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Editor's annotation

We are glad to publish 2nd issue of Journal of Pundra University of Science & Technology. It is a multi-disciplinary peer reviewed research journal published by Pundra University of Science & Technology for preservation high standard with intellectual articles. The Journal of Pundra University of Science & Technology insurances all areas of science, engineering, arts, social sciences and other related areas.

Principally, as a Chief-Editor of Journal of Pundra University of Science & Technology my primary role is to confirm the best work to be submitted to the Journal of Pundra University of Science & Technology and then to accomplish a fair process of review. All submissions are according to the Journal of Pundra University of Science & Technology standard system of peer review, which is laborious and expeditious. We have significantly expanded our pool of excellent reviewers as a result average turnaround times has reduced. Hence, most papers now have at least two reviews and their quality has been steadily improving. Within that framework, we highlight our commitment in publishing the most vital research work and the vibrant new perspectives at their expanding frontiers.

I would like to express my special and sincere thanks to all the members of Journal Committee and Board of Trustees of Pundra University of Science & Technology. Specially to honourable Vice Canceller of Pundra University of Science & Technology for his continuous support to publish this journal.

Finally, I hope the rejuvenation of the Journal of Pundra University of Science & Technology will continue with more precise insight and this 2nd issue will be beneficial to the many researcher and enthaustics.

Prof. Dr. Khawja Jakaria Ahmad Chisty
Chief Editor
&
Dean, Faculty of Science & Engineering,
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Analysis of Association Rules Mining in Distributed Transactional Databases in Bangladesh

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ABSTRACT

Association Rules and Frequent Pattern are one of the key application areas for data mining in transactional databases. Its goal is to find the correlations between the sales of items in a given set of customer transactions. These are the basis for decisions on marketing activities such as cross-sale campaigns, inventory management, and promotional support. However, the current approaches may fall short of identifying significant buying patterns in a distributed fashion, despite the availability of various algorithms for creating frequent periodic patterns and association rules. On the other hand, our proposed algorithm focuses on mining regular and frequent itemsets in large and distributed datasets. Then we generate the association rules for those regular-frequent itemsets. Our empirical analysis demonstrates that the suggested approach is computationally effective in a distributed manner, enabling the Bangladeshi retailer Super Shop to make the best decisions and boost sales.

***Keywords**:* Frequent, Periodic, Distributed pattern, Distributed rules.

1. Introduction:

With the new era of information and globalization, consumers have a wide range of option for purchasing the products, and the options have increased exponentially. In the past, customers only could choose a product from the catalog of the store when he had to buy something. But nowadays the limitations as geographical area, season are not more an issue. Product that year ago was considered as luxury goods are now considered as a very common. All of this caused that different data or information mining and knowledge discovery techniques are available now to compare among products. Different information and knowledge extraction approaches like regularity, periodicity, association rules, classification and clustering have been proposed under the data mining area. Identify the frequent patterns and regular itemsets is a primary step for association rules mining. If a pattern meets the user-defined minimum support threshold value, it is referred to as a frequent pattern, and if a frequent item meets the user-defined maximum periodicity threshold value, it is referred to as a regular frequent. Support in this context refers to frequency, and periodicity refers to the pattern's longest interval between arrivals. In order to determine the most crucial connections between the items, association rules are produced by analyzing transactional databases and employing support and confidence metrics. In this research, we offer several approaches to identify the frequently used itemsets in a huge

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distributed transactional multi-store database based on a Bangladeshi supermarket. We also try to identifying the impact sell out of products for geographical area.Then we generate the association rules for the regular frequent item sets; these aid in the discovery of customer behaviors and relationships between items, which improves the company's benefits and the customer experience.

2. Motivation for the study:

To better serve consumers and increase earnings, a supermarket is primarily interested in understanding the relationships between different purchases. Consumers occasionally purchase diverse product combinations within a single shopping trip, but market analysts do not believe that choosing scenarios is random. So, market analysts face many technical challenges while analyzing the data. The research on mining meaningful associations among customer purchases will be very helpful for a supermarket because retailers are attempting to improve their operations by using quantitative analysis on their data since the interdependencies across products have recently come under more scrutiny. Therefore, it is crucial for a supermarket to learn what its customers are purchasing. When special discounts and promotions are created for certain products, the store can profit from the priority that some products have to be sold together. It is crucial for the store to remove items from the selection that are not making a profit. Getting rid of losing, failing, and weak brands could help businesses increase their earnings and reallocate costs to more beneficial brands. Identifying the seasonal products will also be helpful for decision making. Analyzing data in a distributed environment will provide better accuracy for decision making. The information that data mining tools offer is highly appreciated since it helps the supermarket deliver better customer service and increase profitability.

3. Regular Frequent Itemsets Mining and Issues:

Data mining and knowledge discovery techniques like association rules, sequential patterns, classification, and clustering have been extensively investigated for the purpose of mining regular frequent patterns from supermarket transactional databases. The user may only be interested in the commonly sold products in a retail market, as opposed to the other items.

3.1 Issue Specification

This section introduces the fundamental terms and notations used in regular-frequent pattern mining while also explaining the mathematical principles involved. Let $K = \{k_1, k_2, k_3, ..., k_n\}$ represent a collection of objects stored in a transactional database. A pattern or an itemset is the set $Y = \{k_l, ..., k_n\} \subseteq K$. A group of transactions make up a transactional database, or TDB over K. T is equal to $\{t_1, t_2, ..., t_m\}$ where m is equal to |TDB|, the total number of transactions.

Definition 1. Support (Y): The term "support of Y in TDB" refers to the quantity of transactions in a TDB that contain Y and denoted as **Support(Y).** That is, Support(Y) =|TsY| where, |TsY| indicates the quantity of transactions that contain item Y.

Example 1: The transactional database with a set of items is presented in Table 1 K = {m, n,o,p,q,r,s,t,u,v}. There are only two components in this pattern, "m&n," it is called a 2-pattern. At the intersections with numbers 1,5,6 and 8, the pattern "m&n" can be seen. As a result, Support(m&n) = |Ts(mn)|=4 is used to indicate the total number of supports for "m&n."

Table 1. A transactional database (transection set 1)

T. id	Items					
1	m	n	t	o	p	
2	o	r	n			
3	u	v	m			
4	v	t	q			
5	m	o	s	n	r	p
6	m	n	o	u	s	
7	s	o	q			
8	u	o	m	n		
9	r	s	v			
10	o	q	u	n	s	

Definition 2. Frequent pattern: Support(Y) >= Min_Support, where Min_Support is the user-defined minimum required support threshold value, indicates that pattern Y is frequent[7,10]. When two or more different databases are used to find a frequent pattern, it's called a distributed database. And the pattern is call distributed. As a result, pattern Y is considered to be frequently distributed when both conditions Support1(Y) >= Min_Support and Support2(Y) >= Min_Support are accepted.

Example 2: Suppose the user define minimum support Min_support is 30% of the total transections. Hence, in Table 1, Min_Support is 3 (as total 10 transections). So, the pattern "m&n" is a frequent pattern because the Min_Support<Support(m&n). On the other hand, in Table 3, the pattern "m&n" is also frequent pattern. As we can the pattern (m&n) is distributed accepted pattern.

Definition 3. The differences between TsYk+1 and TsYk are what are used to measure Y's regularity[2,4,8,12]**.** Therefore, RY= TsYk+1 – TsXk. Where the first transaction denoted by Tsf that is 0 and the last transaction is denoted by Tsl= n+1 where, n is the number of transactions[3,9,11]. The expression Regularity(X) = maximum (R_1X, R_2X,..,R_nX) denotes the regularity of X.

Example 3: The item 'm' can be found in Table 1's TDB at the intersections 1, 3, 5, 6 and 8. Support(m) is thus 5. The periods for item "m" thus are 1 (= 1-Tsf), 2 (=3-1), 2 (=5-3), 1 (=6-5), 2 (=8-6) and 2. (Tsl-8). Regularity(m)=maximum (1, 2, 2, 1, 2, 2) is hence equal to 2.

Definition 4: Regular-Frequent Item A frequent item is called regular-frequent if Regularity(Y) ≤ Max_Per, where Max_Per is the user define maximum periodicity threshold value[2,3,8,13].

Example 4: Assume a user defines a pattern's maximum periodicity value as Max_Per = 5. That is, an item is considered "regular or frequent" if it sells at least once every five transactions. In Example 3, we see that the Support (m) = 5 which is larger than Min_Support. So, the item 'm' is a Frequent item and the Regularity (m)=2 which is less than the Max_Per value. So, the item 'm' is a Regular-Frequent Item.

Finally, if a pattern meets both of the following two requirements, it is referred to as a regular-frequent pattern: (i) Its periodicity must not exceed a user-specified maximum periodicity threshold, such as Max_Per(Y), and (ii) Its support must not be less than a user-specified minimum support threshold, Min_Support(Y), where Min_Support (Y) is expressed as a percentage of |TDB|. Hence, the goal of regular frequent pattern mining is to identify all regular frequent patterns in a |TDB| with regularity no greater than Max_Per (Y) and support no less than Min_Support(Y) given Min_Support(Y), Max_Per(Y), and a |TDB|.

4. The Development and Problems of Association Rules:

In this part, we provide a quick explanation of the association rules generation model. In such a database, association rules represent a significant class of regularities.

4.1 Problem Definition

Let K be a collection of entries in a transactional database, where K = $\{k_1, k_2, k_3, ..., k_n\}$. A pattern or an itemset is the set Y = $\{k_j,..., k_l\} \subseteq K$. A transactional database TDB over K is a set of transactions T = $\{t_1, ..., t_m\}$, m = |TDB|, where |TDB| is the total number of transactions. We already know from Example 1 that the number of itemsets that contain an item Y divided by the total number of itemsets represents the item's support. Let Y and Z be distinct itemsets. Let's now define |Y| as the total number of itemsets that contain Y, |D| as the total number of items, and |Y. Z| as the total number of itemsets that contain both Y and Z[2,14]. The following is a definition of the support of itemset Y:

Support(Y) =|Y| / |D|

If %s of the transactions in |D| have X and Y together, the rule Y=>Z is supported.

Support (Y =>Z) =|Y .Z| / |D|

Finally, we can observe that the Support evaluates the frequent of the itemsets in the database.

Definition 5: Confidence measures: The strength of the regulation is measured by confidence. If %c of the transactions that contain Y also contain Z, the rule is said to

have confidence in it.

Confidence (Y.Z) = Support (Y .Z) /Support(Y)

Example 5: In Table 1, the Support (m =>n) = (4 / 10) *100=40% and the Confidence (m=>n) = (4/5) *100%= 80.00%. That means 80.00% customers who purchase the product m also purchase the product n. Which identify the association between the product m and n. In Table 1, the 5 customers purchase the product m and the 4 customers also purchase the product n with m, so the Confidence (m =>n) =80.00%. The goal of association rule mining is to discover rules (Y => Z) for a given collection of transactions D where the support of the rule is larger than a user-specified minimal support. The confidence is higher than Min_Conf which is user-specified minimal number. The task of Association Rule Mining can be divided into two: The Frequent itemsets are located using Min_Support in the first phase, and the rules are constructed using Min_Conf in the second phase.

Table 2. Association rules form table 1 with Min_Support=30% and Min_Conf=50%

Items	Support (%)	Confidence (%)
m=>n	40	80
m=>o	40	80
m=>u	30	60
n=>o	60	100
n=>u	30	50
n=>s	30	50
o=>s	40	57.14
m&n=>o	40	100
m&o=>n	40	100
n&o=>m	40	66.67
n&o=>u	30	50
n&o=>s	30	50
n&u=>o	30	100
n&s=>o	30	100
o&s=>n	30	75

Example 6: Association rules for Table 1 with Min_Support=30% and Min_Conf=50%

5. Our Contribution

Our primary goal in this work is to identify significant purchase patterns in a distributed manner. To improve the accuracy, we use the large transactional databases collected from multiple super shop of Bangladesh. We calculate the regular frequent itemsets in single transactional databases and in distributed multiple transactional databases in

different geographical areas, and then we identify the effect of geographical area for a product. Then we generate the association rule for all regular frequent itemsets.

Table 3. A Transactional Database (Transection set 2)

T. id	Items					
1	P	m	n	u		
2	M	r	o	t		
3	P	v	r			
4	V	s	q	u		
5	M	o	t	n		
6	N	o	q	p		
7	M	o	u	n		
8	S	u	m	n	o	
9	R	v	q			
10	M	o	s	p		

5.1 Distributed Associative Rules Generation and Impact of Geographical Area

Suppose the dataset of Table 1 and Table 3 are collected from two different geographical location.

Table 4. Association rules form table 3 with Min_Support=30% and Min_Conf=50%

Items	Support (%)	Confidence (%)
m=>n	40	66.67
m=>u	30	50
m=>o	50	83.33
n=>u	30	60
n=>o	40	80
m&n=>u	30	75
m&n=>o	30	75
m&u=>n	30	100
m&o=>n	30	60
n&u=>m	30	100
n&o=>m	30	75

The Association rules for Table 1 with **Min_Support=30%** and **Min_Conf=50%** are already shown in Table 2. Now Association rules for Table 3 with **Min_Support=30%** and **Min_Conf=50%.** Now, we combine the dataset of Table 1 and the dataset of Table 3.

Table 5. Association rules in distribute transection

Rules	Support (%)	Confidence (%)
m=>n	45	75
m=>o	50	83.33
m=>u	35	58.33
n=>o	50	90.91
n=>u	30	54.55
m&n=>o	40	88.89
m&n=>u	30	66.67
m&o=>n	40	80
m&u=>n	30	85.71
n&o=>m	40	80
n&u=>m	30	100

Then we also generate the Association rules with **Min_Support=30%** and **Min_Conf=50%** are given in table 4. We can see that Table 1 generate 15(table 2) rules and Table 3 generate 11(table 4) rule that satisfy the user define threshold value. But when we combine two tables then it generates 11(table 5) association rules (distributed rules).

6. Literature review

Agrawal, Imielinski, and Swami were the first to present the constraint-based frequent patterns in 1993[1]. To discover the frequent itemsets, two mining approaches based on transaction numbers and additionally based on products or itemsets on the vertical data format are applied[2,9]. Efficiency is attained by getting rid of irregular or aperiodic patterns during the execution of suboptimal solutions. The database contents are captured in a extremely compact manner due to the tree-based structure[2]. If the support and periodicity of the pattern are similar to those of its constituent elements, it is significant. When removing uninteresting patterns from the support dimension, the all-confidence measure is occasionally used as an interestingness measure. In order to eliminate boring patterns in the periodicity dimension, a new interestingness measure called periodic-all-confidence is also being developed[5]. To tackle the rare-item problem and extract intriguing periodic-frequent patterns, a model integrating both measures and a pattern-growth strategy was offered[5].

The interest in applying association rules for prediction has grown rapidly in the data mining field. Association rules have traditionally been utilized for data exploration, description, and pattern visualization. only rules that can be used for classification will be mined. The pruning technique during itemsets construction help to remove non-frequent and no periodic items that makes the algorithm to faster. The improvement time performance of itemset construction using this pruning technique is so efficient [15].

Han et al.[4] proposed the frequent pattern tree (FP-tree) and the FP growth method, which is more memory and time efficient. To find periodic-frequent patterns, Uday and Reddy[12] presented the PFP-growing pattern growth method. Amphawan, Lenca, and Surarerks have received the most attention among the top-k periodic-frequent patterns[6]. These patterns are crucial for finding relationships, correlations, periods, multi-dimensional patterns, diversified patterns, emerging patterns, common periodic patterns, and other patterns. However, the fundamental model that is used in those investigations does not change. Find all periodic patterns that meet the minimum support the user defines.

7. Experimental Results.

We will present the findings of our experiment in this part. Both algorithms were developed in Java 8 and executed on Windows 10 on a 2.50 GHz system with 12 GB of RAM. The test datasets were collected from January 2019 to December 2019 in one of the largest supermarkets in Bangladesh, which has two branches in different geographical locations one is transection set 1 another is transection set 2. We collected all datasets from both branches of that superstore in 2019. The datasets contain 33462 (16732+16730) transactions. It contains of 3077 different types of items.

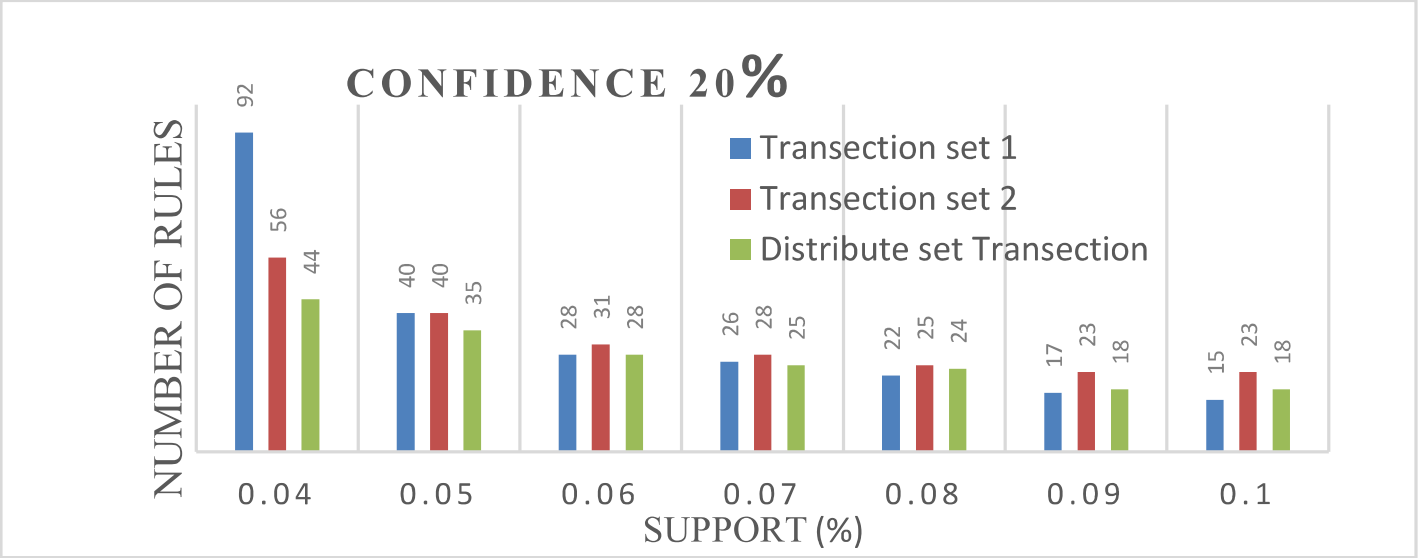

Figure 1.Number of rules in different support fixed and confidence

In figure-1, the minimum support applied to generate association rules is represented by the X-axis, whereas the number of rules is represented by the Y-axis. Here there are three bar which represent rules first for transection set 1 then transection set 2 and last one in combined (distributed) manner. We see that the number of rules is different. After execute both transection in distribute manner and also gets the different number of rules. Those rules are called are more efficient and accurate. As number increasing support, we get the less rules. since 20% confidence is used.

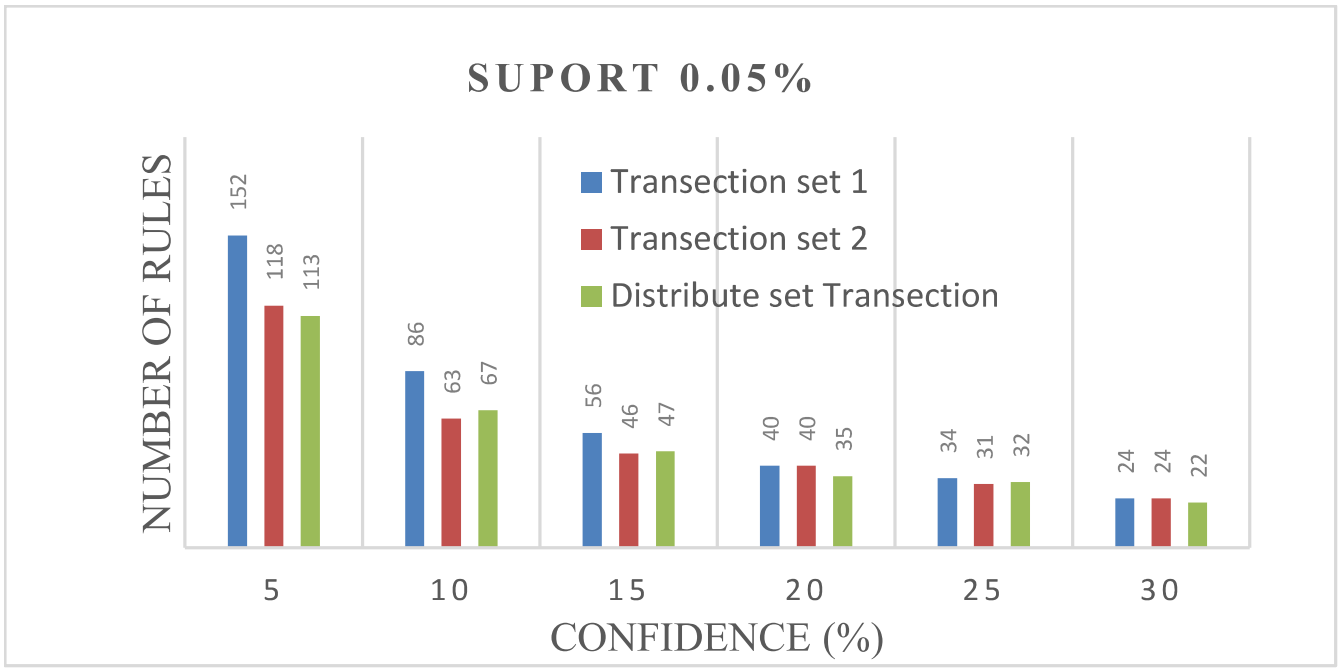

Figure 2. Number of rules in different confidence and fixed support

Figure 2 shows the rules for different confidence levels and the 0.05% minimum_support. The number of association rules is represented on the Y-axis, while the minimum confidence level to find the rules is represented on the X-axis. In this figure, there are also three bars, which represent the rules first for transection set 1, then transection set 2, and the last one in a combined (distributed) manner. We also get a different number of association rules this time.

8. Conclusion

A novel method for discovering association in distributed transection has been developed in this study. Association rules vary geographically dependent. Our system provides the association rules using different sets of transections. We improve the system's runtime efficiency and scalability by deleting the irregular itemsset during FP-growth algorithm execution. Furthermore, it has exceptionally fast runtime and memory stability.

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Representation of Social Hierarchy in Anita Desai's "Games at Twilight"

Khatun M.U.A

Abstract

Hierarchy is considered amongst the most elementary features of social relations, which is prevalent in various forms in groups and organizations. Members of a social hierarchy vary according to their degree of potentiality, impact, expertise, or superiority. Although, there is the prevalence of a kind of class distinction in this system, social hierarchies are common practice all over the world. Anita Desai is a prominent Indian writer whose short story "Games at Twilight" represents the social hierarchy and personality traits related to it through the gathering of children with certain age differences. Providing information and evidences from some socio-psychological research work on social hierarchy and human behavior, this study will show how each individual in the group of the children in this story varies in their power exercise and personality trait and thus forms a hierarchy that can be regarded as a replica of social hierarchy. By scrutinizing the way in which power is demonstrated and established in this group of children, this study will also focus on sibling competition prevailing in the group of the children.

***Keywords*:** Hierarchy, personality, power, society, children.

Introduction

The rank or status of an individual in a social hierarchy may influence her/his behavior or personality traits. From the very beginning of civilization, society is organized on the basis of hierarchy where those at the top always have more benefits and power than others. At the first stage of their life, people start to perceive the social world in terms of comparison, smartness, or popularity. And this tendency to perceive and evaluate people according to their status and power creates the social hierarchy. Generally, the social hierarchies are considered as a sets of ongoing social patterns that demand certain demeanors from the members of that society. The occupants of social hierarchies' are subjected to various requirements, and the conduct expected to them differ according to the social position of the individuals with whom they involve in interaction. Magee[1] defines social hierarchy as the ranking of members in social groups based on the power, influence, or dominance they exhibit, whereby some members are superior or subordinate to others.[2] Considering the definitions of social hierarchy it can be seen that, social hierarchy is a ladder like structure where there is a ranking of individual occupants from higher to lower level or vice-versa. Moreover, it can be seen that the individual occupant who posits himself at the top of the hierarchy is benefited with comparatively more resources and gets the opportunity to exercise more power and dominance than the occupant of lower rank of hierarchy. As a result, the behavior and personality trait of each member of various ranks of the hierarchy varies according

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to their position. Each member of various ranks of the hierarchy varies according to their position. Anita Desai, the novelist from India, is the master of representing people and atmosphere through imagery that highlight the society and its structure skillfully. Her short story "Games at Twilight" can be considered as the microcosm of the real and adult world with social hierarchy where people enjoy as well as suffer due to their respective position in the hierarchy. In this story the gathering of a group of children playing 'Hide and seek" exemplifies the social hierarchy by exercising power and dominance over their subordinate according to their position. The children are of different ages and the age gap plays a vital role in determining their rank in the hierarchy. Moreover, the exercise of power over one another and the treatment of the top level ranker towards the low level individual also reflects and shapes the personality of the children which varies according to their position in the hierarchy. Thus, it can be seen that Raghu, the elder member of the group of children holds the top rank. For being the elder as well as physically strong and powerful one, he dominates the other children who are younger than him. Dominance and power enjoyed by the high rank holder may arise ambition and hope in lower rank people of the hierarchy and the failure of achieving that goal sometimes leads to anguish and frustration. Hence, it can be seen that Ravi, being the lower rank holder cherished the dream of being the winner which he never was. It is also notable that through this dream of winning Ravi wants to change his position from less priority to high priority level. This tendency of Ravi to compete for achieving the higher rank and prestige also demonstrates sibling competition. The other characters such as Mira and Manu also hold different social rank in this hierarchy and they act accordingly. This study will show how all the children showcase various social strata and the social hierarchy in this story "Games at Twilight".

The Austrian psychotherapist, Alfred Adler developed the birth order theory in the 20th century which declares that, the development and personality of an individual depends on the order in which a child is born. Adler also claimed that, a child's personality is majorly shaped by family, community, and social circumstances. Although children of the story "Games at Twilight" are not biological siblings, on the basis of their age difference a birth order can be placed among them. Hence, this study will show how the personality of each child varies according to her/his birth order and how s/he exercises the power of position over others. This study will adopt the qualitative method to clarify all the perception of social hierarchy and personality traits. It will also demonstrate how all the children named Raghu, Mira, Ravi and Manu hold a structure of social hierarchy where Raghu, for being the eldest one, expresses a bold personality and exercises his dominance over others, and the other members also act accordingly. Hence, all the children of "Games at Twilight" together mirror a social hierarchy.

Discussion

Social hierarchy is quite common in every society which is developed gradually for supporting existence within a communal context. For a clear conception of social

hierarchy, it is necessary to understand what is 'rank' and 'status' as these two terms are closely related to social hierarchy. "Rank is a term often used to objectively refer to where one falls within the hierarchy, and is conceptually similar to the ordinal ranking of numerical values along a number line."[3] "Status, on the other hand, can be measured through social opinion or reputation, and is generally associated with admiration and respect."[4] Every species and more specifically human have an inherent aptitude to assemble into a social hierarchy where the top ranking members occupy more influence and advantages than the lower-ranking ones. According to Jessica E. Koski, Hongling Xie, and Ingrid R. Olson hierarchies across species are characterized by:

1. The ranking of group members who vary in physical or intellectual capacities,

2. Rapid and spontaneous formation; and

3. Functional and adaptive value to the existence of the social group.[5]

Hierarchy is made up of on the basis of idiosyncratical variation in ability or strength where the most potential member acquire the top status. Moors & Houwer suggest that, "humans rapidly attribute status information to others and they spontaneously organize into a hierarchical structure."[6]

Several factors such as age, body size and birth order can influence the members of the hierarchical group to hold rank accordingly. Alfred Adler[7] focused on social influences on personality along with birth order which is representative of differences in age, physical size, and status all of which contribute to build up personality. Birth order is a powerful proximate source of sibling strategies. These strategic variations arise because birth order is correlated with differences in age, physical size, power and status within the family. Adler regarded firstborns as "power-hungry conservatives", middle-born as competitive, and youngest children as spoiled and lazy."[8] Thus, in the story "Games at Twilight" Raghu holds the higher rank for being the eldest one who always appears as the most powerful to the other children. Mira comes next to him according to age and she also possesses a dominant status in the hierarchy of the children. Ravi, round whom the story revolves can be regarded as the middle-born who is less powerful and less influential than the previous two members of the hierarchy, but who possesses competitive characteristics. Another character in this story named Manu is the youngest member of the group of children who holds the least important rank in the hierarchy.

"Games at Twilight" deals with a group of children with different ages who are engaged in playing 'Hide and Seek' in a hot afternoon. Desai did not clarify whether these children are biological siblings or not. Hence, for the sake of analysis all the children of the group can be considered as siblings according to their age. If they are included in a group and organized in relation to their birth order, it can be seen that each child will hold a certain rank in the group and exhibit power in relation to her/his respective status in this group. Consequently, their power exercise and dominance over

one another according to their position and limitation will also express their personality. By analyzing the way in which power is demonstrated and established in this group of children, it can be predicted how they ultimately form a social hierarchy.

Social hierarchy in "Games at Twilight" can be traced by analyzing the way in which power is demonstrated and established in the group of children. For attaining dominant and higher status in hierarchy, physical attributes and the top order of birth can play a vital role. Anderson[9] said that, "physical attractiveness is an additional trait that may help in attaining status in humans."[10] Desai's sketching of the elder child, Raghu, represents him as a dominant character. Desai said that, "other children are no match against "Raghu's long, hefty, hairy footballer legs."[11] When Raghu is selected as the "It," or the searcher of the group, first of all he finds out the youngest Manu. When Manu pleaded Raghu to find all the players, the way Raghu responded depict his dominant and predatory status in the hierarchy of the group of children. He said, "I know I have to, idiot."[12] Moreover, when Ravi started to cry after not being recognized as the winner, Raghu said roughly, "Don't be a fool."[13] Thus, his physical appearance and dominant behavior demonstrate his role as an acquisitive subduer in hierarchy of the group of children. Furthermore, if Raghu is considered as the firstborn according to Adler's birth order theory, it can be seen than his personality matches with the personality traits of the firstborn who is considered as "power-hungry conservative". So, it can be said that "Games at Twilight" demonstrates a part of the social hierarchy through the character Raghu who holds the top rank in this social hierarchy.

Along with physical structure, gender can also play an important role in highlighting social rank in a hierarchy. Cheney & Seyfarth[14] asserted that, "gender may influence status as well, depending on the particular species."[15] Mira, the only female member of the group of children is showcased as "motherly". When the boys start to quarrel on who will be appointed as "It," she ascertains the means by which they will select the person to become "It." In this way, the game brings to light the qualities in her that reveal her position as the mother of the group which is obviously another powerful and dominant status in the hierarchy. Again, if Mira is considered as another member of the siblings in Adler's birth order theory, it can be seen that she also posits top order after Raghu as she precedes Ravi and Manu. Her high position in the birth order added her dominant and motherly personality traits. Thus, when Ravi started to cry at the end of the story, in an orderly manner like a mother, Mira said to him, "Stop howling, Ravi. If you want to play, you can stand at the end of the line."[16] These guardian-like activities of Mira posits her just below the rank of Raghu and demonstrates the social hierarchy in the story "Games at Twilight".

Ravi, the protagonist of the story, could perceive his rank in the social hierarchy as one of the younger and insignificant members. For this reason, his assertion to be the winner is easily dispelled exemplifying the difficulties of a younger child like Ravi to posit the status that will help him to achieve his cherished place in the group. Unlike Raghu's strong physical structure, Ravi doesn't have "much faith in his short legs."[17]

Thus, from the point of view of physical consideration Ravi fails to acquire the higher rank due to his being weaker than Raghu.

An important aspect of social hierarchy is that, a person may leastwise try to upgrade in social position as lower ranks are frequently experienced as ignominious, insulting, and deteriorative. In "Games at Twilight" Ravi is such a character who even after holding a lower rank in the hierarchy tries to change his position for gaining prestige by following a powerful rank holder like Raghu. The impact of physical attributes in the social hierarchy is again demonstrated by Ravi who laments for not being tall as Raghu. Ravi's hopes of gaining greater status focuses on sibling competition where each sibling wants to achieve the superior status. When the children forget him and start a new game, the inflexibility of social hierarchy is demonstrated again by Ravi's failure in being recognized as the winner. After this incident, all his dreams and hope of competing Raghu and obtaining prestige are shattered by the sense of insignificance

Considering Adler's birth order theory, Ravi can be regarded as the middle-born whom Adler declared as competitive.[18] Ravi's spirit of competition and goal of being the winner by surpassing Raghu clearly demonstrate his personality trait of competitiveness. But, the nature of social hierarchy which is quite rigid to frequently accept any change barred Ravi to transform his rank in top level of the hierarchy. The confirmation of the idea that in a social hierarchy there is always the existence of those at the peak who will be supplied more opportunities and benefits than others as well as there are always losers who suffer from insignificance.[19] is exemplified by the failure and frustration of Ravi.

The lowest position in the hierarchy of the group of children is occupied by the youngest Manu who can be regarded as the most vulnerable member of the group of children. Manu is represented as opposite of Mira and Raghu, who is sketched as "small" and confused of his hiding place. Raghu immediately found him and he started to cry for being the lame duck. Desai demonstrates how the structure placed in their group is exposed through the game where the younger children are controlled and dominated by the older children. For holding the lowermost position in the social hierarchy Manu is represented as the weak personality.

Desai is the keen observer of the inner mechanism of the society who focuses on the social structure in many of her writings. In the short story "Games at Twilight", she does the same by representing the group of children who signify various social status and rank in the social hierarchy. As childhood is regarded as the microcosm of the adult world, all the child characters in the story "Games at Twilight" demonstrate the social hierarchy through their certain role and position in the given circumstance. Desai's craftiness in replicating the social world and its inner structure is highly appreciable.

Conclusion

Although, at the very beginning of the story Desai introduces the children as gathering

and being bored in their home, whenever they start to play the game hide and seek, each child holds on various roles in their group. As the variations among them are elucidated, Desai demonstrates how the group of children exhibits a concrete social hierarchy that is difficult to outstrip. Desai demonstrates how social politics begin even in childhood, and how the dynamics of children's games can both reinforce that social hierarchy and reflect how rigid it is. On the basis of the concept of social hierarchy and birth order this study has shown the existence of social hierarchy and personality traits of each member of the hierarchy.

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Materials Production in English Language Teaching: Principles and Procedure

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Abstract

Many teachers confess that they do not teach English through English. They say if they do that their learners would not be able to follow them. They say they are forced to use the regional language more against their wish. Much attention has been paid in recent years to the importance of learners' feelings in determining the quality of the learning and learning outcome that takes place in the classroom. The materials should motivate the learners in such a way that they should be ready to engage themselves without constraint in the activities and interactions which take place in the classroom. The scope of this article is concerned with the framework of materials design, its nature, and its role in CLT, its evaluation, and adaptation. The aim of this article is to provide tools and techniques for designing materials and it also intends to provide principles and procedures for those who are in a position to take part in the designing of materials.

Keywords: Attention, Affective, Constraint, Interaction, Adaptation, Materials Designing.

Introduction

Language is a means of communication. The purpose of language is to make communication with each other. Generally, we express our ideas, emotion, thoughts, feelings, etc. to each other by using language. In the communicative approach to language, teaching language is also used for the purpose of making communication with each other. According to Hymes[1], 'language teaching aims to develop 'communicative competence'. We have found innumerable textbooks that are written for the development of communication [2]. It contains different texts for pair work. We have got different information from different pieces of work. The materials for CLT contain not only textbooks but also certain activities based on real-life situations. Learning in the traditional approach was deductive based on memorization but in CLT it becomes understanding. There are four basic skills in communicative language teaching: listening, speaking, reading, and writing. The material should give focus on all these four basic elements of CLT.

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Rational of the study

Communicative Language Teaching plays a very important role in the field of English language teaching. The problem is teachers, parents, and students are still dissatisfied with the progress of communicative language teaching.They feel it is not enough for the development of gaining competency in the language. There are many research-based activities done around the world to find out the reason behind this dissatisfaction. The researchers have observed that there is a huge gap between the principle of communicative language teaching and the practice in the practical field of life. There is a significant gap between learners' educational needs and materials designed for curriculum development. Sometimes matching is found between the curriculum and learners' needs but the process of language teaching becomes different. We have observed that in ancient times grammar books and bilingual dictionaries were very common. Nowadays, there are many communicative language teaching materials included in the syllabus of CLT but still, the gap between learners' needs and curriculum design is not properly matched with each other.

Objective of the Study

The article provides a basic framework for material design. The text provided by the education board may not satisfy the teaching and learning process. Besides this, the readymade materials may not be so effective to use for ESP. So, it is the teacher who needs to produce teaching material for actual teaching and learning based on learners' needs. The article also presents a view of the framework and the practice of material production which are helpful for effective learning. The role of teachers is very important for CLT. The teacher should think of the principles of language teaching before producing materials for teaching CLT in the classroom. The aim of this paper is to ensure learners' expectations and that they should be reflected in designing the curriculum.

Review of Literature

The process of materials production is an attempt that is made to take care of curricular objectives and philosophies along with the principles and other theories of language learning and language teaching. In other words, it can be said that the production and operation of materials involve the objectives of language planning at the government level, the latest theories, techniques, and approaches of language learning and teaching the language items and content decided in the form of teaching, teaching strategies, and techniques. This implies that materials are something that serves as a means of effective learning, which can be met only by their effective use in the classroom. Keeping this central position of materials in mind, we propose to evaluate the prescribed material for classes 9-10 of Bangladesh, *English for Today*. The writer here intends to see whether the prescribed material is premised on the various theories, techniques, and approaches of its production. The article also intends to assess its effectiveness.

It can be said, in a nutshell, therefore, that the present article proposes to identify its

strengths and weaknesses. Hidalgo et. al[3] finds out that there are some writers in South-East Asia who have developed their materials as per the need of the learners.

There are some writers who have proposed frameworks and some writers list the principles which drive their materials. For example, McGrath[4] reviews the literature on principle approaches, frameworks, and procedures for units for material development. On the other hand, Tomlinson[5], and Tomlinson[6] find out the ways of applying commonly agreed theories of language acquisition to material development. We have found that many research-based activities have been conducted in the area of ELT materials but we have found that only insufficient work has been done on the area of ELT materials, the contribution of students and teachers in the ELT classroom especially at the University level. This present study will remove the gap between English Language Teaching materials and English Language Teaching learners in ELT classrooms.

Significance of the Study

The most important message in this paper is that the materials are produced for the development of the students. It is taught by the teachers in the classroom and it must have effectiveness for the students. The students will feel that the reading materials are produced for the development purposes of the students and the students will be benefitted from reading the materials. The reading materials are produced for the betterment of the students and the teachers feel satisfied with the materials. There is a correlation between teachers, students, and the materials. The materials will be student-centric. It will focus on the demand of the students. The teacher will enjoy producing such materials for the students. The reading materials will prove ultimate effectiveness for the students.

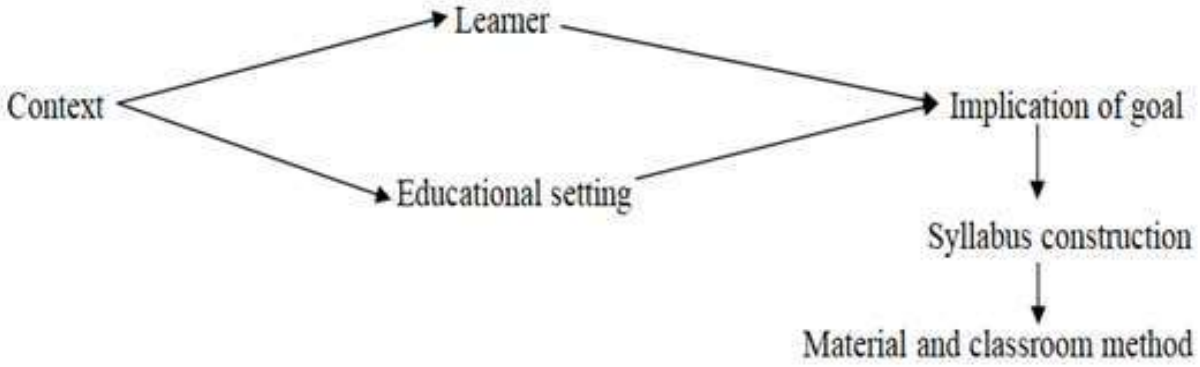


Fig1. (Donough. M.J. & Shaw. C. 1993)

Methods and Methodology

Method: Content analysis method has been applied to conduct this article.

Discussion

The Framework

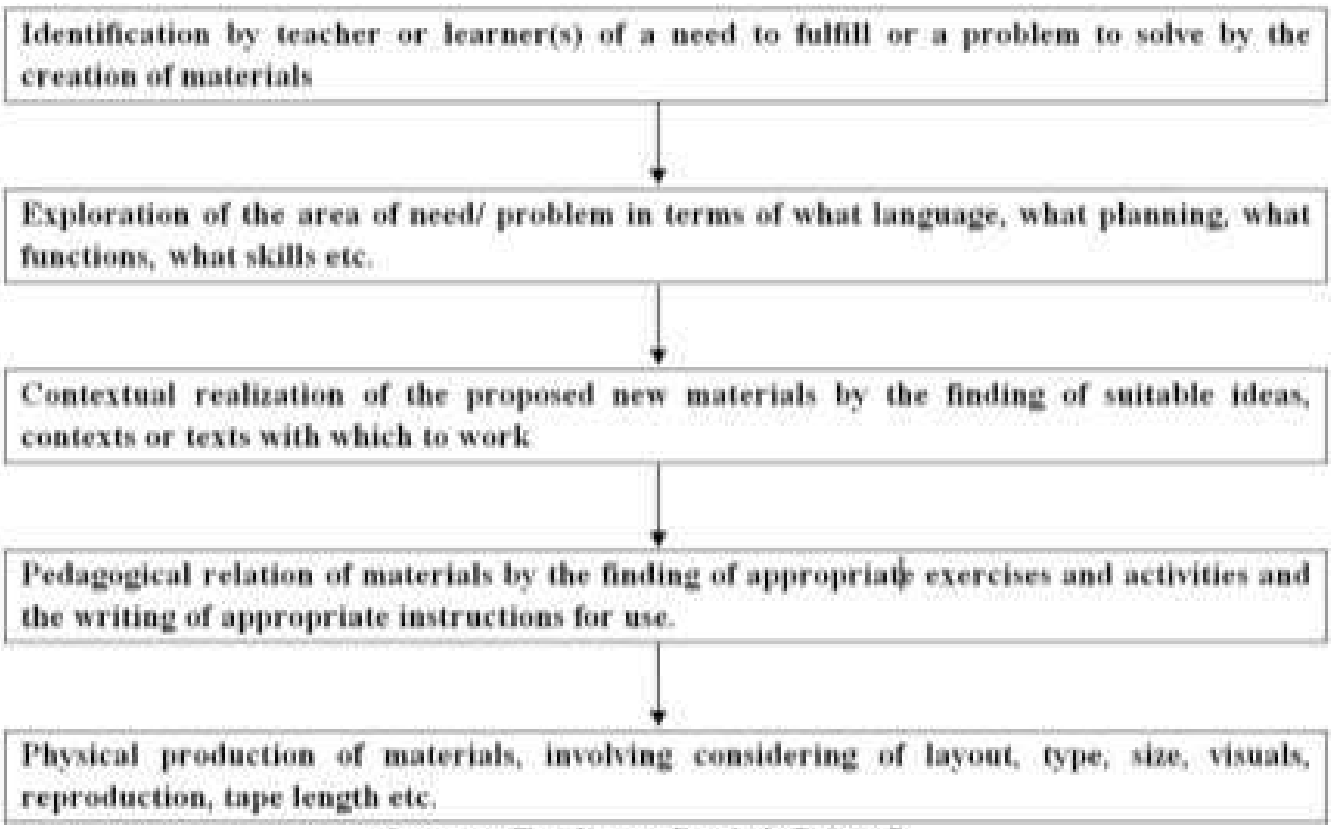
Materials and methods are related to each other. We are showing a scenario below. It will focus on the typical stages of planning an English language program.

The framework starts from the context of the language. It influences both the learners and the educational setting. Based on these two, the implementation of the goal is set up. The syllabus is designed keeping two basic things in mind- one is the goal of the learners' needs and the

Educational elements of the syllabus will follow the learners' requirements. And lastly, materials are produced and this work is influenced by the syllabus. After that, the question of methods comes. Which method should be used in the classroom by the teacher?

The Process of Materials Writing/ Designing

The following diagram(fig2) presents the various steps that are necessary for producing materials



Source: (Tomlinson B. 1998, P-96-97)

Fig2. Diagram for Producing Materials

It is observed that most of the materials writers move in the above direction and use some or all of these steps.

Principles of Selection and Gradation of Course Materials

It is impossible to teach or learn everything in a foreign language. In education, we always have to make with a limited number of hours that can be spent on foreign languages. For this, a choice should be made. To do this, we should always keep in mind the objectives that have been formulated so that the selected items enable the pupils to meet the specified objectives. To select the course content, one should pay attention to a number of factors such as the specific level for which the selection is made and the amount of teaching time available. These factors are of two types :(i) External Factors (ii) Internal Factors

External Factors

External Factors are non-language based. Objectives, levels, and time allotted are external factors that are very important to the selection process. They delineate the framework within which the selected types of language material, amount of language material, and individual language form should take place.

Objectives

One of the external factors is the selection of the objective. The appropriate selection will help the learners to carry out the objective. It makes an important difference whether the selection is made within the framework of foreign language teaching for general purposes or for specific purposes. When selecting 'general' courses one usually bases oneself on a large number of different types of language materials. When selecting 'specific courses one base oneself on special types of language materials, but both types, of course, will have a certain amount of language materials in common, a 'common core' which is the basis of any form of language use.

Level

The courses for beginners and the courses for advanced learners are different from each other. The materials of these two types of courses are not identical to each other. At higher levels, it is more important to have concrete objectives at one's disposal. At the very lowest level, this is less important because of the fact that any language learner will have to master it, irrespective of the use he will put the language to. The last external factor which is of importance in carrying out a well-founded selection is the number of hours available for second language teaching and how they are spread through the curriculum 'De Francis[7] for instance, concludes on the basis of experience that in a non-intensive course more materials can usually be worked through than those in an intensive course of comparable length.

Internal Factors

Selection of the type of language and the content of the course will come from internal factors. According to Mackey[8], the internal selection is in the area of linguistic variation e.g. dialect, register, style, and medium.

Dialect

Dialect means the change or variation in a language. The regional style of pronunciation is different from one locality to another locality of a country. Foreign language learners are not influenced by dialect. They are concerned with the standard use of language. It is the variety most used in modular and education [9]. There are languages; however, that exhibit a number of regional varieties which have attained standard language status.

For example, in British and American English, these variations differ not only in accent but also in grammatical form (for instance, American English – "I have gotten" vs British English – "I have got").

Register

According to Halliday et al.[10], "Register means the language of a specific area/ discipline". The terminology of a subject is different from the terminology of another subject. The use of terminology depends on the situation or environment of the language. We can easily get the difference between the terminology of one subject from the terminology of another subject by judging its usage in language.

Style

Style is connected with the content of the course. According to Joss[11], there are five styles for example, frozen, formal, Consultative, causal, and Intimate ranked in a hierarchy of decreasing formality. Most linguists considered such a division premature and prefer speaking of a style that continues, ranging from formal to informal.

Medium

The distinction between spoken and written language is associated with the selection of medium. Linguistic research had been mainly concerned with written language. Systematic research into spoken language did not become possible until the human voice could be properly recorded. Research has shown that considerable differences exist between spoken and written language.

Gradation

In the process of materials production for language teaching, there are two types of gradation: (i) Linear gradation (ii) Cyclic gradation.

Linear Gradation

A strictly linear sequence is maintained for a typically linear gradation-ordered course; throughout the course, the items are arranged one after the other in a strictly linear sequence. There is an in-depth discussion on each item so that a complete understanding of the item can be gauged before moving on to the next item. Until the last ten years or before that, this linear sequence was a very popular system of gradation. But nowadays cyclic gradation takes the place. A distinction between

material for productive use and material for receptive use is certainly not incompatible with the principles of linear gradation; many linearly ordered courses do not make their distinction [12].

Cyclic Gradation

Some research scholars give a short definition of cyclic gradation. Cyclic gradation is characterized by gradual familiarization with a point; familiarity with specific points is attained by returning back to the point during the course of instruction. In the cyclic approach masterly is achieved by successive approximation to a given standard. In cyclic gradation one item is not presented and discussed exhaustively, as in linear but only essential items are dealt with. McLaughlin[13] says that cyclic gradation resembles the natural process of language learning. Language is not like a block sets on block rather it is a 'system of system' or network of inter-related categories, no part of which is wholly, independent or wholly dependent upon another so cyclic comes closer to the language itself, cyclic gradation is much more strongly related to the way in which language is structured than linear gradation.

Materials Designing in CLT

To analyze the designing of materials in CLT, the skills are taken up separately so that an explicit view of designing materials in CLT can be presented. Learning a language enables learners to communicate effectively in that language and this is the ultimate goal of learning a language. There are four skills that must be acquired to learn a language; these are listening, speaking, reading, and writing. While listening and speaking are auditory or vocal skills; and 'reading' and 'writing' are visual skills, the methods to teach and learn these skills vary considerably in some instances. The language classes therefore should be suitably equipped to address all the four skills referred to above.

Materials for developing Listening skills

Taking into account the context and purpose of listening, the teacher should turn his attention to the way the input is processed in the learners' minds. When a teacher uses English in the classroom, he/she makes listening demands on the learners. When he/she explains, they should understand it; when he/she gives instructions, they have to carry out his/her instructions; when he/she praises or rebukes someone, they should know it. But listening in a foreign is not an easy task. It needs training. Processing can be: top-down or bottom-up. In top-down processing, the learner relates the utterances to the social and situational context in which they are made and make inferences and deductions. In bottom-up processing, the learner comprehends the message by understanding phonological features, discourse markers, grammatical cohesion, lexical cohesion, and the syntactic structure of sentences and clauses. The materials should be targeted toward both kinds of processing.

Exercises for teaching listening skills

Given below is a list of exercises for teaching listening skills. The list is not exhaustive but, it is hoped that this helps in the design of exercises. Exercises where the students are asked to:

i) Understand an incomplete story by listening to it and thinking about the incomplete part, then listen to the actual/complete story and see how much of it accords with their guess.
ii) Listen to a discussion on a topic by an expert and read about the topic from a book and check how much of the latter matches with the discussion.
iii) Listen to one end of a telephone conversation and guess the response of the person on the other end; then listen to the whole conversation from both ends and compare the latter with the former.
iv) Browse a list of jumbled key points to be discussed in a talk and then listen to the talk and form the sequence of the key points while listening to the talk.
v) Listen to a conversation and say at what point the purpose of the conversation was interactional and at what point it was transactional.
vi) View pictures and listen to descriptions of the pictures, identify the pictures from their descriptions, and organize them in the order in which they are described.
vii) View a diagram or picture of an object (e.g. A flower, A small machine) given to them: listen to the description of the object and label the parts of the object.
viii) Listen to an advertisement for a job on the radio and note the eligibility requirements.
ix) Draw a diagram with the help of an aural description
x) Assemble an item with the help of oral instructions
xi) Listen to a piece of information and identity the setting of the conversation adapted from Richards[14].

Materials for the development of speaking skills

Examining the differences between communication inside the classroom and communication outside the classroom will enable us to identify the objects from real life that we can use as stimulus material or input. We have to be aware of the need to prepare our learners for all kinds of contexts and situations and take into account the structural, functional, interactional, and transactional aspects of language.

A methodological framework for materials on speaking skills

The figure (fig3) developed by Littlewood[15], below presents a methodological framework in a diagrammatic form. This is a conceptual map for understanding and connecting the different activities and comprehending them in terms of the goal of communicative ability. Depending on the need for clarity, we can concentrate on different parts of the map.

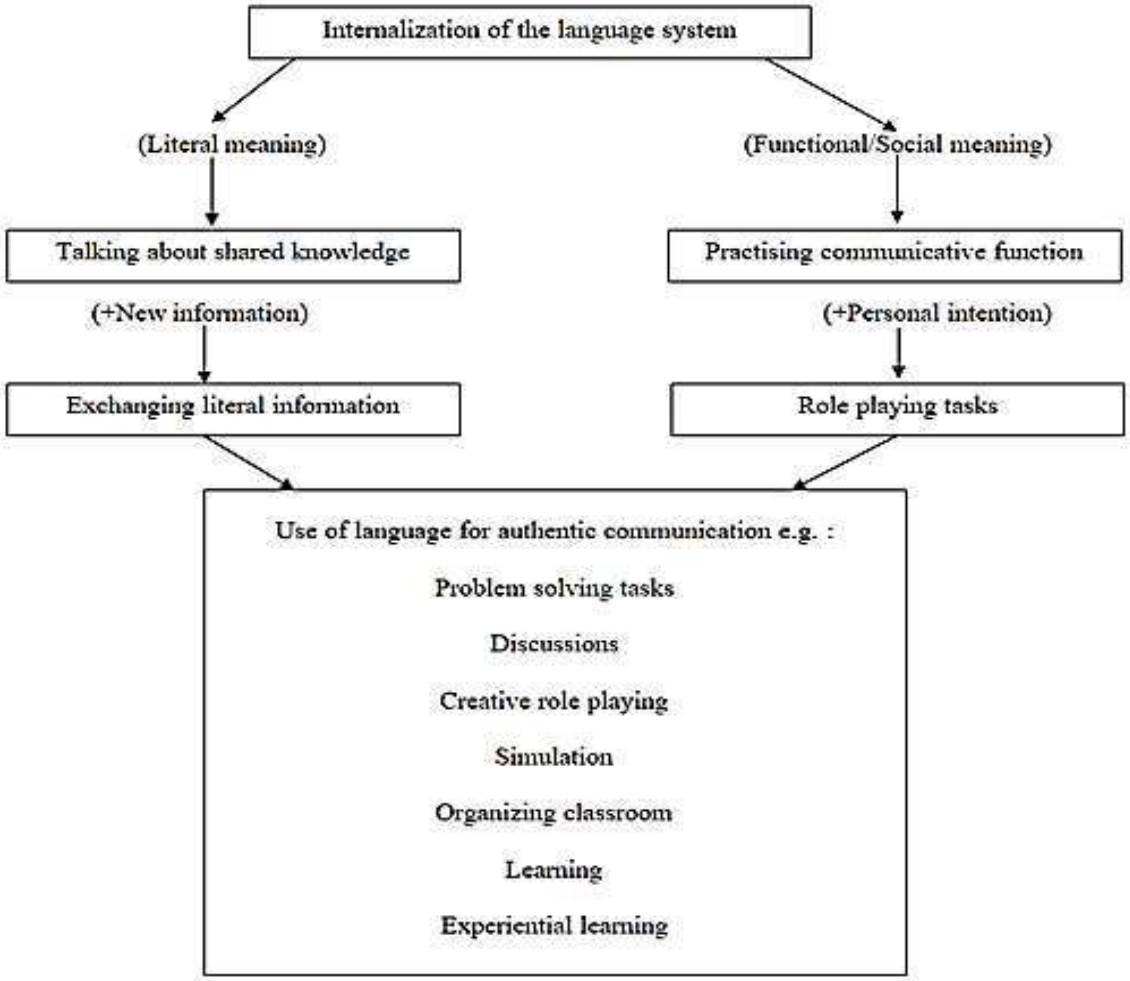


Fig3. (Adopted from Littlewood, 1992:80)

The top and bottom boxes in the framework describe two aspects of the goal toward which the activities must lead. The language system has to be internalized and it has to become available for the communication of meanings. Activities may either solely deal with aspects of the new language system or focus on engaging the learners in authentic communication. In between these two boxes, there are components whose function is to help learners form links between language and the meaning it expresses.

Internalization of the language system is important because it ensures achievement of goal of all language learning activities. In another sense, it describes a component of the methodology for achieving this goal.

If the learners are unable to discriminate sounds, if they confuse tenses while speaking, some part of their learning time should be devoted to mastering the relevant points of the language system.

Materials for developing Reading skills

Learners need practice in understanding clearly stated information. They should be able to distinguish between the main ideas and supporting details in a passage. As a matter

of fact, mostly we read for meaning and in order to extract meaning from the text, we have to find out a variety of skills. According to Munby[16] some important skills are:

- Identifying the script of a language
- Comprehending the meaning and use of unfamiliar lexical items
- Extracting explicitly stated information
- Exploring and comprehending information when not explicitly stated
- Comprehending conceptual terms
- Identifying communicative value of sentences and utterances
- Understanding the formation of sentences
- Understanding parts of a text through lexical cohesive devices
- Understanding cohesion between parts of a text through grammatical cohesive devices
- Identifying relevant literature and preparing reference
- Scanning to identify especially required information
- Converting information to diagrammatic display.

Materials for the development of writing skills

These days the teaching materials for writing skills development are one where the stress is on the process of writing, or on the stages of development of writing. The composing or pre-writing and drafting stage gives tasks that help the learners to make rough plans; formulate mental outline, and develop a sense of direction in writing. For example, some exercises help in brainstorming ideas, making mind maps, selecting and focusing information, organizing points, imagining dialogues etc. The materials required for the teaching of writing skills can be classified into two kinds: those published in books and those which are developed by the teacher. When we discuss the first kind of materials, we should be aware that their usefulness depends not only on the intrinsic pedagogical value of each task, and the organization of each task into a coherent unit but also on their suitability for the students. There might be tremendous scope for the interpretation and adaptation of teaching materials for particular teaching purposes. The important features of the materials for writing skills should be like the following:

i) Analyzing tasks that promote writing skills in terms of their objectives
ii) Adapting tasks for different purposes
iii) Choosing materials for different purposes
iv) Exercises are presented in such a way as to give guidance to the teacher for a graded movement from controlled through guided writing to free writing
v) Exercises are presented to give guidance to the teacher to move in terms of the processes of writing or in terms of the stages of writing

Evaluation of materials

Before evaluating it is of great significance to understand that the prescribed ELT curriculum for evaluation is governed and controlled by National Curriculum & Text Book Board (NCTB) and is compulsory for classes IX to X. These materials are in the form of a readymade text and have been developed by English Language Teaching Improvement Project (ELTIP) jointly funded by Government of Bangladesh and DFLD of the UK Government. The present materials have been evaluated based on ones by McDonough and Shaw[17]. In this context, it is necessary to consider three levels of evaluation which are external evaluation, internal evaluation, and overall evaluation.

External and Internal Evaluation

An overview of the organizational principles involved is gained through the external evaluation of materials. A comprehensive, external overview of how the materials have been organized will be provided by the criteria for evaluating materials. The following queries can be made as a part of the external evaluation of the text: The intended audience, the proficiency level, presentation and organization of units and lessons, book map, layout and presentation, specification, etc.

Internal evaluation entails an in-depth investigation of materials. It is more detailed and comprehensive compared to external evaluation. A detailed internal evaluation of the materials is done to see how far the materials are questioned match up with the aims and objectives of a given teaching program. The following queries can be made as a part of the internal evaluation of the text: Grammar-based, skills-based, situation or national functions, Grading and sequencing of the materials, authenticity, space for self-study, interesting/ motivating, etc.

An overall evaluation is determined by the usability factor, teaching factor, learner ability factor, adaptability factor, flexibility factor, etc.

Adaptation of Materials

The effective use of materials and material adaptation intends to focus on the certain specific context of common strategies visible in material adaptation to see what works in the classroom. Adaptation is needed to modify the materials considering the learners' needs and levels. This takes into account the range of variables operating in a teaching setting as well as the priorities of the teacher. But some commonalities persist in a large number of teaching contexts. A widely held perception is that materials should aim to be in some sense 'communicative' and 'authentic'. Time is another reason for adaptation. If there is a shortage of time to go into details of all the items, the teacher adapts the materials in many ways to complete it within the given time.

Adaptation may attempt to meet the following objectives

i) To apply material adaptation strategies of simplification and re-sequencing.

ii) To design tasks as a take off point for greater interaction activities.
iii) To empower teachers to report more about their teaching contexts and other factors relate to their professional concerns.
iv) To evaluate impact of adapted materials in the classroom context.

It is expected from the teacher to share their teaching experiences in order to adapt teaching materials to facilitate adequate learning outcomes.

Principles and procedures of adaptation

Principles and procedures can be viewed as another kind of matching process or 'congruence', where techniques are determined in accordance with the characteristics of the materials that need authenticity. It is also possible to adapt content using a range of techniques; or conversely a single technique can be applied to different content areas.

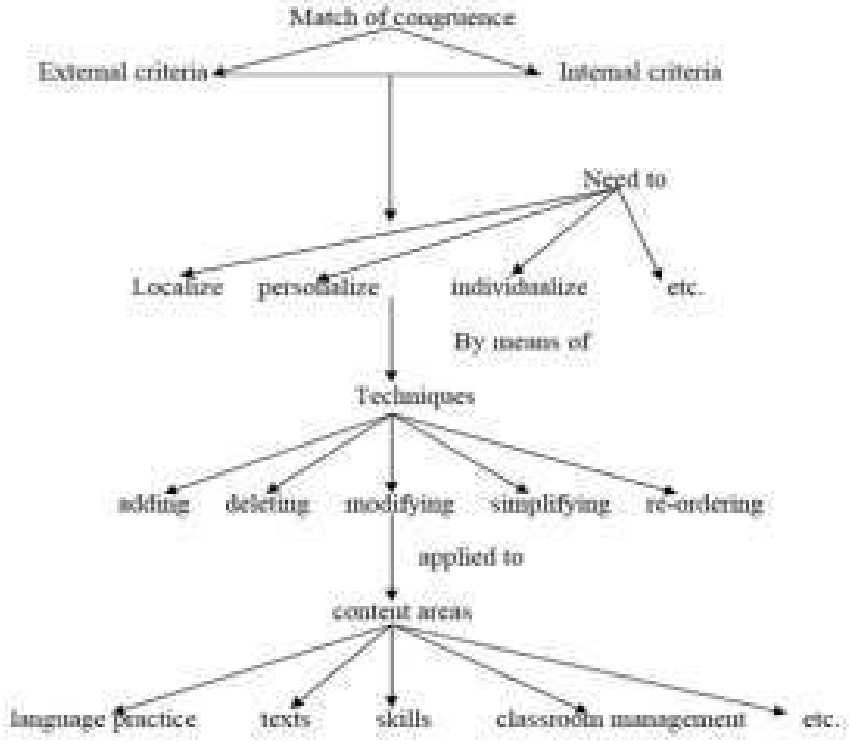


Fig4. (Donough. M.J. & Shaw. C. 1993)

Adaptation can have both quantitative and qualitative effects. Finally, techniques can be used individually or in combination with others, so the scale of possibilities clearly ranges from straight forward to rather complex. (fig4)

A Framework of Materials in Adaptation

The figure shows a framework which can be used to categorize the main possibilities for adaptation.

Adapting materials for teaching listening skills

The passage has been taken from the text book, *English for Today*, prescribed for class IX-X students of Bangla medium schools in Bangladesh. The teacher wanted to use the

text in order to focus on the listening skills. A teacher trying to teach this text in his/her class reported the following difficulties in handling the text,

i. The text is quite long for one listening class of 40 minutes.
ii. It has too many unfamiliar words.
iii. It has long sentences and students may not grasp the whole sentence.

Adaptation strategies

i. The text can be separated into two smaller manageable parts. One part should be used for one listening session at a time.
ii. Some of the unfamiliar words should be discussed beforehand.
iii. The teacher should read at a slower pace, with longer pauses. The text should be read twice or more if possible.
iv. When the unfamiliar words are being explained, the teacher should remember not to use words more difficult than the one which are being explained.
v. Sometimes a picture can say a lot more than words.
vi. The teacher could exploit the same activity for teaching writing.
vii. It is planned to read the text aloud by the students, the pronunciation of the words can be checked.
viii. The teacher should read the text slowly with longer pauses and time himself. He should not run out of time.

Adaptation materials for speaking skill

Generally, it is observed there is no passage in the textbook that is especially designed to teach speaking skills. So, he needs to exploit a reading passage to teach speaking skills. Here are some of the comments given by the students after this attempt:

i. I liked the way the teacher allowed us to speak in the class.
ii. I didn't get a chance to play any role.
iii. The pair work was great fun. Thank God there were no questions to be answered.
iv. Some words are very difficult to speak.
v. The sentences were too long to speak.

These comments suggest that the teacher could have been careful about certain things like.

i. Practicing pronunciation of some difficult words beforehand
ii. Covering longer sentences into shorter ones.

By adapting the text, the teacher managed to do some good things as well. For example: the teacher should

a. Involve most of the students in the activity.

b. Made the activity enjoyable for the class.

Adapting Materials for Teaching Reading Skills

Given below are some authentic activities of the secondary school teachers on what they do while using materials for teaching reading:

i. Translate the text for the students.
ii. Give the meaning of the words before starting the reading.
iii. While reading, give examples from famous movies related to the context.
iv. While reading, ask students to stop at certain point and ask them questions
v. Instead of reading from the beginning, ask the students to read the end part first and then ask them to guess what the story is about.
vi. Ask the students to read and answer the questions at the end of the text.
vii. Teacher could ask the student to underline the most important sentence in each paragraph.
viii. Another strategy that the teacher could use is to jumble up the main ideas of the passage and ask learners to rearrange them in the proper sequence after they have read it.

Adapting Materials for Teaching Writing Skills

The adaptation of materials for writing the teacher needs to think of the level of students, number of the students, objective of the lesson etc. It is observed that the teachers use only the letter given in the textbook to illustrate formal letters. They generally ask the students to write a similar letter by replacing certain words/phrases/sentences. Now, if the aim is to concentrate on the structure of the formal letter, the teacher might like to make to specify the tasks on the solution ending or the body of the letter. It also may be useful to deal with different parts of letter writing separately. Some of the good points of the task are:

i. Good scope for brain storming and developing ideas.
ii. Suitability of the topic for the particular age groups.
iii. Helpful suggestions on how to approach the task
iv. Some organizing ideas before writing in an important sub-skill. The teacher could make it a part of the actual task.
v. One way in which this task may be made more interesting would be to let the learners correct/edit one another's draft.

Conclusion

The present article deals with the principles and procedures of producing, evaluation of teaching materials. In learning a second or foreign language, materials are of utmost importance. Without relevant materials it will not be possible or feasible to teach the language. Therefore, materials have to be carefully selected and developed based on adequate criteria.

In this article firstly an attempt has been made to describe the basic framework to produce teaching materials. The paper has tried to present the various factors which influence the design of materials. After that the principles of selection and gradation have been taken up, which is followed by the procedures of producing materials. The designing of materials in CLT is about to discuss four skills in details. There may arise some problems with the materials when the teacher will start teaching with the materials. This paper has also discussed on the point of evaluation and use some examples of discuss the evaluation. After evaluation of teaching materials, the question arises of adaptation. The teacher may need to take necessary steps to solve the problems with materials if occurs. Finally, the article shows about the adaptation of teaching materials explicitly.

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Causes and Remedies of Juvenile Delinquency in Islamic Perspective

Hasan S

Abstract

With the increase in the type and level of crime in the modern social system based on science and technology following the fourth industrial revolution, the number of juvenile crimes and criminals is also increasing at an alarming rate. This level is increasing day by day. The issue is deeply debated by society's thinkers, as well as sociologists, criminologists, psychologists, lawyers, politicians, and civil society. Failure and inability to nurture and care for our children and adolescents in a suitable environment and standard is a long-standing problem. Correctional programs for runaway and deviant children in Roman society in the seventh and eighth centuries attest to the presence of juvenile delinquency and delinquency in society since antiquity. Parents, society, and the state are increasingly worried about deviant and delinquent children and adolescents. The first legislative concept of juvenile delinquency emerged in 1891 with the establishment of the Juvenile Court in the State of Illinois and the legal definition of juvenile delinquency. Islam is the only benevolent way of life given by Almighty Allah. Islam has the greatest example of creating a crime-free society. According to Islam, crime prevention is better than crime control. Therefore, Islam does not only take measures to remedy and correct crimes after they have been committed in society; rather, it blocks all avenues of opportunity and possibilities to create crime in advance. If someone indulges in criminal activities and destroys the peace and order of society, then Islam has prescribed severe punishment for him. The reasons behind an adult criminal's crime are different from those of a juvenile or juvenile delinquent. This study explores the necessary solutions to prevent juvenile delinquency in the light of Islam by identifying the causes of juvenile delinquency.

***Keywords*:** juvenile, delinquency, Islamic education, social anarchy.

Introduction

Although the separation of juvenile development and correctional programs and the juvenile delinquency justice system in the conventional legal and social systems was a nineteenth-century effort, Islam adopted the necessary, effective, and sophisticated approach in this regard at the beginning of the seventh century.[1] In order to keep teenagers away from delinquency; Islam mainly emphasizes preventive measures through appropriate upbringing. In order for children and adolescents to grow up free of criminality, Islam has laid down preventive duties on parents, families, society, and the state to establish a society in which no juvenile has the opportunity to develop criminality in his mind. Apart from this, Islamic Shari'ah considers juveniles 'غير مكلف' free from responsibility and accountability, and has adopted individual measures for the correction and development of their crimes. Therefore, it can be said strongly that the guidance of Islam in the prevention of juvenile delinquency, correction, and development of delinquent juveniles in all societies is relevant and fruitful.

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Research Method

This research uses a qualitative approach using the document study method. The study explores the causes of juvenile delinquency using references from primary and secondary sources. Following that, an impact of juvenile delinquency on society and its solution in Islamic perspectives provided. This study is based upon information gathered through scanning news papers, journals, Islamic jurisprudence, books, and browsing the internet.

Juvenile

Juvenile refers to the period of a person's life when he passes through childhood but does not reach adulthood. Juvenile is a person's stage between childhood and adulthood. According to Bangla Academy Dictionary, juvenile means age between childhood and youth; minors; 11 to 15 years old.[2] In Oxford Advanced Learner`s Dictionary: Young people who are not yet adults. *In Merriam-Webster Dictionary*: The period of life when a child develops into an adult: The period from puberty to maturity terminating legally at the age of majority.[3] The "National Child Policy, 2011" of Bangladesh defines the adolescent as "Kishor Kishore: Adolescent means children between the ages of 14 and 18 years." "And children shall mean all persons in Bangladesh under eighteen years of age."[4]

In light of the various definitions mentioned above, we can say that a juvenile is a person who is not yet eighteen years of age and who is passing through childhood and entering adulthood. And from the Islamic point of view, the human child is called a juvenile who has not yet dreamed, and for girls, the one who has not yet menstruated is a juvenile.

Delinquency

Delinquency is a social disease as primitive as human society. Basically, crime is the outward expression of man's inherent evil. Almighty Allah has created man as Ashraful Makhlukat, the best creature of creation possessing many noble qualities. Almighty Allah created Adam (A.S.) as the first man and placed him in Paradise, the place of supreme happiness. But because of disobeying Allah's order and eating sandalwood fruit, he was sent from heaven to earth. The first crime in the history of the world was committed by killing Abel. He began to bleed, till now there are various types of crimes in the world such as murder, theft, robbery, robbery, robbery etc. So it is easy to imagine that crime is as original and eternal as human society.[5] On the other hand, the reaction of people and society towards criminals and criminal activities is natural and eternal. Crime and criminal behavior pique the public's interest, arouse curiosity, and instill in them a desire for social justice and the suppression of crime. And he continues to strive to innovate crime prevention and remedial approaches.[6] Poems, essays, dramas, films, etc. have been produced about the crime and this trend continues. These are basically expressions of the human mind's curiosity about crime, criminal behavior, and its consequences.[7] From a social point of view, crime is an anti-social act. That is,

crime encompasses all activities or behaviors that are contrary to the society's prevailing values, customs, ideas, and ideals. By doing this, all these activities destroy the peace and stability of the overall social life and play a sufficient role in making the social life unstable and chaotic. Again, only the members of the society are used to living in groups. In that case, the crime is any activity that is contrary to the collective life of the people of the society, against the interests of the party, and poses a threat to the party's overall existence. Describing the social perspective of crime, the American sociologist and criminologist Elmer Hurber Johnson (1917 AD) said, Crime is an act which the group regards as sufficiently menacing to its fundamental interests to justify formal reaction to restrain the violator."[8]

According to American Historians and Sociologists Harry Elmer Barnes (1889-1968 AD.) and Negley K. Teeters (1896-1971)- "Crime is a form of antisocial behavior that has violated public sentiment to such an extent as to be forbidden by statute."[9]

Classification of Delinquency under law

Delinquency is mainly divided into three categories depending on the harmful aspect of the crime, the nature of the crime, and the extent of punishment from a legal perspective. Such a hierarchy can be called a "traditional hierarchy": a. Treason) b. Felonies c. Misdemeanors.[10]

A criminologist of Netherlands W. Adrian Bonger classified Delinquency into four categories:

a. Economic Crimes)
b. Sexual Crimes)
c. Political Crimes)
d. Miscellaneous Crimes.[11]

For statistical purposes, various institutions in the United States keep records of crimes divided into two categories. The statistics are kept by the Federal Bureau of Investigation (FBI) and the police department by dividing crime into two categories. Class I offense includes seven main offenses, and Class II offense includes 15 offenses. Crime registrars in the police department are divided into two categories to register crimes.

First Section:

- Culpable Homicide:

(a) Homicide and non-homicide; (b) negligent homicide;

- Rape;
- Banditry and robbery;
- Serious assault and serious injury;
- Stealing
- Theft; (a) theft of more than $50; (b) theft of goods valued at less than $50;

- Theft of a motor cycle or motor vehicle

Second Section:

- Slight assault or injury;
- Forgery and counterfeiting;
- Fraud;
- Receiving, selling, or possessing stolen goods;
- Receiving or possessing illegal weapons;
- Operating a prostitution or brothel;
- Sexual offenses;
- Crimes against family and children;
- Drug law violations;
- Drunken driving;
- Disorderly conduct,
- Gambling;
- Violation of traffic laws;
- Suspicious arrest
- Other offenses[12]

Classification of Delinquency in Islamic Perspective

After mentioning the conventional classification of crimes, the following section will analyze the thinking of Muslim thinkers regarding the classification of crimes. When it comes to crimes, Muslim legal scholars have classified them in a variety of ways. They have divided the crime into the following three categories, depending on the degree of punishment:[13]

1. Delinquency of 'الحد' (Hadd*)*

Crimes for which a cap or specific punishment has been specified, Islamic Shariah has made this limit mandatory. This limit has been determined by Shari'ah; and cognizable crimes are seven. Namely: fornication or adultery, false accusation or slander of Zina, drunkenness, theft, robbery, the crime of apostasy, and the crime of rebellion or treason. The punishment for this crime cannot be waived. Neither the perpetrator nor the injured party can forgive this crime. As in the Holy Qur'an, Allah (SWT) mentions the punishment of adultery and says,

ٱلزَّانِيَةُ وَٱلزَّانِى فَٱجْلِدُواْ كُلَّ وَٰحِدٍ مِّنْهُمَا مِاْئَةَ جَلْدَةٍ ۖ وَلَا تَأْخُذْكُم بِهِمَا رَأْفَةٌ فِى دِينِ ٱللَّهِ إِن كُنتُمْ تُؤْمِنُونَ بِٱللَّهِ وَٱلْيَوْمِ ٱلْـَٔاخِرِ ۖ وَلْيَشْهَدْ عَذَابَهُمَا طَآئِفَةٌ مِّنَ ٱلْمُؤْمِنِينَ -

"As for female and male fornicators, give each of them one hundred lashes, and do not let pity for them make you lenient in ˹enforcing˺ the law of Allah, if you ˹truly˺ believe in Allah and the Last Day. And let a number of believers witness their punishment"[14].

2. Delinquency Under 'القصاص' *(*Qisas*) and* 'الدية' Diyat

Crimes covered by Qisas and Diyat are mainly murder crimes. That is, those crimes that are punishable by Qisas (death or limb loss) or Diyat (bloodshed) are termed crimes covered by Qisas and Diyat. The Shariah of this level of crime is well defined by the donor. For example, the crimes of Qatale Amad, Qatale Shivahi Amad, and Qatale Khata, as well as intentionally or unintentionally causing damage to human body parts, are crimes covered by Qisas and Diyat.

3. Delinquency Under 'التعزير'(Tazir)

Shari'ah has not declared the punishment of all crimes in clear terms, so this level of crime That is, those crimes for which Ta'zir punishment has been provided are the crimes covered by Ta'zir. Apart from the crimes covered by Hadd, Qisas, and diyat, other crimes are covered by Ta'zir. The punishment for the crime covered by Ta'zir is not determined in the Shari'ah, but the matter of determining the punishment is entrusted to the government or its representative, the Qazi. In this case, the government or the judge will determine the punishment of the criminal. But the aggrieved person or party can forgive the offender. But when such a crime is committed against society or the state, neither the government nor the judge can pardon the criminal.[15]

Introduction to Juvenile Delinquency

Juvenile delinquency is a social problem. It has an inevitable presence in all societies. But it is different and diverse in nature and dimensions. Many times, children and adolescents deviate from human values and rush towards criminal tendencies. As a result, an innocent child develops a different identity and nature in a very short time, which identity and nature are not desired by the family, society, or the state. In today's modern social system, what is identified as deviant or delinquent juveniles? Juvenile delinquency is increasing at an ever-increasing rate worldwide, and it can soon become a serious social disorder. This will create obstacles in the way of the overall welfare of a society or state. Mohammad Afsar Uddin said, Juvenile delinquency is a problem that persists in our society; and also all over the world to a perceptible degree. The problem has been given so much added emphasis in recent years that some are included to believe that a variable epidemic of delinquent behavior among juvenile has engulfed the whole society.[16]

The development and progress of the country and nation depend on the development and progress of children and adolescents. Therefore, the role of family, society, and the state is immense in the healthy and normal development of children and adolescents. No one wants a section of them to be associated with crime for any reason, posing a serious threat to future generations and hindering healthy social life. Although juvenile delinquency is generally defined as criminal acts committed by minors, even this concept does not adequately explain juvenile delinquency. Because, just as there are differences in criminal acts based on society and culture, there are also differences between societies and countries in terms of the exact age at which a boy or girl is considered a juvenile. Mohammad Afsar Uddin said, the concept of juvenile

delinquency has been vaguely and imprecisely defined in many countries; a clear definition would be most useful in the formulation of workable programmes for the prevention of juvenile delinquency. In finding out a workable definition, it should be remarked that juvenile delinquency is not a mere legislative concept as it is sometimes taken to be. After the Industrial Revolution, juvenile and adult crime levels continued to rise. As a result of industrialization and urbanization, along with social progress, various problems arise, one of which is the increase in crime. During this time, there is a change in human attitudes towards crime, crime prevention, and the justice system. The inevitable consequence of this is the need to analyze juvenile delinquency from a different perspective.

In 1484, William Coxon first used the term 'Delinquent' to describe the common offense of a guilty person. Also in 1605 English poet Shakespeare's famous play 'Macbeth' uses the term.[17]

In Oxford Advanced Learner`s Dictionary, "Delinquency, Crime, usually not of a serious kind, especially as committed by young people" and Juvenile Delinquent is A young person, not yet an adult, who is guilty of a crime.[18]

Hang Chung Mo said, "Delinquency is nothing but an act of non-conformity to community standard."[19]

Hence, it can be seen that juvenile delinquency is a broad term. It also includes all kinds of rebellious and violent activities by teenagers. Even acts of begging, obscenity, stealing money from parents, drinking drugs, playing cards, gambling, etc. are included in juvenile delinquency. In fact, all types of anti-social behavior by juveniles, including anti-criminality, are juvenile crimes, which can become serious if not corrected in time, and after reaching adulthood, someone can be labeled as an adult offender.

Juvenile Delinquency in the eyes of Islam

According to Islam, adolescence is an important part of human life. With the end of this chapter, various Shariah rules and social responsibilities are imposed on every human child. Until then, teenagers were considered exempt from the obligation to obey the rules of the Ghair Mukallaf or Shari'a. Ali ibn Abi Talib reported: The Messenger of Allah, peace and blessings be upon him, said, "*The pen is lifted from three people: a sleeping person until he awakens, a child until he becomes an adult, and an insane person until he regains his sanity.*"[20]

In the light of the above Hadith, we can say that the Hudud and Qisas level punishments prescribed by Shari'a are not applicable to juveniles due to violations of Allah's rights or human rights. However, there is a directive in Islamic law to give them corrective Ta'zir punishment in the public interest and to maintain social order. Because Ta'zir will be effective on any intelligent criminal, regardless of gender, whether male or female, Muslim or non-Muslim, adult or minor.

Causes of Juvenile Delinquency

All over the world, social thinkers, sociologists, criminologists, psychologists, and social reformers have always been particularly concerned with juvenile delinquency. They are working in various ways to control this problem. They are trying to find an explanation for this problem from different perspectives based on different beliefs. American Sociologist Heney Donald Mckay (1899-1980 Ad.) said in his book, 'Juvenile Delinquency in Urban Areas', *In modern society, there are many alternative learning processes in place, in which a child has to get used to a multi-faceted learning process in order to achieve his goals, which can create conflict in his mind. Criminality arises from emphasizing the successful achievement of the individual's desired goals rather than emphasizing the general values of the social system.*[21]

Walter B Miller (1920-2004 Ad.) said in his book, "Lower Class Culture as a Generating Milieu of Gang Delinquency", There are six important factors that drive low-income children and adolescents into delinquency: lower class pre-occupation with Trouble, Toughness, Smartness, Excitement, Fate and Autonomy tends to encourage delinquent behavior among the adolescents as they ardently seek to gain status and solidarity with other lower class boys.[22]

Criminologists, sociologists, psychologists, and jurists have identified the causes of juvenile delinquency in the light of various points of view. The causes of juvenile delinquency are: unhappiness, unstable adolescent emotions, adolescent sexual experience, emotional conflict, love, adultery, pornographic films, low-quality entertainment, job dissatisfaction, becoming emotional, physical limitations, etc.[23] The famous psychologist Sigmund Freud The famous psychologist Sigmund Freud emphasized the human psyche rather than the external environment in investigating the causes of juvenile delinquency.[24] A few theories are highlighted below in determining the causes of crime:

Hereditary or Constitutional Theory

Among the approaches to the investigation of the causes of crime, the biological approach is relatively ancient. The father of modern Criminology Cesare Lombros said, "A typical criminal could be identified by certain anatomical traits such as slanting forehead, abnormal size of ears, irregular arrangement of teeth and so on."[25] Heredity or inherited biological characteristics is one of the causes of juvenile delinquency. Biologists believe that a person's mentality, attitude, behavior, thinking etc. are determined through heredity. Physical and mental birth defects hinder the normal development of children and adolescents. As a result, at one time they got involved in abnormal behavior and criminal activities.[26] Proponents of the biological perspective believe that if five of the above defects are present in children and adolescents, they are more likely to engage in delinquency.[27]

Psychological approach

Psychological factors also have a special influence behind the creation of crime. If there

is no proper development of human personality and mentality, criminality can be created in the person. The originator of this theory is Sigmund Freud.[28] According to Freud, human beings have basic instincts: life Instinct and death Instinct. The life instinct is active at the root of human needs of hunger, thirst, sexual desire, and love instinct. The life instinct acts as an indomitable motivation or driving force for man to survive, to increase his progeny and above all to maintain his existence. Earl Rabb and Gertrude J Selznick said, the structure of a delinquent personality has been identified as follows: (a). Suffering from emotional deprivation; (b). Failure in respect of internalizing moral principles and emotional reasons; and (c). Aggressive response towards authority.[29]

The above factors may be directly or indirectly active in juvenile delinquency. But the main and main cause of juvenile delinquency is mental. Because all human actions are according to the mind's plan. As it was narrated from the Prophet (SAW) that, *"Actions are (*judged*) by intentions (*niyyah*), so each man will receive what he has intended for."*[30] And if the mental development is not completed in a proper and beautiful process, there is an adverse effect on the behavior of children and adolescents, which leads them to delinquency. Allah (SWT) says:

وَنَفْسٍ وَمَا سَوَّىٰهَا۔ فَأَلْهَمَهَا فُجُورَهَا وَتَقْوَىٰهَا۔ قَدْ أَفْلَحَ مَن زَكَّىٰهَا۔وَقَدْ خَابَ مَن دَسَّىٰهَا۔

"And by the soul and ˹the One˺ who fashioned it, then with ˹the knowledge of˺ right and wrong inspired it! Successful indeed is the one who purifies their soul, and doomed is the one who corrupts it!"[31]

Prophet (SAW) said, "*There is a piece of flesh in the body if it becomes good (reformed) the whole body becomes good but if it gets spoilt the whole body gets spoilt and that is the heart.*"[32]

Economic perspective

One of the main causes of crime is economic instability. Again, an abundance of money also creates criminality. Unequal distribution of wealth, unemployment, poverty, inflation, etc. lead to economic instability. As a result, various types of crimes or misdemeanors are committed in society. Theft, robbery, robbery, prostitution, and property crimes are caused by economic reasons. The proponents of this doctrine are Karl Marx (1818–1883 AD) and Friedrich Engels (1820–1895 AD), the fathers of socialism. According to Karl Marx, economic factors are at the root of all crimes, including juvenile delinquency.[33] According to them, theft and robbery are not only done by poor people. Instead, the big industrialists cheat and loot.

Geographical perspective

Historians, sociologists, and psychologists consider human behavior to be particularly dependent on geographical influences. As criminal behavior is a type of human behavior, the influence of geographical factors on it cannot be denied. Because

geographical influence on social life is so vast, it affects everything from population to clothing, food, and drink, economic life, trade, health, birth, death, marriage, religion, art, literature, politics, the rise and fall of civilizations, etc. This effect cannot be denied. This doctrine is close to the concept of juvenile delinquency.[34] This doctrine is close to the concept of juvenile delinquency. This was originally established by Clifford. Their argument is that it can be seen that the crime rate is much higher in urban areas than in rural areas. Crime tends to decrease with increasing distance from the heart of the city.

Sociological perspective

Criminologist and sociologist David Emile Durkheim was the first to discuss the 'sociological approach' in analyzing the causes of crime and juvenile delinquency. He said, The more weakened the group to which one belongs the less one depends on it, the more one consequently depends only on oneself, one recognizes no other rules of conduct than what are founded on one's private interests.[35] Criminals are indifferent to social norms and engage in alternative pursuits. The theory of social control arose mainly in the wake of social chaos and complexity. In the face of ever-new scientific discoveries and technological developments, families, religious institutions, and local communities have been able to play a less effective and cohesive role. People born into a family do not only inherit the property of their parents; rather, they learn the practical rules of the family and imbibe social values. Today, the modern family in urban areas has become an unimportant center for children's activities, play, and mental development. As both parents are busy working outside the home, they cannot give enough time to the children. As a result, the child fails to learn politeness, courage, ethics, and social values. Thus, the family is gradually losing control over the children and adolescents.

Religious views

Some criminologists, sociologists, and historians have analyzed the religious aspect of society in determining the causes of juvenile delinquency. They specifically blame society's irreligion or non-observance of religious rituals for juvenile delinquency. In determining the causes of juvenile delinquency, noted British historian Arnold Toynbee pointed out that "religion is as much a cause of juvenile delinquency as any other delinquency today."[36] Abstention from religious rites, morals, religious activities, in a word, irreligion is the source of juvenile delinquency. Abu Huraira (RA.) reported: The Prophet, peace and blessings be upon him, said, **"***No child is born but that he is upon natural instinct. His parents make him a Jew, or a Christian, or Magian. As an animal delivers a child with limbs intact, do you detect any flaw***?"**[37]

The Learning Theory

The teaching doctrine in the case of juvenile delinquency is that, just as children and adolescents naturally learn normal behavior and speech from family, society, and the state, deviant and criminal behavior also learns from family, society, and the state. If other adult members of the family are engaged in immoral or anti-social activities, juvenile delinquency problems in the family have an opportunity to develop. If any

family members are involved in criminal activities like smuggling, drug trade, money laundering, usury, bribery, etc., then the children of that family will also be involved in the same profession. If there is delinquency among the elder children of the family, then the delinquency also spreads among the younger ones. In this regard, sociologist Abdul Hakim Sarkar said, *"The child sleeping in the same room with its parents sees and overhears things from which the better to do are shielded. Seeing and hearing this shadow of father jealously fall across the young and impressionable mind. It is suppressed and ferments in the conscious. But it is not suppressed forever. Under some sudden stress, if emerges not as hatred of the father, but of authority generally, the policeman or even law-abiding citizen."*[38]

Anomie Theory

Anomie means Personal deviation or transgression from any of the social norms and values in which a person fails to conform to the behavior of the society. It was first presented by French sociologist Emile Durkheim in 1893 in his famous book, "The Division of Labor in Society," The idea of anomie means the lack of normal ethical or social standards. The concept first emerged in 1893, with French sociologist Emile Durkheim. Durkheim`s theory was based upon the idea that the lack of rules and clarity resulted in psychological status of worthlessness, frustration, lack of purpose, and despair.[39] He points out how the rules are followed or acted upon by one, and how the rules are broken or destroyed by the other. As a result, people cannot decide how to treat each other. As a result, he believes, Anomie is a condition in which the standard or expected behavior of human behavior is not clear.

Broken Family

Family is the most important element of social structure. Parental conflict, death, divorce, child neglect, lack of family discipline, etc. disrupt the mental development of children and lead them to an abnormal life. In modern single-family households, children often do not have access to their parents and are deprived of parental love and family education. In many urban single-family households, both husband and wife are employed. Education from mother and father is necessary for both children, but unfortunately, children are deprived of the necessary love, family values, and moral education. As a result, the proper mental development of the child is disrupted. The divorce problem is another important issue for children. The prevalence of divorce is depriving countless children of a normal life, parental affection, and social education at the same time. Such neglected children and adolescents may become delinquent through abuse and exploitation by older offenders.[40]

Insufficient Parental Care and Guardianship

Parents are the best teachers and guides for children. In the socio-economic context of Bangladesh, most of the parents are day laborers or laborers, so they are deprived of learning social values. As a result, due to poverty on the one hand and a lack of adequate values and moral education on the other, parents cannot pay proper attention to their children. They spend most of their time in pursuit of their livelihood. As a

result, children are deprived of their parents' affection, love, moral values, and discipline. Both rich and poor family members often work away from home and fail to give their children the love and time they need. This period of parental companionship is spent with the child's or teenager's other companions. Deprived of guardianship in the absence of parents, children come into contact with bad companions and engage in risky, illegal activities.

Lack of family values

The majority of families in our social system are from the ruling or working classes. Even if they have proper human values, the practice of those values is disrupted due to scarcity. Again, the upper class adopted more corrupt and immoral methods to gain more wealth and influence. For good reason, a lack of values is observed in these families as well. In this situation, their children's basic morals and ethics are very poorly developed. And children who grow up in such a fragile state of mind can become delinquent.

Low quality of education

Most of the children of poor families do not have access to education. Due to the lack of basic education, the difference between good and bad in individual lives, as well as the good and bad necessary for society and the state, has not been developed. As a result, they do not understand the difference between right and wrong or good and bad in most cases. Usually they are devoid of constructive good sense or ideas and involve themselves in immoral activities.

Child cruelty and neglect

50% of children receive cruel treatment from their parents. A parent physically harms a child for no reason. The child is often subjected to cruelty and neglect by the stepfather or mother. It is often seen that the father's second wife or stepmother shows disrespect and neglect towards the child as compared to her own child because of the death of the child's mother—even physical abuse. As a result, the future of the child becomes uncertain due to the cruelty, disrespect, or neglect of the parents towards the child. Because the behavior of the parents greatly affects the life of the child, any of their negative behavior helps the child develop a negative life philosophy.

Impact of Juvenile Delinquency on Society

Juvenile delinquency has multifaceted effects on our society. Understanding these influences is essential to combating juvenile delinquency. A discussion about this is presented below:

Theft

Analyzing data from a survey conducted among residents of juvenile development centers shows that theft is an almost universal and novel crime. Every teenager is habitually involved in stealing small amounts of money or valuables from their homes. In some cases, it is seen that some of the residents have stolen mobile phones, houses,

jewelry, and large amounts of money (from 5,000 to 20,000) from their homes. But in most cases, they have been involved in thefts ranging from Tk 50 to Tk 1000. It can be seen that about 25% of teenagers steal from other people's houses in addition to stealing at home.

Pickpockets

A significant number of juvenile offenders have admitted to involvement in criminal pick pocketing. From the words of the inhabitants, it is understood that they do not habitually pick pockets. Rather, they pickpocket under the leadership of a professional pickpocket. They pick pocket a particular person or group in a cinema hall, market, or other crowded place.

Robbery

The description of the residents of the development center shows that many of them were involved in looting. Most of the time, their parents knew nothing about their abduction. According to their description, the robbers blocked the way of pedestrians or small transport and threatened with firearms, knives, or bombs, etc., and robbed the person or persons of everything.

Wandering aimlessly on the streets, looting, and vandalism

According to the information provided by the criminals, they roamed the streets aimlessly in gangs without any reason. This group of teenagers is usually associated with a local gang. All these teenagers believe that any problem they have will be solved by this circle of older brothers in the neighborhood. So they get involved in more exciting adventures and activities.

Smoking

Many of the delinquent boys were regular smokers. According to research, a large proportion of boys enjoy smoking because they believe that a cigarette keeps them company, removes any mental worries, and that they can sometimes take the right plan in implementing something through smoking. According to them, smoking is proof of their competence, cleverness, and smartness. Many of them mentioned that they got used to smoking after seeing their friends smoke.

Teasing girls

Criminals have been involved in loitering and harassing girls in various ways on the streets. Teenagers' wandering around the streets and eve-teasing girls is a major deviant behavior. It is observed that the youth, along with his friends, take a position from the east at a certain place or junction of the road near the school or college and engage in various indecent acts in groups on the way out of the school or college vacation. Many times a girl is targeted by rude behavior or gestures, blowing kisses, and other noises to annoy her.

Sexual harassment and provocation

Analyzing the data obtained from the residents of the juvenile development centers, it is found that a significant number of the residents have been involved in various forms of sexual harassment and sexual abuse. According to a 14-year-old boy's account, he was caught by the police and reported to a juvenile development center after a family conflict that he had planned for a long time, first playing love and then trying to rape. She also narrates that she did not succeed in the rape; before that, people came and beat her up and handed her over to the police because of the shouting. In addition, some boys also admit to freely visiting prohibited brothels.

Gambling

A common habit of boys in juvenile development centers is gambling. According to them, they can easily deceive themselves and others by playing cards and passing the time happily. Many of the boys are mentioned in the narrative as playing cards or gambling. So it can be understood that they play cards with two or more close friends for gambling or other bets. Besides, some of the boys mention that they have also taken part in gambling by going to various fairs or quizzes that are traditionally celebrated.

Drug taking and trafficking

In the light of the information provided by the residents of the development center, it can be seen that many of them were addicted to drug dealing as well as drinking or taking drugs. Some of them were found to be drug addicts. From their narratives, it is revealed that initially they took mildly intoxicating drugs and gradually got used to taking drugs. According to research, most of them are motivated to use drugs by friends. Some also report taking drugs to relieve depression or emotional distress.

Smuggling

Some of the delinquent boys were found to be involved in smuggling. Adolescents living in development centers, especially children and adolescents from border areas are more involved in this smuggling. Some of the residents of the juvenile development centers were involved in money laundering, gold smuggling, dollar smuggling, drug smuggling, and other smuggling activities. According to their description, they were involved in this work on behalf of a local influential senior criminal and worked for him.

Murder

The level of complicity in child and adolescent homicides is very high nowadays. Analyzing the information received from the residents of the juvenile development center, it is found that the cases of murder by children and adolescents are increasing day by day. Currently, approximately 16.61% of residents in juvenile development centers are involved in resident homicide. This is an ominous signal for society. A maximum of 18.55% of residents were involved in theft and robbery. Moreover, about 15.00% of resident juveniles have been involved in violence against women and children. Apart from this, at present, children and teenagers are being arrested in

various weapons cases. A total of 38 residents of the juvenile development center have been involved in weapons-related crimes. So it can be said that children and teenagers are involved in minor crimes as well as major crimes, including murder.

Islamic guidance in preventing Juvenile Delinquency

Every person wants to live peacefully in society. Everyone wishes that society be free from crime, but some people commit crimes by taking advantage of others and destroying social peace. Therefore, according to Islamic doctrine, it is the responsibility of the society and the state to keep the society free by uncovering the reasons why the crime of the cell takes place. To keep the society free from the crime of sin, the society, the state, and the people are discussed in the example of Islam:

The right to a holy birth

Islam has instructed parents and guardians to take the necessary moral precautions prior to the birth of their child in order for the child to live a crime-free life. For this purpose, Islam has given importance to the honest earnings of parents. So that the effect of righteous earnings on the child of said parents is reflected, and the child can pass from the mother's womb to childhood and adolescence without guilt. Because parents' ill-gotten gains have a direct impact on children, which pushes them towards crime. The main and only condition for childbirth is that the marriage must be performed legally. Allah (SWT) speaks about the purpose of marriage:

وَٱللَّهُ جَعَلَ لَكُم مِّنْ أَنفُسِكُمْ أَزْوَٰجًا وَجَعَلَ لَكُم مِّنْ أَزْوَٰجِكُم بَنِينَ وَحَفَدَةً وَرَزَقَكُم مِّنَ ٱلطَّيِّبَٰتِ۔

"And Allah has made for you spouses of your own kind, and given you through your spouse's children and grandchildren. And He has granted you good, lawful provisions."[41]

Non-discriminatory treatment of children

According to Islam, all children have the right to non-discriminatory treatment. Islam does not allow any discrimination between children. Whether it is a girl or a boy, everyone has equal status with their parents. A narrator (*Rawi*) said: *My father went then to the Prophet (ﷺ) to call him as a witness to my Sadaqah (gift) and he asked, "Have you done the same with all your children?" He replied, "No." He said, "Fear Allah and treat your children equally." My father then returned and took back that gift.*[42]

Properly nurtured

The right of every child and adolescent to be properly nurtured is an important issue. He deserves this right from his parents and the state. Both parents have special responsibilities in child rearing. That is why they should keep a careful eye on every aspect of the children, take proper care of them, provide proper food for them.(United Nations, 1989)According to Islam, raising children is a reward. Allah says:

وَعَلَى ٱلْمَوْلُودِ لَهُ رِزْقُهُنَّ وَكِسْوَتُهُنَّ بِٱلْمَعْرُوفِ-

"The child's father will provide reasonable maintenance and clothing for the mother during that period."[43]

Rasulullah (SAW) said, "*Love children and show kindness to them*."[44]

Provide proper education

Islam has made education a part of worship to encourage universal education so that every Muslim is committed to learning. The first verse of the Quran was about education or enlightenment. Almighty Allah says in the first verse revealed to the Messenger of Allah (SAW):

ٱقْرَأْ بِٱسْمِ رَبِّكَ ٱلَّذِى خَلَقَ-

"Read, O Prophet, in the Name of your Lord Who created."[45]

In another hadith it is said about the importance of enlightenment, Muawiya (Ra.) said, I heard Allah's Messenger (ﷺ) saying, *"If Allah wants to do good to a person, He makes him comprehend the religion. I am just a distributor, but the grant is from Allah."*[46]

Creating an environment for practicing worship

Ibadah has an active influence in forming an ideal man and preventing crime. Ibadah is called obedience to Allah Almighty with modesty and humility. In every aspect of life, Ibadah is the name of following the commands and prohibitions of Allah (SWT) properly.[47] The basic worship of Islam namely Salat, Sawm, Hajj, Zakat is presented in a special training process for people.

Moral development

The moral development of children and adolescents depends on the education of the family, society and educational institutions, but the role of the family is paramount. It is the duty of everyone in the society including parents to teach moral values to children and teenagers by avoiding immorality themselves. If parents and elder members of the family follow the morals, children and teenagers follow them. In this way children and teenagers will become ideal people one day. The Messenger of Allah said:*"There is no gift that a father gives his son more virtuous than good manners."*[48]

Ensuring physical and mental development

It is necessary to ensure the necessary environment for the physical and mental development of children and adolescents. In this context, the United Nations Children's Rights Charter states that for the physical and mental development of the child, the state shall recognize the importance of the activities of the media and present various types of national and international information and content to the child, especially information and topics that will promote the child's socio-emotional welfare and

physical and mental health.[49] The role of food is most important in the physical and mental development of the child. That is why Islam has given special importance to the child to drink mother's milk. In addition, Islam has ordered to play with the child, behave well and teach good manners for the mental development of the child.

Provision of sports, literature and culture for intellectual development

If an environment for sports, literature and culture is created for every teenager in the society, they will be encouraged to lead a healthy life without indulging in vices. They will keep themselves busy in all efforts to develop the latent talents within them. This will reduce the crime rate. Messenger of Allah (ﷺ) said: "*Allah, Most High, will cause three persons to enter Paradise for one arrow: the maker when he has a good motive in making it, the one who shoots it, and the one who hands it; so shoot and ride, but your shooting is dearer to me than your riding. Everything with which a man amuses himself is vain except three (things): a man's training of his horse, his playing with his wife, and his shooting with his bow and arrow.*"[50]

Keeping a friendly relationship between parents and family elders with children

Islam has instructed parents and other elderly family members to behave in a friendly manner towards children and adolescents. A parent's duty is to gain the trust of their teenage children and make them friends. So that children and adolescents do not feel lonely and can open up to their parents or guardians about their problems and needs. No complications or mental incoherence arise in their minds. As a result, these teenagers are able to save themselves from injustice and criminality.

Do not over-punish

Too much rule and strictness never produces good results. Boys and girls who are subjected to beatings and discipline lose their sense of shame and fear no one. Moreover, it can be observed that more beating does not bring any special benefit in most cases. Rather, its results are bad.[51] Islam enjoins the gentle and gentle treatment of children for the protection of children and adolescents and for leading a crime-free life. If it is possible to bring up children and adolescents in this great teaching of Islam, no kind of pride will be created in them and there is no possibility of any crime arising from it.

Assist in friend registration selection

Friends are an integral part of today's youth and youth society. Today's boys and girls cannot imagine their life without friends. Adolescents at this age want to move independently, free from family influence, and socialize with neighbors, playmates, and peers. Through such relationships, children and adolescents can learn things very easily and spontaneously, which cannot be done from parents, relatives or family members. if any of the partners are dishonest or criminal, under their influence, teenagers often become criminal. That is why Islam has emphasized on careful selection of friends. The Prophet (ﷺ) said: "*A man follows the religion of his friend; so each one should consider*

whom he makes his friend."[52] Therefore, the parents of children and the society should monitor who their children are associating with.

Conclusion

The Juvenile are the most important members of society, but they are also the most helpless and vulnerable. They are physically weak as well as mentally tender. So at this time, they need special care and attention from family and society. Special care and attention for children and adolescents play a major role in creating their mental strength and developing their psyche. The role of family and society is especially important in this case. A child's childhood and adolescence are spent in the family and society, and all the education and initiation necessary for later life are acquired during this period. Adolescent and child deviance, delinquency, and criminality are instincts derived from society. Therefore, it is the basic responsibility of the family and society to try their best to correct their delinquency rather than criminalize it. Apart from this, the analysis of the reasons for children and adolescents becoming delinquent shows that no child is born a criminal by birth, but his family and society lead him to crime. Therefore, the family and society are actually responsible for the criminal behavior or crime of children and adolescents, not them. For this reason, the family and society do not have the moral position to punish children and adolescents for any crime but must employ all their efforts to give them a crime-free life by trying to correct their criminal behavior.

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Prospects of *n*-GaAs/*p*-Si/p^+-AlSb double heterojunction solar cell: Theoretical investigations

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Abstract

We present a theoretical analysis of novel Si-based n-GaAs/p-Si/p^+-AlSb dual heterojunction solar cell in this paper. The SCAPS 1D software was utilized to perform this theoretical investigation. GaAs and AlSb were employed as electron transport window and hole transport back surface field (BSF) layers, respectively. The various properties, including thickness, doping concentration, and bulk defects of different layers were varied to reach optimal values. The optimized power conversion efficiency (PCE) of the n-GaAs/p-Si/p^+-AlSb solar cell was observed at 39.94% with the J_{SC} of 52.52 mA/cm^2, the V_{OC} of 0.95 V, and the FF of 80.25%. The significant short circuit current and open circuit voltage allowed for this high efficiency, which is extremely close to the Shockley Queisser (SQ) limit. The AlSb BSF layer, which also functions as the bottom absorber layer through a tail-states-assisted (TSA) two-step photon upconversion process, generated this high current, and the open circuit voltage was discovered due to the high built-in potential in the Si/AlSb interface. These findings suggest that the n-GaAs/p-Si/p^+-AlSb photovoltaic cell is capable of harvesting the solar energy in near future.

***Keywords*:** Si, AlSb, dual-heterojunction, SQ Limit, TSA upconversion, SCAPS-1D.

Introduction

The world's energy consumption has risen continuously as a result of rapid urbanization, economic expansion, and increased industrialization. Until now, the majority of today's energy needs have been satisfied by fossil fuels (oil, coal, natural gas, and uranium), which are today's dominant energy sources. Since, these conventional energy resources are limited and hence, no longer will be available to satisfy global energy demand in future. Moreover, the use of fossil fuels emits CO_2, resulting greenhouse effect and environment pollution[1]. As results, researchers have focused with great attention on renewable energy sources as an alternative of fossil fuel for generation of energy.

Renewable energy also called green or clean energy is created through natural resources, such as, solar radiation, water, wind, biomass, geothermal, and tidal energy[2]. Among all of the resources, solar photovoltaic has been renowned as the best promising green renewable energy sources due to the natural appearance of the sun almost in the word. In recent years, researchers have been revealed solar cell as a cost effective, eco-friendly and paramount alternative of fossil fuel to meet up the world's huge energy demand.

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Solar cells are usually formed using semiconductor materials. At present, most of the solar cells (over 90% on the market) are produced from silicon (Si) because of its some exclusive features such as, it is the second most abundant elements on earth, non-toxic, non-corrosive, and also chemically stable[3-5]. Daryl Chapin and colleagues at Bell Laboratory created the first silicon p-n junction solar cell in 1954, with an efficiency of 6%[6]. After that, the evolution of Si solar cell happened slowly but in recent years it has remarkably developed with prominent performances. Still now, a lot of researchers are going to work in the area of silicon solar cells to enhance the performances.

Currently, the conversion efficiency for Si solar cell has been raised with the improvement of photovoltaic technologies. At the aim of enhancement of efficiency, different types of crystalline silicon solar cell have been revealed based on solar cell structures such as, passivated emitter rear cell (PERC), heterojunction with intrinsic thin-layer cell (HIT), and heterojunction solar cells with interdigitated back contacts (HJ-IBC)[7-8]. Among all of the structures, maximum efficiency of 25.6% has been achieved through HJ-IBC silicon solar cell in 2014[9]. However, study by K. Yoshikawa et al. claims that in 2017, employing HJ-IBC silicon solar cells on a 180 cm^2 practical module, this record holder efficiency of 25.6% was superseded by a 26.6% efficiency[10]. In addition, in theoretical simulation, an efficiency of 29.3% was also obtained for impurity photovoltaic (IPV) silicon solar cells that is so far from shockley queisser limit[11]. Recently, wafer-based silicon solar cells employing $Al_{0.8}Ga_{0.2}Sb$ as BSF layer and ZnSe as window layer theoretically predicted 38% efficiency[12]. We have also reported the theoretical power conversion efficiency of ~38% for Si solar cell utilizing In_3Se_4 as BSF layer. Due to the In_3Se_4 BSF layer's ability to execute the function of a bottom absorber layer through a tail-states-assisted (TSA) two-step photon upconversion process, this maximum efficiency has been discovered[13]. As a result, research into Si solar cells is required in order to approach the Shockley queisser limit.

Moreover, p-type silicon is favored because it costs less than n-type silicon. The p-type silicon can be used to gather photo-generated electrons because its minority carrier (electron) diffusion length is longer than its minority carrier (hole) diffusion length. These procedures lead to decreased carrier recombination rates, increased photocurrent, and superior device performance when employing p-type silicon[14].

In this research, *p*-type Si based novel dual heterojunction solar cell has been investigated. The GaAs as electron transport window layer and AlSb as hole transport back surface field (BSF) layer with Si in the first time of the world have also been used. AlSb belongs to the group of III-V family with a band gap of 1.6 eV[15]. Furthermore, AlSb is very promising materials in the solar cell applications due to its high absorption coefficient. On the other hand, GaAs contains direct band gap of 1.42 eV which has already been used as solar absorber[16]. But with a 4.07 eV electron affinity and a 5.49 eV ionization potential, it could also create a good combination with Si. Hence, in this study, GaAs has been employed as window layer with Si to reveal its potential.

Therefore, using SCAPS 1D software, the innovative *n*-GaAs/*p*-Si/p^+-AlSb dual heterojunction solar cell (DHSC) has been investigated, and the photovoltaic characteristics of this solar cell have been thoroughly analyzed in this study.

2. Design and Numerical Modeling of proposed Si-based photovoltaic device

2.1 Designing proposed structure

Fig. 1(a) and (b) show the suggested Si-based dual heterojunction solar cell's simplified and lit energy band layout, respectively.

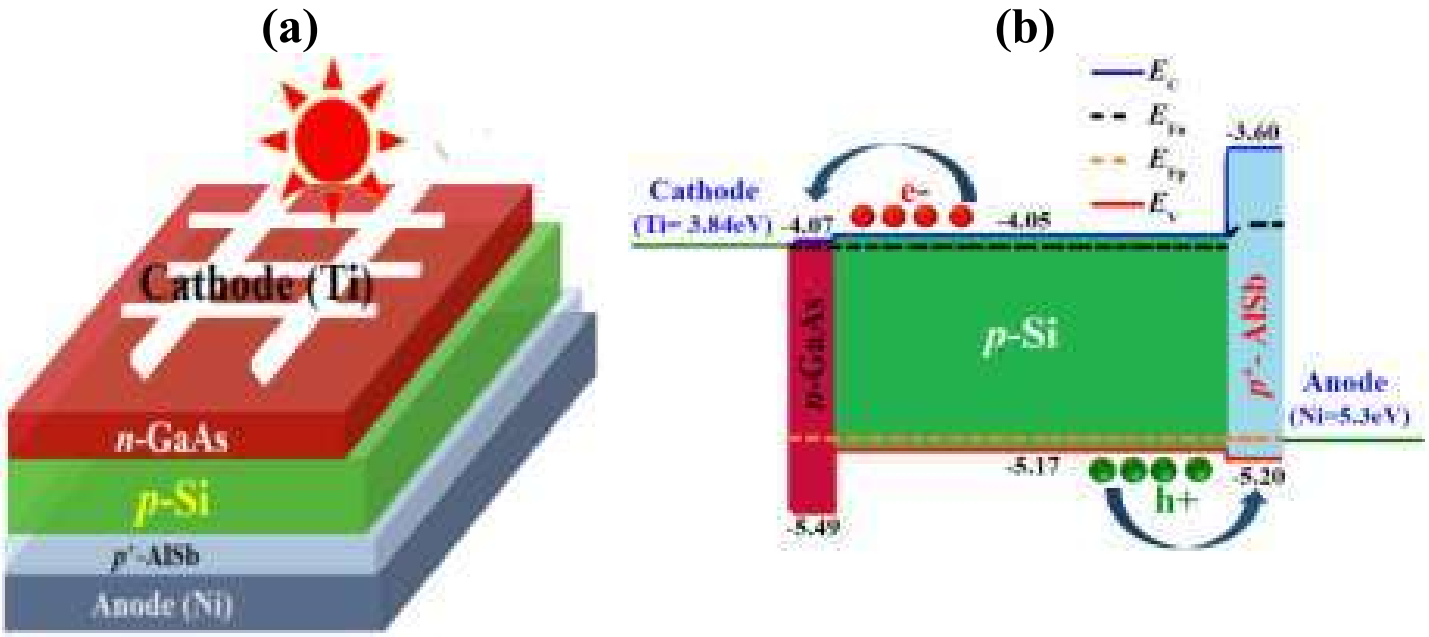

Fig. 1. The (a) schematic diagram and (b) illuminated energy band diagram of designed *n*-GaAs/*p*-Si/p^+-AlSb DHSC.

Here, the *n*-type GaAs serves as the window layer through which photons enter. After that, *p*-type Si, acting as the absorber layer, absorbs the photons[16]. The Ec and Ev values of Si are 4.05 and 5.17 eV, respectively[13].The *n*-type GaAs could create a good pn junction with p-type Si owing to its electron affinity of 4.07 eV and ionization potential of 5.49 eV. Besides, AlSb is a semiconducting substance. It is used as a p^+-type layer in this design, serving as both a second absorber and a BSF layer. AlSb is a good option to build a junction with Si since its Ec and Ev are 3.6 eV and 5.20 eV, respectively[17-18]. As shown in Fig. 1(b), the quasi-Fermi levels for electrons are designated as E_{Fn} and the quasi-Fermi levels for holes are labeled as E_{Fp}. Since the E_{Fn} level is over the VB edge in n-type CdS while E_{Fp} is under the CB edge in GaAs, photogenerated electrons are carried there and halted by the AlSb. Therefore, the window layer blocks the photo-generated holes and they move towards the p^+-type BSF layer. As a result, from the absorber layer, the anode and cathode may readily capture holes and electrons, respectively. Ti and Ni, both plentiful metals, will be employed as the cathode and anode in this device, respectively.

2.2 Numerical Simulation and Materials properties

One dimensional software called SCAPS-1D, created by M. Burgelman et al. at the University of Gent in Belgium, is used to numerically simulate the proposed Si-based *n*-GaAs/*p*-Si/p^+-AlSb dual heterojunction solar cells[19]. Through the resolution of three fundamental semiconductor equations, including Poisson's equation, the continuity equations for free holes and electrons, and the drift-diffusion equation, this software analyzes the structure of solar cells.

Table 1. Materials properties of *n*-GaAs/*p*-Si/p^+-AlSb photovoltic device.

Parameters	*n*-GaAs[16, 17]	*p*-Si[13]	p^+- AlSb[18,20]
Thickness (μm)	0.50	200.0	2.0
Energy band gap (eV)	1.42	1.12	1.60
Electron affinity (eV)	4.07	4.05	3.60
Dielectric constant	13.18	11.90	12.04
DOS of conduction band ($1/cm^3$)	4.7×10^{17}	2.82×10^{19}	7.8×10^{17}
DOS of valence band ($1/cm^3$)	7.0×10^{18}	1.04×10^{19}	1.8×10^{19}
Carrier thermal velocity (electron) (cm/s)	1.00×10^{7}	2.30×10^{7}	1.7×10^{7}
Carrier thermal velocity (hole) (cm/s)	10^{7}	1.65×10^{7}	1.4×10^{7}
Mobility of electron (cm^2/Vs)	4600	1350	200
Mobility of hole (cm^2/Vs)	239	500	420
Donor concentration, N_D ($1/cm^3$)	10^{17}	0	0
Acceptor concentration, N_A ($1/cm^3$)	0	10^{16}	10^{17}
Radiative recombination coefficient (cm^{-3}/s)	0	0	0
Defect density (cm^{-3}) (above E_v w.r.t. E_{ref} (eV))	10^{12}	10^{11}	10^{12}
Types of bulk defects	Acceptor	Donor	Donor
Defect level, Et	Above E_v (SCAPS <2.7)	Above E_v (SCAPS <2.7)	Above E_v (SCAPS <2.7)
Reference energy level (eV)	0.70	0.65	0.80

This simulation was run using a single sun providing 100 mW/cm^2 of illumination, a 1.5G global air mass (AM), and 300 K operating temperature. This simulation avoided radiative recombination coefficient and took ideal series and shunt resistance values into account. Interface flaws as well as acceptor and donor type flaws for all layers were taken into consideration using the Gaussian energy distribution. The surface recombination velocity of both metallic contacts was set at 10^7 cm/s. In this simulation, all layers were assumed to have a characteristic energy of 0.1 eV and a capture cross section for electrons and holes of 1.00×10^{-15} cm^2. But, for the Si absorber layer, 1.00×10^{-17} cm^2 of capture cross section holes were set. The absorption coefficient data for the AlSb layer was collected from the literature based on experimental work[21]. Table 1 displays the settings for the various layers in our simulation, whereas Table 2 displays the parameters for interfaces.

Table 2. Interface defects properties.

Properties	GaAs/Si heterostructure	Si/AlSb heterostructure
Type of defects	Neutral	Neutral
Electron capture cross section [cm^2]	1×10^{-19}	1×10^{-19}
Hole capture cross section [cm^2]	1×10^{-19}	1×10^{-19}
Distribution of energy	Single	Single
Defect level, E_t	Above the maximum E_V	Above the maximum E_V
Reference energy (eV)	0.60	0.60
Overall defects (cm^{-2})	1×10^{11}	1×10^{11}

3. Results and discussion

3.1 The role of the Si layer on *n*-GaAs/*p*-Si/*p*$^+$-AlSb DHSC performances

Here, the dependency of photovoltaic parameters of the *n*-GaAs/*p*-Si/*p*$^+$-AlSb DHSC on the thickness of the Si absorber layer has been investigated. The fluctuation of the PV characteristics of the the *n*-GaAs/*p*-Si/*p*$^+$-AlSb solar cell with regard to the depth of the Si absorber layer is depicted in Figure 2(a). It is seen in the figure that the short circuit current (J_{SC}) rises by a very small amount from 52 to 52.69 mA/cm^2 at 100 to 300 μm thickness of Si. This is due to the wider absorber layer, which can absorb more photons and produce more electron-hole pairs (EHPs)[22-23].

On the other hand, the open circuit voltage (V_{OC}) and fill factor (FF) decrease because of the rise in reverse saturation current with the increment of Si thickness[24]. As a result, the PCE decreases with the width of Si, depending on the values of V_{OC} and FF. At 100 to 300 μm width of the Si layer, it drops from 40.67 to 39.28%. However, a 200 μm thick Si absorber layer was considered as optimized thickness to simulate furthers simulation.

The effect of doping concentration in the Si layer on the PV performances of *n*-GaAs/*p*-Si/p^+-AlSb DHSC is shown Figure 2(b). The J_{SC} and V_{OC} are found to show almost constant behavior within the doping concentration range of Si layer. The FF is found to drop from 80.43 to 75.24% at 10^{14} to 10^{17} cm^{-3} doping of the Si layer. The degradation of FF might have happened due to the increase in series resistance[13]. Since the V_{OC} and J_{SC} are constants, the PCE adopts the same pattern as the FF. It decreases from 40.14 to 37.28% within the doping concentration range.

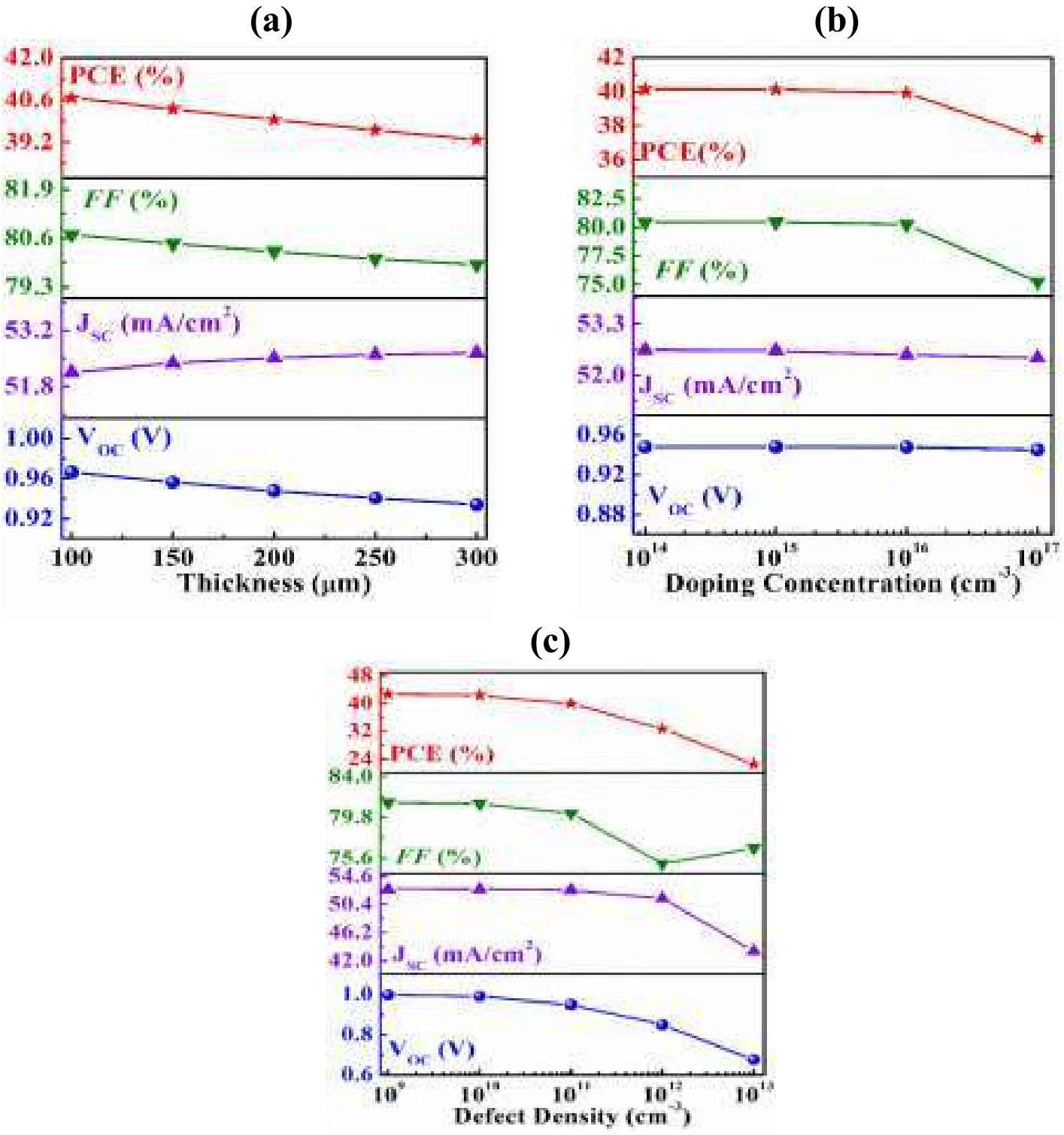

Fig.2. PV parameters dependency on Si absorber layer (a) thickness, (b) carrier concentration and (c) defect density.

The impacts of bulk defects of the Si layer on the cell performances of *n*-GaAs/*p*-Si/p^+-AlSb solar cells are visualized in figure 2(c). At 10^9 to 10^{13} cm^{-3} bulk defects of Si, the J_{SC} drops dramatically from 52.65 to 43.30 mA/cm^2. Since the higher defect level interrupts the ability to absorb more photons and create EHPs that is why the J_{SC} is abruptly decreased[25-27]. As a results, the V_{OC} falls from 1.0 to 0.68 V. The FF is also observed to drop from 81.32 to 76.64 % with increase in bulk defects. At larger defect levels, the FF declines as series resistance rises. As a result, the PCE drops from 42.67 to 22.45% at 10^9 to 10^{13} cm^{-3} Si defects, depending on other PV parameters. For further calculations, we have considered 10^{16} cm^{-3} and 10^{11} cm^{-3} as optimized doping and defect densities for Si.

3.2 The role of the GaAs layer on *n*-GaAs/*p*-Si/p^+-AlSb DHSC performances

Here, we discuss the influence of the GaAs window layer on the cell performances of designed Si-based photovoltaic device. Figure 3 illustrates how the width, dopant density, and bulk flaws of the GaAs window layer affect the PV characteristics of *n*-GaAs/*p*-Si/p^+-AlSb solar cells. All of figures 3(a-c) show that the PV parameters of *n*-GaAs/*p*-Si/p^+-AlSb solar cells are almost independent of width, dopant density, and bulk flaws of GaAs layer.

Hence, it can be concluded that the GaAs window layer has negligible impacts on the cell performances of *n*-GaAs/*p*-Si/p^+-AlSb solar cells.

3.3 The role of the AlSb BSF as well as bottom absorber layer on *n*-GaAs/*p*-Si/p^+-AlSb DHSC performances

3.3.1 The impacts of thickness and doping concentration of the AlSb layer

The effects of the AlSb back surface field layer, which also functions as the bottom absorber layer in the planned Si-based solar cell, have been thoroughly examined in this section. It is seen that the efficiency of Si-based single heterojunction GaAs/Si solar cells is 27.52%. Due to the incorporation of a 1 μm thick AlSb layer, this efficiency increases to 35.8%. This significant increase in efficiency may have been brought about by the AlSb layer, which serves as both a lower absorber and a BSF layer.

The dependence of PV parameters on the AlSb layer's thickness and doping level is shown in Figure 4. First of all, the J_{SC} is seen (Fig. 4a) to increase tremendously from 40 to 47 mA/cm^2 due to the 1 μm thick AlSb layer. Further, it increases gradually with the thickness of the AlSb layer. It enhances to 58.8 mA/cm^2 at 4.0 μm thickness with 10^{15} cm^{-3} doping concentration. The AlSb bottom layer, which could capture higher wavelength lights through a tail-states-assisted (TSA) two-step photon upconversion process, causes the J_{SC} to increase[25, 27-29].

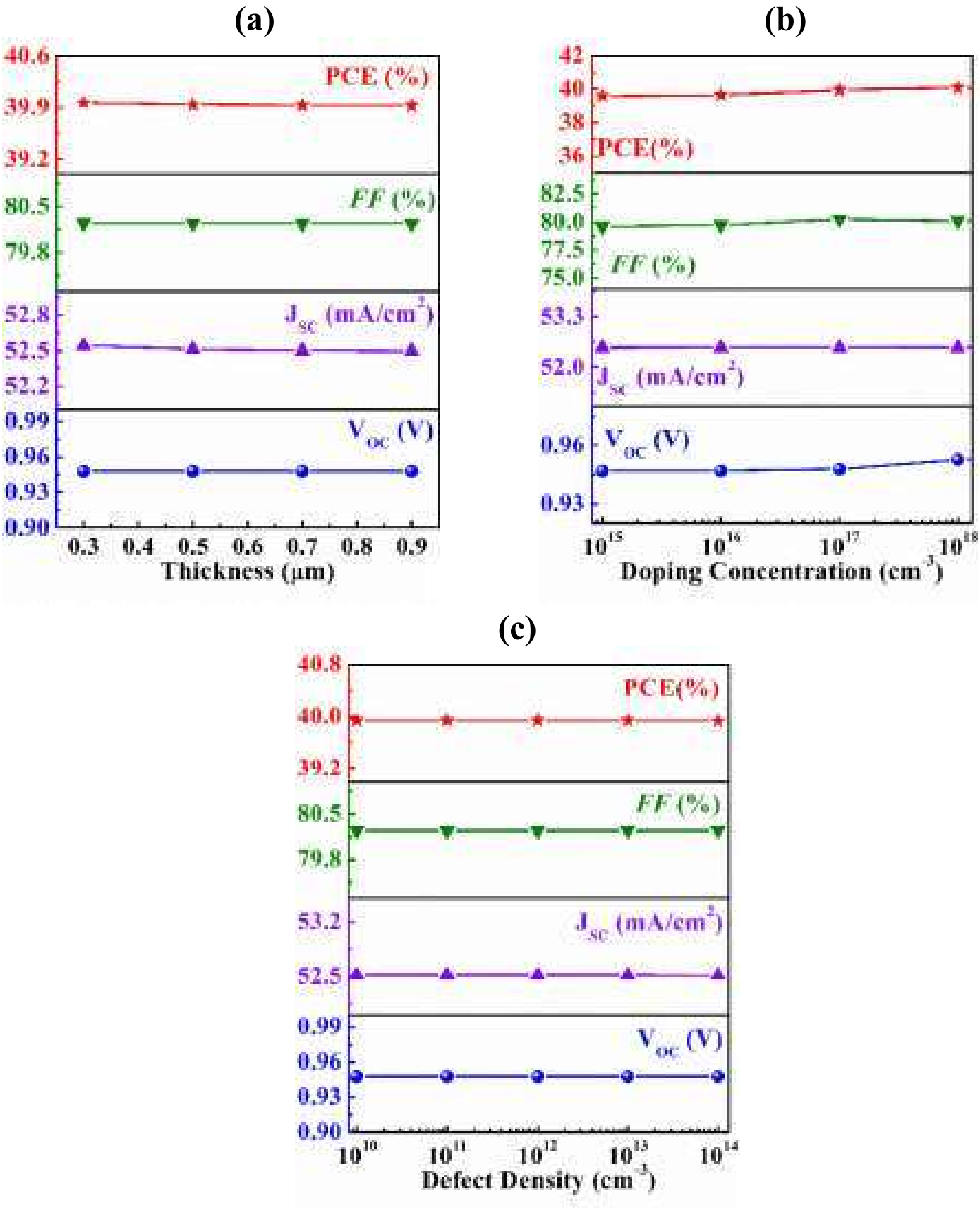

Fig.3. PV parameters dependency on GaAs layer (a) thickness, (b) carrier concentration and (c) defect density.

The AlSb material is able to absorb sub-band gap photons via the TSA two-step photon upconversion process because of its desired band gap, high doping level, and high absorption coefficient in the longer wavelength region. Hence, the J_{SC} rises significantly due to the insertion of the AlSb layer in Si-based GaAs/Si/AlSb solar cells.

Additionally, it is discovered that the J_{SC} decreases as the AlSb layer's doping concentration rises, which is caused by an increase in carrier recombination[13].

On the other hand, the V_{OC} (Fig. 4b) is seen to rise from 0.82 to 0.94 V due to the addition of a 1.0 μm thick AlSb layer. The increment of V_{OC} is reasonable due to the generation of high built-in potential at the Si/AlSb interface[13, 25, 29-30]. After that, V_{OC} moves a negligible amount with the change in width and dopant density of the AlSb layer.

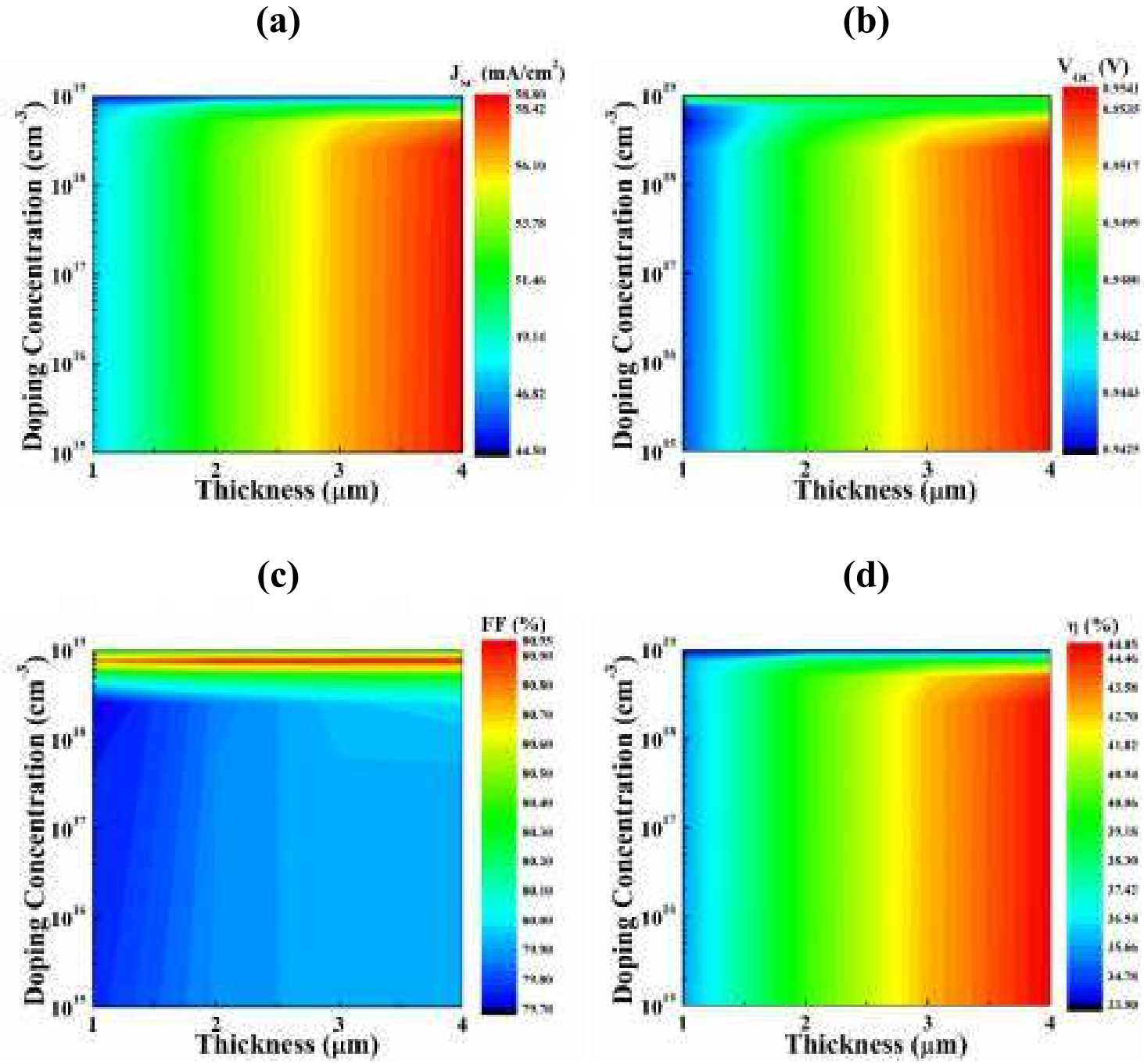

Fig.4. PV parameters dependency on thickness and carrier density of the AlSb BSF layer.

The addition of a 1 μm thick AlSb layer reduces the FF (Fig. 4c) from 84 to 80% due to an increase in series resistance in the *n*-GaAs/*p*-Si/p^+-AlSb heterostructure solar cells.

Depending on J_{SC} and V_{OC}, the PCE (Fig. 4d) increases as the width of the AlSb layer increases. Because of carrier recombination, the PCE gradually increases with thickness but decreases with doping concentration. With a doping concentration of 10^{15} cm^{-3}, the highest PCE was attained at 4 μm thickness.

3.3.2 The influence of bulk defects of AlSb BSF layer

The dependence of PV parameters on the defect density of the AlSb layer is depicted in Figure 5. The fault density of the AlSb layer was altered from 10^{13} to 10^{16} cm^{-3} in order to evaluate the impacts of the imperfections. The V_{OC} is found in independent with the bulk flaws of the AlSb. The J_{SC} is seen to be constant at lesser faults, but it also decreases with higher defects.

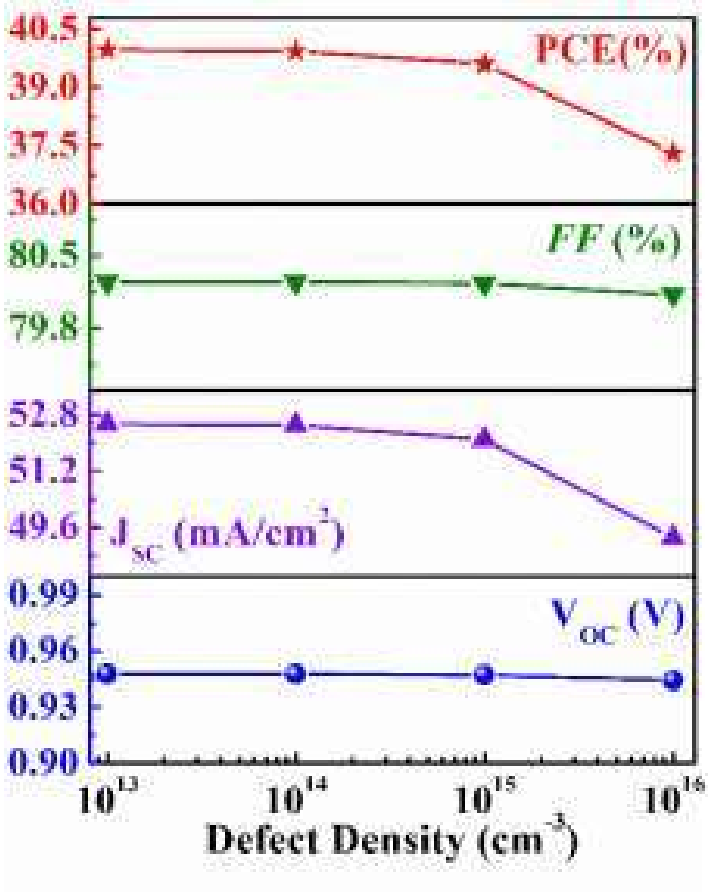

Fig.5. Dependence of PV parameters on bulk flaws of AlSb BSF layer.

This is because a high defect level prevents the collection of photons and the production of more EHPs. The FF is also observed independently of the AlSb layer's defect density. Finally, the PCE also reduces depending on the J_{SC}.

3.4 JV characteristics and QE curve of designed Si-based solar cells with and without AlSb layer

Figure 6(a) depicts the simulated current-voltage characteristics for designed Si-based PV cells with and without AlSb. This image indicates that the addition of AlSb as a BSF layer significantly improved the efficiency of Si-based photovoltaic device. The optimized efficiency for a single *n*-GaAs/*p*-Si solar cell was 27.75% with the J_{SC} of 40

mA/cm^2, the V_{OC} of 0.83 V, and the FF of 84%. Due to the addition of a 2.0 μm thick AlSb BSF layer, which also serves as the bottom absorber layer, this efficiency was reached at 39.94% with the J_{SC} of 52.52 mA/cm^2, the V_{OC} of 0.95 V, and the FF of 80.25%.This improvement in performance is due to a tremendous increment in the current and the Si/AlSb interface by creating a significantly high built-in potential.

The simulated quantum efficiency (QE) of single and double heterojunction Si solar cells is shown in Figure 6(b). This curve also reveals that the QE increases greatly due to the addition of the AlSb layer. It should be noted that it possesses a 40% quantum efficiency at high wavelength regions like 1800 nm. This occurred as a result of the AlSb layer's ability to absorb photons with longer wavelengths through the TSA two-step photon upconversion process[25,27-29]. Therefore, the short circuit current rises, which, predictably, contributes to PCE.

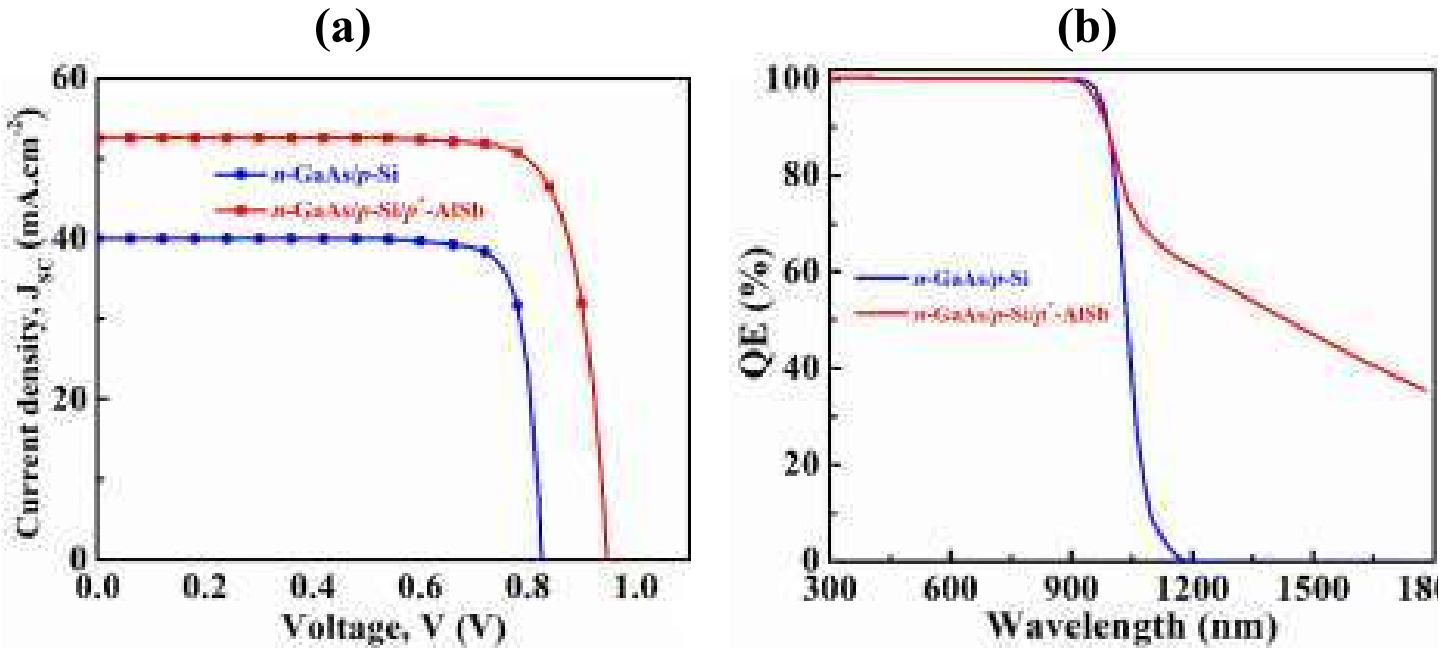

Fig. 6. (a) J-V characteristics for light and (b) QE curves of proposed photovoltaic devices.

4. Conclusion

The designed Si-based *n*-GaAs/*p*-Si/p^+-AlSb dual heterojunction photovoltaic cell has been simulated successfully using SCAPS 1D software. The potential of the AlSb compound as the BSF layer in the Si-based *n*-GaAs/*p*-Si/p^+-AlSb double heterostructure solar cell is revealed in this study. The Si-based solar cell's optimized PCE excluding AlSb layer was 27.75%. This PCE was enhanced to 39.94% with the J_{SC} of 52.52 mA/cm^2, the V_{OC} of 0.95 V, and the FF of 80.25% due to the employment of the AlSb layer, which is extremely near to the Shockley Queisser (SQ) limit. The high short circuit current and open circuit voltage are responsible for these remarkable

results. This study suggests that the *n*-GaAs/*p*-Si/p^+-AlSb DHSC has a high potential for practical implementation in the near future to meet global energy demand.

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Prediction of Several Stages of Lung Cancer Using Machine Learning Algorithms

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ABSTRACT

One of the most concerning causes of death nowadays is lung cancer. Lung cancer can also cause fluid to accumulate around the lungs, which makes it harder for the lung with the disease to expand during inhalation. We can save many people's lungs if we can detect this dangerous issue early. We have applied machine learning algorithms in our research to forecast the existence of lung cancer in human bodies at various stages (low, medium and high). In addition, we have concentrated on an effective strategy to raise the effectiveness of our employed classifiers. Our dataset contains null values; hence the imputing mean value method is employed to handle them. To remove unnecessary features, we have utilized the info-gain attribute selection procedure. To assess prediction accuracy of our classification models, the lung cancer dataset is applied to K-Nearest Neighbors (KNN), Naive Bayes (NB) and Random Forest (RF). We have evaluated the effectiveness of our different classification approaches using calculated measures including accuracy, precision, recall, F1-score and ROC. With the help of our applied info-gain attribute selection procedure and managing null values on a specific column have helped to increase the accuracy of prediction models. With the values of precision, recall, F1-score and ROC are 0.96, 0.95, 0.95 and 0.9 respectively; the highest accuracy has come from Random Forest at 96.67%.

***Keywords**:* classification, lung cancer, machine learning, supervised algorithms.

Introduction

The continual expansion of data in the medical sector has made it challenging to manage this enormous volume of data and gather pertinent facts for precise decision-making. Because of this, it is currently in great demand to implement a competent method that can provide palatable judgments from a vast number of datasets.

Data mining is a good strategy to uncover hidden patterns and compile pertinent facts from a vast dataset to address real-world issues. At this time, a person's body can exhibit lung failure symptoms at a mainly younger and older stage of their lives. Compared to younger individuals, older persons are more likely to have this sort of symptom. Previously unknown patterns and highly linked qualities are found by data mining classification algorithms when employed with a huge dataset, which aids in

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class prediction. It has become simple to identify lung cancer patients without the aid of medical specialists. Then, it will function as a mechanism for more correctly and quickly differentiating between people who have lung cancer and those who do not. To produce predictions, however, several machine learning methods are employed. It's a struggle for us to find the best approach. When determining whether a patient has early-stage lung cancer or not, we employed KNN, Naive Bayes and Random Forest in our study.

In our analysis, there are primarily three contributions. First, from the Kaggle lung cancer dataset with different stages, to diagnose lung cancer, we have accumulated 1000 records-based datasets from the real world. Second, identifying the features that are not essential. We have done it by the info-gain feature selection approach. Finally, evaluate the effectiveness of our three strategies based on several necessary parameters. Besides this, we have also compared our findings with the earlier research.

There are various components to our paper. A review of the literature is included in Section II. The strategy is described in Section III. In Section IV, experiment results are reported. Our paper's conclusion has ultimately become the focus of Section V.

Literature Review

Numerous research applying various data mining approaches have focused on the diagnosis of lung illness and many other significant diseases to anticipate lung illness, several machine learning methods were employed by S. Bharathy*et.al.*[1] to predict lung cancer. Random Forest (RF), with a score of 88.50%, has demonstrated excellent accuracy in contrast to other models. Lung cancer was predicted by D. Rawat *et. al.*[2] using the Artificial Neural Network (ANN) method. The accuracy generated from ANN is 92.23%. Different types of ML techniques are applied by M. Mamun*et.al.*[3] to predict lung cancer. The most accurate approach is XGBoost, which has an accuracy rate of 94.42%. Lung cancer was predicted by S. Nageswaran*et.al.*[4] using the ANN, (KNN), and RF. The highest accuracy of ANN was (98%). P. Chaturvedi *et. al.*[5] diagnosed lung cancer by using the SVM, CNN and ANN. With a 96.70% accuracy rate, the SVM algorithm has produced the best results when compared to other algorithms. UB. Mahadevaswamy *et. al.*[6] used a machine-learning approach to predict lung cancer. The accuracy generated by KNN is the highest at 95.80%. K. Ingle *et. al.*[7] examined several techniques for lung cancer prediction. Comparing several prediction models, the Adaboost model has the highest accuracy of (90.74%). Lung cancer was predicted using machine learning techniques by DM. Abdullah *et.al.*[8]. They obtained the highest Support Vector Machine (SVM) accuracy, which is 95.56%. Lung cancer was predicted using machine learning techniques by C. Thallam*et.al.*[9]. They obtained a 99.50% accuracy rate from the voting classifier model, which is the maximum possible. S. M. M. Hasan *et. al.*[10] studied several supervised machine-learning classification techniques to predict heart illness. This study employs a feature selection method (info-gain) to improve the classification model's accuracy. The most accurate method, which was 92.76% accuracy, is logistic regression. Heart illness using MLP and SVM was

predicted by M. Nahiduzzaman*et.al.*[11]. The maximum two-class classification accuracy they were able to get using SVM was 92.45%. Machine learning techniques were utilized by M. J. Nayeem *et. al.*[12] to predict Heart illness. The highest Random Forest accuracy is 95.63%. Machine learning techniques are applied by M. J. Nayeem *et. al.*[13] to anticipate hepatitis disease where the highest classification accuracy from Random Forest was (92.41%).

Methodologies

A. K-Nearest Neighbors (KNN)

This classifier completes the classification process in three steps. Step 1, calculating the value of K. Step 2, the training data's total distance will be calculated and ranked for each of the test samples. Step 3, the majority vote approach will be applied to assign the class name of test sample data's[10]. The Necessary formula to Calculate the Euclidean distance is as follows:

$$E_x = \sqrt{\sum_{y=1}^{z}(k_y - j_y)^2} \quad (1)$$

B. Naive Bayes

The Bayes theorem is the basis of this classification method. Estimating the chance of a future event given the likelihood of a previous one, the following formula is utilized for the posterior probability calculation:

$$P\,(M|N) = \frac{P\,(N|M)P(M)}{P(N)} \quad (2)$$

C. Random Forest

Both applications for classification and regression leverage this supervised machine-learning technique. It has been utilized to classify data in our research. Three stages make it work. A forest of choice trees is created in the initial stage of learning by joining several trees together. By leveraging the trees that were built in the forest of step 1, in step 2, for each test set, a class name is expected. Finally, the appropriate class name is given based on the results of the majority vote[10].

D. Mean Imputation Technique

It is a technique in which if a column present in the dataset exists null values, then the first mean value for that column is calculated and after that, the null or missing values for that column are imputed by using this calculated mean value.

E. Info-Gain Feature Selection Technique

Feature selection technique aids us to identify the best set of columns which allows for improving the classification model's accuracy. One of the better methods for feature selection is information gain, which determines how much entropy is lost when a

dataset is transformed. By assessing each variable's information gain concerning the target variable, it may be utilized for feature selection.

F. Working Procedure

The Python environment (Jupyter Notebook with Anaconda version 3) is utilized in our research. The required procedure to carry out our research is given below:

- ✓ Collect the dataset from[14] and create a file called DATASET_LUNG_DISEASE.CSV.
- ✓ Examining each column for the existence of null values.
- ✓ Use the mean imputation approach to handle null values, if any.
- ✓ To get rid of unnecessary features, use the info-gain attribute selection procedure. Naming newly created CSV file as DATASET_LUNG_UPDATE. (When no null values exist and only highly linked characteristics are available)
- ✓ Load the DATASET_LUNG_DISEASE.CSV file and classify it by our three classifiers to assess the existence of lung cancer.
- ✓ Activate the DATASET_LUNG_UPDATE.CSV and classify it by our three classifiers to assess whether lung cancer is present or not.
- ✓ The performance metrics are compared for the classification model attained in stages5 and 6 separately.
- ✓ We compare our classification model's accuracy to that of past research.

Fig. 1 depicts the flow chart of our work method, which focuses on all of the previously described essential processes.

Experimentation

This study's dataset has been taken from Kaggle[14]. Our collection consists of 1000 recordings and a total of 26 characteristics. We organized our experiment in to two parts which are shown in Fig. 1.

A. Data Preprocessing

There are 26 different features in our dataset. index, patient id, age, gender, alcohol usage, dust allergy, workplace risk, hereditary risk, chronic lung disease, balanced diet, obesity, smoking, passive smoking, chest discomfort, coughing up blood, fatigue, losing weight, breathing, swallowing difficulties, clubbing of fingernails, frequent colds and dry coughs, snoring, and level. There are three stages of lung cancer in our dataset and they are low, medium and high. The low stage means when the tumor is present in only lung tissues. Medium stage means when the tumor spread to lymph nodes. High stage means the tumor spread not only lymph nodes but also into the patient’s chest. There are some null values in our dataset. To deal with null values, there are several options. Records having null values can occasionally have a detrimental influence on the classification's accuracy. Null values might reduce the accuracy of classification. The processing of records containing null values was previously covered in the

methodology section of this study, and this relates to stages 2 and 3 of our working approach.

The highly related features of the dataset are also determined using the info-gain attribute selection method. The prediction model may be less accurate if there is little association between the attributes. As a consequence; we have used feature selection techniques. 22 out of the 26 attributes including air pollution, alcohol use, dust allergy, occupational hazard, hereditary risk, chronic lung illness, balanced diet, obesity, smoking, passive smoking, chest discomfort, coughing up blood, Fatigue, weight loss, trouble swallowing, asthma, clubbing of the fingernails, recurrent colds, dry coughs, snoring and level has been picked up using this info gain feature selection method.

B. Problem Statement

We have chosen S. Bharathy *et. al.*[1], D. Rawat *et. al.*[2] and M. Mamun *et.al.*[3] as a base research paper for our study.

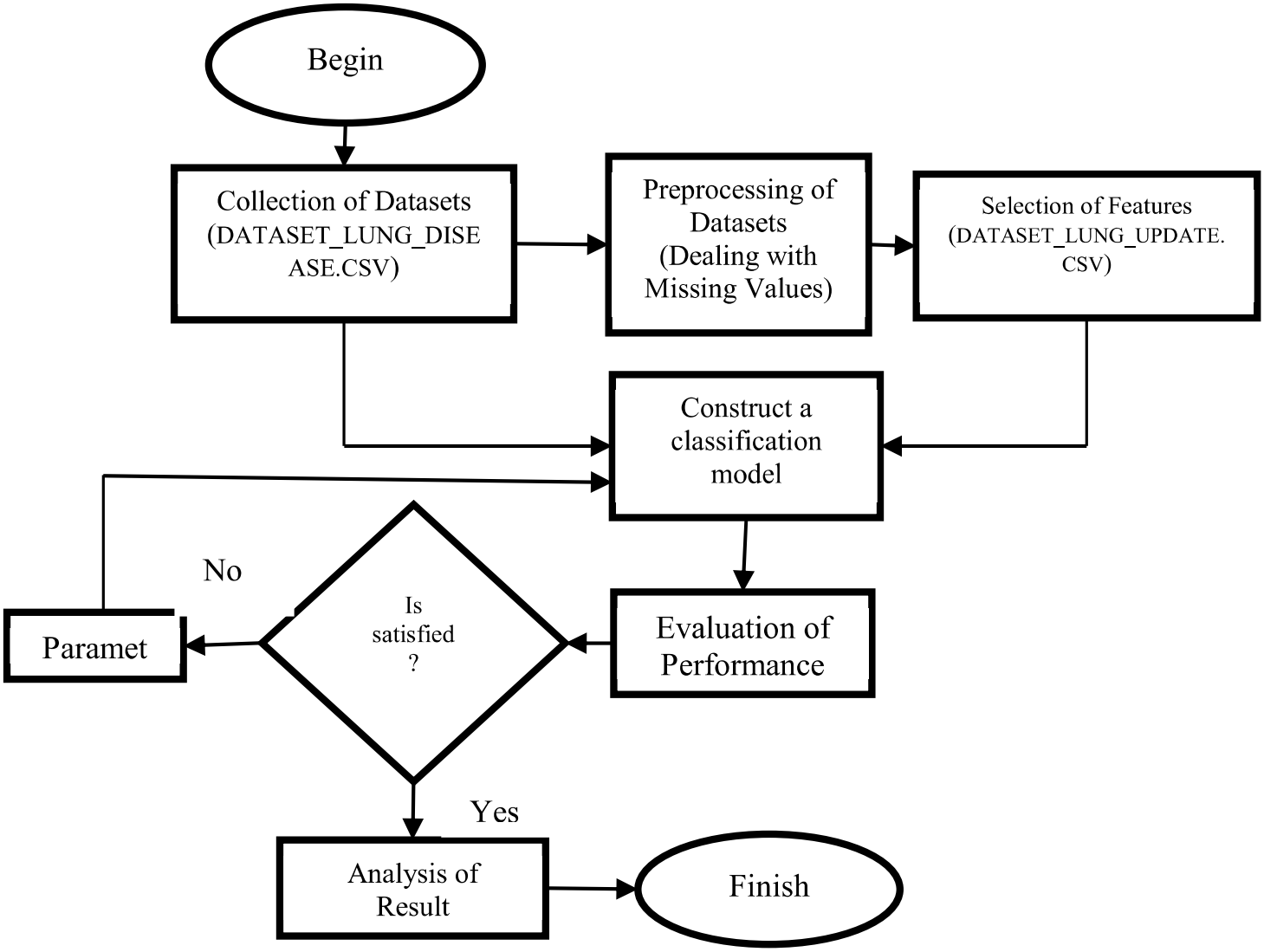

Fig-1: A flowchart showing the procedure at work.

The authors of Ref. 1, 2 and 3 used every feature in their dataset to assess the model's accuracy. They didn't use any kind of attribute selection methodology to obtain strongly

linked features. Besides this, they ignored the presence of null values. They achieved good accuracy but it is only for a small size dataset as well as they predicted only whether lung cancer in the human body exists or not. But in our study, we have predicted lung cancer is either present or not in the human body with their different stages. The number of records present in their dataset was 300. When the number of records in the dataset is huge then the presence of null values and unnecessary features in the dataset can decrease the classification model performance. We have taken a large size dataset (number of records: 1000) comparing with the Ref. 1, 2 and 3 for checking classification model performance. In the real-world dataset, there may be present null values and unnecessary features. Info gain feature selection technique is used in our research to get highly correlated features. Besides this, the mean imputation technique is usedto deal with null values.

C. Result and Discussion

We have applied a 10-fold cross-validation technique as well as divided our dataset in a way where 70% of data is used for the train-up classification model and 30% of data is used for testing model performances and predicted lung cancer with mention their stages (low or medium or high). The classification models are tested on two different criteria. The 26 features from our DATASET_LUNG_DISEASEhave been used initially. We have chosen a selection of 22 characteristics from DATASET_LUNG_UPDATE.CSV which is free from null values. For K-Nearest Neighbors, the value of K is 10 and for Random Forest, the value of num Trees is 100 has shown to be the best value in our research. both Tables I and II, which provide the results for our three classifiers using our two datasets.

Tables I and II of our performance comparison demonstrate how we enhanced the performance of our classification models by employing 22 features as opposed to 26.Our classification models perform better when the blanks in records are filled in using the mean imputation method.

TABLE I: EXISTENCE OF OBSERVATIONS WITH NULL VALUES AND 26-FEATURES (DATASET_LUNG_DISEASE).

Algorithm	Confusion Matrix		Accuracy
KNN	TP=200	FN=35	82.67%
	FP=17	TN=48	
Naive Bayes	TP=200	FN=20	83.33%
	FP=30	TN=50	
Random Forest	TP=220	FN=20	88.33%
	FP=15	TN=45	

TABLE II: EXISTENCE OF OBSERVATIONS WITH OUT NULL VALUES AND 22 HIGHLY CORRELATED FEATURES (DATASET_LUNG_UPDATE)

Algorithm	Confusion Matrix		Accuracy
KNN	TP=200	FN=25	85.00%
	FP=20	TN=55	
Naive Bayes	TP=210	FN=22	86.00%
	FP=20	TN=38	
	FP=13	TN=19	
Random Forest	TP=250	FN=6	96.67%
	FP=4	TN=40	

When contrasting the three classification models, in all three scenarios, the performance of RF (Random Forest) is higher than the other two techniques. In Fig. 2, we can see the performance of our models for all of the two cases.

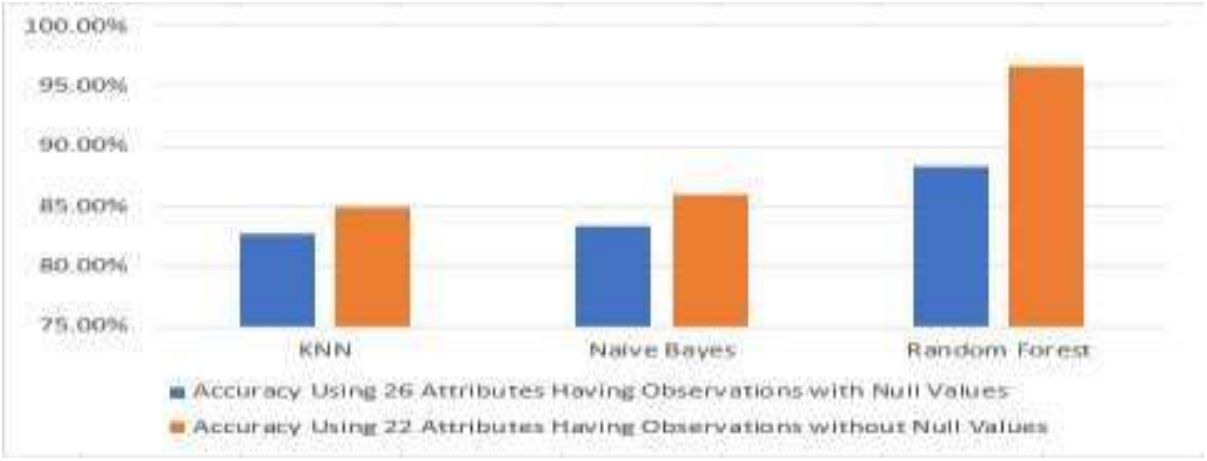

Fig. 2: Bar graph displaying the accuracy of our proposed models.

TABLE III: REPORT ON CLASSIFIER PERFORMANCE

ALGORITHM	PRECISION	RECALL	F1-SCORE	ROC AREA
KNN [DATASET-LUNG-DISEASE]	0.86	0.85	0.85	0.8
KNN [DATASET-LUNG-UPDATE]	0.88	0.86	0.86	0.8
Naive Bayes [DATASET-LUNG-DISEASE]	0.86	0.85	0.85	0.85
Naive Bayes [DATASET-LUNG-UPDATE]	0.89	0.89	0.89	0.8
Random Forest [DATASET-LUNG-DISEASE]	0.9	0.9	0.92	0.9
Random Forest [DATASET-LUNG-UPDATE]	0.96	0.95	0.95	0.9

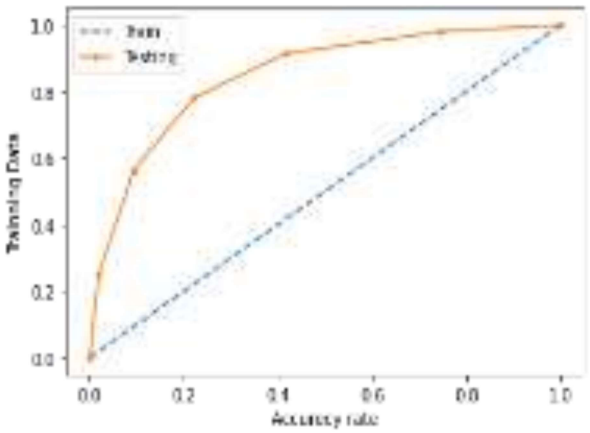

Fig. 3: ROC CURVE FOR KNN [DATASET-LUNG-DISEASE]

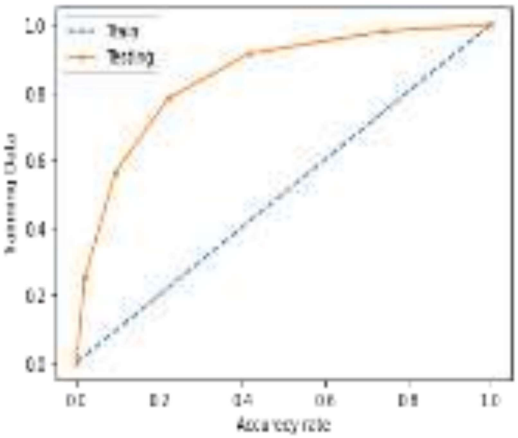

Fig. 4: ROC CURVE FOR KNN [DATASET-LUNG-UPDATE]

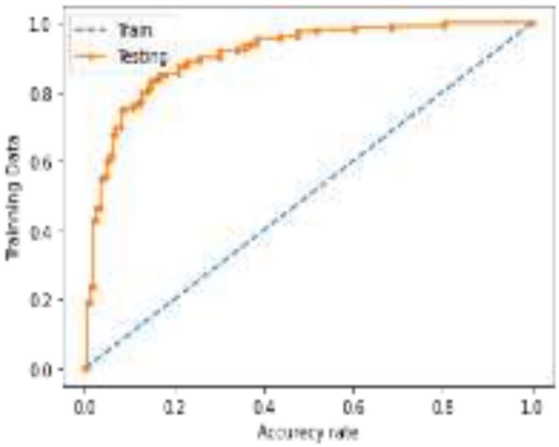

Fig. 5: ROC CURVE FOR NAIVE BAYES [DATASET-LUNG-DISEASE]

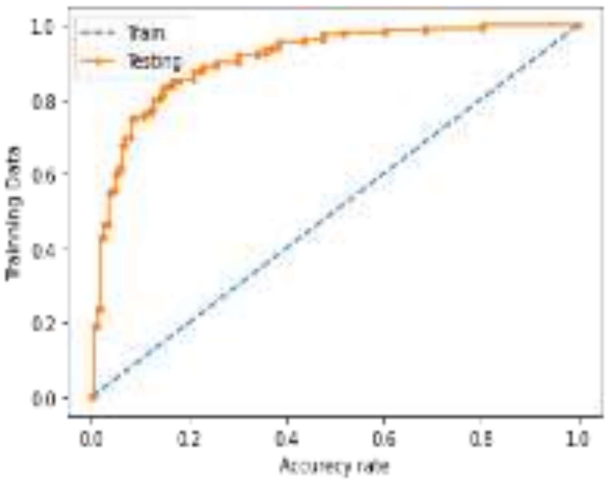

Fig. 6: ROC CURVE FOR NAIVE BAYES [DATASET-LUNG-UPDATE]

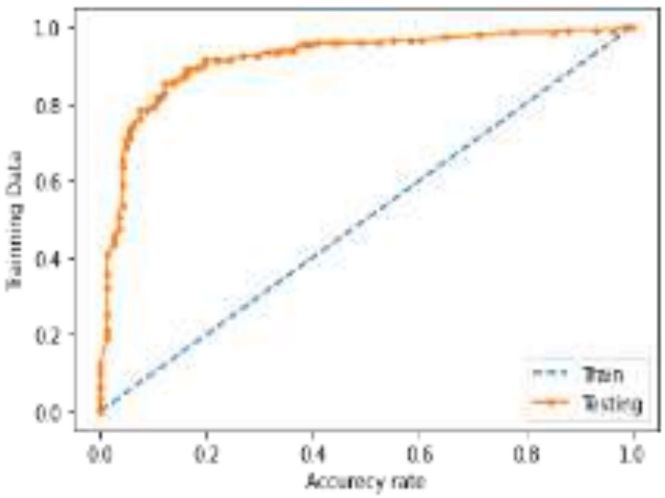

Fig. 7: ROC CURVE FOR RANDOM FOREST [DATASET-LUNG-DISEASE]

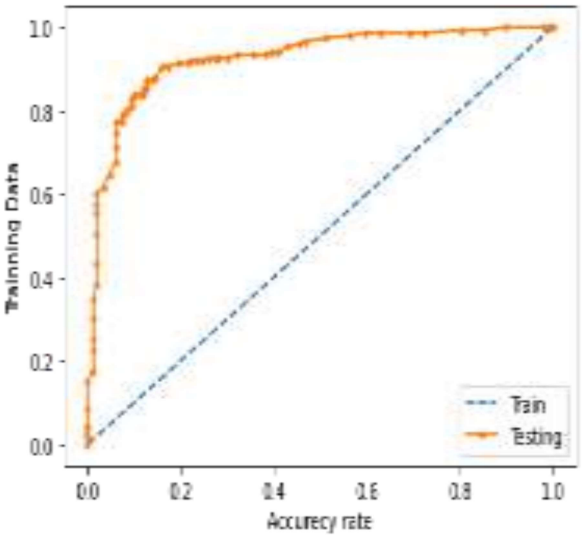

Fig. 8: ROC CURVE FOR RANDOM FOREST [DATASET-LUNG-UPDATE]

Table III shows that the 22 features in dataset_lung_update.csv outperformed the 26 attributes in dataset_lung_disease.csv for all of our models. Using all of the information in our dataset would make it impossible to predict lung status with any degree of accuracy. As a consequence, we identified and subsequently eliminated unneeded features using the information-gain attribute selection technique. In our study, Random Forest has provided the most accurate results, 96.67%. The performance of this

technique is higher compared with our other two techniques. As has been done in part IV of the issue statement component, if we have compared the results with prior research, Using Random Forest, we have got the highest accuracy, which is larger than[1] and is 96.67%. Random Forest provided the best accuracy, which was 88.50%, according to S. Bharathy *et. al.*[1]. The accuracy we have obtained with Random Forest is 96.67%, which is better than[2]. The highest accuracy from ANN was attained by D. Rawat *et. al.*[2] 92.23%. M. Mamun *et. al.*[3] found the highest accuracy from XGBoost to be 94.42%, however, our study have found the best accuracy to be 96.67%, which is higher than Ref. 3. Additionally, even though our dataset has more records than Ref. 1, 2 and 3 combined, we were able to maintain a model accuracy that is comparable to or higher than those.

Conclusion and Future Works

The accuracy of our classification models are improved by using the attribute selection process as well as the management of null values and predicted lung cancer with their stages (low or medium or high). The performance of our classification models has been enhanced by using the info gain attribute selection strategy with mean imputation compared with before where null values and unnecessary features were present in the datasets. The low classification accuracy might be attributed to the null values and lesser contribution columns in the dataset. The Random Forest classifier outperformed comparing with the other two with an overall accuracy score of 96.67%. In addition, the recall, F1-score, and ROC values are respectively 0.96, 0.95, 0.95 and 0.9. Other classification algorithms with improved feature selection methods are advised to be employed in the future.

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The Effects of Dialect Using in Classroom: A Study in Secondary Schools of Satkhira District in Bangladesh

Mostofa M.G

Abstract

This study investigates what dialect teachers use in class, and how it affects students' attitudes and their English language learning. Data were collected from teachers and students from two secondary schools in Satkhira district of Bangladesh. Two teachers and sixteen students were purposively selected from two schools as respondents in this study. Thematic analysis guided the analysis of the collected data. However, all the data and findings show that students and teachers use dialects or local languages in the classrooms. Both teachers and students use this kind of language subconsciously though they don't think that it should be continued in classrooms. There are many reasons for using dialect in the classroom. Study shows that using dialect works as a barrier in learning English but sometimes it works as a promotor of English also.

Keywords: Dialect, Attitude, overgeneralization, Teaching-Learning, Standard Language, Classroom.

1. Introduction

Secondary school teachers typically teach English classes in Bangla in Bangladesh's rural areas, but they lack the knowledge necessary to use the standard language (Bangla). This is why students from rural areas find it difficult to adopt and use formal language in higher education. English is used as a foreign language in Bangladesh. Teachers and students have trouble with language skills because English is a foreign language. How to accurately utter the language's speech sounds is one of the difficulties for language learners, according to Haque[1].

"A dialect is a regional or social variety of a language that is distinguished by pronunciation, grammar, or vocabulary. I refer to dialect as the result of both regional and social variation." The language varieties spoken in certain communities can be classified as standard and non-standard dialects. The standard dialect is a prestigious and codified variety that has the highest social status and is used on formal occasions[2]. The non-standard dialect is any variety of language that is not standardized and lacks prestige[3]. Sometimes the standard variety is considered a language, People living in Bangladesh use different kinds of accents when speaking in Bangla. There are many dialects in Bangladesh and they can be clustered into different groups. People living in North Bangal use their own Bangla accent. It's called North Bengal Dialect including those of Dinajpur Rajshahi, Pabna, etc. In North Bengal, there is a different format of

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Bengali accent for the Rangpur division. People who are living in West Bengal of Bangladesh have a different kind of Bangla accent. Those districts are Mymensingh, Dhaka, etc. There is a South Bengal dialect. This dialectical area includes Chattagram, Noakhali, etc.

There are two kinds of languages in Bangla; standard Bangla and dialectical Bangla. The people of Bangladesh are divided into different forms depending on their dialectical sounds or languages. The standard language is a language that people use as a common language. The use of dialect depends on the specific region. Sometimes people pronounce the same words in different ways. It happens because of educational attainment, social status, cultural affairs, and religious persuasion.

1.1 Problem Statement with Justification

Teachers in Bangladesh, generally conduct their classes in a local language known as dialect. As local dialects are more widely spoken particularly in rural areas, it is common to find teaching and learning activities conducted in them in schools there. This study looked into the impact of dialect use on students' English learning.

Learning a second or foreign language entails accomplishing four language skills. These include speaking, reading, writing, and listening. It is more challenging for students to acquire the four language skills perfectly when a teacher uses dialect in teaching-learning activities. This study contributed to a better understanding of the factors that influence students' achievement in English learning. From this point of view, this study will be performed based on the research question as follows.

1.2 Objectives of the Study

To meet the research questions this study will be performed based on the following objectives:

- To explore the effects of using dialect (Bangla) in English teaching-learning activities in secondary schools in Satkhira.
- To find out the teachers' behaviors and how students react to them.
- To examine whether the use of local dialect in the classroom facilitates the students' learning outcomes or does it work as a barrier to students' learning.
- To examine how the use of dialect affects students' learning of language skills.

1.3 Research Questions

What dialect do teachers use in class, and how does it affect students' attitudes and their English language learning?

2. Literature Review

The language varieties spoken in a certain community can be classified as standard and non-standard dialects. The standard dialect is a prestigious, codified variety that has the highest social status and is used on formal occasions[4]. The non-standard dialect is any variety of language that is not standardized and lacks prestige. Sometimes the standard variety is considered a language, whereas the non-standard variety is considered a dialect[5].

Haugen pointed out that "The Greek word dialectos was first applied in ancient Greece. It was used by every member of a set of languages and it was originally derived from an ordinary Greek language. Every group represented the speech of the main city and had a particular literary function. In other terms, the language called Greek was a separate group, and dialects were written norms. Eventually, they were based on spoken dialects of the regions whose names they hold. Thus, much of the problems over the language or dialect division came from the haziness inherent in that original situation. Maintaining mutual intelligibility was not considered, so there was not a clear division between the two ideas of Dialect and Language. Amusingly, we still have these difficulties with the way the word dialect is used"[6].

In previous studies conducted on similar ideas, researchers in some countries found that students in rural areas taught and learned by dialect (their English accent) are less competent in speaking.

Tannen[7] stated that Dialect differences in oral English are also likely to disadvantage students from vernacular backgrounds because talk conveys messages about social identity, along with other meanings. Shahria Shuchi[8] claimed that all English teachers are not aware of this problem. Some of the teachers believed that lack of awareness creates an obstacle to producing Standard English. Sometimes teachers are not so cooperative. Some teachers neglect this type of problem and they need to take extra care of those students who have a problem producing correct English. Shuchi manifested these from an article named "The Effect of Bangla dialect on English Language Teaching: Teachers' Perspectives and Attitudes"

The above study does not fulfill the purpose of this study rather it makes sense to make this study better.

3. Methodology

The study's participants are secondary school teachers and students. Purposive sampling was used to select two (2) schools from the Satkhira district for this study. To reduce homogeneity, one (1) school in the urban area and another (1) school in the rural area were chosen. Two Focus Group Discussions (FGD) were held in two schools with eight students from each school. Besides that, two teachers were interviewed with semi-structured questionnaires from two different schools.

4. Result and Discussion

4.1 Teachers' Interview

4.1.1 Using Dialect in the English Class

The local dialect is typically used in teaching and learning activities at local schools. They use it subconsciously and consciously at times, but the majority of the time they use it subconsciously. The respondents acknowledged the use of dialect in their English classes, but the urban teacher stated that he typically uses standard language in the classroom. He tries to speak in standard language so that students can understand and learn the ideal language that students should achieve. He added that although he tries to use standard Bangla in the classroom, dialectical sounds occasionally sneak in unintentionally. On the other hand, the teacher from the rural area admitted that because his school is located in a remote area, most teachers in their school use dialect in the classroom. He believes that the students' dialectical sound is caused by their distance from the city.

4.1.2 Dialect as a Barrier to English Learning

"Students face fewer difficulties in dialectically conducted classrooms because there aren't many differences between our Shatkhira local language and standard language." proclaimed the urban teacher.

They believe that their students can comprehend a topic's basic idea. Because they are more similar to the standard language, our students can understand both of these.

4.1.3 Skills are Influenced by Dialect

Both respondents believe that four language skills are not significantly influenced by dialect, but dialect does have an impact on language skills. The urban teacher claimed that dialect has a greater impact on writing and speaking in particular. The local tune is used by the students to create sounds. For instance, they pronounce "against" as "againist" rather than "against." Although they make spelling mistakes when writing, they believe that this is the correct spelling. Shatkhira students add an extra vowel to their words. For example,

Table: 4.1.3

Original word	**Their pronunciation**
Brush	Birush
against	againist
from	forom
global	golobal

This issue was identified by both respondents among the students. They believe that students add extra vowels to words unconsciously. Students believe they are pronouncing correctly, but they are unaware of their errors.

4.1.4 Advantages and Disadvantages of the Use of Dialect in English Classroom

According to the urban teacher, there are fewer benefits than drawbacks. He believes that using dialect in English classrooms should be discouraged because both Bangla and English should be encouraged and used to help students improve their standard language skills.

However, despite the school's remote location, the rural teacher asserted, "I think there are not fewer facilities of use of dialect in English classrooms." Local language, he believes, is beneficial to those who do not frequently listen to the standard language. Some examples of the advantages and disadvantages of the use of dialect in English classrooms are shown in the table below.

Table: 4.1.4

Advantage	**Disadvantage**
Students can understand the topic fast	It impacts speaking mostly
Students can participate in the classroom easily and the rate of participation increases.	Students could be the victim of bullying during their higher education because of their use of dialectical sound
Easy for the teacher to conduct the classroom	Colleagues and friends could humiliate.
Students feel comfortable	It hampers the smoothness of Higher Education.

4.2 Students' FGD

The researcher held two focus groups with students from both schools. Students were divided into groups A and B for better understanding during the FGD.

4.2.1 Language Skills Are Influenced by Dialect

The majority of students in both groups believe that dialect influences speaking the most. They claimed, "It is normal that speaking would be more influenced than other language skills because teachers use dialect in speaking." A student from Group B provided an example of dialectical English pronunciation. He stated that we pronounce 'biskut' rather than 'biscuit.' They created a local pronunciation format for particular English words.

They acknowledge that when they read aloud, they sometimes mispronounce certain words, but they do not believe that dialect has an impact on reading and writing. Making regional or dialectical sounds is typical when reading aloud because it is more similar to speaking.

Nearly all of the students in group A believe that dialect has no impact on listening. Dialectical influences cause them to make mistakes when speaking. On the other hand, a couple of students mentioned that they have trouble understanding standard English and Bangla. They claim that because they are accustomed to hearing dialectical or local Bangla, they are unable to understand the few words that are spoken there.

4.2.2 How Dialect Facilitates English Learning

All of the students agreed when they said, "We can easily understand the topic if the teacher uses a dialect or local language as the medium of English teaching." Both groups of students place a strong emphasis on using the local language in the classroom to better understand the subject. According to their reasoning, since teachers and students speak the same language, they are better able to understand the psychology and language of the students.

On the other hand, students claimed that when dialectical sounds or the local language is used as the medium of instruction, they are more willing to participate in class activities. According to them, classrooms instructed in dialect ensure greater student participation than classrooms instructed in standard language.

5. Summary of the findings

Both teachers and students agree that using dialect in the English classroom has an impact on learning outcomes. Teachers are unaware of the dangers of using dialect in the classroom. Even some teachers disagree that they use dialect in the classroom, despite claims to the contrary from students. Both teachers and students believe that dialectical sound enters the classroom subconsciously. Compared to teachers in rural areas, city teachers are more aware of how language is used in the classroom. Dialect use in the classroom mainly affects two productive language skills. Speaking is the primary skill that dialect use affects or manipulates, according to both students and teachers. According to the researcher, not only teachers but also students and others should be held accountable. Students asserted that if they receive proper instruction, they will produce accurate language pronunciation. Teachers believe that because students are accustomed to dialect, they are more interested in listening to dialect than standard sounds. Several words have been given different sound formations by teachers and students following their dialectical uses.

However, it is impossible to hold the students alone accountable for their inability to produce formal language. The majority of class activities are spoken in dialect. The respondents, both teachers and students are aware of their dialect-related limitations but should give it up. The teacher, the school board, and the authorities must all recognize

the correct situation for students' language learning. It also allows the guardian to be aware of their children's accomplishments.

6. Discussion

After gathering the necessary data, the researcher examined it to conclude. Students who participated in the data collection claim that the local language is used in English classes. Rural students are more likely to be influenced by dialectical sounds. "Because our school is far from the city, our classrooms are more influenced by the local language," the rural teacher explained. Students stated that they use dialect in the English classroom for a variety of reasons. They believe that teachers are primarily to blame. As students mimic their teacher's language, they speak in the manner of their teacher. Shahria Shuchi similarly said that "All English teachers are not aware of this problem. Some of the teachers believed that lack of awareness creates an obstacle to producing Standard English". However, teachers believe that students pick up dialects as their mother tongue from their families, friends, communities, and surroundings and apply this knowledge in the classroom. Fasold[9] stated in the same way that "It requires every teacher wants that the students could learn correct English. The whole matter is carrying out the term „Standard English". They acknowledged that they are accountable for the dialectical applications made by students. The Cross-linguistic transfer is the process by which students learn a second language while using their native tongue. According to their mother tongue, students overgeneralize their target language. They create a novel format for word pronunciation as a result. Using dialect is no barrier in all aspects. To students using dialect facilitate teaching-learning activities. They said that when teachers use dialectal instruction, they can understand the lesson easily. This type of classroom environment helps students to be engaged in teaching activities. A student from group A said, "If the teacher uses standard language in the classroom, we feel shy to take part in the class."

However, there are positive and negative impacts of using dialect in English classrooms. For students' betterment system should be developed so that our students can be competent in language skills. Everybody should use language considering situations. The use of dialect is not always a barrier. The use of dialect by students facilitates teaching and learning activities. This type of classroom environment encourages students to participate in teaching activities. "If the teacher uses standard language in the classroom, we feel shy to participate in the class," a student from group A stated. However, using dialect in English classes has both positive and negative effects. A system for student development should be developed so that our students can be competent in language skills. Everyone should use language to consider situations.

7. Conclusion

Finally, it can be concluded that everyone involved in the teaching-learning process should be more accountable for the student's learning. The education board, policymakers, and teachers in particular should create a setting where students can develop their pure language skills. The students are completely helpless because they

are unable to pronounce words correctly without the assistance of their surroundings. Teachers should use formal language in the classroom to benefit their students. Teachers face some obstacles as well. Sometimes the setting does not allow them to speak Bangla or standard English in the classroom. But, in the end, it is the teacher who can do the most to help students learn standard English. Teachers and students should participate in a scenario where students are given the chance to speak up to illustrate communication teaching methods. Students will learn the proper pronunciation of sounds if they can participate in class communication. Throughout this procedure, the teacher will correct any errors made by the students and instruct them on how to pronounce the word properly. To create competent students, everyone should participate in overcoming the dialectical sound in English. Because this research is limited to high schools in Shatkhira, further research can be conducted throughout Bangladesh. The study can also include both government and non-government schools. Because this study does not cover every level of education, additional research could include primary, secondary, college, and higher education. To generalize the findings, quantitative research can be conducted. However, this study will aid in the investigation of other studies in this field.

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The Study of Comparative Religion in the Aspect of Islam

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Abstract

The term "comparative religion" is popular and appealing in today's world. Comparative religious discourse has substantially advanced. Comparative religion is the study of how other religions are alike and different, as well as how their justifications and irrationalities can be determined using evidence and logic. It also discusses the beginnings, development, antecedents, tenets, and sources of many different religions analyzing the similarities and differences between the social and religious activities of many religions. Westerners assert that they are the founders of this science and that they are where it all started. On the other hand, due to a lack of information, some Muslims view the comparison of religions as being outside of Islam. However, the Quran and Hadith contain a number of instructions in this regard. The objectives of this article is to highlight the perspective of Islam in the study of comparative religion through content analysis by reviewing and analyzing the Qur'an, Hadith, history of Islam and the writings of Islamic thinkers in a qualitative nature. Finally an effort has been made to demonstrate that comparative religion is a field supported by the Qur'an and the Sunnah as like other branches of Islamic knowledge, it is a discipline prescribed by Islam, and Muslims are the founders of this science. The doctrine of comparative religions was originated with the flourishing of Islam. This doctrine is not propounded by the western experts, though some people think so.

Key Words: *Religion, Islam, Al-Quran, Comparative Religion, Muslim*

Introduction

From the beginning of time till the present, religion has been one of the most important factors in promoting human solidarity. Human history has been influenced by religious beliefs, institutions, artistic productions, legal frameworks, and objectives. Nearly 83% of the global population practice one of the twelve main ancient religions, including Baha'i, Buddhism, Christianity, Confucianism, Hinduism, Islam, Jainism, Judaism, Shinto, Sikhism, Taoism, and Zoroastrianism[1]. Comparative research is the process of systematically comparing several worldviews. A thorough knowledge of the philosophical components of religion may often be gained through comparative religious studies. Comparative religion was an idea that first emerged during the time of the prophet Muhammad (SAW) and flourished as the Islamic state expanded under various regimes. During the time of the Abbasids, it peaked. Ibn Hazm was among the Muslim intellectuals who initially introduced the systematic study of comparative religion in the 10th century. In his monumental work, "the Fisal (Detailed Critical Examination)," he provides a critical analysis of several philosophical schools in connection to the religious convictions of Jews, Christians, Brahmans, Zoroastrians, and other dualists[2]. However, the works of Max Muller, Edward Burnett Tylor, William Robertson Smith, James George Frazer, Emile Durkheim, Max Weber and Rudolf Otto

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in the 19th century sparked a considerable interest in comparative and "primitive" religion in western civilization.

What is the comparison?

Comparative analysis of many fields of knowledge has been increasingly popular among writers and researchers in recent years. Such as it is called "comparative literature". Again, it is known as "Fiqhul Mukarin" or comparative fiqh in the field of Islamic studies. It is known as "Muqaranatul Adayan" or comparative religion in the field of additional research on religion. Additionally to these, comparative research is carried out in other fields. While challenging, this kind of research is also enjoyable. due to the substantial study and research required when comparing different things. Research in philosophy, history, theology, literature, and other fields as well as the sphere of art all have varied definitions of comparative discussion. Similar to this, the objectives and methods differ. Comparative analysis of fiqh and religion is different from comparative analysis of literature. And since this issue is well recognized, there is no need to rely on a researcher's or expert's interpretation in the comparative discussion. To avoid obstructing the advancement of knowledge-science and study, those who oppose comparative research and discussion should have a thorough understanding of the topic.

Given these variations in how comparative discussion is understood, researchers need to have a deep understanding of this particular concept. Understanding the Arabic term for comparison is important since the following article will address comparative religion from the perspective of Islam. The Arabic term for this word is مقارنة (*Mukaranah*). The word can mean a variety of things practically. A comparison sense is conveyed when the term *Muqarana* is used with an object or subject. As it is said in Arabic, قارن الشئ بالشئ (compare this thing with another), or قارن بين الشيئين أو الأشياء (compare between two or more things). According to this perspective, comparison between various literary works is known as comparative literature, and comparison between various legal systems is known as comparative jurisprudence[3]. These have led to the development of comparative fiqh, comparative religion, comparative politics, etc.

The dictionary of Al-Mu'zam al-Phalsafi (المعجم الفلسفى) mentions several meanings of the Arabic word *Muqaranah* (مقارنة) among them:

1. The intellectual act of uncovering similarities-contrasts between two or more objects or subjects is called *Muqaranah* (مقارنة) meaning “comparing”. This is called intellectual comparison. This sort of comparison is carried out in order to discover similarities and differences between the two connected subjects based on a connection or bond between them. Furthermore, this relationship involves two or more entities.
2. *Muqaranah* (comparing) meaning, method or practice—principle. This is called systematic comparison. It is the name of a technique that contrasts things of

various shapes based on their outward appearance or relationship between any of the various animal species, organs, or occupations or social classes. This form of systematic comparison is regarded as the best tool or technique in sociology.

3. *Muqaranah* means matter, matter, problem etc. This is called subjective comparison. This can be seen in logic. The term "thematic comparison" in logic refers to a comparison between two objects that are similar in nature but differ in one or more particular properties, either important or small.[4]

Examining the lexical definitions of the Arabic term *Muqarana* found in the Al-Mu'zam al-Wasit dictionary, it appears that the word *Muqarana* means, التسوية و المساواقة; that is, to reconcile or equalize two things[5]. A similar word also means *Muwazan* (الموازنة) or to compare[6]. And this meaning has gained popularity among the common people.

Definition of Comparative Religion

Disparities in viewpoint between Muslim and non-Muslim theologians are also evident in the notion of comparative religion as a result of differences in goals and purposes. Muslims are credited as being the first to introduce comparative religion, according to Muslim theologians. The Qur'an was revealed at the time of the Prophet (PBUH) by using the presentation of the religions of Jews, Christians, and polytheists, and its discussion and review persisted until the 12th century of Hijri. Orientalists began doing research in this area in the 13th and 14th centuries of Hijri, seizing the opportunity presented by Muslims' lack of interest in this information. They achieve success by working hard and conducting continuous research. As a result, they are regarded as the founder and architects of this science in the field of education, and the discussion of the original architects is buried in obscurity[7]. Westerners have been frequently used to define comparative religion. Here, we'll try to give definitions from both Western and Muslim theologians.

Comparative religion according to Muslim theologians

Dr. Sayyed Muhammad Aqeel said, in providing the identity of comparative religion from the point of view of Muslims,

علم يقارن بين الأديان لاستخلاص أوجه الشبه والاختلاف بينهما، ومعرفة الصحيحة منها والفاسدة، إظهارا لحقيقة الإسلام بأدلة يقينية.

Comparative religion is a science that deals with the comparative discussions among religions with the aim of uncovering their similarities and differences and identifying the purity and error between them in order to show the truthiness and reality of Islam with certain evidence[8].

Dr. Jawad Ali said in this regard,

المقارنة وهى تعتمد كما يتبين من إسمها على المقارنات بين الأديان فتناول جميع النواحى بالبحث لتجد ما بين من مطابقات ومفارقات

Determining the exact similarities and contrasts between different religions through a comparative review of their inherent multifaceted aspects is comparative religion[9].

Dr. Mahmud Muhammad Mazruah said,

هو علم الذى يبحث فى سائر الأديان مقارنة بعضها ببعض من نشأتها وتطورها و عوامل انتشارها أو من حيث المحتوى النظرى والتطبيقى أو القصائد والأعمال وهذا الجانب هو الأهم وهو المقصود يعنى بدراسة الجانبين معا جانب الشاة وجانب المحتوى والضمون دراسة تقوم على التحليل ولمقارنة بين دين ودين أو بين دين أو اكثر لتمييز صحيحها من مسقمها وحقها من باطلها.

Comparative religion is the name of a science that reviews by comparing in terms of the origin, development, causes of spread of different religions, the underlying issues of religion, characteristics, similarities and differences, religious activities, basic practices of religion on the basis of comparison and determines true religion from weak religion and rational religion from invalid religion[10].

Comparative religion as defined by Western theologians

Comparative Religion is that science which compares the origin structure and characteristic of the various religion of the world which the view of determining their genuine agreements and deference the measure of relation in which they stand or one of another and their relative superior or in majority when regarded as type[11].

Goals and Objectives of Comparative Religion

This goal is not what comparative research seeks to achieve. Especially when it comes to revealed religions. Since they are a compendium of Allah's revelations. Similar to how philosophy works, these are not human thoughts that may be impacted and influenced by any external influence. From a Muslim's point of view, the aspired and actual purpose of comparative religion is to defend Islam through self-defense by illuminating the real and authentic religion; this is viewed as the true impetus for the development of comparative religion[12]. Under the section titled "The Origin and Development of Comparative Religion from the Point of View of Muslims," a thorough explanation of this problem will be provided.

However, this science has been misapplied by Western academics. As with all of their other methods, they have selected this one to use all of their resources to destroy Islam. For this reason, they have given the subject considerable attention by engaging in intensive propaganda, setting up specific departments in their institutions, and offering

scholarships to people from the Muslim community to study and conduct research on it. Generally speaking, their aim in advancing and disseminating comparative religion is the obliteration of Islam. Furthermore, this is a terrible thing. Considering that their goal is to achieve equality between all religions and maintain them all in a row[13].

Today's Muslim academics and scholars emphasize comparative religion and embrace it in light of the outlines provided by Western scholars. After completing their studies at Western universities, they devote their time to promoting false, dishonest and useless Western policies and education in their own countries. Their actions have contributed to the continued success of Westerners' efforts to repress Islam.

Islamic Perspectives on Comparative Religion

There are some differences of opinion among Islamic scholars and philosophers regarding what comparison means. Some have disregarded it in this regard by declining to discuss comparisons. Regarding Islamic and other matters in particular. They believe that in such a comparison, topics related to Islam and other topics created by unbelievers and fire worshipers will be put in the same category and given equal standing. Therefore, they contend that if this form of comparative research is stopped, it would also stop being discussed how Islam compares to other religions. On the other hand, there is no assurance of the originality and purity of religions other than Islam; additionally, they are frequently caught up in numerous false ideas, distorted, and transformed, and are usually ineffectual. Islam therefore cannot be in any way comparable to them. Some people are starting to favor these lexical interpretations of the word "comparison." The words "comparative discussion" or "research" immediately conjure up these associations in their minds. Additionally, they disapproved of discussions that compared Islam to other subjects. Therefore, it is not necessary to compare Islam to other religions. They believe comparative religion to be a discipline developed by Western academics and unrelated to Islam. The truth is that for a very long time, Western scholars have taken the initiative to define and characterize this science in their own ways, taking advantage of the disdain and neglect of Muslims in this field. However, it is an Islamic science, and Muslims are its founders. Under a few headings, this subject will be covered in depth.

Firstly: Comparative religion is a branch of Islamic scholarship

In the discussion above, we said that some individuals believe that comparative religion is a concept developed by Western researchers and that they have used it as a tactic to combat Islam. However, it was not created by Westerners or is not solely their work; rather, it is a result of Muslim affairs and their actions. Initially, this issue was raised by Muslims. So without a doubt, it is a topic related to Islam. Here are some examples of evidence to back this up[14]:

1. Writings on comparative religion started to be compiled in the second half of the Hijri calendar. In this regard, according to Dr. Ahmad Shalabi, "Muslims started

writing about Tafseer, Hadith, and Fiqh in the middle of the second Hijri, and they also focused on writing about comparative religion.[15]

2. Comparative religion research did not exist prior to the rise of Islam. Because before Islam, there was no religion that recognized other faiths. One of the factors leading to the creation of this Science is the mutual recognition between various religions. Every religion regarded other religions as corrupt and recent creations. Christianity and Judaism are two examples of religions that do not acknowledge one another. Jews rejected Christianity and the prophetic claims of Jesus. Jesus (AS) was hanged when they declared him a heretic. Christians, on the other hand, believed they were descended from the Jews. After their arrival, they believed that neither Judaism nor its adherents could exist. Similarly, Hinduism and Buddhism can be compared. In Andalusia, Christians also had the same opinion of Islam.[16]
3. A number of other religions existed before Islam. Islam has thus been accepted by all religions both intellectually and practically. And the development of comparative religion was based on the field itself. Islam claims that it is the last religion in the line of faith, both theoretically and practically. It also includes substantial aspects from other religions and takes into account all the requirements for human life to endure till the Day of Judgment. Therefore, Almighty Allah states:

شَرَعَ لَكُمْ مِنَ الدِّينِ مَا وَصَّى بِهِ نُوحًا وَالَّذِي أَوْحَيْنَا إِلَيْكَ وَمَا وَصَّيْنَا بِهِ إِبْرَاهِيمَ وَمُوسَى وَعِيسَى أَنْ أَقِيمُوا الدِّينَ وَلَا تَتَفَرَّقُوا فِيهِ[17]

"He has prescribed for you the religion which He prescribed upon Noah, and that which we have revealed to you, and that which We prescribed upon Abraham, Moses, and Jesus, saying, you should establish the religion." And this is why Islam has become such a monotheistic religion, which no other religion can be similar to. That is why the announcement of Allah,

إِنَّ الدِّينَ عِنْدَ اللَّهِ الْإِسْلَامُ[18]

"Undoubtedly, Islam is the only religion with Allah." Allah Ta'ala also says in this context,

وَمَنْ يَبْتَغِ غَيْرَ الْإِسْلَامِ دِينًا فَلَنْ يُقْبَلَ مِنْهُ وَهُوَ فِي الْآخِرَةِ مِنَ الْخَاسِرِينَ[19]

"Whoever wants to accept a religion other than Islam, it will never be accepted and he will be among the losers in the Hereafter."

Muslim scholars have concluded that each Prophet had a message appropriate for his age and worked to further its goals all the while. Once more, as new needs

arose, a new phase of religion also appeared. This one coexists with the previous one in its basic form of monotheism, but its branches change in response to those needs. Regarding earlier religions, this is the tenet and attitude of Islam. In this circumstance, Islamic scholars have focused on how to interpret the words of Allah Ta'ala. The verse interprets:

اللَّهُ لَا إِلَهَ إِلَّا هُوَ الْحَيُّ الْقَيُّومُ ـ نَزَّلَ عَلَيْكَ الْكِتَابَ بِالْحَقِّ مُصَدِّقًا لِمَا بَيْنَ يَدَيْهِ وَأَنْزَلَ التَّوْرَاةَ وَالْإِنْجِيلَ ـ مِنْ قَبْلُ هُدًى لِلنَّاسِ وَأَنْزَلَ الْفُرْقَانَ إِنَّ الَّذِينَ كَفَرُوا بِآيَاتِ اللَّهِ لَهُمْ عَذَابٌ شَدِيدٌ[20]

"There is no god but Allah, the Eternal, and the Sustainer of all things. He has sent down to you the Book with the truth, which supports the Book before it. And He sent down the Torah and the Injeel before this as guidance to mankind; and he revealed the Furqan." There is a severe punishment for those who reject Allah's signs. Their interpretation of this is that whoever rejects Allah Ta'ala or His signs in any religion (even if that religion is known to be untrue) will face a severe punishment for his denial. [21]

On the other hand, from a practical point of view, it can be seen that Islam has recognized the real existence of non-Muslim communities. Islam discusses about *Ahlul Kitab* and *Ahluz Jimmah*. It also outlines their rights and responsibilities towards them. So from this point of view also the validity and existence of comparative religion can be found.[22] Here, for example, the following words of Allah Ta'ala can be cited:

يَا أَهْلَ الْكِتَابِ لِمَ تَلْبِسُونَ الْحَقَّ بِالْبَاطِلِ وَتَكْتُمُونَ الْحَقَّ وَأَنْتُمْ تَعْلَمُونَ[23]

"O People of the scripture! Why do you mix the truth with falsehood and hide the truth when you know?"

يَا أَهْلَ الْكِتَابِ لِمَ تَكْفُرُونَ بِآيَاتِ اللَّهِ وَأَنْتُمْ تَشْهَدُونَ[24]

"O People of the scripture! Why do you deny the revelation of Allah, when you are the bearers of the witness?" There are also numerous verses in this regard in Surah Al-Baqarah, Ale-Imran, Mayidah, A'raf, Tawbah, Hud, Yusuf and Hijr. On the other hand, Al-Quran addresses the unbelievers of Makkah through the words of the Prophet (PBUH) in Surah Kafiroon, where it is said,

قُلْ يَا أَيُّهَا الْكَافِرُونَ ـــ لَا أَعْبُدُ مَا تَعْبُدُونَ ـــ وَلَا أَنْتُمْ عَابِدُونَ مَا أَعْبُدُ ـــ وَلَا أَنَا عَابِدٌ مَا عَبَدْتُمْ ـ وَلَا أَنْتُمْ عَابِدُونَ مَا أَعْبُدُ ـــ لَكُمْ دِينُكُمْ وَلِيَ دِينِ[25]

"Say (O Muhammad!) O disbelievers! I do not worship Him whom you worship and you are not the worshipers of Him whom I worship. And I shall not worship that which you are worshipping. Nor will you worship that which I worship. Your religion is yours, my religion is mine."

Secondly: Al-Quran and Comparative Religion

The Qur'an contains certain verses that are comparative in nature. Which demonstrates that Al-Qur'an is the basis of comparative discussion of religion. Such as:

1. Arguing with the People of the Scripture in a good manner

Al-Qur'an permits debate with the People of the Book as well as Judeo-Christians, which indicate the practice of comparative religion. In this context, Allah Ta'ala says,

تُجَادِلُوا أَهْلَ الْكِتَابِ إِلَّا بِالَّتِي هِيَ أَحْسَنُ[26]

"Do not argue with the people of the Scripture except in the best way (المجادلة بالحسنى)." So (المجادلة بالحسنى) i.e. debating in the best way is the meaning of comparative religion.[27] Sayyid Qutb (Rh) narrated the wisdom of disputing with the People of the Scripture in a good way. He refers to this kind of debate as a comparative religion. According to him, it consists in explaining the wisdom of the arrival of a new message (religion) and uncovering its relationship with previous messages (religions), as well as expressing the need to accept with satisfaction the latest method of calling to the path of Allah, a method which is compatible with the earlier methods according to the wisdom of Allah for human needs, and also perfects them.[28]

2. The reliability of the real *Ilah* (God) and the ineffectiveness of the fake *Ilah* (God)

The Al-Qur'an makes several comparisons between the actual and true *Ilah* (God) and the false *Ilah* (God). The true and real *Ilah* (God) is Allah alone, there is no true *Ilah* (God) but Him, and the statement of Al-Qur'an about the futility by comparing between Him and those who are considered as Gods besides Him is,.

إِنَّمَا تَعْبُدُونَ مِنْ دُونِ اللَّهِ أَوْثَانًا وَتَخْلُقُونَ إِفْكًا إِنَّ الَّذِينَ تَعْبُدُونَ مِنْ دُونِ اللَّهِ لَا يَمْلِكُونَ لَكُمْ رِزْقًا فَابْتَغُوا عِنْدَ اللَّهِ الرِّزْقَ وَاعْبُدُوهُ وَاشْكُرُوا لَهُ إِلَيْهِ تُرْجَعُونَ[29]

"You worship idols besides Allah and invent lies. Those whom you worship besides Allah have no power to give you provision, so seek provision from Allah and worship Him and express gratitude to Him. To Him you shall return." The verse in question is very clearly indicative of the comparative discussion of religion, where the true and false gods are compared. It is said that the real and true God is the one who deserves to be worshiped without any controversy, and none other than him can be worthy of worship. And he is the only provider. On the other hand, the false God who does not

have any authority over people, who is not capable of doing any kind of good or bad to people.

In another place, Allah says,

أَفَمَنْ يَخْلُقُ كَمَنْ لَا يَخْلُقُ أَفَلَا تَذَكَّرُونَ[30]

"Is then He, who creates as one who creates not? Yet will you not remember?"

كَانَ فِيهِمَا آَلِهَةٌ إِلَّا اللَّهُ لَفَسَدَتَا[31]

If there were many gods besides Allah in the heavens and the earth, both would perish."

Here is an illustration of comparing monotheistic and pluralism. Where the opponent of monotheistic is pluralism, is portrayed as a catastrophe and a source of chaos. Because monotheism is the reason the servant is happy and successful.

3. To call the people of the scripture toward Tawheed

In various verses of the Qur'an, the People of the Scripture have been called to monotheism. The Prophets and Messengers who were sent to them established Tawheed among them, which is also the principle of Islam. After the ascension of Prophets and Messengers, especially after the death of Prophet Musa and after ascending the Jesus to the fourth heaven, they moved away from the path of monotheism[32]. Hence the declaration of the Qur'an calling for monotheism by comparing the People of the Scripture and the Muslims:

قُلْ يَا أَهْلَ الْكِتَابِ تَعَالَوْاْ إِلَى كَلَمَةٍ سَوَاء بَيْنَنَا وَبَيْنَكُمْ أَلاَّ نَعْبُدَ إِلاَّ اللّهَ وَلاَ نُشْرِكَ بِهِ شَيْئًا وَلاَ يَتَّخِذَ بَعْضُنَا بَعْضاً أَرْبَابًا مِّن دُونِ اللّهِ فَإِن تَوَلَّوْاْ فَقُولُواْ اشْهَدُواْ بِأَنَّا مُسْلِمُونَ[33]

Say, O People of the Book! Come to one thing, which is equal between us and you, that we worship none but Allah, and associate no partners with Him, and do not take as lords other than Allah alone. Then if they do not accept, then say, 'Be witness, we are loyal.' This verse also implies comparing Islam with other religions.

4. Comparing the creation of Adam with the creation of Jesus

By comparing the creation of Adam (pbuh) with the creation of Jesus, the Jewish and Christian conceptions of Jesus are rejected, and this issue bears a witness to the discussion of comparative religion from the Qur'an. As Allah says,

إِنَّ مَثَلَ عِيسَى عِنْدَ اللَّهِ كَمَثَلِ آَدَمَ خَلَقَهُ مِنْ تُرَابٍ ثُمَّ قَالَ لَهُ كُنْ فَيَكُونَ[34]

"Surely the example of Jesus in the sight of Allah is like the example of Adam. He created him from dust, then said to him, 'Be', so he became."

In this verse there is a comparison between Jesus and Adam. As in creation they are both made of clay. Again Jesus was born by the Word of Allah, Kun Fayakuon (كُنْ فَيَكُون). Similarly Adam (A.S.) was created by the Word of Allah Kun Fayaqun. For they were both born without a father, an exception to the normal rule.[35]

5. A comparative discussion between Jews, Christians and polytheists

Jews, Christians and polytheists have been enmity with Muslims from the beginning to the present, as history has witnessed. In the Qur'an, Allah the Exalted says, comparing their hostility,

لَتَجِدَنَّ أَشَدَّ النَّاسِ عَدَاوَةً لِّلَّذِينَ آمَنُواْ الْيَهُودَ وَالَّذِينَ أَشْرَكُواْ وَلَتَجِدَنَّ أَقْرَبَهُمْ مَّوَدَّةً لِّلَّذِينَ آمَنُواْ الَّذِينَ قَالُوَاْ إِنَّا نَصَارَى ذَلِكَ بِأَنَّ مِنْهُمْ قِسِّيسِينَ وَرُهْبَانًا وَأَنَّهُمْ لاَ يَسْتَكْبِرُونَ[36]

"You will find the Jews and polytheists more hostile to Muslims than any other people, and you will find those who call themselves Christians closer to friendship with Muslims than anyone else. This is because among the Christians there are scholars, there are dervishes and they are not proud." Here Christians are mentioned as the least enemy compared to the followers of these three religions.

6. There is a discussion of different religions in Al-Quran

The Quran discusses several religions in various places. Sometimes directly by naming the religion or its followers, sometimes by allusion. For example, Al-Quran discusses about Islam, Jews, Christians, Sabaites, Magi, polytheists and also discusses the activities of the followers of all these religions. Almighty Allah says:

إِنَّ الَّذِينَ آمَنُوا وَالَّذِينَ هَادُوا وَالصَّابِئِينَ وَالنَّصَارَى وَالْمَجُوسَ وَالَّذِينَ أَشْرَكُوا إِنَّ اللَّهَ يَفْصِلُ بَيْنَهُمْ يَوْمَ الْقِيَامَةِ إِنَّ اللَّهَ عَلَى كُلِّ شَيْءٍ شَهِيدٌ[37]

"Surely Allah will judge between those who believe and those who are Jews, the Sabians, the Christians (Christians), and the fire worshipers and those who commit shirk on the Day of Resurrection. Verily, Allah is over all things a witness."

This verse adds an important chapter to comparative religion. A total of six religions are mentioned in this verse. If we look at the roots of the world's religions, we find them limited to these six creeds.

Thirdly: Al-Hadith and Comparative Religion

When Al-Qur'an has a positive attitude towards the comparative discussion of religion, even when the comparative discussion is clearly reflected in the above-mentioned verses, it is natural that Al-Hadith as a supplement to the Al-Qur'an will also have a positive attitude towards the comparative discussion of religion. There are numerous hadiths of the Prophet (peace be upon him) that provide guidance for comparative discussion and clear indications of comparative religion.

The history of Islam has recorded many such incidents in which numerous debates and dialogues took place between the Prophet (PBUH) and the polytheists. Arguments about the scriptures are also going on with the Jews. Similarly, we see the Prophet's (PBUH) debate with the Christian representative of Najran.[38]

Numerous debates and dialogues were held between the Prophet (pbuh) and some prominent polytheists on the subject of resurrection. In this case, the name of Ubai Ibn Khalaf is particularly noteworthy[39].

Debates were also held between the Prophet (pbuh) and the Jews regarding the religious books. Mahsur Ibn Subhan was once a negotiator for the Jews[40]. He said to the Prophet (PBUH), what evidence do you have that the Qur'an was revealed by Allah? At this time the word of Allah was revealed,

وَلَوْ كَانَ مِنْ عِنْدِ غَيْرِ اللَّهِ لَوَجَدُوا فِيهِ اخْتِلَافًا كَثِيرًا[41]

"If it (the Qur'an) had come from anyone other than Allah, they would have found many inconsistencies in it."

Another time, a significant dialogue took place between the Prophet (PBUH) and ``*Adi Ibn Hatim Ta'i* 'came as the representative of Christianity; but the controversy ended with his declaration of conversion to Islam and his community followed after him[42].

Countless, innumerable dialogues and debates were held with other non-Muslim groups with the Prophet (PBUH). Ibn Hisham mentions some of them in his famous book Seerat. Among the topics that were debated between the Prophet (PBUH) and the followers of other religions were Uluhiyat (Sovereignty), Prophethood, Religious Scripture and other various topics[43].

Therefore, in view of the above discussion and reality, it is clearly evident that Muslims were the first to initiate comparative religion on the basis of Quran-Hadith. Furthermore comparative religion passes through many levels and finally becomes a particular experience with several principles, prescribed methods and distinct goals.

Origin and Development of Comparative Religion from Islamic perspective

Origin of comparative Religion

Muslim Theologians have cited several reasons for the origin of comparative religion in Islam. Notable among them are:

1. Freedom of Thought in Islam:

Islam came with freedom of thought and research. And this freedom of thought has influenced the origin of comparative religion. In this case the name of Abbasid Caliph Ma'mun can be mentioned. He used to organize meetings for discussion among followers of different religions and factions[44].

2. The tolerant and generous attitude of Islam and Muslims towards the people of Scripture

Islam has always been generous and tolerant towards people of different faiths and beliefs, especially the People of the Scripture. The basis of this kind of attitude is Allah's saying,[45] لَا إِكْرَاهَ فِي الدِّينِ i.e., 'There is no compulsion about religion.' And this impact encourages Muslims to read up on, analyze, and evaluate other religions[46].

3. Defending Islam as the only true religion

Allah's words in this context,[47] إِنَّ الدِّينَ عِنْدَ اللَّهِ الْإِسْلَامُ "Undoubtedly, Islam is the only religion chosen by Allah". Basically, this issue is considered as the real reason for the origin of comparative religion. The real purpose was to present Islam as the only true and pure religion by organizing debates and discussions between different religions, stating that it is the only religion based on pure monotheism, which has no place for any kind of Trinitarians, which Judaism and Christianity have, which is not confined to a fixed boundary like Judaism and Christianity; Rather it is universal. And in that case, their criticism will be exposed in the same way as the Quran has criticized other religions[48].

In view of the reality of the history of Islam, we can say that the origin of comparative religion is a type of the method of Islamic Da'wah. When Islam faced various challenges from the followers of all the religions that came before Islam, it became necessary for Muslims to confront them face to face by participating in mutual dialogues, debates, discussion meetings etc. with Jews, Christians and polytheists. Therefore, it can be definitely said that there is another reason besides the mentioned reasons for the origin of comparative religion, and that is the necessity of this science in spreading Islam. Through which the challenges coming from the Jews-Christians and polytheists have been met.[49]

Development of comparative Religion

Comparative religion has undergone numerous stages of development in order to reach the current stage, just like other Islamic sciences. The developmental stages of comparative religion can be divided into several levels. For example,

1. Formation Period

This level begins with the revelation of those verses of Al-Qur'an which indicate a comparative discussion. Such as the word of Allah, "You worship idols besides Allah and invent lies. Those whom you worship besides Allah have no power to give you provision, so seek provision from Allah and worship Him and express gratitude to Him. To Him you shall return[50]." "Is then He, who creates as one who creates not? Yet will you not remember?" [51] "Surely the example of Jesus in the sight of Allah is like the example of Adam. He created him from dust, then said to him, 'Be', so he became"[52]. There are also many other verses which allude to the comparative discussion mentioned earlier. In addition to the Qur'an, the Prophet (PBUH) also engaged in debates with the Jews, Christians and polytheists on Uluhiyat, Prophethood and other religious matters, sat in dialogue with them and debated with them in the *Mujadalah bil Husna* or the best way i.e. the way prescribed by the Qur'an[53].

2. The era of composition and compilation

By arranging religious discussions between Muslims, Jews, and Christians, the first stage of comparative religion was completed, and it thereafter developed gradually toward perfection. It even starts to be helpful to be listed in a bibliography**.** Finally, from the middle of the 2nd century of Hijri., Muslim scholars began to compile works on this subject. Towards the end of the second century of Hijri, Allama Nuwbakhti wrote his famous work *Al-Ara wad Diyanat*, which is considered to be the first work on comparative religion[54].

At this level of the development of comparative religion, extensive research on Christianity can be found. It was during this period that the Torah and Injeel were translated into Arabic during the reign of Caliph Harunur Rashid. Some books translated from Arabic to other languages are also available at this level. The Arabic translation of the Torah and the Injeel during the reign of Harunur Rashid indicates extensive research in the development of comparative religion during this period[55]. Even during the time of Caliph Ma'mun, debates were organized between followers of different religions, religious groups and factions. Given all of these historical details, it is clear that Muslims placed a high value on the practice of comparative religion[56].

3. The era of growth and continuation

In the second level of comparative religion, we find that writing and compilation began at this level, and the most notable work in this regard is Allama Nuobakhti's *Al-Ara Wad Diyanat* (الآراء والديانات). At a similar level, during the reign of Caliph Ma'mun, numerous debates were held. As well as it was held between the Prophet (PBUH) and the Judeo-Christians at the first level. Therefore, in the third stage, comparative religion is very widely developed. During this period, the number of research works on this subject increased greatly, numerous books were written. Especially in the medieval period from the 3rd century of Hijra to the 8th century of Hijri[57]. Here are some

significant books that were written in various eras at this stage in the development of comparative religion[58]:-

(a) *Tarikh Al Umam wa al Muluk* by Muhammad Ibn Jarir at Tabari in 3rd century of Hijrah.
(b) *Al Maqalat Fi Usul Al-Diyanat and Kitab Al Masayel Wal Ilal Fil Mazaheb Wal Milal* by Al Masudi in 4th century of Hijrah.
(c) *Al I'lam bi Manaqib al Islam* by Abul Hasan Al A'meri in 4th century of Hijrah.
(d) *Tahqiq Ma Lil Hind Min Maqulatin Maqbulatin Fil Aqli aw Marjulatin* by Abu Rayhan Al Beruni in 5th century of Hijrah.
(e) *Al Faslu fil Milali wan Nahli wal Ahwa* By Ibn Hazm Al Andalusi in 5th century in Hijrah.
(f) *Kitab Al Milal wan Nehal* by Abdul Karim Shahrastani in 6th century of Hijrah.
(g) *Kitab Ar Rad Al Jamil* by Imam Ghazali in 6th century of Hijrah.
(h) *Kitab Takhjil Man Harrafa at Tawrat wa Injeel* by Abul Baqa al Ja'fury in 7th century of Hijrah.
(i) *Al Jawab As Sahih liman Baddala Di'nal Masih* by Imam Ibn Taymiyyah in 7th century of Hijrah.
(j) *Hidayatul Hayara fi Ajwibatil Yahud wan Nasara* Ibn Qayyim Al Jawjiyyah in 8th century of Hijrah.
(k) *Tuhfat al-Areeb Fir Raddi 'Ala Ahlis Salib* by Abdullah at-Turjuman in 9th century of Hijrah.

4. The Stage of deterioration and extinction

Thus, the wheels of comparative religion gradually stagnated and stayed concealed for a long time, notably throughout the middle Ages, after being busy and active for ages, centuries, and centuries under the leadership of Muslims. And among the reasons for hiding is this,

a) This stage of comparative religion was the stage of weakness and backwardness. During this period, the palaces of the Muslim Caliphs and kings used to gather a lot of Ahl al-Kitab women, who were married by the Muslim Caliphs and their descendants. Additionally, non-Muslim leaders and doctors moved more frequently in these palaces. The collective impact of these people undermines the practice of comparative religion, because the practice of comparative religion used to criticize the distorted religious beliefs of all these individuals. Their influence became so widespread that at one time it was able to suppress the voices of researchers, debaters and spokesmen of comparative religion. As a result, this subject was forced to be hidden from the curriculum of Muslims[59].
b) The Crusaders swept across the Islamic territories of the East to crush Islamic power. And the Muslims also fought them with strength instead of strength. It is

clear that the Crusaders did not seek religious tolerance, liberality or debate between religions. So under the cell of the sword the voice of debate is silenced[60].

c) In this era of weakness and backwardness, Muslims fell further behind due to the conflict between the schools of thoughts (Fiqhi Mazahib). During this era, most of the jurists of different schools of thoughts (Mazhab) were so extreme and stubborn towards their respective schools of thoughts that they almost lost the intention to learn about other schools of thoughts. No one had any respect for anyone. When such is the case among the followers of the same religion, it is natural that there is no desire or effort to learn about other religions. Through this, comparative religion goes further into the abyss[61].

d) When Muslims scornfully reject comparative religions, as was the case above, a subset of Muslims adopts the prevailing viewpoint or attitude toward adherents of pre-Islamic religions. They belonged to a group that did not recognize any religion other than their own. As a result, they did not even recognize comparative discussions between religions. Not only did some Muslims have such a negative view of comparative religion, some of them also attacked comparative religion by saying that no other religion could be equal to Islam, so no other religion could be compared to Islam. However, people who adopt this mindset and embrace this point of view have lost the numerous verses in the Qur'an that clearly and suggestively provide directions for the discussion of comparative religion. Some of which we have already mentioned. It demonstrates that the Al-Quran is the primary source for comparative religion. They did not look at all the religious dialogues or debates held between the Prophet (PBUH) and the Jews-Christians or polytheists, which prove that the Prophet (PBUH) himself engaged in comparative religion. Ahmad Shalabi adds to the above reasons for the decline of comparative religion, that the caliphs in these eras were not interested or focused on learning, as the previous caliphs were[62].

5. The stage of returning to the Islamic sphere

Western scholars' emphasis on comparative religion and their initiation of writings on the subject played a leading role in the return to the Islamic genre of comparative religion. In their writings, the names and contributions of those who contributed to the practice of comparative religion up to the early nineteenth century are prominently mentioned. And the ancient Muslim books were a source of information for the western scholars' concerning this science. Due to the fact that they dispatched delegates to study and conduct research in Eastern Islamic institutions, they frequently returned manuscripts produced by Muslims to their country of origin.

When the Muslims showed neglect and contempt in the practice of comparative religion, the position of the Christians in this science was scattered and fragile. The safe and free association of Muslims and Christians in Syria, Andalusia, and Sicily

introduced the Christians to comparative religions, made clear to them the true value of this learning. Then they are engaged in researching its fundamental basis and trying to benefit from this science[63].

Colonial times followed this one. At that time, Christian missionaries and scholars recognized that regardless of whether a person is materialistic or religious, they all have a special space and propensity towards religion in their hearts. Since they also understand that a religious relationship is in no way inferior to a family or clan bond. Additionally, it is quite helpful to understand the identity, standing, and faith and creed of the invoker. And based on all this, the practice of comparative religion in the West as a medium of spreading Christianity began to grow very quickly and enthusiastically[64].

Western scholars became particularly active in this area due to Muslims' long-standing disinterest in comparative theology; however, Muslims have recently woken up from their denial. Many ages have passed to integrate our past and present in this science. Finally, Muslim preachers and theologian introduced it and formulated some corresponding methods for the discussion of comparative religions. Basically, through this they are committed to spreading Islam.

In this way comparative religion manifested itself in self-glory and returned to Islamic educational institutions and centers of learning. However, it hasn't yet been placed properly. We hope that Muslims will give maximum emphasis in this matter so that the study of comparative religion can be defined in the definition given by Muslims and Islam and able to fight against anti-Islam. However, it is also feasible to disprove their fabrications and lies about Islam. The triviality and worthlessness of error will vanish the day this science is fully operational, and the flag of truth will be made visible. And that day won't be too far off [65].

At present, the importance of Muslims in study of comparative religion is increasing day by day. The proof of which is the progress in research on this topic worldwide.

The University of Malaya in Malaysia the Faculty of Usuluddin has created a curriculum and launched a program on this subject after taking the issue extremely seriously. Additionally, it is commonly practiced in Muslim nations including Bangladesh, India, Pakistan, and Indonesia as well as in Arab countries, where Islamic academies have also been established. At the university level, a number of courses in this area have also been opened.

In the modern era, many Muslim scholars study the comparative religion with the new form according to their own approaches. Sheikh Rahmatullah Al-Kiranawi, Dr. Ahmed Shalabi, Imam Muhammad Abu Zahra, Dr. Ismail Raji Al-Farouqi, Sheikh Ahmed Deedat and Dr. Zakir Abdul Karim Naik are the most well-known of them. In particular, Zakir Naik has been able to elevate comparative religion in the modern era by setting up and taking part in discussions with people of many religions.

Here are some books on comparative religion authored by Muslim theologians in the modern age that are mentioned:

1. *Muqanatul Adyan 1-4 (Al-yahudiyyah, Al-Msihiyyah, Al-Islam, Adyanul Hind Al-Kubra)* by Dr. Ahmad Shalabi. (Arabic)
2. *Muqaranatul Adyan* by Dr. Khalil Sa`di. (Arabic)
3. *Muqaddama Fi Ilmi Muqaranatil Adyan* by Dr. Aqeel Ibn Ali Al-Mahduli. (Arabic)
4. *Izharul Haqq* by Rahmatullah Kiranawee. (Arabic)
5. *Al-Mizan Fi Muqaranatil Adyan* by Muhammad Izzat Tahtawee. (Arabic)
6. *Al-Mujaz Fi Muqaranatil Adyan* by Dr. Muhammad Belal Hossain. (Arabic)
7. *Tulonamulok Dharmao* by Dr. Muhammad Belal Hossain (Bangla)
8. *Is The Bible God's word?, The Choice, Christ in Islam* ,*What the Bible Says about Muhummed* by Ahmad Deedat. (English)
9. *Muhadarat Fin Nasraniyyah* by Imam Abu Zahara. (Arabic)
10. *Fi Muqaranatil Adyan Buhuthun wa Dirasatun* by Dr. Abdullah Sharqwee (Arabic)
11. *Ilmu Muqaranatil Adyan Inda Mufakkiril Islam* by Dr. Ibraim Turky. (Arabic)
12. *Ilmu Muqarantil Adyan Min Manzurin Islamiyyin*: Al-Mafhum wal Manhaz by Dr. Abdur Razzaq Abdullah Hash. (Arabic)
13. *Ilmu Muqarantil Adyan: Usuluhu wa Manahijuhu* by Hasan Al-Bash. (Arabic)

Conclusion

The discussion of Comparative Religion has thoroughly been grown up in the modern era. Comparison of religion means to find out similarities and dissimilarities among different religions and also to determine the rationales and torpidities of these religions by evidence and arguments. With the rise of Islam, the doctrine of comparative religions was developed. Despite what some people believe, the western specialists do not advocate this science. if we study the holy Quran and the Hadith, we could observe that the Prophet (s) himself made conversation with the Christians and Jews about religious issues and that was one kind of religious debate. As like the Prophet (s), the companions of Prophet (s) and the followers also argued with the factions of other religions. In the middle of second Hijri century, the doctrine of comparison of religion had begun to flourish as a unique and separate source of knowledge by the contemporary Muslim experts. They also started writing books about this doctrine. This doctrine had been grown up and flourished in different ages. This development had been continued till ninth century of Hijrah. But after this stage, the Muslim had begun to stumble on this field of knowledge. Gradually the practice in this particular field had become deem and same thing happened in case of new research. The main reasons for this timidity was to get married with the women of *AhlulKitab* (Christians & Jews), the impact of crusades, and the Majahbi (Schools of thoughts) clash among the Muslims and as a result, mutual conflict had arose. The western experts had taken this

opportunity and insisted on the deceitful propaganda that they had propounded this doctrine. Their main intentions were to vitiate the political power of Islam and to drive away the Muslims from their religion by creating confusion about religion. After that, since the last century, the Muslims have awakened from their idleness and they have again involved in the study and research of this area of knowledge. The modern era can be termed as the golden era of the study of comparative religion. Because, in the present time, the Muslims of different countries have begun to study and administered research works on this particular subject even in many universities of the modern Muslim world there have been introduced separate departments on this subject. Thousands of students are studying and doing research on it.

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[16] *Ibid,* p. 25.

[17] Al-Quran, 42:13.

[18] Al-Quran, 3:19.

[19] Al-Quran, 3:85.

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[22] *Ibid*.

[23] Al-Quran, 3:71

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An Empirical Approach to Predicting Concrete Compressive Strength from Early Age Tests

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Abstract

Concrete gains strength with time after casting. It takes a long time to reach 100% strength. Following the first 28 days after casting, the increase that occurs in concrete's compressive strength slows down. Nearly all standards, codes, and guidelines suggest using a design strength of 28 days for concrete. It is required to wait 28 days for the test results in order to assure quality control. Waiting 28 days for such a test is highly time-consuming for big projects. The findings of early age (3 or 7 days) tests can be used to forecast the compressive strength of concrete at 28 days using a straightforward mathematical model presented in this research. The model is a rational polynomial equation with two constants and the number of days since the concrete was placed as the only variable. The strength of a specific day is directly correlated with one of the model's constants. The mathematical model is based on data on crushing strength from a cylindrical test of relatively light-weight concrete built with different amounts of stone chips and Jhama brick chips. The test was performed in a concrete laboratory using compressive testing machine. The model is validated with data collected from some previous studies. The model shows reliable potential to accurately forecast the compressive strength of concrete at various ages.

***Keywords*:** Concrete, Compressive Strength, Stone chips, Jhama brick, Strength prediction

Introduction

From simple projects to multi-story buildings and massive constructions, concrete is a widely used material in the construction industry. In terms of cost, toughness, and utility, concrete structures perform favorably when compared to those made of other structural materials like steel and wood. Compressive strength makes up the majority of concrete's strength. Concrete, in addition to its compressive strength, has good durability and resistance to fire and weathering. Proper curing and maintenance, on the other hand, are critical for assuring the longevity and function of concrete structures. Overall, the dependability and cost-effectiveness of concrete make it a popular choice for construction projects all over the world.

Compressive strength of concrete has been considered an index of quality control for many years[1]. The cylinder test is typically used to calculate concrete's compressive strength. The 28-day cylindrical strength is a significant factor to consider when building a concrete construction. Most design codes consider 28-day cylindrical strength as design strength. To make sure a building is acquiring the desired strength, a building under construction must wait 28 days. Early prediction of concrete compressive strength helps one to swiftly learn about the

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concrete and its likely weakness and determine whether to manage the demolition program or continue with the construction[1]. As a result, the ability to predict the concrete's compressive strength at an initial stage is now very vital to experts.

The explicit mathematical input and output relationship must be accurately understood, according to theory, in order to represent a system. Such precise mathematical modeling is challenging and difficult to track in an unreliable system[1]. The concrete's index properties, such as density, aggregate content, and w/c ratio, which affect the material's behavior, provide the basis of the majority of the model[2]. This study seeks to forecast concrete strength at various ages by using the results of early strength tests rather than other strength-influencing elements, which makes it simpler than other models. Studying the crushing strength data of partially substituted stone aggregate with various Jhama brick proportions allowed for the creation of the model. All the aggregates used on the cylindrical mold are locally available. The validation was done with light weight concrete made with brick aggregate as well as normal weight concrete made of stone chips from different countries. All of the projected findings show a strong correlation and significant accuracy with the observed results.

Background

Several studies have already been conducted on this topic using Artificial Neural Networks, Genetic Algorithm, Fuzzy Logic, and statistical approaches to predict strength at an early stage[3]. Many studies have concentrated on linear and non-linear regression models that take into account several factors that affect the compressive strength of concrete. In order to increase prediction accuracy, the linear regression approach seeks to identify the link between variables by identifying the best fit line. The most popular model of linear regression (Eq. 1) considers the water-cement ratio (w/c) as a factor in strength prediction, as stated in Abrams' law[4].

$$f_c' = a_0 + a_1(w/c) \quad (1)$$

Where f_c'= Compressive strength of concrete

a_0, a_1 are coefficients.

The development of multivariable linear regression (Eq. 2), inspired by Abrams' law, is another technique for predicting concrete compressive strength by taking into account several factors rather than just one.

$$f_c' = a_0 + a_1x_1 + a_2x_2 + \ldots\ldots\ldots\ldots + a_nx_n \quad (2)$$

Where $x_1, x_2, \ldots\ldots\ldots\ldots x_n$ are independent variables which can be replace by the factors that influence concrete strength like water-cement ratio (w/c), quantity of cement (C), quantity of fine aggregate (FA), quantity of coarse aggregate (CA), proportion of partial

replacement of coarse aggregate like stone chips by Jhama brick (JCA), quantity of water (W), density of concrete (ρ) etc. in concrete mix.

Recent researches have also showed that multivariable power models are useful for forecasting the strength of various ages of concrete[5]. The general form the model is as follows (Eq. 3)

$$Y = a_0 X_1^{a_1} X_2^{a_2} \ldots\ldots\ldots\ldots X_n^{a_n} \quad (3)$$

In the equation above, the compressive strength of a particular day (Y or f_{age}) is regarded as the dependent variable and exhibits a strong association with other strength-affecting independent variables (Eq. 4).

$$f_{age} = a_0 C^{a_1} w^{a_2} FA^{a_3} CA^{a_4} JB^{a_5} \rho^{a_6} (w/c)^{a_7} \quad (4)$$

The value of $a_0, a_1, a_2, a_3, a_4, a_5, a_6, and\ a_7,$ are determined by regression analysis from series of experimental data.

The models discussed above take into account several concrete index properties that affect strength developing behavior. None of these models can directly predict the strength of concrete from early-day strength data. Instead of using the other index parameters, this study aims at estimating the concrete strength for light weight and normal weight concrete from an early concrete strength test result.

Experimental Data

A model is a simplification of reality. It is an abstract, simplified instrument for observing or forecasting the behavior of real systems. Because a model is always more simplistic than reality, it is never equal to the genuine system. The propensity of a model to resemble the real system shows how accurate it is.

To make a model that can predict concrete compressive strength and to authenticate its accuracy, a very large number of experimental data points are required. Data used in this research are collected from test carried out in the concrete laboratory of HSTU and literature works[1&2]. 31 sets (Group 1) in total of available data were used to create the mathematical model. To verify the accuracy, a second collection of data (Group 2) that comprises the test results of concrete built with regional brick chips is also employed. Table 1 outlines the assortment of characteristics and concrete strengths of these datasets. No admixtures or additives are used in any of these experiments. There are 7 types of data in Group 1. In first data set, no replacement had been made for stone chips as coarse aggregate. For type 2-6 of Group 1, coarse aggregate was partially replaced with varying percentages of Jhama brick. To investigate the variations, different ingredient mixing proportions and w/c ratios are used. Until the day of testing, all specimens are submerged in water for curing. The effect of temperature variation is neglected in each case.

Modeling

The following equation (Eq. 5) was proposed by the ACI (ACI 209-71) committee for forecasting the compressive strength of concrete at any day on the basis of strength at 28 days[6].

$$(f_c')_t = \frac{t}{a+b.t} \cdot (f_c')_{28d} \quad (5)$$

Where a and b are constants

$(f_c')_{28d}$ = 28-day cylindrical crushing strength

$(f_c')_t$ = Strength of concrete at t-day

Literature suggests the strength gaining nature of concrete maintains a correlation with its age according to the following equation (Eq. 6). It may be mentioned that Eq. 6 is similar to the equation proposed by the ACI committee[2] (Eq. 5)

Table 1: Property Range of Group 1 & Group 2 Test Data

Name	Unit	Group 1	Group 2
Coarse Aggregate (Stone Chips) CA	Kg/m^3	1685-1694	914-1300
Coarse Aggregate (Jhama Brick) JB (As partial replacement)	Kg/m^3	800-805	-
Fine Aggregate (Sand) FA	Kg/m^3	1560 - 1566	457-650
w/c Ratio		0.49	0.45-0.70
FM of CA		7.35	-
Specific Gravity of CA		2.72	-
FM of FA		2.90	2.82
Specific Gravity of FA		2.65	-
3-day test strength	MPa	17.14-27.53	12.3-26.1
7-day test strength	MPa	20.56-34.95	14.6-44
28-day test strength	MPa	21.98-37.12	23.8-44

Table 2: 3, 7, and 28-Days Compressive Strength of Concrete with Different Percentages of Jhama Brick

Concrete mix	3 Days Strength (MPa)	7 Days Strength (MPa)	28 Days Strength (MPa)
0% JB	27.53	34.95	37.12
5% JB	27.37	31.99	36.37
10% JB	27.33	30.29	34.23
15% JB	25.54	27.52	33.01
20% JB	24.05	27.16	30.89
25% JB	19.26	26.17	30.50
30% JB	17.14	20.56	21.98

$$(f_c')_d = \frac{d}{d+\alpha}\beta \quad (6)$$

Where $(f_c')_d$= Strength of concrete at d^{th} day (d=1,2,3…….)

d= Number of days

α and β are the parameters of the model. It can be observed that α has the unit of day and β has the unit of stress, which are consistent with the expression. In this research work, focus has been given on finding the expression for β which can be further used to determine the value of α for a particular data set using Eq. 7.

In this research, attempts have been made to express β as function of strength of a particular day.

$$\beta = \phi\,((f_c')_d) \quad (7)$$

Several mathematical models, such as the linear regression model, the logarithmic model, the exponential model, and the power equation model, were tested to find the correlation. It was discovered through observation that using a power equation for correlation makes it easier to obtain β. Simply, the equation can be written as follow.

$$\beta = m f'^{\,p}_c \quad (8)$$

Using 21 data sets, the coefficient m and the exponent p can be obtained from the best fit equation.

With slight rounding off it is found that, m = 3; p = 0.75. Thus Eq. 8 becomes:

$$\beta=3(f'_{c,3})^{0.75} \quad (9)$$

Similarly using 7 days concrete strength the correlation may be expressed as Eq. 9 and it goes quite well with 7 days strength results.

$$\beta=2.8(f'_{c,7})^{0.75} \quad (10)$$

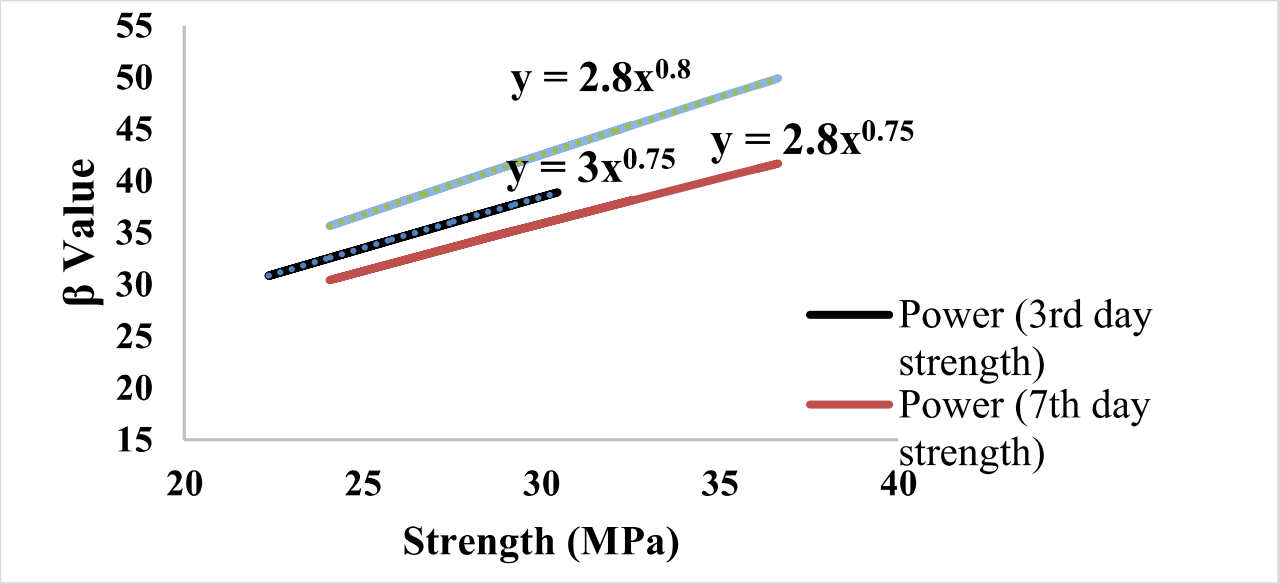

Figure 1: variability of m with concrete strength

With slight rounding off on the exponent the adjusted equation becomes:

$$\beta=2.8(f'_{c,7})^{0.8} \quad (11)$$

Plot of Eq. 9 and Eq. 10 and Eq. 11 is shown in Figure 1.

To find the 28th day concrete strength the corresponding β value can be obtained from 3 days and 7 days concrete strength values form Eq. 9 and Eq. 10 or Eq. 11. Then the value of α can be obtained using Eq. 6. Finally, the α and β can be used to determine 28th day compressive strength of concrete using Eq. 6.

Performance

Any model's performance essentially determine how well it is recognized. Use of statistical parameters is a popular method of performance analysis, which is some system of comparison of output results obtained from the model with actual field or laboratory results[1].The performance measuring statistical parameter like Root Mean Square Error (RMSE), Mean Average Error (MAE), Percent Efficiency (EF) and ratio of prediction to actual values (P/A) are used to check the efficiency of the model for every group of data set[7]. The expressions for these parameters are given below:

$$\text{MAE} = \frac{1}{n}\sum_{i=1}^{n}|P_i - A_i| \tag{12}$$

$$\text{RMSE} = \sqrt{\frac{1}{n}\sum_{1}^{n}(P_i - A_i)^2} \tag{13}$$

$$\text{EF} = \left(1 - \frac{1}{n}\sum_{i=1}^{n}\frac{|P_i - A_i|}{A_i}\right) \times 100\% \tag{14}$$

Here, Ai = Actual value; Pi = Predicted value; n = number of data (1, 2, 3……).

Validation of the Model

The suggested model was created to forecast the compressive strength of normal weight and light weight concrete. The data set from Group-1 which was not used in the model's preparation, is used to test the model's validity, and six results at random are listed in Table 3.

Table 4 provides a summary of the overall performance of the suggested model which shows good accuracy in predicting the compressive strength of concrete at different ages.

The suggested model was created using the compressive strength of a concrete cylinder produced with partially replaced Jhama Bricks. However, for light weight concrete made with locally available brick aggregate the model is slightly adjusted for 7 days test results (Eq). The projected values for compressive strength calculated using brick aggregate from Group 2 data are shown in Table 5.

Table 3: Prediction of Concrete Strength of Relatively Light Weight Concrete

Compressive Strength of Concrete (MPa) A_i			Prediction, P_i (MPa) (Eq. 7)	Ratio	Prediction, P_i (MPa) (Eq. 8)	Ratio
3 Day	7 Day	28 Day	28 Day	P_i/A_i	28 Day	P_i/A_i
18.5	24.18	24.72	25.54	1.03	27.92	1.13
19.38	25.45	31.19	26.49	0.85	29.12	0.93
19.9	28.88	35.61	27.05	0.76	32.31	0.91
19.19	22.39	24.18	26.29	1.09	26.21	1.08
17.14	19.38	22.37	24.05	1.08	23.27	1.04
15.08	19.39	19.9	21.74	1.09	23.28	1.17

Table 4: Performance Summary for Group-1 Data

Data	Group-1	
Base Strength	$f'_{c,3}$(D=3)	$f'_{c,7}$(D=7)
Predicted Strength	$f'_{c,28}$(D=28)	$f'_{c,28}$(D=28)
Efficiency, (EF %)	96.22	96.39
Root Mean Square Error (RMSE)	4.22	2.84
Table 4 *(Continued)*		
Mean Absolute Error (MAE)	3.29	2.65
Min Pi/Ai	0.76	0.91
Max Pi/Ai	1.09	1.17
Avg Pi/Ai	0.98	1.07

Table 5: Prediction of Concrete Strength of Brick Aggregate Concrete

Actual Compressive Strength of Concrete (MPa) A_i		Proposed model Prediction, P_i (MPa) (Eq. 9)	Ratio	Adjusted model Prediction, P_i (MPa) (Eq. 10)	Ratio
7 Day	28 Day	28 Day	P_i/A_i	28 Day	P_i/A_i
20.35	29.7	24.85	0.84	27.52	0.93
20.15	29.05	24.65	0.85	27.29	0.94
13.41	22.78	17.59	0.77	19.15	0.84
14.45	23.5	18.71	0.80	20.44	0.87
14.2	22.13	18.44	0.83	20.13	0.91
15.1	22.65	19.41	0.86	21.24	0.94
13.64	21.97	17.83	0.81	19.44	0.88
14.85	25.37	19.14	0.75	20.93	0.82
15.67	24.83	20.01	0.81	21.93	0.88
14.05	23.86	18.28	0.77	19.95	0.84
15.75	23.25	20.1	0.86	22.03	0.95
13.05	20.27	17.19	0.85	18.7	0.92
12.7	20.12	16.81	0.84	18.27	0.91
16.14	24	20.51	0.85	22.5	0.94
15.03	23.32	19.33	0.83	21.16	0.91
16.88	25.15	21.29	0.85	23.4	0.93

Table 6: Performance Summary for Group-2 Data

Data	Brick Aggregate Concrete	
Base Strength	$f'_{c,7}$(D=7)	$f'_{c,7}$(D=7)
Predicted Strength	$f'_{c,28}$(D=28) (Eq. 10)	$f'_{c,28}$(D=28) (Eq. 11)
Efficiency, (EF %)	82.31	90.06
Root Mean Square Error (RMSE)	4.33	2.54
Mean Absolute Error (MAE)	4.24	2.37
Min Pi/Ai	0.75	0.82
Max Pi/Ai	0.86	0.95
Avg Pi/Ai	0.82	0.90

The 7-day test result's prediction of 28-day compressive strength for concrete made with brick aggregate is pretty acceptable for the suggested model. The efficiency of the model is found to be 82% for different data set. The performance of the model improves with slight adjustment. Table 6 provides an overview of the proposed and adjusted models prediction capabilities.

Table 7: Prediction of Concrete Strength of Stone Aggregate Concrete

Actual Compressive Strength of Concrete (MPa)		Proposed model Prediction, P_i (MPa) (Eq. 9)	Ratio	Adjusted model Prediction, P_i (MPa) (Eq. 10)	Ratio
7 Day	28 Day	28 Day	28 Day	P/A	
24.5	34	28.96	0.85	32.32	0.95
22.5	32.5	27	0.83	30.03	0.92
21.6	32.5	26.1	0.80	28.98	0.89
21.5	32.3	26.01	0.81	28.87	0.89
21.1	30.5	25.6	0.84	28.41	0.93
20.4	30.3	24.91	0.82	27.59	0.91
20.3	29.2	24.8	0.85	27.47	0.94
20	28.9	24.49	0.85	27.11	0.94
18.5	27.7	22.97	0.83	25.34	0.91
17.6	25.9	22.04	0.85	24.27	0.94
17.3	24.5	21.72	0.89	23.91	0.98
14.6	23.8	18.87	0.79	20.62	0.87
31	44	35.15	0.80	39.63	0.90
29.9	39.4	34.12	0.87	38.41	0.97
28.3	37.5	32.61	0.87	36.63	0.98
26.7	36.1	31.09	0.86	34.83	0.96
25.8	35.2	30.22	0.86	33.81	0.96
25.7	34.6	30.12	0.87	33.69	0.97

Table 8: Performance Summary for Stone Aggregate Concrete

Data	Stone Aggregate Concrete	
Base Strength	$f'_{c,7}$(D=7)	$f'_{c,7}$(D=7)
Predicted Strength	$f'_{c,28}$(D=28) (Eq. 10)	$f'_{c,28}$(D=28) (Eq. 11)
Efficiency, (EF %)	84.11	93.39
Root Mean Square Error (RMSE)	5.26	2.3
Mean Absolute Error (MAE)	5.12	2.05
Min Pi/Ai	0.79	0.87
Max Pi/Ai	0.89	0.97
Avg Pi/Ai	0.84	0.93

Discussion on Results

The suggested model can estimate the strength of both light weight and regular weight concrete by using the characteristics of comparatively light weight concrete that help it gain strength. The model is created using the strength data from concrete built with stone aggregate that has been partially substituted with Jhama brick. The efficiency of the model is found to be more than 95% for relatively light weight concrete. Table 4 shows the overall performance of the model for Group-1 data and observed RMSE, MAE and Avg Pi/Ai may be considered as quite satisfactory. The proposed model is then verified for brick aggregate concrete. The prediction performance for the data set is summarized in Table 6. The efficiency in this case is 82% and slight adjustment was made in the model which increase the efficiency to 90%. Finally, the model is validated for normal weight concrete poured in different countries using local aggregate. The average efficiency is 84% and for the adjusted model it is 93%. The RMSE, MAE and Avg Pi/Ai are within acceptable range considering the level of scatter usually exhibited by concrete strength. Figure 2 and Figure 3 shows the overall performance for different data set.

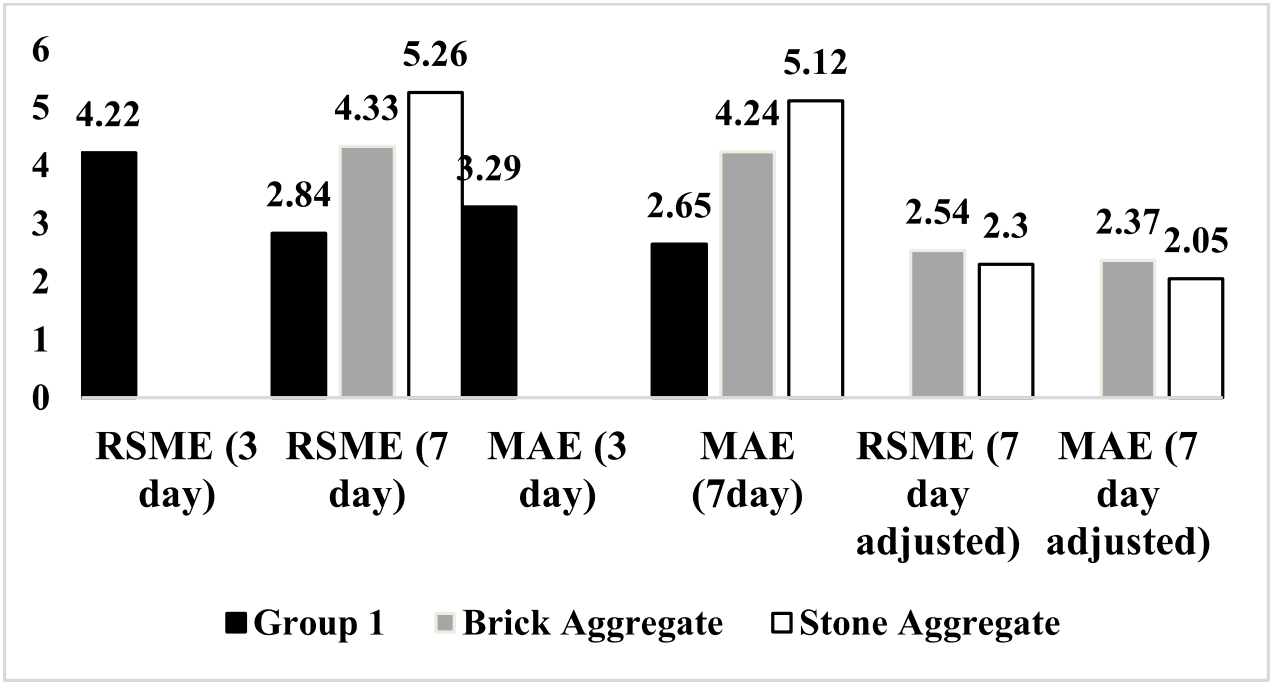

Figure 2: Variations in RMSE and MAE values among groups

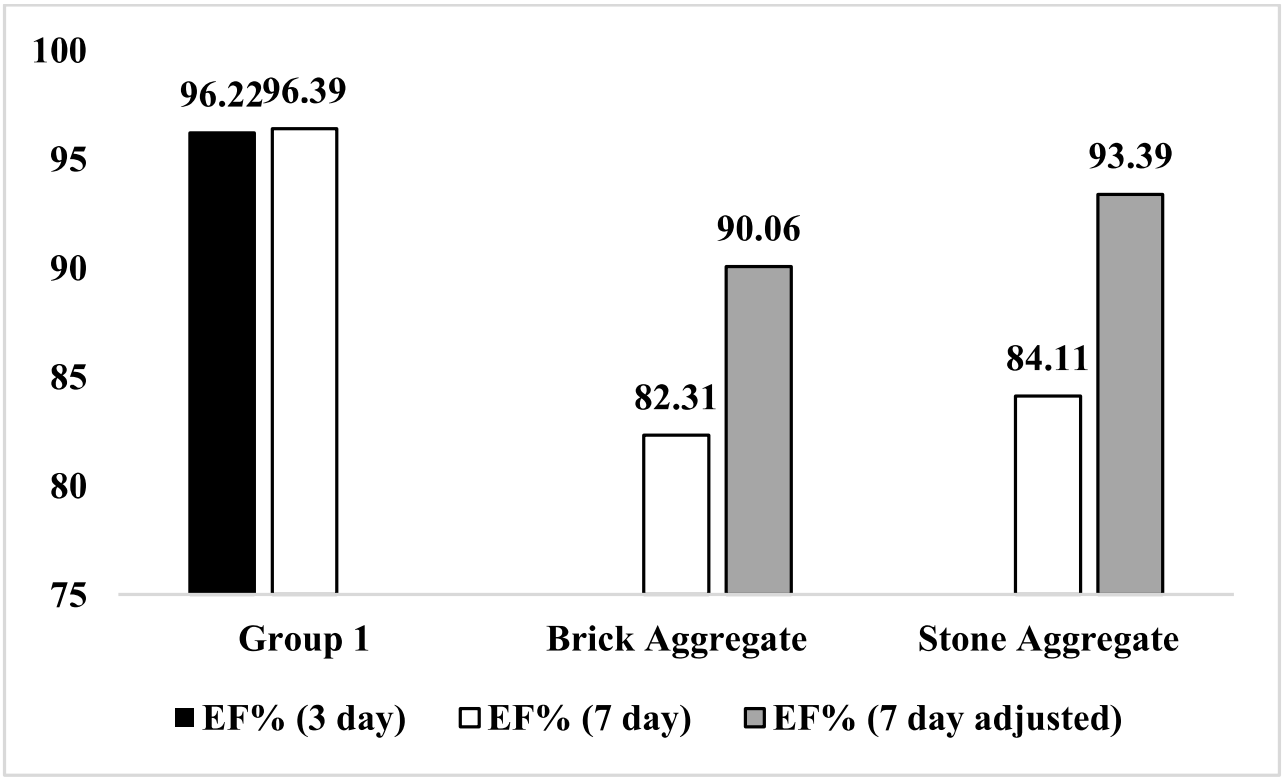

Figure 3: Variation of EF% value for different groups

Conclusions

This study investigates a condensed mathematical model for predicting concrete strength at various time intervals based on a strength at a single day. The model demonstrates that two critical parameters α and β govern the properties of increasing concrete strength with age. By simplifying the prediction model to only include the critical parameters of α and β, this approach can potentially save time and resources for construction projects. This research also shows a power equation relationship between β

parameter and concrete strength. Another advantage of this approach is that it eliminates the requirement for concrete index qualities, which can vary widely based on the materials and methods employed in the mix. The model can provide more reliable estimates of concrete strength by focusing on the important parameters that determine strength increase with age.

In addition to its practical applications, this research contributes to the development of a deeper understanding of the underlying mechanisms of concrete strength increase over time. This knowledge can be used to optimize concrete mix designs and improve the overall performance and durability of concrete structures. The proposed methodology, in addition to estimating concrete strength after 28 days, can be utilized at any age (say, 21, 60, or 90 days).

Future research in this area could involve testing the model on a wider range of concrete mixes and construction conditions to further validate its accuracy and applicability. This could also involve exploring the relationship between the critical parameters and other factors that may impact concrete strength, such as temperature, humidity, and curing methods. Overall, this study offers a promising approach to predicting concrete strength that could have significant benefits for the construction industry.

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