as ATMs, phone banking, internet banking etc. have made the Banks very selective towards the creation and development of new bank branch. The establishment of a new banking unit is an important part of the planning and network management of several large banking institutions, being a complex decision-making process between various possible alternatives.

The methodology presented is widespread in international markets and has been applied in areas such as: corporate and private banking, commercial enterprises, electronics, telecommunications etc. It rationalizes the decision-making process, giving precise results not only useful for present but also for future decisions. This study consists of a fully in-depth and quantified methodology which uses AHP method and other appropriate analysis techniques, offering better knowledge to entrepreneurs about the market in which they operate. It refers to the visualization, analysis and recognition of location-markets based on geographical, economic and demographic criteria with the goal of finding optimal store location for a business or organization.

II. Material And Methods

2.1 Description of the problem and analysis of the given data

A Greek commercial bank in the framework of the development of its network plans to establish a new branch. The Bank has a full presence in almost the entire country except three locations: ***1) NORTH LOCATION, 2) SOUTH LOCATION*** and ***3) EAST LOCATION***. The selection of the propriate location is based on the following criteria:

1. ***Population coverage (POPULATION)***: Expresses the number of potential customers that the branch could attract in this region.

2. ***Total amount of income of local individuals (INCOME)*:** The average per person income reporting in each region multiplied by the number of tax declarations submitted. The resulting amount is the total amount of income in the region.

3. ***Region of establishment (REGION)***: The geographical position where the new branch will be located.

4. ***Competition in the region (COMPETITION)*:** The level of competition in the candidate locations, which plays a key role in attracting and collaborating with potential customers.

5. ***Cost of the Investment (COST)*:** In what cost the total amount of the investment will reach.

The decision of the Bank's management to select the location of this store will be based on the multi-criteria linear programming, using the AHP method. What must first be calculated is the degree of importance of the five criteria between them. As is well known, the importance of any criterion is subjective, since for example for a Bank it is more important to contain costs, while for another Bank it is more important to acquire market share in a new area etc.

In this study, the Bank's management prioritizes the criteria as below: It wants to set as dominant a criterion that is more "objective", more stable in changes over time and more "faithful". The Population criterion is a very important and measurable criterion. However, it cannot be the dominant one because no one can calculate the exact change in the population of an area over a decade, nor can it count on the residents of an area who live and work there occasionally. There is also the case with the criterion of the total declared Income of individuals. There are also expected and reasonable deviations in the number of tax returns of individuals submitted, the average declared income of each taxpayer, etc. This happens because of the phenomenon of tax evasion, where individuals, especially self-employed people, declare less income than they really earn. There is also the phenomenon of someone living and working in a place, but for various reasons makes his tax declaration elsewhere. Therefore, although Income is a very important factor in choosing a location to set up a bank branch, it cannot be defined as the dominant factor. Thus, it must be calculated which of the three remaining criteria is the dominant one. In order of importance, first comes the criterion of Region, because it is considered by the Bank to have a branch in an already developed, or with many prospects area with shopping streets, factories, businesses, etc. In this way, greater benefits will be reaped over time from new partnerships, new customers and businesses, in a dynamic and intense economic and corporate area. Then follows the Competition criterion, since the market share by opening a new branch in an area with low or even zero competition will be quite large. Then, follows the Cost criterion, a very important factor especially in the circumstances of the great economic crisis.

After the first three criteria mentioned above, income follows as the same importance as the Population. This is because a high declared income of a region means that the individuals who declare it (such as employees, pensioners, etc.) can be the core clientele with which the new store will develop partnerships and agreements. Equally important for the same reason is the element of Population. Summarizing, the importance and the weight of each criteria in order and percentage of priority as assessed by the bank's management could be:

1. REGION 27%
2. COMPETITION 23%
3. COST 20%
4. INCOME 15%
5. POPULATION 15%

TOTAL OF CRITERIA WEIGHTS 100%

Once the weights of the five criteria are set, the AHP values should be fairly constructed in order to be applied to Superdecisions program. A fair grading could be based in the percentage of the relative difference between the weights of the criteria. (Table 2.1.1).

Table 2.1.1 Scale of Relative difference in weights between the five criteria

RELATIVE DIFFERENCE IN WEIGHTS %	AHP VALUE
0	1
(0- 12,5%]	2
(12,5 - 25%]	3
(25 - 37,5%]	4
(37,5 - 50%]	5
(50-62,5%]	6
(62,5-75%]	7
(75-87,5%]	8
(87,5-100+%)	9

An example with Region (27%) and Competition (23%): Region is by 17,39% more important than Competition (27-23=4 and 4/23 = 17,39%). So, Region is dominant grade 3 in the AHP scaleagainst Competition. Also, Region is by 35% more important than Cost (27-20=7, 7/20 = 35%). So, Region is dominant grade 4 in the AHP scale against Cost and so goes on and the table of bbinary criteria comparisons is made (Table 2.1.2).

Table 2.1.2: Table of Binary Criteria Comparisons

REGION	9	8	7	6	5	4	**3**	2	1	2	3	4	5	6	7	8	9	**COMPETITION**
REGION	9	8	7	6	5	**4**	3	2	1	2	3	4	5	6	7	8	9	**COST**
REGION	9	**8**	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**INCOME**
REGION	9	**8**	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	**POPULATION**
COMPETITION	9	8	7	6	5	4	**3**	2	1	2	3	4	5	6	7	8	9	**COST**
COMPETITION	9	8	7	**6**	5	4	3	2	1	2	3	4	5	6	7	8	9	**INCOME**
COMPETITION	9	8	7	**6**	5	4	3	2	1	2	3	4	5	6	7	8	9	**POPULATION**
COST	9	8	7	6	5	**4**	3	2	1	2	3	4	5	6	7	8	9	**INCOME**
COST	9	8	7	6	5	**4**	3	2	1	2	3	4	5	6	7	8	9	**POPULATION**
INCOME	9	8	7	6	5	4	3	2	**1**	2	3	4	5	6	7	8	9	**POPULATION**

Next, the analysis of the data and the comparison for each of the three alternatives:

1. POPULATION

In the following table, the data of population of the three locations is presented. (Table2.2.1).

Table2.2.1: Data of population

POPULATION		
NORTH LOCATION	**SOUTH LOCATION**	**EAST LOCATION**
14.168	**20.000**	**13.270**

It is obvious that the larger population means the greater in importance. SOUTH LOCATION (20.000) is shown here, followed by NORTH LOCATION (14.168) and finally comes EAST LOCATION (13.270). SOUTH LOCATION is 41.2% larger in population than NORTH LOCATION and 50.7% from EAST LOCATION. NORTH LOCATION is 6.7% larger in population than EAST LOCATION. Considering that each value from 2 to 9 on the scale corresponds to an increasing difference of 12.5% of one population to the other, the comparisons are show as follows (Table 2.2.2):

Table 2.2.2: Population difference in AHP scale

DIFFERENCE IN POPULATION%	**AHP VALUE**
0	**1**
(0- 12,5%]	**2**
(12,5 - 25%]	**3**
(25 - 37,5%]	**4**
(37,5 - 50%]	**5**
(50-62,5%]	**6**
(62,5-75%]	**7**
(75-87,5%]	**8**
(87,5-100+%)	**9**

Table 2.2.3: Table of binary comparisons of alternativesfor the criterion of Population

SOUTH LOCATION	9	8	7	6	**5**	4	3	2	1	2	3	4	5	6	7	8	9	**NORTH LOCATION**
SOUTH LOCATION	9	8	7	**6**	5	4	3	2	1	2	3	4	5	6	7	8	9	**EAST LOCATION**
NORTH LOCATION	9	8	7	6	5	4	3	**2**	1	2	3	4	5	6	7	8	9	**EAST LOCATION**

2. INCOME

In the tables below are given the data with the declared average incomes over the last five years for each group of individuals (employees, professionals, farmers, etc.).

Table 2.3.1: Declared income of individuals of NORTH LOCATION

AVERAGE INCOME OF THE LAST FIVE YEARS IN EURO			
	NORTH LOCATION		
	NUMBER OF TAX DECLARATIONS	AVERAGE INCOME	TOTAL INCOME
TOTAL	8.967	13.023,5	116.781.770

Table 2.3.2: Declared income of individuals of SOUTH LOCATION

AVERAGE INCOME OF THE LAST FIVE YEARS IN EURO			
	SOUTH LOCATION		
	NUMBER OF TAX DECLARATIONS	AVERAGE INCOME	TOTAL INCOME
TOTAL	12.643	15.682	198.269.413

Table 2.3.3: Declared income of individuals of EAST LOCATION

AVERAGE INCOME OF THE LAST FIVE YEARS IN EURO			
	EAST LOCATION		
	NUMBER OF TAX DECLARATIONS	AVERAGE INCOME	TOTAL INCOME
TOTAL	6.300	13.949	87.876.997

The criterion of declared income plays an important role in choosing a region as the appropriate one to open a new bank branch. Here, SOUTH LOCATION leads with €198.269.413, followed by NORTH LOCATION with €116.781.770, and EAST LOCATION with €87.876.997 comes last. By calculating the differences in the incomes of the regions, SOUTH LOCATION appears with 125.62% higher declared income than EAST LOCATION and 69.77% higher declared income than NORTH LOCATION. Finally, NORTH LOCATION has 32,89% higher declared income against EAST LOCATION.

The table below represents the 2-9 comparison scale and is divided into 25% range classes indicating the difference between the incomes of the three locations. The first class indicates equality and therefore zero difference between two alternatives (Table 2.3.4).

Table 2.3.4: Difference in Income in AHP scale

DIFFERENCE IN INCOME %	AHP VALUE
0	1
(0- 25%]	2
(25 – 50%]	3
(50 - 75%]	4
(75 – 100%]	5
(100-125%]	6
(125-150%]	7
(150-175%]	8
(175-200+%)	9

Table 2.3.5: Table of binary comparisons of alternatives for thecriterion of Income

SOUTH LOCATION	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	EAST LOCATION
SOUTH LOCATION	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	NORTH LOCATION
NORTH LOCATION	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	EAST LOCATION

3. REGION

The geographical position of a location plays a very important role in its choice for the establishment of a new banking store. Below are the characteristics of the three candidate regions in terms of their geographical location:

- **NORTH LOCATION**

This location stands in the northern of Greece. Its economy is mainly agricultural. Fruits, vegetables and wine are produced there. Near the center is the train station. A reference point of the area is its beach, where several shops of health interest (cafes, restaurants, etc.) are active seasonally during the summer. Many of them operate in the winter, serving the needs of the area. This coastal zone extends quite close to the under construction New Port of the wider area. This area is also home to most of the small businesses, which are mostly family-run. There is not a significant number of large factories and large enterprises in the area.

- **SOUTH LOCATION**

It is a semi-central residential complex on the south side of the country, with intense growth especially in recent years. Its main feature is the high population concentration with a population estimated over 20.000 inhabitants. A point of significant commercial interest is its main street, the coastal road in the marina area and on the border of the old Port, with great growth in terms of businesses of all kinds. There is also a large residential development with new building complexes, luxury constructions and apartments overlooking the sea. Large and well-known companies, shops, dealerships, etc. are also located there.

- **EAST LOCATION**

EAST LOCATION is built on a cape side at the East side of the country. It has an area of 97.933 acres and a population of 13.270 inhabitants. The coastal zone of this area is one of the most interesting tourist attractions in the wider area .In addition, it is an important transportation hub and serves through the new Grand Bridge but also with regular ferry bus services, transport with many other regions. Signs of interest in the area of EAST LOCATION are the University, the National Sports Center, the Regional University General Hospital, several sandy beaches, many restaurants, cafes, entertainment centers and hotels that are open for twelve months a year. Also, there can be found the Grand Bridge, the Castle, the Craft Park, some large factory units, public services, commercial enterprises, many school units etc.

Whether a site is commercial or not, whether it is in a central location or not, whether it is a node or not, is not a measurable feature. Though, that can be ascertained by analyzing each alternative location separately to first determine which is dominant over the others in terms of the characteristics mentioned above (point commerciality, node, etc.). Then the order of "dominance" of the three alternatives between them will be highlighted as well as their "rating" on a scale of 1-9 in the comparisons between them (in pairs).Examining in detail the characteristics of each alternative in terms of location, it is logically obvious that EAST LOCATION dominates, due to the Hospital, the Grand Bridge, the large factory units, etc. SOUTH LOCATION follows due to the commercial streets, the port, the marina and the secondary markets throughout many streets. Finally, there is NORTH LOCATION with generally good characteristics, but inferior to the other two locations. What needs to be followed is the definition of the comparison scales between the alternatives. Because the data available for review is not quantitative but qualitative, it is more difficult to define as much as possible a "fair" comparison scale, justifying one's decision correctly. With the above data on the quality characteristics of the above three areas, a relatively "fair" score could be the following (Table 2.4.1):

Table 2.4.1: Table of binary comparisons of alternatives for the criterion of Region

EAST LOCATION	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**SOUTH LOCATION**
EAST LOCATION	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**NORTH LOCATION**
SOUTH LOCATION	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**NORTH LOCATION**

4. COMPETITION

The competition that the new store will face in the region where it will be established is of great significance. It needs a remarkable market share so that it can be economically viable. The table below shows the presence of competing banks in our three candidate locations. In the area ofEAST LOCATION, in the most central shopping street of the area, there is the presence of Delta Bank and some meters far a branch of Coop Bank. These

two stores are the competition for the store being established. In the area of SOUTH LOCATION on the main road again, there is a branch of the Bank of Island. This is the only presence of competition in this location. In the area of NORTH LOCATION there is no branch of a commercial bank. The competition is zero (Table 2.5.1).

Table 2.5.1: Competition in the examined areas

LOCATION	BANK NAME
EAST LOCATION	DELTA BANK
	COOP BANK
SOUTH LOCATION	BANK OF ISLAND
NORTH LOCATION	-

Based on the data of the competition located in each of the three areas, the following conclusion can be drawn: NORTH LOCATION is superior in terms of the criterion of Competition because in this area the presence of another bank is zero. It is followed by SOUTH LOCATION, where there is a store of Bank of Island, and finally comes EAST LOCATION, where there are already two competing bank branches, both on the main street, Delta Bank and Coop Bank. This logic shows the table below by dividing the 2-9 comparison scale into 25% range classes indicating the difference between the largest in alternative income and its lowest. The scale indicates equality and therefore zero difference between two alternatives (Table 2.5.2).

Table 2.5.2: Difference in competition in AHP scale

BRANCHES OF COMPETITORSIN EACH OF THE ALTERNATIVES AREA (DOMINANT LOCATION VS THE OTHERS)	AHP VALUE
0	1
-	2
1	3
-	4
2	5
-	6
3	7
-	8
4+	9

A representative score for the competition criterion follows (Table 2.5.3):

Table 2.5.3: Table of binary comparisons of alternatives for the criterion of Competition

NORTH LOCATION	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	EAST LOCATION
NORTH LOCATION	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SOUTH LOCATION
SOUTH LOCATION	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	EAST LOCATION

5. COST

Next, the cost required to make the investment planned by the Bank must be calculated. The purpose is to keep costs as low as possible so that the investment become profitable. The profile of the new store, regardless of the location of the facility, is planned as follows: 1) Supposing that the property where the Bank will establish its new unit is a ground floor building, with an area of at least 200 sq.mt. 2) The minimum number of people required to operate a new banking department is four (manager, treasurer, supervisor and a teller).In-store, an APS will operate to de-congestion cash registers and to facilitate customer service. 4) the cost of landscaping reaches 1.000 €/sq.mt.5) the cost of electromechanical equipment (with 1 ATM) for four people amounts to € 40.000. 6) The cost of furniture and utensils for 4 people amounts to € 16.000. 7) Staff salaries amount to approximately € 30.000 per person and increase annually at a rate of 3% while employer contributions account for 48% of staff salaries. 8) Other store expenses (stationery, telephones, etc.) amount to € 3.000 per person and increase at a rate of 3% per year. Based on the above, the total costs of the operation of the new store are calculated, which are shown in the following table.

The difference between the cost of installation and operation of the store under establishment for each of the three locations concerns the cost of rent in each location. In few words Bank wants a ground floor building of approximately 200 sq.mt. at a central point and trade route of each region, easily accessible. Annual adjustment

(increase) of 5% of the rent must also be calculated. Considering the rental prices prevailing in each area, the rental cost per month for a property with the above characteristics is as follows (Table 2.6.1):

Table 2.6.1: Rental cost per month for the candidate areas

LOCATION	COST OF RENTAL / MONTH
NORTH LOCATION	€ 1.200
SOUTH LOCATION	€ 3.000
EAST LOCATION	€ 4.000

Based on the above data, a cost budget can be made for the store under establishment in each district. It is obvious that the only cost that differs between the three areas is the cost of annual rent. In the first table, the cost for a monthly rent of € 1,200.00 has been calculated, i.e. for the last year of NORTH LOCATION (Tables 2.6.2 - 2.6.4).

Table 2.6.2 Cost budget of NORTH LOCATION branch

NEW BRANCH COST BUDGET OF NORTH LOCATION (THOUS.EURO)							
YEAR	1	2	3	4	5	6	7
	2020	2021	2022	2023	2024	2025	2026
ANNUAL SALARY	120,0	123,6	127,3	131,1	135,1	139,1	143,3
EMPLOYERS CONTRIBUTIONS	57,6	59,3	61,1	62,9	64,8	66,8	68,8
ANNUAL RENT	14,4	15,1	15,9	16,7	17,5	18,4	19,3
OTHER EXPENSES	12,0	12,4	12,8	13,2	13,6	14,0	14,4
TOTAL ANNUAL COST	204	210,4	217	223,8	230,9	238,2	245,7
TOTAL COST 2020-2027							1.570

Table 2.6.3 Cost budget of SOUTH LOCATION branch

NEW BRANCH COST BUDGET OF SOUTH LOCATION (THOUS.EURO)							
YEAR	1	2	3	4	5	6	7
	2020	2021	2022	2023	2024	2025	2026
ANNUAL SALARY	120	123,6	127,3	131,1	135,1	139,1	143,3
EMPLOYERS CONTRIBUTIONS	57,6	59,3	61,1	62,9	64,8	66,8	68,8
ANNUAL RENT	36	37,8	39,7	41,7	43,8	45,9	48,2
OTHER EXPENSES	12	12,4	12,8	13,2	13,6	14	14,4
TOTAL ANNUAL COST	225,6	233,1	240,9	248,9	257,3	265,8	274,7
TOTAL COST 2020-2026							1.746,3

Table 2.6.4 Cost budget of EAST LOCATION branch

NEW BRANCH COST BUDGET OF EAST LOCATION (THOUS.EURO)							
YEAR	1	2	3	4	5	6	7
	2020	2021	2022	2023	2024	2025	2026
ANNUAL SALARY	120	123,6	127,3	131,1	135,1	139,1	143,3
EMPLOYERS CONTRIBUTIONS	57,6	59,3	61,1	62,9	64,8	66,8	68,8
ANNUAL RENT	48	50,4	52,9	55,6	58,3	61,3	64,3
OTHER EXPENSES	12	12,4	12,8	13,2	13,6	14	14,4
TOTAL ANNUAL COST	237,6	245,7	254,1	262,8	271,8	281,2	290,8
TOTAL COST 2020-2026							1.844

The Bank would like to keep costs low, especially in times of economic crisis. As a result, in terms of the rather significant Cost criterion, the location in which the store to be established will have the lowest operating costs over a seven-year period will be dominant.

The total cost for the first years of operation of the new bank branch has been calculated in the data. Thus, NORTH LOCATION dominates (cost €1.570.000), followed by SOUTH LOCATION (€1.746.300) and EAST LOCATION (€1.844.000). The "dominance" scale between the three alternatives will be defined. NORTH LOCATION has 11.2% lower costs than SOUTH LOCATION and 17.4% lower cost than EAST LOCATION, while SOUTH LOCATION has 5.5% lower costs than EAST LOCATION. A percentage of 5% on the operating costs of seven years of the "cheapest" branch, that of NORTH LOCATION corresponds to: €1.570.000X5%=€78,500.That is, it corresponds to a very measurable size for the bank, the classes that will be created to "score" each alternative will be in the range of 5% and will show the difference in percentage of the cost of the dominant alternative from its subordinates.

Thus, Table 2.6.5 occurs:

Table 2.6.5: Cost difference in AHP scale

DIFFERENCE IN COST %	AHP VALUE
0	1
(0- 5%]	2
(5 – 10%]	3
(10 - 15%]	4
(15 – 20%]	5
(20-25%]	6
(25-30%]	7
(30-35%]	8
(35-40+%)	9

The above table can be written in terms of comparisons on a scale of 1-9 as follows (Table 2.6.6):

Table 2.6.6: Table of binary comparisons of alternatives for the criterion of Cost

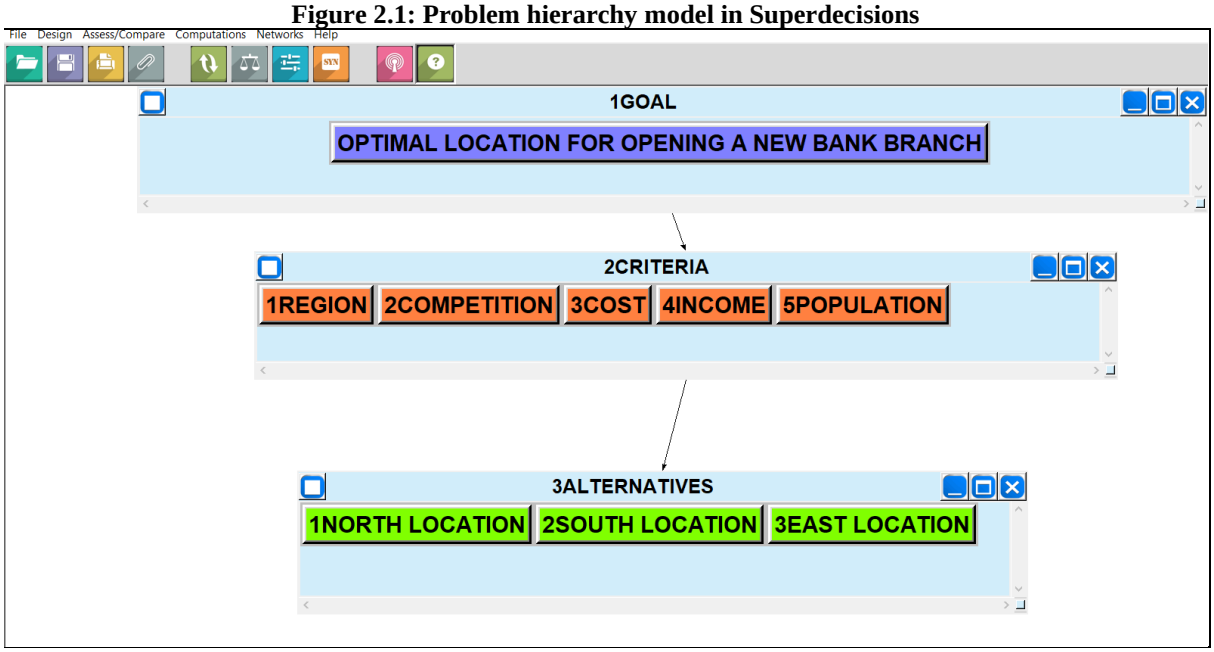
NORTH LOCATION	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SOUTH LOCATION
NORTH LOCATION	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	EAST LOCATION
SOUTH LOCATION	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	EAST LOCATION

2.2Application of AHP in Superdecisions program

First, the levels of analytical hierarchy process (AHP) must be created:

The first and highest level is the goal (GOAL) which is to find the optimal location for the installation of the new bank branch. In the second and middle level, the five selection criteria (CRITERIA) are placed, which play the most important role in making the decision according to the bank's management. The third and last level introduces the three alternatives (ALTERNATIVES) for the bank's new store. Those levels are shown in the following graph of the Superdecisions program (Figure 2.1):

Figure 2.1: Problem hierarchy model in Superdecisions



Then, after the levels of the problem have been defined, the decision criteria will be graded in binary comparisons as explained above. The given scores set above will be entered (Figures 2.2 – 2.3):

Figure 2.2: Two-way criteria comparison window

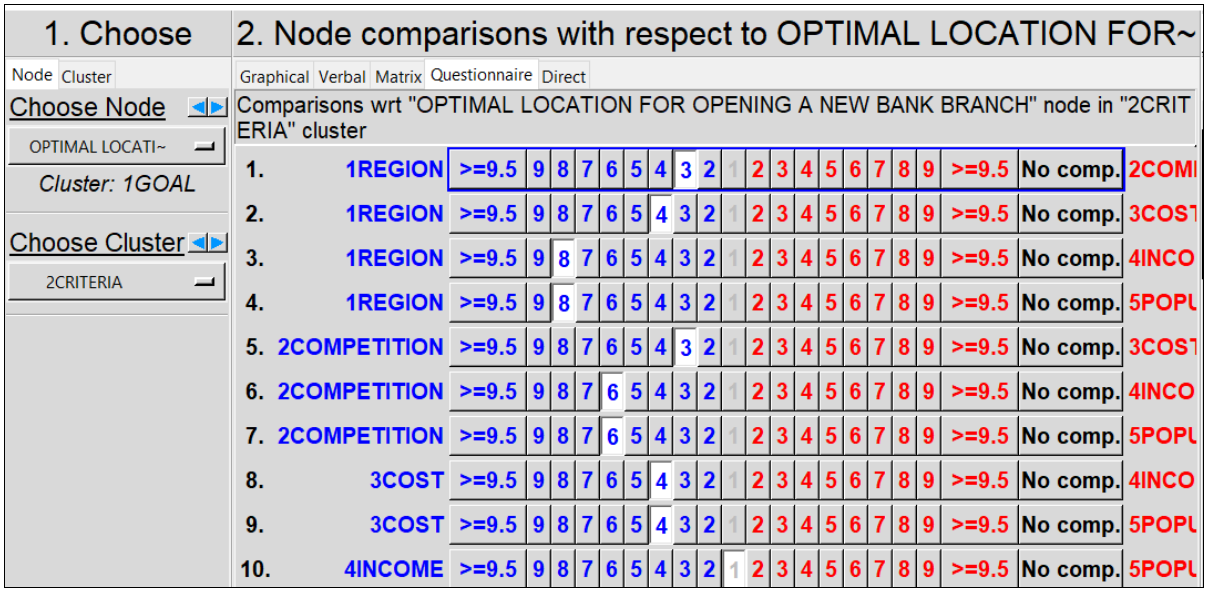
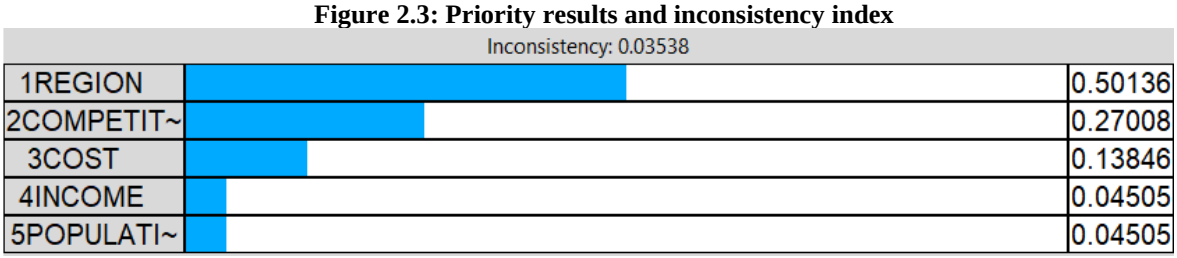


Figure 2.3: Priority results and inconsistency index



According to the data entered in the processing program (Figures 2.2 – 2.3), the weight-importance among the criteria given by the bank's management for making the decision on the new store occurs (Table 2.7):

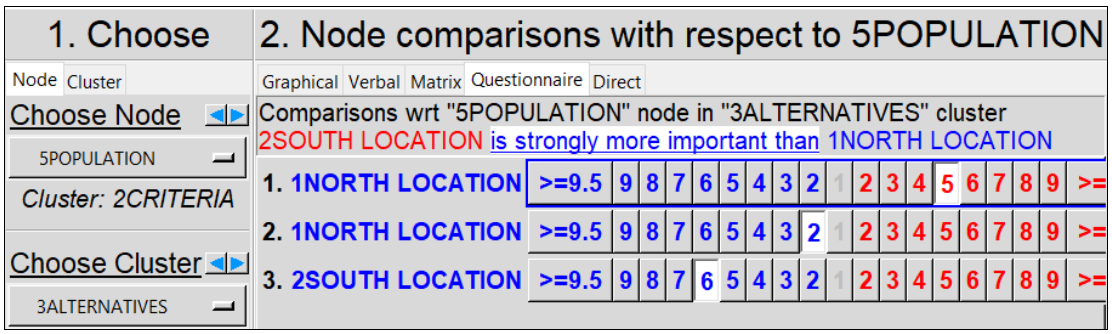
Table 2.7: Priority results

REGION	**50,136 %**
COMPETITION	**27,008 %**
COST	**13,846 %**
POPULATION	**4,505 %**
INCOME	**4,505 %**
TOTAL	**100%**

From the above results, it is clear how important the Region criterion is compared to the other four criteria that participate in decision making. Competition follows with a significant difference, then comes the Cost with about the half importance and finally the Population and the Income with the same weight-importance. Another very important element shown in Figure 2.3 is the inconsistency index. In this case this indicator gets a value of 0.03538. This value is less than 0.1. Therefore, as the AHP theory demands, this is a desirable value and there is no need to make changes to the comparison values given for the criteria. Then, something similar shall follow for the alternatives by comparing them in pairs with respect to each of the five criteria and placing the scores as defined above. This is illustrated in the program as in Figures 2.4-2.8:

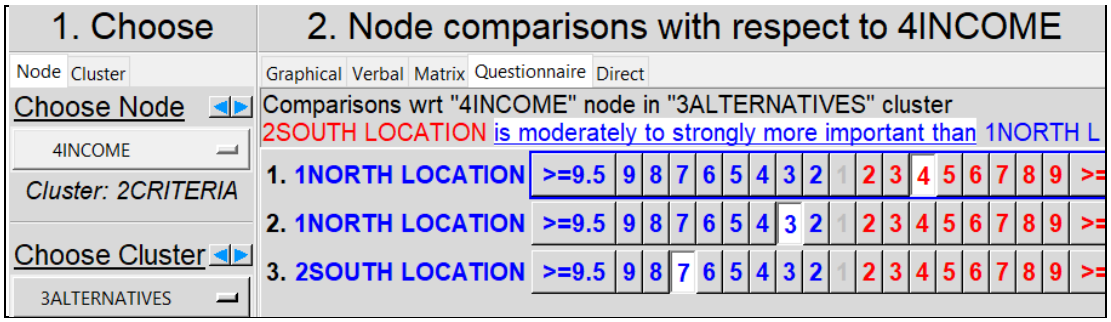
1. POPULATION

Figure 2.4: Population comparison window



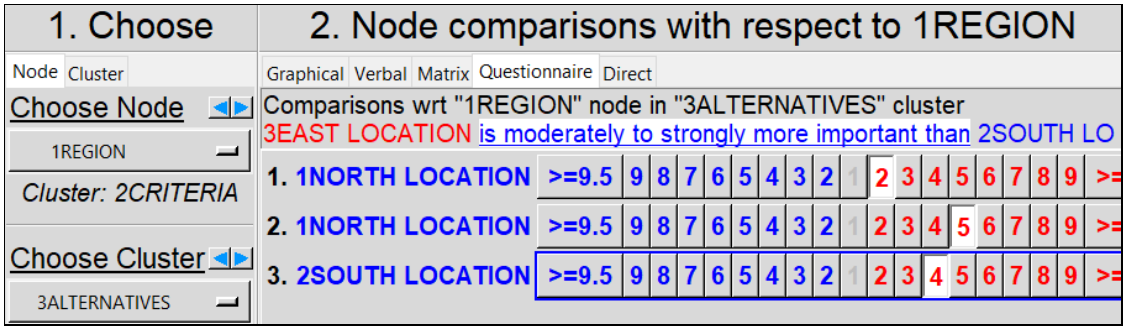
2. INCOME

Figure 2.5: Income comparison window



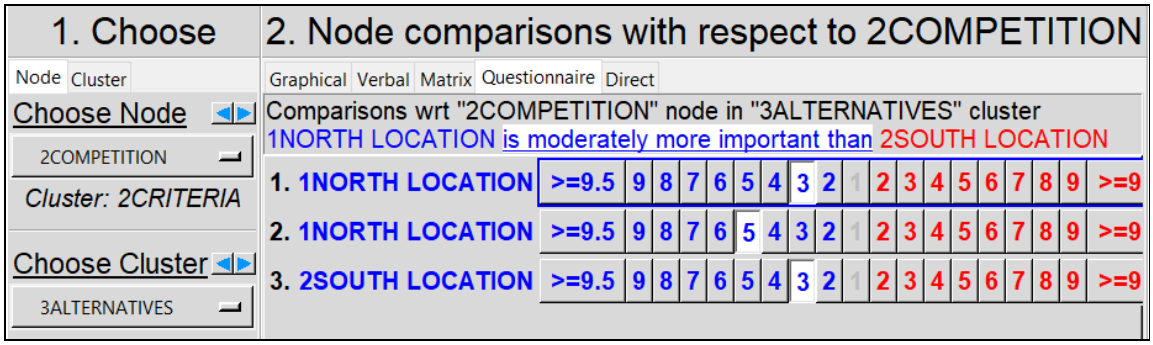
3. REGION

Figure 2.6: Region comparison window



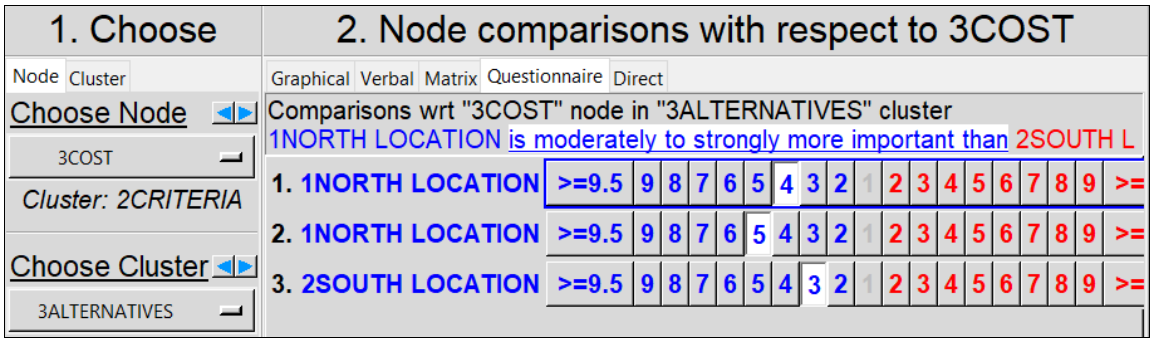
4. COMPETITION

Figure 2.7: Competition comparison window



5. COST

Figure 2.8 Cost comparison window



III. Results

Once all the necessary data has been entered, the program is ready to process and produce the results. That will lead to the optimal decision the Bank should make for the location of the new branch. According to the criteria set and always in accordance with the priorities and the importance given to them, the Superdecisions software produces the following results (Figure 3.1).

Figure 3.1: Results window after data procession

Name	Graphic	Ideals	Normals	Raw
1NORTH LOCATION		0.867661	0.341171	0.170586
2SOUTH LOCATION		0.675522	0.265621	0.132810
3EAST LOCATION		1.000000	0.393208	0.196604

In the last Figure (3.1) one can read the following:
The top left column (Name) shows the names of the three alternatives. The second column from the left (Graphic) graphically shows the ranking and the difference between the three alternatives. The longer the blue bar, the higher the percentage of the corresponding alternative. The column that shows the result for making the decision is the fourth column from the left (Normals). According to this column, the ranking with the corresponding percentages of the three alternatives is as follows:

1. **NORTH LOCATION: 34,1171 %**
2. **SOUTH LOCATION: 26,5621 %**
3. **EAST LOCATION: 39,3208 %**

The third column from the left (Ideals)reflects the results (Normals column) divided by the largest value (here 39,3208) in the following way: The NORTH LOCATION area as an option is 86,7661 % good as the selected area (EAST LOCATION) while the SOUTH LOCATION is 67,5522% as good as the selected one. The fifth column from the left (Raw) illustrates the values in the column of results divided with number 2. So, the management, according to the criteria chosen and prioritized, should select the area of EAST LOCATION as the

best location, then, as a second choice, the NORTH LOCATION and finally the SOUTH LOCATION, as the last choice.

IV. General Conclusions

- **Discussion - Conclusions**

Using AHP method to solve this kind of problems can be very beneficial for any business or organization.

In this study, the problem is divided into small subproblems where comparisons are made between the alternatives for each criterion separately. Thus, the designer can thoroughly analyze the individual advantages and disadvantages of each alternative in a very short time and make important decisions for the present or even plan future business activities with much greater chances of success.

Also, here, an explanation is given for the rating of the alternatives in relation to each criterion. This was achieved with the use of the classes which show the differences between the values of the quantitative data of the alternatives, while, in the qualitative quantities, the grading was justified with logical arguments. In this way, a more "faithful" matching of the criteria and the alternatives was made in relation to the needs and conditions set by the company. Once more, it should be emphasized that the results of the AHP are inextricably linked to the characteristics and gravity of the criteria given by the judge-analyst himself. Therefore, one cannot call these results "objective". On the contrary, they are certainly "subjective", but they fully reflect the importance each analyzer-researcher gives to certain criteria, useful for making decisions. The great goal for the results is to be very representative of the data given and helpful for making the right decision.

- **Proposals for further research**

The AHP method through the Superdecisions software can be useful in making decisions in banking such as:
- Creation of new banking products which fit specific customer groups
- Evaluation of loan applications
- Mergers or partnerships between banking groups and their subsidiaries etc.

In general, in commercial enterprises and organizations, it can support making decisions such as:
- Extension of branch network
- Increase or decrease human resources
- Collaborations with other similar companies
- Promotion or withdrawal of products from the market etc.

References

[1]. Mu, Enrique, Pereyra-Rojas, Milagros.Practical Decision Making, An Introduction to the Analytic Hierarchy Process (AHP) Using Super Decisions. SpringerBriefs in Operations Research. 2017; V.2, 1st ed. Philadelphia: University of Pennsylvania Press; 1992. Available on: https://www.springer.com/gp/book/9783319338606
[2]. Saaty,Vargas, Models, Methods, Concepts & Applications of the Analytic Hierarchy Process, Second Edition, International Series in Operations Research & Management Science. 2012, V.175. Available on: https://www.springer.com/gp/book/9781461435969
[3]. Domański, Kondrasiuk,Analytic Hierarchy Process — Applications in BankingInnovations in Classification, Data Science, and Information Systems, pp 435-445, 2003
[4]. Podvezko Valentinas, Application of AHP Technique, Journal of Business Economics and Management,2009
[5]. SaatyThomas L.,Decision making — the Analytic Hierarchy and Network Processes (AHP/ANP), Journal of Systems Science and Systems Engineering 13, pages1–35, 2004
[6]. Saaty, Vargas, Models, Methods, Concepts & Applications of the Analytic Hierarchy Process, Second Edition, International Series in Operations Research & Management Science. V.175, 2012. Available on: https://www.springer.com/gp/book/9781461435969
[7]. Koutras M. Vasileios,Financial risk management: topics on bank's supervision and risk modeling, 2014

[8]. Leal José Eugenio,AHP-express: A simplified version of the analytical hierarchy process method, 2020
[9]. Maletič, Lasrado, Maletič and Boštjan Gomišček, Analytic Hierarchy Process Application in Different Organizational Settings, Applications and Theory of Analytic Hierarchy Process, Decision Making for Strategic Decisions, Intechopen, 2016
[10]. Pechak Olena, A decision support system for project selection under uncertainty using multicriteria analysis and mathematical programming,2017
[11]. Gkaintes Aris, Corporate governance and corporate finance policies,2018
[12]. European Central Bank : https://www.ecb.europa.eu/home/html/index.en.html
[13]. Superdecisions: http://www.superdecisions.com/

Valentinos Katsimperis, Athanasios Andrikopoulos, "A Multi criteria Decision analysis Model for Finding the Optimal New Bank Branch Location." *IOSR Journal of Computer Engineering (IOSR-JCE)*, 22(3), (2020), pp. 01-13.