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Military Institute of Science and Technology

**Volume 01, November 2022**

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***MIST Journal of Science and Humanities***



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ISSN: 2958-163X

## **Publisher**

**Department of Science and Humanities, Military Institute of Science and Technology (MIST),  
Dhaka, Bangladesh**

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## Message From the Chief Patron

I appreciate Department of Science and Humanities for publishing the first volume of its academic journal, *MIST Journal of Science and Humanities*. I am glad that the department maintained a very high standard of academic quality during the publication of this journal. I expect that the department will continue to accelerate its qualitative enhancement in education through intellectual endeavors.

Research journal is one of the important yardsticks to measure academic standard of an institute. The quality of articles and its impact on relevant field are also significant in research arena. The contents of the journal portray a sketch before me that it contains all these essences of research and I strongly believe this publication will quench the thirst of the scholars in the field of modern science and humanities.

I would like to express my sincere thanks to the editorial board and everyone involved in publishing the *MIST Journal of Science and Humanities* for their hard work and dedication.

I wish the *MIST Journal of Science and Humanities* will continue its journey with more success in future.

A handwritten signature in black ink, appearing to be 'Md Wahid-Uz-Zaman'.

**Major General Md Wahid-Uz-Zaman, BSP, ndc, aowc, psc, te**  
Commandant  
Military Institute of Science of Technology (MIST)



## Message from Chief Advisor

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It is with profound pleasure and anticipation that we celebrate the launch of the *MIST Journal of Science and Humanities*, an academic journal published by the Department of Science & Humanities, MIST. The Journal will contain original articles, review articles, and editorial.

It seems appropriate to emphasize the overriding reasons for launching the journal as well as our aspirations and visions. We believe that the *MIST Journal of Science and Humanities*, with a special address to Bangladeshi contributors, meets real scientific and societal community needs. We wish to assist in promoting and exposure of high-quality research achievements and intellectual input of researchers who often have limited access to sophisticated techniques of modern scholarly publications. We propose an extremely wide thematic scope, including various scientific areas (Physics, Chemistry, and Mathematics) as well as the Humanities arena (English, Sociology, Economics, and Accounting) because we believe that these days, any single published scientific article becomes an influential piece of work in the scientific information circuit and should be appropriately promoted in its environment.

I would like to express my heartfelt gratitude to the Chief Patron for his relentless encouragement and utmost support, our illustrious Editorial Team who worked tirelessly to choose the very best of the works, and the design team whose efforts helped bring colour and life to pages of dull numbers and letters, to the production team for their diligence, and last but not the least our reviewers for their invaluable contribution and support.

With the collective efforts of all parties involved, we encourage research and hope to establish a global platform on which the findings can be displayed.

A handwritten signature in black ink, appearing to read 'Shahin' or 'Shahinoor Alam', with a stylized 'COP' written below it.

**Colonel Md Shahinoor Alam, SPP, PEng**  
Head of the Department  
Department of Science & Humanities, MIST



## Message from Advisor

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By the grace of almighty Allah, the Science and Humanities Department is publishing, *MIST Journal of Science and Humanities* for the first time. It is a smart and timely decision that will assist to adopt state-of-the-art practices to evolve into a modern and scientifically advanced society. The Journal contains original articles, review articles, and editorial. It will also equip the innovators and scholars of the Science and Humanities Department to face the challenges of the Industrial Revolution 4.0.

I would like to express my heartfelt appreciation and gratitude to everyone involved in this monumental task for their hard work and contributions to this remarkable adventure.

It is our profound pleasure and anticipation that we celebrate the launching of the *MIST Journal of Science and Humanities*, an academic journal published by the Department of Science and Humanities, MIST.

A handwritten signature in black ink, appearing to read "Eare Md Morshed Alam". The signature is stylized and fluid.

**Colonel Eare Md Morshed Alam, PhD**  
Professor (Senior Instructor)  
Department of Science & Humanities, MIST



## Editorial

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***Relation between Science, Technology and Society.*** Science is a systematic curiosity-driven study that creates new knowledge that encompasses nature. Technology is the utilization of scientific knowledge to create new devices to solve/reduce the practical problem of society. Science aims to create knowledge and technology aims to find out solutions to the more practical problems of the universe. Therefore, technology is the application of science in a way to reduce human effort. As an example, the discovery of X-rays was accidental and without any intention to be applied in the medical field. Later, engineers utilized this idea not only in the medical field, but also in structural analysis of materials, airport security, astronomy, and so on.

On the other hand, Science also depends on technology to find the practical application of the knowledge generated by scientific research. In addition, technology helps science to gather new information that would have been impossible by providing the latest experimental techniques. For example, the discovery of computer helped scientists in analyzing data/simulating an experiment without doing it in the real world. Therefore, science and technology are mutually dependent.

Based on the number of scientific papers and patents produced, A. Bernardes *et al.* (2003) classify countries into three categories. Countries having no or very less scientific papers and patents, no connections between the scientific and technological fields belong to category I. Most of the least developed countries belong to this category. Category II countries are mostly developing countries that produce scientific papers and patents but the connections between scientific and technological fields are absent. On the other hand, developed countries have sufficient scientific and technological infrastructure and very good connections between them, belonging to category III.

Therefore, the mutual dependence on science and technology is related to the development of society and depends on collaboration amongst scientists, technologists and different organizations to fulfill the requirements of society. When the society is developed, it can invest more money for the development of science and technology. So, the adequate interaction pattern between science, technology and the level of societal development is the key to build a developed country. This means that science determines technological and societal development and reciprocally is being determined by technology, and society.

A handwritten signature in black ink, appearing to read 'Md Jafar Sharif'.

**Lieutenant Colonel Md Jafar Sharif, PhD, Sigs**  
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# Domain Specific Language Implementation in English Language Teaching at MIST

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**Abstract—** The concept of Domain Specific Language (DSL) was introduced by Martin Fowler (2005), a software developer. Few examples of DSL are HTML, DOT, SQL, XML etc. However, this research will comprehend DSL as the comprehension related to departmental/core courses, in the broad spectrum. Languages are tools to solve problems and domain specific languages are specific tools that serve to solve a limited set of problems. Following that idea, this research will shed light on using DSL as an English language teaching approach for Military Institute of Science and Technology's students and its benefits. It will also accumulate student's responses to this teaching method. And in a broader context, whether teachers are familiar, comfortable and well-equipped to apply this method in their English language teaching classrooms.

**Keywords—** domain specific, English language teaching, teaching material

## I. INTRODUCTION

Military Institute of Science and Technology is one the leading educational institutes for engineering students of Bangladesh. It mainly offers tertiary engineering studies in up to eleven different branches. To encourage the fluency and efficiency of using English language as means of communication in both student life as well as professional, all engineering students are offered a "Communicative English Language" course. As Thanky depicts, "Lack of sufficient

communication skills serves only to undermine the image of the engineer." [1]. Thus MIST puts a special value on this foundation course. The course entails the four language skills (reading, listening, writing, speaking) and additionally teaches presentation skills for the students' benefit. Sadly, most students opt out of responding or showing interest in the class if the classes follow a traditional and conventional style of taking an English class. Making the students interact amongst each other as well as with the teacher in a familiar or relatable context helps them find a definite purpose to their English lessons [2]. It optimizes the class to be student centric which is evidenced to be the most effective approach to language teaching.

However, being learners of the science stream, it is expected that students will show interest in engaging with the class if they find the material is related with his/her original genre of studies. In technical terms, the learning materials being oriented around their respected Domain Specific languages is expected to elevate the students' quality and effectiveness of learning English. For example, a Mechanical Engineering class might be asked to practice tasks on a passage on Friction or Force. An appropriate example of teaching material for this class would be 'English in Mechanical Engineering' by Eric H. Glendinning. In the same way, English literature related to specific domains of engineering, such as Twenty Thousand Leagues Under The Sea by Jules Verne, can be used as teaching material for Naval and Marine Engineering students.



The “Communicative English Language” course offered to MIST, level 1 and 2 students thus reflects such an attempt to teach English to tertiary level students in a Domain Specific approach. 209 students participated in a survey which collected their feedback on the specific approach. This paper hence suggests the DSL approach to teaching tertiary level students English as a foundation course.

## II. LITERATURE REVIEW

English Language has become a foundation course for most undergraduate university students. Engineering students are no exception to it. The reason for this is that it provides a platform to learn, practice and improve oneself in the communication and academic sector. Shrestha, *et al.* state, “People involved in diverse fields and professions use it as a means of communication to acquire information, clambering the ladder in their academic field, and reaching the summit of success in their endeavors, conducting researches, publishing their research findings and executing their duties in their respective areas of work”[3]. In the past, the Grammar Translation Method (GTM) and the Communicative Language Teaching (CLT) method were used to teach this tertiary level foundation course. This research aims to show that by applying a Domain specific language implementation approach to teaching this foundation course can help us engage the students more and provide a more tailored education for a diverse stream of students.

Polina V. Ermakova and Olga G. Rossikhina, educators from National University of Science and Technology MISiS, Moscow, Russia, share similar research on Teaching Domain-Specific English to Engineering Students through SPRE Model-Based Projects [4]. Inspired by that, this research aims to create a groundwork for Domain Specific Language implementation in tertiary level of English Language teaching that is being applied at MIST in its foundation English course for engineering students.

## III. RESEARCH METHODOLOGY

For this research, a quantitative method is adopted because this method will provide the definitive statistics to explore the research findings and address its results, benefits and lacking equally. A number of 209 BSc students of the Communicative English Language course, conducted in the Military Institute of Science and Technology, participated in this research. The students’ native tongue is Bengali and they received education on English language as a compulsory subject throughout their primary, secondary and higher secondary education. The data collection process for this research includes a questionnaire administered among 14 lessons of the course from various departments of the institute. As learned from classroom observation and in person viva, there is a mix of advanced, intermediate and beginner learners in every classroom. It can be surmised that the participants understand the English language generally, though around 10% of them struggle to produce the basic language skills.

The questionnaire was used to collect quantitative data mostly with close-ended information to gather the students’ response to the DSL study approach. An open-ended question was also included in the questionnaire in order to learn more in depth about the students’ feedback. The quantitative data from the questionnaire was generated through Google Forms and analyzed with the percentage of responses.

To learn about the students’ response towards the DSL teaching approach, they were asked about their satisfaction level about the English course, they were also enquired to ensure whether their classes were taught with DSL materials with regard to the quadripartite skills of language. It is essential to make sure that the students are developing their competency in all four skills, thus we must focus on distributing the DSL material application while teaching Reading, Writing, Listening and Speaking. Then, the participants were asked to rank their learning

experience and preference with regards to different skills. With these questions, the survey attempted to learn about the participants' state of acceptance and their personal suitability to the DSL implemented English Language course. In addition to that, students were asked to inform how much time in a singular class span were approximately spent on teaching with DSL materials and specifically in with form (i.e: audio, visual, audio-visual, text, games or other)

The questionnaire aimed to find out the students' adaptability state with the implementation of DSL and to identify the weakness and shortcomings of the approach. Furthermore, it attempted to learn about the students' opinion and suggestions for improvements. It also acted as a confirmation that the previously adopted method was neither preferred nor benefitted the participants.

#### IV. RESULTS AND DISCUSSION

A structure of frequency counts and percentage analysis frame was followed for the data analysis, where students participated in a Google Form questionnaire survey. For this research, the survey was conducted within the level 1 and 2 (1st and 2nd years) students of MIST, who have taken the "Communicative English Language" course. 209 students were participants of this survey, where 31.1% were from Electrical, Electronics and Communication Engineering department, 20.1% from Aeronautical Engineering department, 14.4% from Civil Engineering department and rest from other departments (figure 1).

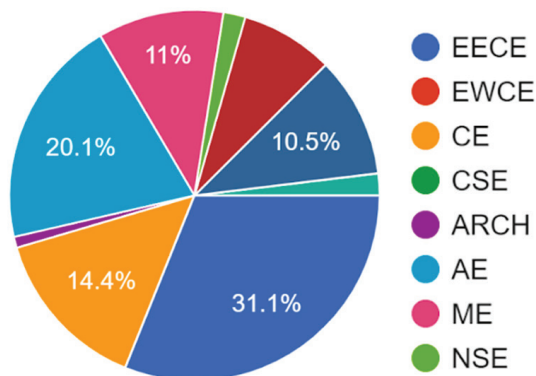


Fig. 1. Participant diversity

The participants shared their responses on how often they were taught with DSL in terms of four different skills of language. On average, 70-75% of students opined on a more frequent response. (figure 2). Students were asked to complete Reading tasks on comprehensive passages related to their educational domain. Whereas for Writing, Listening and Speaking, general as well as DSL tasks were practiced. The reason for being inclusive in teaching other skills is to help the students achieve commendable communication skills outside their study purposes too.

Were You Taught with Domain Specific Materials for Teaching Different Skills?

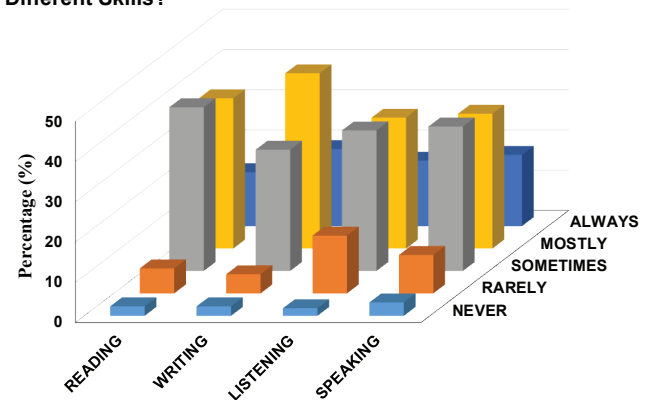


Fig. 2. Usage frequency of DSL in classroom.

One of the limitations found from this evaluation is there is a definite shortage of availability of teaching materials; hence some skills were difficult to keep relevant to DSL. J. Porcaro also shares similar statement that "in most circumstances ESP teachers have limited time and resources" [5]. However, out of 14 scheduled classes, each class was 3 hours long, which provided ample opportunity to conduct a class with at least some portion of DSL materials. Students were asked to identify the form in which they received these materials. Most identified answer was Textual form, Audio and Audio-Visuals being the second most used form in class (figure 3). The reason for so is that teachers tend to prioritize reading skills while using DSL materials, keeping in mind the students' academic needs. Moreover, as the major source for the materials is internet or relevant journals, it is understandable why Text, Audio and Audio-Visual were elected as the most used form of materials.

**In Which Form Were You Provided With Domain-Specific Materials? (Choose As Many Answer Applies)**

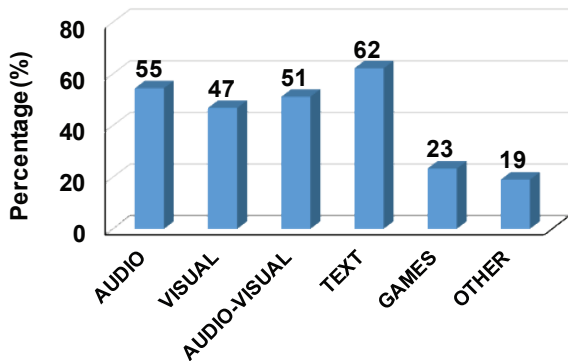


Fig. 3. Identification of form of DSL material used in class.

Students' overall response on how much they believe they have benefited from the DSL implemented course, was collected through the questionnaire. Figure 4 shows that the majority of the students hold a positive review on this matter. Writing and Speaking skills seem to be most agreed upon by the students with the most number of agreeable responses. Writing skills were practiced with short paragraphs, assignments and essay writing on topics relevant to engineering students. Whereas speaking skills were practiced with storytelling, presentations, role plays etc. As these two skills are output based, it is easily understandable why students felt they benefited most from it. On the other hand, Reading and Listening are both input based, thus making it essentially hard to realize the improvements within a short span of time.

**How Much Did You Benefit Being Taught With A Domain Specific Approach?**

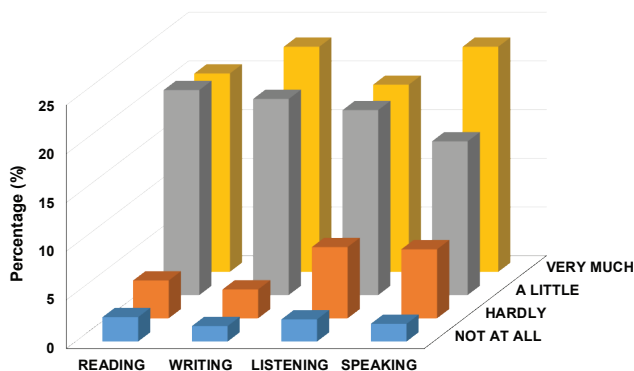


Fig. 4. Students response on DSL approach's benefit on different skills

To concur that the Domain Specific Language Implementation approach is much more suitable

for the engineering students, students were asked to provide their opinion (figure 5). 41.1% of students opined that it is mostly better than the traditional curriculum. Additionally, 30.1% decided that it was indefinitely more effective. In a traditional curriculum of a foundation English course, topics like grammar, translation, letter and essay writing are mostly included. Which do not aim to benefit the diversity of students. Moreover, the examples and tasks set through the traditional curriculum also fail to relate to diverse students' needs. Hence, to bring about a change in the English language education at the tertiary level, a change of traditional approach is a must.

**Do You Think Teaching With Domain Specific Materials Is More Effective Than Traditional English Language Teaching Method?**

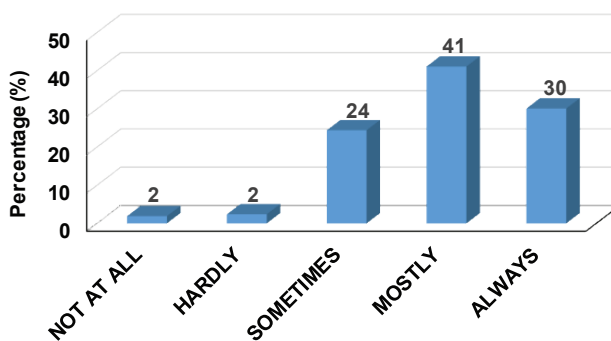


Fig. 5. Effectiveness of Domain Specific Materials in comparison with traditional method.

One other limitation of this course was in a large class of 50+ students it is rather a monumental work to check on every student's assigned task/script in the class and provide feedback on it. Within the allotted time, the teacher can only check a few scripts [6]. In which case, teacher usually ends up checking scripts of only of those who are fast and good student in comparison. Whereas, weaker students are usually left out from task completion or receiving feedback, due to their slow activity [7].

## V. CONCLUSION

Although this research was conducted within a limited scope, the main goal was to learn about the DSL implementation approach's success at

MIST. In an attempt to cover a thorough survey among the applicable students, the research scoped out a few intriguing relevant studies. For instance, it could not go into depth about whether there should be a model or structure to follow with the DSL approach. It could not delve into the search for a sufficient source of DSL material either. Another thing that was omitted in this paper is the next phase into this research; a needs analysis to improve the content and structure of the course.

MIST is an institute of impressive population and diverse disciplines. There are 12 departments existing in the institute where 11 of them are of engineering origin. Therefore, to cater to the diverse demands of the students, implementation of the DSL approach was unavoidable.

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Her research interests include Language and Communication Development, OER, and South-East Asian Literature



# Sensitivity Analysis in Transportation Problem: Monitoring Changes in Market Equilibrium Implementing Optimization Methods and Business Software

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**Abstract**– The focus of this study is to perform sensitivity analysis (SA) to make strategic decisions. Mathematical formulation of Transportation Problems (TP) of manufacturing goods is considered in this work. The data gathered are modeled as a Linear Programming Problem (LPP) and solved with a computer programming language known as LINDO to generate an optimal solution. Then, SA is carried out using the idea of the total differential of changes to the right hand side parameters in TP. The results are also examined using a standard method known as Arsham and Kahn's simplex algorithm as well as LINDO. These types of strategic procedures of SA of TP can be proved useful for making strategic decisions by the logistics managers in optimum decision making to minimize transportation cost.

**Keywords** — TP, LPP, SA, LINDO, Simplex Algorithm

## I. INTRODUCTION

LP is one of the greatest successes to emerge from operation research and management science. It is well developed and widely used. LP problems in practice are often based on numerical data that represent rough approximation of quantities that are inherently difficult to estimate. Because of this, most LP-based studies include a post optimality investigation of how a change in the data changes the solution, which is generally known as SA. TP

on the other hand is one of the most important and successful applications of quantitative analysis to solve business problems [15]. Generally, the purpose of this problem is to minimize the cost of transporting goods from one location to another which can meet the needs of each arrival. But the methods of solving TP sometimes create difficulties. If we convert these problems to Linear Programs and use computer based programs, the difficulties are removed. Market equilibrium is highly influenced by the changing scenario of supply and demand variables. In TP, the right hand side parameters represent the supply and demand quantities which have functional relationship between them. This is why, simultaneous changes should be considered in SA of TP as opposed to traditional methods.

In the past few decades, TP has received noteworthy attention in the literature. As a special type of Linear Programming Problem in 1939, Kantorovich first identified the transportation problem. F.L. Hitchcock modeled the standard mathematical formulation of the problem in 1947. Charnes and Cooper proposed in 1945 the North-West Corner rule for finding an initial basic solution and presented the simplex based stepping stone method [15].

Surprisingly, a lot of real-world applications may be expressed as a TP [3, 7, 12, 14, 15]. In recent years, transportation model sales have increased significantly. Stepping Stone (SS) is the most well-known technique for resolving this





issue [6]. Even though TP has been examined by a number of writers [2, 8–10] and they have developed fresh methods for solving it, sensitivity analysis of TP has not yet been taken into account. Managers who are dealing with changes in warehouse inventory can assess the ratio of changes to the best solution (optimal transportation) to changes to the parameters using post optimality analysis of TP. For instance, research on supply and demand changes may lead to discussions with department shops and store owners to find the best solution. A transportation problem is as tedious and challenging to formalize and solve as a linear programming problem. Because artificial variables are required to create a simplex table, thus the calculations are more complex. The SS algorithm is therefore the best one to solve the problem because it is based on the particular structure of the transportation problem model. Rarely is a transportation problem's sensitivity analysis of the SS-derived solution performed. Regarding the SS solution, Srinivasan and Thompson proposed a method for analyzing the sensitivity of the transportation problem, which was tedious and required numerous calculations [12]. As there is no basic inverse matrix in the ultimate table, the information given by the SS method is insufficient for the SA, it becomes impossible for this algorithm to perform SA of the TP. In order to examine the sensitivity of the transportation problem, Ravi and Wendell provided a method that used symmetric tolerance analysis and a successful networked algorithm. However, their SA is rather constrained, which results in the unrealistic bounds [11]. Unfortunately, the above method relies on trial and error to answer the query regarding the additional value of supply and demand that leads to an optimal solution. However, this issue is also resolved by Arasham and Kahn's algorithm, which was developed to address the TP via simplex. They illustrated a straightforward simplex technique using the properties of the coefficient matrix to solve the TP [4]. A few years later, in 1992, Arsham examined the

sensitivity of the TP's right-side values using the Arsham and Kahn method [5]. A single equal rise in supply and demand is taken into account in Winston's later introduced sensitivity analysis [14]. If the values of several demand and supply variables change at the same time, this SA will be ineffective. These problems make the approach suggested by Doustdargholi, Derakhshan, and Abasgholipour [1] highly effective.

## II. MATHEMATICAL MODEL

### A. Formulation of TP as LP

A specific model of linear programming problems is the transportation problem (TP). The elements that make up this problem are listed below [4]:

- A set of supply points from which a good is transported;  $O_1, O_2, \dots, O_m$ . E.g., depository or farm.
- A set of  $n$  demand points to which a good is transported;  $D_1, D_2, \dots, D_n$ . E.g., shops or stores.
- A list of  $m$  supplies with  $s_m$  units;  $s_1$  units from the resource  $O_1$ ,  $s_2$  units from the resource  $O_2$  and so on up to  $m$  resources.
- A list of  $n$  demands or needs;  $d_1$  units needed  $D_1$ ,  $d_2$  for units needed for  $D_2$  upto  $n$  demands.
- A list of transportation costs,  $c_{ij}$  the unit shipping cost of a product from  $O_i$  to  $D_j$  and there are numbers of these values.

The objective is to identify a transportation solution that satisfies all requirements while offering the lowest shipment cost. The numbers of the transported units from  $O_i$  to  $D_j$  are indicated by  $x_{ij}$  in the number of  $mn$  decision variables. The total transportation cost is obtained as follows:

$$z = \sum_{i=1}^m \sum_{j=1}^n c_{ij} x_{ij} \quad (3.1)$$

Each TP can be considered as ‘balanced’ or can be easily converted into a balanced one without loss of generality by adding required numbers of slack or dummy variables holding the following condition:

$$\sum_{i=1}^m s_i = \sum_{j=1}^n d_j \quad (3.2)$$

where, the supply and demand quantities in a TP must satisfy the following constraints:

$$\sum_{i=1}^m x_{ij} \leq s_i; \quad i = 1, 2, \dots, m \quad (3.3)$$

$$\sum_{j=1}^n x_{ij} \geq d_i; \quad j = 1, 2, \dots, n \quad (3.4)$$

The matrix form of TP is given below:

$$\min \sum_{i=1}^m \sum_{j=1}^n c_{ij} x_{ij}$$

$$s. t. \quad Ax \leq b$$

$$x \geq 0$$

where,  $b = (s_1, s_2, \dots, s_m, -d_1, -d_2, \dots, -d_n)^T$

= vector of right hand-side

$A$  = coefficient matrix of TP

$B$  = basic variables coefficient matrix

which consists of  $m+n-1$  rows

$$(Rank(A) = m + n - 1)$$

Set  $S_b$  allocates the indices of basic variables. Because of this, there are  $m+ n-1$  non-negative members in each basic solution of TP. As a result, one of the transportation constraints is no longer necessary, and the following equation is set for the coefficient matrix's unimodularity:  $|B| = 1$  [11].

### B. Sensitivity Analysis for Changes in Right Hand Side Parameters

To perform sensitivity analysis of TP, the method proposed by Doustdargholi, Derakhshan and Abasgholipour [1] is implemented. Soon after obtaining the optimal solution, the right hand-side values of the concerned TP are changed. Following that, the changes in optimal solution and optimal value are examined.

Let us consider the optimal solution to be as follows:

$$z^* = c_B B^{-1} b \quad , \quad X_B^* = B^{-1} b \quad (3.5)$$

where,  $c_B$  coefficient vector of objective function

$X_B^*$  = basic optimal solution

$z^*$  = the optimal cost

Thus, the ratio of variation of optimal solutions as well as optimal values with respect to the variations  $b_i$  of are as follow:

$$\frac{dx_B^*}{db} = B^{-1} \quad , \quad \frac{dx_{B^i}^*}{db_k} = y_{i,k}^* \quad k = 1, 2, \dots, m \quad (3.6)$$

where,  $y_{i,k}^*$  from the  $(i, k)^{th}$  element of the matrix  $B^{-1}$ .

### C. Changes in Market Equilibrium (Supply and Demand)

In case of deciding market equilibrium, supply and demand are changing variables that have mutual impact on one another. Suppliers always attempt to sell a product in a price as much as they possibly can, while consumers normally attempt to buy products for the lowest possible price. The sensitivity analysis of the right-side parameters in the TP cannot be carried out using the conventional methods for two reasons.

First, multiple parameters may be altered at once in place of just one, and second, the modified parameters must also satisfy the following balanced equation ( $\sum s_i = \sum d_j$ ) (At least one additional right-side parameter needs to be altered since the TP is balanced.)

As a result, the way that the parameters are examined now differs from how it was done with earlier sensitivity analysis techniques. In this particular approach, the idea of complete

differential technique is applied to obtain and measure these values. Among the right hand side parameters changes in 'k' parameters are considered. The condition  $\sum s_i = \sum d_j$  and constraints  $\Delta d_j < d_j$  and  $\Delta s_i < s_i$  are set to keep the TP balanced. Thus, the concerning equations are set as follows with respect to the complete differential concept.

$$dx_{B_i}^* = \frac{\partial x_{B_i}^*}{\partial b_1} db_1 + \frac{\partial x_{B_i}^*}{\partial b_2} db_2 + \dots + \frac{\partial x_{B_i}^*}{\partial b_m} db_m \quad (3.7)$$

In case of general changes in the complete differential part, we consider,  $db_1 = \Delta b_1$ , hence  $dx_{B_i}^* = \Delta x_{B_i}^*$  is set. Now,  $\frac{dx_{B_i}^*}{db_k} = y_{i,k}^*$  is replaced in equation (2.7) and in terms of the changes in k parameters of right hand-side values as well, the equations stated below are set:

$$\Delta x_{B_i}^* = y_{i,1}^* \Delta b_1 + y_{i,2}^* \Delta b_2 + \dots + y_{i,k}^* \Delta b_k \quad (3.8)$$

Due to the unimodularity state of B and since  $y_{i,j}^*$ ,  $j = 1, 2, \dots, k$ , are the entries of  $i^{\text{th}}$  row of matrix  $B^{-1}$ , the following equation is set:

$$\Delta x_{B_i}^* = \sum_{j=1}^k \alpha_j (\Delta b_j), i = 1, 2, \dots, m, \alpha = 1 \text{ or } -1 \text{ or } 0 \quad (3.9)$$

It is certain that the parameters are to be altered in such a way that optimal basis stays unaltered in the sensitivity analysis of a problem. Thus, after the right-hand side values are changed, we are supposed to have:

$$x_{B_i}^* + \Delta x_{B_i}^* \geq 0, \quad i = 1, 2, \dots, m$$

In this way, even after alterations, the basis remains feasible. The approach described below is used to simultaneously change the right-side parameters and analyze the feasible optimal solution and the unchanged basis:

The bounds for  $\Delta b_i$  that do not result in infeasibility of an optimal solution must be found first. Following equations are set for  $\Delta b_i$  as example:

$$x_{B_i}^* + \Delta x_{B_i}^* \geq 0, \quad i = 1, 2, \dots, m$$

$$x_{B_i}^* + \Delta x_{B_i}^* \geq 0, \quad i = 1, 2, \dots, m$$

$$x_{B_i}^* + [y_{i,1}^* + y_{i,2}^* \frac{\Delta b_2}{\Delta b_1} + y_{i,k}^* \frac{\Delta b_k}{\Delta b_1}] \Delta b_1 \geq 0, \quad i = 1, 2, \dots, m$$

$$x_{B_i}^* = \frac{dx_{B_i}^*}{db_1} \geq 0, \quad i = 1, 2, \dots, m$$

$$i = 1, 2, \dots, m$$

$$\text{If } \frac{dx_{B_i}^*}{db_1} < 0,$$

$$\text{then } db_1 \leq \frac{-x_{B_i}^*}{\frac{dx_{B_i}^*}{db_1}}$$

In general,  $\Delta b_1 \leq \min_{S_B} \left\{ \frac{-x_{B_i}^*}{\frac{dx_{B_i}^*}{db_1}} \mid \frac{dx_{B_i}^*}{db_1} < 0 \right\}$  is set which

refers to the maximal changes of  $b_1$ , where  $S_B$  is set of basis variables.

is set which refers to the maximal changes of  $b_1$ , where  $S_B$  is set of basis variables. The ranges of other parameters can be achieved in a similar way.

#### D. Problem Discussions

1) *Numerical Example 1:* In order to understand the aforementioned aspects better, the suggested Warehouse and industry example [11] is adopted, and the variations in supply and demand values are checked. In Table 1, the cost of transportation is showed.

TABLE 1. TP OF RAVI AND WENDELL

	$D_1$	$D_2$	Supply
$O_1$	20	30	200
$O_2$	10	40	100
Demand	150	150	300

2) *Optimal Solution 1:* The numerical solution using commercial software LINDO is given below:

```

F:\LINDO61\Samples\Ex41.ltx
min 20x11+30x12+10x21+40x22
subject to
x11+x12<=160
x21+x22<=140
x11+x21>=195
x12+x22>=105
    
```

Fig. 1. (a) LP formulation of Ravi and Wendell problem

LP OPTIMUM FOUND AT STEP 3

OBJECTIVE FUNCTION VALUE

1) 6500.000

VARIABLE	VALUE	REDUCED COST
X11	50.000000	0.000000
X12	150.000000	0.000000
X21	100.000000	0.000000
X22	0.000000	20.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	0.000000
3)	0.000000	10.000000
4)	0.000000	-20.000000
5)	0.000000	-30.000000

NO. ITERATIONS= 3

RANGES IN WHICH THE BASIS IS UNCHANGED:

VARIABLE	CURRENT COEF	OBJ COEFFICIENT RANGES	
		ALLOWABLE INCREASE	ALLOWABLE DECREASE
X11	20.000000	INFINITY	10.000000
X12	30.000000	20.000000	30.000000
X21	10.000000	10.000000	INFINITY
X22	40.000000	INFINITY	20.000000

ROW	CURRENT RHS	RIGHTHAND SIDE RANGES	
		ALLOWABLE INCREASE	ALLOWABLE DECREASE
2	200.000000	INFINITY	0.000000
3	100.000000	50.000000	0.000000
4	150.000000	0.000000	50.000000
5	150.000000	0.000000	150.000000

Fig. 1. (b) LP formulation of Ravi and Wendell problem

In Fig. 1 optimal solution and post optimality SA results obtained using LINDO is shown along with the LP formulation of the problem depicted in Table 1.

Arsham and Kahn transportation simplex [4] results into the optimal solution as follows:

$$B^{-1} = \begin{bmatrix} 1 & 0 & -1 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$x_B^* = (x_{11}, x_{21}, x_{12}) = (50, 100, 150), z^* = 6500$$

3) SA of right hand side parameters I: In this problem, the changes in amounts of supplies and demands are respectively represented as  $\Delta s_1$ ,

$\Delta s_2$ ,  $\Delta d_1$  and  $\Delta d_2$ . The following changes in supply and demand values are considered for SA:

$$\Delta s_1 = -40, \quad \Delta s_2 = 40, \quad \Delta d_1 = 45, \\ \Delta d_2 = -45$$

Thus  $\sum \Delta s = \sum \Delta d$ .

LINDO provides the following out put, imposing the above changes shown in Fig 2.

LP OPTIMUM FOUND AT STEP 0

OBJECTIVE FUNCTION VALUE

1) 5650.000

VARIABLE	VALUE	REDUCED COST
X11	55.000000	0.000000
X12	105.000000	0.000000
X21	140.000000	0.000000
X22	0.000000	20.000000

ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	0.000000
3)	0.000000	10.000000
4)	0.000000	-20.000000
5)	0.000000	-30.000000

NO. ITERATIONS= 0

RANGES IN WHICH THE BASIS IS UNCHANGED:

VARIABLE	CURRENT COEF	OBJ COEFFICIENT RANGES	
		ALLOWABLE INCREASE	ALLOWABLE DECREASE
X11	20.000000	INFINITY	10.000000
X12	30.000000	20.000000	30.000000
X21	10.000000	10.000000	INFINITY
X22	40.000000	INFINITY	20.000000

ROW	CURRENT RHS	RIGHTHAND SIDE RANGES	
		ALLOWABLE INCREASE	ALLOWABLE DECREASE
2	160.000000	INFINITY	0.000000
3	140.000000	55.000000	0.000000
4	195.000000	0.000000	55.000000
5	105.000000	0.000000	105.000000

Fig. 2. Obtained optimal solution  $z=5650$  using LINDO

The newly formulated LP of TP considering the changes in supply and demand parameters are shown in Fig. 2. Optimal solution  $z = 5650$  is obtained using LINDO is also shown.

Again, for the same changes Arsham produced basic solution is given as follows:

$$x_B^* = (x_{11}, x_{21}, x_{12}) = (55, 140, 105), \\ z^* = 5650$$

It is obvious that these adjustments to supply and demand reduce transportation costs by 850. Now we use the other approach of complete differential [1], thus the following equations are generated:

$$\Delta x_{Bi}^* = [y_{i,1}^* \Delta s_1 + y_{i,2}^* \Delta s_2 + y_{i,3}^* \Delta d_2]$$

$$\Delta x_{1,1}^* = [y_{1,1}^* \Delta s_1 + y_{1,2}^* \Delta s_2 + y_{1,3}^* \Delta d_2] \\ = 1(-40) + 0 - 1(-45) \\ = 5$$

$$\Delta x_{2,1}^* = [y_{2,1}^* \Delta s_1 + y_{2,2}^* \Delta s_2 + y_{2,3}^* \Delta d_2] \\ = 0 + 1(40) + 0 \\ = 40$$

$$\Delta x_{1,2}^* = [y_{3,1}^* \Delta s_1 + y_{3,2}^* \Delta s_2 + y_{3,3}^* \Delta d_2] \\ = 0 + 0 - 1(-45) \\ = -45$$

The outcome for the respective problem is obtained as follows:

$$\begin{aligned}
 x_B^* &= (x_{11}, x_{21}, x_{12}) \\
 &= (50 + 5, 100 + 40, 150 - 45) \\
 &= (55, 140, 105) \\
 z^* &= 5650
 \end{aligned}$$

Now the valid changes for  $s_1$  to avoid infeasibility and the range of its changes are examined,

$$\begin{aligned}
 \frac{dx_{Bi}^*}{ds_1} &= y_{i,1}^* + y_{i,2}^* \frac{\Delta s_2}{\Delta s_1} + y_{i,3}^* \frac{\Delta d_2}{\Delta d_1} \\
 \frac{dx_{11}^*}{ds_1} &= \frac{-1}{8}, \quad \frac{dx_{21}^*}{ds_1} = -1, \quad \frac{dx_{12}^*}{ds_1} = \frac{9}{8} \\
 \Delta s_1 &\leq \min \left\{ \frac{-100}{-1}, \frac{-50}{\frac{-1}{8}} \right\} = 100
 \end{aligned}$$

Apparently,  $\Delta s_1 = 40$  is imposed to the condition stated above. Therefore, these modifications prevent the problem from becoming infeasible. Similarly, the following constraints are set:

$$\Delta d_2 \leq \frac{100}{8}, \quad \Delta s_2 \leq \frac{1200}{9}$$

Hence for the above problem we can conclude that, similar solution is obtained utilizing both methods mentioned in this paper as well as using LINDO under the observation of identical changes in right hand side parameters.

4. *Numerical Example 2:* Let us take a look into another problem where the number of supply points and demand points are not equal that is an unbalanced problem widely known as Davis and Colleagues [5] TP. This problem considers three supply points and two demand points which is further converted into the balanced one as shown in Table 2.

TABLE 2. BALANCED TP OF DAVIS AND COLLEAGUES

	$D_1$	$D_2$	$D_3$	Supply
$O_1$	3	6	0	400
$O_2$	4	5	0	300
$O_3$	7	3	0	400
<b>Demand</b>	450	350	300	1100

5. *Optimal Solution 2:*

The solution using LINDO is given below:

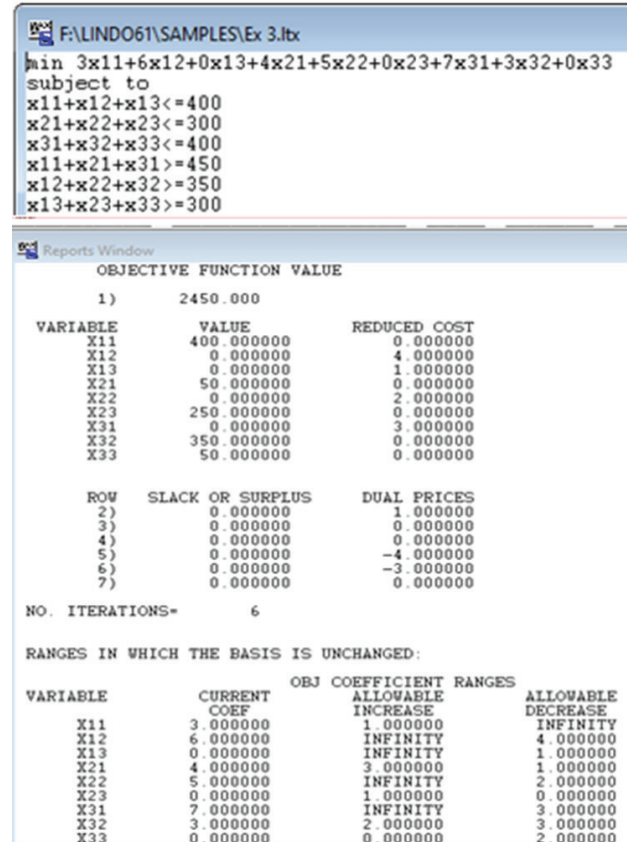


Fig. 3. Obtained Optimal solution  $z=2450$  using LINDO

In Fig. 3 The optimal solution of the Davis and Colleagues problem obtained using LINDO is shown along with SA. Now the optimal solution obtained by Arsham and Kahn simplex algorithm [4] the optimal solution as follows:

$$B^{-1} = \begin{bmatrix} 1 & 0 & -1 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$x_B^* = (x_{11}, x_{21}, x_{12}) = (55, 140, 105)$$

$$z^* = 5650$$

6. *SA of right hand side parameters 2:* The values of changes of supply and demand's in this particular problem are represented as  $\Delta s_1, \Delta s_2, \Delta s_3, \Delta d_1, \Delta d_2$  and  $\Delta d_3$  respectively. In order to

perform SA, following changes are assumed for the variations in supply and demand's values:

$$\begin{aligned}
 \Delta s_1 &= 10, & \Delta s_2 &= 20, & \Delta s_3 &= -20, \\
 \Delta d_1 &= 5, & \Delta d_2 &= -20, & \Delta d_3 &= 25
 \end{aligned}$$

Implementing above changes in transportation problem,

$$(x_{21}, x_{23}, x_{33}, x_{11}, x_{32}) = (45, 275, 50, 410, 330)$$

$$\Delta x_{21}^* = -5, \quad \Delta x_{23}^* = 25, \quad \Delta x_{33}^* = 0,$$

$$\Delta x_{11}^* = 10, \quad \Delta x_{32}^* = -20$$

Hence, obtained results is :

$$x_B^* = (x_{21}, x_{23}, x_{33}, x_{11}, x_{32})$$

$$= (50 - 5, 250 + 25, 50 + 0, 400 + 10, 350 - 20)$$

$$= (45, 275, 50, 410, 330)$$

$$z^* = 2400$$

The solution using LINDO is given below:

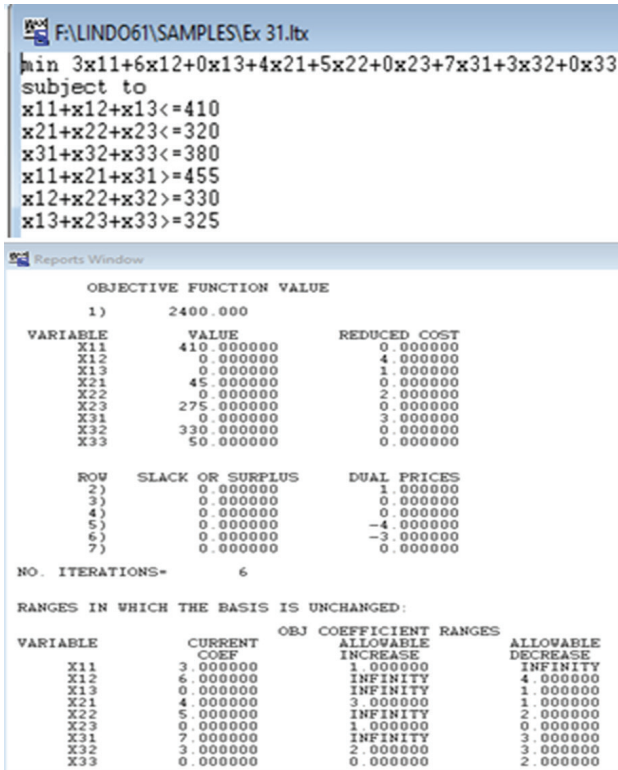


Fig. 4. Obtained optimal solution  $z=2400$  using LINDO

In Fig. 2 the newly formulated LP of TP considering the changes in supply and demand parameters are shown with an optimal solution obtained using LINDO.

### III. RESULTS AND DISCUSSION

In the stated problem of Ravi and Wendell [11] LINDO gives an optimal solution of (Fig.

1), which well agrees with the obtained result of Arsham-Kahn simplex algorithm [4]. In case of post optimality analysis, the allowable changes of supply and demand ranges were determined by the SA method of TP of Doustdargholi, Derakhshan and Abasgholipour [1]. Changes of righthand side parameters were considered accordingly. The optimal result again agrees with LINDO shown in Fig. 2. In this case, transportation cost was reduced by 850.

Similarly, in case of the problem of Davis and Colleagues [4] transportation cost is reduced upto 50 shown in Fig 4. In both cases validity of the methods were established.

### IV. CONCLUSION

In this paper, simultaneous analysis of right hand parameters is done using well established business software LINDO. Due to the unavailability of the inverse basic matrix in LINDO, infeasible outcomes in simultaneous analysis of changes in right hand side parameters may occur from time to time. This particular issue is also applicable for the benchmark method of Arshan-Kahn Algorithm. We have implemented a comparatively new method using the idea of total differential of variations for SA of right hand side parameters in TP proposed by Doustdargholi and Derakhshan in order to address the issue. Feasible optimum results were found and the validity of the method was examined. This types of procedure may prove to be fruitful for logistic managers in case of strategic decision making. This may open the door of scientific decision making as opposed to subjective or intuition based approaches and provide better optimality in TP.

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# Coir Fiber Composites and Its Applications: A Short Review

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**Abstract-** To reduce the environmental effect, appropriate bio-degradable materials are required. Fibers which are naturally obtained from coconut are used as polymer reinforcement material to fabricate biodegradable composite fibers. The fundamental disadvantage of fibers generated from plants and animals is that they generally have low moisture resistance. Besides, chemically treated coir fibers can enhance fiber adhesion to the matrix and improve the mechanical properties of composite materials. Therefore, coir fibers may replace synthetic fibers in many applications as a sustainable and biodegradable material. In this review, preparation methods, properties, and applications of coir fiber composites are discussed.

**Key words-** coir fiber, reinforcement material, biodegradable material, mechanical properties, and Tensile Strength

## I. INTRODUCTION

Due to their excellent thermomechanical properties, non-toxicity, biodegradability, and low density, cellulosic fiber reinforced composite materials gained immense research interest as well as found practical applications across a range of industries, including spacecraft, industrial, civil, military, and biomedical [1,2]. In general, composites show enhanced properties compared to their constituent materials. Polymer-matrix composites, for example, which are significant materials in the electronics sector due to their dielectric qualities utilized in capacitors, are created by combining fillers with

polymer matrices [3-4]. One of the most enticing properties of these filled composites is their dielectric characteristics which can be tuned up by the choice of shape, size, and conductivity of filled pieces in the polymeric matrix.

The term "composite materials," sometimes known as "composition materials" or simply "composites," refers to materials composed of two or more components, each of which exhibits a diverse set of physical and/or chemical characteristics. When two or more fundamental elements are combined, a new material is produced having properties distinct from those of the original components. Composites must be separated from material mixes and solid solutions because the constituent components remain distinct and distinct within the final material structure.

The new composite material typically has a number of desirable properties; for example, composites are frequently stronger, have a lower density, or are less expensive than older materials. Composites are typically composed of two or more separate components that come together to form regions large enough to be considered continua; the core components are frequently strongly fused together at the interface. A wide range of natural and manmade materials, including mortar and concrete, reinforced rubber, alloys, polymers with fillers, composites of aligned and chopped fibers, porous and cracked media, polycrystalline (metal) aggregates, and others, support this result.





Products made of fiber reinforced plastic give field carrying conductors a mechanical boost while also acting as effective insulators. Fibrous reinforcements are incorporated into polymeric matrices to create composite materials with excellent mechanical and electrical applications. They can be utilized to construct printed circuit boards, as well as industrial and domestic plugs, terminals, and connectors [5,6].

Different thermosetting and thermoplastic resins have been strengthened with cellulose fibers from plants including palm, henequen, sisal, coir, jute, bamboo, wood, and paper as well as waste items like pulp, shell flour, and wood flour [7]. These fibers are employed because they are renewable, have acceptable specific strength characteristics, are inexpensive, have improved energy recovery, and are biodegradable. Low specific mass and high mechanical characteristics are combined with natural fiber reinforced polymers. Jute fiber is one of these fibers that is of special relevance since it grows widely in Bangladesh and across the globe. The chemical nature of a fiber has a significant impact on its physical characteristics. Jute fiber has the potential to strengthen polymers like polypropylene (PP), polyvinyl chloride (PVC) and polyethylene (PE) [8-10]. On a dry basis, palm fiber contains 611–71.5% cellulose, 13.6–20.4% hemicellulose, 12–13% lignin, 0.2% pectin, and 3%–5% other compounds [9]. Compared to other natural fibers, composites constructed of palm fibers exhibit average tensile and elastic features.

Mechanical properties of biodegradable jute-fabrics/Biopol composites, such as tensile strength, bending strength, and impact strength, have been investigated by A.K. Mohanty *et al.* [11]. The effects of surface treatments of various fiber and fabric amounts on the performance of the generated composites were investigated. The mechanical properties of Biopol sheets were enhanced up to 50 % for tensile strength,

30 % for bending strength, and 90 % for impact strength when compared to pure Biopol sheets. Jute content's impact on the composites made from defatted HC (Hessian cloth) is also studied, and it is shown that composites with 20 to 25 percent jute content have the best mechanical properties.

Investigations were done on the effect of composition and UV light on tensile and flexural characteristics [12]. Maximum mechanical properties were found at 25% (% wt) fiber loading in the case of Glass/jute reinforced in USP resin. A. Fardausy *et al.* investigated the physical, mechanical, and thermal properties of unidirectional jute fiber reinforced polyvinyl chloride (PVC) film composites and discovered that with the addition of fiber, the percentage of elongation at break decreased while the tensile strength of prepared composites increased [9].

Composite materials are categorized on two separate levels: The matrix (binder) constituent forms the basis for the first classification criteria. The three basic composite categories are organic matrix composites (OMCs), metal matrix composites (MMCs), and ceramic matrix composites (CMCs) [13,14].

Coir, also known as coconut fiber, was discovered to be a natural fiber derived from the cotton flax plant and used to manufacture items such as floor mats, doormats, brushes, and beds. Coir is a fibrous material found in a coconut between the hard, internal shell and the outer layer seen in Fig. 1.

Coir fiber is the most dense and long-lasting of all industrial natural fibers. The fundamental benefit of producing long-lasting things is the low breakdown rate. Ropes made of coir fiber dating from the early nineteenth century have been discovered. For centuries, the remarkable strength of coir fiber has been the primary motivation for rope production [15].



Fig. 1. Extracted Coir Fiber

Coir, a stiff and inflexible lignocellulosic fiber derived from the fibrous mesocarp of coconut fruits, accounts for around 25% of the nut. Coconuts (*cocos nucifera*) are commonly farmed in tropical countries such as Thailand, India, and Sri Lanka [16]. Coir fibers are robust, windproof, and somewhat waterproof due to their high lignin content. They can be chemically modified to alter their properties. Because of their high elongation at break, the fibers may be stretched beyond the elastic limit without rupturing [17]. Detailed research of the structural, morphological, mechanical, and thermal properties of coir fibers has been conducted [18]. Hybridization of coir fiber composites with other fibers such as kenaf, bamboo, rice straws, and glass fibers, among others, has been shown in studies to improve the composites' overall properties [19,20]. Numerous authors have published overviews of the production technique and mechanical properties of other fiber composites, such as, but coir fiber composites have received less attention. This review provides an overview of coir fiber composites.

## II. CHEMICAL COMPOSITION

Lignin, hemicellulose, and cellulose make up the majority of coir fibers. According to several research, Table I displays the chemical composition of raw coir fibers. The data shows that coir fibers typically include 32 to 50% cellulose, 0.15-15% hemicellulose, 30-46% lignin, and 3-4% pectin. This highlights the fact that cellulose and lignin are the two substances that make up plant fibers in the greatest amounts. The origin of the coconut plant from which the fibers were extracted, or the method of extraction might both have an impact on the variances in coir fiber properties.

TABLE I. CHEMICAL COMPOSITION OF COIR FIBER

Sl. No.	Cellulose (%)	Hemicellulose (%)	Lignin (%)	Pectin (%)	Ref.
1.	36-43	0.2	41-45	1.8	[21]
2.	43.4	0.25	45.8	3	[22,23]
3.	36-43	0.15-0.25	41-45	3-4	[24]
4.	42.14	15-17	35.25	-	[25]
5.	32-43	0.15-0.25	40-45	-	[26]
6.	38-46	10-15	37-41	-	[27]
7.	42.44	0.25	45.4	3	[28]
8.	32-43	0.15-0.25	40-45	-	[29]
9.	45.67	0.12-0.25	41-45	-	[30]
10.	43.44	0.25	45.84	3	[31]

## III. FIBER EXTRACTION PROCESS

The husks are removed from the coconuts and immersed in lagoons or brackish waters for up to 10 months in the traditional method of coir fiber extraction. This procedure is difficult and time-consuming. The husks soften and separate because of anaerobic fermentation while immersed. The fibers are then manually washed, dried, and cleaned. This classic retting procedure produces high-quality white fiber suitable for spinning and weaving. Mechanical approaches can be utilized to reduce the amount of time needed for soaking. The husks are crushed, and their fibers are broken up after being steeped in

water for five days. Drums are used to separate coarse fibers from short, woody sections, which are then washed, dried, cleaned, and dried again. Fig. 2 depicts a summary of the fiber extraction process.

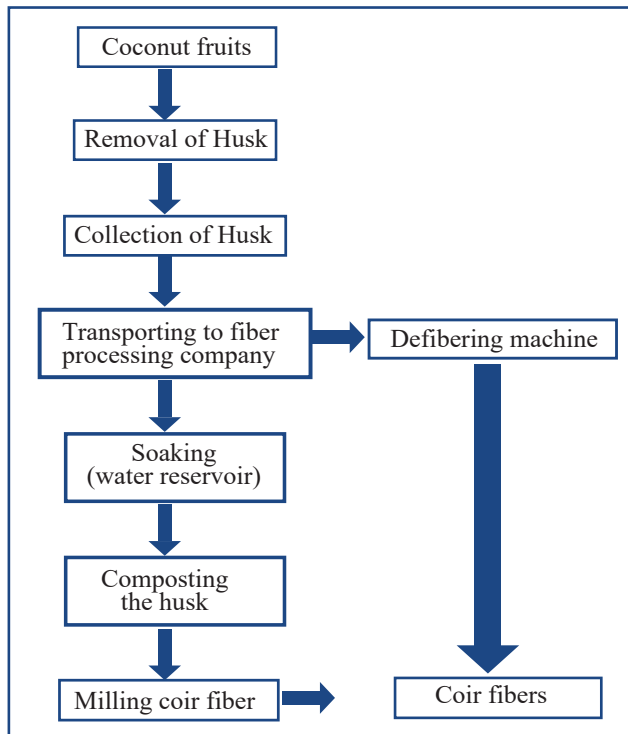


Fig. 2. Fiber extraction process.

#### IV. FABRICATION OF COIR-FIBER-REINFORCED COMPOSITES

Fabrication is an important part of composite production that must be prioritized. Coir fiber reinforced composites are manufactured using a variety of ways.

- A. Cold compression molding: Compression molding is thought to be the best method for creating high-volume composites. This process is carried out at room temperature and without the use of any temperature. The compression molding technique may be used to handle both long and short fibers.
- B. Hot compression molding: This procedure is performed at a certain temperature and pressure. This approach may be used to produce high-quality composite panels by

controlling and adjusting temperature, pressure, and time.

- C. Open molding: The open molding process is said to be the most cost-effective approach for producing composites. The composites are cured at room temperature in an open mold where the natural mold is put. Although the investment is not excessive, it does have certain restrictions, such as longer curation time, human effort, and more trash creation.
- D. Resin transfer molding: The most significant advantage of adopting these processes is that they may make strong and rigid composites while being environmentally and economically friendly. At low temperature and pressure, the resins are transferred to a tight mold.
- E. Extrusion molding: It is used to increase mechanical strength and stiffness. Molding is done at a specified speed and temperature, and it must cool down when the extrusion process is finished.
- F. Injection molding: Plant fiber reinforced with PP composites performed better in this manner. However, there are significant limits to employing injection molding, such as the need for polymers with a lower molecular weight to maintain acceptable viscosity.

#### V. PROPERTIES

##### A. Mechanical properties:

The mechanical properties of coir fiber reinforced composites are affected by the volume % or content of the fibers in the composite. Even little changes in the physical character of the fibers for a given volume content of fibers can cause considerable variances in the overall mechanical performance of composites. As a result, it was established the number of

fibers in coir fiber reinforced composites influenced their mechanical properties. Mechanical properties of coir fiber-reinforced composites with fiber contents ranging from 5 to 15% [32,33].

Robust bonding is produced because of strong interface formation and excellent wetting between the fiber and matrix. Poor wetting between the polyester matrix and the coir fiber will result from a high coir fiber concentration. It was discovered that this caused the matrix to attach less fiber, which may result in a weak interface and weak bonding. With more fibers present, the composite will become more malleable and flexible.

Many of the features of a composite are determined by the quality of its components and how those elements interact. A material's structural features include its increased diameter, density, and weight due to water absorption, and while its mechanical properties include its tensile, flexural, and impact strengths. These qualities can vary depending on the fiber's origin, pre-treatment, and extraction processes [34].

Table II and Table III summarize the findings of numerous researchers' investigations and recordings of certain physical and mechanical characteristics of coir fibers.

TABLE II. PHYSICAL PROPERTIES OF COIR FIBER

Sl. No.	Average diameter (mm)	Water Absorption (%)	Density (g/cm <sup>3</sup> )	Ref.
1	0.025	-	1.2	[35]
2	0.4	130-180	1.2	[36]
3	0.01-0.46	-	1.15-1.46	[21]
4	0.25	-	1.2	[37]
5	0.1-0.45	10	1.3-1.5	[25]
6	0.38	-	1.2	[26]
7	0.1-0.4	-	1.15	[38]
8	0.1-0.45	-	-	[39]
9	0.2	-	1.3	[40]

TABLE III. MECHANICAL PROPERTIES OF COIR FIBER

Sl. No.	Average diameter (mm)	Young's Modulus (GPa)	Tensile Strength (MPa)	Elongation at break (%)	Ref.
1	0.025	2.74	286	20.8	[35]
2	0.4	4-6	175	30	[36]
3	0.01-0.46	2.2-6	95-230	15-51.4	[21]
4	0.25	2.74	286	20.8	[37]
5	0.1-0.45	4-6	105-175	17-47	[25]
6	0.38	2	144	4.5	[26]
7	-	3.23	165.2	39.45	[41]
8	-	4-6	144	15-40	[29]
9	0.1-0.4	4-6	108-252	15-40	[38]
10	-	3.19-3.23	158-165	39-41	[42]
11	-	4-5	250	20-40	[43]
12	0.1-0.45	3-6	106-175	47	[39]
13	-	4-6	131-175	47.2	[44]
14	0.2	3.11	144.6	32.3	[40]
15	-	8	95-118	-	[45]
16	-	4-6	593	30	[46]

In summary, coir fibers have a density of 1.1-1.5 g/cm<sup>3</sup>, a young's modulus of 2-8 GPa, a tensile strength of 105-593 MPa, a water absorption of 10-180%, and an elongation at break of 15-51%.

*B. Tensile Strength:*

There are various reports on alkali treatment of coconut coir, but none offer information on the stress-strain curve. The stress-strain curve of tensile test data of coconut single fiber produced from alkali treatment with 5% NaOH is reported [47,48]. The findings show that the fiber is less ductile and more linearly elastic. The maximum strain at failure is 22.4%, the average tensile strength is 130.9 MPa, and the elastic modulus is 681.4 MPa. A random insertion of 3 cm length of coconut fiber with fraction 15% into the unsaturated polyester provides maximal reinforcing, resulting in a composite tensile strength of roughly 24.5 Mpa.

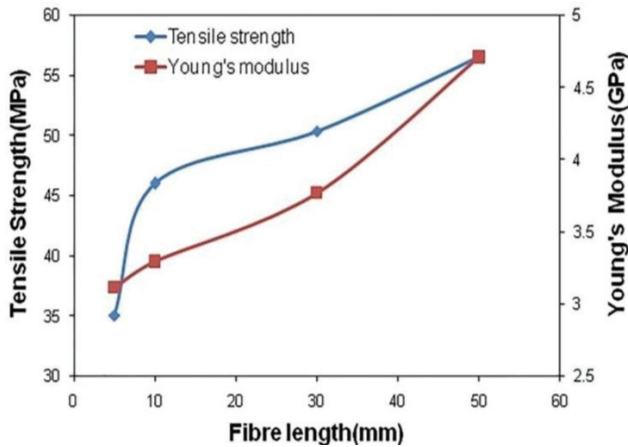


Fig. 3. Tensile Strength vs Fiber length.

Fig. 3 depicts the influence of fiber characteristics on composite tensile strength. The graph clearly shows that the tensile modulus increases as the fiber content increases. Because of the increasing brittleness of the fiber content in composites, the stress/strain curve becomes steeper. When the fiber content increases, so does the degree of impediment, which raises stiffness. The tensile strength of composites, on the other hand, increases with fiber length.

C. Water Absorption:

According to ASTM 570, water absorption experiments including immersion in distilled water at room temperature were performed on coir fiber reinforced epoxy composites in [49]. The amount of water absorbed was calculated by weighing the sample right away after wiping the water from its surface. Samples were periodically withdrawn. Regular weight checks were done on the samples at 24, 48, 72, 96, 120, 144, 168, 192, 216, 240, 264, 288, 312, 336, 360, 384, 408, 432, and 480 hours. Fig. 4 shows the coir fiber after water absorption.

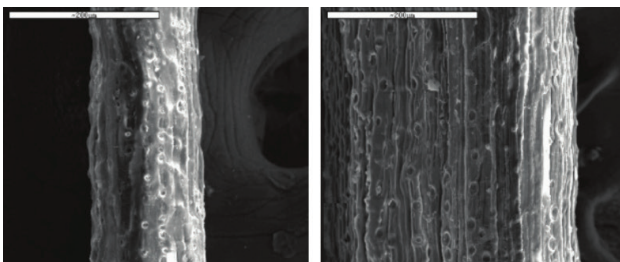


Fig. 4. Coir fiber after water absorption.

D. Density:

It is among the most important aspects in determining a composite material's properties. It mostly relies on the reinforcement and matrix's respective proportions. The void content of composites is defined as the difference between the composites' measured and theoretical density values. The influence of fiber properties on composite density is shown in table IV and Fig. 5. The graph (Fig. 5) clearly demonstrates that with increase of the fiber length from 3mm to 15mm, the density of composites decreases. This is mostly due to the use of long fibers in composites, which reduces packing and disrupts fiber distribution, resulting in enormous vacuum zones [50].

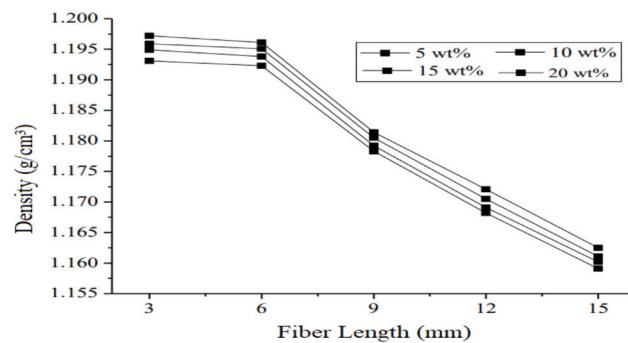


Fig. 5. Density vs Fiber length

TABLE IV. IMPACT OF FIBER PARAMETERS ON COMPOSITE DENSITY.

Specimens	Epoxy	Composite 1		Composite 2	
		Coir fiber	Composite	Coir fiber	Composite
Density (g/cm <sup>3</sup> )	1.15	0.98	1.13	0.93	1.12

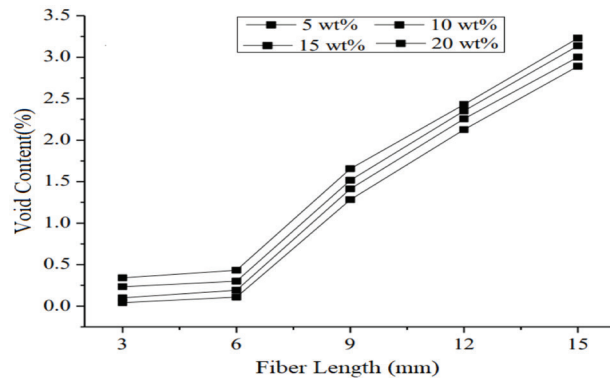


Fig. 6. Void content vs Fiber length

Apparently, higher void contents, in Fig. 6, result in a lower density composite. In contrary, composites get denser as the fiber content increases as shown in Fig. 7 [50].



**Fig. 7.** Impact of fiber parameters on composite density.

#### *E. Impact Test:*

To analyze the specimen's shock resistance, the Charpy test is used to calculate the impact energy of composites in [51]. The amount of energy the specimen absorbed before failing was measured in joules. The amount of energy collected in joules reveals the material's susceptibility to shock loads. For this procedure, the specimens (55x10x10 mm) produced in accordance with ASTM A370 standards were used. Because of the brittle nature of the composites, the impact test results for the coconut fiber reinforced composites were somewhat lower. Each specimen absorbs energy when it receives a powerful pendulum stroke, which causes the creation of cracks. Usually, the break spread through the composite's fiber and resin. As a result, the composite will absorb a lot of energy when a fracture propagates across it. Glass fiber reinforced composite is discovered to have a high breaking load (5.8 KN). It has been discovered that the breaking load of polyester coconut fiber reinforced composite is 2.07 times more than that of epoxy E-glass fiber reinforced composite and 1.93 times greater than that of epoxy coconut fiber reinforced composite [52].

#### *F. Hardness:*

A 1/16" ball indenter is used for the hardness test, and a 100 applied force is used [53].

According to test results, the E-glass fiber reinforced epoxy composites got the highest hardness rating. The data show that the resin, rather than the fiber, is more important in determining the hardness of the material. The maximum hardness was discovered to be 68.2 for the average hardness value of E-glass fiber reinforced epoxy composites. This is because the matrix material grew correspondingly to bind with the resin.

#### *G. Increases aeration and retains water:*

The excellent aeration that coir may provide is widely recognized and beneficial to plants. Proponents of coconut coir also extol its capacity to hold 10 times its weight in water. The roots of plants grown in hydroponic systems containing coir absorb nutrients more rapidly than those grown in soil mixtures. plants will need significantly less watering if you use it as a planting medium.

#### *H. Ease of use and few issues:*

The pH neutrality of coir is one of its advantages. Although coconut coir experts often advise combining the product with other plant amendments, you may also use it on its own. Additionally, it has anti-fungal qualities, and many pests stay away from it, which reduces insect and disease issues.

## VI. APPLICATION

NFCs (Natural Fiber Composites) have substantial potential applications in various industries, including low-cost housing, consumer goods, and other popular applications. Where the use of typical lightweight reinforced polymers is forbidden [19]. They are also heavily used in the manufacturing of automobiles, aerospace (propellers, wings, and tails), boat hulls, storage tanks, and sports goods [54]. Researchers have used coir fiber composites for sound attenuation and the manufacture of particle boards [55,56]. It is utilized in a variety of operations, including the manufacture of coiled coir rope, which is used to manufacture coir mattresses, rubberized

coir pads, coir cushions, carpet underlays, seat cushions, and insulation. Rubberized coir, which is manufactured by spraying rubber latex over brown coir pads to bind the fibers together, is commonly used in the car industry as upholstery padding.

#### A. Coir in Concrete:

Coir's possible use in concrete has been investigated [57]. Coconut fibers have been demonstrated to reduce the formation of cracks in concrete buildings near water or in areas where buildings are vulnerable to additional environmental pressures, including earthquakes [58]. The tensile strength of concrete, which is just a tenth of its compressive strength, makes it a somewhat fragile construction material. In the past, reinforcing bars were used to make up for the stiffness and structural weakness of concrete. However, under some conditions, steel beams could not stop the development of micro-cracks in concrete, and it was hypothesized that coir fibers would provide a remedy. Tests were carried out in labs all around the globe to see how the performance of concrete would be affected by coconut fibers. These studies included adding varied amounts of coconut fibers to concrete and evaluating the resultant materials for workability, flexibility, compression, and strength. These tests included tensile, compression, and contortion strength measurements.

#### B. Low-cost roofing material:

The usage of randomly arranged short coir fiber reinforced cement composites as low-cost roofing materials is investigated [59]. The material parameters that were changed to produce the optimal material were fiber length, fiber volume, and compacting or casting pressure. When appropriate ASTM standards were available, bending, impact, permeability, water absorption, combustibility, and dimensional stability tests were undertaken. The ideal composite, according to the data, has a fiber length of 37 mm, a fiber volume of 75%, and is cast at a pressure of 1.67 MPa. This combination

was discovered to be far less expensive than asbestos-cement sheeting and corrugated galvanized iron. It is also the same price as other low-cost roofing materials like bagasse-thermoset composites.

#### C. Automotive Interior Applications:

The physical, mechanical, and flammability properties of composite panels reinforced with coconut fiber in polypropylene (PP) were investigated [60]. The PP powder and a coupling agent, 3 wt% maleic anhydride grafted PP (MAPP) powder, were mixed with four different amounts of coir fiber content (40, 50, 60, and 70% by weight). Increasing the coir fiber content had a negative influence on the water resistance and internal bond strength of the composites. However, increasing the coir fiber content to 60% boosted the composites' flexural strength, tensile strength, and hardness. The flame resistance of the composites improved as the coir fiber percentage rose. According to the findings, an ideal composite panel composition for automobile interior applications is a blend of 60% coir fiber, 37% PP powder, and 3% MAPP.

#### D. Shell Eco Marathon Vehicle Body Applications:

The major purpose of this research is to investigate a coir fiber-reinforced nanocomposite for application in the Shell Eco-Marathon automobile body. Shell Eco-Marathon automobile is designed to be lightweight in order to maximize efficiency. Coir fiber-reinforced nanocomposite is a material composed of coir fiber, silica nanoparticles, and epoxy resin. Among the variables are the weight percentages of coir fiber, silica nanoparticles, and force applied to the simulated model. The number of silica nanoparticles is constant while the weight percentage of coir fiber in the nanocomposite varies. The purpose of the research is to evaluate how the weight percentage of coir fiber reinforced nanocomposite impacts von Mises stress, resulting displacement, and resulting strain

using Solid Works simulation. Because tension is present, a higher weight proportion of coir fiber may result in increased tensile strength. The weight percentage of coir fiber has a strong correlation with composite strength.

## VII. RESEARCH CHALLENGES

The biggest issue with coir is that, particularly in lower grades, it may have a very high salt concentration. Before using, salt-rich coir should be leached. Coir is abundant in potassium and phosphorus but has a reduced cation-exchange capacity. Although coir is resilient, its lifespan varies based on age and shape, often lasting four years. For four years, recomposed coconut may be used without shrinking or compaction. Husks that haven't decomposed normally survive two years. The only natural fiber that can withstand being damaged by salt water is the coir fiber.

Too much salt in the product has caused some gardeners to suffer coconut coir's drawbacks. The electrical conductivity of water in an overly salty growth media might hinder or prohibit plant roots from absorbing water. Nutrient absorption may also be hampered by it. This often occurs when workers who collect the coir rinse the finished product in saltwater rather than freshwater. The product's salt content has the potential to be quite problematic. Other disadvantages of growing in coir include the need for fertilizer addition because this is an inert (no nutrients) medium. To extract some of the nutrients, combine coir with another soil combination at a 50/50 ratio, but probably still need to add fertilizer. Additionally, coir tends to retain calcium, magnesium, and iron.

## VIII. CONCLUSION

This review emphasizes the developments and applications of coir fiber composites. Coir fiber is the most dense and long-lasting of all industrial natural fibers which consist of 32 to 50% cellulose, 0.15-15% hemicellulose, 30-46% lignin, and 3-4% pectin. Coir-fiber-reinforced composites can be fabricated in various ways like cold compression molding, hot compression

molding, open molding, resin transfer molding, extrusion molding and injection molding. Various properties of the coir fiber composites such as mechanical, tensile strength, water absorption, density, impact test and hardness are discussed. It is found that with the change in the diameter of fiber, properties are also changed. Coir fiber composites have substantial potential applications in various industries, including low-cost housing, consumer goods, and other popular applications. They are also heavily used in the manufacturing of concrete, low-cost roofing material, automotive interior applications, and shell eco marathon vehicle body applications. Coir fiber is the only natural fiber that shows stability in the presence of salt water. Therefore, the eco-friendly nature of coir fiber and its abundant availability in Bangladesh increases its demand in the composite industry.

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# Desalination of Saline water with Low-Cost and Eco-Friendly Bioadsorbents

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**Abstract**—In this work, desalination of saline water is performed by adsorption process using cost-effective bioadsorbents. A number of bioadsorbents, e.g., spent tea leaves, banana peel, orange peel, apple peel, sugarcane, potato peel, cucumber peel and calabash peel are used in batch systems. Among them, sugarcane bagasse shows maximum removal percentage of salinity, i.e., 29%. Additionally, total dissolved solids and conductivity of the samples are measured to understand the effect of adsorption of the bioadsorbents. These results draw attention for developing new technologies with selective bioadsorbents to remove salt from saline water.

**Keywords**—adsorption, bioadsorbents, saline water, salinity

## I. INTRODUCTION

Water is extremely important in our daily lives. It is one of the most abundant commodities on the planet. Despite the fact that it covers the majority of the globe, many countries around the world have scarcity of potable water. Almost 97.5% of the earth's water is salt water found in oceans, while the remaining 2.5% is fresh water found in land water, ice-mountains, streams, and rivers, which meet the greater part of human and animal requirements [1-2, 9]. UNEP (United Nations Environment Program) estimates that 1/3 of the world's population lives in countries

with inadequate water supplies [3]. Massive initiatives are expected to make new water supplies accessible in order to reduce water scarcity in countries with fresh water shortages [4]. According to WHO guidelines, the maximum salinity of drinking water is should be 500 parts per million, with certain exceptions up to 1000 parts per million [5]. The water obtained from any source on earth has a salinity of maximum 10000 parts per million (ppm), with seawater having a salinity of 35000–45000 ppm because of dissolved salts [6]. In every 20 years, the rate of water usage doubles, outpacing the challenge of population growth by two times. Though water demand is getting adverse, the available potable water supplies are diminishing. Recently, the increase of deterioration in fresh water quality has been reported owing to various agricultural and developmental activities. Consequently, water shortage and unreliable water quality are seen as significant barrier to society's long-term growth. So, increase of new fresh water sources becomes an essential. Desalination of sea water can be a significant alternative, considering the fact that the only inexhaustible source of water is the ocean. There are several methods of desalination including membrane-based (e.g., reverse osmosis) and thermal based (e.g., multistage flash distillation), however, all processes need significant amount of energy. It was estimated that 10 million tons of oil per year is required for the production of 1 million m<sup>3</sup> desalinated water/day [10].

Since, fresh water supplies are in short supply to meet the needs of the majority of the population and saltwater is unsuitable for many applications, desalination of saltwater arises as a blessing to the majority of the population [6]. Desalination of seawater to fresh water demonstrates that it is a viable solution to the world's water scarcity. This process is commonly utilized in areas where the main supply of drinking water is seawater or brackish water. For municipal, industrial or any commercial uses, the desalination processes may be utilized. The feed water is treated in major desalination methods and two streams of water are obtained. Concentrate or brine which has salt and mineral concentrations higher than that of original feed water or saltwater [7-8, 11]. Sea water, brackish, wells, surface (rivers and streams), wastewater, and industrial feed and process waters may be included as saltwater or feed water sources. Desalination plants are now used to convert seawater to drinking water on ships and in many arid regions of the world, as well as to treat water that has been contaminated by natural and manmade toxins in other areas. Distillation may be the only water treatment process that totally removes the largest spectrum of pollutants from drinking water [12]. Physical adsorption is similar to the condensation of gases into liquids and relies on the physical or van der Waals force of attraction between the solid adsorbent and the adsorbate molecules [13]. With advancements in technology, desalination and removal of other contaminants processes with bioadsorbents are becoming cost effective compared to other methods of producing usable water to meet the growing demands [15]. The goal of this research is was to established a simple method to convert seawater to fresh water by using different bioadsorbents. This work is also aiming to increase the quality of sea water in the most cost-effective and eco-friendly process.

## II. EXPERIMENTAL

A PVC pipe was used to create the filter for the adsorption process. The filter stands is 30

inches tall and is separated into four sections. Along with the filter paper, three socket threads were employed to unite the split pieces. Hach 51800-10 sensION 5 Waterproof Conductivity Meter, Sieve Shaker Machine EL 80-0200/01, Hot Air Oven (DSO-300D) and High Precision Electronic Balance were used before and after the experiment to prepare the adsorbents and measure the data for the filtrated saltwater.

The filter net is positioned in such a way that it may be easily opened if bio adsorbents become stuck inside and refuse to come out, or if it becomes blocked and fails to transmit water to the next phase. To avoid an incorrect outcome, the filtration process was run several times.

The finest salt used to prepare saline water is kosher salt, which yields a less murky seawater mixture. 35 g (1.2 oz.) kosher salt was added to the jar. Until the scale reads 1,000 g, tap water was poured (35 oz.) in the jar. Because it retains trace levels of minerals like magnesium and calcium that are also found in actual seawater, tap water is preferred than distilled or purified water. The salt was dissolved more easily with lukewarm water. The salt was entirely dissolved when the mixture was swirled. It took several minutes of stirring to get to this point. When the salt is completely dissolved, the water will contain 35 parts per thousand (ppt) of salt, which is a close approximation of saltwater in the laboratory [14].

## III. RESULTS AND DISCUSSION

The adsorbents were processed into smaller particles before selecting final adsorbents for the filter and final experiment. They were collected from the outdoors first, and dried in the open air for 2-3 days. To make the adsorbents effectively dried, the materials were heated using Hot Air Oven at varying temperatures. The elements were able to smash into little particles after the heat treatment.

TABLE 1. PREPARATION OF BIOADSORBENTS

Element	Preparation of Bioadsorbents			
	Weight (g)	Heat Treatment (°C)	Duration of Heat Treatment (min)	Processed Bioadsorbent (g)
Used tea leaves	500	60	90	450
Cucumber peel	1000	60	90	735
Rice husk	1000	-	-	1000
Sugarcane Bagasse	1000	60	90	840
Potato peel	1000	60	90	700
Coconut peel	1000	-	-	1000

It is found that at low temperature of 60°C adsorption happens best. As an exothermic phase adsorption causes low temperatures to react forward. Adsorption increases before equilibrium is achieved with pressure increasing to some degree. No further adsorption happens after saturation regardless of the pressure.

It was noted that none of the bioadsorbents were burned during the heat treatment process. After heat treatment, any bioadsorbents that had been scorched were removed. The majority of the burnt particles were discovered stuck to the foil paper (which was used to keep the individual element). To utilize membrane-filtering adsorbents, six adsorbents were prepared. They are Used tea leaves, Cucumber, Rice husk, Sugarcane, Potato and Coconut husk [annexed in Table I].

Two different saline water samples were made and characterized by measuring total dissolved solids, conductance and salinity (reported in Table II).

TABLE II. CHARACTERISTICS OF PREPARED SALINE WATER

Sample	Characteristics of prepared saline Water		
	Salinity (ppt)	TDS (g/l)	Conductance (S/cm)
Sample 1	32.6	31.5	49.9
Sample 2	27.2	26.3	41.5

Every adsorbent conducted a single-phase experiment to determine how much salinity was removed from each sample of water. The test

was carried out in a separate pipe with a Filter Net within. The single phase experiment is the first stage in determining which bioadsorbents will be used in the filtration pipe. After filtration, the water was analyzed with a Hach Conductance Meter and a HI2211 pH meter to measure the reduction in salinity and the acidity or basicity of aqueous solutions.

TABLE III. RESULT OF EXPERIMENTS FROM SAMPLE 1 AND 2

Saline water sample	Salinity of Sample 1 and 2			
	Adsorbent	Water used (ml)	Salinity (ppt)	Reduced Salinity (ppt)
Sample 1	Tea	150	27.2	24.2
	Sugarcane	150	27.2	21.1
	Rice husk	150	27.2	25.3
	Cucumber	150	27.2	23.3
	Potato	150	27.2	27.3
	Coconut	150	27.2	26.5
Sample 2	Tea	150	32.6	28.7
	Sugarcane	150	32.6	23.3
	Rice husk	150	32.6	30.2
	Cucumber	150	32.6	25.2
	Potato	150	32.6	32.3
	Coconut	150	32.6	29.7

From the data table III it can be observed that the maximum reduction of salinity is about 25% -29%. The color of the filtrated water was changed to a bit lemon color and the pH was found 6.79. The observed reduction of salinity for sample 1 and sample 2 is plotted in figure 1 and figure 2 respectively.

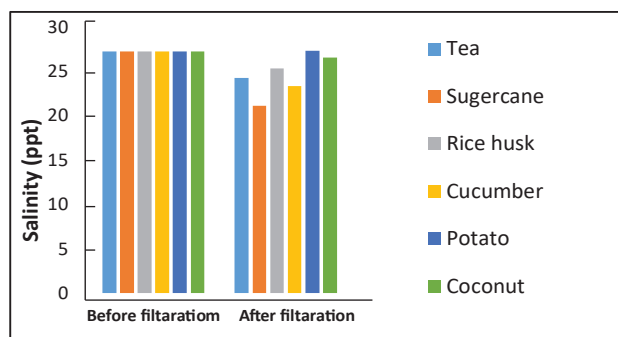


Fig. 1. The change of salinity of sample 1 by different bioadsorbents

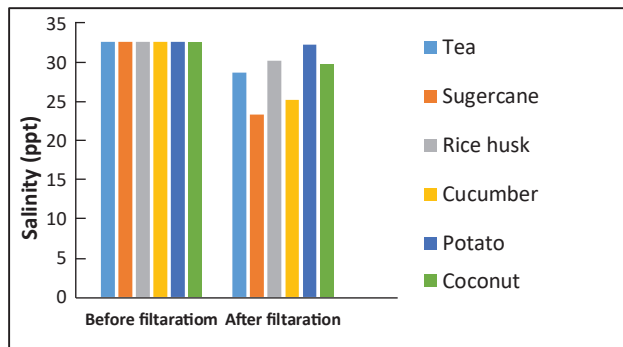


Fig. 2. The change of salinity of sample 2 by different bioadsorbents

The salinity of water sample 1 decrease by all the prepared bioadsorbents (Tea, Sugarcane, rice husk, cucumber, potato, and coconut). However sugarcane and cucumber show the best result decreasing the salinity by approximately by 22% and 14%. Similarly for water sample 2, sugarcane decreases the water salinity by ~29%.

#### IV. CONCLUSION

The bioadsorbents desalination process may able to produce ample amount of fresh water with less energy and to manage drinking water or fresh water with a reasonable cost. In this research a series of bioadsorbents produced from tea, sugar cane, rice husk, cucumber, potato and coconut desalinated two water samples. It is found that all bioadsorbents desalinated the water, whereas sugarcane gives us the best result by decrease the salinity by 29%. This report highlights the key conclusion of desalination technology which can be reliable, less energy-intensive and environment-friendly. Alternatively, these observations generate a new viewpoint on seawater desalination that will benefit individuals living in coastal areas and in marine vehicles.

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# Corporate Governance Practices in Bangladesh: An analysis on Sonali Bank and Basic Bank Limited regarding Compliance to CG Code 2018

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**Abstract**— corporate governance in recent years has become a crucial factor to face the scandal in corporate world. From the Enron case in 2021, in business world it has become the great initiative to avoid the corporate scandal or corruption in every sector of developed and developing countries. This study articulates the facts and figures regarding the corporate governance practices of SBL and basic bank ltd (first one is listed under Dhaka Stock Exchange second is not). It aims to establish an analysis based on the collected data related to the compliance of corporate governance guidelines and codes within the banking industry of Bangladesh and an overall observation about the practices of CG Code 2018 in the respective sector. Both companies have bad records of corporate scandal like Hallmark and basic bank scandal that made think us again that our regulations are so poor in imposing side. Qualitative analysis which includes observation-based analysis and case analysis has been employed to assist the exploration. Basically two years (2019-2020) data have been analyzed from annual report to find out the compliance status of CGG amended in 2018. The result is for SBL NRC (Nomination and Remuneration Committee) and some others conditions are not complied fully. In SBL from total 166 conditions under 9 broad categories 80.72% are complied, 17.47% not complied and 1.80% are not applicable and

for basic bank 65.67% complied, 24.70% not complied and 9.64% are not applicable. In a first view it seems too much satisfactory but there are many loopholes to violate the regulations and get the privileges. These findings would help the policy makers and corporate regulators associated with some insights to prevent future corporate collapse.

**Keywords**— corporate governance, sonali bank limited, basic bank limited, compliance, corporate governance guideline (CGG)

## I. INTRODUCTION

Financial system of any country plays an inevitable role to shape the economic development of that region. It incorporates banks, insurance companies and non-bank financial institutions. The banking sector, out of all the financial arrangements, is most important to our nation's ability to sustain its economy [9]. The functionality of the economy is firmly associated with the efficiency of its banking sector and it is currently a basic piece of our financial framework [1]. Present economic system would practically be inconceivable without the well-founded existence of proper banking system [2]. But in recent years there were few scams in banking sector becoming alarming situation to adopt corporate governance guidelines. Effective monitoring of these financial arrangements (rules and regulations) is also required. Bangladesh Bank carries out the

supervisory role in regard to the operations of banking industry and Bangladesh Securities and Exchange Commission is entitled to the regulation of capital market related forces. According to La Porta, et. al. [3] to ensure the operative execution of corporate objectives and ethical conduct of business; compliance to state laws, rules and regulations is demanded. Corporate governance practice ensures compliance to the statutory legal requirements; protects stakeholders' interest and moreover strengthens the overall efficacy of the corporate accomplishments. Some scandals were occurred for lack of good corporate governance like Sonali Bank Limited loan scandal, basic bank scandal, Janata Bank Limited scandal. So practices of good governance also ensure safety of loan scandal.

#### *A. Background of the studies*

The aim of this paper titled "Corporate Governance Practices in Bangladesh: An analysis Study on Sonali and Basic Bank Regarding Compliance to amended CG Code 2018" is to depict the corporate governance practices among the listed banking companies for the last two years. It also reflects the elementary differences observed in papering corporate governance during the period followed by modification of corporate governance guidelines into 'Corporate Governance Code 2018'. This paper demonstrates the level of compliance of CG in Sonali Bank Limited and Basic Bank those have scandal about loan. The corporate governance practices of selected companies which includes both banking companies and financial institutions and those companies which are subject to scandal in various aspects. Whether the rules are being complied in substance or just in form is represented in this paper. In depth analysis of a particular listed bank is also embodied for showing the factual implication of the specified rules and guidelines. To portray the changes in practices adopted before and after the modification of established guidelines with

regard to banking industry is attempted to be communicated in this particular impact study.

#### *B. Objectives of the Studies*

This study mainly deals with the practices of Corporate Governance Code 2018 in banking and financial institution sector mainly comparative analysis of compliance of CG updated in 2018. It also actively performs the core aspects those are really connected with scandal and fraud.

The main objective of the paper is to check the level of compliance of corporate governance rules and regulations in Sonali Bank Limited and Basic bank as these two banks were marked as loan scam in past years. To know the actual scenario of compliance to corporate governance code by depth analysis of sample company.

This paper mainly discusses the practice of CGC 2020 and chronological changes in CGG 2012 and CGC 2018 issued by the Bangladesh Security and Exchange Commission (BSEC). BSEC issued the corporate governance guideline on 20 February 2006, which had 37 conditions regarding to corporate governance. Corporate Governance Guidelines 2006 was "Comply or Explain" base conditions for listed companies. This is the beginning when corporate governance is considered as separate regulation. Then some changes occurred in the rules and Corporate Governance Guideline 2012 on 3 July, 2012 was published. In the CGG code of 2012, were published with 95 conditions under 7 heads and CGG 2012 became mandatory instead of comply or explain for listed company. The Corporate Governance Code 2018 was published as "Code" instead of "Guidelines" with a title: "Corporate Governance Code 2018" on 10 June, 2018 [21]. In this Code there are 166 conditions where 76 conditions without revisions, new 62 conditions and preceding 28 conditions with change. Almost 75% rules were enhanced in this new code [4]. It became mandatory for all the

companies to adopt those changes made over the time by BSEC to protect the rights of shareholders and ensure a good governance system in the business.

### C. Research Gap

All the research papers are focused on the practices on CG Guidelines. There are a few papers which deal with the depth analysis and identify the actual scenario of practicing of CG Code 2018. This paper is based on the practice of CG Code 2018 in Sonali and Basic bank that have remarked as loan scandal organizations. This paper will also reflect a depth analysis of Sonali Bank Limited, basic bank so that it can be easy to find out scandal may occur without application of sound corporate governance practices which will represent the actual scenario of practices of CG Code 2018 and its related disclosure in the annual report.

### D. Limitations of the Study

During the preparation of this paper some limitations act as the restraining factors which are communicated in this section.

- All relevant data for the analysis could not be accessed in a convenient manner. Annual reports offer a limited view which did not contribute to the inclusive analysis regarding the concerned issue.
- The overall study demands to be accomplished in a comprehensive manner for which ample time is required. Time scarcity prevents the in-depth analysis of each condition of the code and inclusion of more cases regarding the real practices among the industry.
- Banking companies and financial institution which have been analyzed throughout the study are not exposed to random sampling. Non-random sampling has been employed to select these companies.

## II. LITERATURE REVIEW

### A. Concept of Corporate Governance

Corporate Governance is well-defined as a set of systems, methods and values which confirm that a company is governed in the best interest of all stakeholders or corporate governance is a tool that protects shareholders interest and ensures a good governance environment in the market. It aims to promote corporate fairness, accountability, and transparency. So, a good corporate governance results in good business. Corporate Governance is now a major topic and important issue that can be used as tool to maximize wealth of shareholders of an organization. Corporate Governance targets the vision, values and visibility of a business organization [5].

### B. Prior Research about Corporate Governance

Corporate governance is an important tool for modern business environment. There are many prior researches published in international and local aspects about this topic.

### C. Corporate Governance in International Aspects

In the developed countries like UK Corporate governance code is subject to 'Comply or Explain'. It provides that a company is to comply with a code's provision, if not it has to be explained why the condition is not complied. The purpose of 'Comply or Explain' is to permit shareholders to make an informed evaluation as if condition is non-compliance is justified, given the company's settings and if not complied what is the reason behind this, which ensures the shareholders interest at its best [6]. Financial crimes can be classified by broad five categories like: asset misappropriation, accounting fraud, cybercrime, money laundering, and bribery and corruption Pwc [7], global economic survey expressed in 2016.

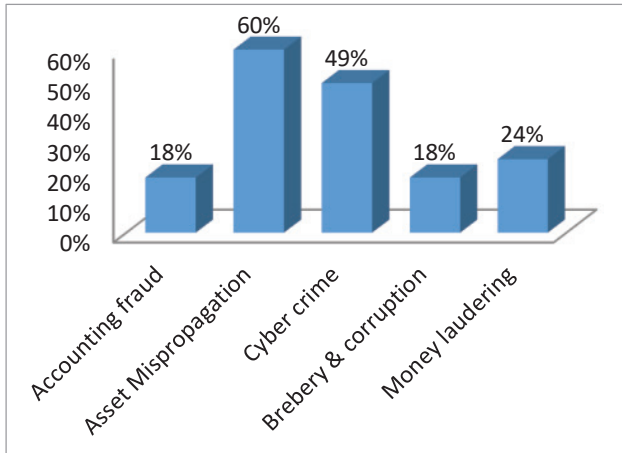


Fig. 1. Top 5 Global economic crimes PwC (2016) [7]

A research paper named “Does Corporate Governance Have an Effect on Performance in the European Banking Sector? evidence from a Crisis Environment” focuses on how corporate governance practices affect bank performance in developed and developing European markets. That study examined the performance of 150 commercial banks from 27 different European countries using data of 7 years (2004 to 2011). The finding implies that banking performance is significantly influenced by governance mechanisms such as ownership concentration, state ownership, board independence, and others. It also eliminates the probabilities of schemes and financial crisis [8]. A research was conducted named “An Empirical Study of Corporate Governance Practices of the Banking Sector of Sri Lanka and the Impact of Firm Specific Characteristics on Disclosure Practices”- results, the relationship between the firm-specific characteristics and disclosure practices, as well as the difference between the needed and actual disclosure practices, are both very different. So, companies were not that much concentrated to disclose the actual view of the organization according to the corporate governance guideline. This research was conducted with variables like board size, company size, total debt, firm age, profit margin (%) and return on equity (ROE) [10]. So, corporate governance becomes an important issue in international aspects which is basically a ‘comply or explain’ system which protects the

shareholders’ interest as well as ensures a good business environment [4].

#### D. Corporate Governance in Bangladesh

In Bangladesh corporate governance regulations was improvised for several times in past one and half decade. It became an important issue in recent time. So, the implication of CG regulation and its impacts are reflecting in many prior research papers which are based on local context. In the early of 2000 corporate governance was not as important as present time as per companies or the shareholders. They were less concerned about corporate governance papering and shareholders were not also interested because it was not enforced at that time and both of the parties were unknown about the benefit of this practices. According to a paper named, “Corporate governance in developing economies: Perspective from the banking sector in Bangladesh”- results that, in practice there were nearly no disclosures about corporate governance in the public sector banks. Some foreign owned banks were concerned about this type of disclosure. But local banks were indifferent about CG regulations [11]. In 2004, Corporate Governance Code 2004 was introduced and the code was mandatory. As per an article titled, “The Evolution of Corporate Governance Practices in Bangladeshi Banks with the Implementation of the Code of Corporate Governance” examined that the corporate governance practices of banks in Bangladesh have significantly improved after introduction of the Code of Corporate Governance for banks in Bangladesh though the code was voluntary and there is significant impact in their financial performance as it can attract attention of shareholders [12]. After that in 2006, guidelines for corporate governance introduced as “Corporate Governance Guidelines 2006” which was voluntarily followed by the companies by disclosing corporate governance papering in the annual report [13]. A research paper named, “Disclosure of Corporate Governance in Banking Sector of Bangladesh” [14] finds that consequences of having more independent

Less corporate governance is a result of increased insider ownership and corporate governance disclosure. This finding gave positive result which will encourage further increase of independent directors on the board. Also, regulatory authorities will focus to influence and stakeholders will be optimistic on organization that has high outside ownership [15]. In 2012 the Corporate Governance Guideline was revised and it became mandatory for all listed companies of Bangladesh [16]. An empirical study on corporate governance practice in Bangladesh titled, "Corporate Governance and Bank Performance: The Case of Bangladesh"- states that there are significant positive relation between financial performance (ROE, ROA) and corporate governance disclosure after the improvisation of corporate governance guideline 2012 [17]. It also suggests that many companies do not adhere to the mandatory standards for board size, independent director appointments, and holding audit committee meetings in accordance with the rules and regulations of the central bank and the Security and Exchange Commission (SEC), indicating a notable gap in corporate governance practice in Bangladesh's banking sector [17]. An article titled, "Corporate governance practices in the banking sector of Bangladesh: Do they really matter?"- shows a positive connection between corporate governance practices and financial performance of banks, the statistical insignificance of the relation raises concern with respect to different issues of corporate governance in the monetary area of Bangladesh [18]. As it become a known topic in modern business environment. Listed companies are, on average, moderately compliant with the code, and compliance is comparatively higher with the Code provisions that coincide with other regulatory provisions [19]. A study named "An Evaluation of Disclosure of Corporate Governance Practices in Banking Sector of Bangladesh" found that the major portion of the sample banks follows the CG practice [20]. There are some issues that show some differences in the corporate governance papering pattern of Islamic and non-Islamic bank

and both type of banks avoids the rules and regulation related to 17 independent directors and the presentation of recent five years financial key terms in the annual report. This paper also recommends that CG practices must be follow as per the guidelines to ensure the accountability and transparency (Islam, 2020).

### III. METHODOLOGY

The entire paper has been conducted based on qualitative research method which encompasses a descriptive study to converse the analysis and implications. Observation based analysis has been applied to fulfill the objective of the paper. Corporate governance practices in accordance with the detailed set of conditions are assimilated in a compressed manner. Content analysis has been engaged in the process of secondary data collection from the annual report of selected companies. In case of in-depth analysis, sample company (SBL and Basic bank ltd.) have been analyzed in a detailed manner. All relevant variables and conditions concerning the compliance code and guidelines have been studied for exploration purpose. Moreover, the paper comprehends both observation method and case study method which will result into making the analysis more representable and viable. Personal interview with the corporate governance authority of the respective companies would pave the way for future analysis on the concerned issue.

#### A. Construction of Data Set

Two years' (2019-2020) data have been assembled for the analysis purpose. Selected companies' data have been extracted from annual reports of respective companies. Collected data include basic information of the companies and detailed information regarding the corporate governance variables of those companies. Rules and compliances have been incorporated thoroughly into the data set. Data have been gathered from essential secondary sources such as various distributed articles, journals, web sites and annual reports of respective sample companies. Stated legal rules and regulations are entitled to the copyright of the standard publishing authority.

Relevant references regarding the sources of the used information have also been offered in the paper. The reliability and validity of the collected data is also confirmed by the companies as they have made these data publicly accessible.

**B. Context**

Corporate Governance is a vital topic for modern business environment. Corporate governance confirms a sound business environment which leads to transparency, accountability and ensures stakeholders rights [23]. It also helps to wealth maximization process of shareholders. As it become an important topic for business environment, this rules and regulations are improvised for several times for last two decades. This chapter focuses on the development of corporate governance laws and the significant changes from the CG Guidelines of 2012 to the CG Code of 2018 [21].

**C. Evolution of Corporate Governance in Bangladesh**

BSEC issued the corporate governance guideline on 20 February 2006, which had 37 conditions regarding to corporate governance. Corporate Governance Guidelines 2006 was “Comply or Explain” base conditions for listed companies [13]. This is the beginning when corporate governance is considered as separate regulation. There were 37 conditions and comply or explain basis. But in 2012 there were 7 broad head under which 93 conditions

TABLE I. 2012 CORPORATE GOVERNANCE CODE

CGG Condition Group #	Issue	No. of Separate Conditions	Condition Nos.
1	Board of Directors	46	Conditions 1.1 to 1.5(xxii)c
2	CFO, HIA & CS	2	Conditions 2.1 to 2.2
3	Audit Committee	27	Conditions 3(i) to 3.5
4	External/Statutory Auditors	8	Conditions 4(i) to 4(viii)
5	Subsidiary Company	5	Conditions 5(i) to 5(v)
6	Duties of CEO and CFO	3	Conditions 6(i)a) to 6(ii)
7	Reporting and Compliance of CG	2	Conditions 7(i) to 7(ii)
Total		93	

Then some changes occurred in the rules and Corporate Governance Guideline 2012 on 3 July, 2012 was published. In the CGG code of 2012, were published with 93 conditions under 7 heads and CGG 2012 became mandatory instead of comply or explain for listed company [16].

TABLE II. CG CODE 2018

CGG Condition Group #	Issue	No of conditions	Condition Nos.
1	Board of Directors	69	Conditions 1.1 to 1.7(c)
2	“Governance of Board of Directors of Subsidiary Company”	5	Conditions 2 (a) to 2 (e)
3	Appointment of MD, CEO, CFO, HIAC, CS	10	Conditions 3.1(a) -3.3(c)
4	Committee of Board of Directors’	2	Conditions 4 (i) - 4 (ii)
5	Audit Committee	34	Conditions 5.1(a) - 5(7)
6	‘Nomination and Remuneration Committee’ (NRC)	29	Conditions 6.1(a) - 6.5 (c)
7	External/Statutory Auditors	11	Conditions 7.1 (i) - 7.3
8*	Maintaining a ‘website’ by the Company	3	Conditions 8.1 - 8.3
9*	Reporting and Compliance of Corporate Governance	3	Conditions 9.1 to 9.3
Total		166	

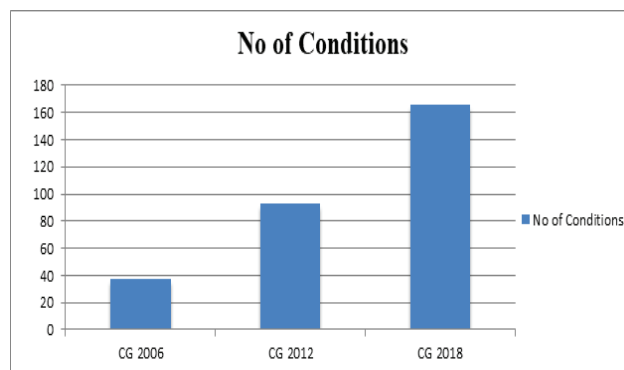


Fig. 2. CG code evolution

The Corporate Governance Code 2018 was published as “Code” instead of “Guidelines” with a title: “Corporate Governance code 2018” on 10 June, 2018 [21]. In this Code there are 166 conditions where 76 conditions without revisions, new 62 conditions and preceding 28 conditions with change. Almost 75% rules were enhanced in this new code [4]. It became mandatory for all the companies operating in Bangladesh.

IV. ANALYSIS

The major Corporate Governance Guidelines (CGG) 2018 conditions total 166 and are broken out into 9 basic categories, such as 1.Directors' Board, 2.Board of Directors of a Subsidiary Company Governance, 3.Chief Executive Officer (CEO) or Managing Director, and 4.Chief Financial Officer (CFO), 5.The company secretary (CS) and the head of internal audit and compliance (HIAC).

A. Board of Directors' Committee

The following sub-committees must be present on the Board of Directors: Audit Committee, Nomination and Remuneration Committee (NRC), External or Statutory Auditors, The Company will keep a webpage up to date and Corporate Governance Reporting and Compliance report.

Analysis of the sample companies based on those broad head conditions are given below.

1) Condition 1 Board of Directors:

The composition of a company's board of directors is covered in this section of the 2018 corporate governance guidelines. Focused issues include the size of the board of directors, independent directors, their qualifications, the dual roles of chairperson and CEO, the director's report to shareholders, board meetings, and codes of behavior for the chairperson, other board members, and CEO. This section consists with 69 conditions. Banks and Financial Institutions disclose most of information as per those conditions. Condition 1(7)(a), 1(7)(b) are not fulfilled by the Financial Institutions because of," The Executive Committee (EC), Audit Committee (AC), and Green Banking Committee are the only three subcommittees of the Board that can be formed by a Financial Institution (FI) in accordance with Bangladesh Bank norms (GBC). Bangladesh Bank does not authorize the Board to have any other subcommittees. However, companies have addressed the problem

with Bangladesh Bank through the Bangladesh Leasing and Finance Companies Association (BLFCA) and Bangladesh Association of Publicly Listed Companies in order to comply with this paragraph of the CGG of the BSEC (BAPLC). We have not yet received any direction in this regard as of the reporting date. For banks, it is in the process (The formation of NRC is under review of Bangladesh Bank.).

B. Recent Corporate Governance Practices: major conditions compliance

1) Independent directors: According to Bala (2018), in place of "Guidelines," the Corporate Governance Code of 2018 has been published as a "Code" with the title "Corporate Governance Code. In the CGG for 2012, there were 95 conditions spread among seven headings and one annexure. While in the CGC of 2018, two earlier heads were combined with three new heads. Size

TABLE III. BOARD OF DIRECTOR AND AUDIT COMMITTEE RELATED CONDITIONS

Company Name	Board Size	No. of Independent Direct or (Condition no.- 1.2)	Is it 1/5th of the total number? (if Yes=1, No=0) (Condition no.- 1.2.a)	Qualification (Sector Expert, Professional accountant/ General)	Duality (Yes=1, No=0) Condition no. 1.4
Sonali Bank	9	1	1	4	0
Basic Bank	5	1	0	2	0

of the board and directors related conditions are most relevant for ensure regulations and avoid scam. Conditions No 1.1 to 1.5(xxii) (c) total 69 conditions related to directors but independent directors have separate conditions. Independent Directors, Condition No 1(2)(a) to Condition No 1(2)(e), should have some distinctive characteristics like 1/5th of board must be independent directors who are independent in nature and no interest, no relationship with CEO/MD. For Sonali Bank Limited and basic bank compliance aspects:



TABLE IV. BOARD OF DIRECTORS AND INDEPENDENT DIRECTORS CONDITIONS

Company	Year	Compliance of Conditions 1.1 to 1.5(xxii)(c): Complied (out of 69 Conditions)	Compliance of Conditions 1.1 to 1.5(xxii)(c): NOT Complied (out of 69 Conditions)	Compliance of Conditions 1.1 to 1.5(xxii)(c): N/A (out of 69 Conditions)	Score (%)
Sonali Bank	2020	66	0	3	95.65
	2019	67	0	2	97.10
Basic Bank	2020	62	0	7	89.85
	2019	65	0	4	94.20

Table shows the basic bank comply 89.85% and 94.20%. Here one matter is noticeable that why 2019 score better than 2020, the reason behind that at middle of the year the board of the directors were changed and new board had come to continue the bank. On the other hand SBL annual report shows everything details and compliance status. Total board size and no of independent directors are maintained as per CGC 2018. It has been expressed in annual report All of SBL's directors, excluding the managing director, are non-executive directors. The number of Board members falls within the parameters established by Bangladesh Bank, the Bank's Articles of Association, the Bank Company Act of 1991 (as amended in 2018), and Bangladesh Securities and Exchange Commission notification No. SEC/CMRRCD/2006-158/134/Admin/44 dated August 7, 2012. Conditions 1.1 to 1.7(b), totaling 69 SBL, are 95.6% complied with in 2020. 1.7(a) and 1.7(b) are related Code of Conduct for the Chairperson, other Board members and Chief Executive Officer.

2) *Managing Director (MD)/Chief Executive Officer (CEO), Chief Financial Officer (CFO), Head of Internal Audit and Compliance (HIAC) and Company Secretary (CS)*: Under this section there are 10 conditions 'Condition 3(1(a) to 3.3(c)'. "The positions of the Managing Director (MD) or Chief Executive Officer (CEO), Company Secretary (CS), Chief Financial Officer (CFO) and Head of Internal

Audit and Compliance (HIAC) shall be filled by different individuals" condition no- 3.1(b). A listed company's MD or CEO, CS, CFO, and HIAC are prohibited from simultaneously holding an executive position in another company. CG codes or regulations are one but in practical that were not applied. So the real aspect for SBL and basic bank is given below

TABLE V. CONDITIONS NO. # 3 MD/ CEO, CS, CFO AND HIAC

COMPANY	YEAR	COMPLIANCE OF CONDITIONS 3(1)(A) TO 3.3(C): COMPLIED (OUT OF 10 CONDITIONS)	COMPLIANCE OF CONDITIONS 3(1)(A) TO 3.3(C): NOT COMPLIED (OUT OF 10 CONDITIONS)	COMPLIANCE OF CONDITIONS 3(1) TO 3.5: N/A (OUT OF 10 CONDITIONS)	Score (%)
SONALI BANK	2020	10	0	0	100
	2019	10	0	0	100
BASIC BANK	2020	7	3	0	70
	2019	8	2	0	80

Here SBL is 100% complied with this condition, all the committee's member and MD, CEO, CFO and HIAC are different position and separate personality. But the basic bank new Chair Prof Dr. Abul Hashem was appointed in 2020 along with two bureaucrats and two professionals. No person in audit committee is from audit or accounting background. So the others performance will be in doubt. Condition no. 5.2(b) and 5.2(c) were not complied in 2018 and 2020. CN 5.2(a) 'The Audit Committee shall be composed of at least 3 (three) members" but in 2020 in basic bank only two members are included in audit committee.

3) *Audit committee (condition 5)*: The most important part of CG, kamal and fahmida, [22] also mentioned that without stator audit no validity will have to statement. 11th BRPD Circular, dated October 27, 2013. The Board of Directors receives help from the Audit Committee to maintain internal controls.

Additionally, it attests that the financial statements properly reflect the company's financial position. It provides instructions on how to make sure the company has an effective controlling system. This section of Corporate Governance Guidelines 2018 has 34 conditions which are dealing with audit committee of organizations. The majority of companies meet the most of the conditions in this area. Because no such event occurred in those specific banks or financial institutions, many companies omitted any information about condition 5(5)(m): monitor whether the funds raised through an initial public offering (IPO), repeat public offering (RPO), or rights share offer have been used as stated in the relevant offer document or prospectus approved by the commission. Other than that, report to authorities and report to board of director are also not applicable for those sample companies.

The condition regarding audit committee

- a) Members of the audit committee are selected by the BoDs from the Directors
- b) The Audit Committee may have up to five (5) members.
- c) The members of the Audit Committee are not Executive Committee members.
- d) Members serve three (three) year terms in office.
- e) The Audit Committee's secretary is the company secretary (CS).[24]

TABLE VI. AUDIT COMMITTEE

Company	Year	Compliance of Conditions 5(i)(a) to 5(7): Complied (out of 34 Conditions)	Compliance of Conditions 5(i)(a) to 5(7): Not Complied (out of 34 Conditions)	Compliance of Conditions 5(i)(a) to 5(7): Gaps (out of 34 Conditions)	Compliance of Conditions 5(i)(a) to 5(7): N/A (out of 34 Conditions)	Score %
Sonal Bank	2020	34	0	0	0	100
	2019	34	0	0	0	100
Basic Bank	2020	32	2	0	0	94.11
	2019	32	2	0	0	94.11

The Audit Committee verifies that the financial statements include accurate and complete information and that they were prepared in

accordance with Bangladesh Bank's relevant prescribed accounting standards and all applicable laws and regulations that are currently in effect in the nation.

TABLE VII. AUDIT COMMITTEE

Company Name	Year	Presence of Audit Sub Committee (Yes=1, No=0)	Independent Director as Chairperson of the Committee	Meeting Held (At least 4 meetings must be held)
Sonal Bank	2020	0	1	8
	2019	0	1	8
Basic Bank	2020	0	1	8
	2019	0	0	4

External or Statutory Auditors: In the corporate governance guidelines 2018, there are 11 conditions in this section. This section focuses on external auditors. All the banks and financial institutions are complying all the conditions of this section. This section is concerned about the external audit partner and the respective rules and regulations.

4) *Nomination and Remuneration Committee (NRC), Condition 6:* The NRC shall collaborate with the Board to develop the nomination requirements or policy to decide the qualifications, desirable characteristics, experiences, and independence of directors and top executives, as well as a policy for the official procedure for considering the compensation of directors and top executives. Clause #5 of Bangladesh Bank's BRPD Circular No. 11 from October 27, 2013, states that no Bangladeshi bank may form any other committees besides the Executive Committee, Audit Committee, and Risk Management Committee. As a result, The Bank could not fulfill this requirement because NRC has not been formed. Disclosure: According to Bangladesh Banking rules, a financial institution (FI) can only form the Audit Committee and Executive Committee as board subcommittees. Bangladesh Bank does not authorize the Board to have any other subcommittees. However, the problem has been raised with Bangladesh Bank through the Bangladesh Leasing and Finance Companies Association in order to comply with this condition of the CGC of the BSEC (BLFCA). They have not

yet obtained any guidance regarding this issue as of the reporting date. All banks requested the Central Bank's advice for Banking Companies in order to resolve the situation.

TABLE VIII. NRC (NOMINATION AND REMUNERATION COMMITTEE)

Company	Year	Compliance of Conditions 6(1)(a) to 6(5)(c): Complied (out of 29 Conditions)	Compliance of Conditions 6(1)(a) to 6(5)(c): Not Complied (out of 29 Conditions)
Sonali Bank	2020	0	29
	2018	0	29
Basic Bank	2020	0	29
	2018	0	29

The selected banks have not yet formed NRC (Nomination and remuneration Committee). The NRC member who is chosen by the Board to act as the Committee's Chairperson must be an independent director, as are all other related requirements like the Committee must have at least three members, including an independent director. Members must also be non-executive directors.

TABLE IX. REPORTING AND COMPLIANCE OF CORPORATE GOVERNANCE

Condition no.	Statement	Sonali Bank	Basic bank
9.1	A Professional Accountant or Secretary (Chartered Accountant or Cost and Management Accountant or Chartered Secretary) will certify the compliance of CGC with annual report.	comply	comply
9.2	In AGM professionals be appointed by shareholders	comply	comply
9.3	'The directors of the company shall state, in accordance with the Annexure-C attached, in the directors' report whether the company has complied with these conditions or not'	comply	Not comply

5) *Maintaining a website by the Company (Condition 8)*: This is a new section that is included in the Corporate Governance Guidelines

2018. There are 3 conditions in this section regarding to maintain a website for all the companies.

All the sample companies comply this regulation which is related to maintaining an official website and update all financial and non-financial data and this must be free for all the stakeholders of the company. Sonali Bank Limited website is [www.sonalibank.com.bd](http://www.sonalibank.com.bd) [24] where anyone can search anything about SBL and [www.basicbanklimited.com](http://www.basicbanklimited.com) [25] is the website of basic bank.

6) *Reporting and Compliance of Corporate Governance(Condition no 9)*: Only there are three conditions regarding reporting of CG in amended 2018 new version.

## V. FINDINGS

Firstly, all the banking companies including SBL and basic bank only show comply or not by putting (√) sign in corporate governance report. In this paper we have found, by depth analysis the conditions those are mostly related to corruption or scam, that SBL and basic bank follows the CGG 2018 (amended) to some extent without some conditions. Condition no# 1 regarding board of directors having 69 conditions, SBL follows most the conditions accept code of conduct for the Chairperson, other board members and Chief Executive Officer. Basic bank is not listed company at DSC but try to follow the conditions. SBL and basic bank both have scandal for loan defaulting as the directors of board are some personals who are not under supervised though they have knowledge, experience etc. independent directors having separate condition (some amendments in 2018). BSEC provides all aspect about independent

TABLE X. INDEXING THE PRACTICES OF CG CODE 2018

Company name	Year	Total no of conditions	Complied Conditions	Score (%)	Not Complied Conditions	Score (%)	Not applicable	Score (%)
Sonali Bank	2020	166	134	80.72	29	17.47	3	1.80
	2019	166	135	81.33	29	17.47	2	1.21
Basic Bank	2020	166	109	65.67	41	24.70	16	9.64
	2019	166	112	67.45	39	23.50	15	9.03

directors but in real sense directors how much they can be independent that is the question. Some institutional factors are bad management, insufficient capital, and other internal factors. Ownership structure-related boardroom disputes, insider misconduct, frauds and forgeries, insufficient or ineffective internal control measures, low asset quality, and other institutional issues are also mentioned. Secondly, audit committee the most powerful determinant for escaping the corruption or scam can play a vital role for banks. For SBL audit committee is most active and professionals, accountant and knowledgeable govt. personal are members of audit committee. Under this regulations provided by BSEC there are 34 conditions. SBL complied with 100% in both 2020 and 2019 but basic bank complied with 94.11 % in both years. Besides audit committee, there would be a sub audit committee but it was absence in both cases. At least 4 meeting should be held in a year of audit committee. SBL held maximum 8 meetings and basic bank held 8 in 2019 and 4 meeting in 2020.

NRC a new aspect for corporate environment created by BSEC is not applied both of the company though it was practiced by various foreign companies. Nomination and remuneration committee can easily solve employee related problems and future growth of employment. In future this may be major factor to be analyzed and a scrutinizer for corruption findings.

Though both banks comply with most of the conditions still scams, corruptions and scandals are occurring in through many ways. We discover that effective management scrutiny, strong internal control systems, high-quality financial reporting, high-quality audits, and full exposure of company activities to the board are crucial elements in ensuring excellent corporate governance in Bangladesh. We believe that when a firm has a dominant CEO, the board is powerless to identify problems with the company, and this is partly to blame that many occurrences were happened for that.

## VI. RECOMMENDATION: FUTURE RESEARCH

The main purpose of us to select these two banks as they involved two corporate scandals (Hallmark and basic bank) and try to know the level of compliance of imposing CGC amended in 2018. Our result is satisfactory to some extent but the conditions must be quantified to know the actual scenario. Only comply status and putting (√) sign is not enough for avoiding corporate scandal and ensure good governance. Our suggestion to find out relations between conditions quantity and performance, conditions for all sectors. For good and secure corporate environment, more and more conditions based specific research may be done. In future, it may be added to the conditions

- Tax practices and tax accounting practices related conditions may be added
- Basel III guidelines must be followed by all banks, as well as the prudent application of banking law.
- Audit sub-committee and NRC related conditions may ensure legal and appropriate report, so these conditions should be followed by all companies.
- Different research may be possible on different sectors compliance level of CGG like textile, food, land and development pharmaceuticals etc.
- Publication of a list of defaulted borrowers on the website

As sectors are different, all conditions may not suit for all companies. So different sectors may have individual corporate guidelines and regulation set by BSEC.

## VII. CONCLUSION

Due to connections to all other sectors, the banking sector provides a complete view of a nation's economy. It is crucial in emerging nations like Bangladesh, where the economy is currently shifting from one centered on agricultural to one

based on industry. As the major component of the financial sector, banks must function at their peak levels of efficiency in order to help the nation's economic growth. The main criterion for an effective and stable banking system is the presence of strong corporate governance and its right practices. Corporate governance requires special attention on a priority basis in a country like Bangladesh where prudential rules and supervision are insufficient to provide a safety net for the bank stakeholders and depositors. Lack of board independence, biased loan distribution, insufficient collateral associated with indecorous personal guarantee, compliant independent directors, and the "unwillingness to pay" motive have all played a role in Bangladesh's banking sectors scandal. Banking practices and legal ignorance in relation to financial concerns have seriously questioned the health of the banking industry. To develop the banking industry, it is important to improve corporate governance practices across banks, thus each element mentioned in this study should be carefully examined.

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# Depression and Anxiety among Tertiary-level EFL Students of Bangladesh during COVID-19 and the Mental Health Support Provided by their Institutions

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**Abstract—** With the advent of the COVID-19 pandemic, tertiary-level EFL students in Bangladesh were forced into a lockdown that changed their way of lives. The unique and unprecedented circumstances surrounding this pandemic resulted in the rise of depression and anxiety among them, making it crucial to explore the mental health triggers of these students and the support provided by their educational institutions. A quantitative survey was conducted among 105 EFL students of 3 public and 6 private universities in Bangladesh. The findings indicate that financial constraints, uncertainties regarding the future, domestic disputes and inadequate resources were some of the reasons behind the rise of anxiety and depression among them. They also depict the dissatisfaction among students regarding the inadequate mental health support provided by their respective educational institutions. Suggestions are made to bring about a sustainable impact including introducing mental health support groups, suicide hotlines and providing regular counseling by professionals.

**Keywords—** COVID-19, EFL students, anxiety, depression, mental health

## I. INTRODUCTION

The novel Coronavirus Disease or the COVID-19 pandemic created an unprecedented situation worldwide. Ever since the World Health Organisation (WHO) declared COVID as

a pandemic on March 11, 2020, governments all over the world scrambled to undertake measures in order to contain the spread of the virus [1]. Some countries imposed total lockdowns in order to flatten the curve and the others tried desperately to limit social interactions by introducing new social distancing rules. Bangladesh did the latter in the initial stages. Public gatherings were restricted, both international and domestic travel halted, business establishments were closed down indefinitely and even government offices had to cease their day-to-day activities in a bid to maintain social distancing and curb the ever rising numbers of COVID-19 cases.

On March 16, 2020, the Ministry of Education of Bangladesh decided to close down all educational institutions from March 18 to March 31, 2020 [2]. However, with the imposition of a further 10-day lockdown declared effective from March 26 to April 4, 2020, all the establishments and educational institutions in the country faced indefinite closure with no indications of when the situation would be under control [3]. As the ‘general holidays’ or ‘lockdowns’ were extended repeatedly, educational institutions decided to begin online or remote classes in mid-2020, in order to recover from the months of missed classes and to avoid an irrecoverably long academic break. As of April 7, 2021, all the educational institutions of the country are still closed and students, teachers as well as the

guardians have faced many challenges in the face of such unprecedented times, especially the tertiary-level students of the country.

According to Aristovnik *et al.*, nearly 1.598 billion students all over the world were confined to their homes due to the pandemic and “the pandemic has had a big impact on higher education students’ practices regarding academic work and life, (their) social life, their personal financial situation, and emotional health (fears, frustrations, anxiety, anger, boredom, etc.)” [4]. The stress of getting accustomed to remote learning, inaccessibility of resources or technology, financial constraints, domestic disputes (applicable for the students residing with their families) and the uncertainty about the future are some of the many reasons giving rise to depression and anxiety among tertiary-level students all around the world. According to Ferdous and Shifat, depression and anxiety are prevalent among tertiary-level students in Bangladesh and the introduction of remote classes have added an extra burden of not only mental stress but also uncertainties and fears among both teachers and students [5]. This paper aims to examine the prevalence of depression as well as anxiety among the tertiary-level students, more specifically, the tertiary-level EFL (English as Foreign Language) students in Bangladesh and to investigate the mental health support provided by Departments of English and other tertiary-level English teaching institutes all around the country during the COVID-19 pandemic.

In order to get a better understanding of the prevalence of depression and anxiety among the tertiary-level EFL students of Bangladesh and the mental health support they have received from their respective Departments and institutions during the COVID-19 pandemic, this article addresses the following questions:

1. How common is depression and anxiety among the tertiary-level EFL students in Bangladesh during the COVID-19 pandemic?

2. Did the respective Departments of English or other tertiary-level English teaching institutes provide any mental health support to the EFL students during the COVID-19 pandemic?

3. Are the students satisfied with the support received?

This article will also shed light on prior literature on this topic, inform of the methodology undertaken to collect data, specify the study participants and data analysis procedures as well as the projected implications of this research.

## II. LITERATURE REVIEW

The unique yet daunting circumstances created by the COVID-19 pandemic have gripped the nation and apart from the devastating loss of lives, it has given rise to many other crises.

Rudestine *et al.* points out that according to Centers for Disease Control and Prevention [CDC] COVID-19 Response Team, the COVID-19 outbreak “and its profound economic consequences created a large-scale traumatic event that is expected to have a substantial impact on the mental well-being of numerous populations.” [6] The CDC also adds that, “The extensive consequences of the pandemic are likely to alter health trajectories, educational systems, and the economy, all of which may contribute to negative mental health outcomes.” According to Husky *et al.*, “While still largely undocumented, the Covid-19 pandemic may impact mental health through direct threats to the individual's health but also through the indirect effects of public health policies and containment efforts [7].” The student community have been proven to be particularly vulnerable to the drastic effects of the pandemic. Adapting to the sudden shift to distance-learning, coping with lockdowns and other social-distancing measures, inadequate resources and financial constraints have proven to be extremely stressful for students at both home and abroad.



Islam *et al.* opines that, in Bangladesh, the “unprecedented experience of ‘home quarantine’ under lockdown with the uncertainty of academic and professional career has multifaceted impacts on the mental health of students. The ongoing COVID-19 pandemic is creating a psycho-emotional chaotic situation as countries have been reporting a sharp rise of mental health problems, including anxiety, depression, stress, sleep disorder as well as fear, among its citizens ” [8]. According to Ferdous and Shifat, anxiety and depression is prevalent among tertiary level students in Bangladesh and the introduction of remote classes during the pandemic has imposed an extra burden of mental stress, fears and anxieties for both teachers and students [9]. Jiao *et al.* states that educational institutional closure has “result(ed) in minimal interaction with peers and decreased the opportunities for exploration and physical activities” among students and this inactivity and stagnation in academic activities have given rise to insecurities and “feelings of being downgraded and unprivileged accumulated in them” and as a result, “they devastatingly feel broken, affecting their mental health [10].”

According to an online-based survey conducted by Islam *et al.*, data collected from tertiary-level students of Bangladesh indicated that “82.4% students were found to have mild to severe depressive symptoms, and 87.7% students were found to have mild to severe anxiety symptoms [11].” Another study conducted by Khan *et al.* reflected that 67.13% of the respondents believed that “prolonged quarantine was a stressor in this outbreak situation [12].” In 2020, Ferdous and Shifat conducted a mixed-method research where 46 ESL (English as Second Language) and EFL students were the main focus and they reported that, among the participants, 70% were extremely stressed and anxious about online learning [13]. According to the previously mentioned cross-sectional study undertaken by Khan *et al.* on college and university students of Bangladesh, it was found that 8.11% of the respondents were reported to be under “severe to extremely severe

stress” and 17.02% respondents were reported to have “severe to extremely severe depression” [14]. The above data clearly indicates the prevalence of stress, anxiety and depression among the tertiary-level students of Bangladesh.

In light of the distressing events brought on by the COVID-19 pandemic, university students all over the world have an increasing need for mental health and wellbeing support from their respective departments and educational institutions. According to Psychiatric Times, “College mental health services must swiftly respond to this changing landscape to support their students during this stressful and potentially isolating experience [15].” Pinsent Masons, a law firm, reports that, a survey conducted by National Union of Students (NUS) in the UK indicate that among the university students whose mental health had deteriorated during the COVID-19 pandemic, only “29% . . . had sought help” and among them only “three in five were satisfied with what they received [16].” As no previous studies have been conducted about the COVID-19 mental health support provided by educational institutions in Bangladesh to tertiary or EFL students, this paper should be useful in regard to gaining valuable insights into this matter.

The evidence above suggests that there are reasons to explore the prevalence of depression and anxiety among the tertiary EFL students of Bangladesh during the COVID-19 pandemic and assess their level of satisfaction with the mental health support provided by their respective educational institutions.

### III. METHODOLOGY

One hundred and five tertiary-level students from the Departments of English and other tertiary-level English teaching institutes from 3 public and 6 private universities were chosen for sampling. Probability sampling was performed on the target population and it was limited to EFL students only. A quantitative survey questionnaire

was designed on the basis of requirement, which contained basic demographic questions about the students as well as questions about the student's mental health, more specifically, depression and anxiety and their perceptions of the mental health support received from their respective departments or institutes. A Likert scale was used to determine the intensity of the student attitude regarding the research questions.

Data collection was web-based and the target population was presented with the e-questionnaires in a Google Form through online portals like Facebook, Messenger, WhatsApp or email. The participants were requested to share the instrument with other EFL students among the 9 selected public and private universities across Bangladesh. Voluntary response sampling was conducted on the population based on ease of access. A quantitative analysis was performed on the collected data and percentages, descriptive statistics as well as graphs were used to present the analyzed data.

#### IV. FINDINGS

The responses received through the questionnaire were categorized in the scale rank of the following order: Strongly Disagree, Disagree, Neutral, Agree and Strongly Agree. In this section, the responses where participants agree or disagree to a certain question might be depicted in isolation or combined (both strongly and simply agree/disagree together). The findings of the data painted a general picture of the mental health condition of the target population during the COVID-19 Pandemic and their reflections on whether the mental health support provided by their respective educational institutions were satisfactory or not. Based on the responses to the demographic questions, 55.2% (n=58) of the target population were male and 44.8% (n=48) were female. Majority of the students (n=49, 46.7%) had already completed their undergraduate studies and the rest were either pursuing their undergraduate studies (32.4%) or had completed their post graduate

studies (21%). Among the participants, 57.1% (n=60) were full-time students, 32.4% (n=34) were employed and 5.7% (n=6) were unemployed.

To start off with, 23.8% of the total population strongly or simply agreed (30.5%) that they had depression or anxiety prior to the COVID-19 pandemic, while 11.4% strongly and 22.9% simply disagreed having any of these two mental illnesses before the advent of COVID. The rest were neutral (11.4%). On the other hand, 23.8% participants strongly agreed that the pandemic negatively impacted their mental health, while 35.2% participants also agreed to the same. On the contrary, 9.5% participants strongly and 17.1% participants simply disagreed about being negatively affected by the COVID-19 pandemic. The rest (14.3%) took a more neutral stance. A combined 62.8% of the target population agreed to have strongly or simply felt sad or empty during the pandemic, whereas a combined 21.9% simply or strongly disagreed.

With regard to physical manifestations of either anxiety or depression, it was seen that a combined 40% agreed to have felt tired or exhausted during the lockdown imposed by different governments during the pandemic. However, the majority (42.9%) seemed to disagree about it on various levels. 51.4% participants either simply or strongly agreed to have had sleeping troubles during the pandemic (either too much, too little or nightmares). A combined 35.3% participant disagreed to it on various levels. Regarding eating troubles (loss of appetite or overeating), majority of the participants denied any such difficulties. 54.3% of the participants either simply or strongly disagreed to it, however, 16.2% of them strongly agreed to facing such troubles, with a further 15.2% simply agreeing to it.

Among the participants, a combined 61.9% either simply or strongly agreed to have been

filled with paranoid thoughts and fears, which got progressively worse during the COVID-19 pandemic. 11.4% of them strongly disagreed and a further 10.5% simply disagreed to such complaints. The rest (16.2%) were neutral. Moreover, 33.3% of the participants felt like a failure or that they had let down their families, whereas, a combined 29.5% either simply or strongly disagreed about it. A further 22.9% of them were neutral about it. Burdened by these paranoid thoughts, a whopping 62.8% of the population (37.1% agreed, 25.7% strongly agreed) reported to having thoughts about death quite often during the pandemic. The rest were either neutral (15.2%) or strongly (13.3%) or simply disagreed (8.6%) to it. A combined 61% of the participants worried that something bad would happen to them, while, a total of 44.7% of them worried that something bad would happen to their families. On the other hand, of the whole population, about 19% and 17.1% were neutral, respectively, whereas, a combined 20% and 38.1% either simply or strongly disagreed to it, respectively.

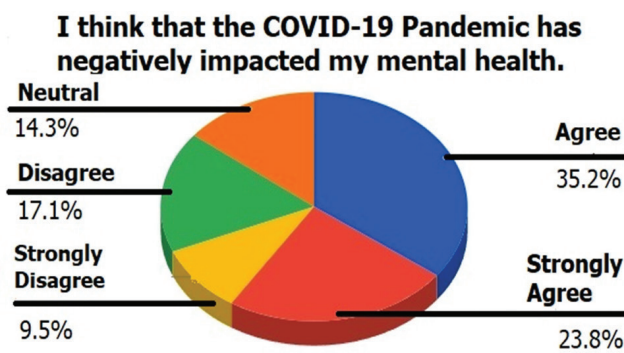


Fig. 1. Source: Author's Study Findings

In response to whether the act of being stuck home for an extended period of time during the COVID-19 pandemic had negatively impacted their mental health, the responses of the participants were very close. A combined 43.8% agreed, however, the majority (a combined 43.9%) disagreed. In response to whether the participants enjoyed the solitude and had no complaints regarding the social distancing measures imposed during the COVID-19

pandemic, the majority (55.2%) disagreed on various levels. Only a combined 25.7% agreed. The majority were neutral (27.6%) when asked whether the feeling of loneliness during the COVID-19 pandemic had negatively affected their mental health. 24.8% of them simply disagreed and a further 15.2% strongly disagreed. On the other hand, 19% of them agreed and another 13.3% strongly agreed.

For the most part, most of the participants did not worry that they were falling behind in studies and extracurricular activities due to the COVID-19 pandemic (25.7% disagreed and 21% strongly disagreed). While a combined 28.5% agreed, a further 24.8% were neutral about it. However, when it came to their career, a majority of 49.5% (33.3% agreed, 16.2% strongly agreed) were concerned that their career would be hampered due to the COVID-19 pandemic. A massive majority of 61.9% (39% agreed, 22.9% strongly agreed) reported that they were under financial constraints during the COVID-19 pandemic and a mere 18.1% combined disagreed. In response to whether their financial troubles were negatively affecting their mental health, a combined 56.2% agreed and only 26.7% in total disagreed. A majority of 48.5% (33.3% agreed, 15.2% strongly agreed) have reported to have faced domestic troubles/disputes which consequently hampered their mental health during the pandemic. A combined 37.2% disagreed to such complaints.

With regard to attending online classes, 30.5% participants simply agreed and a further 19% strongly agreed to enjoying them. A combined 31.4% disagreed. However, a combined 64.8% of them reported that attending online classes were negatively affecting their mental health, whereas, a combined 21.9% disagreed. A majority of about 55.3% agreed on various levels that they did not have adequate technological resources to properly continue online classes or examinations. While a massive majority of 64.7% reported that

inadequate technological resources always weigh on their minds and causes them stress.

In response to whether Department/University/English teaching Institutes, a combined majority of 40% agreed and a near equal of about 37.1% in total disagreed. In response to the very important question of whether the students were satisfied with the mental health support received from their Department/University/English teaching institutes or not, 24.8% participants agreed and another 24.8% strongly disagreed. A combination of about 37.1% of the students agreed to being satisfied, and the rest were neutral about it (13.3%). A majority of about 66.6% students in total agreed that they felt like their the participants had received mental health support from their Department/University/ English teaching institute could have done more about the mental health wellbeing of their students. On the other hand, a majority of about 40.9% (23.8% simply agreed, 17.1% strongly agreed) of the participants reported to feeling let down by their Department/University/English teaching institute regarding their overall response to the COVID-19 pandemic. 21% of the participants were neutral about it, whereas, a combined 38.1% of them disagreed to being let down by their educational institutions regarding their mental health response during the COVID-19 pandemic.

## V. DISCUSSION

From the above responses, it is apparent that, most of the tertiary-level EFL students in Bangladesh were more or less struggling with their mental health during the COVID-19 pandemic, especially with anxiety and depression. While many of the students already suffered from these two mental illnesses prior to the pandemic, they felt that the unique circumstances surrounding the pandemic and the subsequent lockdown exacerbated their conditions. The students faced increasing eating and sleeping troubles and were filled with paranoid thoughts worrying about the safety of themselves and their families.

One of the most alarming discoveries is the high percentage of students reporting to have had thoughts about death during the pandemic. That directly signifies the emotional and psychological vulnerabilities of our youth and raises an immediate call for action regarding more institutional-level mental health support, especially in educational institutions.

Even though most of the students did not seem to think being stuck home during the pandemic, or the consequent loneliness of being forced away from friends, families and loved ones negatively affected their mental health, the majority of them did report about disliking the social distancing measures imposed during the pandemic. For the most part, the students were worried about the effect of the pandemic on their career, more so than their studies. Many of the students faced financial constraints during the pandemic and that heavily weighed on their minds and affected their mental wellbeing. Many students, mostly the ones used to living away home faced domestic disputes which hampered their mental health.

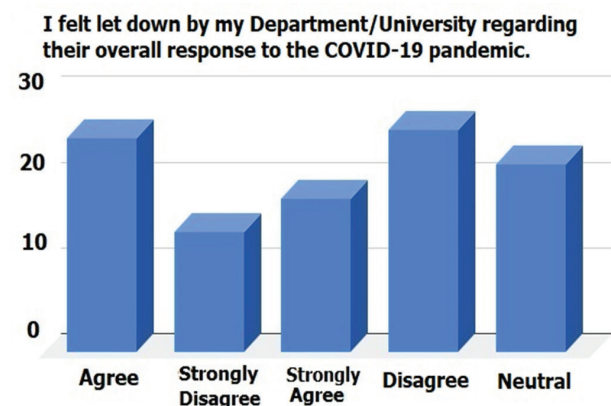


Fig. 2. Source: Author's Study Findings

Even though the students seemed to enjoy online classes, the majority reported that it negatively affected their mental wellbeing. The reason could be the absence of regular learning conditions (physical learning, interaction with teacher/instructors and classmates). Inadequate technological resources to conduct online classes also seemed to heavily weigh on their minds.

As for the mental health support provided by their respective educational institutions, from the responses, it seemed inadequate. As most of the students report being unsatisfied or let down by their educational institutions, further investigation should be conducted on how to change these reactions and numbers. Proper measures should be taken so that in the face of any other crises like the COVID-19 pandemic in the future, students can rely on their respective educational institutions to provide better mental health counseling and other related services and act like a place of comfort for the students, especially students coming from a troubled household.

## VI. CONCLUSION

This study explored the rise of depression and anxiety among tertiary-level EFL students in Bangladesh during the COVID-19 pandemic and the mental health support provided by their respective educational institutions and reported on the findings. Due to the extremely uncertain and distressing times during the ongoing COVID-19 pandemic, a considerable number of EFL students were deeply affected by mental health illnesses like depression and anxiety in Bangladesh. Uncertainties regarding their academic future and careers, financial constraints, domestic disputes, inadequate resources were some of the most common reasons behind developing or further aggravating mental health illnesses like depression and anxiety among the students. The students reported to being dissatisfied with the mental health support they have received from their respective departments or educational institutions. English departments and other English-teaching institutes in Bangladesh still need to go a long way to be able to provide adequate mental health and wellbeing support to their students. In order to bring about a positive change and a sustainable impact, English departments and English teaching institutes all over the country can form mental health support groups, arrange regular counseling sessions from clinical psychologists, create a suicide hotline, to name some. This paper aims to contribute to bring about a positive change regarding mental health responses in general among tertiary-level students

in Bangladesh, especially EFL students, in the post-pandemic world and improve the overall mental wellbeing of our Bangladeshi students.

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# Impact of ADP in the GDP of Bangladesh with Monetary Policy

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**Abstract**—The main aim of this study examines the relationship among GDP, ADP and M2. It also deals with the price stability, full employment and economic growth. In monetary policy government or central bank controls such as the supply of money, availability of money, rate of interest etc. This paper uses various econometric tools where time series analysis is gained main focus to find out the proper result. According to result it is found that GDP is dependent on ADP which indicates the fiscal policy here as well as it is dependent on M2 which indicates monetary policy here. The sensitivity of the model using private credit instead of broad money supply to find out the fact that the model is not affected by this. In both case it is found that there is a positive relation among GDP, ADP and M2. We can enhance our economic growth by adequate public investment and broad money supply as it will increase the employment, investment of our country.

**Keywords**—ADP, GDP, monetary policy and money supply.

## I. INTRODUCTION

Bangladesh is a small developing country. But the economic condition is improving day by day. Fiscal policy and monetary policy are very important two macroeconomic tools which influence a country's economy. Fiscal policy relates to public expenditure and revenue. It deals with the price stability, full employment and economic growth. In

monetary policy government or central bank controls such as the supply of money, availability of money, rate of interest etc. There are great impact of fiscal policy and monetary policy on GDP in Bangladesh [1]. The ADP (Annual Development Program) which is a tool of fiscal policy has a great impact on GDP of Bangladesh. Also, the broad money supply which is an important tool of money supply has impact on the GDP of Bangladesh [2]. In ADP Government of Bangladesh has emphasizes a lot in recent past as there are number of measures have taken to improve the infrastructure of our country by setting up new bridges, repairing roads, improvement of transportation system and so all. Also, Money supply has been seen to increase in a margin to improve the economic condition of our country as well as improving the GDP [3,4]. Recent vast series of mega projects like Padma Bridge, Metro rail project, Deep Sea port, Power plant stations these kinds of mega projects are included as an effort of fiscal policy. Also, the recent drop in the exchange rate of our currency will be a concerning issues in the perspective of monetary policy for our country [5].

## II. LITERATURE REVIEW

Uddin *et al.* introduced and interpreted the relation between governments Annual Development Programme (ADP) and economic growth. They found that ADP traditionally holds the main structure of Bangladesh economy and so ADP is the main determinant of Gross Domestic Product (GDP) in Bangladesh and consider the Gross Capital

Formation (GCF) for more reliable results. This paper indicates that there is a positive impact of ADP on economic development. The outcome of this paper is keeping the high level of public planning in Bangladesh together with improvement in institutional surroundings would be beneficial for economic growth [6].

Irfan Hameed & Ume-Amen focused on the impact of Monetary Policy on GDP [7]. The monetary policy is always affecting the GDP. They found that this paper shows the interest rate has a minor relationship with GDP but the Growth in Money Supply greatly affects the GDP of an economy, obviously various unknown factors also affect the GDP. They also found that Growth in Money Supply has a huge impact on GDP. The Research study can further be used for developmental projects for the Growth of Economy, Quality improvements, Household production, the underground economy, Health and life expectancy, the environment, Political immunity and ethnic justice [4].

Yu Hsing examined potential impacts of fiscal and monetary policies on stock market performance in Poland. Applying the GARCH model and based on a sample during 1999.Q2 to 2012.Q4, this paper finds that Poland's stock market index is not affected by the ratio of government deficits or debt to GDP and is negatively influenced by the money market rate. Poland's stock index is positively associated with industrial production and stock market performance in Germany and the U.S. and negatively affected by the nominal effective exchange rate and the inflation rate [8].

Vito Tanzi & Howell H. Zee discussed in a systematic and comprehensive way the existing literature on the relationship between the growth of countries' economies and various public finance instruments, such as tax policy, expenditure policy, and overall budgetary policy, from the perspectives of allocative efficiency,

macroeconomic stability, and income distribution. It reviews both the conceptual linkages between each of the instruments and growth and the empirical evidence of such relationships. The paper broadly concludes that fiscal policy could play a fundamental role in affecting the long-run growth performance of Vito Tanzi and Howell H. Zee. This paper discusses in a systematic and comprehensive way the existing literature on the relationship between the growth of countries' economies and various public finance instruments, such as tax policy, expenditure policy, and overall budgetary policy, from the perspectives of allocative efficiency, macroeconomic stability, and income distribution. It reviews both the conceptual linkages between each of the instruments and growth and the empirical evidence of such relationships. The paper broadly concludes that fiscal policy could play a fundamental role in affecting the long-run growth performance of countries [9].

Urbanovská investigate the relationship between selected macroeconomic variables – interest rate, price level, money supply and real GDP – in the Czech Republic in order to find out definite implications of its interactions and give recommendation to macroeconomic policy authorities. Implemented vector autoregression approach suggest that three pairs of interest rate change and exist, in particular past price level change Granger-causes interest rate change, past real GDP Granger-causes interest rate change and finally past real GDP change Granger-causes price level change. The model allows forecasting the direction of change in case of variables interest rate and real GDP with a high success rate [10].

In all of these papers we find that the impact of ADP and monetary policy in the GDP of our country but we are here trying to show the impact of both of these in a single model to find out both of their impact on GDP.



### III. DESCRIPTIVE ANALYSIS

It is known that development of a country vastly dependent on its GDP and GDP is controlled by many determinants [11]. ADP which means Annual Development Plan is responsible much in the context of GDP. ADP means the programs taken by the government to increases the development of the country like infrastructure development, setting up new bridges, setting up of new institutions and so. It has been found out from the data that was observed from year 2000-01 to 2016-2017 of Bangladesh in to the context of GDP, ADP and broad money supply.

Due to the improvement of ADP and M2 the GDP increases is being found out. It is because of the fact that from 2000-01 to 2016-17 many infrastructures development programmes have been taken by the government such as many new bridges have been set out, many highways

have been created which works as a catalyst to improve the GDP also the sound monetary policy of sound interest rate and inflation rate improves the broad money supply which is a respondent improving GDP [12]. There is an increasing trend of ADP in Bangladesh as it is continuously increasing from year 2000-01 to 2016-17. There is also an increasing trend of M2 in Bangladesh as it is continuously increasing from year 2000-01 to 2016-17. So, it is clearly understood that there is an increasing trend of GDP, ADP & M2 in the context of Bangladesh from the past 41 years. Also, the PVT credit in Bangladesh as it is continuously increasing from year 2000-01 to 2016-17. So, it is clearly understood that there is an increasing trend of GDP, ADP & M2 in the context of Bangladesh from the past 21 years. From the following figures we see the graphical representation of GDP, ADP, M2 and PVT data from 1976 to 2016 in the following figures

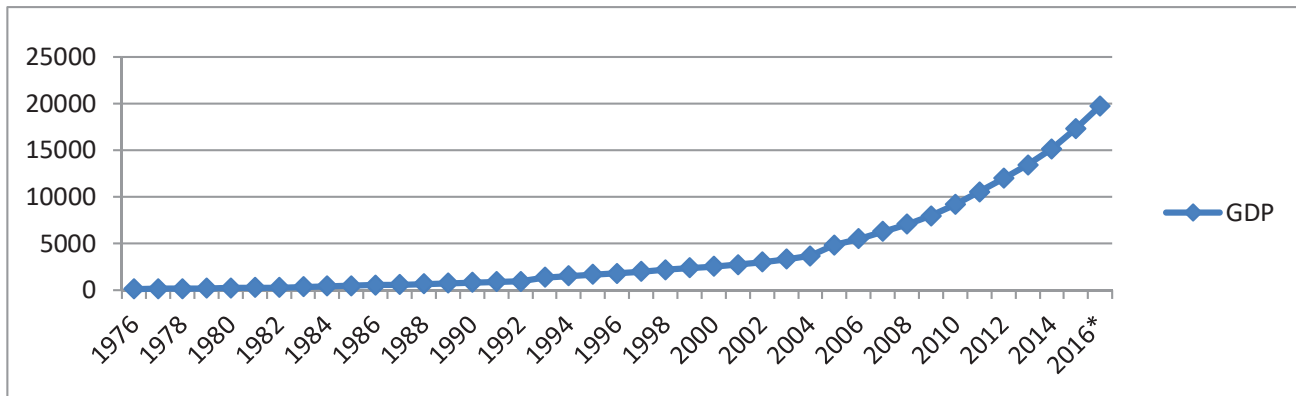


Fig. 1. Gross Domestic Product (GDP) (Source: Bangladesh economic review of 2017).

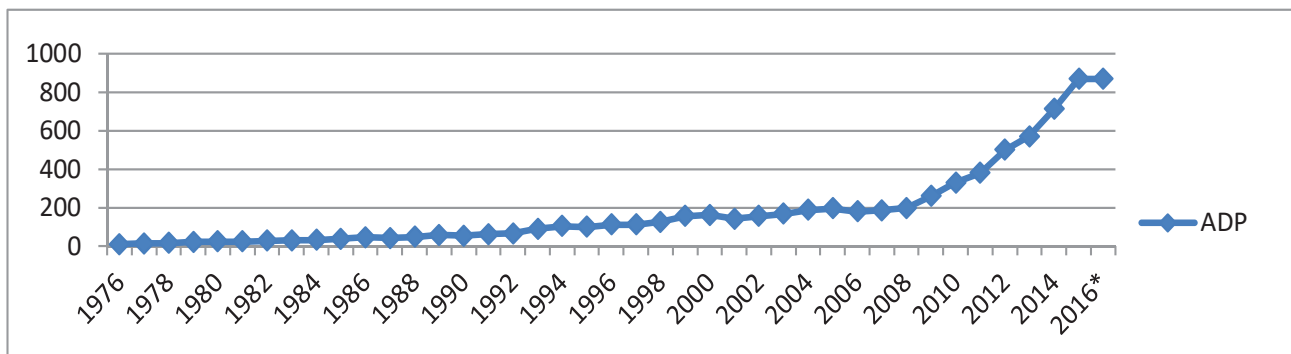


Fig. 2. Annual Development Plan (Source: Bangladesh economic review of 2017)

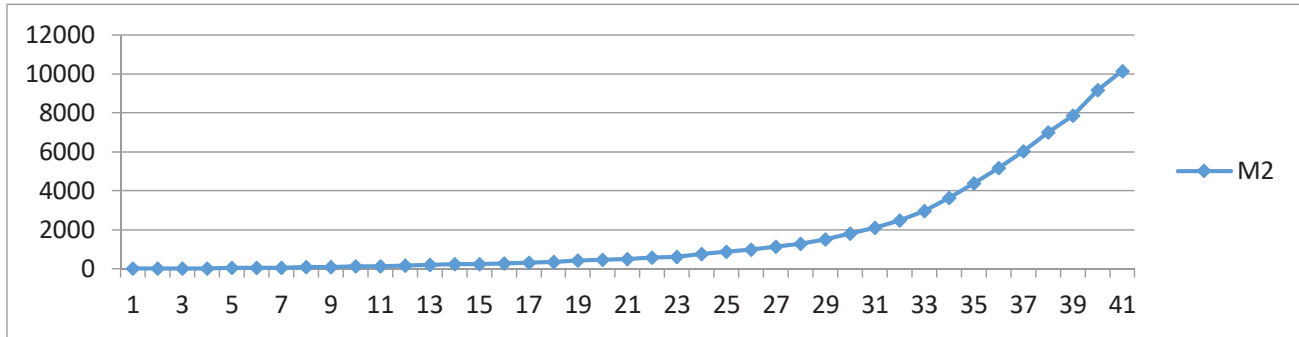


Fig. III. Broad Money Supply (M2) (Source: Bangladesh economic review of 2017)

#### IV. METHODOLOGY

The objective of the paper is to find out the impact of ADP (Annual Development Plan) along with M2 (broad money supply) on GDP of Bangladesh and by collecting the data of last 21 years on this context it is found out that there is a positive impact of ADP in the GDP of Bangladesh. SO, when ADP of our country increases GDP increases side by side too. It will be proved by the model we developed below by considering GDP as a main variable and ADP as well as M2 as control variable.

The analysis is to find out the impact of ADP and M2 which means broad money supply is a part of monetary policy and to show this we use the following model which is

$$GDP = \alpha + \beta_1 ADP + \beta_2 M2 + \mu$$

Where GDP is the main variable or dependent variable and ADP and M2 is the control variable

where ADP is counted as fiscal policy and M2 is counted as monetary policy. To use the model, we use three data from year 2000-01 to 2016-17 which are collected from the source of Bangladesh Finance Ministry website from the article named Bangladesh Economic Review’s statistical appendix from the years and some missing year’s data on this context are collected from the excel sheet of Bangladesh Bank’s data. In order to check the sensitivity of our model we used another model similar as the previous one where private credit (PVT) is included instead of M2. The model is

$$GDP = \alpha + \beta_1 ADP + \beta_2 PVT + \mu$$

#### V. DATA

We use secondary data in this paper to use in our above-mentioned model, the data are collected from the “Bangladesh Economic Review” 2018 statistical appendix.

Variables	Year	Source
GDP	2000-01 to 2016-17	Statistical appendix of Bangladesh Economic Review 2018
ADP	2000-01 to 2016-17	Statistical appendix of Bangladesh Economic Review 2018
M2	2000-01 to 2016-17	Statistical appendix of Bangladesh Economic Review 2018
PVT	2000-01 to 2016-17	Statistical appendix of Bangladesh Economic Review 2018

#### VI. DESCRIPTIVE STATISTICS

There are lot of factors that has impact on GDP among the public investment or ADP is one. We also use a monetary variable which is M2 to see its impact on GDP. In order to find out the relationship

between GDP and Fiscal policy along with monetary policy we use the regression model here through the EViews 7 software. In the following table we write down the descriptive statistics of the data of the variables we use in the model.

TABLE I. DESCRIPTIVE STATISTICS OF THE VARIABLES (ALL ARE USED IN BILLION TK.)

List of the variables	LGDP	LADP	LM2	LPVT
Mean	7.410	4.586	6.238	5.805
Median	7.455	4.703	6.227	5.964
Maximum	9.991	6.767	9.226	8.956
Minimum	4.667	2.301	2.855	1.640
Std Dev	1.571	1.167	1.819	2.0195
Skewness	-0.054	0.028	-0.109	-0.312
Kurtosis	1.942	2.281	2.023	2.212
Jarque Berta	1.931	0.887	1.699	1.727
Probability	0.380	0.641	0.428	0.422
Sum	303.824	187.655	255.755	238.028
Sum sq dev	86.613	54.542	132.396	163.137
Observations	41	41	41	41

## VII. METHODOLOGY AND DATA ANALYSIS

We use our following model because of economic significance. The model is

$$GDP = \alpha + \beta_1 ADP + \beta_2 M2 + \mu$$

Here we use the OLS regression to analyze the data of the variables we collected, through E-views7 software to analysis the data and to test the model whether the variables are significant or not. Estimated results with ordinary least square method is reported in the following table

TABLE II. REGRESSION RESULTS

Variables	Co-efficient	Std-error	T-Statistics	Prob
C	2.264	0.656	34.520	0.000
LADP	0.176	0.075	2.344	0.0244
LM2	0.695	0.048	14.415	0.000

TABLE III. SUMMARY OF THE ABOVE MODEL

R Square	Adjusted R Square	STD error of estimate	Durbin Watson
0.997	0.996	0.0821	0.547

From the EViews result we can easily see that coefficients of all the independent variables are positive it means that increase of ADP and M2 increases the GDP. Also, the p values of all the variables are less than 5% at 95% confidence interval which means that GDP is dependent on ADP and M2 means that it depends on fiscal policy also with monetary policy which is

indicated by the broad money supply M2. Also, from the value of R square which is the measurement of “Goodness of fit” we easily understand that the independent variables 99% explains the dependent variable here.

In order to test the sensitivity of the model private credit is used instead of M2 to check that

whether our model remains significant or not in this context the model will take the following form

$$GDP = \alpha + \beta_1 ADP + \beta_2 PVT + \mu$$

Here OLS regression is used to analyze the data of the variables that has been collected, through

EViews 7 software to analysis the data and to test the model whether the variables are significant or not. Estimated results with ordinary least square method is reported in the following table

TABLE IV. REGRESSION RESULTS

Variables	Coefficients	Std error	T statistics	Prob
C	2.599	0.149	17.34	0.000
LADP	0.477	0.106	4.487	0.001
LPVT	0.451	0.061	7.446	0.000

TABLE V. SUMMARY OF THE ABOVE MODEL

R Square	Adjusted R Square	STD error of estimate	Durbin Watson
0.992	0.991	0.134	0.316

From the EViews result we can easily see that coefficients of all the independent variables are positive it means that increase of ADP and PVT increases the GDP. Also, the p values of all the variables are less than 5% at 95% confidence interval which means that GDP is dependent on ADP and PVT means that it depends on fiscal policy also with monetary policy which is indicated by the private credit system. Also, from the value of R square which is the measurement of “Goodness of fit” we easily understand that the independent variables 99% explains the dependent variable here.

### VIII. FINDINGS

From the regression analysis of the data in the context of our model we have find out that GDP is dependent on ADP which indicates the fiscal policy here as well as it is dependent on M2 which indicates monetary policy here [13]. We test the sensitivity of our model using private credit instead of broad money supply to find out the fact that the model is not affected by this. In both cases, we find out that there is a positive relation among GDP, ADP and M2. So, there is a positive impact of annual development programme and broad money supply in the GDP of Bangladesh. We can enhance our economic growth by adequate public investment and broad

money supply as it will increase the employment, investment of our country.

### IX. CONCLUSION

This study examines that relationship among GDP, ADP and M2. It is notable that monetary policy and fiscal policy has great impact on economic growth in Bangladesh. This result indicates that ADP and M2 are positively related with GDP. If ADP and M2 are improved which leads to increase in GDP. This paper used then it helps the GDP increasing. We applied appropriate econometric test to show the relationship between them. In this paper data is processed up to 2000 – 2016. It is shown that, in these 41 years our economic growth is continuously increasing. Here we consider, GDP is a main variable and M2 is a control variable. The government should consider some a necessary step to against which hinders our economic growth. Such as economical stability, decreasing corruption, skilled workforce, developing infrastructure, practical education and training programs.

### LIMITATIONS OF THE STUDY

This research article is based on the model which is a linear regression model and the model is tested through regression analysis only where others econometric tests couldn't do due to time constraints and lack of manpower.

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# Prolonged School Closures During COVID-19 and Increased Risk of Dropout among 14 to 18-year-old Girl Students in Bangladesh

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**Abstract—** This research intended to find out the impact of school closures on girl students' dropout rate and its causes, including child marriage and other relevant factors, if any. The author has conducted a survey in Bangladesh recently (September 2022) primarily focussing on the effect of this pandemic on the education of girl between 14 and 18 years of age to assess the situation first-hand. This study was designed in quantitative method so that some broad generalization could be drawn. The study was conducted both in urban and rural settings to see if there were any significant difference in the situation between the two settings. It has tried to investigate the relationship between parent's level of education and their awareness about girls' education during the pandemic. Apart from these, the relationship between parents' income and dropout rate of the girl child was also measured. Many studies show that as families had become poorer due to job losses and schools were closed, these push factors had driven up the number of child marriages and unplanned early pregnancies, the study also made some moderate enquiries about marriage of school children between 14 and 18 during the school closure due to the pandemic. This paper summarizes the major findings which broadly conform to similar studies and anecdotal reports from various countries including Bangladesh. This generally confirms the fears and assumptions upon which the research was conducted in the first place.

**Keyword:** dropout, pandemic, COVID-19, prolong closure

## I. INTRODUCTION

The broad topic subject of this research was education of children where it would specifically focus on the COVID-19 and its impact on the education of girl students in Bangladesh, aged between 14 and 18 years. It is widely acknowledged that in any kind of disaster, man-made or natural, women and children are often affected first and worst. It is feared that the COVID-19 Pandemic since 2019 has been no exception. [1] Research, studies and anecdotal reports from various countries including Bangladesh have indicated that long and unexpected school closure due to the pandemic has had a particularly adverse effect on the education of girl children. Since the beginning of the COVID-19 pandemic in 2019 millions of people have been affected by the deadly virus. Almost all countries have been suffering from this virus. The government of Bangladesh had decided to keep all the educational institutions closed from 17 March, 2020, aiming to prevent spread of deadly coronavirus. This was part of the policy of a near-total lockdowns on social and non-essential movements and even daily commercial activities in the country were reduced to a trickle. There are around two lakh educational institutions across the country with more than four crore of students. The lockdown and school closures implemented during the pandemic had caused 743 million girls to miss



out on their education globally, and 10 million more secondary school-aged girls were predicted to be out of school before it is over [2]. Twelve percent (12%) of households in the poorest countries had internet access at home, and access to mobile internet were 26% lower for women and girls than for their male peers [3]. On top of this, girls were the first to be pulled out of school, put to work and care for younger siblings when families face economic hardship. The girl child in Bangladesh is almost perpetually in a state of silent emergency compared to their male counterparts. They are often deprived of equal opportunities as their male counterparts at home, school and workplace largely because of our conservative mindset towards them. It is feared that girls would have been more likely to have less opportunities to continue home based education during this period, and dropped off from school because of COVID-19 related lockdowns and school closures. It also stands to reason that the girl child would be more likely to be married off during this period, which, in turn, is likely to have had an adverse effect on their continued schooling [4]. Many parents had lost their job or earning source which also exasperated the fate of the girl child further. In pandemic time, girls were most likely helping with additional household chores which would have made them fail to continue their study at home[5].

## II. RESEARCH QUESTION

The study focused on four specific areas of query that were deemed relevant:

1. Had educational institution closer due to COVID-19 increased the number of dropout rate of the girls 14 to 18?
2. Was there an increase in child marriage among 14 to 18 year old school going girls during this period and that could this be attributed also to economic hardship due to COVID-19 related lockdowns?
3. Did the parent's education level, living area and income make any difference in their girl children's continued home study during the long school break?
4. What is the preference among the respondents (parents) regarding continued education for the girl child vis-à-vis her male counterpart under financial strain.

## III. PURPOSE OF THE STUDY

The study was designed to find out to what extent, and how the pandemic situation and school closure was contributing to a rising dropout rate among secondary school girls of a particular age group (14-18), if any. However, a comparison of the fate of the girl child's education during the school closure with that of their male counterparts (e.g. male siblings) was deliberately not included within the purview of this research primarily to keep the study simple, short and focussed. The study also intended to understand if the parent's economic hardship during the pandemic related lockdown had triggered early marriage of girls, and if 'yes', to what extent? The co-relation between parents' education level and girl dropout rate was also looked into.

## IV. LITERATURE REVIEW

The author-researcher conducted a comprehensive literature as part of the exercise, prior to develop the methodology and any tool for data collection work at field level. The following is a brief summary of some of the major findings from the literature review:

UNESCO (2020) stated that the COVID-19 pandemic forced most governments around the world to temporarily close educational institutions to contain the spread of the virus. At the peak of the pandemic, more than 1.5 billion learners, or over 90% of the world's student population from pre-primary to higher education,

have seen their education disrupted and at times interrupted [6]. Experience shows that crises often disproportionately affect girls and young women, exacerbating gender-based violence, exploitation, early marriage and unintended pregnancy. This is especially the case as girls are out of school. So many girls may come back pregnant. And in some societies, pregnant girls are not allowed back in schools [7]. This is the time for governments to instill policies that allow girls to have free and equal access to education, regardless of their situation.

Rafaeli, T. and Hutchinson, G. (2020) has found that based on emerging evidence and lessons from past health crises, there is strong evidence to suggest that women and girls in SSA will suffer from extreme and multifaceted negative secondary impact as a result of the COVID-19 crisis. Some of which may include higher poverty rates, increase in unplanned pregnancies, a surge in school dropout rates and child labour of adolescent girls, loss of income and reduced financial empowerment, increased household work, reduced access to healthcare and WASH alongside increased maternal deaths, and greater food insecurity and malnutrition [8].

Girls Not Brides member organization, Democratic Republic of the Congo, (2020) stated that schools were closed, and girls were more at risk of carrying unwanted pregnancies. They had recorded more than five cases of girls who had experienced act of sexual violence in Mwenga territory and required comprehensive care, but following COVID-19 the province was in lockdown [9].

Girls Child Network, Kenya, (2020) stated that 'The COVID-19 pandemic has stalled all our school based engagements to promote access to education for girls and boys in all our projects target areas, because schools were closed. And school mandatory leave as a response to the pandemic is putting a burden of household chores on girls who are not benefiting from

distance learning. With the projected economic crisis, more girls may at risk of marriage [10].

Women's Health and Republic Rights Organization, Sierra Leone, (2020) stated that the closure of schools had increased girls vulnerability to physical and sexual abuse, both by their peers and by older men, as girls were often at home alone and unsupervised [11].

## V. METHODOLOGY

Quantitative method was followed to conduct the research which would find out how much the girls were at risk of drop out. To identify the condition of girls in this pandemic situation, this research followed Quantitative Approach. A variety of the effects were measured through this method. To identify how this Covid-19 had affected girls' education and opportunities, interviewing girls found out different dimensions from their opinions. To identify the factors, this research primarily needed quantitative data. The parents of the girl students of 14 to 18 age group formed the population for this research. 187 respondents were selected as a sample from Dhaka and Cumilla based on purposive sampling method. These 187 respondents were selected from: urban setting 25, urban slums 76 and rural settings 86. They were from different economic levels and different districts, which would help form an obvious idea about the nexus between economic factors and their level of awareness about girls' education. Dividing each of the level into sub-categories based on level of education would provide a clear understanding of the link between the level of awareness and the level of education of the respondents. It was expected that their statements would enrich the study in finding the actual underlying causes of the problem.

For survey questionnaire, at first the objective of the study was defined (see research questions above). Then, the target respondents and methods to reach/achieve those objectives them were selected and a questionnaire was designed. Pre-testing (Pilot testing) of the questionnaire was



carried out. After that the questionnaire was modified taking feedback from piloting/pre-test results. The researcher facilitated all the data collection process being personally present at the site and actively joining in the data collection process. She ensured that the interviewers did not generate any new question, but rather give some interventions only if needed in order to clarify the question or by answering the participants' questions for clarification, if and when this was requested. All the collected data was included in the research process accurately and in full with no omission or addition. Any individual preferences and biasness were carefully avoided during the whole process. As this research is focused on identifying the factors and their effects on continued home study as well as school dropout, quantitative data needed to be analyzed. A descriptive analysis generated expected results. The researcher personally conducted the descriptive analysis of the quantitative data. All the quantitative data were categorized and analyzed following proper method and tools like, SPSS software.

#### VI. ETHICAL CONSIDERATIONS

Before each interview, permission was asked from the target groups mentioning purpose and possible significance of this study. All participants/interviewees were given a clear indication about the total time that would probably be required to complete each interview. The researcher followed all standard norms and decorum expected in conducting such research/studies and was mindful of all ethical issues associated with the research. The researcher collected data as accurately as possible. No data was intentionally excluded from the study or added beyond what the respondents presented. A proper data collection method and data analysis process was followed. Demographic information such as age, educational level and economic status of the participants' were meticulously collected. All data was collected and analyzed maintaining total confidentiality. No information of the study was used for another purpose other than this article, and will not be so used without prior consent of the participants.

#### VII. ANALYSIS AND DISCUSSION

TABLE I. RELATIONSHIP BETWEEN LIVING AREA AND THE CONTINUITY OF GIRLS EDUCATION.

		Did your daughter maintain study during the pandemic, COVID-19 school closure?		Total
		Yes	No	
Living Area	Rural	57.0%	43.0%	100.0%
	Urban	76.0%	24.0%	100.0%
	Urban Slum	40.8%	59.2%	100.0%
Total		52.9%	47.1%	100.0%

Source: Author's calculation

Table 1 is the most basic question the research probed: whether the girl child continued to do her studies at home during the COVID19 pandemic induced school closure. Responses differed according to location of the respondents. Perhaps unsurprisingly, the highest number of positive responses came from the urban respondents (76 %) and the lowest from urban slums (40.8%). Girls in rural settings seems to have done better than urban slums in this respect. A look at the next table may throw some light on some of the reasons. Urban people get more facilities than rural and urban slum area. The shocking finding is that 59.2% of girl students of urban slum area and a whopping 47.1% of all girl students dropped out from school altogether attributed to the long school closure due to the COVID19 pandemic.

TABLE II. RELATIONSHIP BETWEEN LIVING AREA AND GETTING PROPER OPPORTUNITIES AND SCOPE FOR GIRL STUDENTS.

		Did your daughter get proper opportunities and scope for continuing her study during the pandemic period?		Total
		Yes	No	
Living Area	Rural	15.1%	84.9%	100.0 %
	Urban	56.0%	44.0%	100.0 %
	Urban Slum	7.9%	92.1%	100.0 %
Total		17.6%	82.4%	100.0 %

Above table (table 2) shows the relationship between living area and opportunities for the girl child to continue her studies at home during the pandemic. Overall, 82.4% (more than 8 out of every 10) of the respondents thought their school-going female children did not get proper opportunities and only 17.6% students got opportunities. This was deliberately kept a very open question and solicited the respondents' opinion at this stage. The significance of such opinions is that it could help understand their perception as to what elements constitute 'opportunity' (see Figure 1, pie chart for details)

TABLE III: PARENTS' EDUCATION AND GIRLS EDUCATION CONTINUITY.

		Did your daughter maintain study during the pandemic?		Total
		Yes	No	
Education of Interviewee	Below SSC	52.4%	47.6%	100.0 %
	Above SSC	100.0%	0.0%	100.0 %
	No Schooling	10.9%	89.1%	100.0 %
Total		52.9%	47.1%	100.0 %

Source: Author's study findings

The study found that parents who are more educated, were of the opinion that their girl children had continued their studies during the school closure. Again, whether this is just a perception or reflects reality or what they felt as a respectable answer was not probed any further. It is interesting to correlate answers to this question vis-à-vis the education level and continuity of girl education. These answers should also be seen against figure 1, which further elaborates factually some of the elements that could actually explain the reasons for these varied perceptions.

TABLE IV. PARENTS' MONTHLY INCOME AND GIRLS EDUCATION CONTINUITY.

		Did your daughter maintain study during the pandemic?		Total
		Yes	No	
Monthly Family Income	Below 10000	11.5%	88.5 %	100.0%
	10000 to 20000	43.0%	57.0 %	100.0%
	20000 to 30000	100.0%	0.0	100.0%
	30000 to 40000	100.0%	0.0 %	100.0%
Total		52.9%	47.1 %	100.0%

Source: Author's study findings

Economic condition has a great impact on the standard of living. And this influenced the responses regarding the question of whether their girl children had opportunities to continue their studies. This research has found out that more of the comparatively economically better off people think their girl children had the required opportunities, perhaps because they could provide better facilities to their children. However, this may only be a perception until probed further (see figure 1)

TABLE 5. PARENTS' EMPLOYMENT STATUS AND GIRLS CONTINUITY OF EDUCATION.

		Did she get proper opportunities and scope for continuing her study in the pandemic period?		Total
		Yes	No	
Employment	Employed	29.9%	70.1%	100.0%
	Self-employed	0.0%	100.0%	100.0%
	Unemployed	0.0%	100.0%	100.0%
	Housewife	12.1%	87.9%	100.0%
Total		17.6%	82.4%	100.0%

Source: Author's study findings

Parent employment status and the chances of getting proper facilities by parents are co-related. Employed parents were able to give more facilities than the unemployed parent.

Figure 1 reflects an elaboration of sorts to the question of ‘opportunities’ and shows what constituted these perceived opportunities. It is interesting to note that a vast majority (nearly half) of the respondents could not continue studies, while more than 49% had combined opportunity of self-study (21.39%) and with help from house tutor (20.32%). Hardly any went to coaching center, perhaps largely because most of these centers were closed as part of the school closure policy. Although distance teaching/learning was encouraged by the Government and private sector (through on-line coaching, etc.) only about 7% had availed of this opportunity.

**How she had continued her study?**

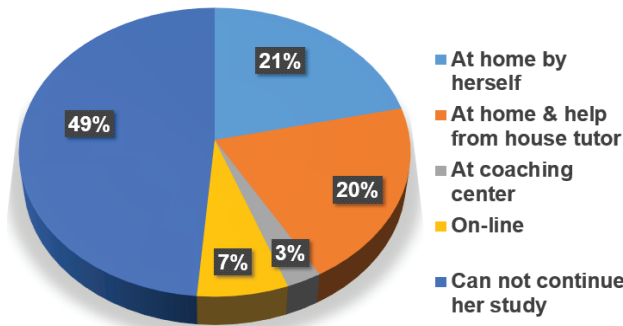


Fig. 1. Respondents answer on how she had continued her study. Source: Author’s calculation.

Figure 2 (below): This research tried to find out some solution from the respondents view point. 50.27% respondents saw for an economically stable situation as a solution because economically unstable situations create problems of drop out. This research did not probe into further details regarding this. 13.37% respondents propose for the short term closure because they thought long term closure created insecurity which lead to increase in dropout rate, especially of girl students.

**What would you suggest to ensure continuity of all girls education during future school?**

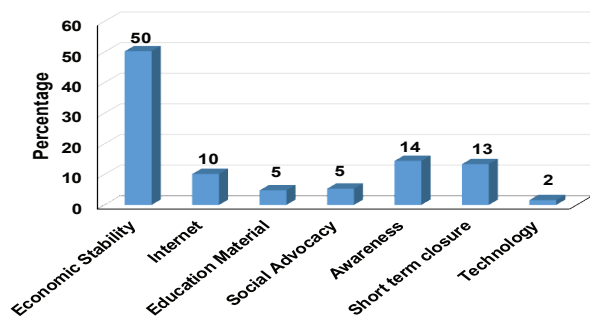


Fig. 2. Respondents’ suggestion to continue girls education. Source: Author’s calculation

Only one simple question was asked to assess the attitude of the respondents about girls’ education versus that of male children.

This research has found that in any economic constraints situation, 33.16% parents would choose their son where only 19.25% parents would choose daughter (see figure 3 below). The significant element to note is the large number of respondents who said they did not know. While this cannot be interpreted as preference for either a boy or a girl’s continued education, the researcher-author considers this hesitation, confusion, uncertainty or reluctance to come up with a clear answer as indicative of a healthy conflict in the mind of the respondent where they cannot bring themselves to pronounce a clear choice. The girl child is beginning to matter more and a resonating ‘NO’ against her is a no, no thing now.

**If you are going through economic problem and you are able to provide education facilities to only Child. Who will you choose?**

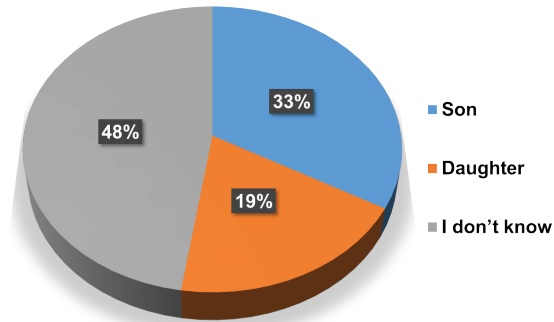


Fig. 3. Choice of the respondents’ son/daughter to provide education during economic problem. Source: Author’s calculation

About the girl child continuing studies after marriage, 64.71% (Source: author’s calculation) parents think that after marriage continuing study is not possible. On the other hand, 11.23% of parents believe that continuing study after marriage is possible. Once again, nearly 65% were not sure (don’t know). This may be interpreted either way, but for the researcher it indicates that a huge percentage did not come up with a resounding ‘NO’. In answering a question about the impact of

economic conditions on getting enough facilities, 64.17% (Source: author's calculation) of respondents think that their economic condition had a great impact on the dropout of their girls. Regarding the use of smartphones and the internet, about 63% (Source: author's calculation) of respondents thought that their girls did not have access to devices like smartphones, mobile and the internet. Only 36.36% of respondents from 3 different areas had access to technical devices. Besides, in answering a question about the seriousness 47.5% (Source: author's calculation) of respondents thought that their family is not serious about girls' education.

Sometimes dropout also happened because of household chores and related activity dropout also happens. In answering a question about the involvement of household chores, 61.5% (Source: author's calculation) of respondents think that because of involvement in household chores, girls failed to give proper concentration on study. Finally, this study found that almost 61.5% (Source: author's calculation) of parents were thinking of marrying off their daughters due to uncertainty about the duration of school closure and affect the marital future of their daughters.

#### VIII. LIMITATIONS OF THE STUDY

Considering cost of the study, and the available resources of this personally funded study, it was not possible to conduct this research in the whole of Bangladesh. Although Bangladesh is socio-culturally largely homogeneous in nature, only 2 districts may fail to represent the whole country properly. In some cases, it may not represent the whole scenario of urban areas' or rural areas for that matter, given the relatively small sample size that was possible to cover. This limitation is likely to be more pronounced because the research participants were purposively selected and a very small number of respondents could be interviewed from the urban setting. The findings, therefore, are very largely

based on responses from urban slums and rural setting. For the purpose of this article, the responses from the three categories of participants have not been shown separately and presents only the overall, consolidated general picture. A mixed approach to sampling and supplementation with a qualitative approach would probably yield more reliable and in-depth information, which was not possible to include in this particular research exercise. This may also somewhat limit the scope of the study to develop a deep insight into the underlying factors that could explain the responses better. The researcher was not able to conduct a year-long observation and door to door cross-checking of the data. And, quantitative data may not cover all the insight that this research rightfully demands.

However, at the least, this study is expected to provide the basis for further follow-up research in future with due consideration to some of the limitations mentioned above. It may not be the full architecture with all its glory but certainly provides a foundation to build on.

#### XI. CONCLUSION

This study intended to find out the impact of the COVID-19 pandemic situation in Bangladesh, consequent of prolonged school closure and its possible impact on learning continuity of high school girl students aged 14 to 18 years. Quantitative data was collected from parents (mothers or equivalent alternatives/guardians.) of a variety of educational levels, economic status and locations (urban/rural). For generalization of the data, this study followed purposive sampling method. An interview method was used using a set of interview questionnaire. This study focuses on quantitative approach that gave this study an opportunity to gain an insight into the problem. In conclusion, it can be said that education planners should be aware of the particular threat that the coronavirus school closures pose to girls and women, and ensure some plans for learning continuity take this factor into account.

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