# IS415 Geospatial Analytics for Business Intelligence
# HawkerLeh: Visualizing Accessibility to Hawker Centres

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***Abstract***-The cuisine found in Singapore is multi faceted and diverse. The best part is, the cuisine is readily available to the public through public eateries, known as hawker centres. However, these eateries might be less accessible to the public living in certain residential areas. Hence, we decided to attempt to portray the accessibility of hawker centres to the various subzones in Singapore. We designed an application (which we named HawkerLeh) that makes use of the Hansen accessibility model of spatial interaction to visualise the relationship between hawker centres locations and residential areas as well as bus stops across Singapore. This research paper will explore two variations of the Hansen accessibility model, show findings from the result of analysis and acknowledge the limitations of our application.

***Keywords***-Smart Nation, Hawker Centre, Bus Stop, Prescriptive Analytics, Geospatial Analytics, Spatial Modelling, Urban Planning, Hansen Accessibility Index

## 1. INTRODUCTION

Hawker centres are a unique aspect of Singaporean culture, where people from all walks of life are able to enjoy local cuisines. Besides offering delicacies from different cultures and sustaining a clean and hygienic environment for the comfort of everyone, it is important for hawker centres to be situated at accessible locations. Furthermore, with the ageing population in Singapore, ensuring that hawker centres are accessible (i.e. located within walkable distance and is connected to public transport) has become more important in recent years. With the National Environmental Agency (NEA) being the main regulator of hawker centres, they have announced plans to build 20 new hawker centres in Singapore ("Hawker Centres and Markets in Singapore", n.d.). With this in mind, we thought about how we could add value to the planning process through analysis and evaluations of current and possible future hawker centre developments.

## 2. MOTIVATION AND OBJECTIVES

Our efforts were motivated by the fact that there was a lack of clear visualization of hawker centres' location data and how accessible residential units and bus stops are to the hawker centres. We wanted the general public to have information on their residential areas to support their suggestions for change, and land planners to have a clearer idea of how their planning can benefit residents.

The model function allows us to obtain the accessibility index of each point of the residential units and bus stops to hawker centres. Hence, the objectives of our application are as follows:

1) Measure the accessibility of hawker centres in Singapore by analyzing current locations of hawker centres, residential areas and bus stops.

2) Provide a visualization of the accessibility indexes on the map, through filters such as subzones, buffer range, type of Hansen accessibility index calculation and hawker centre types.

3) Analysing shortage or surplus of hawker centres in certain areas, through the visualization.

4) File upload for comma separated values files (.csv) for residential points, hawker centres or bus stops.

## 3. RELATED WORKS

We referenced past year research papers and projects done by our peers. We would like to acknowledge Team 3Muskytears, Team JSR and Team Sunday, whose research projects have been very useful in guiding us in our path to create our application.

We would also like to acknowledge a project done by Yin Shanyang, who runs an independent data visualization studio based in Singapore, also known as Swarm Singapore (Yin, 2017). The project focused on the Hawker Centre Accessibility Index, which was similar to our project objectives and served as a good reference that gave us a better idea for our project approach. The link to this project is listed in the references section.

From these works, we saw the importance of data visualization, and how we could portray the results in a clear and easy-to-understand manner. From there, we also brainstormed on possible ways users of our application can manipulate the information and customise the visualization to focus on the information they want to gain out of our application.

The most important information that we learned from the works mentioned above, was the need to acquire suitable and accurate datasets, and the importance of manipulating them in a manner that would enable us to show our objectives and get a clear analysis of results from the application.

## 4. TOOLS & PLATFORM

Our team used the R programming language to develop the application, which is commonly used for computing statistical and graphical analysis. R provided a wide set of in-built functions that was used for all the analysis performed in the application.

In addition, the free R programming platform, RStudio, was utilised for our project. It proved to be a great platform for performing the required analysis, while also providing the means to create the application using its Shiny package. Along with this, other packages such as leaflets, maptools and spatstat was used for our interactive application.

## 5. DATA (SELECTION & PREPARATION)

### Data Gathering, Cleaning and Processing

Firstly, we had to determine the datasets needed for the project, which comprises of the subzone planning and residential dwellings data, the locations of public & private hawker centres, as well as the locations of bus stops and private and public residential areas. We obtained the subzone planning zone with dwelling data and location of public hawker centres from data.gov.sg. For the location of private hawker centres, we scraped data from various websites as such Food Junction, Kopitiam and Koufu and we obtained the location data of bus stops from mytransport.sg. In addition, we had to use a website service to geocode the addresses to latitude and longitude respectively ("Batch geocoding", n.d.). Finally, location data of private and public residential homes are downloaded from bbbike.org. The link to the websites used are listed in the reference.

Next, to ensure that data integrity is not compromised, we removed duplicates and empty rows. We used QGIS, the open-source geographic information system application, to perform, spatial query. It was used to select the data points that were contained within the subzone planning and exclude the points in the residential and bus stops data that were out of Singapore. We then exported the files to be used for analysis using RStudio.

Next, we had to determine which subzone the residential units and bus stops are situated in and add the subzone data column accordingly to support our functionality. Furthermore, population data also had to be included for the residential units. In order to achieve this, we made use of QGIS to map out the master plan subzone planning layer with the residential units and bus stops and then joined the attribute tables of these layers together based on their respective locations. We then added new columns for the respective data tables and exported them individually as CSV files.

However, the data from the residential dwellings were incomplete as they only provided a total number of all the different housing type and the locations of private and public residential data, and not a number for each residential unit. Hence, we had to randomize the number of people living in each residential unit in a subzone based on the estimated population in the whole subzone area. We did the same for the seating capacity of each hawker centre as well due to availability constraints.

To support our functionality of allowing users to select the type of hawker centres they would like to see on the map, again we made use of QGIS to merge the private hawker centres with the public hawker centres into a single SHAPefile, and created an additional column named 'POITYPE' that contains different categories of the hawker centres such as Food Junction, Kopitiam, Koufu and NEA.

**Hansen Accessibility**

From the Hansen accessibility model, we used two different functions to calculate the accessibility index, namely the REAT (Regional Economic Analysis Toolbox) and Spatial Acc functions.

**1) SpatialAcc**

This function measures the accessibility of certain geographical areas to certain amenities. The former usually refers to residential areas while the latter refers to services such as health care or education ("ac function", n.d.). There is a demand and supply factor involved for this function, where the demand refers to the demand for the services, and supply refers to the supply of the services available. For this project, our main objective is to find the accessibility of residential areas to all hawker centres in Singapore. We will be using the population data of the residential areas as demand values and the seating capacity of the hawker centres as the value of supply. This function cannot be performed on bus stops, because none of the bus stops come with a population or demand value while the SpatialAcc function would require a value for the demand parameter. The following are the datasets used:

Origin: Residential areas
Destination: Hawker centres

**2) REAT**

This function also measures the spatial accessibility certain geographical areas have to certain amenities, but does not require a value for the demand, which in this case is the population associated with each residential point. Thus, this function can also be applied for the bus stops location data. For the REAT function, it assigns an "attractivity" variable to the destination points ("hansen function", n.d.). The "attractivity" is considered as the number of opportunities, or the capacity of the facilities of the destination, which in this project, is the seating capacity of each hawker centre. The following are the datasets used:

Origin: Residential areas / Bus Stops
Destination: Hawker centres

One thing to note is that for both functions of Hansen accessibility, the higher the accessibility index, the more accessible the point is to the hawker centres.

## 6. APPLICATION DESIGN

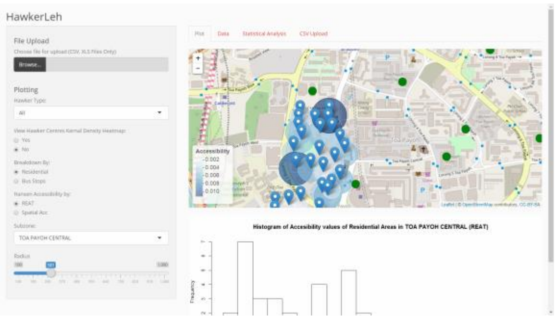


Figure 1: HawkerLeh Application

HawkerLeh is a web application designed with the main objective of providing urban planners a platform to gain insights from the accessibility analysis of residential units and bus stops to various hawker centres and thus facilitate the location planning of future hawker centres in Singapore.

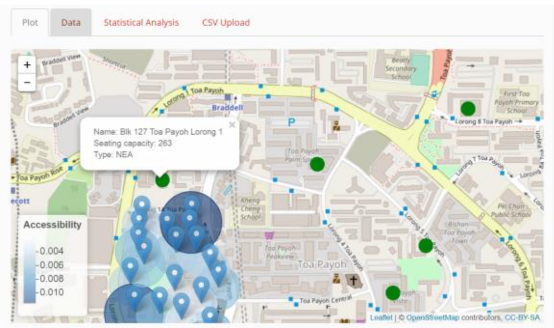


Figure 2: Label for Hawker Centre

The application shows the location points of the relevant data sets with labels to identify the name of the data point, whether it is a hawker centre, residential unit or bus stop.

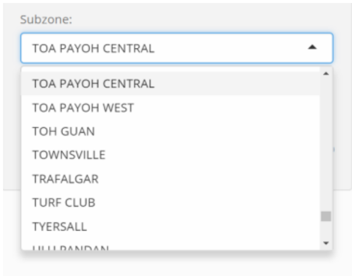


Figure 3: Subzone filter

It also comes with a selection of filters that allow users to focus our analysis on, such as: Hawker Type, Hansen Accessibility function, Breakdown by Residential or Bus Stops, Subzone, and Buffer Radius.

## 7. RESULTS & DISCUSSION

From the map visualization of the accessibility indexes of the residential areas and bus stops in relation to the hawker centres, we plotted a histogram to provide us better understanding of the results.

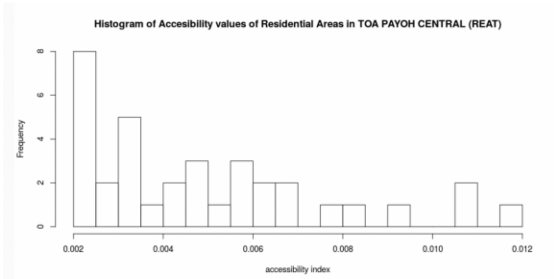


Figure 4: Histogram for Accessibility Indexes of Residential Areas in Toa Payoh Central

Using the residential areas in Toa Payoh Central as an example, we found many residential areas having a similar distribution of accessibility to the hawker centres. Many of these areas have a small proportion of residential units that are very accessible to hawker centres, and a large proportion of them less accessible to hawker centres. Furthermore, residential areas that are located closer to the city centre (e.g. Toa Payoh Central) tend to also have a higher accessibility index in general compared to those much further away (e.g. Admiralty).

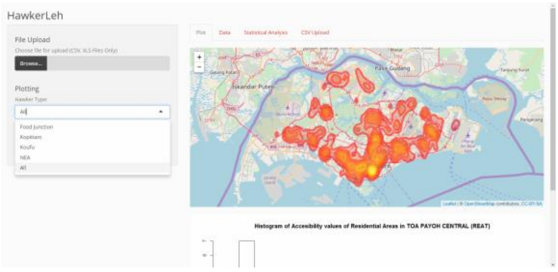


Figure 5: Heatmap of Hawker Centres in Singapore

In addition, we also found evidence of clustering of hawker centres in the central part of Singapore, which could explain the reason for residential areas located near the city centre to have a higher accessibility index, as mentioned earlier. This is done through a heatmap plot on the map that enables us to visualise the concentration of hawker centres in Singapore. Ideally, accessibility values in the residential areas should be relatively uniform as this would then indicate that the residential areas or bus stops have comparatively similar accessibility to hawker centres in Singapore. Alternatively, the accessibility index should at least increase for residential units in the scenario when a new addition of hawker centre nearby the residential area. Hence, land planners should take note of this and utilise the model for future location planning for hawker centres.

## 8. LIMITATION / CHALLENGES

Some limitations and challenges we encountered are:

1) A steep learning curve of creating an application with a programming language we are new to within a timeframe of only eight weeks

2) The residential dataset is not an exhaustive list of all the residential units in Singapore, hence the accuracy of the accessibility indexes can be improved on with comprehensive data

3) Private coffee shops that are usually located at residential blocks are not included due to the lack of information found online.

## 9. CONCLUSION / FUTURE WORKS

During the poster presentation at Geoworks at the PSA Building, we were honoured to be able to interact with representatives from various government organisations such as NEA and SLA. Through the interaction, we obtained some invaluable feedback and believe these would help to enhance the capabilities of the application in the future.

**Representation of accessibility could be improved with a wider variety of data points**

Currently the projects focuses on the accessibility of residential areas and bus stops to hawker centre. However, people do not only travel to hawker centres from their residential areas or bus stops and thus expanding our data to cover more areas such as office buildings, schools, hospitals and even train stations would allow for a more comprehensive and accurate representation of accessibility in Singapore.

**Highlight the data points that are being analyzed for accessibility**

Doing so would allow users to visualise the data points the analysis is based on and enhance their understanding of the Hansen accessibility model.

**Distance histogram to include percentage of accessibility**
This would provide a clearer interpretation of the distance between the locations and users will be able to decipher the information easily.

**Selection of multiple subzone**
In order to provide a much more comprehensive analysis, it would be better to allow multiple selection of subzone in future implementations.

**Improve visualization of distance buffer**
Instead of separately showing the Kernel Density Estimation model on the statistical analysis tab, it would be better to overlay it onto the leaflet itself, so then the users can better understand how does the model on a map, which would be more insightful than displaying it separately.

With regards to this, we managed to include a heatmap that still enables users to visualise the clustering of hawker centres in Singapore.

**Supply and attractivity factor could be number of stalls**
A representative from the Urban Redevelopment Authority (URA), advised us to use the number of stalls in hawker centres as the value of supply in our SpatialAcc calculation and the attractivity factor in the REAT calculation, instead of the seating capacity. This information could be obtained from NEA's website, where they specify the number of mixed rice, western food stalls, etc that are needed for each hawker centre. The rationale for this would be that many people might frequent hawker centres for takeaways instead of dining in, hence a wide variety of stalls and the number of stalls might be a greater attractivity factor for the public instead.

On a side note, we could also consider the influence delivery services has on the hawker centre crowd to see if it has increased or reduced crowd flow to the place. In addition, we could also consider including the travel time taken to get to hawker centres from the point of origin for our analysis.

**Increase our understanding of NEA on the planning process of hawker centres**
Another suggestion would be to approach NEA to find out the process on the planning process of how hawker centres and understand the considerations and requirements involved. It was mentioned that URA and NEA works in close collaboration and one consideration they had was whether people would visit hawker centres with wet markets more frequently compared to the standalone hawker centres, and from there, decide the kind of hawker centres to build.

**Improve accuracy of data**
We could get more data from the Accounting and Corporate Regulatory Authority (ACRA) about the coffee shops and other small privately-owned hawker centres. We also could use the dwelling data and divide it to based on the Housing Development Board (HDB) room size to display a much more accurate representation of the residential units in Singapore.

**Suggestions of possible locations to build hawker centres to improve accessibility**
The planners also gave feedback that a feature that would value add tremendously to the project would be if the application could suggest future locations for the planners to consider when building new

hawker centres in Singapore, such that the accessibility would improve.

There were other generic feedback as well, such as informing the user about the units of measurement used for the radius option under the Hansen REAT analysis. The planners also felt that we should allow the selection of multiple subzones and should also allow uploading SHAPeFiles onto the platform. On a more positive note, we also received comments that the planners found that measuring accessibility using the Hansen accessibility index was useful and they would consider it as a viable option for urban planning as well.

## 10. ACKNOWLEDGEMENTS

Our team would like to thank Professor Kam Tin Seong for his time and guidance throughout the project. Prof Kam has provided us valuable insights and helped steer us in the right direction for our project. We would also like to take this opportunity to thank all the industry representatives who came down for the poster day to view the projects and share their valuable suggestions and opinions. With a more comprehensive set of data and efficient system to run the application, HawkerLeh would provide a more accurate representation of accessibility to hawker centres in Singapore. Moving on, we believe that this application would be scalable to other applications with an aim to measure accessibility and come in handy to planners who aspire to gain insights on how else the accessibility of services can be improved on in Singapore.

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