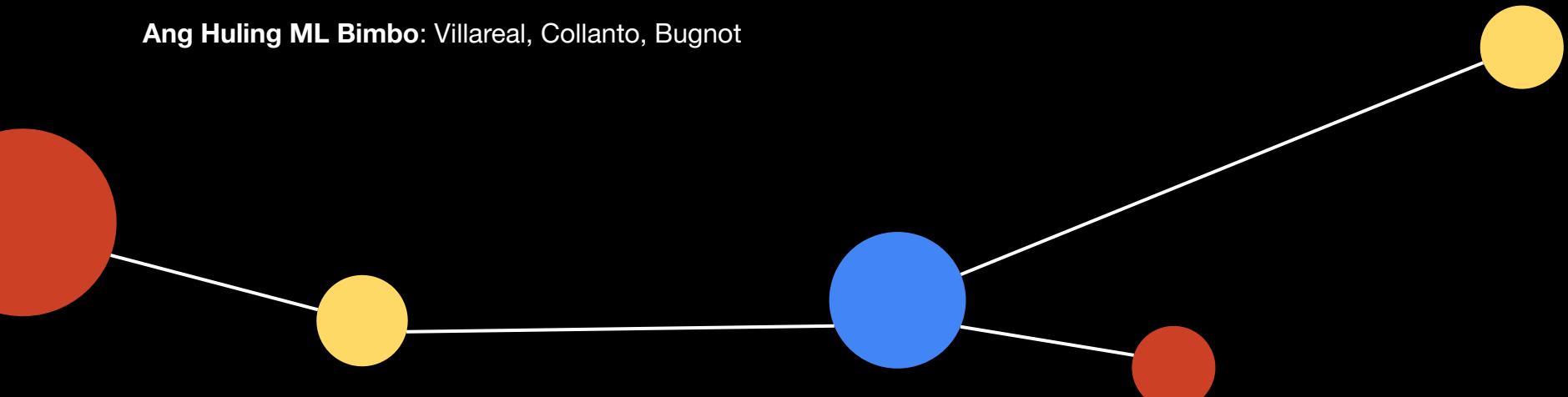


# Optimizing locations for future basic social infrastructures to maximize accessibility in BARMM

A BARMM Data Challenge 2020 Project

**Ang Huling ML Bimbo:** Villareal, Collanto, Bugnot





## Abstract

With the use of geospatial data visualization dashboards and machine learning models - particularly clustering algorithms, this project will **identify optimal locations for establishing infrastructures** or implementing services for educational, socioeconomic, and health purposes.

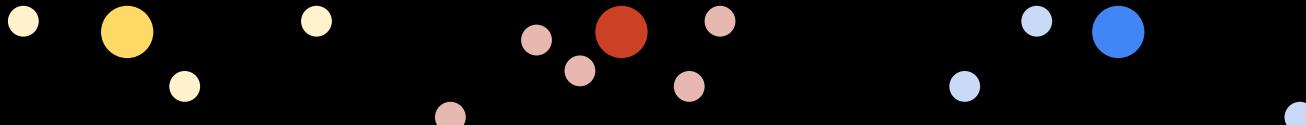


## **Problem: Inaccessibility of Basic Infrastructure in ARMM**

Basic social infrastructures such as schools, hospitals, and financial establishments are situated in places generally inaccessible to the public because of long distances, lack of roadways, or oversaturation.

## Solution: Finding optimal locations for maximum accessibility

By analyzing population data and known location information of already existing infrastructures, we can identify problem areas and recommend the best location for infrastructures in education, health, and finance to maximize public accessibility.



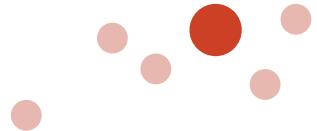
# Data Sources

<b>General</b>	/Administrative Boundaries - BARMM Barangays ao 20190206 (PSA 2016) /Administrative Boundaries - BARMM Municipalities ao 20190206 (PSA 2016) /Administrative Boundaries - BARMM Provinces ao 20190206 (PSA2016) /2-Tabular Data/5-Social/Population 2010, 2015 ARMM,BCT.xlsx
<b>Education</b>	/2-Infrastructure/SchoolsDepEd2017.xlsx
<b>Health</b>	/5-SOCIAL/Social - No. of RHU and BHS in ARMM (DOH, 2018)/Social - No. of RHU and BHS in ARMM, 2018 - DOH.shp <i>External Source:</i> NHFR_RHUFacilities_asofNov82018_2.xlsx; <a href="https://www.google.com/maps/d/viewer?ie=UTF8&amp;oe=UTF8&amp;hl=en&amp;msa=0&amp;start=0&amp;num=200&amp;mid=1iHj9oLetM0ashn-46JIVAjakyV8&amp;ll=6.4684573957861735%2C122.43705112153759&amp;z=9">https://www.google.com/maps/d/viewer?ie=UTF8&amp;oe=UTF8&amp;hl=en&amp;msa=0&amp;start=0&amp;num=200&amp;mid=1iHj9oLetM0ashn-46JIVAjakyV8&amp;ll=6.4684573957861735%2C122.43705112153759&amp;z=9</a>
<b>Finance</b>	/6-ECONOMIC/Economic - Location of Banks in ARMM (Bangko Sentral ng Pilipinas, 2018) <i>External Sources:</i> Google API Places on banks

# Methodology

**K-means clustering** of geographic areas

- 1 Data points.** Use barangay centroids.
- 2 Feature Generation.** Add features such as distance to closest facility, ratio of the number of facilities to target population group
- 3 Model.** Perform K-means clustering of areas based on features
- 4 Visualize.** Plot clusters & summarize cluster characteristics



# Features

## Education

1. Number of schools per category (ES, JHS, SHS, SUC)
2. Population falling within school age range per category
3. Distance to closest school per category

## Health

1. Number of health facilities
2. Population falling within different age brackets
3. Distance to closest health facility (hospital, RHU)

## Finance

1. Number of financial facilities
2. Number of households
3. Distance to closest financial facility



# Sector: HEALTH



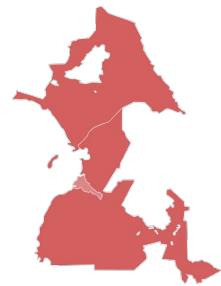
## Region-level Summary Statistics

	Average number per hospital	Average number per RHU
 Children	<b>39,467</b>	<b>16,251</b>
 Adults	<b>38,125</b>	<b>15,698</b>
 Elderly	<b>2,359</b>	<b>971</b>

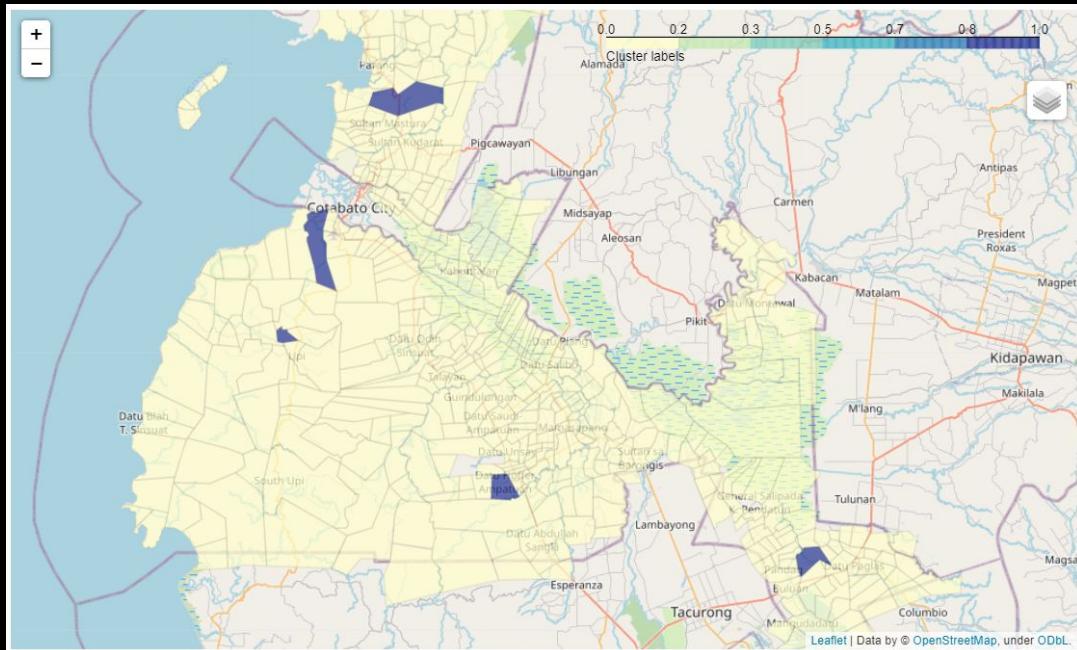
## Province-level Analysis

If we think of the population as **DEMAND** and the number of health facilities as **SUPPLY**, we can then use the following features for clustering:

1. Number of health facilities per barangay
2. Population falling within different age brackets
3. Distance to closest health facility (hospital, RHU)



# Clustering of Brgys in Maguindanao



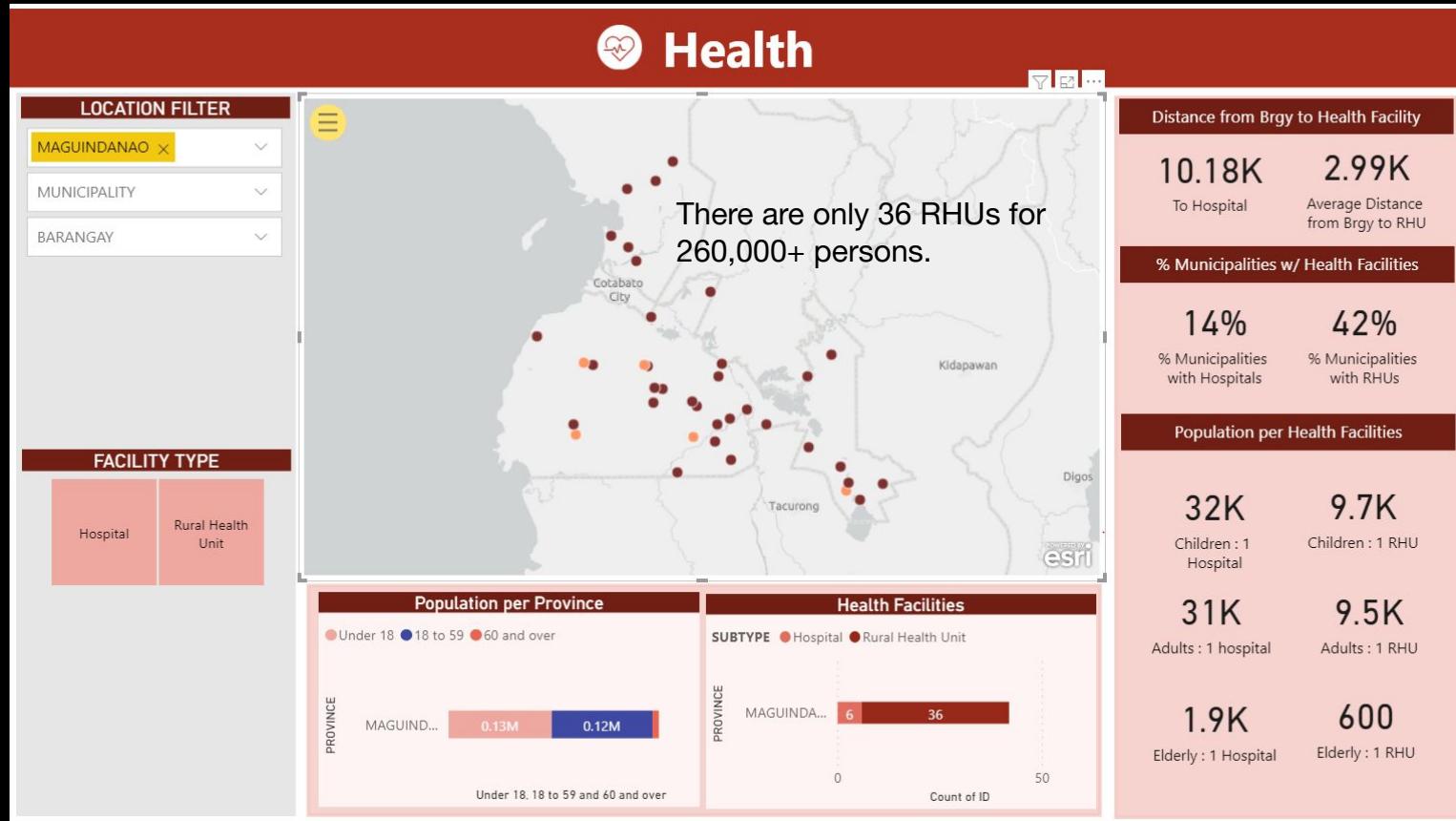
Cluster	0	1
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Hospital Within 2 hrs Within 15 mins

RHU All around 50 mins

Note: For an average walking speed, it is assumed that it takes 10 min to walk 1 km.

# Locations of Hospitals & RHUS in Maguindanao





# Sector: EDUCATION



## Region-level Summary Statistics

Average number of Students per  
School Building/Facility

	Elementary School	<b>241</b>
	Junior High School	<b>1517</b>
	Senior High School	<b>626</b>
	SUC	<b>5257</b>

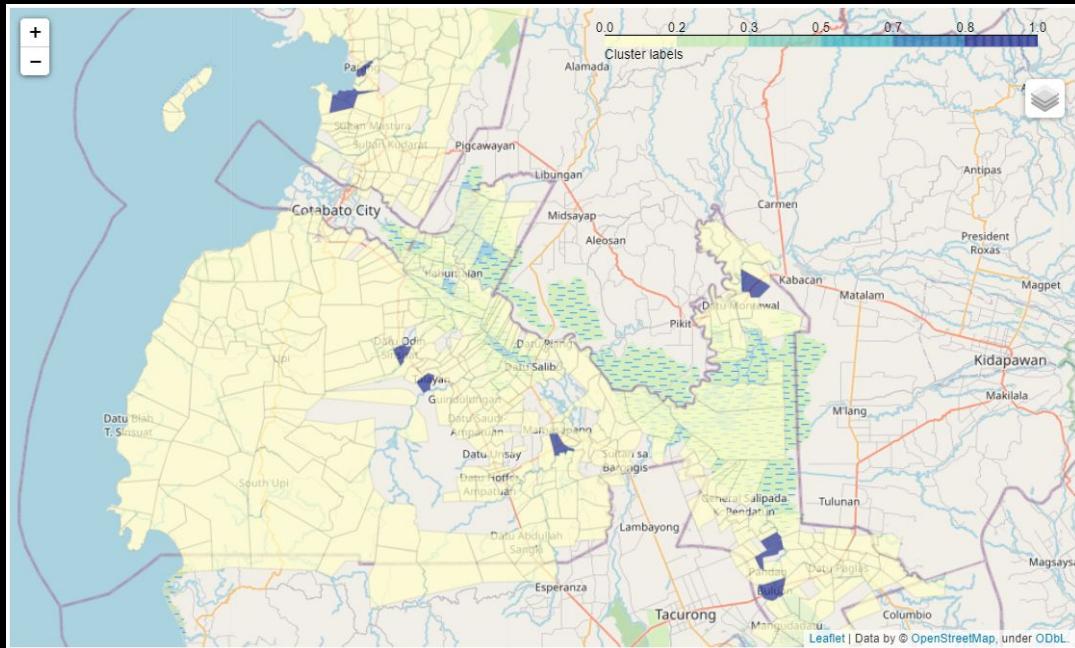
## Province-level Analysis

If we think of the population as **DEMAND** and the number of schools as **SUPPLY**, we can then use the following features for clustering:

1. Number of Schools per category in barangay
2. Population falling within school age range per category
3. Distance to closest school per category



# Clustering of Brgys in Maguindanao



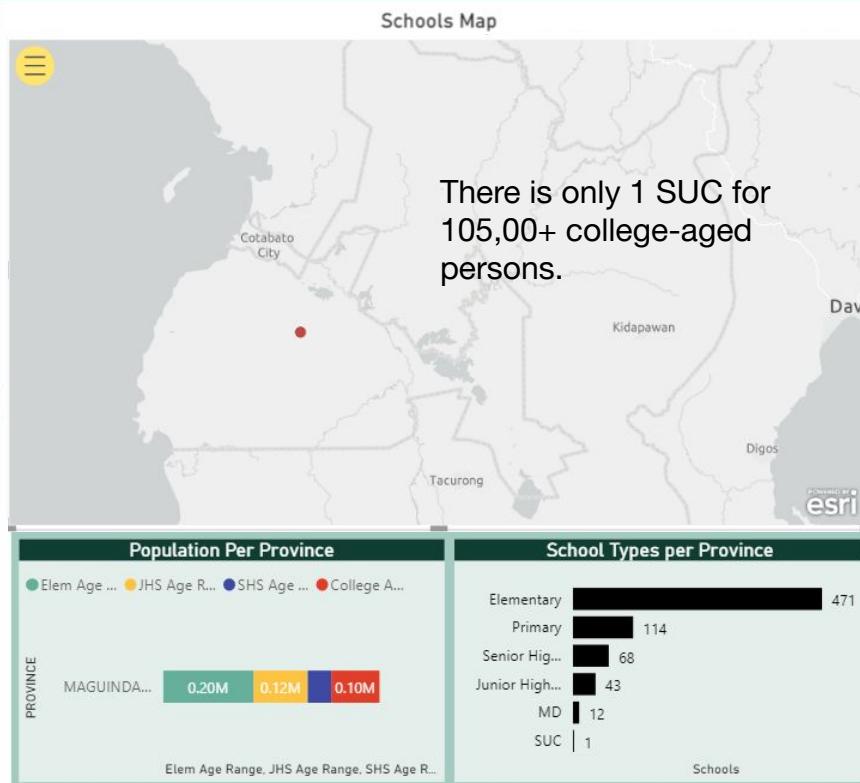
Cluster	0	1
Elementary	within 5 mins	40 + mins
Junior HS	40 + mins	within 30 mins
Senior HS	40 + mins	within 15 mins
SUC	All more than 4 hours	

Note: For an average walking speed, it is assumed that it takes 10 min to walk 1 km.

# Locations of SUCs in Maguindanao

## Education

LOCATION FILTER	
MAGUINDANAO	X
MUNICIPALITY	
BARANGAY	



Distance from Brgy to Nearest School Type	
1.24K	5.49K
Elementary School	To Junior High School
4.21K	28.51K
To Senior High School	To State University & Colleges
% Municipalities w/ School Types	
100%	64%
Elementary Schools	Junior High School
89%	3%
Senior High School	State University & Colleges
# Students / School	
400	43
Students : 1 Elem	Students : 1 Junior High
753	104895
Students : 1 Senior High	Students : 1 SUC



# Sector: FINANCE



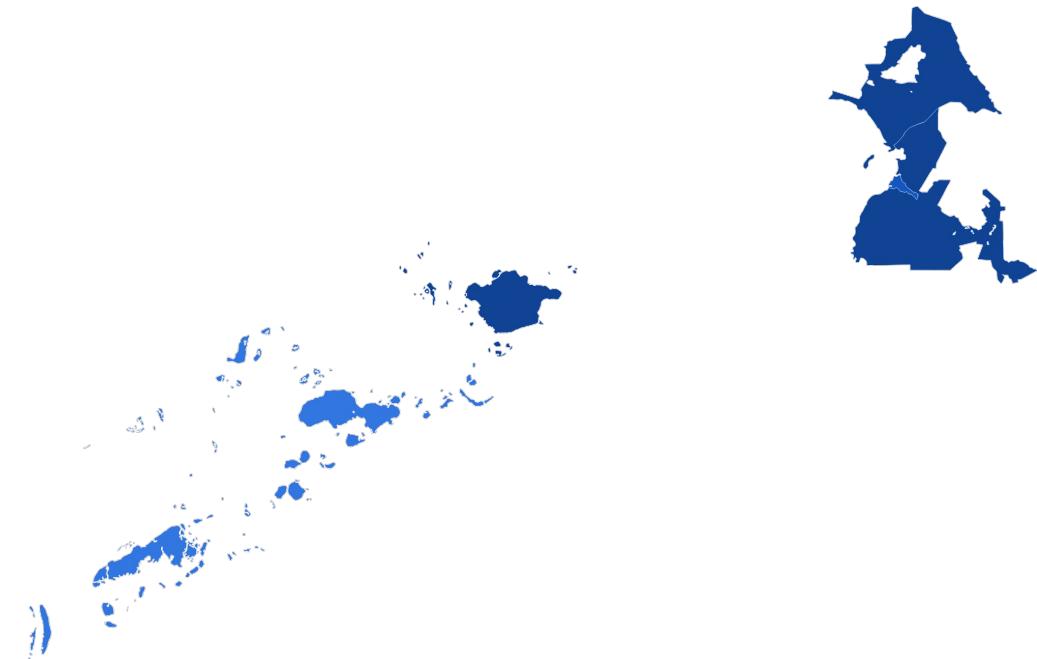
## Region-level Summary Statistics

	Average number of households for:	Average distance of barangay center to:
 Bank	<b>81,704</b>	<b>19 km</b>
 Cooperative	<b>24,821</b>	<b>16 km</b>

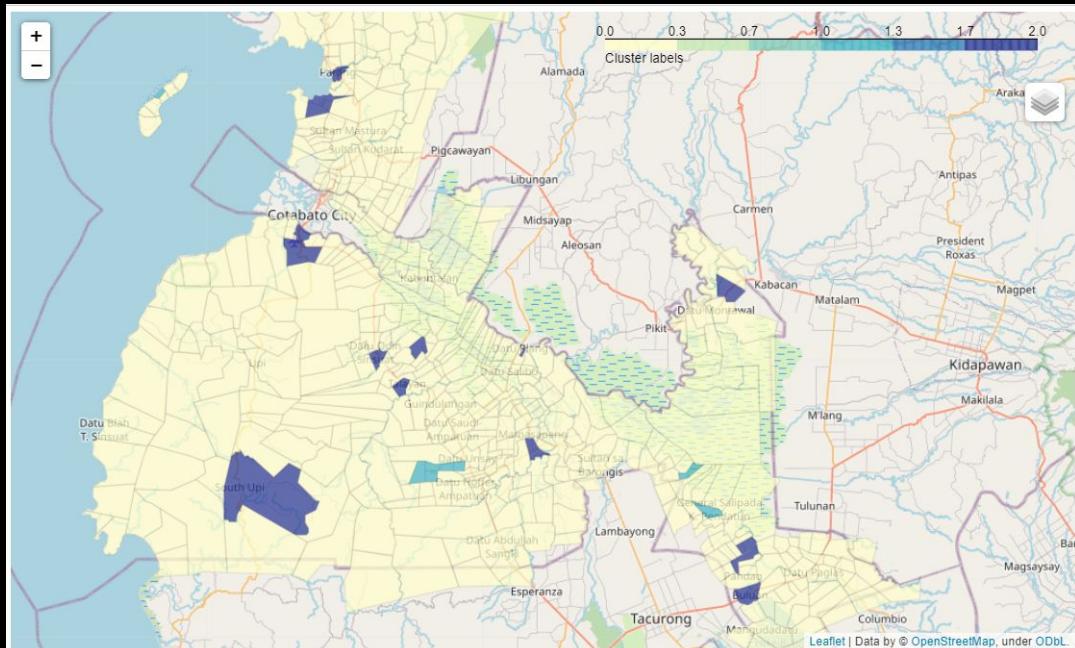
## Province-level Analysis

If we think of the population as **DEMAND** and the number of financial facilities as **SUPPLY**, we can then use the following features for clustering:

1. Number of financial facilities
2. Number of households
3. Distance to closest financial facility



# Clustering of Brgys in Maguindanao



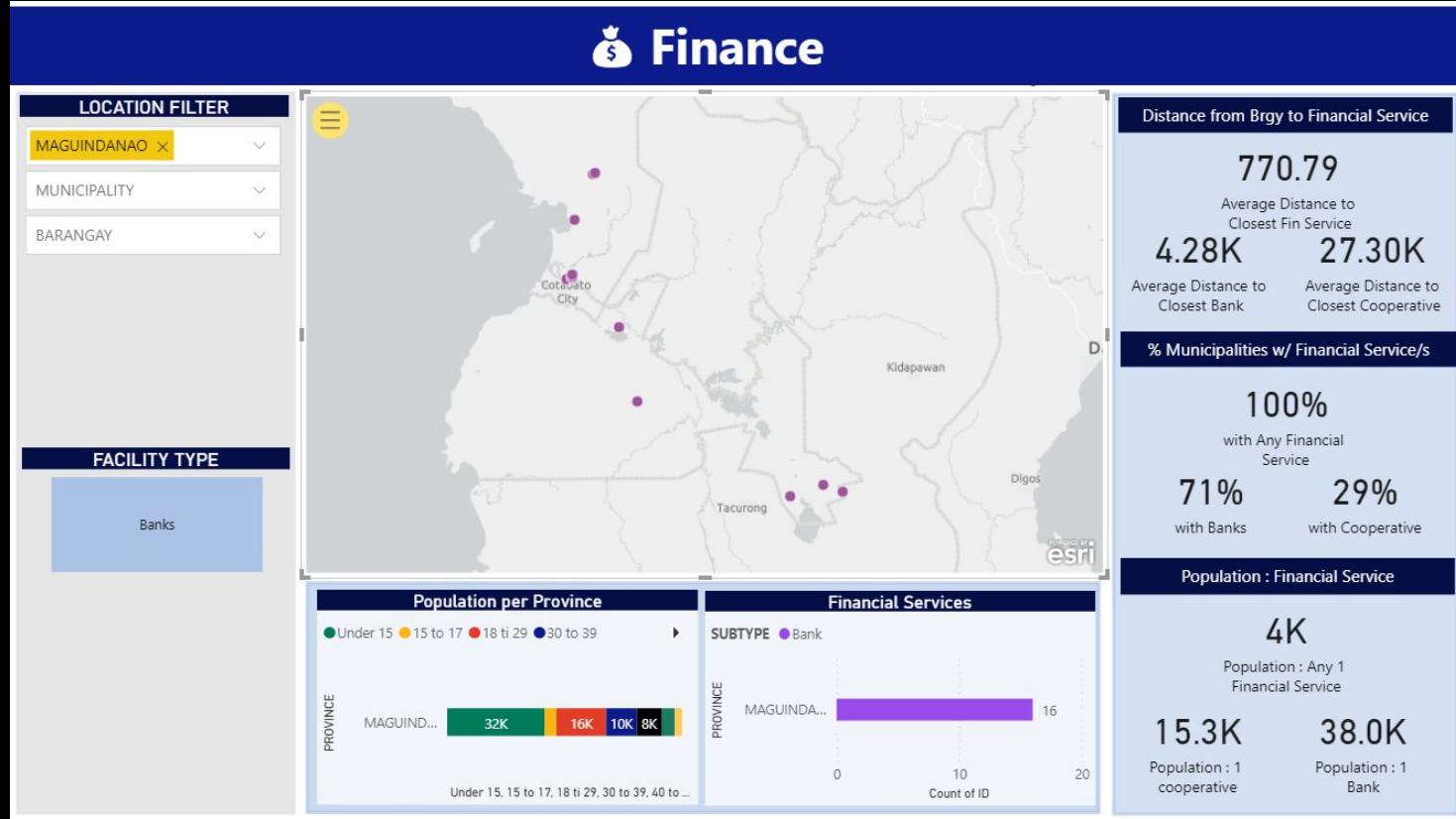
0      1      2

Cluster #

Financial Facility	Time to walk from brgy. center to closest facility
ATM	Cluster 0 & 1 more than 5 hrs Cluster 2 around 4 hrs
Bank	Cluster 0 & 1 around 2 hrs Cluster 2 more than 2 hour
Cooperative	Cluster 0 & 1 more than 5 hrs Cluster 2 around 4 hours
Financial Service	All more than 6 hours

Note: For an average walking speed, it is assumed that it takes 10 min to walk 1 km.

# Locations of Banks/ATMs in Maguindanao





# SUMMARY ANALYSIS



## Priority Facilities

	Education	Health	Finance
Lanao del Sur			
Maguindanao		Hospitals	
Sulu	JHS, SUCs		Banks and cooperatives (all take about an hour to reach on average)
Basilan	SUCs	Hospitals & RHUs	
Tawi-tawi	JHS	Hospitals & RHUs	

## The Next Step

The project presented here is only a proof of concept.

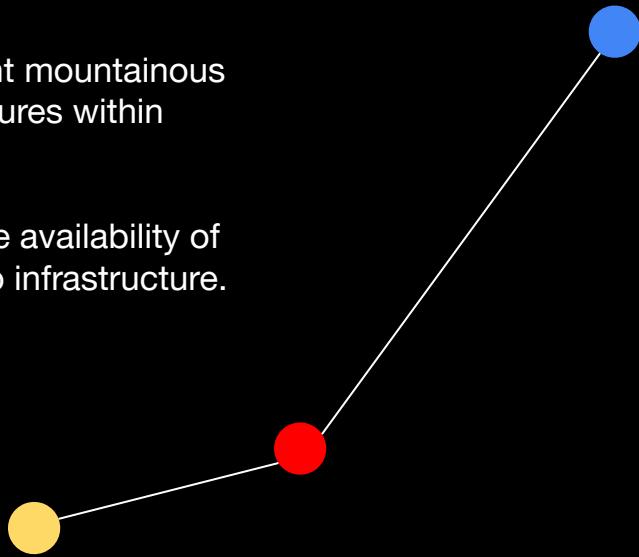
Moving forward, improvements in the model can be done through addition of necessary features for better identification of priority areas. These features can be as follows:

- **RESOURCES** available like hospital beds, etc. for health
- The **NUMBER** of businesses with different categories for finance
- **CAPACITY** or number of people each facility can accommodate
- Features that might provide more context, e.g., presence of conflict, susceptibility to natural hazards

## Long-term Vision

In the long-term, we hope to zoom in on barangays and **identify specific locations** for needed infrastructures using features like:

1. **SEAS Boundaries.** The future model should prevent the model from suggesting locations in sea/oceanic areas.
2. **MOUNTAIN Regions.** The future model should take into account mountainous regions in order to prevent impractical suggestions of infrastructures within inaccessible mountain areas.
3. **ROAD Networks.** The future model should take into account the availability of roads and pavements in measuring accessibility of individuals to infrastructure.



# Accessibility is crucial



## Accessible Schools

means kids don't have to risk walking miles of dangerous land and cross rivers to attend school.



## Accessible Hospitals

means people don't have to die because of treatable illnesses and injuries that we're remedied.



## Accessible Banks

means small businesses can operate with less logistical and financial restraints.

# TEAM



**Rosiel Villareal**

Team Lead



**Anj Collanto**

Technical Lead



**Rein Bugnot**

Design Lead

## Appendix

	Education	Health	Finance
Lanao del Sur	Ave. ES Dist: 0.13 hrs Ave. JHS Dist: 0.38 hrs Ave. SHS Dist: 0.42 hrs Ave. SUC Dist: 0.78 hrs	Ave. Hospital Dist: 1.18 hrs Ave. RHU Dist: 0.49 hrs	<b>Ave. Bank Dist: 1.75 hrs</b> <b>Ave. Coop Dist: 2 hrs</b>
Maguindanao	Ave. ES Dist: 0.20 hrs Ave. JHS Dist: 0.90 hrs Ave. SHS Dist: 0.42 hrs Ave. SUC Dist: 0.78 hrs	<b>Ave. Hospital Dist: 1.94 hrs</b> Ave. RHU Dist: 0.91 hrs	Ave. Bank Dist: 0.71 hrs <b>Ave. Coop Dist: 4.55 hrs</b>
Sulu	Ave. ES Dist: 0.16 hrs <b>Ave. JHS Dist: 2.36 hrs</b> Ave. SHS Dist: 0.72 hrs <b>Ave. SUC Dist: 3.26 hrs</b>	Ave. Hospital Dist: 1.15 hrs Ave. RHU Dist: 0.86 hrs	<b>Ave. Bank Dist: 4.83 hrs</b> Ave. Coop Dist: 0.83 hrs
Basilan	Ave. ES Dist: 0.18 hrs Ave. JHS Dist: 0.94 hrs Ave. SHS Dist: 0.95 hrs <b>Ave. SUC Dist: 3.86 hrs</b>	<b>Ave. Hospital Dist: 2.44 hrs</b> Ave. RHU Dist: 1.37 hrs	<b>Ave. Bank Dist: 3.67 hrs</b> Ave. Coop Dist: 1 hr
Tawi-tawi	Ave. ES Dist: 0.22 hrs <b>Ave. JHS Dist: 1.89 hrs</b> Ave. SHS Dist: 0.95 hrs Ave. SUC Dist: 1.09 hrs	<b>Ave. Hospital Dist: 2.59 hrs</b> Ave. RHU Dist: 1.15 hrs	<b>Ave. Bank Dist: 10.2 hrs</b> <b>Ave. Coop Dist: 4.67 hrs</b>