Data envelopment analysis for identification of bank branches appropriate locations in terms of their efficient operation

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ORIGINAL ARTICLE

Abstract. One of the main banking activities is the branch network. It provides the effective banking, the profitability. Choosing the right location of branches is very important for the bank effective operation. Random or intuitively locations can have a negative impact on key performance indicators in the future. The correct and thoughtful choice of the bank branch location ultimately determines its maximum efficiency. The paper concerns with the determining of the bank branch location in terms of thorough mathematical calculation and many factors influencing bank activity. We developed a special calculation method using the DEA (Data Envelope Analysis) methodology, considering financial, branch location, location features, etc. The paper dwells on the issue of one large branch effectiveness comparing to several smaller branches covering a wider consumer area on the example of the branch on A. Sharifzade street, Baku, Azerbaijan. Indeed, it is important to consider the location in terms of its geolocation and landscape. However, one of the main issues is expediency of establishing one large or several small branches in densely populated areas. Moreover, it is necessary to take into account the infrastructure to improve the bank performance. To consider this issue, we use both hypothetical and statistical data of Capital Bank. It is one of the largest banks in Azerbaijan. Also it has a large network of branches. The article examines expediency of establishing one large or several small branches in the area close to the existing branch of Capital Bank on A. Sharifzade street. The efficiency of the current operating branch was compared with the total efficiency of virtual branches in several combinations. We analysed the indicators of the Inshaatchylar branch and virtual branches in different combinations in different locations in accordance with DEA CRS (Constant Return to Scale) method. Additionally, we determined the effectiveness of both the Inshaatchylar branch and virtual branches in various combinations. Thus, the highest score is the most effective one.

Introduction

Regardless of its affiliation to the private or public sector, size, field of activity, etc., the basis of any organization management is assessment and analysis of its effectiveness.

Efficiency assessment is very important for any enterprise management practice. Efficiency involves the quality of activities, viability, competitiveness in a market. Therefore, it is one of the most important areas of theoretical and empirical research. Both the management of organisations and other stakeholders subjected to the business activities. However, the measurement depends on the nature of the analysed activity. It provides on the basis of appropriate conceptual models defining the description of the studied unit activity considered aspect (mainly financial, strategic, or operational). Economics and management studies usually use the individual processes (most often production), operations (improvements), projects (innovations) performed by organizations or their structural divisions as objects of efficiency assessment. Herewith, the objects under study (organizations, divisions) are described by a certain set of characteristics or parameters in terms of their activity. These values, identified in the object description, are used to measure the performance type relevant to the subject of the assessment (researcher, authority, company management, consultant, etc.).

Methods

Implementation of the enterprise efficiency concept

In the development of the enterprise efficiency concept, it is necessary to distinguish the efficiency and effectiveness of its activities. Firstly, it assesses the extent of goals set for the enterprise. Secondly, comparing the results obtained by the analysed item with the values of the initial factors (usually the cost of resources), it provides an idea of its economic activity. Efficiency has the most general definition as the productivity of an enterprise or productivity in general (performance). Moreover, it corresponds to the concept of profitability.

Indeed, the activity of any organization is usually associated with the consumption of a certain type of resources to create results in the form of products and/or services. Therefore, its effectiveness is usually analysed through comparing the costs incurred and the results obtained. The organization acts as resources converter. It transforms the initial resources (factors/resources, costs, variables / input parameters) into the final products (products / output variables (parameters)). Generally, assessment of the organization effectiveness is determining the effectiveness (productivity) of converting consumed resources into the final goods and services.

Determining the ultimate effectiveness of the branches activities

This research proposed to use a nonparametric analysis method – the Shell Data Analysis Method or Data Envelope Analysis, hereinafter referred to as DEA) [1].

DEA is used to measure performance with multiple inputs and outputs and there are no generally accepted weights for aggregating input and aggregated output data [3; 4].

DEA is the most appropriate research method when examining the efficiency of converting multiple inputs into multiple outputs. For example, the DEA can define alternative input configurations leading to better results without necessarily increasing overall resource usage. DEA is a linear programming method allowing ones to assess best practices based on research objects. In addition, the DEA provides assessment of potential improvements for inefficient facilities.

The effectiveness of the bank branches was assessed using DEA methodology based on the obtained mathematical and economic model. Forecasts have been made to improve the efficiency of bank branches. One of the main issues is the location of branches that will operate profitably in a certain area in the future. Establishing new branches of the bank in a particular perimeter is another relevant issue. Therefore, we use a new methodology, considering the number of branches in a given area (one large branch or several small ones)[5, 6].

We considered Capital Bank, one of the largest banks in Azerbaijan as an example. Therefore, we will consider all details and calculation modes of this mathematical and economic model [2].

Defining the performance results of the bank virtual branches in different combinations

Further, we will use the concept of «virtual branches». This concept means hypothetical branches do not existing physically at the moment. Nevertheless, they are considered as potential branches.

This methodology is general one for different economic entities in different locations. Indeed, we provide our study on A. Sharifzade street, Baku, Azerbaijan. The Capital Bank branch is located on this street. It is a large 2-store branch with a lot of employees. The article consider the most effective bank strategy in terms of its branches – to have one large branch or several small branches on A. Sharifzade street, Baku, Azerbaijan.

Location. This street is located in the Yasamal district. The area has a complex geographical terrain. The Inshaatchylar metro station is located on A. Sharifzade street has a sloping landscape on both sides. On one side the slope is on H. Zardabi («Galaba circle»); on the other side it is Yeni Yasamal. The landscape of the area is hilly. The satellite image is shown in Figure 1 (the yellow line indicates A. Sharifzade street). On this street branches of competing banks are located: UniBank, Bank Respublika, Rabitabank, and Bank of Baku (Fig. 2)

The Inshaatchylar metro station is located on A. Sharifzade street. It is a transport hub in this area. It is located on a hill; Galaba circle is on one side down the hill, and the Bizim Market central market is on the other one. After Bizim Market, the road closes with the Baku Ring Road (in Fig. Dairevi yol). There are no residential or non-residential facilities beyond the Baku Ring Road. Therefore, Sharifzade Street can be

considered as the main destination for the potential establishing of bank branches.

Figure 1. Geographical destinations at the analysed location

Source: google maps

Figure 2. Location of competing banks
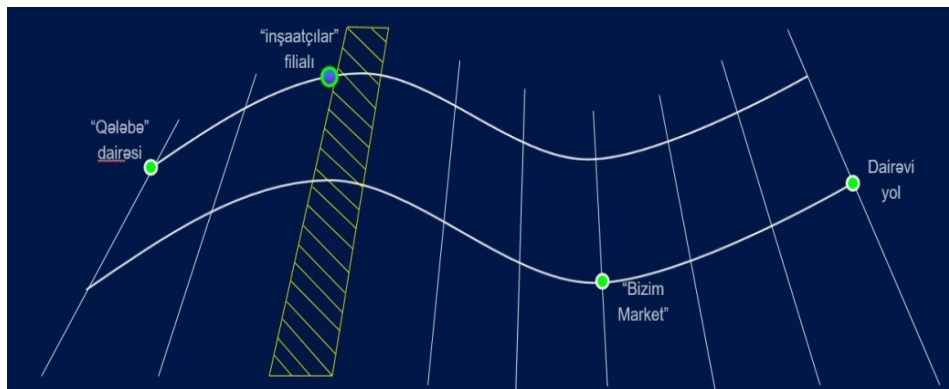
Source: google maps

Figure 3. Geolocation and landscape. The yellow shaded stripe indicates A. Sharifzade street

Source: composed by the author

Possible locations of branches are transport hubs and intersections of main streets (establishing a branch on secondary streets is impractical). These points are indicated in Figure 4. The total length of Sharifzade Street is approximately 4 km. The minimum distance between two branches should not be less than 1 km. Otherwise they will be too close to each other. Hence the average distance person will effortlessly walk to the bank is about 1 km. Taking into account this fact, and using the exclusion method, we reduce the number of potential locations for branches to 4. In Figure 4, they are indicated by red circles. The locations of these points are more effective in comparison with other points. Moreover, we are taking into account the terrain, the intersection of streets, the number of commercial and other objects nearby, etc.

Further, we compare Inshaatchylar physical and virtual branches. The comparison will be made in

terms of their efficiency. Therefore, it is necessary to make profit/loss forecasts for branches.

Figure 4. Potential locations for branches (the physical Inshaatchylar branch is located at the point Inshaatchylar)

Source: google maps

Results

To define the most effective locations for branches, it is necessary to make certain calculations. The real financial and other indicators of the Inshaatchylar branch will be taken and calculations will be implemented using the DEA methodology. The stages include following [7; 8; 9]:

1. Defining the branches costs (Inshaatchylar physical and virtual branches).
2. Defining of income (Inshaatchylar physical and virtual branches).
3. Total revenue calculation in terms of income and costs.
4. Defining of different combinations (virtual or/and physical) branches are more effective in terms their revenues, costs, and profits.

Profit and loss forecast

However, bank branches have many categories of costs. For providing the calculations, we divide the branch costs into 3 main parts: rental costs, employee salaries, and other costs (generalized).

The rental price is the rent for the premises of the branch with an area of 150 sq.m. (in current rental prices in the area). Labour costs for salaries. Other general costs, except for rent and wages ones.

Rent in potential locations

The area of one branch was taken 150 sq.m. based on the following minimum requirements: A service hall – 60 sq.m., a bathroom – 4 sq.m., a director's office – 12 sq.m., a server room – 8 sq.m., an archive room – 10 sq.m., a security room – 6 sq.m., a kitchen – 8 sq.m., corridor – 15 sq.m., cash register – 15 sq.m., warehouse – 4 sq.m., other – 8 sq.m. Total area: 150 sq.m.

Location ASAN Xidmət (ASAN – near the ASAN state institution). The monthly rental price in this area is shown in Table 1. The maximum price of 53.3 manats per 1 sq.m was taken. Monthly rent is charged at 53.3 manat x 150 sq.m. = 8 000 manat per month. The annual rent is 96 000 manats.

Table 1 – Prices for renting branches near ASAN

General information	Option 1	Option 2
The size of the object is	150 sq.m.	240 sq.m.
Monthly rent (including 14% tax)	8 000 manat	3 700 manat
Rent per sq.m.	53.33 manat	15.42 manat
Link to the map location	http://tiny.cc/05jwtz	http://tiny.cc/15jwtz

Source: composed by the author

The Inshaatchylar branch Location. According to the study, the monthly rent of the physical Inshaatchylar branch was 33 592 manats (33 592 : 520 sq.m. = 65 manats per 1 sq.m.). Assume a branch with an area of 150 sq.m. at place of this physical branch (i.e. a virtual branch). Therefore, its rent would be approximately 150

sq.m. x 65 manat ≈ 10 000 manat.

Figure 5. 3D visualization of options 1 and 2

Source: composed by the author

Tibb Texnikumu (Medical College) Location. The monthly rental price of 1 sq.m. within a radius of 300 meters ranges from 12-20 manats. The monthly rent is charged at 20 manats. 20 manats x 150 sq.m. = 3 000 manats per month. The annual rent is 36 000 manats.

Bizim Market Location. The monthly rental price of 1 sq.m. within a radius of 300 meters ranges from 10-25 manats. The monthly rent is charged at 25 manats. 25 manats x 150 sq.m. = 3 750 manats per month. The annual rent is 45 000 manats.

Employee costs (salary)

Inshaatchylar branch. According to the profit and loss report, the salary expenses of the Inshaatchylar branch for the 6-month period in 2020 is 126 222 manats. Hence the annual cost of wages is approximately 252 000 manats.

Virtual branches. Since the area of all branches is 150 sq.m., the number of employees will be the same. Thus, staff costs will be the same for all virtual branches. The required number of employees in virtual branches (people):

The operators – 5, the cashiers – 2, the director – 1, the receptionist – 1, the cleaner – 1.

To determine the annual salary value of virtual branches, the average annual salary value was taken from 9 real branches of Capital Bank (which have 10 employees each). The average value is about 210 000 manats.

Other costs

According to analysis of statistical data, other costs for an average of 150% of the amount of rent and staff costs.

Inshaatchylar branch. Other costs are 982 656 manats. Rent 33 592 x 12 = 403 104 manat. The salary is 252 000 manats. (403 104 + 252 000) x 150% = 982 656 manats.

ASAN virtual branch. Other costs are 459 000 manats. The rent is 96 000 + salary 210 000 = 306 000 x 150% = 459 000 manats.

Inshaatchylar virtual branch. Other costs are 495 000 manats. Rent 120 000 + employees 210 000 = 330 000 x 150% = 495 000 manats. To analyse the hypothesis of the research, we establish a hypothetical virtual Inshaatchylar branch on the site of the physical Inshaatchylar branch.

Tibb Texnikumu (Medical College) virtual branch. Other costs are 369 000 manats. The rent is 36 000 + salary 210 000 = 246 000 x 150% = 369 000 manats.

Bizim Market virtual branch. Other costs are 382 000 manats. The rent is 45 000 + salary 210 000 = 255 000 x 150% = 382 500 manats.

Note: The costs do not include interest costs, since they considered by the calculations of FTP (Fund Transferring Price) in the revenue part.

Table 2 – Branches total costs, manats

Branch	Inshaatchylar vranch	ASAN virtual branch	Inshaatchylar virtual branch	Tibb Texnikumu virtual branch	Bizim Market virtual branch
Rental cost	403 104	96 000	120 000	36 000	45 000
Labour costs	252 000	210 000	210 000	210 000	210 000
Other costs (150%)	982 656	459 000	495 000	369 000	382 500
Total costs	1 637 760	765 000	825 000	615 000	637 500

Source: composed by the author based on statistical data and calculations

The reference branch

The concept of a «reference» branch is introduced in order to calculate the financial performance of virtual branches. To select this type of branch, we take into account a reference factor. This branch should correspond to the Inshaatchylar branch, i.e. it should be located on a street with good traffic, in the area of the transport hub, near the exit of the underground stations, with a dormitory suburb nearby. In addition, this branch should be efficient enough to prevent the overestimation of the virtual branches results calculated on the basis of the reference branch. Taking into account all these parameters, Gara Garaev Capital Bank branch is considered as a reference branch. The efficiency calculation on the base based on of a reference branch was provided by DEA method, taking into account the entire Capital Bank branch network.

Population, pedestrian and car traffic

To calculate the precision location we use the following data: number of people in this area, number of pedestrians, and cars directly pass near the point. Figures 5, 6 and 7 show the potential locations of branches and indicate the perimeters of residential areas, the number of people indicated in Tables 3-7.
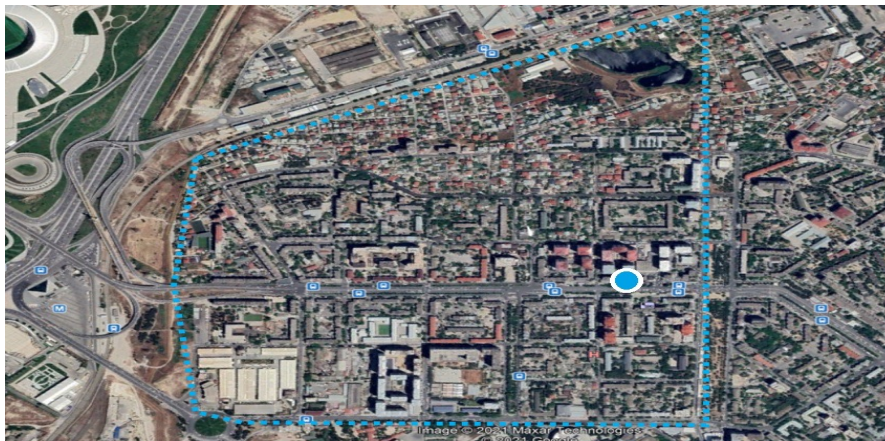

Figure 6. The location of the reference Gara Garaev branch (physical) and the perimeter of the residential area

Source: google maps

Table 3 – Gara Garaev reference branch. The population, number of pedestrians, and cartraffic (people)

Observation hours	Pedestrian traffic	Car traffic	Population
09:00-10:00	1 219	1 725	---
10:00-11:00	1 202	1 696	---
11:00-12:00	1 325	1 768	---
12:00-13:00	1 453	1 833	---
13:00-14:00	1 466	1 920	---

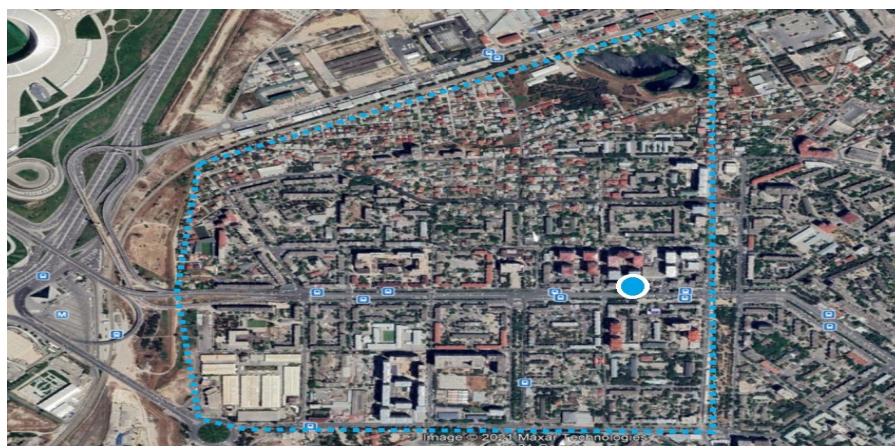| Observation hours	Pedestrian traffic	Car traffic	Population
14:00-15:00	1 735	1 962	---
15:00-16:00	1 691	1 994	---
16:00-17:00	1 836	2 053	---
Total	11 927	14 951	55 000

Source: composed by the author

Figure 7. The location Inshaatchylar (pink), Tibb Texnikumu (yellow), Bizim Market (green) virtual branches and the perimeter of the residential areas

Source: google maps

Table 4 – Inshaatchylar virtual branch. The population, number of pedestrians, and car traffic (people)

Observation hours	Pedestrian traffic	Car traffic	Population
09:00-10:00	962	1 035	---
10:00-11:00	1 074	1 138	---
11:00-12:00	1 125	1 096	---
12:00-13:00	1 442	1 207	---
13:00-14:00	1 309	1 285	---
14:00-15:00	1 275	1 227	---
15:00-16:00	1 293	1 176	---
16:00-17:00	1 525	1 254	---
Total	10 005	9 418	75 000

Table 5 – Tibb Texnikumu virtual branch. The population, number of pedestrians, and car traffic (people)

Observation hours	Pedestrian traffic	Car traffic	Population
09:00-10:00	134	904	---
10:00-11:00	158	847	---
11:00-12:00	198	762	---
12:00-13:00	237	839	---
13:00-14:00	211	871	---
14:00-15:00	188	925	---
15:00-16:00	243	874	---
16:00-17:00	362	886	---
Total	1 731	6 908	31 000

Source: composed by the author

Table 6 – Bizim Market virtual branch. The population, number of pedestrians and car traffic (people)

Observation hours	Pedestrian traffic	Car traffic	Population
09:00-10:00	441	1 904	---
10:00-11:00	327	1 847	---
11:00-12:00	495	1 762	---
12:00-13:00	633	1 813	---
13:00-14:00	797	1 871	---
14:00-15:00	814	1 925	---
15:00-16:00	945	1 874	---
16:00-17:00	826	1 939	---
Total	5 278	14 935	107 000

Source: composed by the author

Figure 8. The location of ASAN virtual branch and the perimeter of the residential area

Source: google maps

Table 7 – ASAN virtual branch. The population, number of pedestrians, and car traffic (people)

Observation hours	Pedestrian traffic	Car traffic	Population
09:00-10:00	480	712	---
10:00-11:00	661	902	---
11:00-12:00	679	820	---
12:00-13:00	715	713	---
13:00-14:00	851	844	---
14:00-15:00	836	979	---
15:00-16:00	685	839	---
16:00-17:00	824	940	---
Total	5 731	6 749	45 000

Source: composed by the author

The data on the population was obtained by traversing the area and collecting data using a survey for each residential building. Pedestrian and car traffic was calculated using the hourly monitoring method (the observation hours 09:00-17:00 were specially selected to coincide with the working hours of the bank branch).

Recalculation of reference branch income in terms of FTP

Moreover, it is necessary to recalculate Gara Garaev reference branch income, since FTP (Fund Transferring Price) was not taken into account in banking statistics.

Total income, including FTP (item 1) is an adjustment of interest income and interest expenses of the FTP branch. Since the FTP indicator contains interest income and interest costs (paragraph 4), we deduct

interest income and interest costs (paragraphs 2 and 3) from total income (paragraph 1) and add FTP percentage income indicator (paragraph 4) to it, i.e.: total revenue (including FTP) = total income - (interest income - interest costs) + interest income from FTP.

Table 8 – Income recalculation of Gara Garaev reference branch in terms of FTP, manats

Income	Manats
Total income	5 854 137
Interest income	5 106 555
Interest costs	-869 315
Interest income from FTP	3 829 075
Total income, including FTP	5 445 972

Source: composed by the author

Virtual branches total income calculation

According to necessary information (number of people and pedestrian, car traffic, reference branch income, etc.), we forecast the income of virtual branches. Data on reference branch is average in efficiency. Therefore the forecast calculations will be realistic ones.

The total anticipated revenue of virtual branches (including FTP) is calculated using the DEA's results-based methodology. The number of employees was also introduced into the analysis. Table 9 shows the anticipated revenues of the branches.

Table 9 – Anticipated revenue of virtual branches

Branch	Pedestrian traffic	Car traffic	Population	Number of employees	Real income	Anticipated revenue
Gara Garaev reference branch	11 927	14 951	55 000	22	5 445 972	-
Inshaatchylar branch	10 005	9 418	258 000	14	--	3 430 551
Inshaatchylar virtual branch	10 005	9 418	75 000	10	--	2 475 442
Tibb Texnikumu virtual branch	1 731	6 908	31 000	10	--	790 390
ASAN virtual branch	5 731	6 749	45 000	10	--	2 458 355
Bizim Market virtual branch	5 278	14 935	107 000	10	--	2 409 980

Source: composed by the author

According to the Table, the real income column shows the real income of Gara Garaev reference branch. Calculations were made using the DEA method to forecast the income of virtual branches (column «Anticipated revenue»). In order to present more correct results, the income of physical Inshaatchylar branch was calculated by the same methodology.

Virtual branches profit calculation

To calculate the profit, we subtract costs from income. The amounts of costs for each virtual branch were defined above. The anticipated revenue of the virtual branches were also calculated. We calculate the profit of virtual branches.

Table 10 – Branches profit calculation

Branch	Inshaatchylar	Inshaatchylar virtual branch	ASAN virtual branch	Tibb Texnikumu virtual branch	Bizim Market virtual branch
Total revenue	3 430 551	2 475 442	2 458 355	790 390	2 409 980
Rental costs	403 104	120 000	96 000	36 000	54 000
Employee costs	252 000	210 000	210 000	210 000	210 000
Other costs	982 656	495 000	459 000	369 000	396 000
Total costs	1 637 760	825 000	765 000	615 000	660 000
Income	1 792 791	1 650 442	1 693 355	175 390	1 749 980

Source: composed by the author

To make the calculations more correct, the income of the Inshaatchylar branch and virtual branches were calculated using the DEA method in comparison with the reference branch. We consider the branch operating for many years and has reached its maximum profitability (for instance, Gara Garayev reference branch has been operating for many years) [10].

Efficiency and results

Hence anticipated revenue of the branches were calculated above. However, it is necessary to find the right combination of virtual branches and compare their efficiency with a large branch (a real Inshaatchylar branch).

Combinations of virtual branches

Under combination we mean the combined efficiency of several virtual branches. It can be 2, 3, or 4 virtual branches in different combinations. The comparison of effectiveness with combinations is calculated according to the DEA methodology [11].

In terms of effectiveness:

– virtual branches 1+2 > Inshaatchylar branch. In this case, instead of Inshaatchylar branch it is more profitable to establish 2 small branches;

– virtual branches 1+2+3 > Inshaatchylar branch. In this case, instead of Inshaatchylar branch it is more profitable to establish 3 small branches;

– virtual branches 1+2 +3+4 > Inshaatchylar branch. In this case, instead of Inshaatchylar branch it is more profitable to establish 4 small branches.

The number of combinations is much greater. The combination with the highest efficiency ratio will finally be more successful. Therefore, the establishing of these branches or the retention of the actual Inshaatchylar branch is considered more appropriate one.

Calculation of combinations effectiveness

Table 11 shows the comparative results of calculating of combinations effectiveness of virtual branches and Inshaatchylar branch.

Table 11 – Combinations of virtual branches and Inshaatchylar branch providing their effectiveness

Combination	crste	Income	Employee costs	Rental costs	Other costs
virtual branches Inshaatchylar + Bizim Market +ASAN	0.381	5 093 777	630 000	270 000	1 350 000

Combination	crste	Income	Employee costs	Rental costs	Other costs
virtual branches Inshaatchylar + Bizim Market	0.381	3 400 422	420 000	174 000	891 000
virtual branches Inshaatchylar + ASAN	0.375	3 343 797	420 000	216 000	954 000
Inshaatchylar branch	0.335	1 792 791	252 000	403 104	982 656
virtual branches Inshaatchylar + Bizim Market +ASAN+Tibb Texnikumu	0.295	5 269 166	840 000	306 000	1 719 000
virtual branches Bizim Market +ASAN+Tibb Texnikumu	0.271	3 618 725	630 000	186 000	1 224 000
virtual branches Inshaatchylar + Bizim Market +Tibb Texnikumu	0.267	3 575 811	630 000	210 000	1 260 000
virtual branches Inshaatchylar + ASAN + Tibb Texnikumu	0.263	3 519 186	630 000	252 000	1 323 000
virtual branches Bizim Market +Tibb Texnikumu	0.216	1 925 370	420 000	90 000	765 000
virtual branches ASAN + Tibb Texnikumu	0.21	1 868 745	420 000	132 000	828 000
virtual branches Inshaatchylar + Tibb Texnikumu	0.205	1 825 831	420 000	156 000	864 000

Source: composed by the author

Conclusion

The calculations were performed using the DEA CRS method. In order to provide a more precise overview, the branch combinations were included in the total list of Capital Bank branches [12]. Therefore, the efficiency of all bank branches was calculated. Moreover, each combination acts as a branch.

Table 11 shows only the results of combinations and the Inshaatchylar branch. To compare, the first column shows the ordinal number of this combination/branch in the total list of bank branch efficiency. In the calculations, the costs categories were taken as input data, and the profit as output ones. Thus, the highest score is the most effective one.
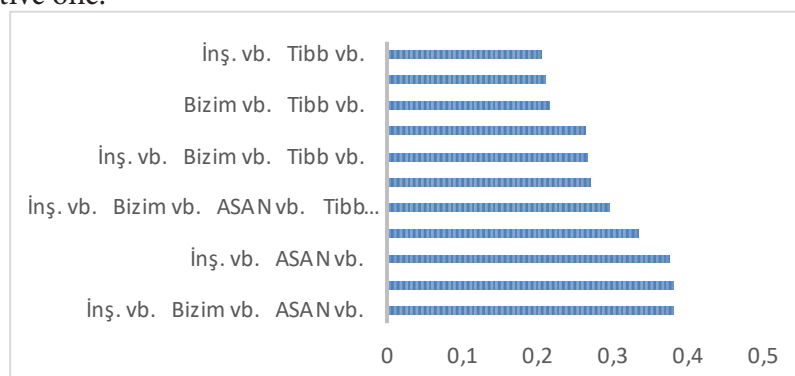

Figure 9. Visualization of results of combinations effectiveness, Inshaatchylar branch (vb means a virtual branch)

Source: composed by the author

Comments on the results:
Ineffective: Inshaatchylar branch +Bizim Market + ASAN +Tibb texnikumu are virtual ones.

Ineffective: Inshaatchylar + ASAN +Tibb Texnikumu virtual branches

Ineffective: Inshaatchylar +Bizim Market +Tibb Texnikumu virtual branches

Ineffective: Inshaatchylar +Bizim Market + ASAN +Tibb Texnikumu virtual branches

Ineffective: Inshaatchylar +Tibb Texnikumu virtual branches

Ineffective: Inshaatchylar + ASAN +Tibb Texnikumu virtual branches

Ineffective: Bizim Market+Tibb Texnikumu virtual branches

Effective: Inshaatchylar + Bizim Market virtual branches

Effective: Inshaatchylar + ASAN virtual branches

The most effective: Inshaatchylar + Bizim Market + ASAN virtual branches

Therefore, two combinations are more effective – Inshaatchylar + ASAN virtual branches and Inshaatchylar + Bizim Market + ASAN virtual branches. Taking into account the higher profit of the combination of Inshaatchylar + Bizim Market + ASAN virtual branches, we consider it the most effective one. According to the study, we can recommend to Capital Bank to replace one large Inshaatchylar branch with three small branches.

The data obtained allow the bank to make decisions on opening and/or relocating its branches. This mathematical and economic methodology can be useful not only in the field of banking, but also in making decisions on the branch network of an economic system.

CONFLICT OF INTEREST
The author declares no conflict of interest.

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