

A Study on the Effectiveness and Efficiency of Public or Private Hospitals within Pakistan

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Abstract

Hospitals play a very important role in human lives. People are in search of quality and timely healthcare facilities. This paper talks about the efficiency and effectiveness of healthcare services. One needs to identify the factors and mechanisms to enhance the performance of government and private hospitals. This study aims to find the important variables that were required to find the best solution for public and private hospitals in Pakistan. The major contributions of the paper are as follows. The paper first deliberates on the need for technical excellence as compared to interpersonal excellence for hospital management. It also performs a qualitative review of the literature on the important variables for determining the effectiveness and efficiencies of the hospital. Then, the paper presents a public survey about the effectiveness and efficiency of public and private hospitals using different questionnaires. These questionnaires were filled by the relatives of patients or patients themselves when they visited hospitals. On this dataset, the paper applies a machine learning algorithm i.e., random forest, to predict which hospital type is suitable for them while considering the variables. These variables include; the services of the hospital, admission process, treatment, doctor's behavior, timely treatment, and knowledge of the staff about SOPs. The data was split into 75 % training and 25 % testing dataset. Python's Library SK-learn was used for implementation. The accuracy of the classifier on the test dataset is 96.91 %. The paper then determines the variables that are contributing the most to the measure of effectiveness and efficiencies of hospitals. The algorithm also ranks these features that can be used to improve a hospital's performance. It also provides a benchmark to the patients in the selection of hospitals for healthcare facilities.

Index Terms: Effectiveness/Efficiency, Machine Learning, Private/Public Hospitals, Random Forest Algorithm, Survey.

I. INTRODUCTION

Healthcare is a specific service with its own set of unique characteristics. Clients in the healthcare sector are immediate sufferers, followed by their relatives and possibly coworkers, because the outcome of the healthcare service may have an impact on all of their lives. Consumers and companies alike can be harmed by a mistake or error in this subject, as lives and standard of living are in danger [1].

The quality of service of a healthcare system can be divided into two categories: technical and functional quality [2]. While technical quality in the healthcare industry is generally characterized by the technical precision of clinical diagnoses and treatments, as well as adherence to expert specifications, quality assurance relates to how the healthcare service is offered to patients [3]. In other words, technical quality refers to what customers receive, but functional quality refers to how they receive it. Technical quality has been demonstrated to fall short of being a truly helpful indicator for explaining how patients assess the effectiveness of a healthcare service experience, according to studies [4], and [5]. According to the [6], while technical excellence is a high priority for individuals, most patients lack the

expertise required to measure the quality of diagnostics and medical series of activities efficiently, or information required for such evaluation is not provided to patient populations. As a result, patients evaluate quality based on interpersonal and environmental aspects, which medical practitioners have typically considered to be secondary. Furthermore, the majority of patients are unable to discriminate between healthcare providers' medical care and curative performances [7]. A correlation between patient experience and their opinion of the excellence of services has been discovered [8-10]. According to some researchers, consumers assess the quality of healthcare by focusing on more practical concerns such as physical facilities, encounters with customer service representatives, or pamphlets rather than difficult-to-evaluate technical components of service delivery [11-14]. Patients must rely on views toward clinicians and the institution itself to assess their personal experiences. Researchers claim that customer happiness and views of healthcare quality are inextricably linked [15]. The primary priority of healthcare practitioners is to ensure that their customers receive high-quality care. Effective healthcare solutions are critical to regions' ability to achieve other development objectives [16]. While it is crucial to acknowledge that health is not a

sufficient driver of economic development, it is important to recognize that a healthy population is more likely to produce the performance improvement required to maintain continuous growth in other aspects of society.

Quality is the most important part of every process, so its importance is evident in the healthcare sector. If there is no quality in the underlying process, all the effort is wasted and we have to do things from scratch, again. When it comes to the healthcare industry, quality becomes the most important factor because we can't undo our mistakes easily and quite often it results in the loss of precious life. The health care system plays a very important role in every person's life irrespective of the region. As per the recent epidemic of coronavirus, the demand for an effective and efficient healthcare system is increased to save the lives of the affected people. Pakistan is a developing country and the economic condition of the country is not good. There is no proper infrastructure or roads available. In addition, the poor sewerage system and water supply cause infections and diseases among people and children. With the rise of COVID cases, the gravity of the situation has worsened.

Pakistan is the 6th most populous country and has its own unique problems. Despite the challenges of the country, the general perception is that the government is not spending an appropriate amount of budget on healthcare facilities. It is required that there should be a proper balance of public and private hospitals along with a policy that gives a proper health plan for treatment.

The healthcare factors of a nation can also be determined by the level of education, religion, and cultural beliefs of the population. People often use their homemade remedies for the treatment which also causes the side effects or at least delays in proper treatment. In addition, in some regions, people don't believe in allopathic medicines prescribed by doctors. Usually, they prefer herbal medicine specialists (called Hakeem locally) or quacks for diagnosing their disease. Also, the expenditure for the treatment of the disease becomes difficult for the common people. Many of these people can't afford the heavy fees of the hospitals. Due to financial problems, most of the population moves to government hospitals or small hospitals to bear the charges and fees of treatment. At the same time, hospitals are not enough in numbers, and capacity, needed to accommodate the load of the increasing population. This results in the long waiting queues in hospitals. The patients are not generally treated on time and sometimes even don't get the proper treatment. This results in catastrophic loss of the patient's life [17].

It is felt that there is no proper balance between healthcare quality and healthcare expenditure. It is also found that the private sector is using healthcare facilities to make huge profits. As compared to public hospitals, private hospitals have more access to life-saving equipment. This advantage is capitalized to make profits which also drives common people to move towards public hospitals or small health organizations. Some of the doctors are employed in both public and private sectors. Their performance and behavior are different in

public and private hospitals. It also has been taken into notice that some doctors working in the public sector also recommend people to visit their private hospitals where they used to practice during off-duty hours. This also creates capsization amongst the public and private hospitals.

The following are the main contributions of this study:

1. This study analyzes the factors impacting the satisfaction of the patient in the selection of a hospital.
2. A questionnaire was developed and floated to various participants in Karachi.
3. The conducted survey was analyzed using a machine learning algorithm named random forest.
4. The evaluated accuracy of the random forest classifier was found to be 96 %.

The rest of the sections of the paper discuss the proposed study. It starts with a discussion of related literature. This is followed by methodology and discussion of results. The paper concludes the research along with future work at the end.

II. LITERATURE REVIEW

There is indeed a significant amount of literature on healthcare efficiency, and there have been current discussions about how to quantify a hospital's quality efficiency and effectiveness in order to meet patient satisfaction and commitment. Service quality is a strategy for developing a vision of the organization's objectives and mission, as well as understanding and assisting each specific employee and recognizing their progress in improving quality performance and customer experience to achieve maximum utility [18-24]. Authors Lai and Cheng state that aside from the described definition of service quality, customer engagement rates and the expense of losing a client can be used to assess the effectiveness of service [25]. If a management accountant or financial consultant can calculate the potential or approximate expense of losing a client, it will be much easier for organizational managers to devote the appropriate number of resources required to satisfy their clients. Author Chen et al., also recommended that organizational managers and staff have a broad understanding of service data processing instead of technical knowledge in a single area [26]. According to the authors, a service organization's quality administrator should have a broad spectrum of expertise not only in his service field, but also in allied departments such as marketing, systems integration, sales and marketing, and logistic support.

Varkey et al. suggested to assess quality, hospital executives must clearly define the efficiency of health services that can be measured and quantified in terms of quality improvements [27]. Mittal, V. and W.A. Kamakura discuss in this work that satisfaction is the most important factor that affects consumer experience [28]. It is the factor that influences consumer relationships in the future. Consumer satisfaction is the most important factor for accepting or rejecting an

assessment based on a product or services consumed or relating to its performance. Kotler et al. proposed that satisfaction is directly related to consumer's expectation and their experience [29].

For many decades, clinics and hospitals have been concerned about the efficiency of healthcare services. Numerous hospitals have lately used quality approaches in their medical practices (e.g., PDCA, 5S, Kaizen, statistical process control, and fault tree analysis) in order to maximize efficiency and improve patient comfort to achieve better satisfaction [30]. According to Cronin Jr, J.J., and S.A. Taylor, expectations of good quality services have increased in the minds of patients because the economic share of the service sector is at an increasing rate almost all around the world and also it goes to half the sum of GNP's [31]. Consumers pay big attention to making the service successful or fail. The perception in the consumer's mind also plays a vital role while taking experience of that service or product. Therefore, providing the best quality services to consumers is the most important factor adopted by many organizations to maintain their sustainability in the market [32-35].

Lafond, while discussing improving the quality of investments in the medical sector highlights the main requirement of consideration is that even if access issues were to be significantly improved, full utilization of the health-care system will still be impossible if service quality is inadequate [36]. The government of Nepal, for instance, made significant efforts in basic health care; nonetheless, utilization remained low due to consumers' negative impressions of public health care.

Nevertheless, Ferlier et al., because of the complex nature of healthcare delivery services, the unanticipated characteristics of healthcare, vocational differences, interdependence among medical staff (i.e. pediatricians, nurses, and admin personnel), and systems, measuring performance improvement in health providers is exceptionally hard [37]. Lee et al., discuss the attributed uncertainty associated with the increased cognitive thought process, the challenge of solving the given issue, selecting the most appropriate option, and practical experience as one of the most challenging tasks to evaluate the efficiency and effectiveness of healthcare services [38]. Another tough aspect of healthcare system monitoring is determining if a relatively close caused injury or if an adverse event was an uncommon occurrence [39]. Utilizing external standards to evaluate service quality can actually boost the performance of quality effective healthcare services. Performance management is a continuous and interactive activity in the medical sector that assesses and compares the consequences of major work methods to help the healthcare organization analyze internal and external effectiveness. Establishing and specifying an awareness of health care issues, facilitating and maintaining a trend of continuous improvement and improved outcomes, uninterrupted monitoring of effectiveness and providing information of findings to support the adjustment, testing shift approach for sustainable performance, and involving

relevant parties of the healthcare organization as essential elements required to improve performance of the healthcare organizations [40], and [41].

According to the circumstances, the organizational practices, and the unique issues encountered by the healthcare sector in Pakistan, different hospitals may require different levels of technical proficiency and interpersonal abilities. On the other hand, it is widely acknowledged that for efficient operations in hospitals, a requirement of interpersonal and knowledge of technology are necessary. Superior technical competence is essential for guaranteeing successful resource management, putting best practices into execution, upholding high standards of quality, and guaranteeing efficient delivery of healthcare [42]. On the other side, relational excellence is essential for developing enduring connections with patients, the medical community, and other participants. Collaboration, solving issues, and empathic interactions, are all crucial elements of social success. In accordance with WHO, Pakistan is now ranked 122 out of 190 nations in the context of health services. In Pakistan, just 37 USD per cap is given for critical healthcare facilities, despite the fact that this sum should be at least 44 USD per person. The percentage of completely functional hospitals in Pakistan's rural medical centers is the lowest, at 8 %, 7.69 %, and 7.41 %, accordingly [43]. The review of the literature reveals that there is a shortage of analysis of healthcare services for the Pakistani environment. Since Pakistan is an underdeveloped country, there is no major and modern healthcare infrastructure available in the country. Also, the government is not spending the expected budget according to the population size in healthcare facilities. The common people face different circumstances like unavailability of beds, doctors, or medicines. At the same time, common people cannot afford the charges by the private sector. In order to facilitate the crowd, this study tries to find the key indicators to solve the management issues of hospitals such that they can improve their efficiency and effectiveness to treat more patients and reduce the influx.

The aim of this study is to find the proper factors and variables to gauge the efficiency of government and private hospitals including small, medium, and large. For this purpose, in this research, a survey is created focusing on different factors normally faced by a person visiting hospitals. The survey questionnaires were filled by the people who had at least visited any public or private hospital in the past few years. On the responses gathered for the survey, different machine learning models were employed that can predict if someone should visit either public or private hospitals using the mentioned variables.

III. METHODOLOGY

We will now discuss the proposed methodology for analyzing the effectiveness and efficiencies of public and private hospitals.

A. Data Collection

A survey was conducted to find the importance of features and variables determining the quality of service in private and public hospitals. Table I shows the questionnaire. The target audience of this study primarily is the Pakistani health industry. We collected most of the samples from Karachi. Around 1035 people gave the responses against our survey. These were the people who have visited hospitals in the past and shared their thoughts about the government and private hospitals.

We created a Google form with 14 different questions. The questionnaire is well structured so anyone can give the answer to who visited hospitals in the past and explain their experience about the quality and service of the hospitals. The aim of the study is to find the root cause of bottlenecks in the effectiveness and efficiency of hospitals where they are lacking in controlling the resources, how they can improve their management control, and what are the key indicators to improve their performance.

Table I: Questionnaire for the Study

S. No.	Questionnaire
1.	Have you ever had the experience of visiting a public hospital or a private hospital?
2.	What is the Hospital's name?
3.	What is the Hospital type?
4.	How satisfied are you with the process of patient admission?
5.	How satisfied are you with your treatment?
6.	How satisfied are you with the services you have been provided with?
7.	Are you satisfied with the charges that the hospital has taken?
8.	Were you treated on time?
9.	How satisfied are you with management and staff co-operation?
10.	How satisfied are you with the knowledge of staff at the hospital?
11.	How satisfied are you with the responsiveness of staff on your queries?
12.	How satisfied are you with the cleanliness of the Hospital?
13.	During your stay in the hospital, how much you satisfied with the explanation from the doctors?
14.	During your stay in the hospital, how satisfied are you with the behavior of the doctors?
15.	Any general comments

B. Data Preprocessing

In our dataset, there are 14 independent variables and one dependent variable. We used the ordinal data encoding technique to encode the categorical data like gender feature i.e., replace the male value with 1 and female with 0. Similarly, we replace different age groups from 0 to 4 with appropriate encoding schemes. We have selected only those features that are important for predicting the correct result before applying machine learning algorithms. For instance, we removed the names of the form submitters. Similarly, we removed the feature in which we asked whether you ever had the experience of visiting a public hospital or a private hospital. The numerical data was standardized to have values between 0 and 1. After analyzing the response of the people, we performed manual labeling of the target variable.

C. Predictive Model

As our dataset is predicting which hospital (either public or private) is more effective and efficient, it is a classification problem. We used a random forest algorithm. The random forest algorithm's distinctive advantages and characteristics in a variety of contexts serve as the main argument for utilizing it. The random forest can be operationally challenging, the advantages generally dominate the disadvantages, particularly when compared to prior research or other techniques.

The random forest algorithm has been chosen in this research for the following reasons [44-46]:

- It delivers precise outcomes across a variety of datasets, i.e., it can work for both public and private hospitals.
- It is capable of handling features that are categorical and numerical without the need for intensive preprocessing.
- It can reduce the problems with overfitting that single decision trees have.
- It is capable of handling values that are absent in the dataset in an efficient manner.

It's essential to take into account the trade-offs when contrasting random forests with prior research or different algorithms.

Some examples of comparisons could be [47-49]:

- The precision and dependability of random forest may be superior to those of older techniques, which would support the higher processing cost.
- The ensemble aspect of random forest may produce better results if older techniques struggle with generalization on unknown data or suffer from overfitting.
- Random Forest's combined approach could provide an improved proportion if previous algorithms are highly complex.
- The capacity of the random forest to calculate feature relevance scores can reveal information about the dataset that could potentially be missing from earlier approaches.
- Despite the fact that random forest might be resource-intensive, its ability to be parallelized can assist in controlling its processing requirements.

It remains essential to keep in mind that the features of the datasets, the task at present, the accessibility of resources on the machine, and the needed degree of correctness and practicality should all be taken into consideration while choosing any machine learning technique.

It separates data more efficiently by creating n number of trees as compared to a decision tree or logistic regression. It is also good for medium size datasets. The data was split into 75 % training and 25 % testing dataset. The Python's Library SK-learn was used for implementation. Table II shows the parameters of the experiment. Random forest was used with 100 estimators. The criteria used were entropy. The accuracy of the classifier on the test

dataset is 96.91 %. Then, we analyze which features are contributing the most in deciding about the effectiveness/satisfaction of the hospital.

Table II: Parameters of the Study

S. No.	Parameter	Value
1.	Library	SK-learn
2.	Classifier	Random Forest
3.	n_estimators	100
4.	Criterion	Entropy
5.	Train: test	75 : 25
6.	min_impurity_decrease	0
7.	min_samples_leaf	1
8.	min_samples_split	2

Figure I shows the results. The visualization of feature importance is shown in figure II.

By checking the figure, the most important factors in the order of their importance are as follows:

1. Services of the Hospital
2. Admission Process
3. Treatment
4. Doctor's Behavior
5. Timely Treatment
6. Knowledge of the Staff about SOPs

How much you satisfied with the knowledge of staff at hospital?	0.129274
During your stay in hospital, How much you satisfied with explanation of doctors?	0.126678
Hospital Name	0.123685
How much you satisfied with your treatment?	0.110450
How much you satisfied from services you have been provided with?	0.098755
During your stay in Hospital, How much you satisfied with the behaviour of doctors?	0.081028
How much you satisfied with the responsiveness of staff on your queries?	0.070217
How much you satisfied with management and staff co-operation?	0.070010
Were you treated on time?	0.050074
How much you satisfied with the process of patient admission?	0.046253
How much you satisfied with the cleanliness of Hospital?	0.037337
Are you satisfied with charges that hospital has taken?	0.027699
Age Group	0.011908
Gender	0.009042
Hospital Type	0.007591
Have you ever had the experience of visiting a public hospital or a private hospital?	0.000000

Figure I: Feature's Contribution to the Selection of Hospital

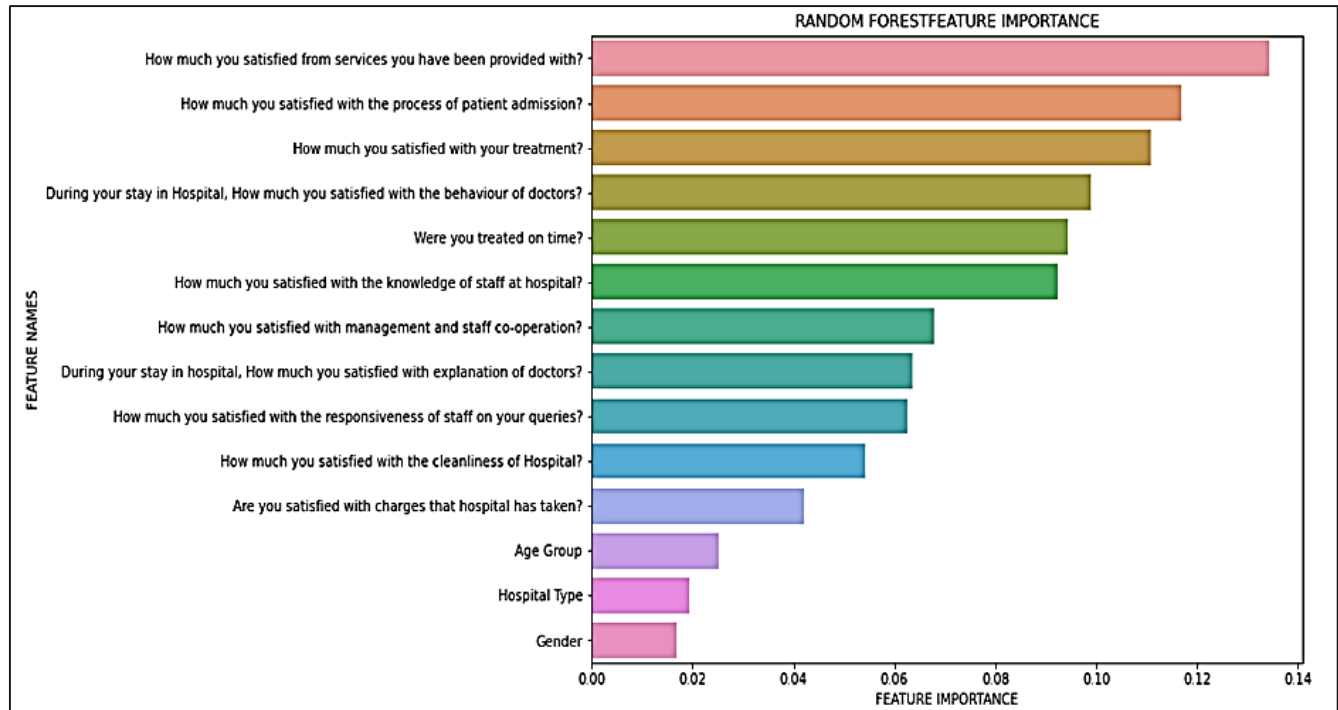


Figure II: Visualization of the Features that are Important for the Selection of Hospital

The above-mentioned variables are very important for any hospital organization either public or private to make their process efficient and effective. By considering these variables, they can enhance their quality and can handle

more patients easily. It is to be noted that the type of the hospital, age group, and gender doesn't have any impact on the satisfaction of the patient.

Figure III shows the results after only the most important parameters were considered for performing classification. The classification accuracy is approximately 96 % with all the features while it dropped when we consider only important features.

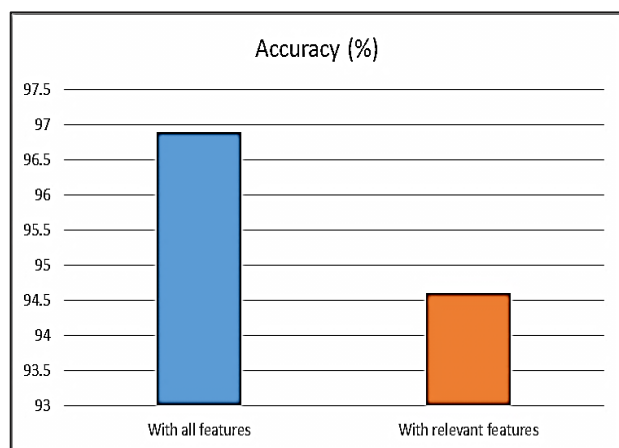


Figure III: Accuracy of Classifier on Various Scenarios

IV. DISCUSSIONS ON RESULTS

This study analyzes the factors impacting the satisfaction of the patient in the selection of hospitals. A questionnaire was developed and floated to various participants in Karachi. As per the findings, the public and private sectors can consider the variables that were asked in the survey to improve their services and handle patients effectively. According to recent research, many patients criticize Karachi's healthcare sector for being more preoccupied with generating a good income than with offering high-quality medical treatments at affordable prices. Many patients have reported that some hospitals charge excessively for health insurance and perform tests that are not necessarily required.

Some hospitals are overburdened, making it more difficult to schedule suitable patient-doctor visits. As Pakistan is an underdeveloped country and many of the people are not literate here, another highlighting issue they are facing is a communication gap between the patient and the doctor as they are not able to understand any technical word or explanation from the doctor.

According to our study, hospitals should treat patients on time and should improve the process of patients' admission. There should be a process that audits the fairness of treatment in public or private hospitals so that people can get good treatment according to the charges of the hospital. To resolve segregation issues, opinion formers in both hospitals and clinics either public or private must consider multiple key aspects to enhance efficiency and effectiveness, including creating and specifying an awareness of health-related issues, facilitating and maintaining a culture of adjustment and patient safety, uninterrupted monitoring of effectiveness and tracking of findings to maintain change, evaluating change opportunities for effective performance, and engaging important stakeholders groups. Furthermore, both health authorities can enhance their performance

level by continuing to follow some guidelines, such as choosing quality projects that are highly relevant for the health center, offering special specialized training to physicians and nurses about the quality application domains and tools of healthcare systems, trying to develop the abilities to customize and use quality measures to understand the critical performance metrics of healthcare services, and not ignoring those services that are underserved. Healthcare facilities would be able to meet customers' satisfaction by providing high-quality services after the effectiveness and efficiency of the services have improved.

V. CONCLUSION

In this paper, the factors affecting the effectiveness and efficiencies of public and private hospitals are analyzed. A survey was conducted and then it was analyzed using a machine learning algorithm. The accuracy of the random forest classifier was found to be 96 %. In the future other machine learning algorithms can be used for analysis further. The most important feature to be considered for improving the effectiveness of the healthcare sector is the services of the hospital, admission process, and treatment.

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Authors Contributions

The contribution of the authors was as follows: Noman Islam's contribution to this study was the concept, technical implementation, project administration, and correspondence. The methodology to conduct this research work was proposed by Muhammad Usman Raees. All the authors namely Noman Islam, Muhammad Usman Raees, and Darakshan Syed, jointly perform, supervision, data collection, data compilation/validation, and paper writing.

Conflict of Interest

The authors declare no conflict of interest and confirm that this work is original and not plagiarized from any other source, i.e., electronic or print media. The information obtained from all of the sources is properly recognized and cited below.

Data Availability Statement

The testing data is available in this paper.

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