

A Study of Hospital Competition in Yogyakarta City with Huff's Gravity Model and Valuation Methods

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Abstract

This analysis was conducted to identify the level of hospital competition in Yogyakarta City. The object of this study is 12 hospitals in Yogyakarta City. The analytical tools in this study consist of two methods. The first method is the Huff's Gravity Model used to estimate the probability of visits to each hospital so that the competition between hospitals can be known. The second method is the valuation method using the income approach to calculate the potential value of the hospital. The results of this study show that the largest visit probability and potential value are owned by RS PKU Muhammadiyah Yogyakarta with a probability value of 19.91% and a potential value of IDR 8,493,747,933,578 for an optimistic estimate, IDR 3,370,534,894,277 for a moderate estimate, and IDR 1,400,068,340,700 pessimistic estimate. The contribution of this research can be considered in making investment decisions, especially in planning the establishment of a new hospital or expanding the capacity of an existing hospital. For investors who will invest in the hospital industry, they should look for locations that are easily accessible and avoid building hospitals with lower types near hospitals with high types; this will affect the level of probability of visits to the hospital itself. If the level of visit opportunity is low, then the potential value that will be obtained will also be low.

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Introduction

The growth of hospitals in Indonesia have increased over time. The data showed that during the period of 2017-2021, there was an increase in the number of hospitals in Indonesia by 9.6%. In 2017,

the number of hospitals was 2,776, increasing to 3,042 in 2021, consisting of 2,522 General Hospitals and 520 Special Hospitals. The growth of hospitals in the province of Yogyakarta Special Region also experienced a very significant increase over the last 10 years, which was 27.69% from 65 hospitals in 2012 to 81 hospitals in 2021. Then in Yogyakarta City itself, there are currently 19 hospitals consisting of 12 General Hospitals and 7 Special Hospitals.

Along with this growth, there is fierce competition among hospitals to get the market in the hospital industry. Yogyakarta City and Sleman Regency are the centers of hospital competition in DIY Province because there are as many as 59% of hospitals located in these regencies/cities, with a proportion of 35.80% of hospitals located in Sleman Regency and 23.45% of hospitals located in Yogyakarta City. With the highest population density in DIY Province, Yogyakarta City is considered to be a city with quite tight hospital competition in DIY Province.

The rapid development of the city of Yogyakarta can be seen from the emergence of a new Central Business District, one of which is health services in the form of hospitals in several parts of the city. The emergence of these new health service center was triggered by population growth and increasingly high community dynamics. The increasing population, increasing number of new students, increasing number of universities, increasing tourists, and various other causes encourage investors to develop new health service centers to respond to the increasing needs of society. This situation can be seen from the increase in the number of hospitals over time in the last ten years.

The question that arises from the increasing number of new hospitals is whether competition between hospitals in Yogyakarta has reached saturation point and what the opportunities are for each existing hospital. To answer this, the Huff probability model can be used to determine each hospital's chances. With the increasing competition among hospitals, the hospital that can offer greater appeal has a greater chance of being visited by customers. In this case, property managers must think hard to develop effective management strategies to attract customers. There are many things that can be done by hospitals to attract customer interest to use the hospital, such as improving the quality standards of service, providing sophisticated medical equipment, adding types of services, both services from professional human resources or by offering more advanced facilities and infrastructure.

Previous studies have provided valuable insights into the application of the Huff Gravity Model in the context of healthcare services. Additionally, Youn's study (2012) in Daejeon, Korea, revealed that consumers tend to prefer traveling to larger hospitals, believed to offer better medical services,

irrespective of distance. This study provided crucial understanding of consumer preferences based on the size and reputation of hospitals.

In another research conducted by Zhang et al. (2015), the GIS model was employed to evaluate spatial equity, while the Huff model was used to calculate the distribution of hospital choices among villagers. The findings of this study offered relevant information on the efficiency of healthcare resource utilization at the local level.

Furthermore, Huang et al.'s study (2023), applying the Huff model to calculate the Hospital Service Area (HSA) in the colorectal cancer screening program, demonstrated that the model could assign each community to the hospital with the highest probability of providing services to its residents. This information provided further insights into the application of the Huff model in the context of specific health programs, particularly in efforts to enhance cancer screening services.

By summarizing these findings, this research seeks to develop the Huff Gravity Model to estimate visit opportunities at hospitals in Yogyakarta City, with the hope of providing insights into the level of competition in the healthcare sector in the region.

While these studies have significantly contributed to the application of the Huff Gravity Model in healthcare settings, it is important to note that none of the mentioned research explicitly discussed the valuation method with a direct capitalization method. Therefore, the difference between this study and other studies is that this study also uses a valuation method with a direct capitalization method to determine the potential value of each hospital. Thus, this statement became the basis for the author's motivation to research this topic with a case study at a public hospital in Yogyakarta.

Moreover, this study aims to analyze the hospital industry competition in Yogyakarta City. This study is expected to be able to explain whether the hospital industry in Yogyakarta City has reached saturation point. In addition, the contribution of this study is to provide an overview of market potential and investment prospects for hospital property by conducting a coverage area analysis to estimate the probability of market absorption of hospital property in Yogyakarta City. The findings will benefit the medical facility planning.

Literature Review

Huff model was first used in the field of business (Huff, 2000). This model is based on gravity models by Reilly (1931) and Anderson (2010) which describe the magnitude of interaction by two factors, namely mass and distance. At first, gravity models were used only for the demographic research. From the 1930s, their use has been extended even to define the areas of commercial service

centers (Mitrikova & Antolikova, 2016). The Huff model contains a distance decay function to model this effect on market share because in general, providers will have less market share in more distant areas (Huff, 1964). The Huff model further takes competition between providers into account when estimating detection probabilities and allows for aspatial attractiveness (e.g. size of the lab), which influences the market share (Braeye et al. 2019).

The Huff Gravity Model is often used in previous studies to estimate retail business competition because (1) its ease of use (Park, Ko, Youn, & Kim, 2006), (Lv, Bai, Yin, & Dong, 2008), (Woo, Lee, Jin, & Youn, 2009) and (2) its prediction accuracy (Drezner and Dressner, 2002), although it is only limited to two variables namely retail size and travel time (Huff, 1963). The Huff model uses merchant attractiveness for the mass factor (the square footage of a merchant facility is used in the original Huff model) and the distance between a customer and a merchant for the distance factor (Suhara, et al., 2021). In the face of a number of commercial outlets in the area, the probability of each network residents choose is different. The size of this probability is determined by the size of commercial outlet and the distance of residents to this outlet.

Hidayat (2006) and Rozak&Putu (2013) conducted research using the Huff Gravity Model to measure the probability level of consumer visits to shopping centers. The results of the study can be used to estimate the level of competition in each shopping center.

Youn et al. (2012) developed the Huff model to estimate the demand for general hospital services in Daejeon City, Korea. The study used the facility size variable in the form of the number of beds and the travel time variable to the health facility. The study estimated hospital sales based on market share estimates and then verified the results by making comparisons with actual market share. The results showed that the size of the health center had a greater influence than travel time. The results prove that Daejeon residents are more interested in the size of the hospital than travel time when looking for medical services.

Empirical studies on hospital industry competition using this model are still rare in Indonesia. This study attempts to develop the Huff Gravity Model, which is commonly used in retail studies, to estimate the visit opportunities at hospitals in Yogyakarta City so that the level of competition and potential value of each hospital is known.

Method

The method used in the analysis is divided into several stages of analysis, the Huff Gravity Model is used to estimate the probability of visits to each hospital so that the competition between hospitals

can be known and the valuation method using the income approach to calculate the potential value of the hospital.

Huff's Gravity Model

By the Huff model calculation, we can draw the probabilities of customers choosing each shop, which provide the basis for the operator's business strategy (Zhang et.al, 2015).

The expression is shown as Formula 1.

$$P(C_{ij}) = \frac{S_j / (T_{ij})^n}{\sum (S_j / (T_{ij})^n)} \quad (1)$$

Formula (1): $P(C_{ij})$ stands for the probability of the customers of region i to store j . S_j stands for the scale of store j in square meters (m^2). T_{ij} stands for the distance or the time it takes from the customers of region i to store j . The distance measured in kilometers per hour (km/hr). The n as the effect index, if t stands for the time, $n = 1$, and if t stands for the distance, $n = 2$.

Based on the hospital's perspective, the hospital reads the interactions that exist between patients as consumers and the presence of the hospital as a producer, which considers the two variables above (Lowe and San, 1996). The Huff model was used to delineate the hospital service area, which helps revealing the area of hospital services and the attractiveness of the hospital (Huang et al. 2023 and Jia et al. 2015). As in retail, distance or accessibility, convenient location, is an important consideration for patients seeking healthcare services (Victor et al. 2012).

To determine the probability of visits to each hospital, an analysis using the Huff's Gravity Model is performed.

$$A_{ij} = \frac{S_j / (T_{ij})^b}{\sum (S_j / (T_{ij})^b)} \quad (2)$$

Formula (2): A_{ij} stands for the probability of the customers of region i travelling to use hospital j . S_j stands for the size of facility j , which is the hospital's number of beds. T_{ij} stands for the travel time or distance from location i to hospital j . For β value setting, according to the specific situation of the study area, in combination with related literature, taking $\beta=2$.

The travel distance measurement is carried out on 14 sub-districts in Yogyakarta City which covers 45 villages/sub-districts. To obtain the travel time data, the travel distance data is divided by the average normal speed on the highway, which is 30 km/hour. This travel time will later be

presented in minutes. The travel distance and travel time are processed using the ArcGis 10.8 device. The result of this analysis is the average visit opportunity for each hospital.

The method used in this research is secondary data collection consisting of data on operating hospitals and their locations, number of hospital beds, road network map of Yogyakarta City, population of Yogyakarta City, and per capita income of Yogyakarta City. While the primary data used are per capita expenditure for health of Yogyakarta City residents. The object of research is 12 general hospitals in Yogyakarta City because they are considered to represent all hospitals in Yogyakarta City. General hospital is a hospital that provides primary services in all fields and types of diseases. General hospitals are often preferred for their cutting-edge facilities and wide range of services (Youn et. al. 2012). The population in this study are residents who live in Yogyakarta City. The technique used to determine the sample of this study uses probability sampling, namely simple random sampling where the researcher gives the same opportunity to each member of the population to be selected as a random sample, regardless of the population strata itself.

According to Roscoe (1975) in Sekaran (2013), a sample size of more than 30 and less than 500 is appropriate for most research. The total number of questionnaires distributed was 200 with the distribution of questionnaire distribution times carried out randomly, not on certain days or hours.

Valuation Method

If the visit probability results are linked to the number of residents who are the target consumers, then the gross number of potential visits for each hospital can be calculated. The next process is to determine the potential gross income obtained from the calculation of multiplying the gross number of potential visits by the per capita expenditure of residents for health (average per capita income multiplied by income spent for health). Then this potential gross income is multiplied by the ratio of consumers to the number of residents based on optimistic scenarios (70%), moderate (50%) and pessimistic (30%) to produce effective gross income. The effective gross income is then reduced by the estimated operating costs to obtain net operating income. The operating costs in this study are 40% of the effective gross income (Harjanto, 2001). The net operating income that has been obtained is then divided by the capitalization rate based on optimistic scenarios (5%), moderate (9%) and pessimistic (13%), then the potential value of each hospital will be known (Harjanto, 2006). The final result of this process is the potential value of each hospital with three estimates or scenarios, namely: optimistic estimate, moderate estimate, pessimistic estimate. The general formulation used is:

$$V = NOI/R \quad (3)$$

Formula (3), the V is the value of the property, NOI is the net operate income, whilst the R is the overall capitalization rate.

Result and Discussion

The initial stage of analysis is the data collection process. The data collected is secondary data obtained from publications and records from the Badan Pusat Statistik (BPS) and the Geospatial Information Agency. The data format required in this analysis is a shapefile or a base map. When the necessary data has been collected, the following process is spatial analysis by measuring travel distance and travel time using the road of Yogyakarta City network map. Analysis was performed using ArcGIS 10.8 to calculate travel time and travel distance to the hospital. Most studies calculate travel time by setting a driving speed to each road level and then using road network analysis tools to find the minimum travel time between any two sites, e.g. using the Network Analysis toolbox of ArcGIS (Tao & Cheng, 2019).

The centroid of the administrative boundary of each village represents the location of demanders at the village level. Travel distance by car from each village to each hospital was calculated. The route used in this study is the shortest route which is assumed to be the most efficient route in reaching the destination of the hospital. Based on distance measurements using ArcGIS 10.8 software, the average distance traveled through the normal route from the village to each hospital is obtained. The distance data that has been obtained is then calculated by calculating the travel time by dividing the distance traveled assuming the average normal speed in the city is 30 km per hour. The driving speed is often set according to the actual driving speed in the study area (Tao & Cheng, 2014).

Table 1 shows that the lowest average travel time is the travel time to RS Ludira Husada Tama, which is 6.06 minutes, while the highest average travel time is the travel time to RSI Hidayatullah, which is 10.18 minutes. Both the SNI and WHO standards do not regulate the travel time limit of hospitals to residential areas. However, previous researchers such as Fortney et al. (2000), Luo and Wang (2003), Weinhold et al. (2022) defined that the travel time that can be tolerated between settlements and hospitals is 30 minutes as a threshold. Referring to this standard, the travel time in each sub-district in Yogyakarta City to one of the 12 hospitals studied has met the requirements.

Table 1. Average Distance and Travel Time to the Hospital

No	Hospital Name	Average distances (km)	Average travel time (minutes)
1	Bethesda Hospital	3.93	7.85
2	Panti Rapih Hospital	4.89	9.77
3	PKU Muhammadiyah Hospital	3.15	6.29
4	Regional General Hospital Kota Yogyakarta	4.44	8.88
5	Hidayatullah Islamic Hospital	5.09	10.18
6	Siloam Hospital	3.91	7.81
7	Dr. Sutarto Hospital	4.19	8.37
8	Pratama Hospital	3.56	7.11
9	Happyland Hospital	4.65	9.29
10	AMC Muhammadiyah Hospital	3.95	7.89
11	Ludira Husada Tama Hospital	3.03	6.06
12	Bethesda Lempuyangwangi Hospital	3.82	7.63

Source: processed data from ArcGis 10.8

The next step is to calculate the probability of residents visiting 12 hospitals in the city of Yogyakarta, analyzed using the Huff's Probability Model as shown in Formula 2. The analysis was carried out based on the criteria of travel time and number of hospital beds. The results of calculating the average probability of visits can be seen in the Table 2.

Table 2. Average Visit Opportunity of Hospitals

No	Hospital Name	Average visit probability (%)
1	Bethesda Hospital	16.91
2	Panti Rapih Hospital	8.35
3	PKU Muhammadiyah Hospital	19.91
4	Regional General Hospital Kota Yogyakarta	11.9
5	Siloam Hospital	3.12
6	Dr. Sutarto Hospital	5.33
7	Hidayatullah Islamic Hospital	9.23
8	Pratama Hospital	5.29
9	Happyland Hospital	2.61
10	AMC Muhammadiyah Hospital	4.31
11	Ludira Husada Tama Hospital	6.57
12	Bethesda Lempuyangwangi Hospital	6.49

Source: processed data from ArcGis 10.8

Table 2 shows that PKU Muhammadiyah Yogyakarta Hospital has the greatest probability of 19.91%. This can be interpreted that of all potential consumers in Yogyakarta City, as much as 19.91% will have the opportunity to visit PKU Muhammadiyah Yogyakarta Hospital and the lowest visit probability is owned by Happy Land Hospital at 2.61%. If these results are related to travel time and number of beds, it can be seen that there is a tendency for people to choose a hospital based on the number of beds, which represents hospital services, compared to the travel time to the hospital.

These results are consistent with the study of Youn et al. (2012) which states that hospital size has a greater effect than travel time, which means that consumers are more interested in hospital size, which in this study is assumed to be directly proportional to the number of hospital beds, than the travel time when seeking medical services. It cannot be separated from the type of hospital available, where the higher the type of hospital means, the more complete the services available at the hospital in the form of the availability of facilities and infrastructure as well as the competence and availability of health personnel. Therefore, the higher the type of hospital, the more often it will be used as a reference hospital. This is by UU No 44 2009 concerning Hospitals, which states that hospitals must refer patients to more capable facilities if they cannot serve patients according to their service capabilities.

Based on the Table 2, it also can be seen that PKU Muhammadiyah Yogyakarta has the highest visit opportunity ratio when compared with 12 other hospitals. The tendency of consumer preferences to prefer hospitals with a higher class, which practically causes an imbalance in the distribution of consumers for hospitals with a lower class.

Moreover, Happy Land Hospital, Siloam Hospital, and AMC Muhammadiyah Hospital, have a visit opportunity ratio of less than 5%, it can be seen that these three hospitals have much lower competitiveness when compared to the 9 hospitals other. The unequal difference between these three hospitals and the other 9 hospitals is understandable considering that there are differences in each class of hospital. In other words, the different classes of hospitals mean that the three can only be compared if three or more hospitals are in the same class.

Apart from that, Table 2 also indicates that the large difference between the probability ratio of PKU Muhammadiyah Yogyakarta and the probability ratio of other hospitals, causes a gap in health service competition in Yogyakarta City. Investment opportunities arise to fill this gap and increase competitiveness in the health sector. Investments in health infrastructure, medical technology or the provision of specialist services can create a more competitive market situation, which in turn can contribute positively to the growth of the health sector and increase the accessibility of health

services for the population. Thus, as the results of Todaro and Smith (2015) analysis show, investment opportunities in the health sector can contribute to regional economic growth and increase the welfare of local communities. By knowing the probability of a visit, hospital management/managers can estimate the number of visitors who will visit the hospital. If the probability of a visit is high, the potential to generate income will also be high, and conversely if the probability of a visit is low, the potential for income will also be low. In the theory of economic growth, it is acknowledged that factors promoting the economic advancement of a region or country encompass the population and labor force, capital or financial resources, natural resources, environmental considerations, as well as technology and social aspects (Lubis, 2022).

From the results of the analysis of the Huff's Gravity Model (Table 2) and the results of calculating the average gross number of potential visits, as well as some data (income spent on health, potential gross income, effective gross income, estimated operating costs, and operating net income), then it can be estimated the potential value of each shopping center which is the object of research as contained in the Table 3.

Table 3. Hospital Potential Value

No	Hospital Name	Potential Value (Rp)		
		Optimistic Estimates	Moderate Estimates	Pessimistic Estimates
1	Bethesda Hospital	7,213,892,954,398	2,862,655,934,285	1,189,103,234,241
2	Panti Rapih Hospital	3,562,168,557,201	1,413,558,951,270	587,170,641,297
3	PKU Muhammadiyah Hospital	8,493,747,933,578	3,370,534,894,277	1,400,068,340,700
4	Regional General Hospital Kota Yogyakarta	5,076,682,509,535	2,014,556,551,403	836,815,798,275
5	Siloam Hospital	1,330,981,161,254	528,167,127,482	219,392,499,108
6	Dr. Sutarto Hospital	2,273,811,441,312	902,306,127,505	374,804,083,733
7	Hidayatullah Islamic Hospital	3,937,622,914,247	1,562,548,775,495	649,058,722,129
8	Pratama Hospital	2,256,807,167,895	895,558,399,958	372,001,181,521
9	Happyland Hospital	1,113,439,823,340	441,841,199,738	183,534,036,814
10	AMC Muhammadiyah Hospital	1,838,728,765,484	729,654,272,017	303,087,159,146
11	Ludira Husada Tama Hospital	2,802,757,706,401	1,112,205,439,048	461,993,028,528

Table 3 explains the estimation of the potential value of hospitals in the City of Yogyakarta. It

shows that PKU Muhammadiyah Yogyakarta Hospital which has the largest number of visitors has the greatest potential value of IDR 8,493,747,933,578 for an optimistic estimate, IDR 3,370,534,894,277 for a moderate estimate, and IDR 1,400,068,340,700 pessimistic estimate. Happy Land Hospital has the smallest potential value compared to other hospitals, which is IDR 1,113,439,823,340 for optimistic estimates, IDR 441,841,199,738 for moderate estimates, and IDR 183,534,036,814 for pessimistic estimates.

The potential value of this hospital shows the size of the business potential of each hospital in the city of Yogyakarta based on the market potential that can be absorbed by each hospital. However, this potential value will increase if the hospital management can make efforts to improve the quality of hospital services in the form of the availability of medical facilities and equipment and are supported by medical personnel who are quite reliable in their fields who can attract visitors, as explained by Zhang et al. (2015). Based on hospital reviews, the variables considered in the model do not only refer to the two variables above but also take into account the quality and professionalism of health workers, the completeness and modernity of supporting facilities as well as hospital capacity and resources.

Conclusion

Based on the analysis of Huff's Gravity Model to calculate the level of competition among existing hospitals, it can be seen that the largest visit probability is owned by PKU Muhammadiyah Yogyakarta Hospital at 19.91% and the lowest visit probability is owned by Happy Land Hospital at 2.61%. The results of the probability of hospital visits show that distance is not the main reason for people choosing a hospital. Still, the primary consideration is the completeness of the hospital's services, which in this study is directly proportional to the size of the hospital (number of beds). The contribution of this research can be considered in making investment decisions, especially in planning the establishment of a new hospital or expanding the capacity of an existing hospital. For hospital managers or investors who will invest capital in the hospital industry should look for locations that are easy to reach and should avoid building lower type hospitals near higher type hospitals, this will affect the likelihood of hospital visits themselves. If the level of opportunity for visits is low, the potential value obtained will also be low. For future researchers, it would be better to add variables and expand the coverage of the hospital's service area, namely by including the surrounding districts that are influenced by the presence of the hospital under study, adding the population of each subdistrict and community income to get more accurate results, analyzing the data

by classifying based on hospital types, and adding real hospital occupancy rate data so that it can be compared with research results.

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