

Best place for a new sporting facility in Košice

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Introduction

We will focus on the second largest city in Slovakia, Košice. In the current pandemic situation, many people decreased their physical activity that would probably affect their health condition. After the world came back to 'normal', it may happen that even more people than in the times before Covid-19 would look for some sporting activity.

For adults in such a small city the distance does not play the role, but for children and youths it is an important parameter whether the sporting facility is in the walking distance or not. The adults may use their cars but especially for small children the most appropriate way to visit a sporting facility is by walk, here we for the sake of simplicity omit the possibility of public transport. Therefore, we assume that a people are willing to use the sporting facility if and only if it is located in the same borough.

Let us suppose that some investor is interested in building a new sporting facility in Košice to support this growing future demand. The criteria for a location is simple – there must be a sufficient demand and it should be in a reasonable distance from other facilities to be sufficiently attractive among other competitors. Our aim is to give her a few streets that fits those criteria.

Data

At first, we have to search for all available sporting facilities in Košice using Foursquare service. There are different possibilities for search query like gym, fitness, court, stadium, arena etc. All records with those search queries are supposed to be used. Cleaning of those records is a must because at least one type of high school/grammar school in Slovakia is called "Gymnázium" so we have to carefully look through those records. There could be also a misinterpretation of "food court" or "county court" as well.

The demand in a simplistic way is as a ratio of population of particular borough divided by the number of available facilities in that borough. The population in boroughs of Košice corresponding to 2018 is available on this wiki page¹. Some of them are tiny so we have to filter them somehow out based on the population and number of available facilities.

In order to cover distance from each street in a borough with a largest demand to the existing sporting facility we plan to use a catalog of all streets in Košice (datasource here²) with their precise location with the help of some geocoder API. The street with a largest distance to the closest sporting facility in that borough should be the best locations where to build a new sporting facility. Note that distance between two facilities is a Euclidian distance between their location; we do not cope with walking routes because of many shortcuts for pedestrians that are not on the google.maps.com or other map portals.

¹ https://sk.wikipedia.org/wiki/Mestsk%C3%A9_%C4%8Dasti_Ko%C5%A1%C3%ADc

² <https://www.kosice.sk/mesto/katalog-ulic>

Libraries

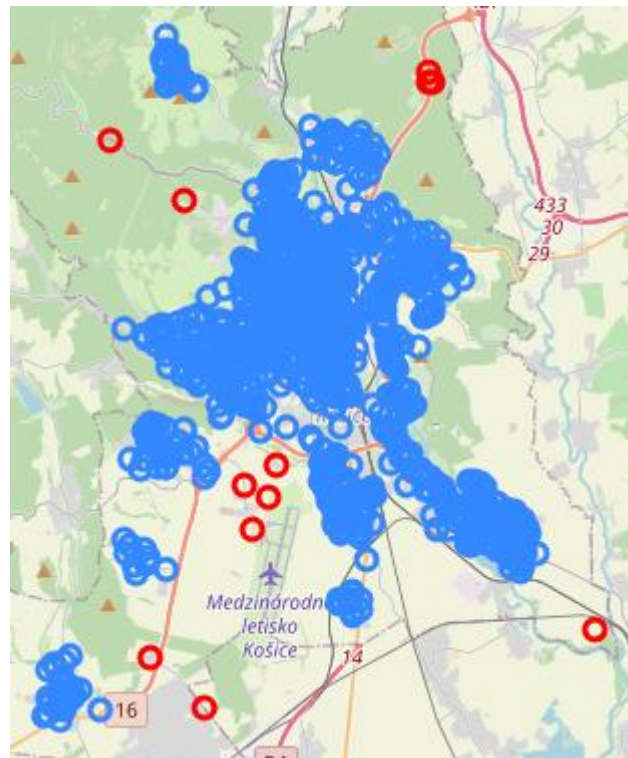
In order to get the correct longitude and latitude (further location) of a place given by address we used OpenCageGeocode³ because GeoPy do not provide longitude and latitude based on the street name (it returns coordinates of the city only). There are more geocoding free providers (usually with required registering) that offer limited number of calls per day or month. OpenCage was a good choice because after registering they do not require fill credit card details (as Google geocoding do).

Beside standard libraries like Requests, Pandas and Folium, we implement BeautifulSoup⁴ (from bs4) to scrap webpages and Haversine⁵ as well for measuring distances between two locations.

Methodology

Streets

At present, there are 928 streets of Košice. Using of GeoPy we obtain their's locations but after visualizing them on map there are some outliers – street that are far away from other streets and places where people live. Those locations are not in the walking distance from inhabited parts of the city, i.e. there are not a good choice for a new facility, they were removed from the dataset. Precisely there were 12 streets. Among all streets (denoted by blue circles) the eliminated streets are marked on the map below by the red color.



We observed also some duplicates in the list of the streets: some road are long enough to spread along two or more boroughs. Those records are not invalid, we will just have two or more location for one

³ <https://opencagedata.com/>

⁴ <https://pypi.org/project/beautifulsoup4/>

⁵ <https://pypi.org/project/haversine/>

street – that's fine because in the final step of the project we run through all streets in single neighbor and there no duplicates will exist.

Boroughs

List of street contains the boroughs of Košice as well, precisely there are 22 boroughs. The population corresponding to the census in 2018 was paired and the results are shown in the following Table 1.

Table 1 List of boroughs by population

Borough	Longitude	Latitude	Order	District	Size	Population
<i>Košice - Západ</i>	21.2298198	48.7136684	1	Košice II	553	39 848
<i>Košice - Dargovských hrdinov</i>	21.282077	48.7388517	2	Košice III	1109	26 004
<i>Košice - Nad jazerom</i>	21.2885299	48.686518	3	Košice IV	366	24 613
<i>Košice - Sídliisko KVP</i>	21.213507	48.7138812	4	Košice II	178	23 603
<i>Košice - Juh</i>	21.2605959	48.7068711	5	Košice IV	977	22 863
<i>Košice - Sídliisko Ťahanovce</i>	21.2682934	48.7557164	6	Košice I	826	22 129
<i>Košice - Staré Mesto</i>	21.2578294	48.7206148	7	Košice I	434	20 698
<i>Košice - Sever</i>	21.2485258	48.7384853	8	Košice I	5458	20 124
<i>Košice - Luník IX</i>	21.2213124	48.6974436	9	Košice II	107	6 499
<i>Košice - Šaca</i>	21.1712124	48.6318242	10	Košice II	4121	5 961
<i>Košice - Krásna</i>	21.3151716	48.6703947	11	Košice IV	2005	5 627
<i>Košice - Barca</i>	21.265998	48.6765971	12	Košice IV	1813	3 677
<i>Košice - Košická Nová Ves</i>	21.2997873	48.7314663	13	Košice III	577	2 806
<i>Košice - Ťahanovce</i>	21.2584875	48.7545152	14	Košice I	728	2 551
<i>Košice - Vyšné Opátske</i>	21.2796139	48.7128797	15	Košice IV	419	2 584
<i>Košice - Myslava</i>	21.2039714	48.7087999	16	Košice II	701	2 399
<i>Košice - Pereš</i>	21.2102575	48.6888064	17	Košice II	133	2 010
<i>Košice - Kavečany</i>	21.2067674	48.7748988	18	Košice I	1005	1 337
<i>Košice - Poľov</i>	21.1919793	48.6643911	19	Košice II	1296	1 206
<i>Košice - Šebastovce</i>	21.2684872	48.6553605	20	Košice IV	51	745
<i>Košice - Lorinčík</i>	21.1921169	48.6886069	21	Košice II	297	770
<i>Košice - Džungľa</i>	21.2703577	48.7362219	22	Košice I	47	703

Facilities

There are many different keyword that may identify some sporting facility. Among gym, arena and stadium we add tennis, hockey, squash, bowling, golf and bedminton as well. As a result, 74 facilities were found by Foursquare.

Nevertheless, not all of them are truly sporting facilities. It is a pity but one branch of high schools in Slovakia is called 'Gymnázium' so we have filter those 23 records out. Another anomaly were shops so they we removed them as well.

On the other side, some known facilities were not included in the search of Foursquare and are listed in the local websites e.g. <https://www.sportoviska.sk/>. The added facilities are listed in Table 2 Added facilities.

Table 2 Added facilities

Name	Latitude	Longitude	Borough
<i>City Gym</i>	48.729583	21.288412	Košice - Dargovských hrdinov
<i>Vodnolyžiarský vleč Trixen</i>	48.689345	21.28447	Košice - Nad jazerom
<i>MFK Ťahanovce</i>	48.757462	21.255165	Košice - Ťahanovce
<i>Baddy Fitness</i>	48.7528863	21.2692675	Košice - Sídlisko Ťahanovce
<i>Baddy Fitness</i>	48.7084648	21.2362396	Košice - Západ
<i>Game bar bowling</i>	48.6822057	21.2894243	Košice - Nad jazerom

There are also many more sporting possibilities within school areals and sport clubs (e.g. <https://kacjednota.webnode.sk/>) but the entrance to those facilities are not free therefore we decided not to include them in our dataset.

Finally, the borough has to be assign to each facility. We used list of streets and assign a borough of the closest street to each facility.

Final set of all facilities are on Figure 1.

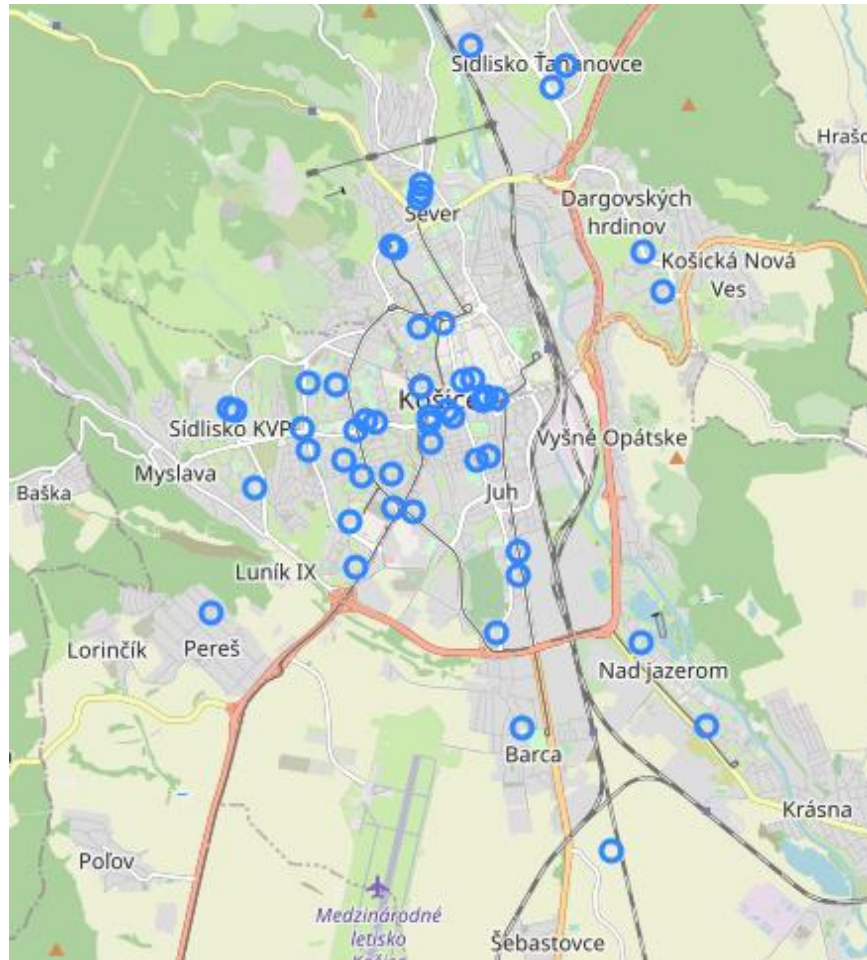


Figure 1 Current public sporting facilities

Results

Analysis consists of two steps.

First, we have to identify the borough with the highest demand for a new facility. Each facility is assigned to the borough according to the simple rule – it is a borough of the closest street to it. The boroughs of Košice are of various population size. We have to be careful when handling boroughs with small number of citizens. But fortunately it turns out that there was no borough with more than 10 000 of people without a sporting facility. After assigning number of facilities to each borough the demand was calculated by the formula.

$$Demand = \begin{cases} \frac{Population}{1000 \cdot Facilities} & \text{if Facilities} > 0 \\ - & \text{otherwise} \end{cases}$$

Results order by demand descending are in Table 3. Due to quite close results we decided to look for the best place for a new sporting facility in top 2 boroughs, i.e. *Dargovských hrdinov* and *Sídliisko Ťahanovce*, both of them have two facilities yet.

Table 3 Boroughs by demand

Borough	Order	Size	Population	Facilities	Demand
<i>Košice - Dargovských hrdinov</i>	2	1 109	26 004	2	13,00
<i>Košice - Sídliisko Ťahanovce</i>	6	826	22 129	2	11,06
<i>Košice - Nad jazerom</i>	3	366	24 613	3	8,20
<i>Košice - Sídliisko KVP</i>	4	178	23 603	3	7,87
<i>Košice - Šaca</i>	10	4 121	5 961	1	5,96
<i>Košice - Sever</i>	8	5 458	20 124	5	4,02
<i>Košice - Západ</i>	1	553	39 848	12	3,32
<i>Košice - Ťahanovce</i>	14	728	2 551	1	2,55
<i>Košice - Staré Mesto</i>	7	434	20 698	9	2,30
<i>Košice - Juh</i>	5	977	22 863	12	1,91
<i>Košice - Barca</i>	12	1 813	3 677	2	1,84
<i>Košice - Poľov</i>	19	1 296	1 206	2	0,60
<i>Košice - Lorinčík</i>	21	297	770	2	0,39
<i>Košice - Luník IX</i>	9	107	6 499	0	-
<i>Košice - Krásna</i>	11	2 005	5 627	0	-
<i>Košice - Košická Nová Ves</i>	13	577	2 806	0	-
<i>Košice - Vyšné Opátske</i>	15	419	2 584	0	-
<i>Košice - Myslava</i>	16	701	2 399	0	-
<i>Košice - Pereš</i>	17	133	2 010	0	-
<i>Košice - Kavečany</i>	18	1 005	1 337	0	-
<i>Košice - Šebastovce</i>	20	51	745	0	-
<i>Košice - Džungľa</i>	22	47	703	0	-

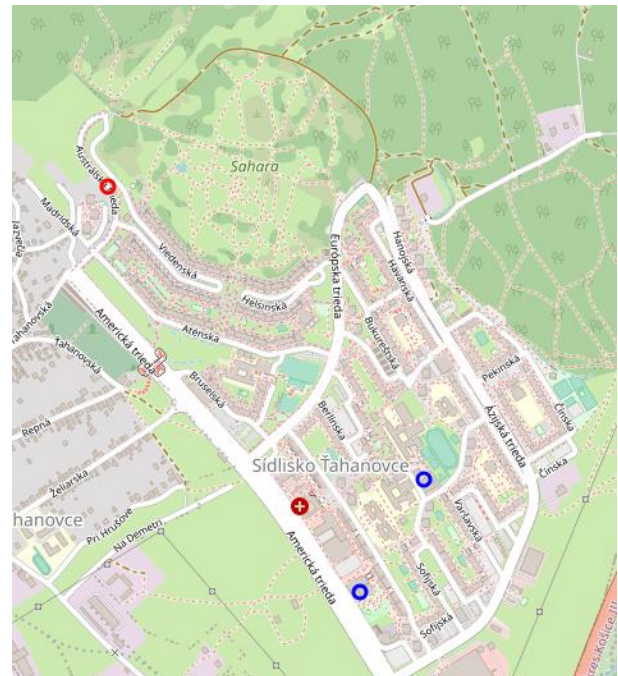
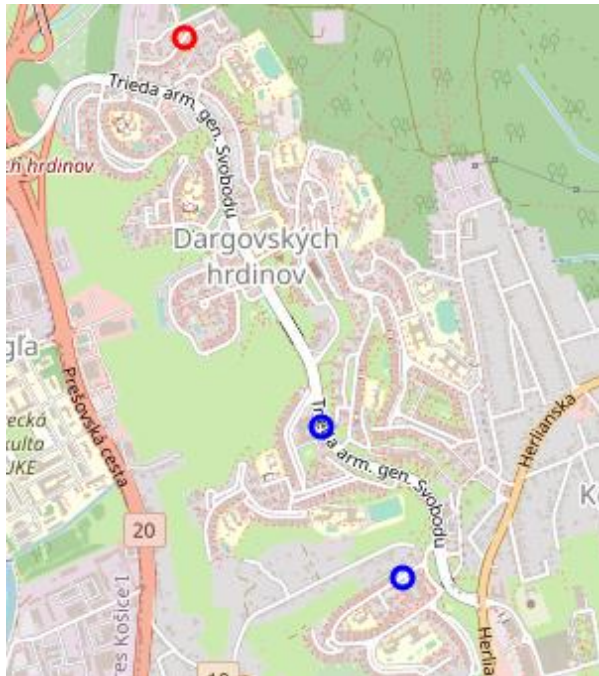
The proposal for the best location is a street that is far enough from other facilities but within that borough. More precisely, for each street we measure minimal distance from current facilities (denoted as $\|street - facility\|$) and then pick up the street with maximal value of that measure. Exactly

$$Best\ place = \operatorname{argmax}_{street} \{street \mid f(street) = \min_{facilities} \|street - facility\|\}.$$

After that procedure we found one street for two aforementioned boroughs. The proposed city is marked by red circle, current facilities by blue circles.

Best place for Košice - **Dargovských hrdinov**:

Adlerova street (48.744975, 21.2789492).



Best place for Košice - **Sídliisko Ťahanovce**:
 Austrálska trieda (48.7618460, 21.2608134).

Discussion

It is surprising that two of the largest boroughs have only two public sporting facilities. Here we see at least two reasoning why it seem sufficient to have one public facility for roughly ten thousands of citizens in the borough.

First, adults are usually working within the downtown so they can use facilities in there and student use the facilities within the school they attend. If this is a case, detailed dataset regarding current public and school facilities' occupation would definitely help.

Second, from spring to autumn season people use the free of charge sporting activities (like running, jogging, and workout machines in parks) and therefore there is a small demand in those part of the year for paid activities. From the investors point of view there are two choices how to handle that situation. One is to make the new facility open only within winter season. Another solution is to utilize the exterior to make it attractive for public, e.g. organize running events, offer free-of-charge trainings etc.

Conclusion

As can be easily seen, both proposal lies on the opposite side to the current facilities. Locality for Sídliisko Ťahanovce close to the city park seems to be even better choice. The selected boroughs are large enough (more than 20 000 people) so due to given criteria we found some interesting locations for a prospective investor.