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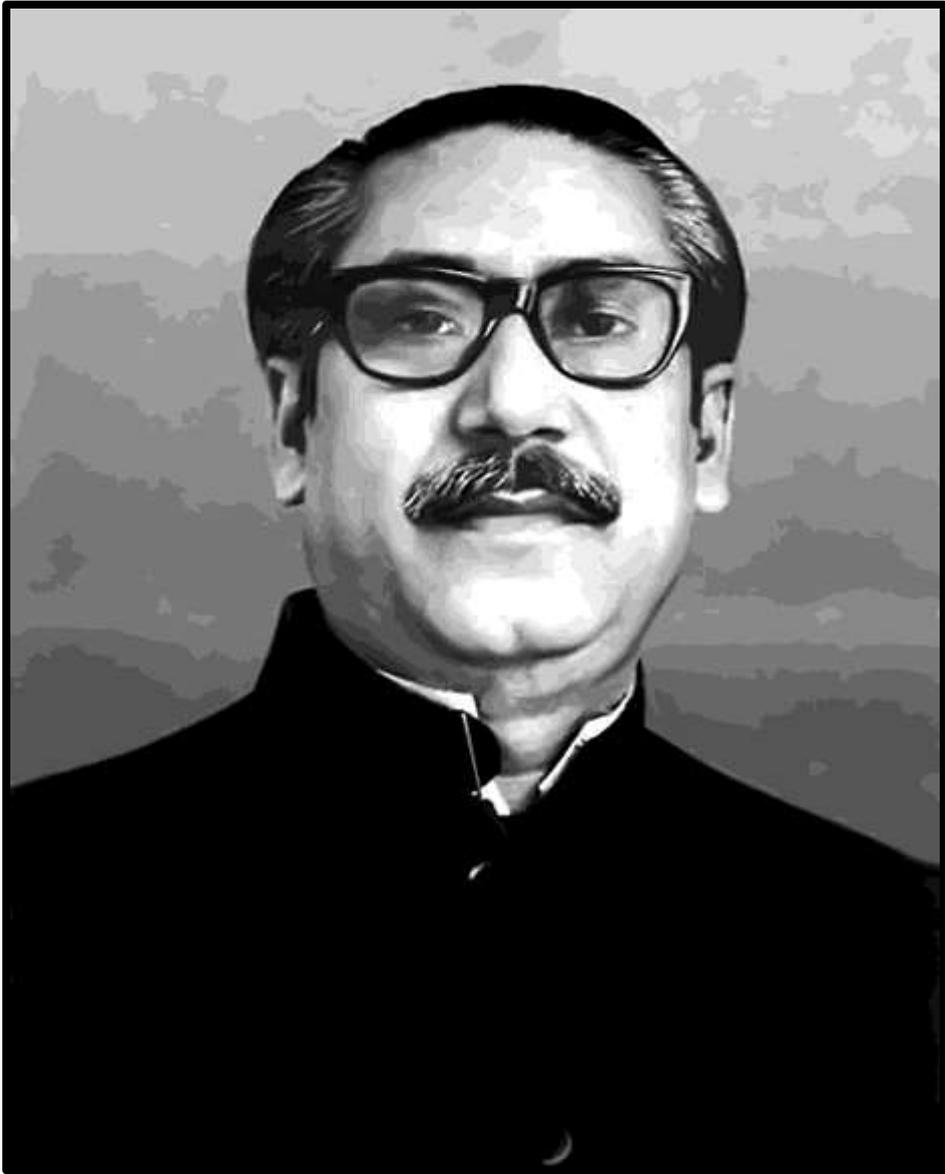
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**Father of the Nation Bangabandhu Sheikh Mujibur Rahman**  
(17 March, 1920 - 15 August, 1975)





**Philanthropist Rai Bahadur Ranada Prasad Shaha**  
(15 November, 1896 – Abducted by Collaborators of the Pak-Army 7 May, 1971)



## **Message from the Vice- Chancellor**

*I am very happy to announce that the first special volume of RPSU Research Journal is being published. Our university has a bunch of young and experienced teachers. The main task of the university teachers is to inculcate the established knowledge in their respective fields, distribute them among the students and create new knowledge through research. We know that one of the important criteria for ranking a university is the quality of research works published by the teachers of that university. Our teachers from this new educational institution have already published a good number of research papers in various national and international journals. So we feel the urge to publish an International standard journal from our university. In this regard, there is a wide response from our teachers. The chairman of the Board of Trustees of Ranada Prasad Shaha University inspires us in this matter and cooperates in every respect. To commemorate the centenary of the father of the nation Bangabandhu Sheikh Mujibur Rahman and the 125<sup>th</sup> birth anniversary of the Rai Bahadur Ranada Prasad Shaha, the founder of the Kumudini Welfare Trust, an initiative was taken to publish the first volume of the RPSU Research Journal. A number of National and International academics and scholars have extended their support to make this initiative a success. Many thanks to them. The teachers of RPSU have played the most important role in publishing this memorable volume. Many thanks to them too. I wish the Journal a successful future.*

**Prof. Dr. Manindra Kumar Roy**

*Vice-Chancellor*

*Ranada Prasad Shaha University*

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## Editorial Note

This is the first and special issue of RPSU Research Journal dedicated to the 100 Years Birth Anniversary of the father of the nation Bangabandhu Sheikh Mujibur Rahman and the 125 Years Birth Anniversary of the founder of Kumudini Welfare Trust of Bengal Ltd. Shahid Danabir Rai Bahadur Ranada Prasad Shaha.

RPSU Research Journal is a peer-reviewed Journal covering the areas of English, Law , Business, Science, Life science ,Textiles, Engineering and Technology related disciplines. The main objectives of this Journal is to encourage the emerging scholars, researchers and academicians in order to develop creative as well as critical thinking and analytic abilities for developing a tradition of research culture in the university. The journal will establish a network among the research communities of different areas of academia and industry by publishing their research based articles, case studies, book review, reviews on various topics of current interest in different disciplines. There is an advisory board comprising distinguished academicians from home and abroad who played vital roles by reviewing the articles for the Journal and helped to alleviate cross-cultural issues across the globe.

Eleven research papers in different disciplines along with a book review have been selected for this special volume.

The first article is written on the political philosophy of Bangabandhu reflected in the constitution of Bangladesh. The author rightly stated that Nationalism, Secularism, Socialism and Democracy were the defining philosophy that Bangabandhu articulated for practical application in the political life of Bangladesh. The study detects the philosophies on the basis of his two diaries and reveals its reflection on four directive principles of Bangladesh constitution.

The second article is a brief account of the life history of the Philanthropist Rai Bahadur Ranada Prasad Shaha. The author first chronologically discussed the whole life history R P Shaha and then he cited the important educational institutions established by R P Shaha like Bharateswari Homes, Kumudini Women College, Devendra College, and health related institutions like Kumudini Hospital. The author truly observed that the establishment of the Kumunidi Welfare Trust (KWT) of Bengal is a great effort in the history of mankind of this subcontinent. Then the author systematically narrated the development of Kumudini Welfare Trust by Mrs. Joya Pati, the youngest daughter of R P Shaha and Mr. Rajiv Prasad Shaha , the grandson of R P Shaha.

It is a nicely written one surfacing out quite vividly the life and achievements of Ranada Prasad Shaha, a great son of this soil. The author painstakingly, and also quite vividly, surfaced out every chapter of the life of this great man – his very hard early life, the life of a destitute from which he could lift himself up by his tremendous labour-giving capacity, sincerity towards everything that he had to do for earning his

daily livelihood, and to every purpose that this Great man had to serve. The author dealt also quite vividly with R P Shaha's

achievements, services to the country and its people – in short with everything that this noble man did for humanity.

The Third paper was from the field of computer Science. In this paper the authors used a bio-informatics method for investigating to find the common genes that are associated with Influenza, Pneumonia and Corona virus.

The fourth paper was focused on the machine learning-based approach for detecting fake job post and for identifying real job posts which is an important issue in recent times. The authors showed that Logistic Regression and Random Forest Classifies worked better among the suggested five models.

The fifth paper emphasized on the FOIL and the AC methods to factor a quadratic trinomial function into two factors.

The sixth paper revealed to develop a method of forced motion of differential equation which is applied to nonlinear differential system in presence of external forces.

The seventh paper is a paper in the field of statistical decision theory related to minimax estimation. The authors first found the minimax estimator of the parameter of the Rayleigh distribution for the modified LINEX loss function and then compared this estimator with the classical maximum likelihood estimator. It was observed that the minimax estimator is better than the classical one for the said loss function. At last the authors interpreted the problems of minimax estimators with the two persons zero-sum game.

The eighth paper in this Journal belongs to the field of Pharmacy. It highlighted the influence of environmental factors on the stability of F16 in KP and PB formulations. The author cited that the study was designed according to the World Health Organization (WHO) and ICH guidelines to ensure correct formulations and proper storage conditions. The F16 formulations, KP and PB were found to be highly stable at controlled room temperature during one-month of storage.

The authors of paper nine analyzed and compared the performance of 20 private banks, 4 state owned banks and 6 foreign banks on CAMELS framework. The outcomes of this study revealed that based on CAMEL factors private foreign banks performed better than public bank in Bangladesh.

The tenth and eleventh papers are from the department of English. The authors of tenth paper tried to explore the legendary Bengali poet Jibanananda Das's sense of loneliness and alienation with a sharp focus on his poetry. The authors truly narrated that the poetry of Das richly reflects his perceptive power of life and the world which enables him to create a new poetic domain. The authors mentioned that "it is

characterized by a sense of desolation, distillation, ineffable sadness, melancholy, alienation and even reconciliation as well”.

The eleventh paper has attempted to move toward Comparative Translation, through its focus on the thorough understanding of the ‘Impressionistic theories’ propounded by Yan Fu, Fu Lei and Qian Zhongshu. The paper has applied these “Impressionistic theories” to the four Bangla translations of “The Greek Interpreter”. This study shows that, if Bangla can be read by employing Chinese theories, so can the other languages that are like Bangla. This finding ultimately opens up a space for more accommodative and global study, that shows we do not have to rely on just western approach for studying translations.

At last a book named ‘Moulik Parishankhya’ was reviewed. The authors of the book are well known statisticians of Bangladesh. One of the authors was awarded ‘Ekushey Padak’ by Chittagong University for writing best text book published by Bangla Academy. It is a text book on basic statistics for university students. A very few books are available in the university level by the Bangladeshi authors. We believe the book will fulfill the basic concepts of statistics for the first year statistics students of Bangladesh and the West Bengal of India. Our best wishes to the authors.

Finally, I would like to convey my sincere thanks and esteemed gratitude to Mr. Rajiv Prasad Shaha, Honorable Chairman of the University Trustee and the Patron of \this journal for giving me all kinds of financial support to bring this issue into light. I also thanks to all the members of the Editorial Board, Reviewers and the authors for their valuable contributions. It is our earnest hopes that the students and the researchers concerned will be very much benefited by reading the articles published in this special volume.

**Prof. Shusil Kumar Das, PhD**

**Executive Editor**

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# Reflections of the Political Philosophy of Bangabandhu Sheikh Mujibur Rahman in *The Constitution of the People's Republic of Bangladesh* (1972)

**Kazi Latifur Reza**

Assistan Professor, Department of Law & Human Rights, RPSU

Corresponding Author: kaziminer@gmail.com

## Abstract

*The father of the nation, Bangabandhu Sheikh Mujibur Rahman, is an unparalleled nationalist leader in the history of Bangladesh. He offered the nation one of the greatest constitutions within a short time after the independence of Bangladesh. One will find reflections of the political philosophy of Bangabandhu in The Constitution of the People's Republic of Bangladesh. Moreover, the four founding pillars of the Constitution—nationalism, secularism, socialism and democracy—are the key ideas of Bangabandhu's political philosophy which are focused in his remarkable works—The Unfinished Memoirs (2012) and Prison Diaries ((2018). The present study will make an attempt to highlight the political philosophy of Bangabandhu Sheikh Mujibur Rahman as expressed in his texts—The Unfinished Memoirs (2012) and Prison Diaries ((2018). And this essay will explore the reflections of his political philosophy in The Constitution of the People's Republic of Bangladesh.*

**Keywords:** Bangabandhu, political philosophy, nationalism, secularism, socialism, democracy, and constitution

## 1. Introduction

Bangabandhu Sheikh Mujibur Rahman is the father of the nation of the people of Bangladesh. Today, he is described as a successful poet of politics, and also of the country. The greatness of Bangabandhu will be realistically understood and appreciated if we scrutinize his political career and philosophy. According to Dr. Rounaq Jahan, "It is even more challenging to analyze the political ideas underpinning his life's work" (Jahan, 2019).

This is our misfortune that there is no complete investigative biography of the great leader Bangabandhu Sheikh Mujibur Rahman till now. However, we are blessed that two books written by him have recently been published. The first book is *The Unfinished Memoirs* (2012), which presents the early political life of Bangabandhu Sheikh Mujibur Rahman as well as his political views. The second text is *Prison Diary* (2018), which narrates his prisonlife after the pounce of the Six Point Movement in 1966. Bangabandhu explained his political thoughts and views more clearly in this book. He also focused here on the necessity of the movement against the autocratic government of Pakistan.

This is very obvious for us that the two books are used as unique sources which can help us identify the ideals and political philosophy of Bangabandhu. Besides, we can see the

reflections of his political philosophy in the four fundamental principles of the state adopted in *The Constitution of the People's Republic of Bangladesh* in 1972. However, we know that it is very challenging to identify the political philosophy on the basis of his two books, and to reveal its reflections in the four guiding principles of *The Constitution* within a short study. This paper will make an attempt to identify Bangabandhu's political philosophy as reflected in his books and speeches. Besides, it tries to draw a relation between his political philosophy and the four directive principles found in the constitution of the country.

## **2. Literature Review**

The researcher has studied a number of articles written on the political philosophy of Bangabandhu with an aim to find out the research gap. And, the researcher has analyzed the works of other researchers and tried to focus on their gaps to carry on further study in this regard.

Kazi Ismat Jahan Suvra discusses in her article how Bangabandhu has become the unique leader of people and an inseparable part of our history. It portrays Bangabandhu's early life and political struggle and his contribution in our Independence (Suvra, 2021). Mohammad Alam Chowdhury argues that Bangabandhu Sheikh Mujibur Rahman closed his political career through democratic values that emerged from his philosophical spirit. Bangabandhu Sheikh Mujibur Rahman doesn't think not only about a particular group of people, but also of the entire world and the entire human society (Chowdhury, & Rahman, 2020). Shah Mohammad Jubaer thinks that Sheikh Mujibur Rahman is the most towering figure in Bangladeshi politics; it has been explained, claimed, and counterclaimed by different political parties and intellectuals who take him as a secular, a Bengali, and a socialist, or a mix of all. As a leader, there is no end to his merits and there would be no end to the works on him (Jubaer & Hassan, 2021). Saeyd Rashed Hasan Chowdury focuses on the role of Bangabandhu Sheikh Mujibur Rahman and his contribution in establishing equality and love, and promoting religious cohesion, tolerance, and brotherhood among the masses; besides, he taught people to respect each other's religion, emotions, and practices in Bangladesh (Chowdury & Nafis, 2019). Ayesha Siddika and Amia Saara Khan state that the original constitution of Bangladesh shows the understanding of democracy of Bangabandhu. It has been argued that the vision and mission of Sheikh Mujibur Rahman was the emancipation of the Bengalis through the establishment of the golden Bengal; obviously, democracy was a spirit envisioned by him which could chase the dream of the millions (Siddika & Khan, 2021). Dr. Rounaq Jahan discusses the political philosophy of Bangabandhu on the basis of his two immortal books. It shows that the two books based on his personal diaries can help us understand his ideals and political philosophy (Jahan, 2019). Anisur Rahman explained in an article published in *The Daily Star* Bangabandhu's political contribution in the constitution of Bangladesh. Moreover, Anisur Raham claims that the constitution is the direction for the future generations given by Bangabandhu (Rahman, 2021).

Shamim Mohammed Afzal mentioned in his book that Bangabandhu Sheikh Mujibur Rahman, is an integral part of the national history, heritage, and glory of Bangladesh. Bangabandhu took many breakthrough steps in spreading the message of Islam to the majority of the people of this country, as well as peace, communal status, generosity, tolerance, and humanity among the people (Afzal, 2010).

Traditionally, most of the literature attempted to analyze the political history of Bangabandhu; only a small numbers of the research papers identified the political philosophy of Bangabandhu in the light of the independence movement. These literatures often specified the political philosophy of Bangabandhu as a way forward to achieve his political goals. But, one or two literatures have emphasized his political philosophy and its relation with the constitution. Therefore, this study is designed to address the reflection of the political philosophy of Bangabandhu in formulating, arranging, and providing unique constitutional practice of four directive principles, such as democracy, nationalism, secularism, socialism.

### **3. Objectives of the Study**

The objectives of the study are as follows:

- a. There is very little scholastic research on the political philosophy of Sheikh Mujibur Rahman; so, the primary object of this research paper is to identify and clarify the concept of his political philosophy.
- b. The main objective of the research is to identify the reflections of the political philosophy of Bangabandhu Sheikh Mujibur Rahman in the four fundamental principles—democracy, nationalism, secularism, socialism—which are considered as the most important basic features of the Constitution of People’s Republic of Bangladesh.

### **4. Methodology of the Study**

For conducting this research, a qualitative method has been used. Two texts of Bangabandhu Sheikh Mujibur Rahman have been used as primary sources; besides, some other books and articles have also been used as secondary sources. Textual analysis has been adopted to accomplish this paper.

### **5. Political Philosophy of Bangabandhu**

Bangabandhu was one of the greatest charismatic nationalist leaders in the twentieth century (Rahman,2019). As recorded in *The Unfinished Memoirs*, Bangabandhu was born in the village of Tungipara, Gopalganj; he was the third child of his parents (Rahman, 2012, pp. 6-7). When he was seven years old, Sheikh Mujib began his schooling at Gimadanga Primary School. Two years later, he entered into ‘Class Three’ at Gopalganj Public School. However, he survived a severe infection at an early age that had left him with a weakened heart. Sheikh Mujib finally returned to school but only after four years, owing to the severity of the surgery and slow recovery. He did not go back to his old

Reflections of the Political Philosophy of Bangabandhu Sheikh Mujibur Rahman in The  
Constitution of the People's Republic of Bangladesh (1972)

school as his friends had moved far ahead of him in their studies. So, his father enrolled him in the Gopalganj Mission School, and appointed a private tutor for him. During those years, the private tutor, Kazi Abdul Hamid, was the mentor and a source of inspiration to Bangabandhu. He directed the young leader's work ethic towards helping the disadvantaged, which is inscribed in his *The Unfinished Memoirs* (Rahman, 2012, pp.9-14). After his mentor's death, Bangabandhu, while leading the Muslim Welfare Association, began showing his tendency to fight for the downtrodden regardless of the consequence (Rahman, 2012).

From his high school days, he became gradually interested in politics. He was barely 20-year-old when he first met Sher-e-Bangla, and more importantly Huseyn Shaheed Suhrawardy, when they visited Gopalganj for attending a public meeting (Rahamn, 2012, pp.8-9). A year later, in 1940, Sheikh Mujib joined the Nikhil Bharat Muslim Chhatra Federation and was elected to a one-year term (Rahamn, 2012, p-13).

Having passed his School Examination from Gopalganj Mission School in 1942, he enrolled as an intermediate student at the Islamia College in Kolkata. There, he lodged in the Baker Hostel and became active in student politics (Rahamn, 2012, pp-14-15). Sheikh Mujib joined the (Bengal) Muslim League in 1943 and became immediately drawn to Suhrawardy's brand of politics. Eventually, Suhrawardy became the political mentor and guru of Sheikh Mujib. As a student politician, he combated for the state of Pakistan (Rahamn, 2012, pp.15-17).

Having completed his studies from Islamia College, Kolkata in 1947, he took admission in law at the University of Dhaka. The university authorities expelled him in 1948 on the charge of making provocation of the fourth-class employees in their agitation against the University authority's indifference towards their legitimate demand. He went to jail twice in 1948. Sheikh Mujibur Rahman worked for the formation of the East Pakistan Muslim Students League in 1948 and the Awami Muslim League in June 1949. He was selected for the post of Joint Secretary of the newly established East Pakistan Awami Muslim League in 1949 while he was sent to jail again due to his active participation in the Language Movement (Rahamn, 2012, pp.70-89). Over the years, the Language Movement brought Bengali nation to a single political platform. In this way, through the creation of the non-communal Bengali nationalist sentiment, and liberal outlook, the Language Movement brought the Bengalis to a new horizon. In *The Unfinished Memoirs*, Bangabandhu records his love of everything that was of Bengal. He was deeply attached to Bengali culture as a whole and the Bengali language in particular. Bangabandhu said that no nation could bear any insult directed at its mother tongue (Rahman, 2012, pp.197). Bangabandhu was, in fact, representing the constituent elements of Bengali nationalism as he shared his psyche. As it was, this statement sufficiently indicated the tri-dimensional composition of this nationalism: ethnicity, language and geography.

In 1953, Sheikh Mujib was elected the General Secretary of the East Pakistan Awami Muslim League (Rahamn, 2012, p. xviii). Then Mujib took initiatives to drop the word,

“Muslim”, in 1955 from the party’s name to bring the spirit of secularism among the people (Rahamn, 2012, p. xix).

In the provincial elections of March 1954, the Awami League played a pioneering role in the creation of the Jukto Front (Banglapedia 2021). After Huseyn Shaheed Suhrawardy’s death in 1963 (Banglapedia 2021), Sheikh Mujib revived the Awami League in January 1964 (Rashiduzzaman,1970). He demonstrated his desire to reform the party which would echo the desire of Bangalee people; besides, he announced the Six-Point programme at a conference of Pakistan’s opposition parties held in Lahore in February 1966 (Rahaman, 2012,p-xxi). Bangabandhu started building a political movement against this systemic discrimination. The rise of Bengali nationalism was swift and relentless between 1952 and 1966 (Ahsan, 2005).

In May of that year, he was arrested under the Defense of Pakistan Rules; he was charged with conspiracy to break up Pakistan, which is known as the Agartala Conspiracy Case, in January 1968 (Rahaman, 2012,p-xxi). Countrywide, mass uprising compelled the government to withdraw the case of the Agartala Conspiracy on February 22, 1969. On the next day, the Bangalees staged a huge meeting at the then Race Course Maidan in which Sheikh Mujib was formally given the title s Bangabandhu (Rashiduzzaman,1970).

Under Bangabandhu’s leadership, the Awami League got an absolute majority in the election in 1970 (Rahman, 2012, p-xxii). Bangabandhu’s speech on March 7, 1971, is one of the best speeches in the whole world for its uniqueness, profoundness, multidimensional and dynamic character, extraordinary multiplication, and directional excellence. Nationalism, socialism, democracy, and secularism were clearly reflected in Bangabandhu’s speech. In his speech, he spoke in favor of Bengali nationalism and the economic, democratic, cultural, and political emancipation of the people of Bengal. Through this speech, Bangabandhu called for the War of Liberation (Rahman, 2012, pp. xxiii-xxv).

## **6. Discussions and Findings**

### **a. Nationalism**

Bangabandhu was proud of his Bengali identity. Although he was involved in the Pakistan movement, he believed that the two states should be established on the basis of the Lahore Resolution (Shah, 2021).

Bangabandhu joined the Muslim League when he had been a student in Kolkata. He worked with Shaheed Suhrawardy and his followers, who were then known as the progressive group (Rahman 2012, pp.16-17). He writes in his *The Unfinished Memoirs* that under Mr. Suhrawardy’s leadership, we wanted to make the Muslim League the party of the people and make it represent the middle-class Bengali (Rahman 2012, pp. 17-18).

Earlier, it used to serve the interests of landlords, moneyed men, and Nawabs and Khan Bahadurs (Rahman 2012 pp-35-36). So, we here realized that he was involved in the Pakistan movement with the hope that the poor Bengali peasants would be liberated from the exploitation of the landlords’ class.

Pakistan got independence in 1947. Bangabandhu observed that the Muslim League failed to meet the demand of the Bengalis (Rahman 2012, pp.96-97). Subsequently, Bangabandhu became involved in the Language Movement. So, the government arrested and imprisoned him for demanding recognition of Bengali as one of the state languages of Pakistan in 1948 (Rahman 2012, pp- 99-100).

In his *The Unfinished Memoirs*, he explains that there is no point in pursuing the Muslim League any longer. This party has now become the spokesman of the established class. So, it can no longer be called the party of the people (Rahman 2012, pp.121-129).

In fact, we see that Bangabandhu became very much influenced by the rationality for the establishment of the Awami League as an opposition political party for championing the rights of the Bengalis.

The Awami Muslim League was founded in 1949 (Rashiduzzaman, 1970). In 1955, the Awami League throws down the word, “Muslim”, from its name; and Bangabandhu again became the General Secretary of the party (Mamoon & Khan, 2009). On the other hand, he felt that the Bengali nationalist movement was the movement for the achievement of democracy as well as liberation of the oppressed people (Rahman 2012 pp.128).

Then came the 1958 movement for self-governance (Nisar, 2021). In February 1966, Bangabandhu presented his historic Six Points demand, which turned into a mass movement in 1969 against the Agartala Conspiracy (Ludden, 2011). Finally, the independence of the Bangalees came out through the sacrifice of the blood of the millions of people. In 1972, in our Constitution, nationalism was defined as the Bengali nationalism (Article-9). We see the reflection of Bangabandhu's thoughts of Bengali nationalism in one of the four fundamental principles of the Constitution of Bangladesh.

## **b. Secularism**

This is very much true that Bangabandhu was a Bengali nationalist, but he never tried to create any division between different groups of people. Bangabandhu worked with Sher-e-Bangla A. K. Fazlul Haque and Hossein Shahid Suhrawardy with an aim to create Pakistan. However, he was frustrated to see the use of the religions for mere political interest. In *The Unfinished Memoirs*, he states that after the creation of Pakistan I thought there was no need for the communal institution as Pakistan was born, there should be a non-communal institution which would have a specific manifesto (Rahman 2012, pp. 93-95). He believed in coexistence and mutual tolerance of different communal groups; he always stood against communal violence.

He said in his *The Unfinished Memoirs* that—“be very careful, keep in mind that the enemy has infiltrated our ranks to engage in the work of provocateurs. Whether Bengalee or non-Bengalee, Hindu or Muslim, all are our brothers and it is our responsibility to ensure their safety” (Rahman 2012, pp. 264-257).

In his *The Unfinished Memoirs*, he strongly condemns the anti-Qadiani riots that took place in Lahore in 1953 (Rahman 2012, pp. 244-247). In 1954, when riots broke out

between the Bengalees and the non-Bengali workers in Adamjee jute mills in Narayanganj, he rushed to the area to calm down the situation. (Rahman, 2012, pp. 263-264) In 1964, when Hindu-Muslim riots spread, Bangabandhu said that secularism was not the absence of religion in the state; it was the absence of state-religion instead (Khan, 2020). The people of Bengal never liked religious overpowering. However, he warned that religion cannot be used for political gain (Rahman, 2021, October12). We see the reflection of Bangabandhu's ideas of secularism in one of the fundamental principles of our constitution. The meaning of secularism should be understood in the light of Bangabandhu's view of it. And, it is properly reflected in the constitution. The content of Bangladeshi secularism has found place in the revived Article 12. As per this Article, the word secularism will mean the following:

- i) elimination of communalism
- ii) non-granting of political status to a religion
- iii) non-abusing religion for political purpose and
- iv) freedom of religion and practice of non-discrimination and non-persecution on religious grounds (Bangladesh, 2016).

From the above discussion, it is apparent that the essence of secularism is not something devoid of religion, rather it has emphasized on not using religion to support political purpose and religious freedom.

### **c. Socialism**

Bangabandhu states in his *The Unfinished Memoirs* that he believes in socialism and not in capitalism. Moreover, he explains that capitalism is a tool of the oppressor. As long as capitalism is the mainspring of the economic order, people all over the world will continue to be oppressed (Rahman 2012, p. 237). He meant by socialism a system which would free people from exploitation and oppression and remove inequality. Again, he said that everywhere we could see new schools and colleges coming up. The government has taken charge of education (Rahman, 2012, p. 236). He further observes that the communist government had confiscated the land owned by landlords and had distributed it among all the farmers. Thus landless peasants had become landowners. China now belonged to peasants and workers and the class that used to dominate and exploit had had their day (Rahman, 2012, p. 232).

Bangabandhu wanted to explore socialism in his own way: "I will not import this socialism from any country. This will be the socialism of the people of Bangladesh. That means this will lead to an exploitation-free society and fair distribution of wealth. In many countries, there is no democracy in their kinds of socialism. There can be both democracy and socialism from the soil of Bangladesh. Democracy will prevail in Bangladesh" (Rahman 2021, April 6). In this context, it can safely be said that his idea of socialism as a fundamental structure of the constitution of Bangladesh which is reflected to the attainment of a just and egalitarian society (Article-10), refers to a society in which there would be no exploitation; equality of opportunity is mentioned in Article -13, 14, 16, 17, 18, 19 of the Constitution (Bangladesh, 2016).

In fact, Bangabandhu Sheikh Mujibur Rahman provided the four pillars of the constitution. Socialism is one of them. Therefore, along with the other three pillars, he presented socialism as a Fundamental Principle of state. This was a highly advanced thinking of Bangabandhu in the world of political and ideological thoughts.

#### **d. Democracy**

After keenly observing the Muslim League government, Bangabandhu came to understand clearly why the government must be by the people, for the people, and of the people. He also realized why democracy worked best, and why any government in power should work on democratic assumptions. In his book, *The Unfinished Memoirs*, he once expressed the idea that the Muslim League would be the party of the people. However, he later realized that Muslim League had not become an organization that was rooted in the people (Rahman 2012, pp.96-124). There are, thus, many lessons that we can have from *The Unfinished Memoirs*.

In Pakistan, the budding politician found a lot of evidences of undemocratic policies pursued by men ensconced at the top and at a remove from the ordinary people. For instance, about Liaquat Ali Khan, the first Prime Minister of Pakistan, Bangabandhu has this to say at one point of *The Unfinished Memoirs*, that Mr. Liaquat Ali used to talk about democracy, but he never practiced it (Rahman 2012, pp. 134-137).

In *The Prison Diary* (2018), he discusses at length the different methods of suppression of people's movements pursued by an autocratic state. He highlights the importance of fundamental civil and political rights, particularly the need for ensuring freedom of expression for sustaining democracy. More than once, Bangabandhu had the feeling that the Muslim League government was asking for trouble by trying to smother any opposition to it. When he met Khwaja Nazimuddin in Karachi at that time, the young Mujib had the temerity to tell the Prime Minister of Pakistan that the Awami League is in the opposition. It should be given the opportunity to act unhindered. After all, a democracy cannot function without an opposition (Rahman 2018).

In '*The Unfinished Memoirs*' there are also other clear indications about what Bangabandhu was thinking regarding how democracies should be functioning ideally at this stage of his career. They could not, for instance, be established without political parties (Rahman 2012, pp. 242-244). A constitution, too, had to be framed immediately after the birth of a country.

Bangabandhu, the architect of Bangladesh's independence, marked it as a political wisdom. . The order stated that those elected in the national and provincial parliaments held in December 1970 and January 1971 would be deemed as members of the Constituent Assembly of Bangladesh (Maniruzzaman, August 1975). Of course, we know that no other political leader had ever been able to drive their country to the road to democracy after a bloody war of independence.

We see that Bangabandhu had envisioned to draft and adopt a constitution in the Constituent Assembly in the shortest time. His dreams and political philosophy have been

reflected in the constitution and, democracy is treated as the fundamental human right as per Article-11 (Bangladesh, 2016).

## 7. Conclusion

Bangabandhu is one of the charismatic nationalist leaders in the twentieth century. He spent his whole life to fight for the independence of Bangladesh. He became committed to politics from his early life. He had been seen as an example of democratic practice in his life; and, democracy was a fundamental part of his political philosophy. His writings as well as speeches bear the testimony of his deep respect for this political system. Democracy is also incorporated as one of the four fundamental principles of the constitution. The idea of socialism of Bangabandhu was purely original. Bangabandhu was a born rationalist and could adjust to new realities by using his amazing sensitivity. He was not a communist. But, he believed in socialism; not in capitalism (Rahman, 2012, p-237). Bangabandhu Sheikh Mujibur Rahman wanted to establish socialism in the country within the democratic framework of the state. Bangabandhu established the secular Bangladesh by adding the principle of secularism to the constitution of Bangladesh. He has given equal rights to all the citizens, irrespective of caste, creed, and religion, through the constitution of Bangladesh. Bangabandhu described that the Muslims, the Hindus, the Buddhists, the Christians will practise their own religion; however, he was against the political use of religion (Sen, 2021). Bengali nationalism started to grow in the backdrops of Pakistani colonial attitude and cultural aggression on the Bengali nation, particularly its attack on their mother tongue. There grew a spirit inside the Bengali people within few days of partition, which was further triggered by the Language Movement in 1952, thus leading to the ultimate rise of Bengali nationalism. In his *The Unfinished Memoirs*, he wrote regarding this movement. Bangabandhu Sheikh Mujibur Rahman, father of the Bengali nation and first president of Bangladesh, paved the way for the Bangalees' independence in 1971 after a historic civil war against Pakistan. His journey as a political leader resulted in the birth of Bangladesh. So, all his philosophical ideas are reflected well in the constitution of Bangladesh. We know that Bangabandhu did not borrow totally the ideas of Nationalism, Secularism, Socialism, and Democracy from the western world. He blended western ideology with his own political philosophy. In this article, we have explored his political philosophy through a study of his two texts. And, we have realized how his political views are reflected through the four pillars of the Constitution: nationalism, socialism, democracy and secularism.

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## **Ranada Prasad Shaha: A Proud Son of the Soil**

***Manindra Kumar Roy***

*Vice-Chancellor, Ranada Prasad Shaha University*

*Corresponding Author: vc@rpsu.edu.bd*

### **Abstract**

*In this article, a brief life history of Shaheed Danabir Rai Bahadur Ranada Prasad Shaha has been presented. The events of his life have been briefly summarized consistently in a very simple and straightforward way.*

**Keywords:** Philanthropist, Kumudini Devi, Kumudini Welfare Trust of Bengal, 49<sup>th</sup> Bengal Regiment, Jamadar, Bharateswari Homes, Kumudini Hospital and Independence Day Award

### **1. Introduction**

A very few extraordinary talented and genius people are born on this earth who become legends through their kindness and benevolent works. These great men are memorable. One of them was Shaheed Danabir Rai Bahadur Ranada Prasad Shaha (R P Shaha) from the village Mirzapur of Tangail subdivision in Mymensingh district. He has been widely acclaimed as ‘Danabir’ for his huge donation and constant help to the needy people, and the British Government honoured him with the title ‘Rai Bahadur’ for his gracious works and benevolent endeavours for the welfare of common men.

I feel honoured to have been given the opportunity to write this tribute, on the occasion of his 125<sup>th</sup> birth anniversary, to R P Shaha – a legend of the twentieth century Indian subcontinent. He was a great Philanthropist, business magnet and one of the 25 richest persons of the then Pakistan. I heard the name of this great man when I was a schoolboy of only class III. My father was once suffering from piles, when one of my maternal uncles, a B.Sc. student of Karatia Sadaat College, Tangail, suggested my father to go to the Kumudini Hospital, Mirzapur, and my father got fully cured after the piles operation from this hospital. Thereafter many people from our area (Harirampur of Manikganj) used to go there for treatments. R P Shaha founded that hospital after the name of his beloved mother Kumudini Devi.

However, I have been working as a Vice-Chancellor at Ranada Prasad Shaha University (RPSU), a sister institute of Kumudini Welfare Trust (KWT) of Bengal (BD)Ltd since January 01, 2016, initially, as an acting Vice-Chancellor and thereafter as a regular Vice-Chancellor since August 1, 2017. *The* university has been founded by R P Shah’s grandson Rajiv Prasada Shaha in 2013. By this time, I got the opportunity to know about this kindhearted man R P Shaha and his founded KWT as a whole. Only a few works have, however, been done so far on R P Shaha, which inspired me to write this tribute.

Perhaps Ranada Prasad Shaha Jiban Katha (2005), a biography by Hena Sultana, is the first literature on R P Shaha. Ranada Prasad Shaha Sharrak Grantha (2013) – a souvenir is the second such work containing 70 articles, five poems, and his family genealogical tree. The contents of these articles highlighted the diverse life history of R P Shaha. Most of these write ups are the memoirs of the near and dear ones of R P Shaha, and persons associated with the KWT. Of the write ups, those by Mr. Mohidul Haque and Mr. Muhammad Lutful Haque are particularly notable. A booklet published in 2017 on R P Shaha is also a good effort. Articles also appear frequently in the newspapers on the birth day occasion of this noble man.

## **2. Early Life**

Ranada was born on the 15<sup>th</sup> November, 1896 (the day of Utthan Ekadashi in the month of Kartik in 1302 of the Bengali year) afternoon in the house of his maternal uncle in Kaisur of Shimulia near Savar in Dhaka district. It is mentionable here that the birthday of R P Shaha is celebrated on the Utthan Ekadashi of every year. His ancestral home was in Mirzapur, a village of Tangail district. His father was Devendra Podder and mother was Kumudini Devi. Ranada was the second of the four siblings. Father Devendra Podder did not have a permanent job, and not much formal education. He however had a good knowledge about the rules of lands then. Hence, he chose writing documents as his profession. Ranada was very restless, but cheerful and lively from his childhood, and was growing up in the care of his loving mother. In 1903, at the age 7, he was sent to a Primary school in Mirzapur. Very sadly, while giving birth to a child, his mother Kumudini Devi succumbed to tetanus and died prematurely without any medical treatment and care in the same year. The tragic death of the mother made a deep impression on the mind of Ranada, a seven year old child. Instantly, the inner mind of Ranada had grown up and promised to set up a charity hospital after his mother's name if he could ever become wealthy, so that no mother dies without treatment giving birth to a child.

Less than a year later, on the advice of neighbours and relatives, in 1904 Devendra Podder married Kakon Dashi as his second wife to look after the children. Kakon Dasi never treated Ranada and his siblings humanely. Due to scarcity, Ranad's elder brother Madan Shaha had to go to the house of his maternal uncles in Kolkata. His sister Maran Dasi was married at the age of only eight years. The younger brother Fani was adopted by the zamidar of Mahera at the age of 2 years.

The untimely death of mother, the neglect of father, and cruelty and oppression of the stepmother, made the cheerful and lively Ranada rather reckless. After passing class three, father Devendra Podder sent Ranada to the house of his maternal uncle in 1905. The economic condition of the uncles was quite good. The uncles accepted him, but the aunties could not accept him easily, rather used to express annoyance. Ranada, the poor boy not only getting any care, rather frequently subjected to humiliation, ran away from his uncle's house at the age of only nine. One day Raja Jagat Kishore Roy, the Zamidar of Muktagachha, while hunting in a forest found Ranada in an unconscious state and took

him home. He spent there a few years where he was treated with affection and care. Observing the manners of the people of the zamidar family and their cultural activities, Ranada developed a taste for music and theatre which he displayed in his later life. The life style of this highly cultured family influenced him to a greater extent. The biggest picture of Raja Jagat Kishore Roy in the Library-cum-Museum room of the KWT, Mirzapur, reflects his gratitude to that family.

### **3. Most Difficult Adolescent Time**

After spending a few years at the house of the zamidar of Muktagachha, he decided to go to Kolkata, the dream city and the then capital of India (Kolkata was the capital of India till 1912), for a change in fortune. Ranada arrived in Kolkata in 1910 at the age of only 14. His maternal uncles used a rented house in Shovabazar of Kolkata for trade and also to stay. Ranada's elder brother Madan Shaha was helping in their business. He did not know the address of that house. His life in Kolkata became, therefore, very critical. He had no money, even no place to sleep in. Selling newspaper, lying on the sidewalk, drinking roadside tap water, working in hotels, cleaning streets, washing cars were the livelihood earning means in those critical days. He did anything to satisfy his hunger. Finally, he got the address of the uncle's house. Luck did not favour him here also. He had to leave the uncle's house due to some mishaps, for which his elder brother asked him to go home with only five rupees, the last of his savings. But he did not return home remembering the old hardship of Mirzapur and stayed in Kolkata and took a job in a sweet-mart shop in Shabhabazar. Here he used to bake bread and doing different kinds of odd jobs. At this time, like many Bengali youths, Ranada got involved in the armed Swadeshi movement for the purpose of self-sacrificing to the service of the country, and because of this he was imprisoned for few days.

### **4. Soldier Life**

World War I began on July 28, 1914, and on August 04, 1914 England joined the war. Prominent local leaders - the local Raja-Maharaja, the Nawab-Zamidar of India, and even the leaders of Bengali nationalism movement who were involved in the 'Swadeshi movement' supported England in the War. R P Shaha joined the British Army in 2015, the year of his father's demise. He first joined the Bengal Ambulance Corps, and was sent to Mesopotamia (Iraq) where he rescued twelve disabled soldiers from a burning field hospital. In November 1916 he joined the Bengali Platoon as a soldier. R P Shaha went to Nowshera (in Pakistan) for training with the Bengali Platoon. After 3 months of training there, he left with the regiment to Karachi. There he met our national poet Kazi Nazrul Islam. The poet was also a soldier there. They had been close friends ever since. R P Shaha then became a temporary Lance Naik. In the same year R P Shaha was trained at the Central Physical Training and Bayonet Fighting School at Puna, and was promoted to Subedar Major. In July 2017 Bengali Platoon was transformed into 49<sup>th</sup> Bengal Regiment. On 25<sup>th</sup> August 1917, R P Shaha was promoted to Jamadar, the first title of the then National Indian Army commission.

At the end of World War I, Emperor Geogre-V of India declared July 29, 1919 as the day of peace. Ranada Prasad Shah was honoured to participate in the peace celebration at the invitation of King George-V for his Courageous and dedicated service and heroic contribution to the first World War. This glory of R P Shaha was the glory of Bengali nation. Rabindranath Tagore himself soaked R P Shaha in congratulations.

### **5. Service and Family Life**

R P Shaha was given the job of a Railway Ticket Collector by the British Government in 1920 according to his pertinence. The job area was from Sirajganj to Shilaidaha in Kushtia. This year he married Kiran Bala Devi, the daughter of the zamidar of Baliati, Manikganj. Kiran Bala was not only his wife but also was the inspiration behind all his works. She had always given her husband support and inspiration. She was very patient and affectionate. R P Shaha always said “My wife is my ‘Bhagya Lakshmi’, she is my right hand”. The position of husband in Hindu Society is to the right side of the wife. But he always sat left side of his wife Kiran Bala. Such was his respect and gratitude to his wife. R P Shaha and Kiran Bala had four children. Their first daughter Bijoya Shaha was born on the day of Bijoy Dashami in 1920 and hence her name. The second daughter Jaya Shaha was born in 1932. The first son Durga Prasad Shaha was born in 1938. He was known as ‘Bharo Khoka’. But unfortunately, he was mentally handicapped. The second son Bhabani Prasad Shaha (Rabi) was born in first January, 1944.

### **6. As a Business Magnet**

The railway job of R P Shaha did not last long. He was forced to resign from his job in 1932 in a false case. However, he received some cash as compensation and started coal business. At first he used to supply coal from house to house. In a very short time, he became an established successful coal businessman. As a coal trader he came to know with a launch owner who had not been able to pay the coal to R P Shaha for some time. That’s why he was looking buyers to sell his only launch. R P Shaha himself bought that launch called ‘Bengal River’. He started shipping business with coal. At one point he set up a launch repairing dockyard. R P Shaha noticed that shipping business was quite profitable. So, he thought to establish a shipping company. But he had no sufficient capital. So he formed the ‘Bengal River Service Company’ - a partnership business with several wealthy people, including the zamidar of Mahera where he was working as an associate worker. Nipendra Nath Roy Chowdhury was the managing director of the company. At his sudden death, R P Shaha had to take the charge of the company. As the business was very risky, the other partners sold their shares to R P Shaha. As a result, he himself became the owner of the ‘Bengal River Service Company’. R P Shaha’s character had an amazing quality. He bought three powerhouses at Narayanganj, Mymensingh and Comilla. He had uncanny business acumen. He bought business enterprises that others failed in, and his skills and perseverance made them successful.

The main task of this company was to bring goods by sea from different countries of the world including India. At one time the company had 75 large cargo ships. R P Shaha made

his debut as an established businessman, mainly through the shipping business. Within just six years from 1932 to 1938, R P Shaha became known as a rich and wealthy businessman. It is notable here that the Tannery Industry in this region was also initiated by the businessman, R P Shaha in the 1940's which is the today's one of the bright potential industries in Bangladesh. Later he became one of the 25 richest people of Pakistan.

In 1940 R P Shaha bought all the jute businesses including jute baling press machines, warehouses from the Scottish firm George Henderson and Company at Narayanganj. Note that George Henderson and Company made all the purchase from the famous English firm named David and Company. During the World War II he was appointed one of the agents to buy food grains for the Government. It is mentionable here that on March 29, 1945, R P Shaha bought all the properties of George Henderson and Company including 100 acres of land in Narayanganj which was transformed into the head office of the Kumudini Welfare Trust (KWT) of Bengal (BD) Ltd. in 1947.

### **7. As a Philanthropist in the Field of Education and Health**

RP Shaha had never forgotten his childhood promise. Time now came to fulfill his dreams using all his resources. In 1938 he returned to Mirzapur and told his childhood friend Satish Bonik about his long-cherished desire to establish initially a maternity hospital and a residential girl's school at Mirzapur.

#### **a. As an Educationist**

RP Shaha had no formal education. He disappeared from the house of his maternal uncle when he was a school boy of class IV. He was self-educated. The whole world was his school. He got practical education and knowledge in all fields of life from this school. He was always thirsty for knowledge, and read many books of Rabindra Nath Tagore, Shakespeare and other famous writers. He taught himself in the field of literatures, arts, athletics and drama in addition to communication, aesthetics. Even he participated in dramas. Proof of this is found in the paintings, photographs, and picturesque preserved in the library cum museum at the Kumunidini complex at Mirzapur and at the Narayanganj campus. He realized the value of education. He understood that no nation could develop without proper education, which is one of the basic needs of human beings. He also realized that the women of rural Bengal were confined in houses and extremely oppressed. Though about half of the society, they were neglected, harassed and deprived from their basic rights. They were full of all kinds of superstitions. There was no alternative to women's education to make these women socially conscious, self-confident and dignified. "Educated mothers will give gifts to educated society"- he was a believer in this philosophy of Napoleon. So, in 1938, with only 7-8 students, he started a school in the backyard of his uncle Sri Jogendra Podder at the village of Mirzapur. At this time R P Shaha's wife Kiran Bala Devi laid the foundation stone of a full residential girl's school of 200 students where educational activities were started in 1945 with only 55 students. Now-a-days it is famously known as Bharateswari Homes.

The students were given here free food, clothes, bedding and medical facilities. The students from different parts of the country came to study and trained. The main purpose of the school was to make women educated, disciplined, and self-reliant for a better future. Besides the class room teachings, they were given training in music, dancing, physical fitness and household skills with special emphasis on cleaning, washing and cooking. Until the sixties of the 20<sup>th</sup> century Bharatesawrai Homes was completely free of cost for students. It is notable here that Bharateswari Devi was the great grandmother of R P Shaha. She had education up to primary level and she used to help villagers by reading letters from members of their families who worked far away from home and also helped the village children in their education. Currently, the Bharateswari Homes houses about 1200 students of secondary and higher secondary levels. The girls of Bharateswari Homes even today recite the prayer before their everyday meal “O Most Merciful, by Your infinite grace, we are all going to accept our meals, so that we are eternally to You, so that we are not be helpless in Your blessings”- Amen. The main purpose of R P Shaha’s life is hidden in this prayer. This institution is nationally known for the unique physical display providing by its students in nation programs. Every year the students take part in National Day’s celebration and important festivals in Dhaka and win prizes and trophies.

Bharateswari Homes was given the Independence Day Award 2020 for its excellent educational performance.

R P Shaha established a residential Kumudini Women’s College in Tangail for higher education that later has been converted to the Government Kumudini Women’s University College. Devendra College was established in Manikganj after the name of his father which is today the Government Devendra University College. Huseyn Shaheed Suhrawardy Degree College in Magura, Shaheed Altab Memorial School in Barisal, Tangail Bhuyapur College, Chaumuhoni College, Santosh Maulana Bhashani Islamic University which later on named as Maulana Bhashani Science and Technology University, SK Pilot School in Mirzapur, Maulana Mohammad Ali College in Tangail, Karatia Sadaat Degree College and Mirzapur Degree College were also established with his financial supports. On July 22, 2021 the KWT was informed that Joshore College was renamed after Michael Modhusudan College Joshore on R P Shaha’s request for his huge donation in 1945. In this way he honoured the talented people of his homeland. He had also provided financial support to many educational institutions in India, including Kalimpong Residential School at Darjeeling.

## **b. Works in Health Sector**

From childhood Ranada was dreaming to establish a modern charitable hospital for the general people. In the epicenter of his dream was the scene of almost untreated mother’s death seen in his childhood. He did not forget that sad memory even after he became very rich. In 1938, he first set up a charitable dispensary after the name of his grandmother Shova Sundari on the banks of the river Lohjong in his village Mirzapur. There were free patient visits and medication. Later Kumudini Hospital was established here after the

name of his beloved mother and Bidhanalay was set up for the outdoor patients and medical services. The foundation stone of the hospital was laid in 1938 by R P Shaha. Finally, he was able to materialize his dream. On July 27, 1944, the then Governor of undivided Bengal, Lord R.G. Casey, inaugurated the Kumudini Hospital in honour to his mother Kumudini Devi through a 20-bed maternity ward. In his inaugural speech Lord Casey said “Some of you may wonder why I should take such close personal interest in a hospital which happens to be situated in a part of Bengal never before visited by a Governor of the province. My answer to this is simple. I have come here today because I feel that this hospital affords a high example of what can be done when the initiative enterprise and public spirit of one man are directed towards the welfare and the wellbeing of the community.” R P Shaha recruited young widows from villages around the hospital and provided education and training to these deprived, neglected and downtrodden women who silently bore the abuse of the contemporary society. He recruited highly qualified local and foreign doctors for Kumudini hospital. The world-famous surgeon Dr. G.S. Jhanda who was one of the five-member medical board of John F. Kennedy after being shot, German Dr. K.S. Saidi worked in this hospital. Also, among the eminent doctors of the country Dr. A.K.N. Islam, surgeon Dr. Rashidul Chowdhury, Dr. Badruddoza Chowdhury, Dr. Alim Chowdhury (a martyr) and Dr.T. Hossain served Kumudini Hospital at one time. From its inception until 1996, it provided free medical care to patients, as well as free medical advice, accommodation including medicines. In 1949, the first radiotherapy unit in this area was launched in Kumudini hospital for the treatment of deadly cancer. Within a few years, Kumudini hospital was transformed into a general hospital with 750-beds.

In 1970, a 50-bed boat Tuberculosis Ward was launched on the bank of the Lohjong River to treat tuberculosis patients. It was inaugurated by the then Vice-Chancellor Justice Abu Saeed Chowdhury of Dhaka University. Today Kumudini hospital has 1050-beds which provide high quality, and almost free, medical care.

In 1954, the maternity ward at the Combined Military Hospital in Dhaka, the then capital of East Pakistan was established by R P Shaha. He also established charitable clinics in present day Kolkata, Darjeeling, Jharkhand and Madhupur in India. He also contributed to the multifaceted social reconstruction work in Narayanganj by donating lands for the establishment of a 150-bedded general hospital, residence of Deputy Commissioner and government officials, government food warehouse of Naryanganj and the Shaheed Nagar on the bank of the river Shitalakhya in the memory of Huseyn Shaheed Suhrawardy, due to which the then neglected masses of Bengal achieved a significant development.

Not only in Bengal, during the Pakistan period, in the fifties of the 20th century R P Shaha established Iskander Mirza hospital in the city of Peshawar after the name of the President of Pakistan, Iskander Mirza. For establishing this hospital, Iskander Mirza congratulated RP Shaha and called him ‘Hatem Tai’ of Pakistan. R P Shaha also established a hospital in Hazira district of Pakistan named after the mother of General Ayub Khan, known as an Iron man, President of Pakistan.

During the World War II in 1943-44 a severe famine broke out over the whole undivided Bengal known as 'Bengal Famine of Fifties' (1350 Bengali year). More than three million people died of starvation, malaria, and other diseases aggravated by malnutrition, population displacement, unsanitary conditions and lack of health care. The main reason was the buying of extra food for the British soldiers by the Government. At this time, R P Shaha came and stood by the endangered hungry people. He opened 275 'langarkhanas' (gruel houses) and saved starving people of Tangail, Faridpur, Mymensingh, Manikganj with food for 8 months. In recognition of his humanitarian work, the then Governor General of India Field Marshal Wavell, conferred the title of 'Rai Bahadur' on Ranada Prasad Shaha on 18 June 18, 1944. On July 31, 1944 in response to the request of the then Governor of Bengal, he donated Rs.2,50,000 to British Red Cross.

### **8. Kumudini Welfare Trust of Bengal (BD) Ltd.**

Although R P Shaha was a businessman by profession but he dedicated his life to the welfare of the society. In June 1947, Ranada Prasad Shaha founded his dream institute "Kumudini Welfare Trust of Bengal (BD) Ltd" and executed all his property in the name of the Trust. Note that his closest friend, the then Food Minister of undivided Bengal, Huseyn Shaheed Suhrawardy provided all the legal assistance to form the Trust and was the first member of this Trust. KWT of Bengal was a unique human welfare and social service organization. Its logo is Kumudini Cares whose main chant (mantra) is education, health and environment. Education and health are two of the five basic human needs. And the environment plays a very important role in the implementation of these two. So R P Shaha coordinated these three. All the activities of the Trust are divided into two streams. One stream is dedicated to human service and social welfare. Bhareswari Homes, Kumudini Hospitals, Library cum Museum, Ashananda Hall, Anadaniketana are these types of Institutions located at Kumudini's Mirzapur Complex. He called all these institutions as pilgrimages. The other genre Institutions such as Jute related business bale pressing, warehouse etc, and River transport and others income generating units were located at Khanpur and Shitalakhya at the head office campus of KWT in Narayanganj. Welfare activities of the Trust were run by the income generating units. KWT is a self-contained organization. It is a new idea of social development, a new philosophy. So, R P Shaha is an ideal, a Philosophy, an institution.

But the regret is that person like R P Shaha was not free of enemy. Some jealous disgusted people had tried to prove him to be a spy of India, a traitor and a heretic. But they did never succeed. Truth always wins. And it was a fact that R P Shaha was a great personality. He never did politics. But he was extremely politically conscious. In 1961, President Ayub Khan formed Constitutional Commission. As a member of this Commission, R P Shaha put forward various recommendations and demands for alleviating the suffering of the people of East Pakistan which was extremely timely.

## **9. Distinguished Visitors**

R P Shaha maintained good relations with everyone above political ideology. So we saw that almost all the powerful personalities of Karachi-Pindi-Dhaka, irrespective of party affiliation, visited Mirzapur and Khanpur Kumudini Complex. The Prime Minister of undivided Bengal Khawaja Nazimuddin, Chief Minister Huseyn Shaheed Suhrawardy, Prime Minister Liaquat Ali Khan, East Bengal Chief Minister Aatur Rahman, President Iskander Mirza, Governor General of Pakistan Mohammad Ali, Mojlum Jananeta Abdul Hamid Khan Bhashani, Bangabandhu Sheik Mujibur Rahman and may more visited Mirzapur Kumudini Complex and the Khanpur head office of KWT at Naryanganj. It is mentionable here that Bangabandhu had family ties with R P Shaha. Bangabandhu used to address R P Shaha as Dada and Kiran Bala as Baudi. The daughter of Bangabandhu and the Prime Minister of Bangladesh Jananetri Sheik Hasina visited KWT in 2019. What I was saying that many renowned national and international personalities such as Health and Social Service Minister of East Pakistan Dharendra Nath Datta, His Excellency the Aga Khan and Begum Aga Khan, Shimanta Ghandi Khan Abdul Ghafar Khan, imminent Journalist Tafazzal Hossain Manik Mia, imminent poet Mozammel Haque, linguist Dr. Muhammad Shahidullah, Muzaffar Ahmed and the composer of the song of Ekushey February Prabhat Ferry, language soldier Dr. Abdul Gaffar Chowdhury and others also visited Kumudini. Everyone praised P R Shaha and assured him all kinds of support and cooperation. Please note that Ayub Khan, when he was the GOC of East Pakistan, repaired the Dhaka-Tangail Road at the request of R P Shaha. It is also notable that Huseyan Shaheed Suhrawardy visited Kumudini Complex in the mid-fifties and wrote in the visitor's book:

“A poor man became a millionaire, and the millionaire voluntarily became poor man, spending his all in the service of humanity, for the suffering and the distressed, for the furtherance of education, for rendering a service to the state, which the state itself has not undertaken. But is the Rai Bahadur poor; he is rich in the esteem, in the affection, in the love of a grateful people; having given all his worldly possessions, he has obtained more than those who were his compeers. May that state and the people he has served so well give him that recognition which is his due, and not destroy the great institution he has built with such love and devotion.”

## **10. Ideology and Philosophy**

The patriotism of R P Shaha was beyond any compare. In this case, his ideal man was Mohan Lal, one of the generals of Sirajudaula, the last Nawab of Bangla-Bihar-Orissa. Swami Vivekananda was his ideal man for humanity and social welfare. R P Shaha was known as Danabir by the general mass. He did not like the word donation. He said that needy people deserved it.” If one donates with the right hand, the left hand will not know it”, this was his policy.

R P Shaha loved to work. Karma is religion. He followed this message of Gita throughout his life. He was hardworking, disciplined, dutiful, law abiding and dedicated to his work

like, generally like the Europeans. Homes students and hospital nurses were given the European dresses so that they could work easily and comfortably. He himself was comfortable wearing shorts, shirt and hats supervising the works. So, the people of the village even his sister-in-law (Baro Boudi) Brajabala used to call him Saheb and his house was known as 'Saheb Bari'.

He was a reformist, free-spirited and secular man. He believed that all human beings belong to the same race and that is man. And the religion of all people of the world is one that is (dhekichhata), small fish, some dal and curd were his daily food." Simple living and high thinking" were the core principle of his daily life.

He had named various organizations in the memory of each of his three predecessors, such as Kumudini Welfare Trust, Kumudini Hospital and Kumudini women's College after the name of his beloved mother Kumudini Devi; Debendra College after the name of his father Debendra Nath Podder; Shova Sundari Charitable Dispensary after the name of his grandmother; Sarbananda Ward after the name of his grandfather; Ashananda Hall after the name of his great grandfather, and Bharatesari Homes after the name of his great grandmother. It is mentionable here that no institution was named after his own name.

R P Shaha made KWT like a family to make the work environment easier, comfortable and more beautiful, and bound all those associated with the Trust into one spiritual bond. He considered all the officers and the employees of all the organizations under KWT as members of the Kumudini family. It is mentionable here that the first educational institution he founded was named as 'Bharateswari Homes'. The atmosphere here would be like a home, he desired. R P Shaha was the head of the Kumudini family who was everyone's favorite and everybody called him 'Jetha Moni'. His wife Kiran Bala was known as 'Jethima', the elder daughter Bijya Shaha was everybody's 'Bardi'; younger daughter Joya Shaha as 'Chotdi'; the beloved son Bhabani Prasad Shaha as 'Robida', and his wife Srimati Shaha as 'Boudi'. There is another special personality in the Kumudini family who was the former principal of Bharateswari Homes and one of the present directors of KWT and a very respected person Miss Prativa Mutsuddi. R P Shaha used to call her mother. Motherly affection made her a permanent member of the Kumudini family. Today she is Barama (grandmother) of the Kumudini family. This language soldier and the educationist was honoured with Ekushey Padak in 2002.

The natural environment of Mirzapur Kumudini Complex is very beautiful and picturesque. Different species of trees have been planted here to keep it free from pollution. The complex is rich in various shrubs, flowers and fruit trees. A huge pond with paved stairs in each side containing clear water is surrounded by a set of nice buildings where all things are clean and tidy. A special attraction for the visitors is the 'Bisnapada Pati Brikhya Shala' named after the husband of Jaya Pati, the former Managing Director (MD) of KWT. Also, there is a combined waste management system for waste disposals of hospital, homes and other institutes. This made the environment of Kumudini Complex safer and healthier.

## **11. Death and Judgment**

The war of liberation of Bangladesh started from the black night of March 25, 1971 when the barbaric Pakistani Army cracked down on the general mass of Bengal in the name of 'Operation Search Light'. The Pakistani army killed many unarmed and innocent Bengalis, including the listed intellectuals. It is to be noted that the former Health and Social Welfare Minister of East Pakistan and Bhasha Shainik (language soldier) Dharendra Nath Dutta (March 29, 1971), Prof Jogesh Chandra Ghosh (April 4, 1971) founder of Sadhana Aushadhalya, Nutan Chandra Singha (April 13, 1971) founder of Kundeswari Aushadhalya were picked up from their houses and killed brutally by the Pak army and their local collaborators. The bad day came also for the Kumunidi family. R P Shaha and his son Bhabani Prasad Shaha were summoned to the Governor's house by the Pakistani occupation Army on April 29, 1971. The whole family was afraid of having bad news anytime. But they returned home unharmed on May 05, 1971 after about a week. This might be due to the fact that inspite of political affiliation R P Shaha always maintained a good working relationship with the Pakistani authorities as well as all preceding and successive governments. The family was very happy to have them back alive but it was very fleeting. On May 7, 1971 the barbaric Pakistani Army with the help of their local collaborators abducted R P Shaha with his son Bhabani Prasad Shaha, childhood friend Gopal Saha and three more employees Moazem, Matlab and Rakhil from the head office of KWT Khanpur, Narayanganj at 11:30 pm. They had never come back and no trace of them had been found. R P Shaha was 74 and his son Bhavani Prasad Shaha was 27 when they were abducted. Srimati Shaha, the daughter in law of R P Shaha, and wife of Bhabani Prasad Shaha, was widowed at the age of only 20, four years after her marriage. Their only son Rajiv was 3 years old at that time. Many of his well-wishers earlier requested R P Shaha to leave for India. But knowing that death was inevitable, he did not flee to India leaving the family members of the KWT behind, but secretly cared for the wounded freedom fighters. That is why he and all the three persons mentioned above got the status of martyr in the liberation war.

After a long time, Bangabandhu's daughter Jananetri Sheikh Hasina completed the judicial trial of that murder. Maulana Wadud, the main accused in the murder, was killed by the freedom fighter as soon as the country became independent. His eldest son involved in this murder had already died. His youngest son Mahbur Rahman was the only survivor among the convicted. He was tried and sentenced to death by hanging, but he died in prison before the death sentence was carried out. The Kumudini family expressed their satisfaction at the trial.

## **12. Awards and Honours**

In 1969, President Ayub Khan awarded R P Shaha the highest title of Pakistan "Helal-a-Pakistan" in recognition of his public welfare and social work. R P Shaha declined to take the title in protest of the massacre of the people of Bengal in the mass uprising of 1969 and in support of the movement for the establishment of the rights of the people of Bengal.

The government of the People's Republic of Bangladesh posthumously rewarded R P Shaha the Independence Day Award in 1977. The KWT, established by him, has also been honoured with the Independence Day award by the Government of Bangladesh in 1982. R P Shaha commemorative stamps were issued by the Bangladesh Postal Department in Shaheed Series in 1991. In addition, P R Shaha was posthumously honoured by the Ibrahim Gold Medal in 1997 and by the Atish Dipankar Gold Medal for Social Service in 2007. Death could not erase him from the human memory, rather his noble service and great achievements had given him immortality.

### **13. KWT from 1971 to 1999**

After the death of R P Shaha, his worthy youngest daughter Jaya Pati became the managing director of KWT, and discharged her duty with great skills which increased the area of KWT day by day. She even added new institutions at Nayanganj Campus like Kumudini Handicraft, Kumudini Germents, Trade Training School, Kumudini Pharmaceuticals and Kumudini Nursing School at the Mirzapur campus. In 2021, Mrs. Joya Pati was awarded the "Bangamata Begam Fazilatunnesa Sheikh Mujib Padak" in the field of education and culture. It is mentionable here that she had been assisted all the time by Mrs. Sreemati Shaha, the only daughter-in-law of R P Shaha. Kumudini Handicraft has made the local cottage industry popular in the world through the free advanced training of poor and helpless working women in the rural Bangladesh. And the driving force in this work is the majestic Mrs. Sreemati Shaha. In recognition of these great social services, Mrs. Sreemati Shaha was awarded the "Begum Rokeya Padak" in 2006, and "Begum Sufia Kamal Padak" in 2021.

### **14. KWT Today**

Mr. Rajiv Prasad Shah, the worthy grandson of the Rai Bahadur, and the only son of Bhabani Prasad Shaha, is currently the Managing Director of KWT. He has been serving as the Chairman and Managing Director of this Trust since 2000 with great efficiency. In a short span of time, he has completed two unfinished works of his grandfather. He founded Kumudini Women's Medical College at Mirzapur Complex in 2001 and Ranada Prasad Shaha University after his grandfather's name at Narayanganj in 2013. At Kumudini Women's College about 250 girl students from different countries study here. It is one of the best private medical colleges of Bangladesh. Ranada Prasad Shaha University is committed to providing quality education. Ensuring quality education in compliance with the UGC and the Ministry of Education has already become a source of trust for students and their parents of the university. Hopefully, under the dynamic leadership of the present administration, this university will soon reach an important position in higher education in this sub-continent, and the city Narayanganj will be known by this university. It is also noted that industrialist, social worker and educationist Mr. Rajiv Prasad Shaha founded the Kumudini Nursing College in 2007, Dental Unit of Kumudini Women's Medical college in 2012, Kumudini Medical Technology Institute in 2019, Kumudini Post graduate Nursing Institute in 2020 at Mirzapur Complex and the Kumudini International Institute of

Medical Sciences & Cancer Research at Narayanganj which was inaugurated, virtually, by the honourable Prime Minister Sheikh Hasina in 2021. Two more institutes named Kumudini Unanni and Ayurvedic Medical College & Hospital, and Kumudini Laboratories Ltd are on process and going to be established at Narayanganj very soon under KWT. Besides, he has a plan to build an Inland River Container Port at Naryanganj at a cost of Tk.345 crore and an Old Home on a 3-acre land at Mirzapur.

## **16. Conclusion**

So, we can say without hesitation that Danabir Rai Bahandur Ranada Prasad Shaha did not leave us, and is very much still with us. Day by day, the branches of his Kumudini Welfare Trust are flourishing and prospering. In fact, the person Ranada Prasad Shaha has become an institution of his ideal, philosophy and pursuit. Great man never dies. All his deeds, and the glorious achievements made after R P Shaha has proved this fact. He will live forever among us through Kumudini – a giant body left by a ‘very great son of this land’ – our Bangladesh.

May Kumudini Welfare Trust be Permanent  
May the memory of Ranada Prasad Shaha remain forever.

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# Investigation to Find the Common Gene and Design Protein-Protein Interaction Network for Drug Design Among Viral Diseases: A Bioinformatics Approach

Tanjina Akter<sup>1</sup>, Arpita Roy<sup>2</sup>, Kingkar Prosad Ghosh<sup>3</sup> and A.H.M. Shahariar Parvez<sup>4</sup>

<sup>1</sup>Lecturer, Department of Computer Science and Engineering, RPSU

<sup>2</sup>Assistant Researcher, Department of Computer Science and Engineering, RPSU

<sup>3</sup>Associate Professor, Department of Computer Science and Engineering, RPSU

<sup>4</sup>Assistant Professor, Department of Computer Science and Engineering, RPSU

Corresponding Author: kingkar@rpsu.edu.bd

## Abstract

*Influenza virus causes viral pneumonia, an important cause of morbidity and mortality of human lives. The greatest stride of the 21st century; three outbreaks of coronavirus-associated pneumonia, namely Severe Acute Respiratory Syndrome, Middle-East Respiratory Syndrome, and the ongoing Coronavirus Infectious Disease-2019 (COVID-19) were reported. After the reporting, with the viral genome data of SARS-CoV-2 been made available bioinformatics platforms have become a critical tool to gain the fight against the disease pandemic. For creating the potential drug design, COVID-19 finds the common genes among the viral diseases by using bioinformatics. The principal study of this research is to find the relationship between genetic variant for three diseases and to design Protein-Protein Interaction network, Protein-Drug Interaction, Co-expression and Physical Interaction. A computational investigation was implemented to understand the PPI network and PDI network for Influenza, Pneumonia and Coronavirus. Related genes were collected from the NCBI gene database for each disease. A data mining technique was utilized to discover the common genes between the three diseases. Based upon computational model, a total of 20 common genes are found. The investigation shows that about 80% of the collected gene from different gene database is responsible for viral diseases. After preprocessing, filtering by using R-toolkit the number of collected gene for three diseases (Disease1= Influenza, Disease2= Pneumonia and Disease3= Coronavirus) is reduced to 17%. Gene mining is done by intersection that reduces the common associated gene from 17% to 3%. This research was therefore helpful in the identification and study of drug target for the coronavirus.*

**Keywords:** SARS-CoV-2, COVID-19, Pneumonia, NCBI, PPI network, PDI network

## 1. Introduction

The Computational Biology and Gene Regulation group of bioinformatics to vaccine research and drug discovery has been so essential in the fight against infectious diseases. The greatest combat of the 21st century against a debilitating disease agent SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2) virus discovered in Wuhan, China, December 2019, has piqued an unprecedented usage of bioinformatics tools in deciphering

the molecular characterizations of infectious pathogens (Chukwudozie & Duru, 2021). COVID-19 and influenza (flu) are both infectious respiratory diseases, and they share some similar symptoms. However, they are caused by different viruses, and there are some differences in who is most vulnerable to severe disease. Identifying disease genes from a vast amount of genetic data is one of the most challenging tasks in the post-genomic era (Asif & Martiniano, 2018). To control the ongoing COVID-19 pandemic, it is utmost importance to get insight into the evolution and pathogenesis of the virus (Hufsky & Lamkiewicz, 2021). This utilizes disease genes to build functional semantic similarity among genes. Identifying COVID-19 disease genes from Pneumonia disease genes appropriately, in turn means identifying COVID-19 from Pneumonia (Habib & Rahman, 2021). This research is being focused on gene expression regulation and the mechanisms by which it can be disrupted in human diseases. Various Prior research have been held on bioinformatics that includes analyzing genes, finding PPI, PDI network and common pathway for associated diseases (Aker & Pinky, 2018). Influenza, Pneumonia and Coronavirus are viral disease caused that can be lethal for humans. Viral diseases are extremely widespread infections caused by viruses, a type of microorganism (Policard & Jain, 2021). These three diseases may have direct and indirect connection with each other through inter-related associated gene. For finding the common genes and creating a potential drug design are strongly in focus disease genes among the viral diseases by using bioinformatics.

The main contributions of this paper are:

- a. For finding the common genes from viral disease named Influenza, Pneumonia and Coronavirus.
- b. A relative study to diagnosis of disease genes from the viral genes that combat against a debilitating disease agent SARS-CoV-2 virus.
- c. To create a protein-protein interaction network for genetic interaction of coronavirus-associated pneumonia.
- d. To design a protein drug interaction network for drug design and vaccine for novel corona virus.

In this research, we use a bio-informatics method for investigating to find the common genes that are associated with influenza, pneumonia and coronavirus. In the current study, the goal of our research is to find out the common genes and create an interconnection of Protein Protein Interaction (PPI) and Protein Drug Interaction (PDI) networks among the viral diseases for drug design.

## 2. Background

Bioinformatics contains biology in terms of molecules and then understanding biological information and applying related information technology: genes, genomes, proteins, cells, ecosystems, medical information and so on. In previous, bioinformatics to vaccine research and drug discovery has never been so essential in the fight against infectious diseases. The concern of Bioinformatics Applications in the Discovery of Vaccine

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Candidates and Potential Drugs for COVID-19 Treatment revealed (Chukwudozie & Duru, 2021). The performance of genomics and bioinformatics analysis on this family of viruses described (Woo & Huang, 2010). Bioinformatics performs a major role in data preparation, data sequencing, large dataset maintenance, data storage, data shift, DNA shortening, PPI networking, and treatment schedule. The gene analysis, modern bioinformatics tools have a tremendous contribution, i.e., PPI Network creation and Drug design (TchankouoNguetcheu & Khun, 2010).

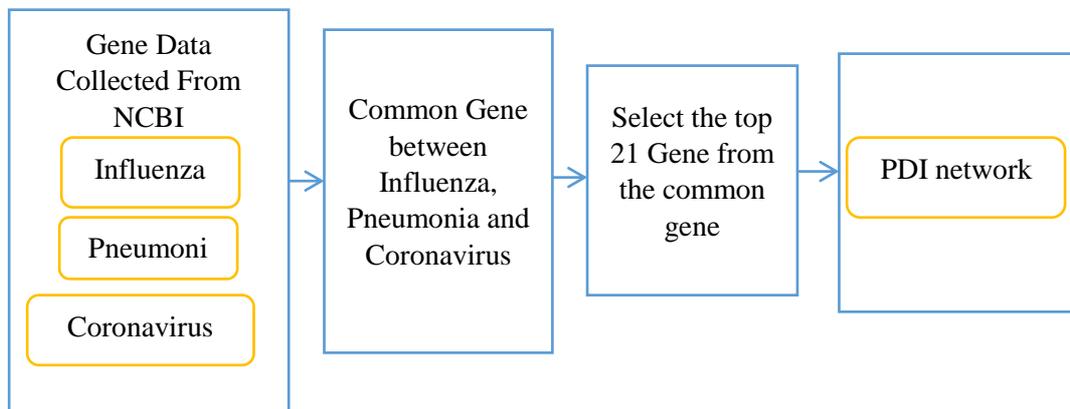
Coronavirus disease (COVID-19) is an infectious disease caused by a newly discovered coronavirus (Hufsky & Lamkiewicz, 2021). Most people infected with the COVID-19 virus will experience mild to moderate respiratory illness and recover without requiring special treatment. In December 2019, a cluster of pneumonia cases resembling viral pneumonia was detected in Wuhan, China, and led to a rapid outbreak. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is a novel coronavirus that was determined to be the causative agent (Chukwudozie & Duru, 2021). The global spread of infection led the World Health Organization to declare a pandemic on March 11, 2020. SARS-CoV-2 and the resulting disease, COVID-19, has caused a worldwide health crisis. COVID-19 is highly transmissible, and increasing mortality rates create an urgent need for vaccines and treatments (Policard & Jain, 2021).

Protein-protein interaction (PPI) networks are viable tools to understand cell functions, disease machinery, and drug design/repositioning (Vella, Marini, & Vitali, 2018). The PPI Network's orientation and visualization helps us to understand more about the genetic relations between the organisms through moderated functions and protein structures (Athanasios & Charalampos, 2017). The vital regulatory genes with network pathway were proposed for (PPIs) network. J. De Las Rivas et al. proposed Protein-protein interactions (PPIs) which were the highly specific physical interactions between two or more protein molecules, generated by biological processes (Rivas & Fontanillo, 2010). The study of protein-drug interaction was of pivotal importance to understand the structural features essential for ligand affinity (Singh, 2019). W. DeAzevedo Jr. et al. developed structure-based virtual screening approaches and described the explosion of information about protein structures (Jr., Caceres, & Pauli, 2009).

The design of protein-protein interaction network and protein-drug interaction network is the process of PPI and PDI for common diseases (Hasan & Paul, 2020). The understanding of protein-drug interactions using ion mobility-mass spectrometry was proposed by (Eyers & Vonderach, 2018). D. Frishman et al. developed the Modern genome annotation system (Frishman & Valencia, 2009). In paper (Kurgan & Wang, 2020) identified the similarity similarity-based prediction of drug-protein interactions. The Article revealed that yet now no clinically approved antiviral drug or vaccine available to be used against COVID-19 (Shereenb & Khana, 2020). However, few broad-spectrum antiviral drugs have been evaluated against corona virus in clinical trials, resulted in clinical recovery.

### 3. Proposed Methodology

A variety of bio-informatics tools are being used to find common genes. Then PPI network and PDI network will be generated with those common genes that show a random network. In this regard, the steps are intended to take is shown in the following block diagram.



**Fig. 1:** Block diagram of proposed methodology

#### 3.1 Collection of gene

Bioinformatics tools and services have very few well-established databases. The NCBI (National Center for Biotechnology Information) includes a series of databases relevant to biotechnology and is an essential resource for bioinformatics tool. NCBI is the most common online downloadable gene database. Major databases include Gene Bank and PubMed are used for DNA sequences and biomedical literature. To select the gene from gene database that includes in NCBI and search the list of the genes according to diseases name. The genes are downloaded by their Name in the increasing order of FASTA format.

#### 3.2 Preprocessing and filtering

The collected gene is required to modify that is called preprocessing. At this stage, there were filtered genes that were responsible only for Homo sapiens from the total collected genes for each disease. Only genes that are responsible for human disease are retained for further processing. The genes are sorted by according to their Name. After preprocessing the sorted genes are filtered and stored in CSV file.

#### 3.3 Gene mining

The data mining method is primarily used to generate appropriate data. Gene mining becomes another important part of this research. The responsible gene for human has been mined and kept in several columns. A large number of genes can cause problems. Selected gene files that are excavated are linked to find interrelated genes in the disease. The associated mined genes are kept in sorted order in three column of a list.

### 3.4 Linkage of gene

In this step, the interrelated genes among diseases are recognized. To find the linkage among diseases, the names of the diseases enter in the query. The correlation between each pair of selected diseases ((Disease\_1, Disease\_2), (Disease\_2, Disease\_3) and (Disease\_3, Disease\_1)) will be identified which will help to find the associated genes.

```
<- Reduce(intersect, list(disease _1,disease_2))  
<- Reduce(intersect, list(disease _2, disease_3))  
<- Reduce(intersect, list(disease _3, disease_1))
```

**Fig. 2:** Reduction procedure using R

### 3.5 Finding the common genes

To find the link in the gene, we have already created the link between (Disease\_1, Disease\_2), (Disease\_2, Disease\_3) and (Disease\_3, Disease\_1). The final link is to intersect the pair of [(Disease\_1, Disease\_2), (Disease\_2, Disease\_3), (Disease\_3, Disease\_1)] to get the general related gene. Common genes: reduction (intersection, list ((Disease\_1, Disease\_2)), (Disease\_2, Disease\_3), (Disease\_3, Disease\_1)).

### 3.6 Protein-Protein Interaction

PPI or Protein-Protein Interaction is a biological network referring to intentional physical contact established between two or more proteins as a result of biochemical events. PPI networks are valuable tools for understanding cell processes, machinery for diseases, and drug design/repositioning. Moreover, because of the complexities of the network, interpreting a PPI is a particularly difficult task. Cytoscape is a very well-known and faithful bioinformatics research tool used to develop PPI networks (Hasan & Paul, 2020).

### 3.7 Protein Drug Interaction

PDI or Protein-Drug Interaction is a biological network referring to binding of drugs with proteins in the blood stream is an important process in determining the eventual activity. To understand the fundamental characteristics of ligand relation, research into the interaction of protein-drugs is of authentic importance. There is a way to resolve this gap by using computational methods to predict protein targets for a given drug molecules (Xia, Gill, & Hancock, 2015). Protein drug interaction is produced for all interrelated, responsible, prevalent genes of the targeted diseases.

## 4. Result and Discussion

### 4.1 Collecting the genes

We have collected corresponding genes from the gene database. The collected primary numbers of genes without preprocessing & filtering are calculated as, 2385 for Influenza, 503 for Pneumonia and 1119 for Coronavirus. The number of liability genes collected from the NCBI database for selected diseases.

**Table 1. Gene selected for each diseases**

Disease Name	Total no. of Genes
Influenza	2385
Pneumonia	503
Coronavirus	1119

#### 4.2 Preprocessing, filtering the genes

After completing preprocessing and filtering the responsible genes for Homo sapiens are 433 for Influenza, 215 for Pneumonia and 196 for Coronavirus. The selected number of resultant genes is kept in Table 2.

**Table 2. Gene selected for Homo sapiens**

Disease Name	Total no. of Homo Sapiens Gene
Influenza	433
Pneumonia	215
Coronavirus	196

The number of total genes is listed and all of the genes are sorted in ascending order.

#### Influenza

'ABL1','ACE2','ACTN4','ADAR','AGFG1','AICDA','AIFM1','AIM2','AIMP2','ANP32A','ANP32B','ANXA1','ANXA2','ANXA6','APCS','APOBEC3G','APP','ARCN1','ARHGAP21','ATP1B1','ATXN10','B4GALNT2','BAD','BAX','BCL2L2','BST2','BTLA','CACNA1C','CALCA','CALCOCO2','CAMP','CASP1','CASP3','CCL11','CCL2','CCL3','CCL5','CCND3','CCNT1','CCR5','CD163','CD207','CD209','CD244','CD4','CD55','CD81','CD8A','CDC25B','CDC42','CDK9','CFTR','CHD1','CHD3','CHD6','CHRM2','CLEC4M','CLEC5A','CLU','CLUH','CNOT4','COQ10A','COX6C','CPSF4','CPT2','CRK','CRKL','CRP','CSF2','CTHRC1','CTSW','CTTN','CXCL10','CXCL8','CXCR5','DCAF1','DDX21','DDX39B','DDX58','DEFA1','DEFB103B','DHX30','DHX58','DHX9','DICER1','DLG1','DMBT1','DNAJA1','DNAJB1','DNAJC15','DNMT1','DPF2','DR1','EBI3','EEF1D','EGFR','EIF2AK2','EIF2AK3','EIF4B','EIF4E','ELAVL1','ENO1','ERAP2','ERI1','ERN1','ERVW1','ESR1','F2','F2RL1','FCGR2A','FCN3','FGFR1','FHL2','FKBP5','FMR1','FN1','FPR2','FYB1','GALNT3','GAS8','GBP5','GINS4','GLDC','GNB2','GRIN1','HARS1','HAVCR2','HAX1','HCRTR2','HDAC6','HDAC8','HIF1A','HLA-A','HLA-B','HLAC','HLADMB',

'HLADPB1','HLADQB1','HLADRB1','HMGB1','HNRNPA2B1','HNRNPK','HPRT1','HSP90AA1','HSPA4','HSPA8','ICAM1','IDO1','IFI27','IFIH1','IFIT2','FITM1','FITM2','FITM3','IFNA1','IFNA2','IFNAR1','IFNB1',

'IFNG','IFNL1','IFNL3','IK','IKBKB','IKBKE','IKBKG','IL10','IL10RB','IL12A','IL15','IL17A','IL18','IL1B','IL2','IL21','IL22RA1','IL24','IL27','IL2RA','IL32','IL37','IL6','ILF3','IPO5','IRF1','IRF3','IRF7','ISG15','ISG20',

'ITCH','ITGA5','ITGB6','ITK','IVNS1ABP','JAK1','JUN','KAT2A','KAT2B','KAT5','KIF13A','KIR2DL1','KIR2DL5A','KIR2DL5B','KIR2DS5','KIR3DS1','KLK1','KLK12','KLK5','KLRD1','KLRG1','KPNA1','KPNA4','KPNA6','LAMP3','LGALS1','LGALS8','LGALS9','LILRB1','LLGL2','LOC100422637','LOC100422638',

'LOC100422639','LOC117134604','LSM14A','MAGI1','MAP1LC3A','MAP3K14','MAP3K5','MAPK14',

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'MAPK8','MAVS','MBL2','MCOLN2','MIF','MIR1249','MIR125A','MIR132','MIR136','MIR141','MIR146A','MIR17','MIR188','MIR193B','MIR203A','MIR21','MIR22','MIR221','MIR29A','MIR29C','MIR302A','MIR30E','MIR326','MIR33A','MIR4276','MIR4776-1','MIR4776-2','MIR485','MIR584','MIR91','MIR939','MIRLET7C',

'MLKL','MMP13','MMP2','MMP9','MOAP1','MORC3','MOV10','MRC1','MUC1','MX1','MX2','MXD1','MYL1','NCBP1','NCL','NCR1','NDRG1','NEU1','NEWENTRY','NFE2L2','NFKB1','NFKBIB','NLRC5','NLRP3','NOLC1','NOS2','NOS3','NOX4','NR3C1','NUMA1','NXF1','OSM','OTUB1','P2RY11','PABPC1','PAK1',

'PARP1','PARP10','PDCD1','PDIA3','PDPN','PECAM1','PEPD','PFN2','PIK3C2B','PIK3CA','PIK3CG','PIK3R1','PIK3R2','PKM','PKP2','PLD2','PLG','PML','POU1F1','PPAN','PPANP2RY11','PPARGC1B','PIIA','PPP6C',

'PRKCD','PRKD3','PRPF18','PRPF19','PRPF8','PRSS1','PRSS3','PSMB8AS1','PTEN','PTGES3','PTGS2','PTK2','PTPN22','PTX3','RAB11A','RBM14','RBP4','RELA','RNASEL','RNF128','RNF43','RPL28','RPL6','RPS6KA3',

'RRP1B','RSAD2','RTF2','RTRAF','RUNX1','RUVBL2','S1PR1','SCRIB','SERPINE1','SETD7','SFPQ','SFTPA1','SFTPA2','SFTPBP','SFTPD','SGK1','SGPL1','SIVA1','SLBP','SMU1','SNORD105','SOCS1','SOCS3','SOCS5',

'SOD1','SPHK1','SPINT2','SPP1','ST14','ST3GAL1','ST3GAL4','STAT1','STAT2','STAU1','SUMO1','SYNCRIP','TGFB1','TLR10','TLR2','TLR3','TLR4','TLR7','TMPRSS11A','TMPRSS11D','TMPRSS11E','TMPRSS13',

'TMPRSS2','TMPRSS4','TNF','TNFAIP3','TNFRSF6B','TNFSF10','TNFSF13','TNFSF13B','TNFSF4','TNFSF9','TOMM40','TP53','TRA','TRA2B','TRAF1','TRAPPC6A','TRB','TRIM22','TRIM28','TRIM41','TRIM56','TSG101','TSLP','TUFM','TXN','U2AF2','UBD','UBE2I','VEGFA','VIM','VPS28','VPS4A','VPS4B','WARS1','XBP1',

'XDH','XPO1','YBX3','ZBTB25','ZC3H12A','ZFP36','ZFP36L1','ZNF365'

**Fig. 3:** Sorted and filtered genes of Influenza

**Pneumonia**

'ABCG1','ACE','ADM','AGER','AGTR1','AKR1B10','ALB','AMPD1','AQP5','ARMS2','ATM','ATP8B1','AVP','AXL','BDNF','BPI','BTLA','C3','CADM1','CALCA','CAMP','CASP6','CCL16','CCL17','CCL19','CCL2','CCL21','CCL3','CCL5','CCND1','CCR7','CCRL2','CD14','CD274','CD276','CD40LG','CD5L','CD86','CFLAR','CFTR','CHI3L1','CLEC4E','CLEC7A','CMA1','COL1A1','COL3A1','CR1','CRP','CST3','CTSBB','CXCL1','CXCL10','CXCL11','CXCL12','CXCL8','CXCR1','CXCR2','CXCR3','CXCR4','CXCR5','CXCR6','CYBB','CYP19A1','CYP11A1','CYP21A2','CYSLTR2','DEFB103B','DEFB4A','EGFR','ELANE','ESM1','FABP2','FAS','FCGR1A','FCGR2A','FCGR3A','FCN1','FCN2','FER','FGF21','GAS5','GSTM1','GZMA','HAVCR1','HAVCR2','HBM','HDAC9','HMGB1','HMOX1','HPR','ICAM1','IFNG','IGF2','IL10','IL13','IL13RA1','IL13RA2','IL16','IL17A','IL18','IL1B','IL1RN','IL22','IL23A','IL2RA','IL36G','IL37','IL4','IL4R','IL5','IL6','IRAK1','IRAK3','IRF5','ITGAM','KRT10','LCN2','LGALS9','LTA','MALAT1','MARCO','MASP2','MBL2','MIF','MIR1236','MIR146A','MIR146B','MIR155','MIR16-1','MIR16-2','MIR20A','MIR223','MIR370','MIR3941','MIR455','MMP1','MMP12','MMP2','MMP3','MMP7','MMP9','MRC1','MUC1','MUC5B','MYD88','MYLK','NAMPT','NEWENTRY','NLRP3','NOS3','NPPA','NPPB','NR2F2','NTF3','OLR1','PADI4','PDCD1','PDCD4','PLAT','PLAUR','POSTN','PPARG','PRF1','PRKCA','PSMB8','PTAFR','PTGS2','S100A12','S100A9','SCGB1A1','SDC1','SELE','SELPLG','SERPINA1','SERPINA4','SERPINE1','SFTPA1','SFTPA2','SFTPBP','SFTPC','SFTPD','SLPI','SNCA','SNHG16','SOCS3','SOD3','SPP1','STAT3','STX2','TAC1','TFPI','TGFB1','TGFB1','THBD','TIMP1','TIMP3','TLR2','TLR3','TLR4','TLR5','TLR6','TLR9','TNC','TNF','TNFRSF1A','TNFRSF8','TNFSF13B','TNFSF14','TNNT2','TREM1','TRPV4','TXN','VDR','VEGFA','WFDC2'

**Fig. 4:** Sorted and filtered genes of Pneumonia

**Coronavirus**

```
'AAK1','ABO','ACE','ACE2','ADA','ADAM17','AGT','AGTR2','AHR','ALB','ALPP','ANPEP','APOBEC3G','
ATP1A1','BCL2L1','BDKRB1','BECN1','BST2','CANX','CARD9','CASP3','CCL2','CCL3','CD14','CD19','CD
209','CD4','CD8A','CEACAM1','CEACAM5','CLEC4G','CLEC4M','CRP','CSF2','CSF3','CST3','CTSB','CTSL
','CTSS','CXCL1','CXCL10','CXCL2','CXCL3','CXCL5','CXCL6','CXCL8','CXCL9','DDX1','DDX58','DPP4','
EGFR','EGR1','ENPEP','EZR','F2','F3','FCGR3A','FGB','FGF2','FNDC5','FURIN','FUT3','GC','GOT1','GPT','
HCVS',
'HLA-A','HLA-C','HSP90AA1','HSP90AB1','HSPA5','IFIH1','IFITM3','IFNA1','IFNA2','IFNAR1','IFNAR2',
'IFNB1','IFNG','IFTAP','IL10','IL17A','IL18','IL1A','IL1B','IL1RN','IL2','IL2RA','IL4','IL6','IL6R','IL6ST','IL7',
',
'IRF3','IRF9','JAK1','JAK2','KLK13','KNG1','LOC111099027','LOC111413032','LOC112637023','LOC11263
7025','LOC112639999','LOC112679198','LOC112679202','LOC116186942','LOC117134593','LOC11713460
4',
'LOC117134605','LOC117134606','LOC117134607','LOC117134608','LOC117134611','LOC117135104','LO
C117135105','LOC117135106','LOC117152610','LOC117152611','LOC117204000','LOC117204001','LOC11
7282006','LOC117307477','LOC117307478','LOC117600004','LOC117693187','LOC118966792','LOC11908
6083','LOC119230225','LOC119266102','MAPK8','MASP2','MAVS','MB','MBL2','MTHFR','MTOR','MX1','
NCAM1','NEFL','NFKB1','NLRP3','NMI','NPHP4','NPIP3','NPPB','NRP1','PHB','PHB2','PI4KB','PKLR','PL
A2G4A','PLG','POLD1','PPIA','PPIB','PPIF','PSMC6','PSMD1','PTBP1','PTGDR','APGEF3','REN','RSAD2','S
ERPINC1','SERPINE1','SFTPD','SIGLEC1','SKP2','SLC6A19','SMAD3','SMAD7','STAT1','STAT2','STAT3',
'STAT6','TGFB1','TICAM1','TLR4','TLR7','TMPRSS11A','TMPRSS11D','TMPRSS2','TNF','TNNC1','TNNS13',
'TRAF3','TRIM25','TRIM56','TYK2','UBB','UBE2I','USP13','VCP','VEGFA','ZC3HAV1'
```

**Fig. 5:** Sorted and filtered genes of Coronavirus**4.3 Linkage of gene**

In this form, we have professed the correlative genes among diseases. The coherent genes between each pair of selected diseases (Influenza-Pneumonia, Pneumonia-Coronavirus and Influenza-Coronavirus) are defined. To trace the linkage among diseases enter name in the query as follow in below Figure.

```
> AR <- Reduce(intersect, list(Influenza, Pneumonia))
> AR
[1] "BTLA" "CALCA" "CAMP" "CCL2" "CCL3" "CCL5" "CFTR" [8] "CRP" "CXCL10" "CXCL8"
"CXCR5" "DEFB103B" "EGFR" "FCGR2A" [15] "HAVCR2" "HMGB1" "ICAM1" "IFNG" "IL10" "IL17A"
"IL18" [22] "IL1B" "IL2RA" "IL37" "IL6" "LGALS9" "MBL2" "MIF" [29] "MIR146A" "MMP2" "MMP9"
"MRC1" "MUC1" "NEWENTRY" "NLRP3" [36] "NOS3" "PDCD1" "PTGS2" "SERPINE1" "SFTPA1"
"SFTPA2" "SFTPB" [43] "SFTPD" "SOCS3" "SPP1" "TGFB1" "TLR2" "TLR3" "TLR4" [50] "TNF"
"TNFSF13B" "TXN" "VEGFA"

> BR <- Reduce(intersect, list(Pneumonia, Coronavirus))
> BR
[1] "ACE" "ALB" "CCL2" "CCL3" "CD14" "CRP" "CST3" [8] "CTSB" "CXCL1" "CXCL10" "CXCL8"
"EGFR" "FCGR3A" "IFNG" [15] "IL10" "IL17A" "IL18" "IL1B" "IL1RN" "IL2RA" "IL4" [22] "IL6"
"MASP2" "MBL2" "NLRP3" "NPPB" "SERPINE1" "SFTPD" [29] "STAT3" "TGFB1" "TLR4" "TNF"
"VEGFA"

> CR <- Reduce(intersect, list(Influenza, Coronavirus))
> CR
[1] "ACE2" "APOBEC3G" "BST2" "CASP3" "CCL2" [6] "CCL3" "CD209" "CD4" "CD8A" "CLEC4M"
```

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```
[11] "CRP" "CSF2" "CXCL10" "CXCL8" "DDX58" [16] "EGFR" "F2" "HLA-A" "HLA-C" "HSP90AA1"
[21] "IFIH1" "IFITM3" "IFNA1" "IFNA2" "IFNAR1" [26] "IFNB1" "IFNG" "IL10" "IL17A" "IL18" [31]
"IL1B" "IL2" "IL2RA" "IL6" "IRF3" [36] "JAK1" "LOC117134604" "MAPK8" "MAVS" "MBL2" [41]
"MX1" "NFKB1" "NLRP3" "PLG" "PPIA" [46] "RSAD2" "SERPINE1" "SFTPD" "STAT1" "STAT2" [51]
"TGFB1" "TLR4" "TLR7" "TMPRSS11A" "TMPRSS11D" [56] "TMPRSS2" "TNF" "TRIM56" "UBE2I"
"VEGFA"
```

**Fig. 6:** Linkage procedure using R (Code Segment)

Here AR, BR, CR are the linkage variable of common gene concretion procedure.

- AR indicates (Influenza and Pneumonia).
- BR indicates (Pneumonia and Coronavirus).
- CR indicates (Influenza and Coronavirus).

### 4.4 Common gene investigating after linkage

We have already created linkage between the pair of (Influenza and Pneumonia), (Pneumonia and Coronavirus) and (Influenza and Coronavirus) to find the linkage among the genes. The ultimate linkage is made by splitting the pair of ((Influenza and Pneumonia), (Pneumonia and Coronavirus), (Influenza and Coronavirus)) to find the common associated genes. We have traced twenty one common linked genes among the diseases are displayed in the Figure 7.

```
> common_gene<-Reduce(intersect, list(AR,BR,CR))
> common_gene
[1] "CCL2" "CCL3" "CRP" "CXCL10" "CXCL8" "EGFR" "IFNG" [8] "IL10" "IL17A" "IL18" "IL1B"
"IL2RA" "IL6" "MBL2" [15] "NLRP3" "SERPINE1" "SFTPD" "TGFB1" "TLR4" "TNF" "VEGFA"
```

**Fig. 7:** Inventing common genes using R

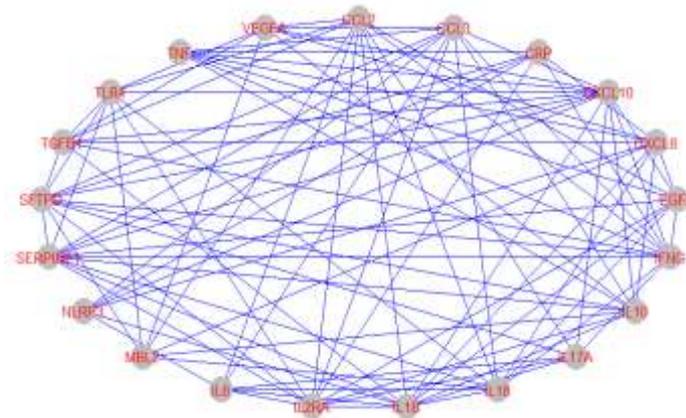
The decisive cross linkage genes are shown in Table 03.

**Table 3. Number of cross linkage gene**

Cross Linkage	No. of Gene
<b>Influenza and Pneumonia</b>	53
<b>Pneumonia and Coronavirus</b>	33
<b>Influenza and Coronavirus</b>	60
<b>Common Gene</b>	21

### 4.5 Generating Random Network Using R

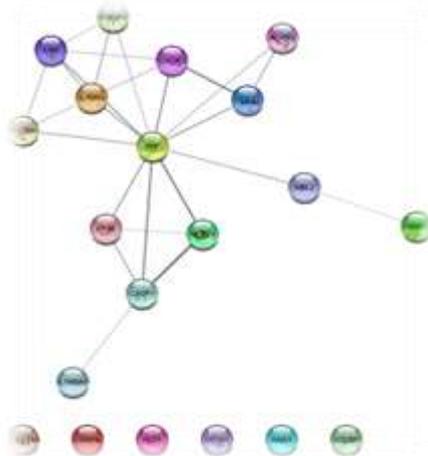
In final step, we have explored 21 common genes that create a random network using R. The random network is given in Fig. 8



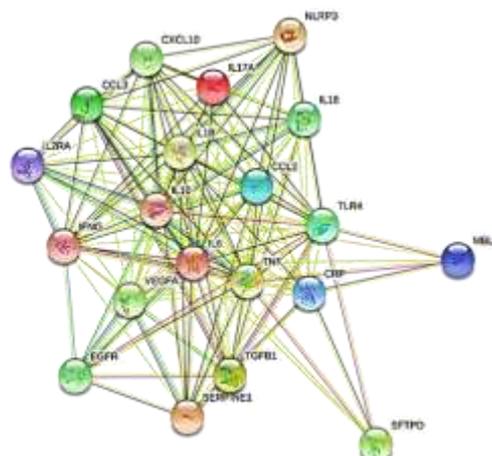
**Fig. 8:** Prepare a random network by R

#### 4.6 Finding Common Gene Regulatory Pathway or PPI Network

Cytoscape is an open source software project for integrating bimolecular interaction networks with high-throughput expression data and other molecular states into a unified conceptual framework (Habib & Ahmed, 2017). Using Cytoscape, a PPI network is created. These networks are used to represent the directly or indirectly connected gene and protein interaction (Kawsar & Taz, 2020). It is clear that only 20 genes are responsible for direct interconnection with each other in the networks for co-expression (O'Meara, Ballouz, & Shoichet, 2016). The Fig. 9 is generated in Cytoscape with 20 common genes.



**Fig. 9:** Network with 20 common genes using Cytoscape



**Fig. 10:** Network with 20 common genes using String

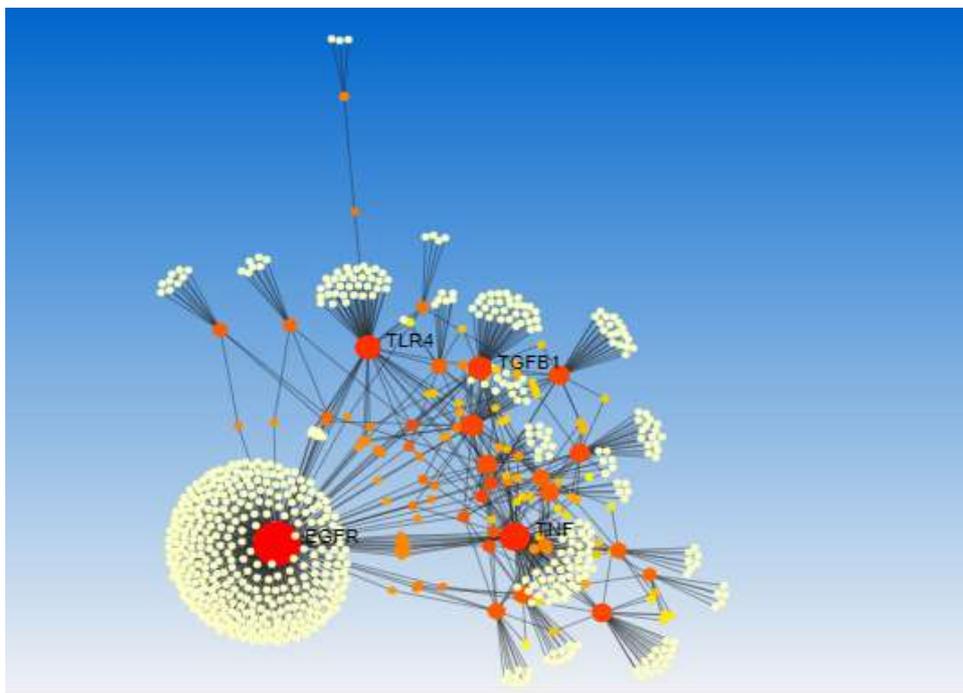
STRING (Search Tool for the Retrieval of Interacting Genes/Proteins) is a biological database that contains various information and shows predicted protein–protein

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interactions (Souiai & Guerfali, 2014). In Fig. 10 the network with 20 common genes is generated using STRING.

### 4.7 Generic PPI

Network Analyst is a comprehensive Internet tool designed to perform regular and complicated meta-examinations of gene expression data. The PPI network is the connection between genes and hub protein, which are linked directly, and others which are linked indirectly. Using the Network Analyst web-based tool, simple interaction format (SIF) files are created using the IMEx interactome database for the network diagram (Orchard & Kerrien, 2012). There are 730 nodes and 908 edges to be built in the network. Nodes are proteins, and the edges establish a relationship between proteins. Fig.11 shows the PPI network for the selected top 20 genes.



**Fig. 11:** A network of top 20 selected weighted genes for protein-protein interaction (PPI)

### 4.8 Protein Drug Interaction

Structural and mechanistic evaluation of the protein target is an important issue during drug development, ideally combined with a multi-level understanding of how ligand binding modulates conformation and biological function (O'Meara, Ballouz, & Shoichet, 2016). The complete sets of drugs that can be used for the above selected top 20 common genes for associated disease are shown in Fig. 12. The Network Analyst tool generates PDI network using the Drug Bank database that's includes 48 nodes and 53 edges.

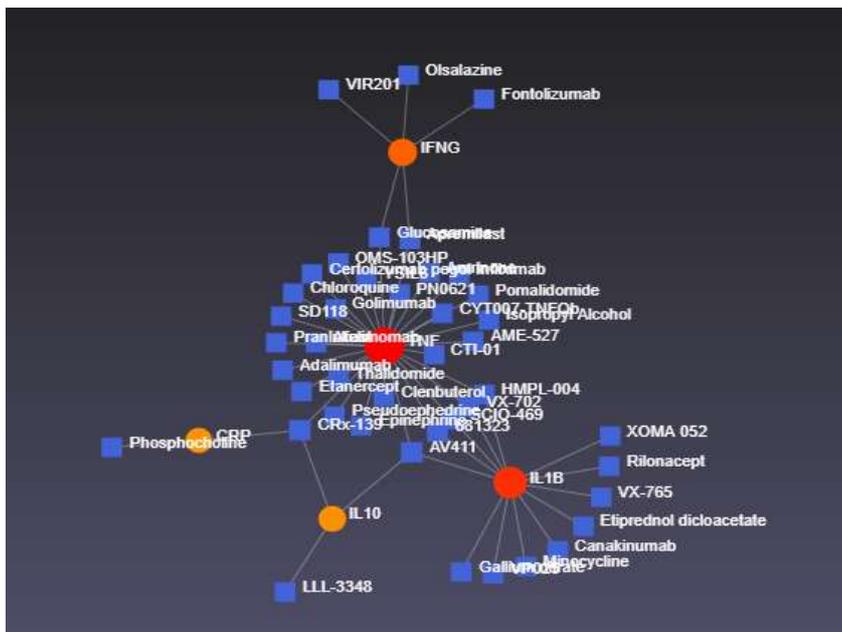


Fig. 12: Protein drug interaction design created by using Network Analyst tool

#### 4.9 Discussion

The three diseases (Influenza, Pneumonia and Coronavirus) have twenty one common genes that are directly or indirectly connected to each other. The numbers of collected gene are reduced up 80%, 17%, 3% and finally less than 1% respectively. The genes are reduced gradually after processing and the percentage of the gene reduction value are 48%, 9%, 10%, 4%, 22%, 4%, 3% and finally less than 1%.

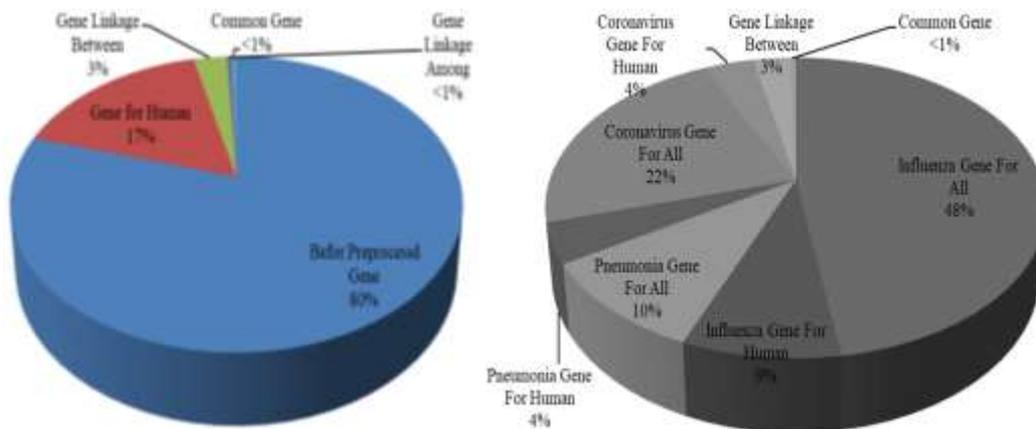


Fig. 13: Reduced collected gene after linkage and mine

## 5. Conclusion

In this study we have presented an overview of three diseases: Influenza, Pneumonia and Coronavirus for finding the common gene that have been used for network interaction and drug design. Two most important features PPI and PDI have been carefully analyzed for modeling includes selecting the correct datasets, algorithms, variables, and strategies for efficiently formatting data for data mining. By following the gene linkage method, we have successfully reduced the number of genes between the associated diseases. In the current study, a cross-discussion sub pathway was constructed by mapping inter-genes to PPI to demonstrate the connection between the selected diseases. Based on the study of the PPI network is obtained by using the biological tool Cytoscape to display the interrelated genes among the three diseases. Physical Interaction Pathways of liable genes assured a common drug design for the scheme. This research may also be helpful to understand the interrelated network, which will require further research for contributing to design common drug for associated diseases.

## Abbreviation

COVID-19	Coronavirus Infectious Disease-2019
SARS-COV-2	Severe Acute Respiratory Syndrome Coronavirus 2
NCBI	National Center for Biotechnology Information
PPI	Protein-protein interaction
PDI	Protein drug interaction
SIF	Simple interaction format
STRING	Search Tool for the Retrieval of Interacting Genes/Proteins

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# Machine Learning Approaches for Classifying Online Job Advertisements

*Naima Islam Nodi<sup>1</sup>, Kingkar Prosad Ghosh<sup>2</sup> and Zannatul Ferdousi<sup>3</sup>*

*<sup>1</sup>Lecturer, Department of Computer Science and Engineering, RPSU*

*<sup>2</sup>Associate Professor, Department of Computer Science and Engineering, RPSU*

*<sup>3</sup>Assistant Researcher, Department of Computer Science and Engineering, RPSU*

*Corresponding Author: kingkar@rpsu.edu.bd*

## Abstract

*Employment scams are on the rise and it has become one of the most important issues in recent times. Nowadays, most companies prefer to post their job advertisements on the internet so that the circular reaches easily and timely to anyone. For this reason, a machine learning-based approach has been used to identify fake and real job posts in this paper. To identify a scam in job postings, Single Classifier Based prediction, Logistic Regression, and Ensemble Classifier Based Prediction are considered initially. The results of all classifiers are compared to identify the best scam prediction model.*

**Keywords:** Fake Job, Single classifier, Ensemble classifier, Logistic Regression, Random Forest Classifier

## 1. Introduction

We are currently living under house arrest due to the Covid-19 situation. As a result, the unemployment rate is increasing day by day all over the world. So thousands of people are looking for jobs. Online scammers have chosen this as a great opportunity, and for this almost every day people are falling into their traps. For home confinement situations, most companies prefer to post their job advertisements through online, so that the candidates can find the job of their choice at home. Taking advantage of this opportunity, online scammers are creating job posts against various reputed companies so that they can gain people's trust and trap them. Now it is very difficult and complicated for us as humans to detect all these fake advertisements with the naked eye. So in this paper, we have worked with various machine learning algorithms including Multinomial Naïve Bayes, Logistic regression, Decision tree, Gradient boosting, and Random forest classifier. These methods have worked well with our dataset and can correctly classify most of the fake and real job advertisements.

## 2. Background Studies

The word "Machine Learning" was acquainted in 1959 by Arthur Samuel, a pioneer in the bounds of artificial intelligence and computer gaming (Machine Learning, 2021). Machine learning is a group study of computer algorithms and branches of artificial intelligence

that can improve automatically through experience and by using data without being programmed (Mitchell, 1997).

The most renowned works on Job Postings Classification were done in “**Machine Learning and Job Postings Classification: A Comparative Study**” (Nasser & Alzaanin, 2020). In this paper, they have investigated multiple machine learning classifiers which are,

- Multinomial Naïve Bayes
- Support Vector Machine
- Decision Tree
- K Nearest Neighbor
- Random Forest Classifier

The dataset contains fake and real job posts also. After cleaning and preprocessing data, TF-IDF has been applied for feature extraction. The main purpose of this research is to measure the activity of the proposed approaches on a text classification problem and compare it with others. The used text cleaning techniques are:

- Lowercasing
- Drop null
- Tokenization
- Remove punctuation
- Remove stopping words
- Stemming

A research entitled “**Predicting Fake Job Postings**” (Jain, 2020) have proposed,

- Full times roles, minimum requirements of a bachelor degree and a Mid-Senior level work is the key point of fake postings.
- These postings are directly connected to individuals' job sectors.
- In these fake job postings, most companies have no company profile and logo.
- In a word cloud, the job postings have some common behavioral themes and no similarity with genuine ones.

In “**Fake Job Predictor: A classifier that used text and numeric data to identify fraudulent job postings**” (Srivastava, 2021), the main concern was to create a classifier that will be capable of detecting a fake and real job post correctly. The final result of this paper was a combination of two different models (one is text data and another is numeric data). The following five stages have been followed there:

- Defining the problems
- Collecting the data
- Preprocessing and cleaning the data
- Modeling
- Evaluating

Another useful research on “**ORF Detector: Ensemble Learning Based Online Recruitment Fraud Detection**” (Lal, et al., 2019) highlights:

- Usage of three baseline classifiers such as J48, logistic regression, random forest classifier.
- Applying three ensemble techniques, Average Vote (AV), Majority Vote (MV), and Maximum Vote (MXV) to build an ORF detector.
- Extract 21 features from the target job advertisement and create a feature vector.

### **3. Related Works**

There are lots of works related to online fraud such as email spam detection, fake news detection, payment fraud detection, review spam detection, fake account detection, stolen credit card, formjacking, etc.

#### **3.1 Email spam detection**

Spam Mail or unwanted junk mail sent out in bulk for commercial purposes. Email spam is one of the common issues in recent times and it may be an unavoidable crisis. When accosting the problem of email spam detection, content-based filtering, case-based filtering, heuristic-based filtering, memory, or instance-based filtering approaches are taken into discretion (Dutta & Bandyopadhyay, 2020). Clean Email is one of the best email filtering services on the market.

#### **3.2 Fake news detection**

Currently, fake news spreading is among common online frauds. Misunderstandings are created in a society with wrong information through fake news. The basic study of fake news detection depends on three aspects (Dutta & Bandyopadhyay, 2020) on how the fake news is written, how it spread, and how users are being affected. In (Kumar, 2020), a Support Vector Machine (SVM) based classification has been proposed on the EMSCAD dataset, which is a single classifier based approach. However, in our paper we have tried to apply the Ensemble-based classifiers on the same dataset.

#### **3.3 Payment fraud detection**

It is a common type of fraud that can be handled through advanced AI. The most common type of payment fraud is lost credit cards, theft card ID, stolen credit cards, etc. The current advent of cards with a chip (EMV cards) helped to reduce card-present fraud (Kovalenko & Chuprina, 2021). Few machine learning techniques can be used in business to scan transactions before submitting payment.

#### **3.4 Review spam detection**

While purchasing products, people often post their reviews regarding the products online. Prior to buying a product, people usually keep informed by reading online reviews (Radovanović & Krstajić, 2018). To make more profit, sellers often provide wrong

information about the product. Machine learning and Natural language processing can be applied to solve these spam reviews. Lexicon-based approaches may be an alternative to machine learning techniques that have been used to eliminate spam reviews (Hussain, Mirza, Rasool, Hussain, & Kaleem, 2019).

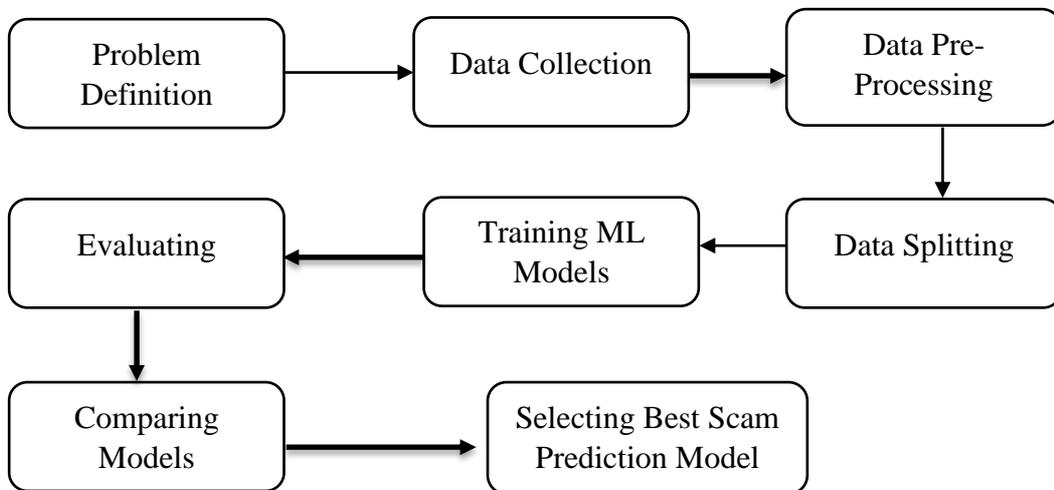
### 3.5 Fake accounts on social network

The use of social networks is on the rise. Most companies and organizations prefer to use social networks to express their views, advertise their products, and express future policies. Social networks are being harmed and damaged by creating fake accounts. To eliminate fake users and accounts from social networks, providers are working frequently.

## 4. Proposed Methodologies

The purpose of this research is to detect a fake and a real job post correctly. To do so, the dataset has been taken from Employment Scam Aegean Dataset (EMSCAD) and this dataset is further processed and uploaded on the Kaggle. The dataset has 17,880 real-life job postings where 17,014 are real and only 866 are fraud job post advertisements.

Our procedure includes data pre-processing, to process, clean and prepare the dataset; discuss and learn about the proposed machine learning approaches; and finally implement the approaches to detect the most preferable algorithm in the mentioned area. The following diagram depicts the data flow of our working stages.



**Fig. 1:** Data flow of working stages

### 4.1 Data Pre-Processing

In this paper, the proposed method is to use the dataset for testing the performance of all the supervised machine learning model. For a better understanding, multiple procedures

are used for getting a balanced dataset. Before fitting the data to any model, some pre-processing techniques have been applied to the dataset. Following are the brief steps of our data pre-processing:

- i. Checking all the missing values and replacing them with blank.
- ii. Delete the unnecessary columns (job\_id, telecommunication, has \_company \_logo, etc.).
- iii. All the important text data is combined in one column and the rest are deleted except the target column.

We have checked the total number of real and fraudulent postings. Fig. 2 highlights the structure of the dataset, where the fraudulent column suggests either the entry is real or made.

	fraudulent	text
0	0	Marketing Intern US, NY, New York We're Food52...
1	0	Customer Service - Cloud Video Production NZ, ...
2	0	Commissioning Machinery Assistant (CMA) US, IA...
3	0	Account Executive - Washington DC US, DC, Wash...
4	0	Bill Review Manager US, FL, Fort Worth SpotSou...
5	0	Accounting Clerk US, MD, Job OverviewApex i...
6	0	Head of Content (m/f) DE, BE, Berlin Founded i...
7	0	Lead Guest Service Specialist US, CA, San F...
8	0	HP BSM SME US, FL, Pensacola Solutions3 is a w...
9	0	Customer Service Associate - Part Time US, AZ...

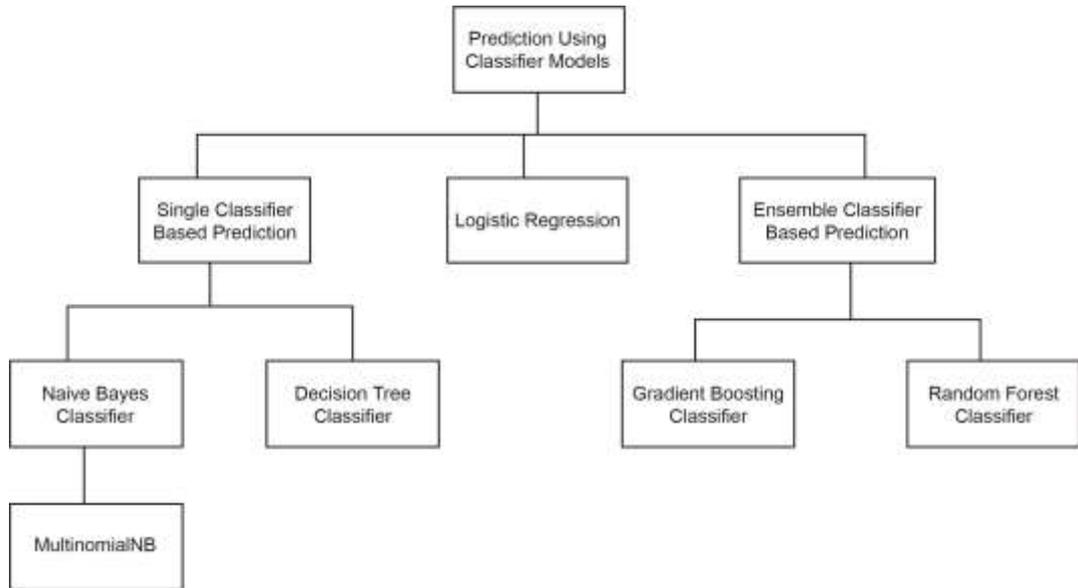
**Fig. 2:** Structure of dataset

## 4.2 Proposed Machine Learning Approaches

The main concern of the paper is to select the best employment scam prediction model. For this reason, some algorithms have been tested for making a decision on which one is efficient. Here we have used five supervised machine learning algorithm that works well with the proposal.

### i. **Multinomial Naïve Bayes (MNB)**

Multinomial Naïve Bayes algorithm is a supervised machine learning algorithm, which is based on the Bayes theorem and used for a classification problem (Naïve Bayes Classifier Algorithm, 2021). It is a straightforward and classification algorithm that is suitable for large data sizes. It is used to classify different applications such as text classification, sentiment analysis, spam filtering, etc. but it is not suitable for regression and numeric data classification.



**Fig. 3:** Supervised machine learning models used in this research

**ii. Decision Tree Classifiers (DTC)**

A decision tree is a non-parametric supervised machine learning algorithm. It is used not only for classification but also for regression problems. The tree can be divided into two-part, namely decision nodes, and leaves (Decision Trees for Classification: A Machine Learning Algorithm, 2017). To make any decision using decision nodes and its outcomes are leaf nodes. Decision trees usually mimic human thinking ability while making a decision. Building a tree using the CART algorithm stands for Classification and Regression Tree Algorithm.

**iii. Logistic Regression (LR)**

Logistic Regression is the most simple and commonly used machine learning algorithm for two-class classification (Navlani, 2019). It is easy to perform on a dataset and very efficient to train and classifying unknown records. It also can be regularized to eliminate over-fitting. Logistic regression describes the relationship between independent and dependent variables. Logistic regression's output has a nice probabilistic interpretation.

**iv. Gradient Boosting Classifier (GBC)**

Gradient boosting classifier is an ensemble-based machine learning algorithm that works with many weak learning models and used when doing any gradient boosting. Gradient boosting is a technique for classification and regression which provides a prediction model in the ensemble-based form of weak prediction models, generally decision trees (Gradient boosting, 2021). Gradient boosting has three main components loss function, weak learner, and additive model. Like naïve bayes, it takes more time to train on a model.

v. **Random Forest Classifier (RFC)**

Random Forest is also a supervised machine learning technique and it is the most flexible and easy-to-use algorithm. Random forests create decision trees on randomly selected data samples, get a prediction from each tree, and select the best solution using voting (Navlani, Understanding Random Forests Classifiers in Python, 2018). For large dataset sizes, a random forest classifier is the most efficient method and achieves high accuracy. It also works well with both categorical and continuous values.

### 4.3 Implementation

Preparing the training and test data, we have trained the model for classifying fake job postings. After successful training of the classifiers, predictions have been built through it on the test data and accuracies have been gained by the evaluation metrics. It has been marked that the feature “fraudulent” of the dataset is set aside as a target class for classification purposes. Firstly, the classifiers are trained using 80% of the entire dataset and then 20% of the entire dataset is used for the prediction purpose.

While evaluating the performance skill of a model, it is required to use some metrics to validate the evaluation. For this reason, the following mentioned metrics are taken into consideration to classify the best significant problem-solving approach. Accuracy is a metric that defines the ratio of true predictions over the total number of predictions considered. The accuracy may not be a sufficient metric for evaluating the model’s performance. If a fake post is a true one, it creates a vital problem. So, it is required to think about false positive and false negative cases that balance to misclassification. For measuring this reparation, precision and recall are also necessary.

A confusion matrix or an error matrix, is a specific table layout that allows visualization of the performance of an algorithm, typically a supervised learning one. Each row of the matrix represents the instances in an actual class while each column represents the instances in a predicted class. A confusion matrix is a review of prediction results on a classification problem. The quantity of correct and incorrect predictions are summarized with calculate values and stopped by each class. Finally, the classifier that has the best performance concerning all the metrics is chosen as the best candidate model.

		Predicted class		Total
		<i>yes</i>	<i>no</i>	
Actual class	<i>yes</i>	<i>TP</i>	<i>FN</i>	<i>P</i>
	<i>no</i>	<i>FP</i>	<i>TN</i>	<i>N</i>
Total		<i>P'</i>	<i>N'</i>	<i>P + N</i>

**Fig. 4:** Confusion Matrix

Here, Predicted class represents the predicted results from the model and Actual class represents the correct outcome which can be found from the labeled data in supervised learning. True Positives (TP) refer to the positive tuples that were correctly labeled by the classifier, True Negatives (TN) are the negative tuples that were correctly labeled, False Positives (FP) are the negative tuples that were incorrectly labeled as positive, and False Negatives (FN) are the positive tuples that were mislabeled as negative by the classifier. Accuracy, Recall, Precision, and F1 score is calculated from the confusion matrix using the following equations,

$$\text{Accuracy} = \frac{TP+TN}{P+N}$$

$$\text{Precision} = \frac{TP}{TP+FP}$$

$$\text{Recall} = \frac{TP}{TP+FN}$$

$$\text{F1 Score} = \frac{2 * \text{Precision} * \text{Recall}}{\text{Precision} + \text{Recall}}$$

Precision and recall are two numbers that together are used to calculate the performance of classification or information retrieval systems. Precision can be thought of as a measure of exactness, what percentage of tuples labeled as positive are actually such; whereas recall is a measure of completeness, what percentage of positive tuples are labeled as such. The accuracy of a classifier on a given test set is the percentage of test set tuples that are correctly classified by the classifier. This is also referred to as the overall recognition rate of the classifier, that is, it reflects how well the classifier recognizes tuples of the various classes. The F1-score is a method of combining the recall and precision of the model, and it is distinct as the harmonic mean of the model's precision and recall.

## 5. Experimental Result

All the above-supervised machine learning classifiers that we have used in this research are trained and tested on the given dataset and from the confusion matrix, the accuracy, precision, recall, and f1 score were measured. The following Table 1 compares the performance of all supervised machine learning models that have been proposed in this paper. Again, Fig. 5 to Fig. 8 illustrates the relative accuracy, precision, and recall and F1 score of these algorithms respectively.

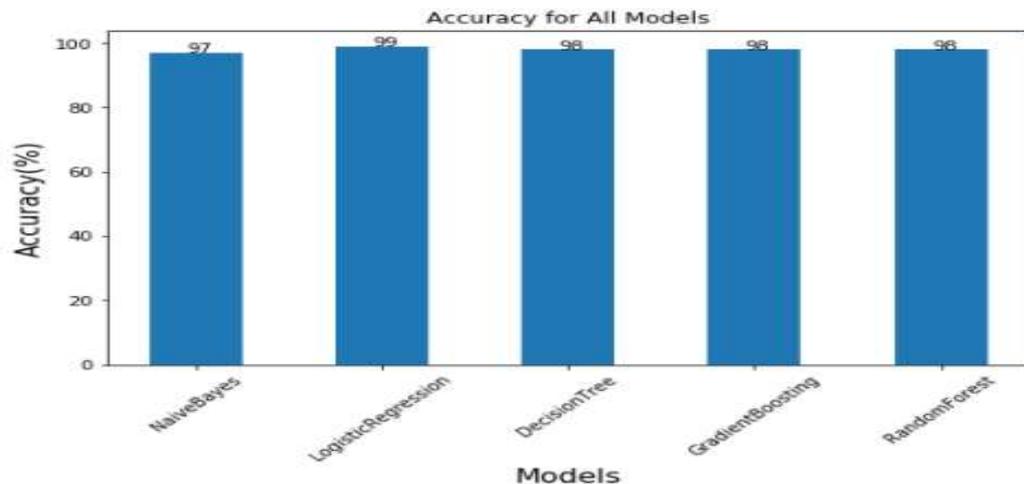
From Table 1 it seems that the accuracy of all the classifiers provides highest output as it only represents total True positives and True negatives ratio with all positive and negative labels. That is why accuracy does not always provide the best performance measurements. The precision represents the ratio of True Positives with total of True Positives and False Positives, which sometimes fails to present feasible result when the dataset is imbalanced and filled with False Positive and False Negative values. In that case recall and F1 score gives more information about the dataset as well as the query. However, for overall

performance measurement we need to consider all the criterion to get a complete understanding.

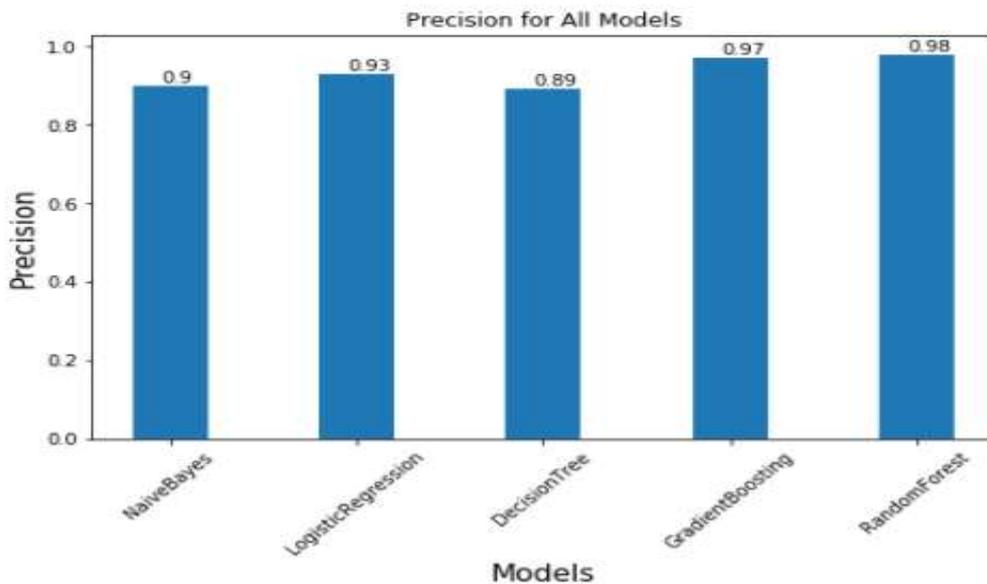
**Table 1. Performance of All Supervised Machine Learning Model**

Classifiers	Accuracy	Recall	Precision	F1 score
MNB	97%	78%	90%	83%
DTC	98%	88%	89%	88%
LR	99%	89%	93%	91%
GBC	98%	83%	97%	89%
RFC	98%	79%	98%	86%

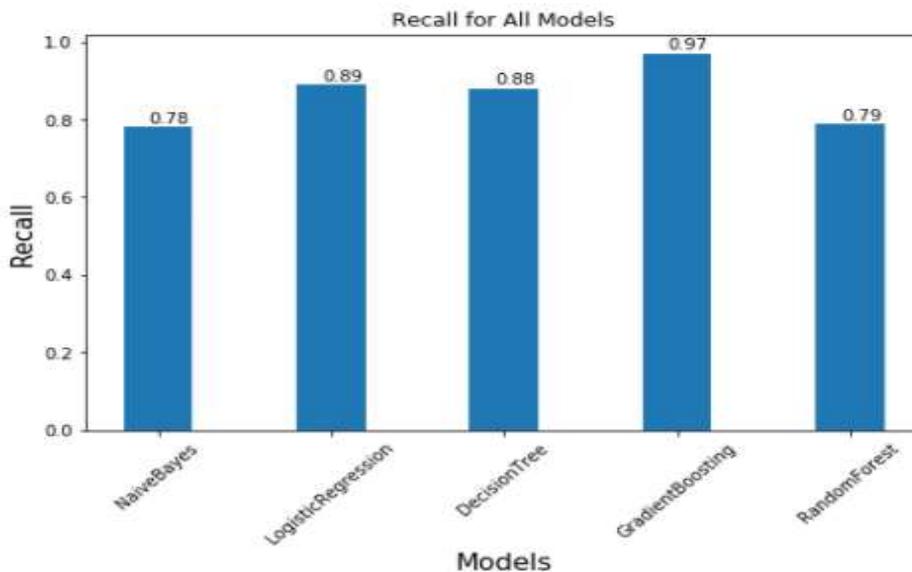
This Table clarifies that the Logistic Regression and Random Forest Classifier have worked best on the given dataset and showed the best performance among other models. Logistic Regression which is the go-to method for binary classification problems, shows preferably better performance in all the measuring category. Then again Random Forest Classifier provides notable precision that is highest among all the others. Recall of Multinomial Naïve Bayes shows lowest result, because this classifier works best in cause-effect problem classifying. Though Decision Tree Classifier provides decent outcome in all the sections, it is an unstable classifier that is less effective in predicting the outcome of a continuous variable. Finally, the Gradient Boosting Classifier is prone to over-fitting problem, thus showcasing the imbalance nature of our dataset. So, after considering all these deficiencies, advantages, and consequences it can be inferred that Logistic Regression and Random Forest Classifiers have performed comparatively better among all these mentioned supervised classifiers.



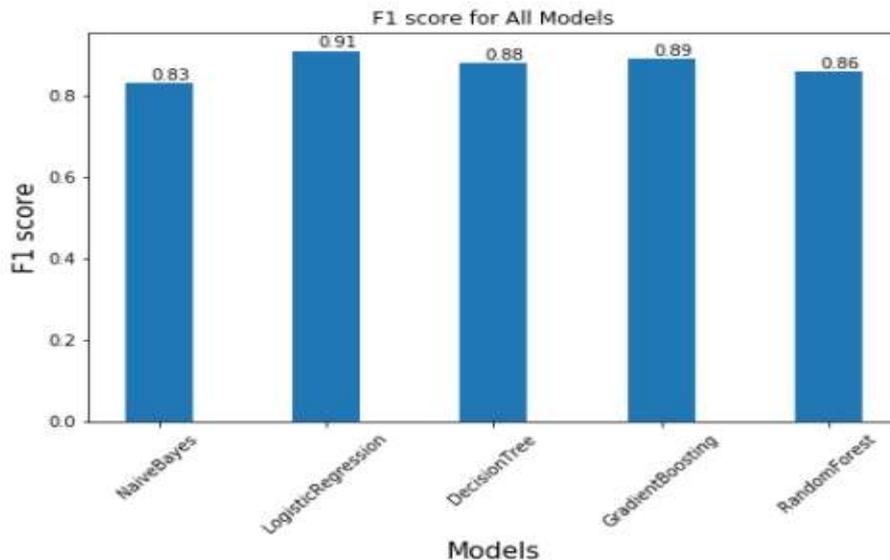
**Fig. 5:** Comparison of Accuracy for all proposed learning models



**Fig. 6:** Comparison of Precision for all proposed learning models



**Fig. 7:** Comparison of Recall for all proposed learning models



**Fig. 8:** Comparison of F1 score for all proposed learning models

Here, Naïve Bayes shows poor performance in the three charts comparing other machine learning models. The reason behind is the low performance of naïve bayes lies in the structure of this model. The dataset contains 17,880 real-life job postings which is too large and naïve bayes achieves better performance when a smaller data size is used concerning the other proposed models in this work. From Fig. 5, it seems that Decision Tree, Gradient Boosting, and Random Forest Classifier gave the almost same result in these models and their score of accuracy is 98%. But Logistic Regression has worked best among all the models and the accuracy score of this model is 99% which is the maximum value among other models.

In Fig. 6, Random Forest and Gradient Boosting classifier have given the best performance among all the models and the precision values are 0.98 and 0.97 respectively. However, Gradient Boosting gives highest recall value, as the dataset contains a significant amount of True Positive values. Comparing other models, the Decision tree classifier has given overall good performance although it had taken more time to train the model, like naïve bayes. That means the ensemble classifier prediction has worked better than the single classifier-based prediction model in the case of precision calculation. However, Logistic regression and Random forest classifier can be regarded as better job scam prediction models with compare to other mentioned algorithms.

## 6. Research Challenges

From measuring quality to analyzing the dataset statistically, plays an important role. The very first requirement in any research is an enriched and informative dataset. In this research, we have used the dataset from EMSCAD which is further processed by Kaggle.

In this dataset 93% of the real-life job postings where are only 7% of the jobs are fraud. So the dataset is very unbalanced. Due to this, it is a really difficult challenge to find which job postings advertisements are fake or not. A balanced dataset should be able to give better results.

## 7. Conclusion

In today's world, the demand for jobs is increasing. On the other hand, the number of fake job posts is increasing. This research aims to provide potential solution to this problem. In this paper, some machine learning approaches have been discussed so that job seekers can choose the right job post for them. The entire supervised machine learning model has performed well for the mentioned dataset. Comparing the result of these models and by considering all the aspects, it can be concluded that the Logistic Regression and Random Forest Classifier model have given better outcome among the entire proposed models in this research. Consequently, the Ensemble-based classifier gives better performance than Single based classifier prediction.

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## Factoring a Quadratic Trinomial Function: A Formula for the two Parameters of the AC-Test Method

*Naresh Chandra Mallick*

*Adjunct Faculty, Ranada Prasad Shaha University  
Corresponding Author: naresh.ch.mallick@gmail.com*

### Abstract

*We use the FOIL and the AC-test methods to factor a quadratic trinomial function into two factors. FOIL finds four parameters of the two factors direct while the AC-test method finds two parameters and then eventually finds the four parameters of the FOIL method. Thus both methods find the parameters by the trial and error method. This paper finds a formula in terms of the three coefficients of the quadratic trinomial function that finds the two parameters of the AC-test method with proper signs and thus helps avoid the trial and the error process to find them.*

**Keywords:** AC-test and the FOIL methods; consistency; inconsistency; quadratic trinomial function

### 1. Introduction

A quadratic trinomial function with argument  $x^r y^s$  is of the form  $\Phi(x, y) = Ax^{2r} + Bx^r y^s + Cy^{2s}$ , where  $A$ ,  $B$ ,  $C$ ,  $r$ , and  $s$  are all real numbers. If  $s = 0$ , the quadratic trinomial function reduces to  $\Psi(x) = Ax^{2r} + Bx^r + C$  and the argument is  $x^r$ . Depending on the values of  $A$ ,  $B$ , and  $C$ ,  $\Phi(x, y)$  can be factored into two factors:  $(a_1 x^r + c_1 y^s)$  and  $(a_2 x^r + c_2 y^s)$ .

The FOIL method expands the product of two binomial factors, namely  $(a_1 + c_1)$  and  $(a_2 + c_2)$  and the product is  $[a_1 a_2 + (a_1 c_2 + c_1 a_2) + c_1 c_2]$ . The method names  $a_1 a_2$  the First,  $a_1 c_2$  the Outer,  $c_1 a_2$  the Inner, and  $c_1 c_2$  the Last and justifies the name FOIL method. By the commutative law in mathematics, the positions of the terms in a binomial factor can be changed without affecting the final result and in such a case the First can be made the Last. Assuming the positions of letters stay the same, when we relate the FOIL method to the quadratic trinomial,  $a_1 a_2 = A$ , the sum of the outer and the inner terms  $(a_1 c_2 + c_1 a_2) = B$ , and  $c_1 c_2 = C$ . Factorization of a quadratic trinomial using the FOIL method is the reverse of expanding the two binomial factors. In other words, it expresses the trinomial as product of two binomial factors made it. The reverse FOIL method finds the four parameters or constants  $a_1$ ,  $a_2$ ,  $c_1$ , and  $c_2$  that meet these three constraints. The number of parameters is more than the number of constraints or equations, the system has no unique solution for the four parameters. We find the parameters by the trial and the error process. One can find more details of this reverse FOIL method by googling the phrase FOIL method. To find these parameters, we need to find the pair of factors of the coefficient  $A$  that includes the permutations of factors and with necessary permutations of

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AC-Test Method

signs. The same is true for the other coefficient  $C$ . If there is  $p$  pairs of factors of the coefficient  $A$  and  $q$  pairs of  $B$ , we may need a maximum of  $pq$  trials that ensures the successful two pairs (one for  $A$  and the other for  $B$ ). The successful two pairs offer us the desired four parameters and then we are done. For a big problem, one can imagine the enormity and the complexity of it. In addition, the FOIL method is yet to make its presence known universally. For many parts of the world, the name is not even known. On the other hand, the AC-method is known universally. Now let us make an attempt to relate the AC-test method with the reverse FOIL method. The product of the outer term  $M = a_1c_2$  and the inner term  $N = c_1a_2$  of the reverse FOIL method is equal to  $AC$ . The method does not find the four parameters, instead, it finds two parameters  $M$  and  $N$  such that their sum is equal to  $B$  and their product is equal to  $AC$  and thus the name: the AC-test method. Once it finds these two parameters, it rewrites the given trinomial as sum of four terms  $Ax^{2r} + Mx^ry^s + Nx^ry^s + Cy^{2s}$ ; it factors out the highest common factor (HCF)  $a_1x^r$  of  $Ax^{2r} + Mx^ry^s$  ( $a_1$  is the HCF of  $A$  and  $M$ ) and rewrites  $Ax^{2r} + Mx^ry^s = a_1x^r(a_2x^r + c_2y^s)$ . The sum of the second two terms  $Nx^ry^s$  and  $Cy^{2s}$  have a common factor  $c_1y^s$  where  $c_1$  is also the HCF of  $N$  and  $C$  and is equal to  $N/a_2 = C/c_2$ ; rewrites  $Nx^ry^s + Cy^{2s} = c_1y^s(a_2x^r + c_2y^s)$ . Now the sum of the four terms is equal to the sum of two composite terms  $[a_1x^r(a_2x^r + c_2y^s)] + [c_1y^s(a_2x^r + c_2y^s)]$ . Once the common factor  $(a_2x^r + c_2y^s)$  is factored out, we have the final factorization and is equal to  $(a_2x^r + c_2y^s)(a_1x^r + c_1y^s)$ . The AC-test method eventually finds the FOIL four parameters to finalize the factorization but in a different easy way. Until now, the AC-test method finds these two parameters  $M$  and  $N$  taking care of appropriate signs by the trial and the error process. Since the two parameters  $M$  and  $N$  meet two restrictions (equations) namely  $(M + N) = B$  and  $MN = AC$ , the system is consistent (exactly identified), has a unique solution and does not require the trial and the error process to find them. Using the restrictions that two parameters meet, this paper derives a formula that finds these two parameters of the AC-test method with appropriate signs attached. For the antiquity nature of both models, their origination history is hard to come by (Barnett, Kearns, 1994, Larson, Hostetter, 2001)

The website <http://www.newton.dep.anl.gov/askasci/math99/math99282.htm> (3) answers to a question “who came up with the FOIL method” is ‘may be some Greek’ or ‘Mr. Foil.’ Professors Larson, R. R. of Pennsylvania State University and Hosteltler, R. of The Behrend College, in their book, *College Algebra*, Fifth Edition, Houghton Mifflin Company, in Prerequisites Chapter, pp. 26–38 have defined the acronym of the letters of FOIL, expanded two binomial factors, offered a graphical representation, and furnished reversed factorization by the FOIL method. To factor a simple quadratic trinomial function  $f(x) = 2x^2 + x - 15$  by the reverse FOIL method, they had to try eight different possible factorization on page thirty-seven and the correct factorization was  $(2x - 5)(x + 3)$ . On page thirty-eight, the book briefly touched the AC-test method as the middle term breaking factorization—the phrase widely used in Asia.

Professors Barnett, R. and Kearns, T. in their book *Intermediate Algebra: Structure and Use*, Fifth Edition, McGraw-Hill, Inc., have detail treatments of both the reverse FOIL and the AC-test methods. They invested pages from seventy-six to ninety-one to display the reverse FOIL method to find two binomial factors in factoring a quadratic trinomial function. The book also display the AC-test method in factoring a second degree polynomial function on pages ninety-one through ninety-six. They listed all possible pair of factors of the AC-method to factor a couple of simple quadratic trinomial function. The website <http://www.purplemath.com/modules/factquad3.htm> to factor a quadratic trinomial  $(20x^2 - 17x - 63)$  ( $A = 20, B = -17, C = -63$ ) listed eighteen of possible thirty-six pair of factors of the  $AC = -1260$  and found the successful pair  $(-45, 28)$  by adjusting the signs manually and the final factorization using the AC-test method was  $(4x - 9)(5x + 7)$ . The use of the formula derived in this paper helps avoid all these complexities in finding the two parameters  $M = -45$  and  $N = 28$ .

Section 2 of this paper derives the formula for the two parameters  $M$  and  $N$  of the AC-test method in terms of  $A$ ,  $B$ , and  $C$ ; Section 3 concludes the paper. Appendix A factors one simple quadratic trinomial function illustrating the systematic process for applying both the reverse FOIL and the current trial and the error process of the AC-test methods. Appendix B illustrates the application of the formula this paper derives for different types of quadratic trinomial functions and also the Rules or Steps to use the derived formula correctly.

## 2. Formula for the two parameters of the AC-test method

To factor a quadratic trinomial function

$$\Phi(x, y) = Ax^{2r} + Bx^r y^s + Cy^{2s}, \quad (2.1)$$

having the argument  $x^r y^s$  into two factors, the AC-test method finds two parameters  $M$  and  $N$  that satisfy the following two constraints:

$$N + M = B \quad (2.2)$$

$$NM = AC. \quad (2.3)$$

This paper uses two methods to find these two parameters  $M$  and  $N$ .

### 2.1 Method that finds the two parameters separately:

Constraints (2.2) and (2.3) respectively provide us the sum and the product of the two parameters of the AC-test method. Since we know the sum and the product of them, we can also find the difference between them. Below we find the difference between  $N$  and  $M$  in terms of  $A$ ,  $B$ , and  $C$ . We assume that  $N \geq M$ , from the established theory in algebra

$$\begin{aligned} (N - M)^2 &= (M + N)^2 - 4MN = B^2 - 4AC \\ N - M &= \sqrt{(B^2 - 4AC)}. \end{aligned} \quad (2.4)$$

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The constraint (2.4) is derived from the known constraints (2.2) and (2.3). Now adding (2.2) and (2.4) and subtracting (2.4) from (2.2), the  $N$  and  $M$  respectively are

$$N = \frac{B + \sqrt{(B^2 - 4AC)}}{2} \quad (2.5)$$

$$M = \frac{B - \sqrt{(B^2 - 4AC)}}{2}. \quad (2.6)$$

**2.2 Method that finds the two parameters jointly using a quadratic equation formula:**

Let us find the two parameters without using (2.4). From constraint (2.2), we have  $N = B - M$  and substituting this in constraint (2.3) we have

$$\begin{aligned} M(B - M) &= AC \\ M^2 - BM + AC &= 0. \end{aligned} \quad (2.7)$$

For given  $A$ ,  $B$ , and  $C$  of  $\Phi(x, y)$  in (2.1), the expression (2.7) is a quadratic equation in  $M$  that has two roots. The values of these two roots are equal to  $M$  and  $N$ . Using the formula for the two roots of a standard quadratic equation, the two roots of (2.7) are equal to

$$M, N = \frac{B \mp \sqrt{(B^2 - 4AC)}}{2}. \quad (2.8)$$

The values of  $N$  and  $M$  are same as in (2.5) and (2.6) respectively. This formula (2.8) should not be confused with the formula  $[-B \mp \sqrt{(B^2 - 4AC)}]/(2A)$  for the two roots of a quadratic equation  $Ax^2 + Bx + C = 0$ .

Having find these two parameters  $M$  and  $N$ , the AC-test method replaces the middle term  $Bx^r y^s$  by  $(Mx^r y^s + Nx^r y^s)$ ; rewrites the quadratic trinomial function as the sum of four terms  $Ax^{2r} + Mx^r y^s + Nx^r y^s + Cy^{2s}$ . By the method of grouping, it factors  $(Ax^{2r} + Mx^r y^s)$  to  $a_2 x^r (a_1 x^r + c_1 y^s)$  ( $a_2$  is the highest common factor of  $A$  and  $M$ ); factors  $(Nx^r y^s + Cy^{2s})$  to  $c_2 y^s (a_1 x^r + c_1 y^s)$  ( $c_2 = N/a_1$  is the highest common factor of  $N$  and  $C$ ). These steps reduce the given quadratic trinomial function as the sum of two compound terms and is equal to  $[a_2 x^r (a_1 x^r + c_1 y^s)] + [c_2 y^s (a_1 x^r + c_1 y^s)]$ . Now, it factors out the common factor  $(a_1 x^r + c_1 y^s)$  by using the distributive law and the final factorization is  $(a_1 x^r + c_1 y^s)(a_2 x^r + c_2 y^s)$ . The FOIL method finds the parameters  $a_1$ ,  $a_2$ ,  $c_1$ , and  $c_2$  directly whereas the AC-test method finds them indirectly from the the AC-test parameters  $M$  and  $N$  from formula (2.8).

**An example:** Factor the following quadratic trinomial

$$\Phi(x, y) = 4,410x^2 + 16,653xy - 13,810,511y^2$$

Although the reverse FOIL method and the current practice of the AC-test method can solve this problem, the enormity and complexity involved are substantial and are exemplified in the Appendix A with an example. The use of formula (2.8) that this paper

derives however helps avoid all these problems. In this example,  $A = 4,410$ ,  $B = 16,653$ , and  $C = -13,810,511$ . Using the formula (2.8), we find the AC-test two parameters  $M$  and  $N$  and then factor the given expression.

$$\begin{aligned} M, N &= \frac{16653 \mp \sqrt{16653^2 + 4 \times 4410 \times 13810511}}{2} \\ &= \frac{16653 \mp 493857}{2}, M = -238,602, N = 255,255. \\ \Phi(x, y) &= 4410x^2 - 238,602xy + 255,255xy - 13,810,511y^2 \\ &= (2 \times 3^2 \times 5 \times 7^2)x^2 - (2 \times 3 \times 7 \times 13 \times 19 \times 23)xy \\ &\quad + 255,255xy - 13,810,511y^2 \\ &= 42x(105x - 5,681y) + 2,431y(105x - 5,681y) \\ &= (105x - 5,681y)(42x + 2,431y). \end{aligned}$$

In this problem, the first two absolute coefficients are 4,410 and 238,602 and are very large, to find their HCF  $a_2$ ; have their prime factors, the HCF is equal to  $a_2 = 2 \times 3 \times 7 = 42$ . Once either  $a_1 = 105$  or  $c_1 = 5,681$  is found, the HCF of the last two absolute coefficients  $N = 255,255$  and  $C = 13,810,511$  is  $c_2 = N/a_1 = 255,255/105 = 2,431$  or  $c_2 = C/c_1 = 13,810,511/5,681 = 2,431$ .

### 3. Conclusion

To factor a quadratic trinomial function into two factors, we use either the FOIL (First, Outer, Inner, and Last) or the AC-test method. The FOIL method finds four parameters directly that satisfy three different constraints. The number of parameters to be found is greater than the number of constraints; the system has infinitely many solutions. We do not have a unique solution. Hence there is no alternative to the trial and the error method to find the required parameters. Also, this method does not provide us any rule to check whether a given trinomial function is factor-able or a prime. On the other hand, the AC-test method finds two parameters and they meet two constraints. The numbers of parameters and constraints are equal, hence the system is consistent (identified) and has a unique solution for the required parameters. This simple fact was overlooked for centuries and we are still practicing the trial and the error method to find them. This paper derives a formula in terms of the three coefficients of the quadratic trinomial function that finds the two parameters of the AC-test method with proper signs. The formula offers us a tool to check to see whether a given quadratic trinomial function is factor-able or not. If this formula gets adapted, the textbook authors do not require investing pages to list the possible pair of factors of  $AC$  and it will make teaching and learning of the topic users' friendly.

### Appendix A

**Problem 1:** Factor the following quadratic trinomial by the reverse FOIL method

$$\Phi(x, y) = 12x^2 - 47xy + 45y^2.$$

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In this problem,  $r = s = 1$ , the argument is  $xy$ ,  $A = 12$ ,  $B = -47$ , and  $C = 45$ . As per the reverse FOIL method,  $A$  has three different pair of factors ( $p = 3$ ) and in vector notation, they are  $A_{1'} = (12, 1)$ ,  $A_{2'} = (6, 2)$  and  $A_{3'} = (4, 3)$ . In finding out the C's pair of factors, we need to take into consideration the signs of both B and C. In this example, C is positive and B is negative, therefore both elements of a C's pair carry a negative sign and we need to take the permutations of elements of each pair (not signs). For this example  $q = 6$ , in vector notation, they are  $C_{1'} = (-45, -1)$ ,  $C_{2'} = (-1, -45)$ ,  $C_{3'} = (-15, -3)$ ,  $C_{4'} = (-3, -15)$ ,  $C_{5'} = (-9, -5)$ , and  $C_{6'} = (-5, -9)$ . The Outer and the Inner product of  $A_{i'}$  and  $C_{j'}$  is equal to  $(a_{1i}c_{2j} + a_{2i}c_{1j})$  and for the final pairs, it will be equal to  $B$ . Note that all pairs meet the other two conditions. We need to find these two successful pairs. In order to find them, each pair of A's factors has to be tried with all pairs of C's factors and for this example, we have  $3 \times 6 = 18$  cases to try.

Now take  $A_{1'} = (12, 1)$  and try it with all pair of factors of  $C$  and the sums of Outer and the Inner products  $(12c_{2j} + c_{1j})$   $j = 1, 2, 3, \dots, 6$  are listed in table 1 below.

**Table 1. Sums of the Outer and the Inner products with  $A_{1'} = (12, 1)$**

$(c_{1j}, c_{2j})$	$12c_{2j} + c_{1j}$
(-45, -1)	-57
(-1, -45)	-541
(-15, -3)	-51
(-3, -15)	-183
(-9, -5)	-69
(-5, -9)	-113

Table 1 lists six sums of the Outer and the Inner products of the reverse FOIL method and the successful pairs of factors are not among them.

Now we try  $A_{2'} = (6, 2)$  with all six pair of factors of  $C$  and the sum of the Outer and the Inner products  $(6c_{2j} + 2c_{1j})$  are listed in table 2 in the next page.

**Table 2. Sums of Outer and Inner products with  $A_{2'} = (6, 1)$**

$(c_{1i}, c_{2i})$	$6c_{2i} + 2c_{1i}$
(-45, -1)	-96
(-1, -45)	-272
(-15, -3)	-48
(-3, -15)	-96
(-9, -5)	-48
(-5, -9)	-64

Table 2 lists six sums of the Outer and the Inner products of the reverse FOIL method and the successful pair of factors are not yet in.

Taking the last pair  $A_3 = (4, 3)$ , the sums of Outer and the Inner products ( $4c_{2j} + 3c_{1j}$ ) are listed in table 3 and the successful pair of  $C$  is shown in bold.

**Table 3. Sums of Outer and Inner products with  $A_3 = (4, 3)$**

$(c_{1j}, c_{2i})$	$4c_{2i} + 3c_{1i}$
(-45, -1)	-139
(-1, -45)	-183
(-15, -3)	-57
(-3, -15)	-69
(-9, -5)	-47
(-5, -9)	-51

Table 3 lists the last six of eighteen possible sum of the Outer and the Inner products of the reverse FOIL method and the success pairs are  $C_5 = (-9, -5)$  and  $A_3 = (4, 3)$  are in and we do not need to try the other eighteen possible factorization . Using these successful pairs, the factorization of the given problem is:

$$\Phi(x, y) = 12x^2 - 47xy + 45y^2 = (4x - 9y)(3x - 5y).$$

In probabilistic term, the probability of getting the successful pairs is  $1/36$ .

### **The trial and the error process of AC-test method for the same problem 1**

For this problem,  $AC = 12 \times 45 = 540$  and  $B = -47$ , since AC is positive and B is negative, both M and N should carry a negative sign. The AC has twelve different pairs of factors and one of them is a successful one. Let us list them in table 4 and find the successful one.

**Table 4. Pair of factors of AC and the sum of elements of each pair**

$(M, N)$	$M+N$
(-540, -1)	-541
(-270, -2)	-272
(-180, -3)	-183
(-135, -4)	-139
(-108, -5)	-113
(-90, -6)	-96
(-60, -9)	-69
(-54, -10)	-64
(-45, -12)	-57
(-36, -15)	-51
(-30, -18)	-48
<b>(-27, -20)</b>	<b>-47</b>

Using the successful pair  $(-27, -20)$ , the factorization is carried out here

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$$\begin{aligned}\Phi(x, y) &= 12x^2 - 47xy + 45y^2 = 12x^2 - 27xy - 20xy + 45y^2 \\ &= 3x(4x - 9y) - 5y(4x - 9y) = (4x - 9y)(3x - 5y).\end{aligned}$$

In probabilistic term, the probability of getting the right pair is  $1/12$ .

**Use of formula (2.8) to solve the same problem 1:**

$$\begin{aligned}\Phi(x, y) &= 12x^2 - 47xy + 45y^2 \\ M, N &= \frac{-47 \mp \sqrt{47^2 - 4 \times 12 \times 45}}{2}, M = -27, N = -20. \\ \Phi(x, y) &= 12x^2 - 27xy - 20xy + 45y^2 \\ &= 3x(4x - 9y) - 5y(4x - 9y) = (4x - 9y)(3x - 5y).\end{aligned}$$

*The systematic solutions of this problem using the reverse FOIL method and the trial and the error process of the AC-test method substantiate the complexities involved in both of them. As mentioned earlier, there is no alternative to the trial and the error process for the reverse FOIL method, however, for the AC-test method, there is an easy fix of this problem; this paper offers this solution by deriving a formula that finds the two parameters of the method.*

**Appendix B**

The application of the derived formula (2.8) is exemplified in this Appendix for different types of problems.

**Example 1.** Factor a unitary leading coefficient quadratic trinomial function

$$\begin{aligned}\Psi(x) &= x^2 - 432x + 34,775. \\ M, N &= \frac{-432 \mp \sqrt{432^2 - 4 \times 34,775}}{2}, M = -325, N = -107 \\ \Psi(x) &= x^2 - 325x - 107x + 34,775 = x(x - 325) - 107(x - 325) \\ &= (x - 325)(x - 107).\end{aligned}$$

**Example 2.** A quadratic trinomial function with negative leading coefficient. Factor

$$\begin{aligned}\Phi(x, y) &= -21x^2 + 394xy + 15,755y^2. \\ M, N &= \frac{394 \mp \sqrt{394^2 - 4 \times (-21) \times 15,755}}{2} \\ M &= -411, N = 805. \\ \Phi(x, y) &= -21x^2 + 394xy + 15,755y^2 = -21x^2 + 805xy - 411xy + 15,755y^2 \\ &= 7x(-3x + 115y) + 137y(-3x + 115y)\end{aligned}$$

$$= (-3x + 115y)(7x + 137y).$$

**Example 3.** A perfect square quadratic trinomial function. Factor

$$\Phi(u, v) = 11,025u^2 - 28,770uv + 18,769v^2$$

$$M N = \frac{-28,770 \mp \sqrt{28,770^2 - 4 \times 11,025 \times 18,769}}{2}$$

$$M = -14,385, N = -14,385$$

$$\begin{aligned} \Phi(u, v) &= 11,025u^2 - 14,385uv - 14,385uv + 18,769v^2 \\ &= (3^2 \times 5^2 \times 7^2)u^2 - (3 \times 5 \times 7 \times 137)uv - 14,345uv + 18,769v^2 \\ &= 105u(105u - 137v) - 137v(105u - 137v) = (105u - 137v)^2. \end{aligned}$$

### Rule

1. Find the argument of the given quadratic trinomial function. If the given trinomial is not in order, first rewrite it in a orderly fashion. For example, if  $\Psi(x, y) = 27xy - 63y^2 + 6x^2$ , the argument of it is  $xy$ , therefore  $27xy$  should be the middle term and you can write  $6x^2$  as the first or the last term. Your ordered quadratic function  $\Psi(x, y) = 6x^2 + 27xy - 63y^2 = -63y^2 + 27xy + 6x^2$ .

2. Now check to see where there is a common factor present, if it does, factor it out first and keep this factor as multiplier and work on the trinomial which is factor of this multiplier. For example  $\Phi(x, y) = 18x^3 + 81x^2y - 189xy^2$ , number 3 is factor of all three terms plus the letter  $x$  is also a factor of three terms. Therefore, factor out  $3x$  and rewrite the given quadratic trinomial  $\Phi(x, y) = 3x(6x^2 + 27xy - 63y^2)$  and now apply the formula on the quadratic trinomial  $6x^2 + 27xy - 63y^2$  and your result on this part is  $(3x - 7y)(2x + 9y)$  and report the factorization  $3x(3x - 7y)(2x + 9y)$  as your final result.

3. If the given trinomial contains one or more fractions, eliminate the fractions by expressing the entire trinomial as a common denominator and then apply the formula on the numerator. For example  $\Omega(x, y) = \frac{3}{2}x^2 + \frac{27}{4}xy - \frac{63}{4}y^2$ , the denominators of the fractions are 2 and 4 and their lowest common multiplier (LCM) is 4. Rewrite the trinomial as  $\Omega(x, y) = \frac{6x^2 + 27xy - 63y^2}{4}$ , apply the formula on the numerator quadratic trinomial and report the final result  $\Omega(x, y) = \frac{(3x-7)(2x+9)}{4}$ .

4. If the given quadratic function has one or more rational decimal coefficients, express them as fractions and then follow rule number 3.

5. Check to see  $(B^2 - 4AC)$  is a perfect square, if not, the given quadratic trinomial is a prime, you cannot factor it. If this is equal to zero, the given quadratic trinomial is a perfect square(both factors are the same). Your  $M$  and  $N$  are both equal to  $B/2$

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# Approximate Solution of Second Order Linear Differential Equation Constant Coefficients and Forced Motion of Differential Equation System.

*Md. Asaduzzaman*

*Assistant Professor, Department of Computer Science and Engineering, RPSU  
Corresponding Author:asaduzzaman@rpsu.edu.bd*

## Abstract

*Nonlinear oscillation systems are such phenomena that mostly occur in the field of nonlinear mechanics or science and engineering. There are several nonlinear oscillating systems in which parameters are not small. Those oscillating systems are usually ruled by the nonlinear differential equation. In this study, we developed a method of forced motion of differential equation which is applied to nonlinear differential systems in presence of external forces. By applying this method in an example, we find a solution by considering initial conditions. The figures explained the nonlinear phenomena for the critical situation.*

**Keywords:** Non-linear equations, Krylov-Bogoliubov method, Damped nonlinear system, Damped oscillatory motion and Forced motion

## 1. Introduction

Oscillations occur when a system is disturbed from a position of stable equilibrium. This displacement from equilibrium changes periodically over time. Thus, Oscillations are said to be periodic, and display periodic motion which systems are important in engineering because many practical engineering components consist of nonlinear systems that can be modeled using the oscillator systems such as elastic beams supported by two springs or mass-on-moving belt nonlinear pendulum and vibration of a milling machine. Hence solving of governing equations and due to limitation of existing exact solutions have been one of the most time-consuming and difficult affairs among researchers of nonlinear problems. The KBM [ ( Bogoliubov, N.N. and Mitropolskii, Yu. A. ,1961), (Bogoliubov, N.N. and Mitropolskii, Yu. A.,1963) and (Mitropolskii, Yu., 1964)] method is particularly convenient and is the widely used technique to obtain the approximate solutions and ( Mendelson, K. S.,1970) for damped nonlinear oscillation. (Dey, Pinakee, Zulfikar, M.A. and Shamsul Alam, M.,2007) obtained an asymptotic Method for Time Dependent Non-linear Over-damped Systems and also worked Second Approximate Solutions of Second order damped Forced Nonlinear systems which the results may be useful to researchers working in the field of nonlinear mechanics, dynamics, mathematical physics, control theory, population dynamics etc. Recently, (Karim, R, Dey, Pinakee and Asaduzzaman, M. (2020) and (Karim, R., 2020) investigated Krylov-Bogoliubv method for obtaining an approximate solution of slowly varying amplitude and phase of nonlinear differential

systems with varying coefficients and finding Approximate solutions of Damped nonlinear systems with varying parameter and damping force. In this paper, we determined approximate solution of damped oscillatory motion and forced motion of differential equation systems to tackle real world dynamical phenomena.

## 2. Methodology

Let us consider that the equations

$$\ddot{x} = F(x, \dot{x}, \varepsilon) \quad (2.1)$$

The solutions of these fully nonlinear equations are based on the recurrent relations and are given in the forms of power series of the small parameter  $\varepsilon$ . By using elliptic functions in the sense of the Krylov and Bogoliubov method, Cap [4] has investigated some the nonlinear systems of the type

$$\ddot{x} + \omega^2 f(x) = \varepsilon F(x, \dot{x}) \quad (2.2)$$

The method of Krylov- Bogoliubov- Mitropolskii (KBM) has been extended by Popov [25] to damped nonlinear systems is

$$\ddot{x} + 2k\dot{x} + \omega^2 = \varepsilon f(x, \dot{x}), \quad (2.3)$$

Again, we now consider an important special case of forced motion. That is, we not only consider the effect of damping upon the mass on the spring but also the effect upon it of a periodic external impressed force  $F$  defined by  $F(t) = E_1 \cos \omega t$  for all  $t \geq 0$ , where  $E_1$  and  $\omega$  are constants. Then the basic differential equation is

$$\mu \frac{d^2x}{dt^2} + \gamma \frac{dx}{dt} = E_1 \cos \omega t - \varphi x \quad (2.4)$$

Dividing through by  $\mu$  and letting

$$\frac{\gamma}{\mu} = 2b, \frac{\varphi}{\mu} = \lambda^2 \text{ and } \frac{E_1}{\mu} = H_1 \quad (2.5)$$

This takes the more convenient form

$$\frac{d^2x}{dt^2} + 2b \frac{dx}{dt} + \lambda^2 x = H_1 \cos \omega t \quad (2.6)$$

We shall assume that the positive damping constant  $\gamma$  is small enough so that the damping is less than critical. In other words we assume that  $b < \lambda$ . Hence by Equation the complementary function of Equation (2.5) can be written

$$x_i = ce^{-bt} \cos(\sqrt{\lambda^2 - b^2}t + \phi) \quad (2.7)$$

We shall now find a particular integral of (2.5) by the method of undetermined coefficients. We let

$$x_j = M \cos \omega t + N \sin \omega t \quad (2.8)$$

$$\frac{dx_j}{dt} = -\omega M \sin \omega t + \omega N \cos \omega t \quad (2.9)$$

$$\frac{d^2 x_j}{dt^2} = -\omega^2 M \cos \omega t - \omega^2 N \sin \omega t.$$

Substituting into Equation (2.4), we have

$$[-2 b h \omega M + (\lambda^2 - \omega^2) N] \sin \omega t + [(\lambda^2 - \omega^2) A + 2 b \omega N] \cos \omega t = H_1 \cos \omega t.$$

Thus, we have the following two equations from which to determine  $M$  and  $N$ :

$$-2 b h \omega M + (\lambda^2 - \omega^2) N = 0,$$

$$(\lambda^2 - \omega^2) M + 2 b \omega N = H_1,$$

Solving these, we obtain

$$M = \frac{H_1(\lambda^2 - \omega^2)}{(\lambda^2 - \omega^2)^2 + 4b^2\omega^2}$$

$$N = \frac{2b\omega E_1}{(\lambda^2 - \omega^2)^2 + 4b^2\omega^2}$$

Substituting these values into equation (2.6), we obtain a particular integral in the form

$$x_j = \frac{H_1}{(\lambda^2 - \omega^2)^2 + 4b^2\omega^2} [(\lambda^2 - \omega^2) \cos \omega t + 2b\omega \sin \omega t]$$

We now put this in the alternative “phase angle” form; we write

$$(\lambda^2 - \omega^2) \cos \omega t + 2b\omega \sin \omega t$$

$$= \sqrt{(\lambda^2 - \omega^2)^2 + 4b^2\omega^2} \left[ \frac{(\lambda^2 - \omega^2)}{\sqrt{(\lambda^2 - \omega^2)^2 + 4b^2\omega^2}} \cos \omega t + \frac{2b\omega}{\sqrt{(\lambda^2 - \omega^2)^2 + 4b^2\omega^2}} \sin \omega t \right]$$

$$= \sqrt{(\lambda^2 - \omega^2)^2 + 4b^2\omega^2} [\cos \omega t \cos \theta + \sin \omega t \sin \theta]$$

where

$$\cos \theta = \frac{(\lambda^2 - \omega^2)}{\sqrt{(\lambda^2 - \omega^2)^2 + 4b^2\omega^2}}$$

$$\sin \theta = \frac{2b\omega}{\sqrt{(\lambda^2 - \omega^2)^2 + 4b^2\omega^2}}$$

Thus the particular integral in the form

$$x_j = \frac{E_1}{(\lambda^2 - \omega^2)^2 + 4b^2\omega^2} \cos(\omega t - \theta), \quad (2.10)$$

Where  $\theta$  is determined from Equations (2.8). Thus, using (2.5) and (2.9) the general solution of Equation (2.5) is

Approximate Solution of Second Order Linear Differential Equation Constant Coefficients and Forced Motion of Differential Equation System.

$$\begin{aligned}
 x &= x_i + x_j \\
 &= ce^{-bt} \cos(\sqrt{\lambda^2 - b^2}t + \phi) + \frac{E_1}{(\lambda^2 - \omega^2)^2 + 4b^2\omega^2} \cos(\omega t - \theta),
 \end{aligned} \tag{2.11}$$

**Example1.** A 16-lb weight is attached to the lower end of a coil spring suspended from the ceiling the spring being 2.5 lb/ft. The weight comes to rest in its equilibrium position. Beginning at  $t = 0$  an external force given by  $E_1(t) = 2\cos t$  is applied to the system.

The basic differential for the above systems is

$$\mu \frac{d^2x}{dt^2} + \gamma \frac{dx}{dt} = E_1 \cos \omega t - \varphi x \tag{2.12}$$

Here  $\mu = \frac{w}{g} = \frac{16}{32} = \frac{1}{2}$  (slug),  $\gamma = 1$ ,  $\varphi = 2.5$ , and  $E_1(t) = 2\cos t$ .

Thus Equation (2.12) becomes

$$\frac{1}{2} \frac{d^2x}{dt^2} + \frac{dx}{dt} + 2.5x = 2\cos t$$

Or

$$\frac{d^2x}{dt^2} + 2 \frac{dx}{dt} + 5x = 4\cos t \tag{2.13}$$

Beginning at  $t = 0$ , so the initial condition are

$$\begin{aligned}
 x(0) &= 0, \\
 x'(0) &= 0.
 \end{aligned} \tag{2.14}$$

**Solution:** The auxiliary equation of the homogeneous equation corresponding to (3.10) is

$$k^2 + 2k + 5 = 0; \text{ Its root are } -1 \pm 2i.$$

Thus the complementary function of Equation (2.13) is

$$x_c = e^{-2t}(b_1 \sin 2t + b_2 \cos 2t).$$

where  $b_1$  and  $b_2$  are arbitrary constants .Using the method of undetermined coefficients to obtain a particular integral ,we let

$$x_p = P \cos 2t + Q \sin 2t.$$

Upon differentiating and substituting into (2.13) ,we find the following equation for the determination of A and B

$$-2P + 14Q = 0,$$

$$4P + 2Q = 4.$$

Solving these, we find  $P = \frac{4}{5}$ ,  $Q = \frac{2}{5}$

Thus a particular integral is

$$x_p = \frac{4}{5} \cos t + \frac{2}{5} \sin t$$

And the general solution of (2.13) is

$$\begin{aligned} x &= x_c + x_p \\ &= e^{-2t}(b_1 \sin 2t + b_2 \cos 2t) + \frac{1}{2} \cos t + \frac{2}{5} \sin t \end{aligned} \quad (2.15)$$

Differentiating (3.12) with respect to  $t$ , we obtain

$$\frac{dx}{dt} = e^{-t}[(-b_1 - 2b_2) \sin 2t + (2b_1 - b_2) \cos t - \frac{4}{5} \sin t + \frac{2}{3} \cos 2t] \quad (2.16)$$

Applying the initial conditions (2.14) to Equations (2.15) and (2.16), we see that

$$b_2 + \frac{4}{5} = 0,$$

$$2b_1 - b_2 + \frac{2}{5} = 0$$

From those equations we find that

$$b_1 = -\frac{3}{5}, b_2 = -\frac{4}{5}$$

Hence the solution is

$$x = e^{-t} \left( -\frac{3}{5} \sin 2t - \frac{4}{5} \cos 2t \right) + \frac{4}{5} \cos t + \frac{2}{5} \sin t \quad (2.17)$$

Let us write this in the "phase angle" form. We get first

$$\begin{aligned} 3 \sin 2t + 4 \cos 2t &= 5 \left( \frac{3}{5} \sin 2t + \frac{4}{5} \cos 2t \right) \\ &= 5 \cos(2t - \emptyset), \end{aligned}$$

where

$$\cos \emptyset = \frac{4}{5}, \sin \emptyset = \frac{3}{5} \quad (2.18)$$

$$\begin{aligned} 4 \cos t + 2 \sin t &= 2\sqrt{5} \left( \frac{2}{\sqrt{5}} \cos t + \frac{1}{\sqrt{5}} \sin t \right) \\ &= 2\sqrt{5} \cos(t - \theta) \end{aligned}$$

where

$$\cos \theta = \frac{2}{\sqrt{5}}, \sin \theta = \frac{1}{\sqrt{5}} \quad (2.19)$$

Thus we may write the solution (3.14) as

$$x = -\frac{e^{-t}}{8} \cos(2t - \emptyset) + \frac{2}{\sqrt{5}} \cos(t - \theta), \quad (2.20)$$

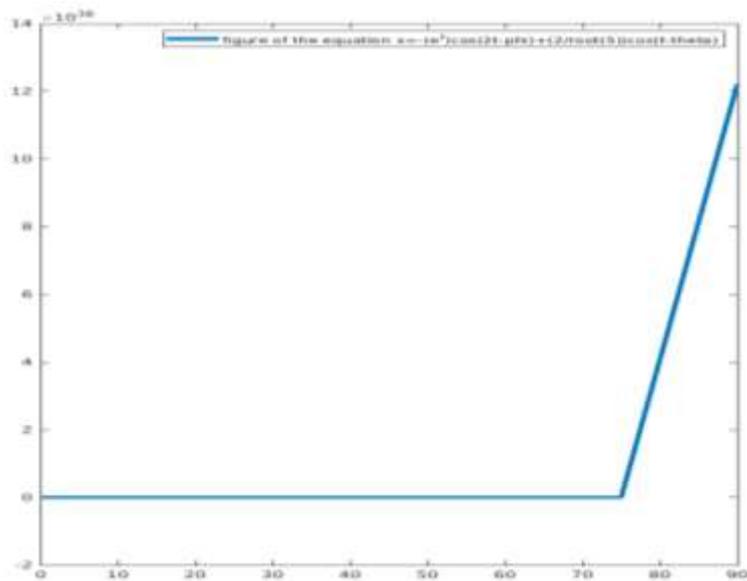
where  $\theta, \emptyset$  are determined by Equations, respectively. We find that  $\emptyset \approx 0.65$  (rad) and  $\theta \approx 0.46$  (rad). Thus the solution of (2.20) is given approximately by

Approximate Solution of Second Order Linear Differential Equation Constant Coefficients and Forced Motion of Differential Equation System.

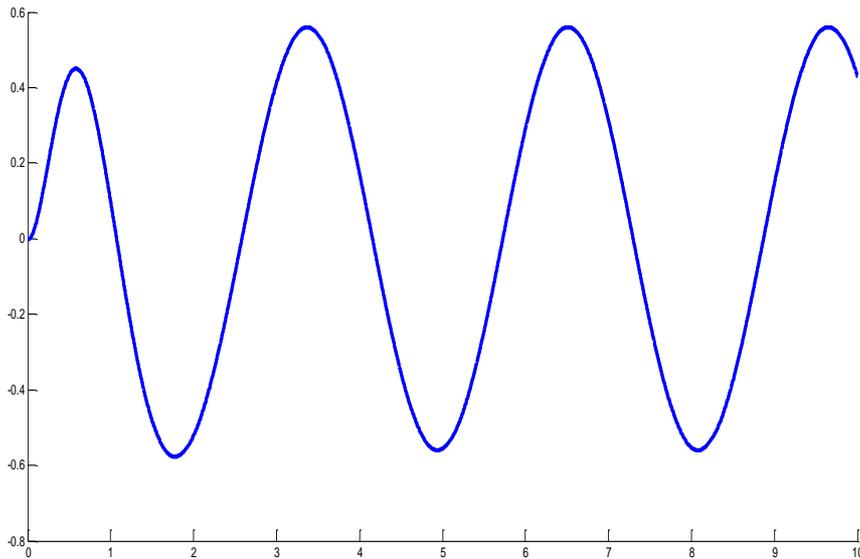
$$x = -0.13e^{-t} \cos(2t - 0.65) + 0.89 \cos(t - 0.46)$$



**Figure. 1:** Using matlab by equation (2.20) X-axis indicates the incremented value of ‘t’, while Y-axis represents the value of the variable ‘X’ different values.



**Figure. 2:** Using matlab by equation (2.20) X-axis indicates the incremented value of ‘t’, while Y-axis represents the value of the variable ‘X’ different values



**Figure. 3 :** Using MATHEMATICA , X-axis belongs to t value and Y-axis belongs to X ; when  $t = 0$  , Complete solution of equation 2.20

### 3. Results and Discussions

In order to test the accuracy of an approximate solution obtained by a certain perturbation method, one can easily compare the approximate solution to the numerical solution (considered to be exact). The term  $-\frac{e^{-t}}{8} \cos(2t - \phi) \approx -0.13e^{-t} \cos(2t - 0.65)$  is the transient term, representing a damped oscillatory motion .It becomes negligible in a sort time ; for example, for  $t > 3$ , its numerical value is less than 0.002. The graph is shown in the **Fig. 3** .The term

$$\frac{2}{\sqrt{5}} \cos(t - \theta) \approx 0.89 \cos(t - 0.46).$$

Is the steady-state term, representing a simple harmonic motion of amplitude  $\frac{2}{\sqrt{5}} \approx 0.89$  and period  $\pi$ . The graph appears in the **Fig. 1** The graph in the **Fig. 3** is that of the complete solution of equation It is clear from this figure the effect of the transient term soon becomes negligible, and that after a short time the contribution of the steady-state term is essentially all that remains. So, It is thus very important to be able to study and understand these mechanical systems in order to control them in critical situations.

#### 4. Conclusion

In this Study a technique is developed for obtaining the solution of nonlinear differential systems under the action of external force. In general, the variational equations for the amplitudes and phase are solved numerically. In this case, the perturbation method facilitates the numerical method which is better results work in nonlinear differential equation.

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## Minimax Estimation of the Shape Parameter of the Erlang Family of Distributions

Manindra Kumar Roy<sup>1</sup>, Md. Ayub Ali<sup>2</sup> and Dulal Chandra Roy<sup>3</sup>

<sup>1</sup>Vice-Chancellor, Ranada Prasad Shaha University.

<sup>2</sup>Research Fellow, Department of Statistics, University of Rajshahi

<sup>3</sup>Professor, Department of Statistics, University of Rajshahi

Corresponding Author: vc@rpsu.edu.bd

### Abstract

*In this paper, minimax estimator of the shape parameter of the Erlang family of distributions has been obtained for the modified linear exponential (MLINEX) loss function by applying the important theorem of Lehmann (1950). Then the obtained results have been interpreted in the light of two-person zero-sum-game according to Wald (1950) and compared with the classical Maximum Likelihood Estimator. Efficiency of the estimators has also been studied.*

**Keywords:** Minimax estimator, Erlang family of distributions, modified linear exponential loss function

### 1. Introduction

In statistical inference, the minimax estimation is a non-classical approach introduced by Wald (1950) exploiting the concept of statistical decision theory and game theory. Here he made a remarkable conclusion that all problems arise in statistical inference could be converted into two-person-zero sum game. It opens a new dimension in the theory of estimation and enriched the method of point estimation. Roy (1982, 1983) studied minimax estimation of the mean of normal distribution for convex and 0-1 type of loss functions and variance of rectangular distribution for quadratic loss function. Roy et al. (2002, 2004, 2007) also studied minimax estimation of the parameter of Weibull, Pareto and Rayleigh distribution for quadratic and MLINEX loss functions. The most important elements in the minimax approach are the specification of the prior distribution and the appropriate selection of loss functions.

The Erlang family has a close association with the exponential distribution going beyond the fact that the first Erlang distribution is exponential. If we have  $k$  random variables  $X_1, X_2, \dots, X_k$  which are independent and have a common exponential distribution with mean  $(\frac{1}{k\mu})$ , then the random variable  $Z = (X_1, X_2, \dots, X_k)$  follows the  $k$ th Erlang

distribution with parameter  $k$  and this distribution plays an important role in queuing theory. The Erlang distribution was developed by A. K. Erlang to examine the number of telephone calls which might be at the same time to the operators of switching stations.

This work on telephone traffic engineering has been expanded to consider waiting times in queueing system in general. The distribution is also used in the field of stochastic processes.

A continuous random variable  $X$  follows the Erlang family of distributions if its probability density function is given by

$$f(x | \alpha, \beta) = \frac{(\alpha\beta)^\alpha}{\Gamma(\alpha - 1)} e^{-\alpha\beta x} x^{\alpha-1}; x > 0, \alpha, \beta \geq 0 \dots (1.1)$$

= 0; otherwise.

where  $\alpha$  is assumed to be known positive integer and  $\beta$  is the shape parameter of the distribution.

In this paper, we have derived minimax estimator of the shape parameter  $\beta$  of the Erlang family of distributions by using MLINEX loss function for known positive integer value of  $\alpha$ . The derivation depends primarily on the theorem due to Lehmann (1950) stated as follows:

**Lehmann's Theorem:** Let  $\{F_\theta; \theta \in \Theta\}$  be a family of distribution functions and  $D$  a class of estimators of  $\theta$ . Suppose that  $d^* \in D$  is a Bayes estimator against a prior distribution  $\xi^*(\theta)$  on the parameter space  $\Theta$  and risk function  $R(d^*, \theta) = \text{constant}$  on  $\Theta$ ; then  $d^*$  is a minimax estimator of  $\theta$ .

## 2. Preliminaries

### Modified Linear Exponential (MLINEX) loss function

MLINEX loss function was proposed by Wahed and Borhan Uddin (1998) which is asymmetric and convex loss function for estimating  $\beta$  by  $\hat{\beta}$  and is given by

$$L(\hat{\beta}, \beta) = W \left[ \left( \frac{\hat{\beta}}{\beta} \right)^c - c \ln \left( \frac{\hat{\beta}}{\beta} \right) - 1 \right]; c \neq 0, W > 0 \dots (2.1)$$

where  $\hat{\beta}$  denotes the estimator of  $\beta$  and  $W$  and  $c$  are two known parameters of loss function.

### Bayes Estimator

The Bayes estimator of  $\beta$  under MLINEX loss function provided by Wahed and Borhan Uddin (1998) is given by

$$\hat{\beta} = [E_{\beta}(\beta^{-c})]^{-\frac{1}{c}} \quad \dots \quad (2.2)$$

**Risk function**

Risk function is the expected value of loss function with respect to the given sample observations. Let  $L(\hat{\beta}, \beta)$  be the loss function for estimating  $\beta$  by  $\hat{\beta}$ , then the risk function denoted by  $R(\hat{\beta}, \beta)$  is defined as

$$R(\hat{\beta}, \beta) = E[L(\hat{\beta}, \beta)] \quad \dots \quad (2.3)$$

**3. Main Results**

**Bayes Estimator of  $\beta$**

Let  $X = (X_1, X_2, \dots, X_n)$  be a random sample of size  $n$  drawn from the Erlang distribution given in (1.1). Then the joint density function of the given sample is

$$\begin{aligned} \phi(X | \alpha, \beta) &= \prod_{i=1}^n f(x_i | \alpha, \beta) \\ &= \frac{(\alpha\beta)^{n\alpha}}{(\Gamma(\alpha - 1))^n} e^{-\alpha\beta \sum_{i=1}^n x_i} \prod_{i=1}^n x_i^{\alpha-1} \quad \dots \quad (3.1) \end{aligned}$$

Let us assume that the parameter  $\beta$  has Jeffrey’s non-informative prior density defined as

$$g(\beta) \propto \frac{1}{\beta} ; \beta > 0 \quad \dots \quad (3.2)$$

Then the posterior density of  $\beta$  for the given sample  $X$  can be written by combining (3.1) and (3.2) as

$$f(\beta | X) = \frac{\prod_{i=1}^n f(x_i | \alpha, \beta) g(\beta)}{\int_{\beta} \prod_{i=1}^n f(x_i | \alpha, \beta) g(\beta) d\beta} = \frac{\frac{(\alpha\beta)^{n\alpha}}{(\Gamma(\alpha - 1))^n} e^{-\alpha\beta \sum_{i=1}^n x_i} \prod_{i=1}^n x_i^{\alpha-1} \frac{1}{\beta}}{\int_0^{\infty} \frac{(\alpha\beta)^{n\alpha}}{(\Gamma(\alpha - 1))^n} e^{-\alpha\beta \sum_{i=1}^n x_i} \prod_{i=1}^n x_i^{\alpha-1} \frac{1}{\beta} d\beta}$$

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$$= \frac{e^{-\alpha\beta \sum_{i=1}^n x_i} \beta^{n\alpha-1}}{\int_0^{\infty} e^{-\alpha\beta \sum_{i=1}^n x_i} \beta^{n\alpha-1} d\beta} = \frac{\left(\alpha \sum_{i=1}^n x_i\right)^{n\alpha} e^{-\alpha\beta \sum_{i=1}^n x_i} \beta^{n\alpha-1}}{\Gamma(n\alpha)}$$

which is Gamma distribution with parameters  $n\alpha$  and  $\alpha \sum_{i=1}^n x_i$  i.e.,  $\beta \sim G(n\alpha, \alpha \sum_{i=1}^n x_i)$ .

Therefore, the Bayes estimator of  $\beta$  under MLINEX loss function (2.1) is given by

$$\hat{\beta}_{MX} = \left[ E_{\beta}(\beta^{-c}) \right]^{\frac{1}{c}}$$

where 
$$E_{\beta}(\beta^{-c}) = \int_{\beta} \beta^{-c} f(\beta | X) d\beta$$

$$= \frac{\left(\alpha \sum_{i=1}^n x_i\right)^{n\alpha} \int_0^{\infty} e^{-\alpha\beta \sum_{i=1}^n x_i} \beta^{n\alpha-c-1} d\beta}{\Gamma(n\alpha)}$$

$$= \frac{\alpha^c \Gamma(n\alpha - c) \left(\sum_{i=1}^n x_i\right)^c}{\Gamma(n\alpha)}$$

Therefore

$$\hat{\beta}_{MX} = \frac{1}{\alpha} \left( \frac{\Gamma(n\alpha)}{\Gamma(n\alpha - c)} \right)^{\frac{1}{c}} \frac{1}{\sum_{i=1}^n x_i} = \frac{K}{T}$$

where  $K = \frac{1}{\alpha} \left( \frac{\Gamma(n\alpha)}{\Gamma(n\alpha - c)} \right)^{\frac{1}{c}}$  and  $T = \sum_{i=1}^n x_i$  is a complete sufficient statistic for  $\beta$ .

### Risk function

The risk function under the MLINEX loss function (2.1) is given by

$$\begin{aligned} R_M(\hat{\beta}) &= E[L(\hat{\beta}_{MX}, \beta)] \\ &= WE \left[ \left( \frac{\hat{\beta}_{MX}}{\beta} \right)^c - c \ln \left( \frac{\hat{\beta}_{MX}}{\beta} \right) - 1 \right] \\ &= W \left[ \frac{1}{\beta^c} E(\hat{\beta}_{MX}) - c E(\ln \hat{\beta}_{MX}) + c \ln \beta - 1 \right] \quad (3.3) \end{aligned}$$

Here  $E(\hat{\beta}_{MX}^c) = E\left(\frac{K}{T}\right)^c = K^c E\left(\frac{1}{T^c}\right)$

Since  $X$  is an Erlang family of variate with parameter  $\alpha, \beta$ , so  $T = \sum_{i=1}^n x_i$  is distributed as Gamma variate with parameters  $(n\alpha, \alpha\beta)$ .

Therefore,

$$h(t) = \frac{(\alpha\beta)^{n\alpha}}{\Gamma(n\alpha)} e^{-\alpha\beta t} t^{n\alpha-1}; \quad t, \alpha, \beta > 0$$

$$\text{Then } E\left[\frac{1}{T^c}\right] = \frac{(\alpha\beta)^{n\alpha}}{\Gamma(n\alpha)} \int_0^\infty e^{-\alpha\beta t} t^{n\alpha-c-1} dt$$

$$= \frac{(\alpha\beta)^{n\alpha}}{\Gamma(n\alpha)} \frac{\Gamma(n\alpha - c)}{(\alpha\beta)^{n\alpha-c}} = (\alpha\beta)^c \frac{\Gamma(n\alpha - c)}{\Gamma(n\alpha)}$$

$$\text{Therefore, } E(\hat{\beta}_{MX}^c) = K^c (\alpha\beta)^c \frac{\Gamma(n\alpha - c)}{\Gamma(n\alpha)} = \beta^c \dots \quad (3.4)$$

$$\text{Since } K = \frac{1}{\alpha} \left( \frac{\Gamma(n\alpha)}{\Gamma(n\alpha - c)} \right)^{\frac{1}{c}}$$

$$\text{Again } E(\ln \hat{\beta}_{MX}) = E\left[\ln \frac{K}{T}\right] = \ln K + E(\ln T) \dots \quad (3.5)$$

$$E[\ln T] = \frac{(\alpha\beta)^{n\alpha}}{\Gamma(n\alpha)} \int_0^\infty \ln t e^{-\alpha\beta t} t^{n\alpha-1} dt$$

Let  $\alpha\beta t = y \Rightarrow t = \frac{dy}{\alpha\beta}$  (limit remain unchanged)

Hence, we obtain,

$$\begin{aligned} E(\ln T) &= \frac{(\alpha\beta)^{n\alpha}}{\Gamma(n\alpha)} \int_0^{\infty} \ln\left(\frac{y}{\alpha\beta}\right) e^{-y} \left(\frac{y}{\alpha\beta}\right)^{n\alpha-1} \frac{dy}{\alpha\beta} \\ &= \frac{1}{\Gamma(n\alpha)} \int_0^{\infty} \ln\left(\frac{y}{\alpha\beta}\right) e^{-y} y^{n\alpha-1} dy \\ &= \frac{1}{\Gamma(n\alpha)} \int_0^{\infty} \ln\left(\frac{y}{\alpha}\right) e^{-y} y^{n\alpha-1} dy + \frac{\ln\left(\frac{1}{\beta}\right)}{\Gamma(n\alpha)} \int_0^{\infty} e^{-y} y^{n\alpha-1} dy \\ &= \frac{\Gamma(n\alpha)'}{\Gamma(n\alpha)} + \ln\left(\frac{1}{\beta}\right) = \frac{\Gamma(n\alpha)'}{\Gamma(n\alpha)} - \ln \beta \end{aligned}$$

where  $\int_0^{\infty} \ln\left(\frac{y}{\alpha}\right) e^{-y} y^{n\alpha-1} dy = \Gamma(n\alpha)'$  is the first derivative of  $\Gamma(n\alpha)$  with respect to  $y$ .

Therefore, we obtain

$$E(\ln \hat{\beta}_{MX}) = \ln K + \ln \beta - \frac{\Gamma(n\alpha)'}{\Gamma(n\alpha)} \quad \dots (3.6)$$

Using the above results in (3.3) and (3.5), we have from (3.1)

$$\begin{aligned} R_M(\hat{\beta}) &= W \left[ \frac{\beta^c}{\beta^c} - c \ln K - c \ln \beta + c \frac{\Gamma(n\alpha)'}{\Gamma(n\alpha)} + c \ln \beta - 1 \right] \\ &= W \left[ c \frac{\Gamma(n\alpha)'}{\Gamma(n\alpha)} + \ln K^{-c} \right] \\ &= W \left[ \ln \alpha^c \frac{\Gamma(n\alpha - c)}{\Gamma(n\alpha)} + c \frac{\Gamma(n\alpha)'}{\Gamma(n\alpha)} \right] \end{aligned}$$

which is constant with respect to  $\beta$  as  $n\alpha$  and  $c$  are known constant and independent of  $\beta$ .

Therefore, using the Lehmann's theorem stated in section 1, it follows that

$\hat{\beta}_{MX} = \frac{1}{\alpha} \left( \frac{\Gamma(n\alpha)}{\Gamma(n\alpha - c)} \right)^{\frac{1}{c}} \frac{1}{\sum_{i=1}^n x_i}$  is the minimax estimator of the shape parameter  $\beta$  of the

Erlang distribution under the MLINEX loss function for a known value of  $\alpha$  .

#### 4. Interpretation of minimax estimators with Two-Person Zero-Sum Game

According to Wald (1950) the following statistical problem is equivalent to two-person zero-sum-game between the Statistician (Player-II) and Nature (Player-I). Here the pure strategies of nature are the different values of the parameter  $\beta$  in the interval  $(0, \infty)$ . The mixed strategies of Nature are the prior densities of  $\beta$  in the interval  $(0, \infty)$ . The pure strategies of Statistician are the all possible decision functions in the interval  $(0, \infty)$ .

Expectation of the loss function  $L(\beta, d)$  is the risk function,  $R(\beta, d) = E[L(\beta, d)]$  which is the winning of player-I.  $R(\xi, d)$  is the value of  $\int R(\beta, d) d\xi(\beta)$ ,  $\xi(\beta)$  is the prior density of  $\beta$ . If the loss function is continuous in both  $d$  and  $\beta$ , convex in  $d$  for each  $\beta$  then there exist measures  $\xi^*$  and  $d^*$  for all  $\beta$  and  $d$  so that the following relation holds good.

$$R(\xi, d^*) \leq R(\xi^*, d^*) \leq R(\xi^*, d)$$

The number  $R(\xi^*, d^*)$  is known to be the value of the game and  $\xi^*$  and  $d^*$  are the corresponding optimum strategies of Player-I and Player-II. In statistical term  $\xi^*$  is the least favourable prior density of  $\beta$  and  $d^*$  is a minimax estimator of  $\beta$ . Here  $d^* = \hat{\beta}_{MX}$ .

It has been shown that, here according to Wald(1950)

Player-I : Nature (Parameter)

Player-II : Statistician

Pure strategies of Nature : The different values of the parameter  $\beta$  in the interval  $(0, \infty)$ .

Pure strategies of Statistician : All possible decision functions in the interval  $(0, \infty)$ .

Winning of Player-I :  $R(\beta, d) = E[L(\beta, d)]$

$$\text{Value of the game} = W \left[ \ln \alpha^c \frac{\Gamma(n\alpha - c)}{\Gamma(n\alpha)} + c \frac{\Gamma(n\alpha)'}{\Gamma(n\alpha)} \right]$$

Optimum strategy of Player-I :  $g(\beta) \propto \frac{1}{\beta}$  ;  $\beta > 0$

$$\text{Optimum strategy of Player-II : } \hat{\beta}_{MX} = \frac{1}{\alpha} \left( \frac{\Gamma(n\alpha)}{\Gamma(n\alpha - c)} \right)^{\frac{1}{c}} \frac{1}{\sum_{i=1}^n x_i}$$

### 5. Efficiency of the estimator

In this section, we have compared the efficiency of the minimax estimator under MILNEX loss function with classical likelihood (ML) estimator.

The likelihood function of  $\beta$  for the given sample  $X = (x_1, x_2, \dots, x_n)$  is

$$\begin{aligned} L(\beta) &= \prod_{i=1}^n f(x_i | \alpha, \beta) \\ &= \frac{(\alpha\beta)^{n\alpha}}{(\Gamma(\alpha - 1))^n} e^{-\alpha\beta \sum_{i=1}^n x_i} \prod_{i=1}^n x_i^{\alpha-1} \end{aligned}$$

The log of the likelihood function is

$$\log L(\beta) = n\alpha \log(\alpha\beta) + \log \left( \frac{1}{\Gamma(\alpha - 1)} \right)^n - \alpha\beta \sum_{i=1}^n x_i + (\alpha - 1) \sum_{i=1}^n \log x_i$$

ML estimator of  $\beta$  can be obtained from the solution of the equation

$$\frac{\partial \log L(\beta)}{\partial \beta} = 0$$

$$\text{which gives } \hat{\beta}_{ML} = \frac{n}{\sum_{i=1}^n x_i} = \frac{n}{T}$$

$$V(\hat{\beta}_{ML}) = V\left(\frac{n}{T}\right) = \left[ \frac{\alpha^2 \beta^2}{(n\alpha - 1)(n\alpha - 2)} - \frac{\alpha^2 \beta^2}{(n\alpha - 1)^2} \right]$$

$$\therefore V(\hat{\beta}_{ML}) = \frac{n^2 \alpha^2 \beta^2}{(n\alpha - 1)^2 (n\alpha - 2)}$$

Again, it can be easily shown that the variance of the minimax estimator under MLINEX loss function is

$$V(\hat{\beta}_{MX}) = K^2 V\left(\frac{1}{T}\right) = K^2 \frac{\alpha^2 \beta^2}{(n\alpha - 1)^2 (n\alpha - 2)}$$

The relative efficiency of  $\hat{\beta}_{MX}$  with respect to  $\hat{\beta}_{ML}$  is given by

$$RE = \frac{V(\hat{\beta}_{ML})}{V(\hat{\beta}_{MX})} = \frac{\frac{n^2 \alpha^2 \beta^2}{(n\alpha - 1)^2 (n\alpha - 2)}}{K^2 \frac{\alpha^2 \beta^2}{(n\alpha - 1)^2 (n\alpha - 2)}} = \frac{\alpha^2 n^2}{\left(\frac{\Gamma(n\alpha)}{\Gamma(n\alpha - c)}\right)^{2/c}} = \alpha^2 n^2 \left(\frac{\Gamma(n\alpha - c)}{\Gamma(n\alpha)}\right)^{2/c}$$

**6. Empirical Investigation and Discussions**

In this section, we are mainly interested to compare the relative efficiency of  $\hat{\beta}_{MX}$  with respect to  $\hat{\beta}_{ML}$  for different values of the parameters  $\alpha$ ,  $c$  and  $n$  (different sample sizes).

**Table 6.1. The percent relative efficiency (RE) of  $\hat{\beta}_{MX}$  with respect to  $\hat{\beta}_{ML}$**

	n=20			n=25			n=30		
$\alpha$ $C$	1	2	3	1	2	3	1	2	3
1	110.81	105.20	103.42	108.51	104.13	102.73	107.02	103.42	102.26
2	116.96	107.97	105.21	113.23	106.30	104.13	110.84	105.21	103.43
3	123.72	110.86	107.04	118.30	108.54	105.57	114.90	107.04	104.61
4	131.15	113.88	108.93	123.77	110.87	107.05	119.21	108.93	105.82
5	139.38	117.05	110.88	129.67	113.28	108.55	123.80	110.88	107.05
6	148.53	120.36	112.88	136.07	115.78	110.10	128.70	112.88	108.30
7	158.75	123.84	114.95	143.03	118.38	111.68	133.94	114.95	109.58
8	170.25	127.50	117.08	150.62	121.07	113.30	139.54	117.08	110.89
9	183.28	131.33	119.30	158.92	123.87	114.96	145.56	119.28	112.22
10	198.15	135.37	121.54	168.05	126.78	116.66	152.04	121.54	113.58
11	215.31	139.62	123.88	178.12	129.81	118.40	159.04	123.89	114.96
12	235.30	144.11	126.31	189.31	132.96	120.19	166.60	126.31	116.38

## Minimax Estimation of the Shape Parameter of the Erlang Family of Distributions

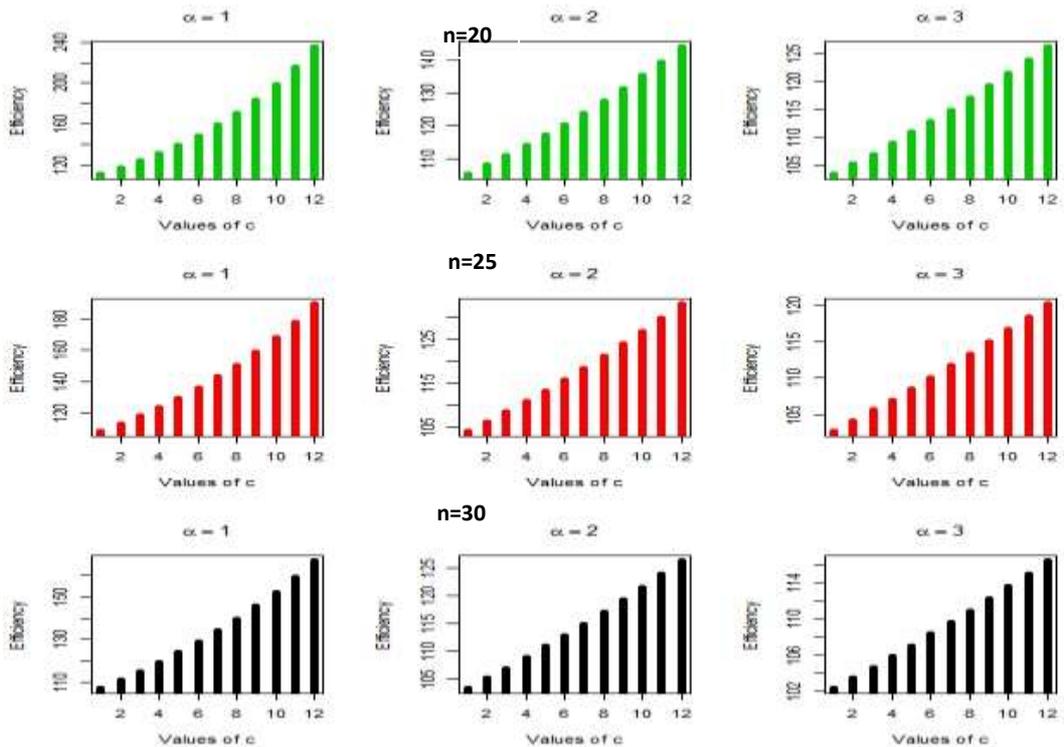


Fig 6.1: Graphical presentation of RE of  $\hat{\beta}_{MX}$  with respect to  $\hat{\beta}_{ML}$

The above Table 6.1 clearly points to the fact that the minimax estimator (non-classical) under MLINEX loss function is more efficient than classical maximum likelihood estimator of the shape parameter  $\beta$  for the different values of the parameters  $\alpha$  and  $c$ . It is also noted that percent relative efficiencies of estimators increase with the increase of the values of  $c$ . At the same time percent relative efficiencies decrease with the increase of the values of  $\alpha$  and  $n$ .

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## Stability studies of F16 kolliphor and F16 phosphate buffer formulations at different storage conditions

*Sonia Barua*

*Assistant Professor, Department of Pharmacy, RPSU*

*Corresponding Author: soniabarua@rpsu.edu.bd*

### Abstract

*Environmental factors can influence the stability of any formulated drug, which may lead to changes in its physicochemical properties. The purpose of this study is to determine the stability of newly formulated F16 (code name of anticancer drug), which is a small molecule with potent anti-angiogenic and anti-cancer abilities. In preclinical evaluation, it prevents the cancer cell proliferation by inhibiting the vascular endothelial growth factor receptors (VEGFRs) and produces high accumulation into the tumor tissues. However, the stability of this drug in formulations is not clear due to its high hydrophobic characteristics. For the experimental purposes, two different formulations were designed code-named F16 in Kolliphor (kolliphor-lipophilic solvent) and F16 in PB (phosphate buffer solution) and exposed at  $25 \pm 2^\circ\text{C}/40 \pm 5\% \text{ RH}$  (Relative Humidity),  $5 \pm 2^\circ\text{C}$ , and  $50 \pm 2^\circ\text{C}/40 \pm 5\% \text{ RH}$  for 30 days. The obtained data depicted its best stability at room temperature ( $25 \pm 2^\circ\text{C}/40 \pm 5\%$ ) during one-month storage. The measurement of light sensitivity values indicated the effect of KP on the stability of F16 in presence of light. On the other hand, in an aqueous buffer solution, the sediments of F16 were observed due to their insoluble properties in water. A validated HPLC method was used to measure drug decomposition. In summary, the obtained results from the stability testing will help us to appropriately designed the F16 formulations with suitable storage conditions.*

**Keywords:** F16, Lipophilic medium, stress testing, FDA and ICH guideline, Photo degradation, HPLC analysis

### 1. Introduction

The stability of a pharmaceutical product implies the capability of a particular formulation in a specific system to remain within its specified limits (i.e., its shelf life). For all drugs, a stability-indicating method must be established, which will ensure the safety, efficacy, and quality of the drug substances and finished products. This testing should cover as appropriate, the physical, chemical, biological, and microbiological attributes (Blessy et al., 2014, ICH, 2003, FDA, 1996, Brummer, 2011). In Pharmaceutical formulations, the safety and efficacy of the final dosage forms rely on the chemical stability of the active molecules. It was shown that certain environmental conditions such as heat or light may influence the drug decomposition in the formulations due to the drug excipient interactions or changes in the physicochemical properties of the ingredients (Agarkhed et al., 2014) Riboflavin might go degradation under exposure to light and elevated

temperature ranging from 290-423 K due to the presence of urea and quinoxalinecarboxylic acid in its structure which could be stabilized by the addition of metal ion-containing aqueous solution. These metal ions form conjugation with riboflavin (Astanov et al., 2014).

F16 is an anti-angiogenic agent which was discovered at Rumbaugh Goodwin Institute for Cancer Research, Nova Southeastern University, upon the collaboration with the Lombardi Cancer Center of Georgetown University and it received the US patent approval in 2011. This compound was discovered through molecular modeling, and its anti-angiogenic properties were confirmed using a series of *in vitro* and *in vivo* assays, in which it exhibited potent anti-angiogenic and anti-tumor activities via selectively antagonizing vascular endothelial growth factor receptor 2 (VEGFR2), which is a receptor for vascular endothelial growth factors for regulating the angiogenesis and cell proliferation process (Rathinavelu et al., 2017). Furthermore, our recent data demonstrate that F16 can permeate the blood-brain barrier (BBB) and thus, can become a very promising drug to treat glioblastoma, an aggressive form of brain tumor. Since our drug is lipophilic, we select a lipophilic vehicle for better solubility and delivery into the body. The aqueous buffer solution has been used for the comparison of the formulations in terms of drug stability.

A validated HPLC method was selected to identify and quantify the amount of degradation component of F16 while storing at various storage conditions. In addition to its chemical stability, the light sensitivity of F16 in the formulations was assessed by using the photo-degradation data. The results of our study are presented here.

## **2. Materials and methods**

### **a. Materials**

An analytical pure sample of F16 (anticancer drug) was procured from Life chemicals Inc. (Ontario, Canada). Ultra-pure water, acetonitrile (HPLC grade) VWR international Ltd (Radnor, PA, USA), Kolliphor and DMSO were purchased from Sigma Aldrich, (St louis, MO, USA) Phosphate buffer saline (PBS) was purchased from Mediatech Inc. (Manassas, VA, USA).

### **b. Apparatus and chromatographic conditions**

The drug degradation studies were performed on a Perkin Elmer (LC-200 series, Waltham, MA, USA) HPLC system equipped with UV-Vis detector (series 200) set at 238 nm, Autosampler with 10  $\mu$ l injection volume and Totalchrom chromatography software (Version 1.50). Chromatographic separation was achieved isocratically at 25°C on a Phenomenex C18 HPLC column (Torrance, CA, USA) with dimensions 4.6. mm (I.D), 250 mm (length), and 5  $\mu$ m (particle size). The mobile phase composed of Acetonitrile, filtered through a 0.2  $\mu$ m membrane filter (Pall Corporation, NY, USA) with a flow rate of 0.75 ml/min. All analyses were conducted in replicates.

### **c. Stability studies**

According to the ICH guideline, three different storage conditions, as shown in Table 1, were selected to assess the chemical stability of the F16 in the formulations. The degradation profile of F16 under these conditions was evaluated by scheduling the sampling plan at five time points: 0, 1, 7, 14, and 30 days. The physical stability of the F16 formulations such as clarity and color change were determined with every time point. The duration of this study was set for one month and repeated twice.

### **d. Thermal degradation studies**

Thermal degradation studies or stress testing of pharmaceutical products can help to identify the influence of temperature on drug decomposition. This experiment is designed to establish the intrinsic stability and possible degradation of the drug molecule in the formulations. In our study, the susceptibility of F16 KP and F16 PB formulations to dry heat was studied by exposing them at  $50 \pm 2^\circ\text{C}$  with  $40 \pm 5\%$  RH for one month using a hot air oven. The degradation of samples was evaluated by drawing the sample at 0, 1, 7, 14, and 30 days of interval. Each sample was diluted with the acetonitrile and injected into the HPLC to identify any degradation peak of the analyte. Replicate analyses were performed for each injection.

### **e. Photo-degradation studies**

This study was carried out in a photo-stability chamber by using, cool, white light to determine the photo-reactivity of F16 in the formulations. F16 KP and F16 PB were kept in the photo-stability chamber with maintaining a constant temperature and relative humidity ( $25 \pm 2^\circ\text{C}/40 \pm 5\%$  RH). Aliquots were withdrawn at suitable time intervals (at days 0, 1, 7, 14, and 30) and diluted in acetonitrile for analysis. The total duration of the study was 30 days and the study was repeated twice with sufficient amount of replicates.

## **3. Preparation of F16 KP and F16 PB formulations**

F16 KP formulation prepared by addition of 5% DMSO to solubilize the F16 component and finally add this drug containing DMSO to the lipophilic vehicle kolliphor. The final formulation is named as F16 KP.

F16 PB formulation prepared by solubilizing the F16 in 5% DMSO and after that this solution mixture is added to the phosphate buffer solution (PB). The final formulation is named as F16 PB.

## **4. Statistical analysis**

All analyses were performed using Prism 8 (GraphPad Software, San Diego, CA, USA) and Microsoft excel 2010. Data are expressed as mean  $\pm$  SD. The P values of less than 0.05 were considered statistically significant.

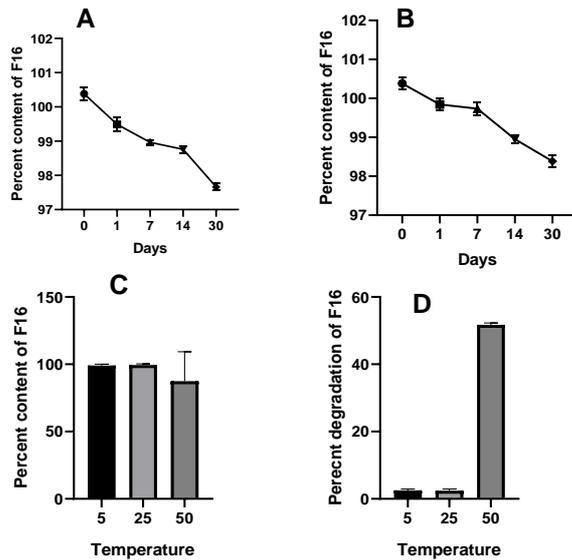
## 5. Results

Environmental factors such as temperature, humidity, and light are known to influence the stability of the final dosage form, leading to changes in the physicochemical properties and activities of the product. Therefore, stability studies utilizing suitable attributes are one of the most important areas in the field of pharmaceutical formulations. Various factors contribute to this effect, such as the chemical nature of the excipient, drug-to-excipient ratio, moisture, pH of the formulations, temperature, and light etc (Sharma & Bansal, 2016). Stanisz et al., reported that it is essential to evaluate the drug-excipient interaction to develop the formulations with safety and efficacy, as part of establishing the final dosage form. To further confirm this effect Knepp et al., evaluated that certain excipients such as Tween 80 and other non-ionic polyether surfactants that can undergo oxidation during bulk material storage and the subsequent use and the resultant alkylhydroperoxides formed can contribute to the degradation of active therapeutics.

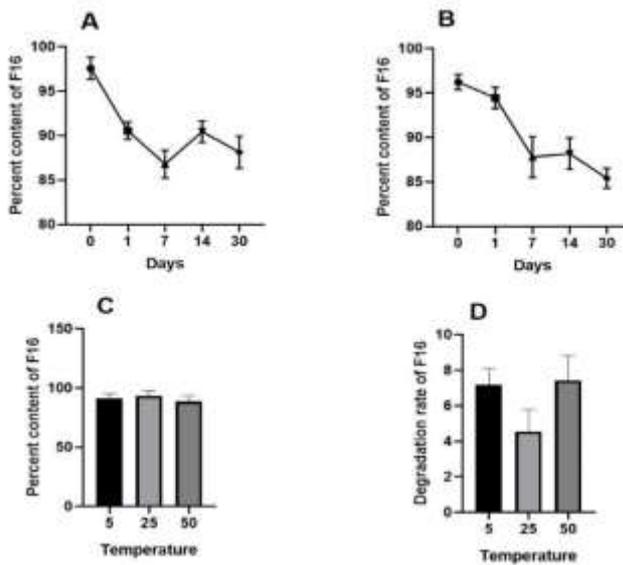
On the other hand, buffer components in parenteral formulations can also cause stability issues. Hence, Li et al., developed three different dosage forms of tezacitabine by using phosphate, glycine and tris buffer systems and found that the drug is most stable in phosphate buffer as compared to the other two buffer systems. Similarly, Li et al., demonstrated that peptide formulations in tris buffer solution underwent degradation at a higher temperature compared to other solutions tested. Although this is not typically observed at lower temperatures, formulators need to be aware of this possible instability when using certain buffers. Cetirizine is a known antihistamine which is converted to monoester with sorbitol and glycerol at 40°C within one week of storage with considerable loss of pharmaceutical abilities. Methylphenidate is a known CNS stimulant, which is transformed into methylphenidate-glycerin isomers within 3 months at 4°C /75% RH and 18 months at 25°C/60 RH storage conditions respectively (Hotha et al., 2016). Thus, various factors are known to influence the stability of formulated drugs.

Table 1 shows the various parameters employed to design the stability testing of our current formulations. The chemical stability of the F16 formulations was carried out by keeping the samples at 25°C ± 2°C /40 ± 5% RH and in the refrigerator at 5°C ± 2 at dark place. Figure 1(A, B) and 2(A, B) illustrate that F16 is chemically stable in KP and PB formulations respectively under room temperature and refrigerator conditions although the drug content is gradually decreased from day 1 to day 30 with formulation F16 KP. However, due to the reduced solubility of F16 in the aqueous phase, there is a significant reduction in drug content that was observed on days 1, 7, 14 and 30 as compared to the initial day with the formulation of F16 PB (Figure 2C). However, no significant reduction in the overall degradation rate has been observed in both the formulations under these two conditions as shown in figure 1 (C, D) and (2D).

Stability studies of F16 kolliphor and F16 phosphate buffer formulations at different storage conditions



**Fig. 1:** Percent content of F16 in KP formulation exposed at 5°C ± 2 (A) and 25°C±2 (B). Comparison of stability of F16 in KP (C) formulations at different storage conditions. Percent degradation rate of F16 in KP (D) formulations at different storage conditions

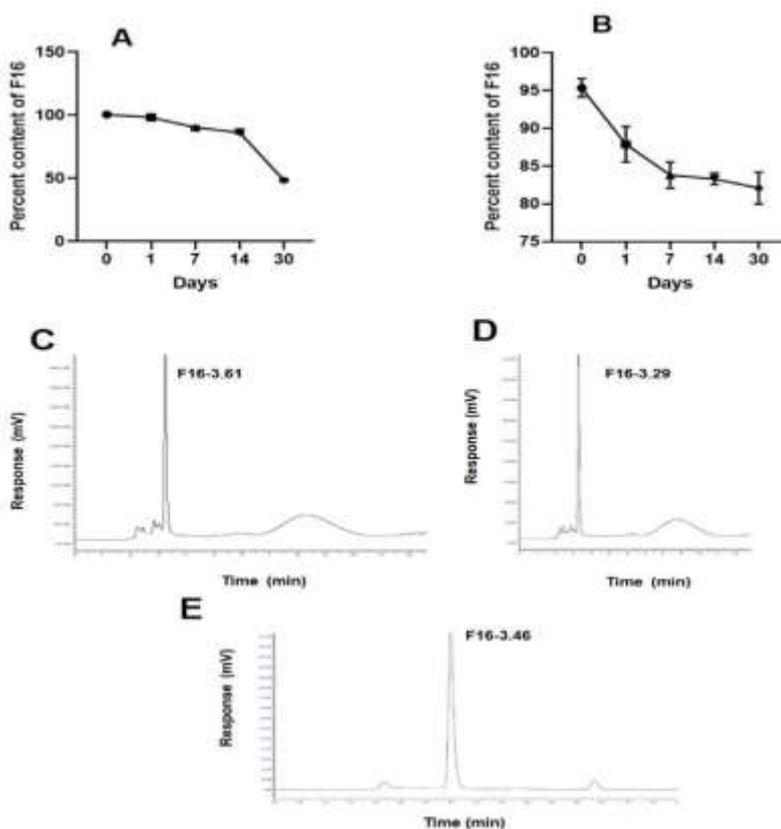


**Fig. 2:** Percent content of F16 in PB formulation exposed at 5°C ± 2 (A) and 25°C ± 2 (B). Comparison of stability of F16 in PB (C) formulations at different storage conditions. Percent degradation rate of F16 in PB (D) formulations at different storage conditions

When the drugs were analyzed using the HPLC, no changes in the Retention time ( $R_t$ ) were observed in the HPLC chromatogram of F16 when comparing day 0 with day 30. The physical stability data showed that there are no changes in physical parameters such as color and clarity of the formulations during 30 days of visual observation at  $25^\circ\text{C} \pm 2^\circ\text{C} / 40 \pm 5\% \text{ RH}$  and  $5^\circ\text{C} \pm 2$  respectively as shown in table 2 and 3.

## 6. Thermal degradation studies

Thermal degradation studies are an integral part of the drug development process providing knowledge about the degradation chemistry of drug substances and drug products (Singh & Bakshi, 2000). This parameter can determine the influence of temperature that might affect the quality of the drug substances and drug products and thus helps to evaluate the storage conditions of the final dosage forms (Reed et al., 2003, Ishii et al., 2007).



**Fig. 3:** Percent content of F16 in KP (A) and PB (B) formulations exposed at  $50^\circ\text{C} \pm 2$  (C). HPLC chromatogram of F16 (C) at day 0 and day 30 (D). HPLC chromatogram of F16 standard (E).

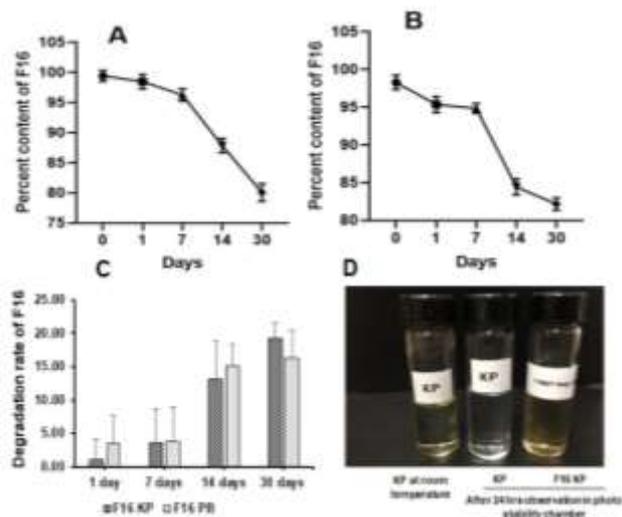
## Stability studies of F16 kolliphor and F16 phosphate buffer formulations at different storage conditions

In our experiments, the F16 KP and F16 PB formulations that were kept at 50°C, in a hot air oven, were withdrawn after 0, 1, 7, 14, and 30 days of exposure and injected into HPLC system to examine the presence of any degradation component of F16. Figure 3A shows that the effect of temperature on the stability of F16 in KP formulations started at day 7 (assay content  $99.53 \pm 4.50\%$ ) and significantly increased at day 30 (assay content  $49.70 \pm 5.17\%$ ) as compared to the drug content of the 0 day, which was  $100.95 \pm 3.25\%$ . Figure 3B exhibits a gradual decrease in the percent content of F16 in PB formulations due to its insoluble nature in the aqueous phase. The overall percent degradation rate of F16 in KP formulation was found to be 16.89% during one-month storage, which is significant as compared to 5°C and 25°C respectively (Figure 1C). The HPLC chromatogram (Figure 3C, D) showed a decrease in the retention time ( $R_t$ ) of the analyte peak with increasing exposure time (day 30) at 50°C. On the other hand, Figure 2D showed that the overall percent degradation rate of F16 in PB formulation was around 7.08% during one-month storage, which is not significant as compared to 5°C and 25°C respectively.

### 7. Discussion

Our data depicted that the lipophilic vehicle plays a significant role in decreasing the content of F16 in the formulations observed under elevated temperature and exposure to light. Our refrigerator and room temperature data (5°C and 25°C respectively) exhibited the stability of F16 in both the formulations during one-month storage; however, there is a significant amount of reduction in F16 content was found at 50°C with the KP formulation. This happens because temperature produces a high degree of influence on all varieties of chemical reactions. As the temperature increases, molecules tend to move faster with increased kinetic energy, changing the molecular structure of the compound which eventually affects its absorption and physicochemical properties such as changes of the color (Moreno & Salgado, 2008). In our experiment, a formulation containing kolliphor, which is a lipophilic solvent containing hydrophilic and hydrophobic components (kolliphor), might undergo decomposition at elevated temperatures. To verify this effect, we placed the KP without adding the F16 at 50°C showing a decrease in viscosity of solvent after 24 hrs of observation which confirmed the changes of the molecular structure of this excipient which might be leading to changes in F16 content in the formulations with increased exposure time. Furthermore, significant changes in the color of the F16 KP formulation were examined at this condition, which further confirmed this phenomenon. Various studies reported the effect of temperature on the stability of drugs and excipients in the final dosage forms. Agarkhed et al., demonstrated that polysorbate 80, which is a non-ionic surfactant widely used as an excipient in pharmaceutical formulations, undergoes degradation at higher temperatures due to increased peroxide content. The author stated that the presence of transition metals such as copper might also catalyze auto-oxidation of polysorbates at a higher temperature thereby affecting the formulation stability, which was confirmed by the differential scanning calorimeter (DSC) method.

The photo-chemical reactions upon exposure to solar, UV, and visible light are known to lead to physical or chemical changes of the finished product (Horspool & Lensi, 2004). The response of the drug to light absorption and excitation can be assessed in terms of photodegradation (photolysis) reactions through the formation of free radicals or photosensitization reactions by intermolecular energy transfer. Thus, the sensitivity of a drug to a particular spectral region of light was shown to vary with its chemical structure, photo-reactivity, and nature of the dosage form (Ahmed et al., 2016, Horspool & Lensi, 2004). As shown in figure, 4A the drug content of F16 was considerably reduced to 87.85 and 80.06 % respectively in KP formulation after 14 and 30 days exposure to light. The F16 in PB formulation also gradually decreased to 84.43 and 82.16 % respectively on days 14 and 30, when compared to the initial day content of 98.29 % (Figure 4B). This is because the hydrophobic nature of F16 in the aqueous phase of PB formulation loses its solubility with increased time. Figure 4C represents the overall degradation rate of F16 in both the formulations during one-month storage and values found to be 19.37 % (lipophilic formulations) and 16.13% (aqueous buffer formulations) respectively at day 30.



**Fig. 4:** Percent content of F16 in KP (A) and F16 PB (B) formulations exposed at  $25^{\circ}\text{C} \pm 2/40\% \pm 5\%$  RH, keeping at photostability chamber. Percent photodegradation rate of F16 in KP and PB formulations exposed at  $25^{\circ}\text{C} \pm 2/40\% \pm 5\%$  RH (C). Changes in physicochemical properties of the formulations storing at photostability chamber after 24 hrs observation (D)

The data obtained from our studies demonstrated that the lipophilic vehicle could affect the stability of F16 in the presence of light. This was confirmed by keeping F16 in the photostability chamber, which resulted in the discolored appearance of the solvent. Even though a relationship between structure and photo-reactivity can be difficult to predict it has been demonstrated that certain structural types of the excipient may have a high

## Stability studies of F16 kolliphor and F16 phosphate buffer formulations at different storage conditions

possibility for photodecomposition of the drug. This may be ascribed to a change in the polarity and some cases the viscosity of the medium or a change in sample absorbance due to an increase in solubility and dissolution of particle aggregates. A large number of studies reported the effect of light on the stability of drug substances and the finished products (Turro et al., 2010, Connors et al., 1986., Ahmed & Tollin, 1981, Ahmad & Valid, 2004). Consequently, the selection of better solvents with good buffering capacity or pH stabilizers with appropriate packaging materials has been suggested for maintaining the quality, efficacy, and safety of the final dosage form during storage and use (Kriestensen et al., 1993, Piechocki & Thoma, 2007, Ahmad & Ahmed, 1981, Bilski et al., 1998, Tovsen et al 2015, Asker and Habib, 1990). In our present study, we considered that our formulation is stable at normal temperatures but is photo-sensitive due to the physicochemical properties of the lipophilic vehicle. Therefore, our drug in KP formulation need to be stored in darkness for better stability and activity.

### 8. Conclusion

The present investigation highlights the influence of environmental factors on the stability of F16 in KP and PB formulations. Our study was designed according to the World Health Organization (WHO) and ICH guidelines to ensure correct formulations and proper storage conditions. The F16 formulations, KP and PB, were found to be highly stable at controlled room temperature during one-month of storage. However, a considerable amount of decrease in F16 from the KP formulation was observed at elevated temperature indicating the effect of excipient in drug instability. The photo-chemical analysis of both the formulations depicted the light sensitivity of F16 due to lipophilic vehicle suggesting storage in dark conditions with controlled room temperature.

### Declaration of conflicting interests

The authors declared no potential conflicts of interest concerning to the research, authorship, and/or publication of this article.

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**Table 1: Design of stability studies**

Formulation types	Storage conditions	Sampling plan	Stability parameters	Evaluation method
<b>F16 PB</b>	25 ± 2°C/40 ± 5%RH	0, 1, 7, 14 and 30 days	Particle formation	Visual observation
	5 ± 2°C		Color change	Visual observation
	50 ± 2°C/40 ± 5%RH		Sediments	Visual observation
	Photo stability		Content of F16	HPLC
	(25 ± 2°C/40 ± 5%RH)		Photo degradation	HPLC
<b>F16 KP</b>	25 ± 2°C/40 ± 5%RH	0, 1, 7, 14 and 30 days	Particle formation	Visual observation
	5 ± 2°C		Color change	Visual observation
	50 ± 2°C/40 ± 5%RH		Sediments	Visual observation
	Photo stability		Content of F16	HPLC
	(25 ± 2°C/40 ± 5%RH)		Photo degradation	HPLC

**Table 2: Evaluation of physico-chemical characteristics of F16 KP formulation**

Visual observation of F16 in KP at different storage conditions					
Storage conditions	Formulations type	Days	Particle formation	Color change	Sediments
5 °C	F16 in KP	0	No	No	No
		1	No	No	No
		7	No	No	No
		14	No	No	No
		30	No	No	No
25 °c	F16 in KP	0	No	No	No
		1	No	No	No
		7	No	No	No
		14	No	No	No
		30	No	No	No
50 °C	F16 in KP	0	No	No	No
		1	No	Slight reddish Yellow	No
		7	No	Reddish yellow	No
		14	No	Reddish yellow	No
		30	No	Reddish yellow	No

Stability studies of F16 kolliphor and F16 phosphate buffer formulations at different storage conditions

**Table 3: Evaluation of physico-chemical characteristics of F16 PB formulation**

Visual observation of F16 in PB different storage conditions					
Storage conditions	Formulation Types	Days	Particle formations	Color changes	Sediments
5 ° c	F16 in PB	0	Yes	No	Yes
		1	Yes	No	Yes
		7	Yes	No	Yes
		14	Yes	No	Yes
		30	Yes	No	Yes
25 ° C	F16 in PB	0	Yes	No	Yes
		1	Yes	No	Yes
		7	Yes	No	Yes
		14	Yes	No	Yes
		30	Yes	No	Yes
50 ° C	F16 in PB	0	Yes	No	Yes
		1	Yes	No	Yes
		7	Yes	Yellow	Yes
		14	Yes	Yellow	Yes

## CAMELS Based Analysis on Banking Industry in Bangladesh

*Md. Nazmul Hasan<sup>1</sup> and S.M. Akber<sup>2</sup>*

<sup>1</sup>Associate Professor, Department of Business Administration, RPSU

<sup>2</sup>Assistant Professor, Department of Business Administration, RPSU

Corresponding Author: nazmul\_bba@rpsu.edu.bd

### Abstract

*This paper aims to analyze and compare the private/foreign banks and public bank's performance in Bangladesh based on CAMELS framework. To get a sound outcome, the study used a sample of 30 banks. Out of them, 20 are private commercial banks, 4 are state owned banks and 6 are foreign banks operating their business in Bangladesh. The data used in this study were collected within the time period of 2015-2019. To attain the objectives properly, this paper used several ratios under the headings of six indicators. The indicators are capital adequacy, asset quality, management qualification, earning capacity, liquidity management and sensitivity towards market. The outcome of the study says that based on CAMELS factors private/foreign banks perform better than public banks in Bangladesh. Here two factors, management qualification and earning capacity, are the most significant factors that basically differentiate between the performance of private/foreign banks and the public banks in Bangladesh. Other factors are statistically insignificant.*

**Keywords:** Capital adequacy, Asset quality, Management qualification, Earning capacity, Liquidity management, Sensitivity towards market and Bank's performance

### 1. Introduction

The bank is considered as the financial backbone of any country's economy. An efficient channeling of fund through banking sector effects the developments of other sectors also. The banking sector has a significant contribution to the overall growth of an economy (Mishkin, 2019). For this, a proper monitoring of this industry is required to ensure an uninterrupted growth of an economy. Currently the number of scheduled banks in Bangladesh are 61 which are also classified into several categories such as public limited banks, specialized banks, private commercial banks, and foreign banks (Bangladesh Bank, 2019).

To analyze the performance of banking sector there are several methods to use. CAMELS' framework is one of them. It was developed by Federal Regulators of USA in beginning of 1970's. It is based on six elements that evaluate the efficiency of the bank's operation. The elements are Capital adequacy, Asset quality, Management performance, Earning capacity, Liquidity Management Quality and Sensitivity toward market. Based on these elements bank's performance are evaluated (Rose, 2016).

## **2. Objective of the Study**

The aim of this study is to analyze and compare the public and private/foreign bank's performance in Bangladesh based on CAMELS framework.

## **3. Literature Review**

As the performance of banks are considered such an important issue for this, it has received greater attention in the literature of banking. Several researches were conducted based on CAMELS framework. CAMELS use financial ratios to evaluate the performance of bank (Yue, 1992).

Beaver (1966) conducted a research to forecast the bankruptcy through using financial ratios but he considered only a single ratio at a time. Latter Altman (1968) introduced multiple discriminant analysis where he considered multiple ratios at a time to predict the same outcome. The model is known as Altman's Z-score model. A shortcoming of this model was, it didn't consider industry specific healthy suggestion through its ratios. This shortcoming was solved by Maishanu (2004). In his study, he recommended eight financial ratios to evaluate the financial strength of a bank.

Mouse (2005) carried out a research on modeling the prediction of bankruptcy. In his research he used several financial ratios of liquidity, turnover, and leverage in his multiple discrepant model and decision tree model. In his research, he finally came out with an outcome that decision tree model works better compare to other approaches.

The objective of the CAMEL framework at the time of its introduction was to examine the on-site bank performance (Whalen and Thomson, 1988). In CAMEL, there are five factors, viz. adequacy of capital, quality of asset, management performance, and capacity of earning and maintenance of liquidity. Here each of the items represents the major elements of bank's financial statement. An inadequate performance of any of these factors leads to failure of a bank's performance.

There are other studies that explain the reasons for choosing CAMEL for evaluating the bank's performance. Waldron et al (2006) made a study on CAMEL where they recommended that one of these elements' threat represent the existence in the loss of assets. The CAMEL framework latter extended to CAMELS framework. The sixth element is sensitivity towards market.

Wirnkar and Tanko (2008) made a study using the CAMEL framework on Nigerian banks' performance. Sangmi and Nazir (2010) conducted a research in the same area based on two Indian banks. Although the pattern is same but the outcome of the research differs from place to place. Agarwal and Sinha (2010) researched on the performance of Indian microfinance institutions, but the outcome differ from other countries.

## **4. Problem Statement**

The paper mainly focuses on analyzing and comparing the public and private/foreign bank's performance in Bangladesh based on CAMELS framework following the above

literature review. It's been observed that there is a significant difference between the performance of public and private/foreign banks in the short run, but it differs from country to country or in different financial industries. In fact, different authors came out with different outcomes. So this paper aims for a practical research to analyze and compare the public and private/foreign bank's performance in Bangladesh based on CAMELS framework and tries to fulfill the research gap in this area.

## **5. Methodology of the Study**

### **5.1 Sampling Design and Sample Size**

This paper aims to analyze and compare the public and private/foreign bank's performance in Bangladesh based on CAMELS framework. To get a sound outcome, it performed for a sample of thirty banks operating their business in Bangladesh. Out of them twenty are private commercial banks, four are state owned commercial banks and six are foreign banks operating their business in Bangladesh. For selecting the banks, judgmental techniques were used to get a sound outcome. The duration of the study was from 2015-2019.

### **5.2 Source of the Collected Data**

In the sample, all the private commercial banks enlisted in Dhaka Stock Exchange have been included. The study mostly worked on secondary data. These data are collected from the bank's annual report and Bangladesh bank web site.

### **5.3 Data Processing**

This study is quantitative in nature. It is with CAMELS based financial variables and ratios. The variables of the study are (a) Tier I & II capital and (b) Capital adequacy ratio (CAR) for Capital Adequacy.

For Quality of Asset it considers (a) Gross nonperforming assets (GNPS), (b) Net non-performing assets (NNPA) and (c) Net non-performing assets to total advances Ratio (NNPATA).

For Management Quality it considers (a) Total investments to total assets ratio (TITA), (b) Sales per employee (SPE), (c) Total advances to total deposits ratio (TATD), and (d) Profit after tax per employee (PATE).

For Earning Capacity it considers (a) Return on net worth (RNW), (b) Operating profit to average working fund ratio (OPAWF) and (c) Profit after tax to total assets ratio (PATTA).

For liquidity management it considers (a) Government securities to total investments ratio (GSTI) and (b) Government securities to total assets ratio (GSTA). For Sensitivity toward market it considers beta.

To calculate the CAMELS ratings every ratio corresponded to the CAMELS factor was considered. To normalize the variables:  $\frac{X-l}{U-l}$ , formula was used. Here u is the upper bound and l represents the lower bound. The ratings were assigned as follows 1 = 0.0 - 0.2, 2 = 0.2 - 0.4, 3 = 0.4 - 0.6, 4 = 0.6 - 0.8, and 5 = 0.8 - 1.0 (except for non-performing assets and beta). Then the CAMELS rating was calculated as the total ratings of the individual variables.

## **6. Analysis with Interpretations**

### **6.1 Capital Adequacy**

Table 1 represents the scenario of Tier- I & II capital and the capital adequacy ratio (CAR) of private/foreign and public banks in Bangladesh. The outcome of the analysis says that Tier-I capital is higher for private/foreign banks compared to public banks. But for Tier-II capital public sector banks maintain a better position. Private/foreign banks also maintain a better position for capital adequacy ratio compared to public sector banks. But the difference is not statistically significant.

### **6.2 Quality Asset**

Table 2 represents the scenario of gross non-performing assets (GNPS), net non-performing assets (NNPA), and net non-performing assets to total advances ratio (NNPATA) of private/foreign and public banks in Bangladesh. The outcome of the analysis says that gross non-performing assets and net Non-performing assets are higher in public sector banks compared to private/foreign banks. The most important thing is, this difference is statistically significant. Although net non-performing assets to total advances ratio is a different, but it is not statistically significant.

### **6.3 Management Quality**

Table 3 represents total investments to total assets ratio (TITA), total advances to total deposits ratio (TATD), sales per employee (SPE), and profit after tax per employee (PATE) of private/foreign banks and public banks in Bangladesh. The outcome of the analysis says that for total investments to total assets ratio, private/foreign banks perform better compared to public banks. But total advances to total deposits ratio is higher for public banks compared to private/ foreign banks. The most important thing is that the difference is not statistically significant. The outcome also says that for sales per employee ratio private/ foreign banks perform better than public banks and the difference is statistically significant. For profit after tax per employee private/foreign banks perform better compared to public banks but here the difference is not statistically significant.

### **6.4 Earning Capacity**

Table 4 represents return on net worth (RNW), operating profit to average working fund ratio (OPAWF), and profit after tax to total assets ratio (PATTA) of private/foreign banks and public banks in Bangladesh. The outcome of the analysis says that for return on net

worth public banks perform better than private banks and the performance difference is statistically significant. But for operating profit to average working fund ratio and profit after tax to total assets ratio, private/foreign banks perform better compared to public banks in Bangladesh and their performance difference is statistically insignificant.

### **6.5 Liquidity Management Quality**

Table 5 represents the government securities to total investment ratio (GSTI) and government securities to total assets ratio (GSTA) of private/foreign banks and public banks in Bangladesh. The outcome of the analysis says that regarding government securities to total investment ratio and government securities to total assets ratio, private/foreign banks perform better than public banks in Bangladesh and the differences are statistically indifferent.

### **6.6 Sensitivity Towards Market**

Table 6 represents beta of private/foreign banks and public banks in Bangladesh. The outcome of the analysis says that beta is higher for public banks compared to private/foreign banks and the difference is statistically insignificant.

### **6.7 Whole Scenerio of Camels Ratings**

Table 7 shows the whole scenerio of CAMELS ratings of all banks used as sample of the study for the period of 2015-2019. The outcome of the analysis says that Woori Bank performs its best in 2019.

Table 8 shows the whole CAMELS ratings of private/foreign banks and public banks in Bangladesh. The outcome of the analysis says that for this criteria private/foreign banks perform better than public banks and the difference is statistically insignificant.

## **7. Findings**

The outcome of the study says that based on CAMELS factors during the period of 2015-2019 private/foreign banks performed better than public banks in Bangladesh. Here two factors, management qualification and earning capacity are the most significant factors that basically differentiate between the performance of private/foreign banks and the public banks in Bangladesh. Other factors are statistically insignificant.

## **8. Recommendations**

Based on the outcome of the study it can be said that public banks need to have a quick adoption for the changing the market situation. The differences have established mainly credit policy, service to the customer and use of IT in their banks. Public banks need to develop their assets quality as well as customer services and credit and lending and credit policies to cope up with changing situations and to be more competitive with the private/foreign banks. At the same time they need to monitor their performance continuously. It will help them to reduce their non-performing loans. At the same time

they need to take necessary steps to motivate their employees to increase their productivity.

The study has some limitations also. Two major limitations of this study are its sample size and the duration of the study. They are because of scarcity of data. Another limitation is that CAMELS framework doesn't consider other forms of risk for example credit risk. So it is not a comprehensive framework. To get a better outcome further studies can be done through including other risk factors to analyze the bank's performance more comprehensively.

## 9. Conclusion

This study mostly focuses to measure the bank's performance through using CAMELS ratings within the time period of 2015-2019. In CAMELS rating there are six indicators that are used to measure the performance of a bank. The indicators are capital adequacy, asset quality, and management qualification, earning capacity, liquidity position and sensitivity towards market. Although this framework has some limitations, it is used by all over the world to measure the bank's performance. One of the major limitations is when two or more bank stand in the same row, then it becomes difficult to rank them. Still by using CAMELS one can get a 360 degree idea about the bank's performance.

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## Appendix

Table 1. Capital Adequacy

		2015		2016		2017		2018		2019	
		Private/ foreign	Public	Private/ foreign	Public	Private/ foreign	Public	Private/ foreign	Public	Private/ foreign	Public
Tier I	mean	14.6154	10.9821	13.8982	10.5741	14.3257	9.6852	13.8561	10.9831	14.8792	10.9820
	Std. dev.	9.2356	7.6483	9.7651	7.4023	9.7651	6.2341	6.7152	4.5620	7.5621	3.4672
	F-static	3.5678		1.2031		2.6853		2.8350		3.4152	
	P-value	0.0686		0.2051		0.1671		0.0567		0.0259	
Tier II	mean	4.8268	5.7521	4.2451	5.6248	4.8799	6.2135	4.5638	6.0761	4.6421	6.7641
	Std. dev.	2.4891	1.4281	1.5042	1.7538	1.6842	1.5431	1.7300	1.4513	1.2530	1.5046
	F-static	2.2001		12.7852		8.9351		11.6431		11.3021	
	P-value	0.1534		0.0067		0.2461		0.0120		0.0010	
CAR	mean	18.5082	16.8710	18.8021	16.8710	17.6231	15.871	17.2034	15.5621	17.0421	15.6853
	Std. dev.	7.1029	6.1268	8.2461	6.5372	9.1287	5.8621	9.3521	7.3621	8.2278	5.2351
	F-static	1.0872		1.2681		1.6231		1.5621		1.6542	
	P-value	0.0578		0.3110		0.0621		0.0541		0.0587	

Table 2. Quality of Asset

		2015		2016		2017		2018		2019	
		Private/ foreign	Public								
GNPS	mean	378.4178	2462.3265	372.8186	2758.4357	353.2487	2235.8357	416.8647	2247.7732	492.5687	2317.6754
	Std. dev.	445.8632	2568.1648	486.5623	2419.8762	437.5794	2108.3058	690.6410	2031.4099	1178.562	2237.7432
	F-static	9.3421		10.6253		10.7631		8.8920		4.5681	
	P-value	0.0010		0.0020		0.0030		0.0068		0.0721	
NNPA	mean	78.5361	751.1631	168.6827	674.5631	129.2436		166.7321	622.8321	196.7621	687.1254
	Std. dev.	68.4241	1510.6071	198.4231	876.0641	196.5631	656.5268	298.4257	878.6143	641.0819	978.8257
	F-static	8.6321		5.5041		5.5631	647.5378	3.1245		3.2641	
	P-value	0.0020		0.0320		0.0040		0.0310		0.0325	
NNPATA	mean	3.4651	3.8379	3.5124	2.9527	2.1315	2.4261	1.6852	1.7842	1.5532	1.8346
	Std. dev.	1.9680	1.8357	3.3576	2.5168	2.1632	1.2436	1.2456	1.6147	1.4738	1.1352
	F-static	0.1764		0.2045		0.5520		0.6520		0.4635	
	P-value	0.5361		0.5461		0.3789		0.3862		0.5678	

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**Table 3. Management Quality**

		2015		2016		2017		2018		2019	
		Private/ foreign	Public								
TITA	mean	45.8452	41.7652	46.2345	43.1257	42.1254	38.7546	38.5738	35.4672	37.8459	33.2671
	Std. dev.	15.7561	12.4586	7.8972	8.5245	7.1256	7.2357	8.6850	7.8540	10.2358	8.7853
	F-static	2.6432		0.6569		0.0251		0.7651		3.4250	
	P-value	0.0661		0.4231		0.5164		0.0845		0.0856	
TATD	mean	74.3546	118.1242	84.1368	129.7325	86.1852	807.1259	93.6789	786.4582	86.7654	671.4256
	Std. dev.	38.6219	196.1347	44.7274	196.4327	45.2790	403.2347	54.4981	981.2471	43.4651	781.3478
	F-static	1.1350		1.2359		0.0542		0.8651		0.9250	
	P-value	0.1245		0.3521		0.2345		0.2456		0.2468	
SPE	mean	6.6758	3.4531	7.3851	4.2451	7.7856	4.9752	8.5467	5.7645	9.6541	6.4824
	Std. dev.	3.1647	1.1257	3.2342	2.4561	3.2451	2.7582	4.4681	3.0218	4.5835	4.1251
	F-static	18.6429		12.2381		8.9869		9.6572		6.1570	
	P-value	0.0201		0.0035		0.0045		0.0035		0.0160	
PATE	mean	0.2856	0.1152	0.2387	0.1628	0.2345	0.1651	0.2358	0.1764	0.2654	0.1876
	Std. dev.	0.4856	0.2241	0.4651	0.2538	0.4628	0.2159	0.2652	0.2361	0.2645	0.2456
	F-static	1.3528		0.7610		0.7500		0.5683		0.9217	
	P-value	0.1850		0.2680		0.2510		0.3570		0.2460	

**Table 4. Earning Capacity**

		2015		2016		2017		2018		2019	
		Private/ foreign	Public								
RNW	mean	16.7658	22.4651	10.7541	20.4210	12.2358	16.2852	13.8961	19.5623	13.7631	20.3468
	Std. dev.	10.2264	12.5373	8.5261	10.3458	7.3489	8.4168	8.4529	6.6381	7.9565	6.8124
	F-static	12.3461		15.6458		6.8759		9.1842		14.6531	
	P-value	0.0135		0.0209		0.0240		0.0150		0.0240	
OPAWF	mean	4.3452	4.1245	3.4578	3.1629	3.7450	3.2685	3.4589	2.8754	4.1629	2.8754
	Std. dev.	2.8935	1.5721	1.6924	0.6784	2.1054	1.2456	2.6538	1.5439	1.7689	1.4567
	F-static	0.0652		1.2648		1.2095		6.2468		7.4580	
	P-value	0.4146		0.3250		0.2048		0.0302		0.0200	
PATTA	mean	2.4567	2.1257	1.5629	1.1052	2.2568	1.8921	2.5731	1.6481	2.1689	1.4657
	Std. dev.	1.2351	0.6589	1.3859	0.5269	1.8723	0.9531	1.1248	0.3582	1.2456	0.6748
	F-static	0.0460		1.1568		1.3861		2.5845		5.2507	
	P-value	0.5621		0.3268		0.2570		0.0260		0.0258	

**Table 5. Liquidity Management**

		2015		2016		2017		2018		2019	
		Private/ foreign	Public								
GSTI	mean	83.3561	89.8253	85.5378	91.4582	86.9852	92.5678	82.8611	93.4652	83.5562	97.6432
	Std. dev.	19.1453	11.7638	12.5628	15.1735	11.4698	13.5781	15.8652	9.7892	19.7581	15.5678
	F-static	2.3251		7.5834		5.4651		4.7651		2.4500	
	P-value	0.1986		0.0240		0.0320		0.0150		0.3010	
GSTA	mean	35.1782	39.1529	34.5631	39.8790	31.5649	35.7690	32.5678	34.9468	31.1659	32.1456
	Std. dev.	9.8256	8.2678	8.3986	9.4658	5.2659	6.4586	3.3962	5.1268	8.3651	7.9856
	F-static	3.4057		2.6500		1.1650		1.1580		1.2849	
	P-value	0.0321		0.2155		0.2460		0.4298		0.2570	

**Table 6. Sensitivity to Market Risk**

		2015		2016		2017		2018		2019	
		Private/ foreign	Public								
BETA	mean	0.5261	0.9748	0.5340	0.9371	0.5581	0.7731	0.5639	0.8451	0.5752	0.7431
	Std. dev.	0.6348	0.8621	0.6248	0.8459	0.6912	0.7106	0.6751	0.7451	0.5849	0.6549
	F-static	6.7341		6.2780		3.6781		3.8421		2.4789	
	P-value	0.0250		0.0369		0.0126		0.0261		0.0370	

CAMELS Based Analysis on Banking Industry in Bangladesh

**Table 7. Overall CAMELS Ratings**

<b>Bank</b>	<b>CAMELS 2015</b>	<b>CAMELS 2016</b>	<b>CAMELS 2017</b>	<b>CAMELS 2018</b>	<b>CAMELS 2019</b>
AB Bank Limited	31	32	33	34	34
Bank Asia Ltd.	29	28	31	30	32
BRAC Bank Ltd.	31	30	32	33	34
The City Bank Ltd.	33	27	25	26	29
Dhaka Bank Ltd.	31	30	32	33	35
Dutch-Bangla Bank Ltd.	28	29	30	29	30
Eastern Bank Ltd.	30	31	32	33	33
IFIC Bank Ltd.	29	28	27	29	30
Jamuna Bank Ltd.	20	30	31	30	32
Mercantile Bank Ltd.	30	33	34	34	35
Mutual Trust Bank Ltd.	31	30	32	32	33
National Bank Ltd.	28	29	30	29	32
National Credit and Commerce Bank Ltd.	27	29	28	30	29
One Bank Limited	30	31	32	32	32
Prime Bank Ltd.	30	31	32	33	35
Premier Bank Ltd.	25	26	28	27	29
Pubali Bank Ltd.	30	31	32	32	34
Southeast Bank Ltd.	31	33	34	33	35
Standard Bank Limited	28	30	29	27	25
United Commercial Bank Ltd.	28	30	29	30	32
Sonali Bank Limited.	27	29	28	30	33
Janata Bank Limited.	29	30	28	30	32
Agrani Bank Limited.	25	28	30	29	33
Rupali Bank Limited.	28	29	27	29	31
Citibank N.A.	31	35	36	38	37
Commercial Bank of Ceylon.	30	32	35	37	36
National Bank of Pakistan.	32	31	33	33	35
Woori Bank.	31	33	35	36	38
Bank Alfalah	30	32	33	35	37
Habib Bank Limited	33	36	35	37	36

**Table 8. Overall CAMELS Rating**

		2015		2016		2017		2018		2019	
		Private/ foreign	Public								
CAMELS	mean	31.7658	27.3215	32.5672	29.0000	32.1587	28.2500	32.4657	29.5000	33.6782	32.2500
	Std. dev.	4.4251	1.4790	3.3051	0.7071	2.8456	1.0897	2.5681	0.5001	3.1857	0.8291
	F-static	1.4621		1.6258		1.2547		1.7351		1.4731	
	P-value	0.1450		0.2058		0.5641		0.2561		0.1068	

## **Alienation and Loneliness in Jibanananda Das's Poetry**

**A. K. Zunayet Ahammed<sup>1</sup> and Ms. Rokeya<sup>2</sup>**

<sup>1</sup>Associate Professor, Department of English, Ranada Prasad Shaha University

<sup>2</sup>Assistant Professor, Department of English, Asian University of Bangladesh

Corresponding Author: zunayet1972@gmail.com

### **Abstract**

*The aim of this research paper is to explore the legendary Bengali poet, Jibanananda Das's sense of loneliness and alienation with a sharp focus on his poetry. Das is one of the most important and the most well read Bengali poets after Rabindranath Tagore and Kazi Nazrul Islam. His poetry richly reflects his perceptive power of life and the world which enables him to create a new poetic domain. It is characterised by a sense of desolation, destitution, ineffable sadness, melancholy, alienation and even reconciliation as well. His poetic world has truly been shaped to such an extent that some of his poems take refuge in history, imagination and the subconscious mind while most of the poems speak of despondency, unhappiness, alienation, discontent and even death wish, bringing in a new dimension in modernist poetry in Bengal. Among the poets of his generation, Das is said to be "the last romantic, the first modern" but his poetry is quintessentially somewhat different from that of others in creativity, in originality, and in multi-layered emotional appeal.*

**Keywords:** alienation, loneliness, agony, despair and weariness

### **1. Introduction**

Jibanananda Das (1899-1954), a Bengali poet, writer, novelist, and essayist, is mostly known as the leading poet of Bengali literature after Rabindranath Tagore, and considered one of the greatest modern poets in Bengal. After thirties, Das, one of the 'five pandava', became an ardent lover of poetry. His use of sensuous imagery, though not readily understandable, colours and seasons and soothing richness and variety to the texture of the modern poetry distinguished him from all others. His pictorial verses full of vivid images are highly praised by Rabindranath Tagore. In many of his poems, Das is seen to be a poet of an offended state of mind, often seems to be in a trance. His world is out of joint- full of predicaments, misfortune, darkness, and adversity haunting him throughout his life with the chill of pain, and even making him long for death and so he felt awfully desolate and alienated. Das's poems altogether are often painful. To understand all the things, certainly, Das's poetry is to be felt rather than merely read or heard.

### **2. Literature Review**

It may be mentioned that a number of researchers have worked on different areas of Jibanananda Das and his poetry. Many significant essays and dissertations were also written on Das, but so far as we find that the poet and his works related to alienation and

loneliness are not analysed. We have already gone through some articles like "Life, a Drop of Water: The Dilemma of Perception and Reality in Jibanananda's Poems" by Biswarup Das published in *International Journal of Comparative Literature and Translation*, "Jibanananda Das's Concept of Poetry vis-à-vis European Poets as Reflected in His Bengali Treatise On Poetry Entitled Kobitar Kotha" by Dr. Manas Sinha published in *Palarch's Journal Of Archaeology Of Egypt/Egyptology*, "The Inescapable Association between Nature and Bengali Nationalism in Jibanananda Das's *Ruposhi Bangla*" by Nahid Afroz and Sheikh Shareeful published in *International Journal on Studies in English Language and Literature(IJSELL)*, Sultana Jahan's article on "Reading Jibanananda Das's "Banalata Sen from a surrealist perspective" published in *IJUC Studies*, along with some other write-ups. The researchers above have analysed different aspects of Das's life through their articles with a close reading of his poetry. One of them shows the dilemma of perception and reality in Das's poetry. Another researcher tries his best to portray Das's concept of poetry vis-a-vis European poets in his writing. Nahid Afroz and Sheikh Shareeful in their research paper have also critically talked about the inescapable association between nature and Bengali nationalism in Jibanananda Das's *Ruposhi Bangla*. Audity Falguni in her article "Jibanananda Das: Poet of autumnal dew" has also tried to depict Das as a poet of autumnal dew. But she cannot manifest Das fully. On another side, Anjan Basu in "Jibanananda Das: The Loneliest Poet of the Twentieth Century" somehow attempts to exhibit Das but he did not do that the way he wanted. These researchers have worked on Das, no doubts. But none of them worked with alienation, loneliness, melancholy and deep sadness with which Das's life was suffused. So, we believe, the subject on which we are doing our research has not been researched as far as we know. Still research is going on different areas of Das and his works. But yet there are lots of opportunities to research on many new and updated fields of him. We believe, this study is an effort to fill this gap to a great extent.

### **3. Materials and Methods**

The basis of the research method applied to research this paper is the qualitative descriptive method. While researching on Jibanananda Das and his poetry, we have tried to add some new ideas. Literature available in the related field has been surveyed and consulted and for this library information search is also done. To undertake the research, the ideas have been collected from different sources. For update information, concerned websites are also browsed. Finally, the information and related references have been reviewed, and the analysis has also been shaped by our argument to establish the concept of alienation and loneliness in Das's poetry. But these are not enough. Even today, we notice the research gap where more studies need to be conducted. So, we feel the necessity to work in this area.

#### 4. Discussions

The word 'alienation' in literature comes after the 1<sup>st</sup> World war (1914-18) and prior to that, the essence of alienation was not seen in literature. The idea alienation is contained in the thoughts of Marx, Hegel, and Feuerbach and so on. It seems to separate one thing from another. If somebody thinks that they are separated from their own selves, it means they fail either to understand themselves or to compromise with their conscience. They can neither think of themselves as part of the society nor take part in the regular social activities as their own. Das is a man of this type who, out of bitter feeling of life and the world, failed to cope with his wife, men, family, society and the world as well. Agonised, the poet failed to make his life happy as he always tossed between hope and despair. His thought of life and era like Hamlet, King Lear and Macbeth afflicted him with poison of pain. His mental state was not suicidal as Hamlet had but yet he thought of dying many times. Truly, Das is a victim of this crude alienation. He is completely lost in himself with 'darkness' in his artistic world. The following lines echo the anguish of his alienated or weary soul:

Today nowhere there is solace in the world;  
There is no peace in the world for a long time.  
Here there is no shelter  
for a heart like a bird. (Ahammed, 2012)

Das's life was very eventful. The more he was facing the time and the decaying civilisation, the more he was terribly suffering within. Gradually he was being alienated or separated from all human beings. His poetry is full of sad experiences where he is completely isolated. This isolation is not for avoiding difficulties or for getting rid of the responsibilities of society. It is not the loneliness of an escapist but the loneliness of a great poet. The name of this feeling is perception or consciousness. The life-long loneliness of Das has destroyed all of his possibilities of being a social success as he has lost faith in man. The following lines precisely reflect the intensity of his sense of loneliness and alienation:

As I take my place amidst the throng  
I wonder-am I the only one alienated  
Because of my obsession?  
.....  
.....  
Why then this feeling of loneliness  
Why then am I so alone? (Alam, 1999)

Das's life did not run smoothly. Poverty, discontinuation of job, professional disappointment, conjugal unhappiness, doubts, disbelief, uncertainties, people's moral decadence, maladjustment to family, society, impact of the two world wars, picture of destruction, lost civilisation around him, bitter criticism of his contemporary literary critics and readers and friends as well, no recognition as a great poet during his life time,

other difficulties related to his everyday life- all these are the causes of his dissatisfaction and disappointment. Dissatisfaction in all walks of life makes his life lonely. Everything is rotten to him and it is obvious when he says,

The night fades away  
On the eyes;  
There is nothing  
Without night

.....

.....

They all come near and go far and far away. (Ahammed, 2012)

However, like the romantics, Das always visualises the 'light' and the 'dark' in his life. Throughout his career, he has to undergo terrible suffering the way the tragic heroes suffer. To him 'promise of peace' is nowhere in the world and he widely perceives himself that his coming to this world is an accident without any pleasure. It seems Das lived in a wasteland world where there was no hope, no aspiration, no love and no dream of starting life again in a new way. He seemed to feel quite lonely and desolate. So, every moment Das sought pleasure of life "against the confusion of life by seeking a Byzantium-like art world or a Helen for contemporary life (Alam, 1999)." Samuel Beckettian frustration and dejection also cast long shadows on Das's life. Despite his dismay and despair, Das creates a strange poetical world with many unpoetical elements pouring his 'stream of sadness'. To him "the world today is sunk in deep, deep sickness (Shirazi, 2009)". The following lines are also suffused with his acute mental agony and sense of alienation:

It seemed to me that I had never had human feelings.  
O Man, O Women,  
I never could become part of your world;  
But neither was I a wanderer from some other world. (Alam, 1999)

In this context, another two lines from "Dover Beach" by Matthew Arnold which seem to be the utterance of Das himself can necessarily be mentioned:

"Hath really neither joy, nor love, nor light,  
Nor certitude, nor peace, nor help for pain; (Peltason, 1994)"

Since Das was upset from his early life, he dreamed of living in the dark for ever for imbibing the essence of death. In the later part of his life as well, looking at the society, civilization and the world, he did see nothing but 'night', a symbol of sadness. Trying to cope with social life, he felt very sickly and this feeling of great sadness made him suffer very much. No belief, no certainty of the world ensured him any solace. The following lines remind us of the desolation in Das's mind:

His wife had been laying next to him – his child too;  
He had love, and dreams – it was moonlight –

Why then would some ghost haunt him? Why then could he sleep no longer?

Or perhaps he hadn't slept for ages – at any rate, now he sleeps soundly, in the morgue (Alam, 1999)

Das had unhappy feelings towards his own life. The unpleasant shadow of poverty consumed him. He could not overcome it throughout his life. He was in dire financial straits. In order to make ends meet, he gave private tuition to students while applying for full-time position in academia. Six years after his marriage, he was without any job and this bitter experience of life troubled him a lot. In his diary what Das has written about his own life is as follows:

“As unsuccessful man, a failure, an unemployed, kicked (Kaisar, 1999).”

During this period of unemployment, strife and utter frustration, he was totally sporadic from all things. Sadly enough, in this situation, he realised that he had nobody of his own in the world. Burdened with untold misery, he even had to take a job as an agent in the Insurance Company with the money of his elder brother Ashokananda Das as loan but failed there too (Syed, 1998). This failure made him pensive. In fact, his life was full of sorrows. Not only that. Das was troubled by moral decadence of human beings. Like many other incidents, even a tenant to whom Das sublet his house to get relief of financial crisis earned money with the wealth of her beauty and youth and he was so deeply shocked at her moral turpitude that he suffered from stream of consciousness (Chowdhury, 2009).

As a modern poet, Das also suffers from harsh reality of life as stated by many great critics. The key note of modernism in art and literature delineates that nobody can create either any art or literature without deep feelings of despondency. It exudes from the experiences of life. The modernist certainly goes on to express that sorrow is the last word of life, the final truth. The philosophy of life emerged from art and literature is considered to be pessimism. Das uses this term in his poetry from different viewpoints. About Das, Fakrul Alam has rightly said, “Jibananda Das (1899-1954) is arguably the most important Bengali poet after Rabindranath Tagore, without any doubt one of the leading modern poets of Bengal, and certainly one of the greatest Bengali poets of all times (Alam, 1999).”

In the sky of Bengali poetry, Das is the only poet who has deliberately used ‘owls’ many times with different connotations. The owl, a colourful bird of nature, signifies ill omen and it is fond of darkness and for this, it comes out of its nest at night. Das having belief in folk tales brought the essence of it in his poetry. Through the visual images ‘night’ and ‘darkness’, symbols of misfortune, like many other symbols, he has tried to give an impression of a ‘game’ of the day and the night going on between his poetic firmament and internal consciousness of his soul. In addition, these images describe the unhappy state of his mind. A picture of his mental agony can be depicted in the lines below:

It seemed to me that  
To sink into darkness is much better than that  
Here is the edge of the world  
Of weariness and restlessness  
Where live all the mysterious people. (Ahammed, 2012)

Again, Das uses various seasons such as autumn, winter, spring and so on in his poetry. His thoughts about these seasons are mixed. At the time of his dismay and despair, he often refers to autumn, a symbol of transient life span. "Autumn merely bridges the Monsoon and the winter with a pale, insignificant existence. Yet, he is different from Baudelaire. Baudelaire cherished to go anywhere so long it was out of the world. On the contrary, Das had no motivation for moving to a distant land presumably because there was no promise of peace anywhere else (Shirazi, 2009)." His despair and desolation can be comprehended in the following:

"Nowhere shall you find peace.  
Will you go from one chime to another distant chime? (Shirazi, 2009)"

In spring, a happy season in our country, nature looks festive but yet its beauty does not delight the discerning mind of the poet at all. The emptiness of fading dews and the coming of winter fail to create a wrenching effect upon his mind. He feels isolated in the rush of yellow leaves where fade the dew drops. Thus, through the external objects, Das always tries to draw an inner picture of his mind.

Unhappy conjugal life was another cause of his mental agony and loneliness (Fazlul, 1999). Soon after wedding with Labanya in 1930, personality clash erupted and Das gave up hope of a happy married life. The gap with his wife never narrowed. With his losing job, Labanya was going on ill-behaving with him. In every respect, she was quite indifferent about him and did not give wifely love to him. There was neither peace nor harmony in their life. In spite of living together, they remained apart from each other. And for this lifelessness, every moment he was suffering awfully within and felt absolutely lonely. Even, while Das was struggling with death after a tram accident on 14 October 1957, Labanya did not find time for more than once for visiting her husband on death bed. At that time, she was busy in film-making in Tollygonj.

Das was sick of morbidity all times in his life. Another cause of his mental agony, alienation and weariness is that he was brutally criticised by the poets-Nirandranath, Sajanikanta Das, Praymandra Mitra and so on (Syed, 1998). For writing "A Day Eight Years Ago", Nirandranath unkindly criticised him though Das said that it was rather a dramatic representation not a subjective poem at all. Yet he considered him to be a poet of "self – destructive weariness". Das was seriously offended with this charge against him. He defends that in the modern age, to get rid of either 'self – destructive weariness' or loneliness, a poet should not 'buy' only 'optimistic attitude'. It may be the idea of optimism but it can never be generally accepted by all the poets. Das strongly believes that 'optimistic attitude' cannot necessarily help anybody to be away from that 'self-

destructive weariness'. He also says that his poems almost touch all that a poem should do in the true sense. The readers, rather indifferent, also did not take his poetry seriously. All these cause his mental agony.

Again, Buddhadev Basu says, Jibanananda Das is a complicated poet (Jaman, 791). The choice of his words is too difficult for the readers to discover the inner meanings of his poetry. For the difficulties in his poetry, Basu called him a poet to be derailed from his own nature and religion. Das was criticised by many other critics as Basu did. Of course, in support of complicity, W. B. Yeats says,

“The form of sincere poetry, unlike the form of the popular poetry, may indeed be sometimes obscure or ungrammatical (Jaman, 1999).”

Unfortunately, Das did not get recognition as a great poet during his life time though he strongly deserved it and was being consumed by the idea of self-annihilation (Mojumder 2003). The poem “Din Rat” or “Days and Night” records his acute pain or despair in the following lines:

The whole day went by purposelessly;  
The whole night will pass miserably,  
Full of frustrations and failures;  
.....  
All knowingly guilty birds in their nests now lie (Alam, 1999)

Das, in the later part of his life, was frustrated with the thought that his poetry was not being well evaluated in the obvious sense of the term. It was becoming increasingly painful for him. In a letter to Churjit Dasgupta, he clearly expressed his sadness in the lines below:

“About my poetry there are many obscure ideas around. For this, I think I will write a big article (Syed, 1998).”

Sadly enough, later he could not write that article to teach the critics and the readers. Even for some critics' harsh comments on the poem “Campe” or “Camping”, Das had to lose his job at City College (Fazlul H., 1999). Many accused Das of promoting indecency and incest through this poem. He could never take it easily even before his death. About the poem, Fakrul Alam has remarked: “This poem was attacked for being obscene soon after it was printed in the famous journal *Paricay* for what was seen as its theme of incest. Jibanananda Das refuted this charge by saying that he had not written an obscene poem and that if there was one dominant note in it, it was of the helplessness of life. Only the prurient imagination, Das declares, could find his poem offensive, since when he describes the call of the doe to the stag as that of a “soul sister” he has in mind something like P. B. Shelley’s “soul sister” (Syed, 1998).”

Das felt unhappy with the company of man and with their humiliation. It is this man that hurt his feelings violently and for their ill treatment, he rolled him up in a shell and

thought himself to be a social misfit or a poem of lamentation. Similarly, we see, at a certain stage of life, poet Nazrul Islam also appeared to be tired of mixing with man. So, in this situation, some lines from Nazrul Islam can be quoted: "Has man troubled me less? They very unkindly hurt my feelings. Yet, this man—for this beast, I sing, for them only I am still (Fazlul H., 1999)." In a letter to Achintya Kumar, he indicates, "It is my faults that I cannot easily mix with man (Chowdhury, 1999)." Actually, as a good soul, he cannot trust men as they give him trouble. But he cannot express it publicly. Rather, he has expressed his dissatisfaction and hatred through his poetry as a shield to stimulate their consciousness. In the following lines he upholds his hatred for the lost civilisation and the destroyed people:

Darkness once again descends on the sky  
Darkness like light's mysterious sister.  
Like that women  
Who has loved me always,  
But whose feature I have never seen,  
In Phalgun's early spring sky, darkness is becoming my familiar. (Alam, 1999)

Exactly just after the death of Das, Bimal Chandra Ghosh in "Kabi Jibanananda Dasar Jibondarsan" cited during his stay at Kolkata for the last few years, if somebody asked him why he did not mix with men, he simply replied that he didn't feel good. Obviously, this utterance expresses anguish of his heart, no doubt. Coming into contact with man was really intolerable to Das. Das loves nature more than men. Likewise, they, he perceives, kill themselves out of jealousy. With this thought, he feels completely desolate and has said:

I know bird, white-plumed bird, child of the Malabar sea Spray.  
You do not look back, have no past, no memories; in your soul you do not bear  
A gray scroll; on wintry nights you do not cry like birds of this world in pain and in fog  
In forlorn mornings of the mind, you do not strive to weave dreams out of blood that has been shed. (Alam, 1999)

Death always haunts the poet. It is another favourite word that is frequently used in the poetry of Das. In "Mrityr Agye" or "Before Death" a praiseworthy poem, Das wishes to sing of death which is inevitable in life. In the poem, the poet has said nothing but inward anguish. Truly, there is no sad picture of age in the poem, it only embodies 'anguish' and 'misery'. Moreover, the impact of the two world wars afflicted him so terribly that his life became a mass of loneliness. Das was alienated not only from art but also from his practical life along with the society he lived in. For his aloofness from his family and the society, he felt completely unhappy and disappointed. A vivid picture of languor, emptiness and sadness is distinctly focused in the following lines:

We who have walked past lonely haystacks on winter evenings

Have seen shy river women scattering flowers of fog  
Like country women in some remote sylvan;  
We who have seen fireflies fill akanda and dhundul trees in the dark.  
(Alam, 1999)

“Sometimes ‘dying’ is considered a travel from the earth to the sky. The poet contemplates, one day death will come and ask him to fall asleep on the grass under a starry sky. Somewhere death is visualized as a sea ahead that remains to be crossed (Chowdhury, 2009).” A few lines are quoted below to express the poet’s readiness for death:

“Tonight the smell of a distant world fills to the brim  
this Bengali mind of mind; if one day death comes to suggest  
under a far star on unfamiliar grass- I’ll take my rest....(Chowdhury, 2009)”.

Despite the sense of loneliness and alienation, Das is optimistic too (Syed, 715). We observe the spark of optimism in his later poems such as ‘Aaj’ or ‘Today’, ‘Jol’ or ‘Water’, ‘Brikkha’ or ‘Trees’ and so on where he shows his faith towards man. These poems express his state of optimism very clearly. Although he is optimistic in his later poems, in the most cases Das was lonely and desolate as discussed before. His sensitiveness also makes him suffer a lot and from his sufferings and attacks of the critics and the readers, he wants to get optimistic pleasure for his soul when he says:

“Men who exist in men, rise to men from the past  
Firstly to take the value of their consciousness  
even after their death. (Ahammed, 2012)”

Based on the above discussions, it may be stated that Jibanananda Das’s poetry shows many vicissitudes Das had in his life. His poetry deals with the intensity of his sense of loneliness and alienation, his severe pain or despair and desolation suffused with his life, his acute mental agony and hatred for the lost civilisation and the destroyed people, his dissatisfaction, weariness and death wish regarding his own life, and so on.

## **5. Conclusion**

To sum up, Jibanananda Das’s poetry distinctly expresses his sense of disenchantment, pessimism and helplessness he increasingly felt and faced during his life time. Most of his poems are truly replete with melancholy, loneliness, alienation, desolation and tinged with death wish. And by applying the poetic devices and figurative language in his poetry, the poet always tries to draw an inner picture of his agonised and weary soul. As he was lonesome and isolated, Buddhadev Basu rightly called him the “loneliest poet.

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# Comparative Translation: Reading Bangla Translations of Doyle's "The Greek Interpreter" through Chinese Translation Theories

Nusrat Tajkia

Lecturer, Department of English, RPSU  
Corresponding Author: nusrat\_eng@rpsu.edu.bd

## Abstract

*Postcolonial Studies and Decoloniality have rendered Comparative Literature and its major ancillary Translation Studies significantly less Eurocentric and more accommodative. A recent substantial addition to such move is the emergence of Comparative Translation Studies that intends to minimize methodological and area-restricted isolationism evident in the practice of and research on translation. Taking cue from this development, the present paper draws from Chinese translation theories in its study of four Bangla translations of Arthur Conan Doyle's "The Adventure of the Greek Interpreter," a short story in the 12-story-cycle in The Memoirs of Sherlock Holmes. In its bid to examine the effectiveness of eastern translation theories in analyzing a text translated in an eastern language, the paper taps three impressionistic Chinese theorists. First, Yan Fu's "three principles," namely "fidelity", "fluency" or "expressiveness" and elegance), are employed to examine whether Bangla translations of "The Greek interpreter" is true to the SL in spirit, accessible to the TL reader, and effective in its style. Second, Fu Lei's concept of "spiritual resonance" is used to examine if said translations command spiritual, not formal, equivalence to the text in SL. Third, Qian Zhongshu's concept of "realm of transformation" is employed to examine whether said translations attain "the transmigration of souls," i.e., the body is transformed but the soul remains the same. Thus, the present paper intends to explore, first, if employment of non-western theories offers new insight into the practice and analysis of translation, and, second, if such comparative approach to translation, i.e., placing eastern approach vis-à-vis western formalist ones, makes way to a better understanding of translation.*

**Keywords:** Comparative Translation, Bangla Translation and Chinese Translation Theories

## 1. Introduction

Since Sir Arthur Conan Doyle's first publication in 1887, Sherlock Holmes stories has been translated in "at least 60 languages" (Porter, 2012). Tse Chung states "that the primary objective of comparative translation studies is to study the various circumstances under which translations of the same text were produced in an attempt to account for why one translation was different from the other" (Tyulenev & Zheng, 2017). This paper has undertaken this exact task, by going through four different Bangla translations of Arthur Conan Doyle's "The Greek Interpreter," a short story in the 12-story-cycle in *The Memoirs of Sherlock Holmes* published in 1893. In order to move towards a global and

less area restricted approach, this paper is using Chinese impressionistic translation theories propounded by Yan Fu, Fu Lei and Qian Zhongshu (Chan, 2004). This article attempts to understand, Yan Fu's *Xin*, *Da*, and *Ya*, Fu Lei's conception of *Shensi* and Qian Zhongshu's *Huajing*. Instead of studying Comparative Literature and Translation Studies as each other's supplements, moving toward Comparative Translation Studies is a more logical approach, as it "aims at overcoming area-restricted isolationism" (Tyulenev & Zheng, 2017). This paper deals with the three impressionistic Chinese theorists' (i.e. Yan Fu, Fu Lei and Qian Zhongshu) work, to better understand the conceptions propounded by them. This paper attempts the application of these theories to four Bangla translations of "The Greek Interpreter."

## 2. Literature Review

### Chinese Impressionistic Translation Theory

According to, "Hong Kong scholar," Chu Chi-yu, there are two "core components in traditional Chinese theories", '*an ben*' (following closely the source text) and '*qiu xin*' (seeking faithfulness)" (Yifeng & Lei, 2008). For Chan (2004), "the early twentieth-century theorist Yan Fu (1854-1921), whose 'three principles of translation' practically set the perimeters for present-day discussions on translations in China" (p. 3). According to Ivo Spira, Yan Fu chose "an erudite and archaic Chinese literary style to render modern concepts that originated in a foreign language" (Munday, 2016). Yifeng & Lei (2008), argue "Chinese translation theories can be traced back to '*zhi*' (literal translation), which emphasizes the complete imitation and reproduction of the syntax of the source text, '*xin*' (free translation) which allows for certain freedom in terms of syntax, and finally '*hua jing*' (reaching the acme of perfection)". However, Yan Fu, "from his study of Buddhist translation... identifies the mistaken concept of '*zhi*' (literal translation), and then proposes '*xin*' (faithfulness)" (Yifeng & Lei, 2008).

*Xin*, *da*, *ya*— Yan Fu's, three principles, have multiple variants, when they come to their English counterparts. Sun (2012) translates "the tripartite dictum of *xin*, *da*, *ya*" as "faithfulness, lucidity, and elegance". Zhen's (2004) translation is as follows, "Xin/da/ya, or fidelity/comprehensibility/grace" (p.147). Huawen (2014) goes for "faithfulness (*xin* 信), expressiveness (*da* 達), and elegance (*ya* 雅)" (p. 169). In "On Translation" by Chen Xiyang, he argues for the predominance of *xin*, amongst Yan Fu's tripartite model, and gives us "three kinds of affinity between translations and their originals — affinity in form, idea and spirit— which can all be related to *xin*" (Chan, 2004). Eugene Nida's theories on translation are "for many Chinese scholars, a substitute for Yan Fu's tripartite dictum as a neat formula for translation practice" (Sun, 2012). Yan Fu practiced fluency, which is evident in "his own translation of Huxley," however, "he stood on the side of fidelity to the original" (Chan, 2004). According to Chan (2004), "elegance" has been underscored as a useless analytical tool and it exists simply because Yan Fu aims at advocating "the ornate classical prose style of the Toongcheng school, however "lack of specificity" has rendered all three terms to be weak analytical tools". According to Sun

(2012) “Yan Fu was a functionalist” and “faithfulness was alleged to be the most important factor in translation as clearly set forth by him” . On this note Sun (2012) also added that the “Chinese translation scholars” were too preoccupied with scrutinizing Yan Fu for not practicing what he preached.

Yifeng and Lei (2008) contended that Fu Lei and Qian Zhongshu’s translation theories are respectively “represented by ‘spiritual resemblance’ and ‘realm of transformation’” as “the typically aphoristic models of expression” . Fu Lei made it clear that use of the term was “appropriated from traditional Chinese aesthetics, a term associated in particular with painting criticism” (Chan, 2004). Chan (2004) argues that according to Fu lei, “[i]n terms of effect, translation, like imitation in painting, should be in search of resemblance in spirit rather than in form”. According to Munday (2016), Spirit has “lost the religious sense it originally possessed and was thenceforth used in the sense of creative energy of a text” . Fu Lei’s concept of *shensi*, like Yan Fu’s *xin*, *da*, and *ya*, has multiple variants in meaning. For example, Wang (2015) translated “shensi” as “spiritual thought” (p. 23). According to Shuen-Fu Lin,

“the word *shen* in *Shensi* carries a double meaning: ‘on the one hand, it qualifies *si* or thinking as an activity of a person’s *jingshen* (spirit) that resides in his mind-heart. On the other hand, it also connotes that this *si* has a marvelous, unfathomable, or daimonic quality” (Ghosh, 2017).

Huawen (2014) contends that “神似 (*shensi*, spiritual similarity) in Chinese criticism for translation, can be used to identify the relationship between the source text and the target text” . Egan’s close reading of Liu Xie’s concept of *Shensi* articulates that the “idea of *shen* ...derived from and largely identical to the ancient idea of *daimon*, the subtlest element of the human psyche that corresponds to the manifold divinities of the natural world” (Cai, 2001). Cai (2001) further argues that, for Liu *shen* operates “in terms of a flight of the mind out of the physical body to roam afar in defiance of time and space” and “the writer’s ‘daimonic roaming’ is aided and in many ways controlled by [the writer’s] sensory perception and linguistic cognition” . For modern scholars, *shensi* is the mental faculty called *xiangxiang*, “which is the “modern Chinese equivalent of imagination” that connotes “the ideas of artistic creativity, invention, and novelty derived from the nineteenth-century Western Romantic views on art and imagination.” (Cai, 2001). However, “*Shensi* or daimonic thinking does not completely correspond to the dominant Western notion of imagination, it embodies both aspects of ‘image-producing faculty’ and ‘unifying artistic creativity’” (Cai, 2001).

Huajing, or as far as the “English equivalent [goes] ‘transformation of realm,’ was initiated into the discourse on translation by Qian Zhongshu (錢鍾書, 1910–1998)” (Huawen, 2014). Huawen (2014), in order to refer to *huajing*, has coined the term, “real-m-ization”, which is a “combination of realm and realization” and further contends that it “refers to the process of transforming a poetic realm across languages” (p.170). “The metaphor” according to Chan (2004), proposed by Qian Zhongshu for “perfect translation

is the transmigration of souls ... wherein the body undergoes a transformation, but the "soul" is retained" Huawen (2014) argues,

Since hua (化) can be either a verb or adjective with the sense of either "transform" or "transformed," huajing has taken on two semantic shades as well. It can refer to the aesthetic state a poem has attained, where hua serves as the modifier of jing (境). In addition, hua can play the syntactic role of a verb, and then huajing denotes the act of transforming a realm .

Huajing is "the process of realm transformation" achieving "an equivalent realm in the target text as that in the source text" (Huawen, 2014).

### 3. Materials and Methods

This is a library research. Data have been collected through printed books and journal available in the book markets of Bangladesh. This research also used downloadable materials from the internet. One single language can require multiple translations, which alludes "to the fact that the boundaries of any languages are not clean lines but gray zones" (Domínguez et al., 2015). On this note, this paper uses four different Bangla translations of "The Greek Interpreter". Three (i.e., Bardhan, Dutta, Sena) of the translations are from West Bengal and one (i.e., Choudhry and Haque) is from Bangladesh. All of these translations are referred to by using translator's name in this paper.

As analytical research this paper deals with multiple translations of one text, where the translations are analyzed by applying Chinese impressionistic theories. In translation studies there is a tendency to use and or to rely on western theories. This research is using an eastern translation theory to read multiple Bangla texts. When we are comparing different texts, there should be "assurance of sufficient resemblance between or among the things compared" (Miner, 1990). Earl Miner (1990) referred to Donne and Jonson as "a sound comparison," however, he also contained that this comparison could backfire if one is to compare "the dramatic element in Donne's lyric with Jonson's plays," as they are vastly different. Miner argued that, the same kind of problems can arise if one were to comparing Chinese Tang poets like Li Bo and Du Fu, or even Japanese Matsuo Bashō with Yosa Buson. However, according to Miner (1990),

comparison of the Chinese with the Japanese poets, the Chinese now seem very similar but different from the Japanese, who now seem quite like. If we then enlarge the scale further, introducing Donne and Jonson (or Hugo and Baudelaire, etc.), we are struck by the resemblances of the Chinese and Japanese poets to the one side and those of the west to the other.

This example illustrates depending on 'scale' that Asian literature is allowed to be compared with European literature. In turn it justifies the use of Chinese Translation theory to read Bangla translations of a text from the west. Chinese Translation theories

mostly study the relationship between English and Chinese. So, in theory, we should be able to read something translated from English into Bangla using Chinese Translation theory. In Chinese translation theory, a theory is expedient, as long as it can be applicable to “actual translation practice” (Sun, 2012).

#### 4. Discussion

##### Reading “The Greek interpreter” with *Xin, Da, Ya, Shensi, and Huajing*

A short summary of “The Greek Interpreter” would be, Sherlock Holmes takes his companion Dr. Watson to introduce to his brother, Mycroft at the ‘Diogenes Club’. At the club Mycroft introduces Holmes and Watson with Mr. Melas, “the Grecian Interpreter” (Doyle, 2010). Mr. Melas then recounts his horrible experience about a “man with the sticking-plaster upon his face” (Doyle, 2010). This man with the sticking-plaster named Paul Kratides is held captive by Harold Latimer and Wilson Kemp. As Kratides is Greek and doesn’t know a single word of English, Melas’ assistance is required. The crux of the matter is that Sophy, Kratides’ sister has eloped with Latimer. Kemp and Latimer want Kratides and Sophy’s property. As the story develops, Kemp and Latimer run away with Sophy and leave Melas and Kratides to their death. Because of bureaucratic technicalities Holmes and others reaches Martles (where Kratides was held captive) too late. They were able to save Melas but Kratides ends up dying. The story ends with a “curious newspaper cutting that states news about two English men “[inflicting] mortal injuries upon each other” (Doyle, 2010). However, Holmes believes this was the way Sophy avenged “the wrongs of herself and her brother” (Doyle, 2010).

This paper analyzes multiple sentences from the story and their use of words for the application of *xin, da, ya, shensi* and *huajing*. The translations of the title “The Greek Interpreter” itself can contribute to understanding the impressionistic Chinese translation theories. Choudhry and Haque’s translation “গ্রীক দোভাষি” and Dutta’s “গ্রীক ভাষান্তরিক” exemplify *xin* or, faithfulness/ fidelity because here we will find “affinity in ... idea and spirit” (Chan, 2004) which is related to *xin*. *Da* is evident in, Bardhan’s “গ্রীক দোভাষীর দুর্দশা” and Sena’s, “গ্রীক দোভাষীর বিপদ” –as the two translations have copied the idea and style of the target text but have the “effortlessness of the original composition” (Venuti, 204, p.18). Here, the titles convey what the story is really about, that is-a troubled interpreter, the title has seamlessly converted in to the target language. *Ya* or elegance, happens to be the vaguest in Yan Fu’s tripartite model (Chan, 2004). Specifying a title as “elegant”, among the four Bangla title would be a very subjective venture. Bardhan and Sena’s titles also vouch for *Shensi* and *Huajing*. If *Shensi* is “resemblance in spirit rather than in form” (Chan, 2004, ) and *Huajing* reflects bodily transformation where the soul stays the same (Chan, 2004), then Bardhan and Sena’s translations have transformed the meaning by adding that the story is about a Greek interpreter in trouble, yet at the core, manages to maintain that the story is about a Greek interpreter. “The Greek Interpreter” begins with the following sentence, “During my long and intimate acquaintance with Mr. Sherlock Holmes I had never heard him refer to his relations, and hardly ever to his own early life”

(Doyle, 2010). All of the translations indicate affinity in spirit and idea, not in form. For example, Choudhry and Haque introduces Mycroft, who isn't mentioned in the sentence. Bardhan translates "early life" as "ছেলেবেলা," Dutta goes for "প্রথম জীবন," which is the closest translation, whereas Choudhry and Haque as well as Sena skips this part. The four translators take completely different approaches to translating – "Art in the blood is liable to take the strangest forms." (Doyle, 2010). Bhardhan's translation is- "শিল্পীয় তন্ময়তা আর পর্যবেক্ষণ শক্তি নাতির রক্তেও তাই রয়ে গেছে" (Doyle, 2012). Choudhury and Haque, did not translate this sentence. Dutta's translation is, "রক্তে যদি শিল্পের নেশা থাকে তাহলে তা অদ্ভুত রূপান্তর গ্রহণ করতে পারে" (Doyle, 1999). And Sena's translation is "রক্তের মধ্যে যদি শিল্পকলার দিকে ঝোঁক থাকে তো তার ফলাফল যে কী হতে পারে তা বলা শিবেরও অসাধ্য" (Doyle, 2015b). Bhardhan chooses to mention the word 'grandchildren,' which makes the communication in the target text more lucid and conveys the notion of being artistically capable is associated to genetics. Dutta's translation is closer to the original in terms that he translated "liable to take the strangest forms" into "অদ্ভুত রূপান্তর গ্রহণ করতে পারে". Sena's translation "তার ফলাফল যে কী হতে পারে তা বলা শিবেরও অসাধ্য"– which means– even Shiva will not be able to say what inherently achieved artistic capability can do. Not knowing what inherited artistic capability can do–is the core message of the texts By Dutta and Sena. Our next example "I was hurried through the hall into the vehicle" (Doyle, 2010): which Bhardhan translates as "আমাকে ঠেলেঠেলে তুলে দেয়া হলো গাড়ির মধ্যে" (Doyle, 2012) which–omits "Going through the hall"–but conveys the hurried situation of the context. Choudhury's and Haque's translation, "আগের মতোই আমায় ঠেলেতে ঠেলেতে বাইরে নিয়ে এলেন; যে গাড়িতে আসার সময় চেপেছিলাম দরজা খুলে তাতেই আবার জোর করে ঢোকানো হল আমাকে" (Doyle, 1999)- elaborates the situation and becomes more lucid as far as the target text is concerned. Dutta's translation, "দ্রুতগতিতে হল পার করে আমাকে গাড়িতে বসানো হল" (Doyle, 2015a), is in all probability the closest to the original. Sena's translation, "আমকে আবার প্রায় গরু তাড়ানোর মতো করে হলের ভেতর দিয়ে এনে গাড়িতে চাপিয়ে দিল" (Doyle, 2015)-employs a cultural reference which reflects that the person in question was being hurried in the way you chase a cow. In the story while describing Melas' occupation, Mycroft says "He earns his living partly as interpreter in the law courts and partly by acting as guide to any wealthy Orientals who may visit Northumberland Avenue Hotels" (Doyle, 2010). Bhardhan translates "wealthy Orientals" as "টাকার কুমির" (Doyle, 2012), Choudhury and Haque opts for "বড়লোকেরা" (Doyle, 1999)- both versions convey only the wealthy part, but not the word Oriental. Dutta's "প্রাচ্যদেশীয় কোন ধনী" (Doyle, 2015a, p. 434) is the closest and perhaps most accurate, as it refers to both the words 'wealthy' and 'oriental' parts. Sena's translation "বিদেশিরা" (Doyle, 2015b) just means foreigners. Among the four translations, Dutta's translation reflects more of Yan Fu's *xin*, as his translation sometimes feels like word for word translation. Whereas translations done by, Bhardhan, Choudhury and Haque, and Sena feel as if they were more target audience friendly, thus the implication of *da*. Regarding the application of *ya*, due to its vagueness in the conception, it will be a hard if not an impossible task to decide which of the translation is "elegant". Should we choose the one that stays more faithful to the source text or the one that that is more target audience friendly?

For our final example, we will use a partial conversation between the Greek interpreter and the Greek captive:

- “ ‘ You can do no good by this obstinacy. Who are you?’  
“ ‘ I care not. I am a stranger in London.’  
“ ‘ Your fate will be on your own head. How long have you been here?’  
“ ‘Let it be so. Three weeks.’  
“ ‘The property can never be yours. What ails you?’  
“ ‘It shall not go to villains. They are starving me.’ (Doyle, 2010).

Bhardhan translates it as,

- “কেন গোঁয়ারতুমি করছেন ? কে আপনি?”  
“বেশ করছি । লন্ডনে আমি নবাগত ।”  
“অবাধ্যতার শাস্তি মৃত্যু । কদিন এসেছেন?”  
“হোক না মৃত্যু । তিন সপ্তাহ”  
“এ-সম্পত্তি এ-জীবনে আপনি পাবেন না । কী হয়েছে আপনার?”  
“আমি না-পাই, শয়তানের বাচ্চাদেরও দেব না । না-খাইয়ে রেখেছে আমাকে ।” (Doyle, 2012).

Choudhury and Haque’s translation is as follows:

- ‘এভাবে জেদ করে কেন নিজের দুর্ভোগ বাড়ান? কে আপনি?’  
‘আমার হচ্ছে । –আমি এখানে নতুন এসেছি ।’  
‘কথা মত কাজ না করলে মৃত্যু নিশ্চিত; এখানে কতদিন আছেন?’  
‘প্রাণের ভয় আমার নেই আগেই বলেছি । তিন হপ্তা ।’  
‘এ সম্পত্তি আপনার হাতে আসবে না । আপনার কি অসুখ হয়েছে?’  
‘আমি যা পাই শয়তান গুলোর হাতে কখনোই তুলে দেব না । ওরা আমায় খেতে না দিয়ে আটকে রেখেছে ।’ (Doyle, 1999).

Dutta translates the passage as:

- “এই ধরনের একগুয়েমি আপনার ভাল হবে না । আপনি কে?”  
“আমি কেয়ার করি না । আমি লন্ডনে নবাগত ।”  
“আপনার কপালে অনেক দুঃখ আছে । কতদিন এখানে এসেছেন?”  
“তাই হোক । তিন সপ্তাহ ।”  
“এ সম্পত্তি কখনো আপনার হবে না । আপনার কষ্ট কি?”  
“শয়তানরাও সে সম্পত্তি পাবে না । ওরা আমাকে অভুক্ত রেখেছে ।” (Doyle, 2015a).

Sena’s version goes like-

- ‘এ রকম একগুয়েমি করে কোনও লাভ হবে না । আপনি কে?’  
‘আমি তোয়াক্কা করি না । আমি একজন বিদেশি, লন্ডনে এসে পড়েছি ।’  
‘তাহলে তোমার অদৃষ্টে যা ঘটবে তার জন্য তুমি নিজেই দায়ী হবে । কতদিন এখানে এসেছেন?’  
‘তা হোকগে । তিন সপ্তাহ হল ।’  
‘ও সম্পত্তি জীবনেও আর তোমার হবে না । আপনার কী হয়েছে?’  
‘ও সম্পত্তি শয়তানদের খপ্পরে যাবে না । ওরা আমাকে খেতে না দিয়ে আটকে রেখেছে ।’ (Doyle, 2015b).

In the four translations of the same extract, there are usage of the same type of word. For instance, “obstinacy” is translated as “গোঁয়ারতুমি” (Bhardhan), “জেদ” (Choudhury and Haque), “একগুয়েমি” (Dutta) and “একগুয়েমি” (Sena). The choice of words by the translators from the West Bengal are the similar, but the Bangladeshi translators use “জেদ”. Again, the word “villains” has been translated almost in the same way: “শয়তানের বাচ্চা” ( Bhardhan), “শয়তান গুলোর” (Choudhury and Haque), “শয়তানরাও” (Dutta) and “শয়তানদের” (Sena) which

reflects that the connotation for "villains", on both the sides of the Bengal is devils. But we see drastic changes when it comes to the sentence – "Your fate will be on your own head" which is translated as: "অবাধতার শাস্তি মৃত্যু" (Bhardhan), "কথা মত কাজ না করলে মৃত্যু নিশ্চিত" (Choudhury and Haque), "আপনার কপালে অনেক দুঃখ আছে" (Dutta) and "তাহলে তোমার অদৃষ্টে যা ঘটবে তার জন্য তুমি নিজেই দায়ী হবে" (Sena). The translation for – "Your fate will be on your own head" – varies from being mere threat to death threat, but at the core, the gravity of the situation is conveyed. In these translations we see "transposition" of words- according to Duan (1994), which occurs due to "the working of Imagination". The four translators display four completely different versions of the translation of "The Greek Interpreter"; yet at the core they manage to convey the same message. By choosing different or same words the translators give an input of their own culture, showing that "the translator can initiate cultural change" (Tyulenev & Zheng, 2017). This choice of words reflects the translators' creativity to produce their translations for the target cultures. According to Das (2008) "translation is creative for it re-creates an SL text in a new way in the target-language" (p. 58). This creativity in turn reflects the concept of 'shensi' that "embodies both aspects of image producing faculty' and 'unifying artistic creativity'" (Cai, 2001). Again, the translation process goes through changes as evident in the aforementioned definitions on translation. From the analysis of the different translations of "the Greek Interpreter", it is unmistakably evident that the source text has gone through "transformation", however considering that the target texts have, in most of the instances if not all, managed to convey the intended meaning of the source text. Thus achieving, "an equivalent realm in the target text as that in the source text." (Huawen, 2014). This "realm of transformation" reflects Qian Zhongshu's concept of 'huajing.

## 5. Conclusion

This paper has attempted to move toward Comparative Translation, through its focus on the thorough understanding of the 'Impressionistic theories' propounded by Yan Fu, Fu Lei and Qian Zhongshu. The paper has applied these "Impressionistic theories" to four Bangla translations of "The Greek Interpreter". This study shows that, if Bangla can be read by employing Chinese theories, so can other languages that are like Bangla. This finding ultimately opens up a space for more accommodative and global study, that shows we do not have to rely on just western approach for studying translations.

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## **Book Review Reports on 'Moulik Parisankhyan' by Manindra Kumar Roy and Dulal Chandra Roy**

'Moulik Parisankhyan' written by Prof. Dr. Manindra Kumar Roy and Prof. Dr. Dulal Chandra Roy is an important and necessary addition in statistical learning in Bengali. It is not easy to write a book in Bengali. When I sat with this book for reviewing, I was amazed regarding the simple writing style of the authors and their easy to understand explanations of the basic statistical terms in Bengali.

For the last few years M.K. Roy solely and jointly published a number of text books ranging from Higher Secondary School to M.Sc. level. Fundamentals of Probability and Probability Distributions written by them is a well circulated text book in the South-East Asian region. Parisaankhik Binnash Parichiti Vol.1 and Vol. 2 written Dr. M.K. Roy and published by Bangla Academy was selected as one of the best research-based text books of Chittagong University in 1998 and Dr. M.K. Roy was awarded Ekushey Padak for the books.

A very few text books on Statistics have been written in Bangla so far. 'Mother tongue is the medium of instruction' is the key to the development of a nation. Countries in the developed world, especially Russia, Japan, China, Germany and even our Southeast Asian countries such as Thailand, Vietnam etc. are the bright examples and bear witness.

The book 'Moulik Parisankhyan' is a basic book on statistics written in Bengali. It goes without saying that there is no good textbook of statistics in the mother tongue for the students of university. Therefore, the book Basic Statistics, written for undergraduate students, demands special distinction.

At the beginning of the book, short biographies of four eminent statisticians that every student studying statistics must know, is an admirable initiative of the authors.

The book has seven chapters where the basics of statistics were discussed in a very simple and straightforward manner. A student studying statistics should know all these topics very well.

In the first chapter, the authors discussed the origin and meaning of the word statistics, its definition, important basic concepts, uses, historical background, importance, and its limitation which I think will make the students prepared to study statistics.

Data constitutes the foundation of all statistical analysis and interpretation. Hence the first step in statistical work is to collect data through proper data collection techniques. In the second chapter of the book, the authors discussed the important methods of collecting the different types of data, specially primary and secondary data. The collected raw data are then classified according to variables. Then the classified data have been summarized in the form of a frequency table. At these stages, the authors systematically presented the

summarized data by different types of diagrams and graphs according to the variable concerned.

The authors made a remarkable note that a numerical data set or its condensed form, the frequency distribution, has four important characteristics. They are central tendency, dispersion, skewness and kurtosis. They have been broadly discussed in the subsequent chapters three, four and five.

Central tendency is the most important characteristic of a data set which is the subject matter of the third chapter, the largest chapter, of the book. The two authors very carefully and elaborately described the concepts of central tendency, its important measures, their definitions, properties, advantages and disadvantages, uses, comparative studies, related theorems and a good number of worked-out examples. All these are very helpful for the first year students of statistics. We know, graphically, median is generally located from an ogive curve, yet in this book, the authors have logically shown how median can also be located from a histogram.

Dispersion is the second important characteristic of a frequency distribution or a data set which is the content of the fourth chapter of this book. The authors systematically discuss the concepts of dispersion, its definitions, important absolute and relative measures, important properties, related theorems and a large number of worked-out examples. Authors have truly mentioned that relative measures of dispersions are more important than absolute measures especially when two or more distributions are measured in different units of measurements. The one and only graphical method of dispersion is the Lorenz curve, which is used to measure the concentration of wealth of a country among the citizens, this is also discussed in this chapter. Important exploratory data analysis techniques such as Five Number Summary, Box and Whisker plots were discussed in a very simple way with multiple examples to measure the shape characteristics of a distribution.

Skewness and Kurtosis measures the shape characteristics of a set of data or a frequency distribution. Fifth chapter of this book deals with the important measures of skewness and kurtosis with a number of theorems and examples.

So far, the authors discussed the different statistical techniques based on a single variable. In practice, two or more variables can be obtained from each experimental unit of a population, or data may be obtained from more than one related variables. These types of data are usually analyzed with the help of correlation and regression analysis. Simple correlation and regression in case of two variables has been consistently discussed in chapter 6.

To understand the concept of simple correlation and its numerical measure correlation coefficient, the authors cited a number of very simple examples which helps the students clearly understand the concept of correlation. Then the authors discussed their important properties with a good number of theorems using practical examples. In a similar way, the

authors discussed the rank correlation. Lastly, simple regression lines and their regression coefficients, properties, uses, related theorem and a number of examples were successively discussed in this chapter.

Chapter seven is the extension of the chapter six where more than two related variables were considered. Here the authors again consecutively discussed multiple regression, multiple correlation and partial correlation in a very simple and easy way with quite a few related theorems and practical examples.

Finally, I would like to end with mentioning one crucial of limitation of this book. Information technology plays a significant role in solving various statistical problems and analyzing data in the present era. The statistical methods mentioned in this book can easily be solved by the software like Excel, SPSS, Stata, R, SAS, etc., an issue that has been completely overlooked by the authors. I believe that if the authors look into adding this in the next edition, it will be helpful to enrich the quality of the book.

Without any hesitation, I would say I liked reading the whole book on this circumstance as a reviewer. In writing the book, the authors have left their mark on their long statistical teaching knowledge and experience. Reading this book will benefit those who want to get a basic idea about statistics, including students of statistics. We expect more such books in the mother tongue from the authors. Finally, I wish the writers success and all the best for future such efforts.

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