

An Integrated Decision-Making Model in Building or Expanding Health Facilities

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Abstract

In the Philippines, the healthcare delivery system has been described as somewhat operationally inefficient as it is consisting of government and private health, diagnostic, and treatment facilities spread unevenly across the archipelago. Thus, the objective of this study is to (1) assess the current basis of DOH and other regulatory agencies in building/expanding health facilities, (2) know the factors that have significant effect in the decision-making and (3) develop an integrated decision-making model that will make use of forecasting, simulation and optimization modeling approaches. The study proposed an integrated decision-making model that consists of three major categories to consider: volume drivers, health resources parameters and health facility requirements based on reviewed documents and articles. This model was developed to aid in decision- and policy-making related to health infrastructures.

Keywords

Healthcare Delivery System, Integrated Model

1. Introduction

Healthcare service is a patient-oriented service that requires continuous interaction with customers and utilizes a large volume of nursing care (Mardiah & Basri, 2013). In this sector, it has been increasingly vital for healthcare administrators to understand what kind of facility, equipment, and workforce decisions are critical to achieve the commonly acknowledged goal of providing quality health service within an accessible location at a reasonable cost (Ling et al., 2002). Evidently, the healthcare environment received much attention in the research world in the past decades (Chen & Lin, 2017). Several of the researches that have been studied were about nurse and surgeon scheduling problems (Legrain et al., 2015; Chow et al., 2011), patient appointment system problems (Klassen et al., 2009; Granja et al., 2014), medical resource planning and reallocation problems (Tai et al., 2013), hospital capacity problems (Kokangul, 2008), emergency medical service problems (Ajmi et al., 2015; Chi et al., 2008), hospital location-allocation problems (Mestre et al., 2014) and hospital collaboration problems (Chen et al., 2013). In most of these studies, there have been fruitful efforts in developing solutions to these problems that made use of demand forecasting, simulation and optimization modeling approaches. However, studies regarding the use of these modeling approaches are not widely known and limited in the Philippine setting.

In a news article retrieved from The Manila Times (2018), the Philippine health system has rapidly evolved with many challenges through time. Additionally, the article mentioned that the fundamental goal of the Philippines' government in the health system is improving the access of health services for every Filipino. The Department of Health (DOH, 2011) has instituted various reforms and policies to come up with an arrangement that serves best to the country's population with effective, efficient, fair distributions of resources and funds for organized infrastructure to flourish well (Kumar, 2017). Unfortunately, there is also a dearth of studies that developed a model to examine the healthcare system in the said country.

In a study carried out by Lavado et al. (2010), the Philippine Healthcare Delivery System has, in general, been characterized as somewhat operationally inefficient as it is consisting of government and private health, diagnostic, and treatment facilities spread unevenly across the archipelago. His findings showed that the hospitals with higher service capabilities are highly concentrated in urban areas such as Metro Manila and other nearby cities. Due to this distribution, a huge human reservoir for health is also highly concentrated in the same urban areas (DOH, 2008). The

visible manifestations of this weakness among the lower capable facilities were high costs, long waiting time for patients, and low technical performance levels (Lavado, 2010). Moreover, in another health system review written by Romualdez et al. (2011), it also cited that inequities were evident in the distribution of health facilities across the country. One possible reason could be that private individuals and corporations were hesitant to establish hospitals in most regions where market forces could not guarantee a reasonable return of investment (Crisostomo, 2013). Furthermore, the authors described it in a way that there was too much infrastructure in some area and too little in others without any real logical pattern (Romualdez et al., 2011).

The main objective of this study is to explore the Healthcare Delivery System in the Philippines. Specifically, this research aims:

- To assess the current basis of DOH and other regulatory agencies in building/expanding health facilities;
- To know the factors that have significant effect in the decision-making of building/expanding health facilities;
- To develop an integrated decision-making model that will make use of forecasting, simulation and optimization modeling approaches.

This research undertaking will be beneficial to the Philippine health sector, specifically for the Department of Health (DOH), Health Facilities Enhancement Program (HFEP), Health Facility Development Bureau (HFDB) and Local Government Units (LGUs) for planning and policy-making. For other researchers, it will be an effective reference for it will pinpoint opportunities for further research.

This study consolidated journal articles and other references that are relevant to assessment/benchmarking, forecasting, simulation and optimization modeling approaches in the healthcare environment. Their relevance to the purpose of this study is discussed in the following subsection.

A research conducted in Mapúa University motivated the theoretical framework of this study that used a compressed framework in port optimization and ports integration in the Philippines (Alvarez, 2018). The study reviewed a combination of tools and methods to prepare the port for the volume in the coming years based on the gathered factors – factors that drive the flow of container and passenger throughput of a certain port. The proposed framework focused in optimizing the port's throughput and to achieve this, the factors must undergo four processes, namely, assessment, forecasting, simulation and optimization as shown in Figure 1.

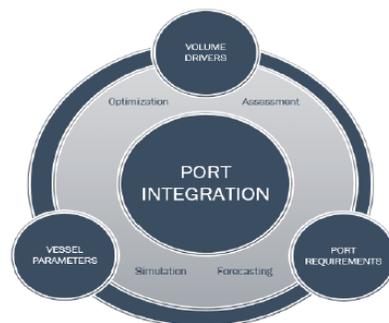


Figure 1. Compressed Framework of Port Integration

For the purpose of this study, the compressed framework was revised in such a way that it would be applicable to the health sector. In addition, the modeling approaches abovementioned have several related researches related to the subject under study and discussed further in the next sub-sections.

An assessment will be helpful in understanding the current operations in the Philippine healthcare system to pinpoint factors that are uniquely determined for the country's case. Most of the information discussed in this sub-section came from different sources but were all retrieved from the Philippine's Department of Health (DOH) archives.

In terms of organization and governance, the Philippines health system's governing agency is the Department of Health (DOH), whilst both the local government units (LGUs) and the private sector provide services to communities and individuals (Romualdez et al., 2011). The distribution of their roles in the system is as follows:

- Department of Health (DOH): The governing body mandated to provide and develop national policy direction, national plans, technical standards and guidelines in health.
- Provincial Government: The governing body granted to have autonomy and responsibility to provide health services in their jurisdiction (Local Government Code of 1991), as well as, mandated to provide secondary hospital care through provincial and district hospitals and to coordinate health service delivery provided by cities and municipalities of the provinces.
- Private Sector: The sector composed of for-profit and non-profit providers that cater to 30% of the population.

The National Centre for Health Facilities Development (NCHFD) of DOH created the Philippine Hospital Development Plan in 1995, later renamed as the Philippine Health Facility Enhancement Program (HFEP) with the aim of crafting a more responsive hospital system to ensure accessibility and availability of essential health for all across the country. The plan included billions of investment to develop LGU hospitals, provincial hospitals, city hospitals, DOH retained hospitals, rural health centers and village health stations. Furthermore, it also empowered health sector reforms such as the rationalization of service delivery and upgrading the service capabilities of health facilities (Elgo, 2009). The rationalization plan mentioned urges the provinces to analyze their health needs, health resources and deliver outputs that are benchmarked against DOH standards.

Relevant guidelines in building health facilities according to appropriate architectural practices, functional programmes and codes of the DOH are included in AO 29 series of 2006 (Guidelines for Rationalizing the Health Care Delivery System based on Health Needs) and AO 4-A and 4-B of 2006 (Guidelines for the Issuance of Certificate of Need to Establish a New Hospital).

The AO on the Certificate of Need (CON), created in 2006, stipulates the requirements for establishing new hospitals, upgrading or converting them, and increasing the bed capacity of existing hospitals (Romualdez et al., 2011). This applies to both government and private health facilities. The CON takes into account the proposed health facility's catchment population, location and the LGUs' commitment to the funding and maintenance the health facility. Moreover, in medium to larger-scale facilities, utilization rate, number of staff and bed-to-population ratio are considered. Each CON is evaluated in the context of the rationalization plan (Romualdez et al., 2011).

In this sub-section, the proponent was able to provide a glimpse of the health care service delivery system (related to health facilities) and the considerations thereof.

Forecasting in the health sector has been a useful tool for predicting future health events or situations such as demands for health services and healthcare needs (Soyiri & Reidpath, 2013). Not only that it has increased in sophistication in the field of health, but also in many specialized areas which include economics and commerce (Makridakis et al, 2009), environment (McMichael, 2003), technology and politics (Fildes, 2006). According to an overview of health forecasting by Soyiri and Reidpath (2013), health forecasting is important for health service delivery for three reasons: (1) enhance preventive health care/services; (2) create alerts for the management of patient overflows (in situations of peak demand for health care services); and (3) significantly reduce the associated costs in supplies and staff redundancy. Moreover, forecasting found to be a key component in improving both health service provision and individual patient outcome (Rogers et al., 2010; Jessup et al., 2010). Few of the formal demand forecasting studies focused in managing hospital services demand such as the daily volume of patients in order to meet the number of beds required to cater them in the emergency department (Calegari et al., 2016; Sahebi et al., 2018). It was also commonly applied to certain hospital department visits, daily hospital attendance and admissions (Boyle et al., 2011; Sekhri et al., 2006).

In the Philippine context, forecasting utilized in studies related to demand analyses of the Philippine healthcare, which most researches dated back to 1970s-1980s. Rimando (1976), Paqueo (1977), Akin and his colleagues (1981), and Ching (1985) investigated the utilization of various types of health services and determined the factors affecting or influencing such use. Their studies followed a general demand system wherein the choice or use of service depends on the relative use of money and time costs associated with the service, the customer's income and a set of control variables like social, demographic and biological. However, some of their findings are contradicting.

In a later study conducted by Ching (1992), her study has addressed the growing concern of researchers and policy makers about the demand for healthcare, particularly, about the issue of access, financing and equity. She investigated

the following factors considered in the previous studies found to have an effect in the healthcare demand: income, price, health insurance, age, sex, family size, education, health knowledge and beliefs, health need, and distance of source of health care. In addition, she included socio-economic indicators presented to be as helpful in identifying the health scenario in the Philippines. Her paper showed a detailed description of each region (size and topography), GDP per capita per region, and other health indicators such as life expectancy at birth, infant mortality rate, and crude death rate (Ching, 1992). The study concluded that both economic and non-economic factors have a significant effect on the healthcare demand in the Philippines.

For the purpose of this study, the proponent desires to use demand forecasting as the knowledge-basis about the level of demand the healthcare sector will be facing in the coming years based on the assessment of the all related and significant factors.

Because of the complexity and emergent behavior of the healthcare delivery system, decision makers aim to evaluate interventions that can improve its effectiveness and efficiency. In a journal by Marshall et al. (2015), it revealed that although modeling approaches such as decision trees and Markov models have been standardized to evaluate healthcare interventions, these are not sufficient for analyzing complex systems such as the healthcare delivery system. In turn, dynamic simulation model offers advantages with recent advances in accessible computing power and data analytics that make it possible to simulate the impact of the interventions without costly and time-consuming experimentation (Marshall et al., 2015).

The following projects have successfully used system modeling and simulation techniques to address specific health service needs, taken from MASHnet website (2014) and Pit et al. (2015): (1) a capacity planning for emergency medical services modelling in Wales applied various techniques such as forecasting, queuing theory, scheduling, location analysis and discrete event simulation integrated into their workforce capacity planning tools wherein the planners are able to predict future demand levels, evaluate fleet size to meet government targets, and develop efficient rosters for vehicles and crew members; and (2) a geographical model designed to analyze scenarios of demand following proposed hospital relocation which made use of geographical modeling and forecasting to provide essential guidance for strategic planning and demand management.

There were other researches that made use of simulation models to re-enact the behavior of a specific healthcare system or an entire healthcare system in order to evaluate its performance and analyze the outcome of different scenarios such as those by Swisher et al. (2001), Blasak et al. (2003), Baesler et al. (2003), Sinreich & Marmor (2005), Gunal & Pidd (2010), and Katsaliaki & Mustafee (2010). Generally, they used discrete-event and dynamic simulation models separately, or the combination of both in system modeling. Later, these references could serve us a helpful insight in this research.

For the purpose of this study, the concepts of simulation model will be used to provide a dry run of the healthcare facility's operations ('what if' scenarios) whilst facing a certain volume of patients and limited health resources. This will also test if the healthcare facility will have sufficient capacity to accommodate the forecasted level of demand it will be facing.

Optimization has been widely used by several researchers to model healthcare problems such as priority patient appointment scheduling (Puterman & Queyranne., 2008), surgical scheduling and bed utilization (Chow et al., 2011), hospital case mix and capacity planning (Puterman, 2008; Ma & Demeulemeester, 2012), radiotherapy beam direction (Carlsson, 2008), and shift scheduling (Brummelen, 2018). In general, most optimization and other operation research tools can be used to address various healthcare challenges that are related to capacity (physical space or staffing), reduction of demand and variability in processes, and resources allocation.

Other healthcare optimization problems it could be applied to include facility location problems in highly developed cities. There were four well-known location-allocation models with different constrained sources studied by Hakimi (1964), Toregas et al. (1971), Church & Reville (1974) and Venkateshan et al. (2017). These studies made use of the p-median location problem, p-centre location problem, set covering location problem, and maximal covering location problem, respectively. It aimed either to minimize the transport distance, allocation costs, demand served by a facility or to maximize satisfied demand on the premise of facilities with fixed quantity (Wang et al., 2018).

However, in the event the decision-makers prefer to pursue multiple objectives in a realistic world, other researchers used Multiple Objective Decision Making (MODM) methods (Syam & Côté, 2012; Farahani et al., 2014; Ye & Kim, 2016). Their studies' objectives considered both cost minimization and service availability maximization to cater patients more efficiently whilst balancing tradeoffs. A similar study conducted by Zhang et al. (2016) in Hongkong used Multi-Objective Optimization (MOO) to optimize the location of new health-care facilities in Hong Kong for 2020. It provided a set of diverse plans that they can compare and analyze or select the solution that best supports their further decisions (Zhang et al., 2016).

For the purpose of this study, optimization will be used to maximize the usage of the healthcare facilities and its resources. It will also help in recommending solutions in establishing new healthcare facilities and/or in expanding an existing one in the future.

The compressed framework from Figure 1 was altered for the purpose of this study – for the healthcare sector specifically in building/expanding health facilities.

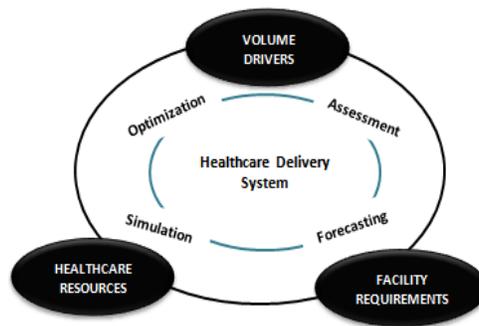


Figure 2. Theoretical Framework of the Study

2. Methodology

The conceptual framework in Figure 3 showed how the different approaches were integrated in this study and it has broken down the expected outcomes for the assessment, forecasting, simulation and optimization modeling approaches. In the application of this decision-making model, it desired to help decision-makers by providing them a basis for policy development in the healthcare sector or in making effective health-related decisions and/or plans.

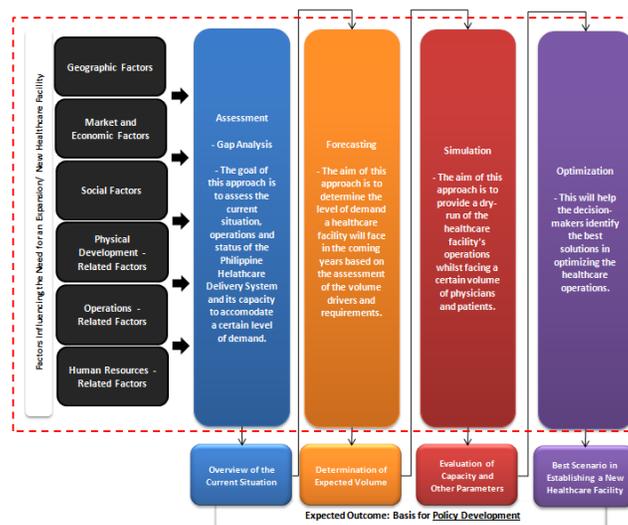


Figure 3. Conceptual Framework of the Study

The framework considered major factors namely, geographic, market and economic, social, physical development – related, operations – related and human resources – related as adapted from a World Health Organization (WHO)’s Regional Publications on health facilities’ guidelines for development and operations (1998) which comprise of 88 sub-factors. The sub-factors were the potential forces that influence the movement of health workers, health resources and patients in a certain healthcare facility. It served as a guide concerning the trend and growth of demand in a city or province. Moreover, it can be utilized as a basis in determining the type and number of health workers, resources and patients that can be accommodated in a certain type of healthcare facility. As well as, it can aid in recommending solutions in establishing new healthcare facilities or in expanding an existing one in a country in the future. The following table showed some of the factors under study:

Geographic	Market and Economic	Social	Physical-Development	Operations	Human Resources
Proximities	Gross Domestic Product (GDP)	Population Size	Basic Document and Information	Beds	Health Workers
Access to Roads	Total Health Expenditures Growth Rate	Population Density	Operational Policy	Medicines	Functions
Adequate Means of Transportation	Revenue Growth	Age Group Distribution	Site Utilization	Medical Equipment	
Route Restrictions	Net Income Growth	Sex Profile	Circulation	Medical Goods	
Climate State	Inflation Rate	Marital Status	Physical Growth of Health Facilities	Support	
Geopolitical Restrictions	Health Sector Employment Rate	Religion and Spiritual Values	Energy Conservation		
Size of the Site	Total Fertility Rate	Ethnic and Cultural Group	Financial Aspects		
Topography	Mortality Rate	Type of Residence	Master Planning		
Drainage		Educational Attainment	Building Shape		
Soil Conditions		Income Level per Household			
Utilities		Type of Illnesses			
Natural Features		Severity of Illnesses			
		Health Knowledge, Awareness and Beliefs			

Table 1. Factors under Study

In this research, the proponent of the study reviewed and consolidated different articles or journals related to the topic to include all the factors identified that could aid in the formulation of the integrated model. Furthermore, data were collected using primary data and secondary data. The primary data were the necessary information requested and gathered from the Department of Health (DOH) main office and its official website. Furthermore, the factors collected from related sources were then evaluated using a survey questionnaire and this served as the secondary data. The reason for doing so was to filter the factors that were only significant in the Philippine’s context. Respondents came from Department of Health (HFEP and/or HFDB), Provincial Government of Laguna, private hospital administrators, medical professionals and the community. Laguna province was chosen as the sample representative of this study as it has been one of the top-performing provinces in the CALABARZON Region under the LGU Scorecard and, Monitoring and Evaluation for Equity and Effectiveness of DOH retrieved from Philippine News Agency (Pa-a, 2018). Region 4-A (CALABARZON) has been progressively growing in numbers in terms of population size and currently larger than the National Capital Region (NCR).

After the data collection, a descriptive statistics summary was used to describe the percentage distribution and profile of the respondents. Subsequently, each factor was statistically tested with the null hypotheses that (1) the gathered responses from different target groups does not have a significant difference between them, and (2) the demographics of the different target groups does not have a significant effect on the different factors. For the first set of hypotheses, Analysis of Variance (ANOVA) analysis was used to scrutinize whether there is a statistically significant difference between the group means – a significance value below 0.05 would mean there is a statistically significant difference in the converted mean of the factors between the different target groups. Then, multiple regression analysis was used for the second set of hypotheses to predict the value of a variable based on the value of two or more other variables.

Moreover, the Pearson correlation (r) coefficient and the two-tailed p-value were used to examine the strength and direction of the linear relationship between two continuous variables. The r coefficient gives the value for correlation at confidence interval of 95%, while p-value provides the value of significance of correlation between the two variables at the same confidence interval. Finally, factor analysis was used to simplify the data by reducing many factors into a fewer number of significant dimensions. The relationship of each variable to the underlying factor is expressed by the factor loading which is similar to the correlation coefficient discussed above. Once the significant factors were identified, a summary was presented to show how they were considered in the integrated model. At the end of the study, there will be recommendations about which variables can be used in the different approaches and what techniques can be used for future studies.

3. Results and Discussion

The percentage distribution of the respondents of this study comprised of the community (55.91%) has the largest percentage followed by the medical professionals (23.62%), Department of Health representatives (7.09%), and medical directors from the private sector (2.36%), and the provincial government representatives (1.57%). The small percentage (9.45%) of the respondents who did not participate was mostly medical directors from the private sector.

3.1 Statistical Tests

Analysis of Variance (ANOVA) was used in order to assess the gathered responses from the different target groups. This aimed to check if there is a significant difference among them or otherwise. Table 2 shows that there is no significant difference in the responses of the different target groups.

Factors	Significance	Interpretation
Geographic Factors	0.499	No significant difference
Market and Economic Factors	0.510	No significant difference
Social Factors	0.730	No significant difference
Physical Development Factors	0.556	No significant difference
Operations-related Factors	0.619	No significant difference
Human Resources-related Factors	0.621	No significant difference

Table 2. Result of the Analysis of Variance (ANOVA)

Furthermore, multiple regression was used to check if the demographics of the respondents have a significant effect on the different factors. Tables 3 – 5 reveal that the demographics of the different target groups do not have any significant effect on the factors. This meant that the factors are not affected by sex, age distribution, role in the organization, years of experience in the field, city/municipality, marital status, occupation, monthly household income level and years of residency in Laguna of the respondents.

Independent Variable	Dependent Variable	Beta Coefficient	Significance	Interpretation
Decision-Makers Demographics	Geographic Factors	-0.071	0.810	Not significant
	Market and Economic Factors	-0.055	0.852	Not significant
	Social Factors	-0.511	0.062	Not significant
	Physical Development Factors	-0.575	0.061	Not significant
	Operations-related Factors	-0.350	0.220	Not significant
	Human Resources-related Factors	0.114	0.697	Not significant

Table 3. Result of the Decision-makers' Demographics vs. the Factors

Independent Variable	Dependent Variable	Beta Coefficient	Significance	Interpretation
Medical Professional Demographics	Geographic Factors	-0.064	0.735	Not significant
	Market and Economic Factors	-0.071	0.710	Not significant
	Social Factors	-0.690	0.715	Not significant
	Physical Development Factors	-0.255	0.174	Not significant
	Operations-related Factors	-0.132	0.487	Not significant
	Human Resources-related Factors	-0.082	0.668	Not significant

Table 4. Result of the Medical Professional's Demographics vs. the Factors

Independent Variable	Dependent Variable	Beta Coefficient	Significance	Interpretation
Community Demographics	Geographic Factors	0.049	0.683	Not significant
	Market and Economic Factors	-0.101	0.401	Not significant
	Social Factors	-0.104	0.389	Not significant
	Physical Development Factors	0.085	0.480	Not significant
	Operations-related Factors	0.105	0.383	Not significant
	Human Resources-related Factors	0.187	0.119	Not significant

Table 5. Result of the Community’s Demographics vs. the Factors

For the results of the Pearson correlation (r) coefficient and the two-tailed p-value, some factors have a weak positive correlation (between 0.2 to 0.5) to another factor such as geographic factors vs. operations-related factors, geographic factors vs. human resources-related factors, market and economic factors vs. human resources-related factors, and social factors vs. human resources-related factors. While, there is a strong positive correlation (ranging from 0.8 to 1) between the operations-related factors and the human resources-related factors. The rest of the other factors have correlation coefficient values ranging from 0.5 to 0.8, which reveals a moderate positive correlation between them. In this range, geographic factors are moderately associated with market and economic factors, market and economic factors with social factors, and physical development-related factors with operations-related factors. In addition, the two-tailed p-values are significant at the 0.01 level.

Lastly, the Eigenvalues, variance, factor loadings, communalities and Cronbach’s alpha for the four-factor solution were analyzed. As a regulation, factor loadings which are greater than ± 0.5 are mostly measured essential for real-world significance. All loadings which provided the connections between the variables and the factors exceeded the 0.5 verge level with loading ranging from 0.700-0.934. Also, to test the reliability of the test questionnaire and the scale used, reliability test was conducted, and as a rule, Cronbach’s alpha must exceed the value of 0.7. Results show that the Cronbach’s alpha of the different factors exceeded the recommended value ranging from 0.885 – 0.952. In addition, the communalities are ranging from 0.519 – 0.903 which reveals how much of the variance in the variables has been accounted for by the extracted factors. Using factor analysis, the original structure of 88 sub-factors is reduced to 60 sub-factors.

The sub-factors under the geographic factors, market and economic factors and social factors are grouped together as the volume drivers; physical development-related factors as the health facility requirements and; the operations-related and human resources-related factors as the health resources parameters. The revised conceptual framework is shown in Figure 4.

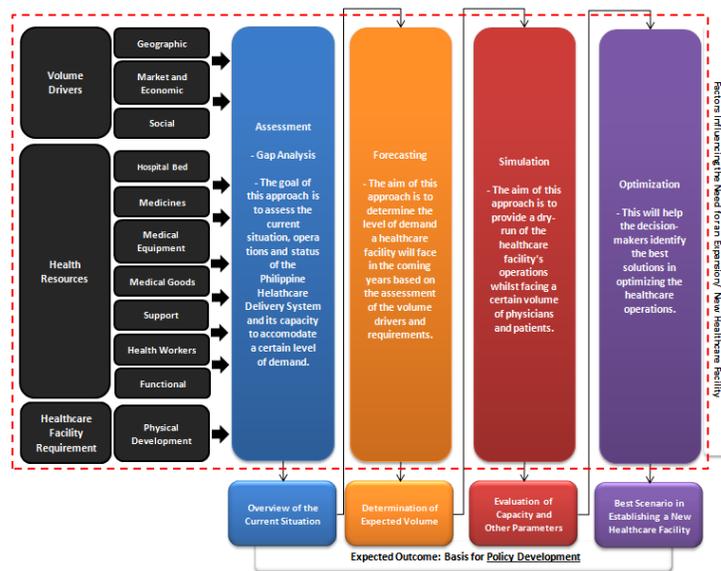


Figure 4. Integrated Decision-Making Model in Building/Expanding Health Facilities

The volume drivers are categorized into geographic, market and economy, and social factors. These external factors influence the movement of the health resources and patients in a certain health facility. The geographic factors are proximities, access to roads, adequate means of transportation, route restrictions, climate state, geopolitical restrictions, soil conditions and drainage. These factors will be used to determine the strategic location where a health facility should be situated. While the market and economic factors comprise of Gross Domestic Product (GDP); total health expenditure, revenue and income growth rate; inflation rate, health sector employment rate, total fertility rate and mortality rate. These factors will be involved in the assessment of the current situation and movement of resources up to its utilization in the healthcare operations. Lastly, the social factors consist of population density, age group distribution, sex profile, marital status, religion and spiritual values, ethnic and cultural group, type of illnesses and severity of illnesses. Patients are greatly affected by these factors since they describe their behaviors and needs for a facility.

The health resources parameters are categorized seven as they have different data types: hospital bed, medicines, medical equipment, medical goods, support, health workers and functional workers. Future researchers of this study can consider the following for each sub-category: for the bed – ease of use and maintenance, utilization and delivery time, for the medicines – quality, relative efficacy and safety; cost, for the equipment – utilization and cost, and for the medical goods – stability under anticipated conditions of storage and use; ease of use and maintenance; cost. For the health facility's support, these are found to be essential – laundry and housekeeping, dietary services, maintenance and engineering, and mortuary. The purpose of these parameters is to know whether a certain number of patients can be accommodated in a certain health facility at a time given certain constraints.

Finally, the health facility requirements which are usually predetermined by governing authorities or bodies – in the form of a policy, a standard code of conduct, a bill or a law. It comprises of the basic document and information, operational policy, site utilization, circulation, physical growth of health facilities, financial aspects and building shape. These requirements are essential to all the stages of the study as it will influence if the operations will run smoothly in the short- and long-term.

4. Conclusion

The researcher reviewed related documents and materials from the Department of Health (DOH)'s official website. Relevant guidelines in building health facilities provided by the DOH can be found in the AO 29 series of 2006 (Guidelines for Rationalizing the Health Care Delivery System based on Health Needs) and AO 4-A and 4-B of 2006 (Guidelines for the Issuance of Certificate of Need to Establish a New Hospital). This applies to both government and private health facilities. The Certificate of Need (CON) takes into account the proposed health facility's catchment population, location and the LGUs' commitment to the funding and maintenance of the health facility. In addition, utilization rate, number of staff and bed-to-population ratio are considered. Each CON is evaluated in the context of the rationalization plan. With this information, the researcher thought of considering other factors that secondary sources have taken into account. Several of the factors and sub-factors were from a World Health Organization (WHO)'s Regional Publications on health facilities' guidelines for development and operations (1998). It was then evaluated using a survey instrument with a 5-point Likert scale to determine its importance to the subject of the study. Statistical tests were done to reduce the pool of data and attain only the significant ones as shown and grouped in Figure 4. The integrated model can be used, not just for policy-making, but also in strategically planning where to build future health infrastructures with specific configurations in a city/province.

Future studies can be done through the integrated decision-making model since this study's aim is just to consolidate all the factors that could be useful inputs in the model. Other researchers can continue the research by pinpointing which is the best forecasting, simulation and optimization modeling approaches that can be applied to each stage/phase. Furthermore, other fields can also consider creating software or a system that can handle such big data and incorporate the modeling approaches as its logical flow.

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