**University of Bahrain**

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| **College of Science** | **Department of Mathematics** |



**Assessing Bahrain Hospital Bed Capacity during the COVID-19 Pandemic**

This report is submitted in partial fulfilment of the requirements for the Research Methods course in pursuit of a master’s degree in Big Data Science and Analytics

**Prepared by**

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**Kingdom of Bahrain**

**December 2020**

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Abstract

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Chapter One

Introduction to the Study

‎‎1.1 Introduction

‎1.2 Research Problem

‎1.3 Research Questions

‎1.4 Research Objectives

‎1.5 Research Significance

‎1.6 Research Setting

‎1.7 Definition of Terms

Chapter One

Introduction to the Study

Introduction

This section introduces the research and report.

Research Problem

This section describes the research problem addressed by this research.

Research Questions

This section describes the questions that this research aimed to answer.

Research Objectives

This section describes the objectives that this research aimed to achieve.

Research Significance

This section describes the importance of this research.

Research Setting

This section describes the context of how this research was conducted, including scope.

Definition of Terms

This section lists all the terms and their abbreviations used within the report.

Chapter Two

Theoretical Framework and Literature Review

‎‎1.1 Introduction

‎2.1 Literature Review

‎2.2 Theoretical Framework

‎2.3 Research Hypothesis

Chapter Two

Theoretical Framework and Literature Review

Literature Review

This section goes through similar research topics conducted and compares between previous relevant works related to this research.

Theoretical Framework

This section describes the how this research will be implemented and carried out.

Research Hypothesis

This section defines and describes the hypothesis assumed by the researchers.

Chapter Three

Methods and Procedures

‎3.1 Research Study’s Methodology

‎3.2 Research Study’s Population and Sample

‎3.3 Research Study’s Tools

‎3.4 Data Collection and Procedures

‎3.5 Statistical Approaches

Chapter Three

Methods and Procedures

Methodology

In this research, we have adopted an exploratory scenario-based research design in which we will assess the capability, in terms of hospital bed capacity, of the Kingdom of Bahrain to respond to the sudden increase of COVID-19 cases that will require hospitalization. Based on quantitative historical data (for COVID-19 cases), we will use a statistical growth model to project the increase in the number of cases for a pre-defined period of three months. Thus, with the projected number of hospitalized cases and based on the current capacity of the health system, we will assess the health system’s ability to respond to the increase of infections and avoid reaching saturation (i.e., over-exceeded).

The below figure, **Fig. 1**, illustrates the scenario-based design template that we developed for this research, highlighting the variables that can be altered across different scenarios.

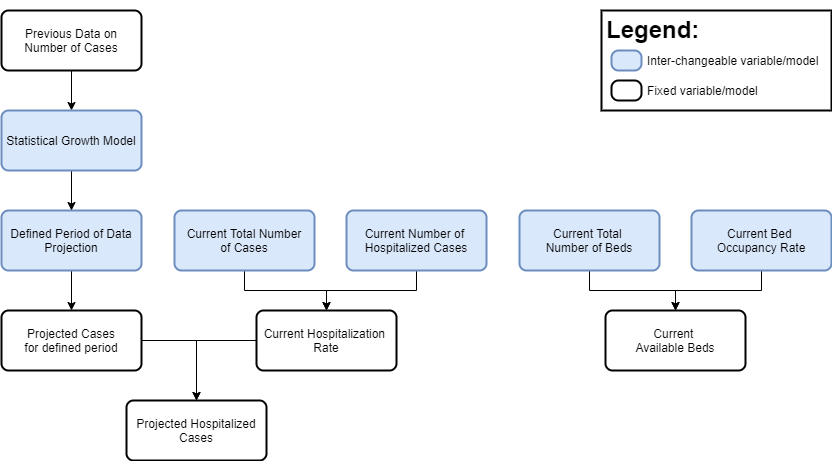


Fig. : Scenario-Based Design Template

The table below, Table (1), illustrate the assumptions and definitions that we will use to define the context of our scenario (based on the scenario-based design template).

Table (): Adopted Scenario Variables

|  |  |
| --- | --- |
| **Variable** | **Implementation in our scenario** |
| Statistical Growth Model | For the statistical growth model, we will use the Logistic Growth Model to project the number of cases in our scenario. A different model would project a different number and hence change the scenario. |
| Defined Period of Data Projection | For the defined period of data projection, we will project data for three months (90 days) and hence our scenario is limited to this timeframe. |
| Current Total Number of Cases | In our scenario, we will use the total number of cases and hospitalized cases as published by the Ministry of Health (2020) on the 1st of August 2020. These values play an important role as they determine the hospitalization rate for our scenario. |
| Current Number of Hospitalized Cases |
| Current Total Number of Beds | In our scenario, we will calculate this value based on publicly available data. |
| Current Bed Occupancy Rate (BOR) | The current hospital BOR was assumed at 80% as per conversation with a health worker in the Kingdom of Bahrain (Hilal, 2020) and the Field Intensive Care Units (FICU) BOR was obtained (0.38%) from publicly reported figures by Naar (2020). |

In summary, this research aims to assess the hospital bed capacity of the Kingdom of Bahrain in the scenario that the COVID-19 infections follow a logistic growth pattern and based on the 80% of hospital bed occupancy rate and 0.38% FICU bed occupancy rate. The scenario will be projecting cases for the upcoming 90 days relative to the current available hospital bed capacity.

Population

The population considered in this study will be all hospitals (public and private) in the Kingdom of Bahrain. This study will also include Field Intensive Care Units, which are ad-hoc centers (isolation and quarantine) that were created to increase hospital bed capacity in the Kingdom of Bahrain (Naar, 2020). As the COVID-19 epidemic will impact the country, the entire health system will need to work together, under the direction of the National Taskforce for Combating the Coronavirus (COVID-19) and Ministry of Health, to ensure a rapid response to the epidemic.

Research Study Tools

In this section, we will illustrate how the data will be extracted and which data analysis tools will be used to conduct the statistical analysis for this research.

Data and Variable Extraction

To extract historical data related to COVID-19 in Bahrain, including the total number of cases and deaths, the publicly reliable dataset provided by Our World in Data (Roser et al., 2020) will be extracted in comma separated values (CSV) format. This public dataset includes the following attributes which will be used in our study:

1. Date
2. Total Cases – the cumulative total number of COVID-19 cases as of the given date
3. Total Deaths – the cumulative total number of deaths caused by COVID-19 as of the given date
4. Population – the population of the country as of 2020
5. Hospital Beds per Thousand – the number of hospital beds per 1,000 people

However, since the total number of hospital beds in the Kingdom of Bahrain could not be extracted from previous studies or reports, it will be calculated based on the variable Beds per Thousand People (BPTP) and Population. From the public dataset provided by Our World in Data (Roser et al., 2020), the variables are reported as and . To calculate the total hospital beds (), these variables will be used in the following formula:

Furthermore, the total number of Field Intensive Care Units’ (FICU) beds and their occupancy rate, including both Isolation Centers and Quarantine Centers (IQC), will also be calculated based on publicly reported figures by Naar (2020) – which reported 4,257 and 5,489 beds in Isolation Centers () and Quarantine Centers () respectively. The report also stated that 3,218 IC beds () and 533 QC beds () were occupied at the time of publishing. Using these variables, the total beds in isolation and quarantine centers () can be calculated as per the below formula:

While the bed occupancy rate (BOR) in isolation and quarantine centers (denoted by ) can be calculated by the following formula:

Lastly, we will extract the current number of active cases () and hospitalized cases () from Bahrain’s Ministry of Health (2020) public daily report and calculate the current hospitalization rate (), which will be used to project hospitalized cases, using the following formula:

Other Study Tools

To execute the statistical analysis in this research, the reliable and data analysis feature-heavy “R” programming language and environment will be utilized.

Data Collection and Procedures

All data that will be collected in this research is secondary data as it has not been gathered directly by the authors, however, the data sources are globally and governmentally reliable sources. The data is quantitative, and time-series based. Data will be extracted into CSV format and loaded into the data analysis tool used (R) for processing and cleaning. The below figure, **Fig. 2**, illustrates, on a high-level, the data collection and procedure that will be carried out in this research.

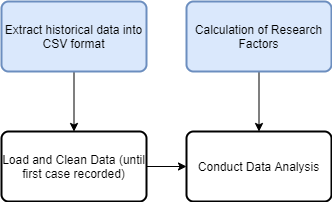


Fig. : High-level Data Collection Procedure

Statistical Approaches

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Chapter Four

Results, Discussion, Conclusion and Recommendations

‎4.1 Results

‎4.2 Discussion

‎4.3 Conclusion

‎4.4 Recommendations and Limitations

Chapter Four

Results, Discussion, Conclusion and Recommendations

Results

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Discussion

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Conclusion

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Recommendations and Limitations

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Limitations

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Naar, I. (2020). *Coronavirus: Bahrain expands bed capacity at its isolation, quarantine centers*. Al Arabiya English. https://english.alarabiya.net/en/coronavirus/2020/05/13/Coronavirus-Bahrain-expands-bed-capacity-at-its-isolation-quarantine-centers

Roser, M., Ritchie, H., Ortiz-Ospina, E., & Hasell, J. (2020). *Coronavirus Pandemic (COVID-19)*. OurWorldInData.Org. https://ourworldindata.org/coronavirus