From Invisible to Investable: Breaking the Myths of Gender Bias in Credit Access for Bangladeshi Women Entrepreneurs

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Abstract

Credit scoring, a process that financial institutions utilize to gauge an individual's creditworthiness based on financial data and numerous other aspects, is crucial in determining loan eligibility. However, discriminatory banking practices in Bangladesh hampered female entrepreneurs, forcing them into the informal credit systems. This study attempts to identify the challenges faced by the women entrepreneurs, disregarded by the financial institutions of Bangladesh in accessing credit. It also shed light onto the mismatches of banking practices and obligations in loan allocation. In this study, a mixed-methods approach with a combination of qualitative and quantitative analysis has been utilized. It incorporates insights shared by 26 participants, including finance officials and female entrepreneurs, in addition to data analyzed from a publicly available dataset (default of credit card clients). Findings indicate that women demonstrate better repayment practices than men but are still dominated by the gender biases in formal credit systems. Banking system is required to be tendered for spacing the women-led businesses in Bangladesh rectifying their confined operations in assessing and approving credit services.

1 Introduction

The emerging term 'credit scoring' states the creditworthiness of people that facilitates the financial institutions providing credit services [41] such as personal loans, mortgages, business loans, etc. It magnifies the classification of the aspiring credit applicant justifying their eligibility based on the financial data and other relevant information. Along with the global south context of exposure, the more restrictions to access formal loans with high interest rates, the higher the chances to lead more people to choose informal credits either from non-banking financial institutions (NBFI) or from non-government organizations (NGOs). In Bangladesh, Bangladesh Bank has modified the 'Credit Risk Grading Manual' [42] to drive their credit risk management mechanism. In the socioeconomic context of our country, female entrepreneurs are deprived of equal consideration from formal financial institutions regarding documentation or other credentials. Consequently, women entrepreneurs are heading towards the manual approaches of credit applications and maintenance [1]. To ensure an augmented community and to enhance equal facility with real assessment, it requires synchronizing the implemented models, proper familiarization of current practices, the simplest mode of interactions from the institutions. It will enrich the client community of the financial institutions and aid the female entrepreneurs in encompassing their assets with secured credits.

Although the proceedings of loan application should be generalized throughout the country regardless of gender [48], women's entrepreneurship in Bangladesh is obstructed due to the banking discrepancies for accessing credits [2]. Despite having the state's law for granting a specific percentage of loans to women per year [43] , and having specific schemes of the banking institutions to associate women entrepreneurs availing and maintaining loans easily [44], they are becoming apathetic to the formal loans and directed towards the credit scheme of the informal institutional systems [45].

In this research domain, several studies have taken place that unfold the common SME loan-related problems [2] Relating to this scenario, women entrepreneurs in Bangladesh are also found to be suppressed by some additional challenges [7] along with the regular ones. As a result, the complicated formal approaches of banking institutions are impeding the growth of female entrepreneurship in Bangladesh. Related works have also shown the limited exposure of SME loans for female entrepreneurs [8] whereas, strategic management and policy renovation have also been suggested both in physical and virtual forms [11]. In a nation where full credit reporting is still in its infancy [4], ensuring superfluous transparency is crucial to aid female entrepreneurship financial institutions[8]. Unfortunately, micro-financing institutions (MFIs) are penetrating this gap of banks to support the female entrepreneurs thus hampering its prime focus of mitigating poverty as non-profit organizations in our country [13]. There is frequent literature on the formation, continuity, growth, and institutional forces of women-led SMEs [8], the impact of gender discrimination in banking institutions, deficient data availability, and proper reasoning of reluctance to the banking formalities of loan applications have not been well investigated.

The obstructed as well as insecure context of credit applications by the women entrepreneurs geared up this study to portray the ultimate storyline to ease the formal loan sanction process to the female entrepreneurs by comparing and correlating their performances along with the current practices of these. The research questions of this study are as follows:

RQ1: What are the driving forces behind credit risk assessment in Bangladesh to align the institution's performance with its current practices of technology?

RQ2: What are the fundamental takeaways from Bangladesh's financial institutions to support women entrepreneurs to expand their access to credit?

Thus, this study aims to examine the institutional discrimination that affects female-led businesses and obstructs economies. Drawing from the institutional practices, our study examines different institutional processes and engagement of female entrepreneurs in Bangladesh. It represents a real visualization of data with several propositions that are threatening female-led entrepreneurship in Bangladesh and blocking the economic growth of our country.

This qualitative study explored 26 participants including financial officials and female entrepreneurs; it revealed the prime affairs related to formal credit practices and their biased approaches such as the state of business, requisition of guarantors, limited exposure of technology in Bangladesh. In contrast, the quantitative analysis revealed that both gender and education influence repayment and default rates, with women demonstrating better repayment behavior than men, especially in contexts where financial stability initiatives favor highly educated men.

2 Related Works

This section examines gender and racial biases in credit scoring from research and previous works, explores fairness-enhancing approaches like machine learning (ML), and outlines the challenges women entrepreneurs in Bangladesh face in accessing financing, including low credit scores and their underlying causes.

2.1 Bias and Gender in Credit Scoring

Carmen Leong et al. [29] examines the racial and gender biases that affect credit scores and access to credit lines for new businesses. The findings reveal that Black-owned businesses are consistently assigned lower credit scores and face more limited access to credit compared to White-owned businesses, despite controlling for other similar characteristics. This demonstrates how discrimination can shape the financial opportunities available to entrepreneurs based on race and gender, ultimately affecting the success and growth of new businesses. Another study highlights the challenges faced by new businesses, particularly in rural South Africa, where 36 women-owned businesses in the service sector. The study found that only 16.67% of these businesses secured start-up funding through bank loans, while 15% relied on personal savings and 6% turned to family or friends. This underscores the heavy reliance on informal funding sources during the early stages of business development [4]. Additionally, a recent study by Abdul-Azeez et al. [2] on Small and Medium Enterprise (SME) in the Global South reveals that complex registration, licensing, and taxation laws increase costs, consume valuable time, and limit market opportunities for new business owners due to high taxes and significant market barriers. This challenge is compounded by gender disparities to access funding. Data from Renerdai, a P2P lending company in China, reveals that despite female borrowers outperforming male borrowers in loan performance, default probabilities, and expected profits, no significant difference in funding success rates was observed [31]. Similarly, P. De Andrés' et al. [26] study of over 80,000 Spanish firms found that women entrepreneurs face lower credit access in the founding year but excel in loan repayments. Both studies suggest that implicit discrimination, rather than performance-based factors, limits women's access to funding and highlights the need for adjustments in credit scoring models to reduce unconscious bias. Study [36] investigates the gender gap in credit scoring among subprime borrowers by using alternative credit data. While women on average have a relatively negative credit score, the default rate tends to be lower compared with that of males. Both Kelley et al. [15] and a study [37] show that while ML models are often less biased than traditional models, they can still reinforce bias if not carefully designed. Kelley et al. found that adding gender-aware adjustments to ML models can reduce bias, promote fairness, and increase profitability. Both studies point out that removing gender information can hurt women, as they are often seen as higher-risk borrowers due to historical biases. Additionally, ML models that use data like digital footprints and transaction histories can make existing inequalities worse, especially for women, young people, and single parents. While using alternative credit data can improve predictions, it can also increase bias if not handled properly. Another type of bias, which is more subjective, was explored in study [32], where the authors examined how credit market outcomes are influenced by gender preferences. Corrales-Barquero et al. [16] highlighted the need for further research on gender bias in credit scoring, noted a gap in addressing gender bias specifically and a lack of real-world case studies. Research conducted by Dissanayake, K. [8] advocates for policies that facilitate access to formal loans for women entrepreneurs, along with tailored support to address the unique challenges they face at each stage of their business. These findings highlight the critical need for addressing bias in credit scoring systems. In a similar manner, study [27] investigated fairness and bias in automated credit scoring systems using Germany's credit card dataset. By applying explainable AI (XAI) techniques, the authors specifically considered gender and age as protected variables, further emphasizing the importance of transparency and fairness in model design. The goal of the research [35] is examining the factors which impact credit access for women-led businesses in Italy, by using the RIL dataset. Later it finds that women-led firms are significantly less likely to apply for credit, where the authors suggest that women face challenges due to psychological

and cultural factors such as self-exclusion, risk aversion, and lack of confidence, rather than systemic gender bias in the

banking system. As a result, the study recommends targeted interventions, such as financial education and support programs, to encourage women entrepreneurs to seek external funding confidently.

2.2 Approaches for Efficient Credit Scoring

To address bias in the system, numerous studies have been conducted for the benefit of both borrowers and lenders. One study examining borrower-lender perspectives in Libya found that limited borrower information on finances and creditworthiness leads to adverse selection by banks [3].

Research on fairness in credit scoring addresses unintended biases from demographic and financial data. The study [37] explains that while ML-based models can link an applicant's digital footprint and transaction history, among other factors, they may amplify existing inequities for vulnerable groups such as women, the young, and single parents. N. Kingsman [39] introduced fairness-aware frameworks, which includes pre-processing, in-processing, and post-processing methods, to improve equity and efficiency in credit allocation**.** Another paper by C. Hurlin et al. [28]. proposed a formal framework for assessing the fairness of credit scoring models, optimizing the tradeoff between fairness and performance by identifying variables that contribute to unfairness generally for entrepreneurs. Beside exploring fair ML to reduce bias, Zafer et al. [24] also focused on enhancing risk assessment by incorporating alternative data. They had positive findings that ML provides a more equitable, data-driven approach to creditworthiness, enhancing financial inclusion for entrepreneurs excluded from traditional lending. Djeundje et al. [18] explored how credit scoring models can be improved for individuals without conventional credit histories by incorporating alternative data, such as email usage and psychometric variables.

In addition to general bias among entrepreneurs, ML should also address gender bias. This paper [25] uses ML to examine the impact of gender and emotional biases (such as optimism, overconfidence, and loss aversion) on credit decisions in Tunisian banks, employing a Bayesian network analysis approach. A field experiment by Lizarazu et al. [33] on ethnicity and gender among potential borrowers shows rather a unique finding. Compared to non-indigenous men, non-indigenous women have twice the chance of loan approval, while there is no difference in loan approval between indigenous and non-indigenous men.

A review study conducted three years ago on the use of alternative credit scoring showed that alternative credit scoring is rapidly evolving, reflecting the growing interest in using non-traditional data sources to assess creditworthiness in both developed and developing contexts [20]. A recent study in India highlights that digitization, including "soft information" and "big data," could improve financing for small businesses. [10]. Focusing on underserved rural borrowers, such as small farmers, women, and youth, who lack traditional loan histories, Kumar et al. explored ML methods for credit scoring in their paper [30]. 007fenqi, a platform that integrates microloan services and e-commerce, uses alternative data for credit rating, including campus card details of underprivileged college students in China, who generally have minimal formal financial data [19]. The study by De Cnudde et al. [22] on the use of Facebook data in microfinance identified another promising alternative data source—interest-based data, particularly Facebook Likes, which are more predictive of creditworthiness than social connections. This finding is supported by a more recent work by Di Maggio et al. [21], which emphasized the value of social media and psychometric data as valuable alternatives for credit scoring. The impact of other alternative data, such as supermarket purchase behaviors, on reducing gender gaps

in credit risk predictions is conducted on Lee, J. et al. [17]. Whereas study [34] analyzed the impact of both AI and ML on credit risk assessments, focusing on the use of alternative data sources. It highlights how these technologies can help financial institutions extend credit to financially excluded households.

Along with the use of alternative data, we must also be mindful that removing gender information can harm women by categorizing them as high-risk borrowers due to historical biases. To address this, a study [38] demonstrated that strategies such as correcting data, adjusting algorithms, refining outputs, and optimizing subgroup thresholds can reduce gender bias by over 90% while maintaining accuracy. Researchers support the use of fairness-aware frameworks and updating regulations to face these challenges and guarantee equal access to credit.

2.3 Credit Scoring Scenario in Bangladesh

Mahmud et al. [5] examines the effectiveness of Bangladeshi banks versus microfinance institutions (MFIs) in rural areas. Banks build long-term relationships to reduce credit risk. Due to the heterogeneous characteristics, size, opaqueness and informal structure of Cottage, Micro, Small, and Medium Enterprise (CMSME), they seem to always be excluded from formal financing. MFIs fill gaps left by banks but often charge higher interest rates and impose restrictive loan conditions. Formal SMEs with a relatively stable foundation may have limited access to commercial banks. As of 2023 women own just 17.9% of all loan accounts and 6.5% of bank assets, underscoring their limited access to credit. Despite their substantial contribution to the economy, with women-owned businesses generating around 20% of the country's GDP, these businesses received only 17.9% of all CMSME loans in that year [6]. A more recent study shows that the limited funding offered by MFIs and informal loans continues to constrain the growth of larger business ventures, which is another drawback on the part of MFIs [17]. Additionally, societal perceptions and gender norms continue to undermine women's roles in business, creating significant barriers to their entrepreneurial success. According to research by the Bill & Melinda Gates Foundation-supported Microsave Consulting (MSC), 65% and 50% of women micro-entrepreneurs, especially those operating on digital platforms, rely primarily on their spouses for important business decisions and income management, respectively [13]. In addition, issues such as unequal inheritance rights and patriarchal structures prevent women from securing the collateral needed to access traditional financing, further hindering their entrepreneurial potential [1] and gaining decent credit scoring. A study conducted by one of the UN economic and social commissions for Asia and the Pacific (UN-ESCAP) of 150 women business owners in Bangladesh highlights specific obstacles they face, particularly in accessing formal loans [11]. Positive aspects of online businesses, such as flexibility in managing family responsibilities and increased customer reach also came up in this paper. However, accessing formal loans to expand business later still remained a significant barrier. One respondent shared, "Accessing funding has been a struggle; banks often overlook women-led businesses, but social media has allowed me to bootstrap my venture." To address such challenges, the paper recommends that the government classify social media-based businesses separately in trade license applications and waive the physical location requirement. These are just a few obstacles identified from real case studies. Additionally, the paper calls for raising awareness of specialized loan products and simplifying the registration process, including online application and renewal. Despite efforts like Bangladesh Bank's Women Entrepreneur Support Fund - Credit Guarantee Scheme (WESF-CGS), which seeks to improve access to loans through guarantees, the program's stringent eligibility requirements—such as the need for businesses to demonstrate two years of profitability—exclude many women entrepreneurs, particularly those with new ventures[1]. These persistent challenges highlight the need for more inclusive financial mechanisms that support women at all stages of their entrepreneurial journey, aiming

to bridge the gap and foster gender equity in the business world. This study aims to address this research gap by exploring the credit assessment scenario for the country's women entrepreneurs.

3. Methodology

This section outlines the methodology for both the qualitative and quantitative studies, including participant recruitment and data analysis for the qualitative study, and data preprocessing for the quantitative analysis.

3.1 Qualitative Study

This research inquiry emphasized comprehending the scenarios of current practices, technological interventions, and future recommendations of loan processing from both the ends of the financial institutions as well as from the borrowers as part of this study on how different financial institutions will be confederated with the concept of credit scoring services. We conducted in-person interviews with a total of 26 stakeholders from different institutions. We considered 22 participants from government and private banks, non-bank financial institutions, and non-government institutions as lenders and examined 4 entrepreneurs as borrowers. The research was conducted from October 2023 to June 2024.

3.1.1 Participant Recruitment

Participants were reached using a purposive sampling method, where the main criteria for the bank officials included the institutional structure, they are employed or associated with, their role, designation and involvement in the credit assessment process. We aimed to ensure proportional distribution of bank officials where private banks had the most representation among formal financial institutions followed by Government banks, and NBFIs (refer to Table 1 for detailed distribution of participants). We also maintained balanced representation of high, medium and low-level officials where the levels denote their authority in decision making of credit application assessment. Such representation helped us to get an overall picture along with the roles and pain points of different bank officials. Recruitment criteria for the women entrepreneurs included their business status and their experience in the loan application process. We tried to recruit entrepreneurs who had different levels and types of business as well as diverse experience of loan application with participants who did not take loan due to different barriers, participants with rejected loan applications, as well as loan applicants who successfully received the loan.

Table 1: Institution-specific details of participants

INSTITUTION-SPECIFIC DETAILS				
Types of Organization	**Top Level Officer**	**Mid-Level Officer**	**Low Level Officer**	**Total Number of Participants**
Private Bank	1	5	2	8
Non-Government Organization	1	1	3	5
Government Bank	1	4	0	5
Non-Bank Financial Institution	1	3	0	4
Entrepreneur	Not Applicable			4

3.1.2 Interview Data Analysis

Individual respondents were native citizens, so the traditional Bengali language was used to leverage common cultural ground during the conversation. Then we did verbatim transcriptions of the interviews. As all the people involved with the study (researchers and participants) were native Bengali speakers, we were able to code and analyze without translating which allowed us to preserve the exact forms of stories shared by the participants enhancing the reflection of participants' emotion in the analysis [46]. Inductive coding was conducted on the transcriptions. From a close reading of transcripts, there were 381 open codes generated initially from the interviews. Finally, it ended with 55 codes and 3 major themes (financial requirement and documentation, technology support throughout the financial institutions, and technology recommendation) engendered from the multiple iterations and analysis of the data given by the participants. We focused on stories about (1) the requirement of the basic documents, the limiting features of the current system to hinder the progress of female entrepreneurs; (2) the importance of the authentication of the guarantors, the redundant requisitions and privacy interference by the institutions, and finally (3) technologies in the corresponding phases and women led businesses' restrictions to avail the associated benefits of loan approval. Five researchers participated in the initial coding phase and agreed on most codes. In case of any disagreement to reach a consensus, the researchers discussed it and resolved it together.

3.1.3 Research Ethics and Positionality

Before the interview, we discussed the research aims, principles, interview procedure, guidelines, data anonymity, participants' right to quit, and permissions with participants. All research materials are stored on a secure drive that only the researchers have access to. All participants were orally thanked for their precious time at the end of the interviews. All of the researchers were born and brought up in Bangladesh. The research was conducted by mixed-gender researchers. The researchers' backgrounds, positions, and research exposures have impacted the research lens to conduct qualitative research on credit scoring.

3.2 Quantitative Study

For this study, we have analyzed the default of credit card clients (DCC) [M2] dataset which is publicly available. DCC [40] has 23 features, most of which are regarding the payments made by credit card clients, like the number of bill statements, amount of previous payments, and history of past payments.

3.2.1 Data Preprocessing

Next, we preprocessed the data to ensure data quality and readiness for analysis so as to improve its cleanliness. These steps included recording categorical variables, binning numeric values, and renaming columns for clarity. Original Feature name after renaming is provided in Appendix (1).

The SEX feature was transformed from numeric labels (1 for male, 2 for female) to MALE and FEMALE, while the MARRIAGE column was recorded into categories such as MARRIED, SINGLE, OTHERS, and UNKNOWN. The AGE column was grouped into six defined age ranges (20s to 70s),

and the original column was dropped to reduce dimensionality. Payment amount columns (PAY_AMT1 to PAY_AMT6) were binned into ranges (0, 0-100, 100-1000, etc.) to simplify the analysis of repayment patterns, and the original columns were removed.

By matching the column names to their corresponding times or contexts, the renaming was done to improve the dataset's readability and clarity. The original names, such as PAY_0, PAY_2, and BILL_AMT1, were ambiguous and did not clearly indicate the associated month or payment type, making the dataset less intuitive to understand. To address this, repayment status columns were renamed to represent certain months, like REPAYMENT_SEP and REPAYMENT_AUG, in order to remedy this and provide clear temporal context. To ensure consistency and readability, the billing amounts (BILL_AMT1, BILL_AMT2) and payment amounts (PAY_AMT1, PAY_AMT2) were also renamed to BILL_AMT_SEP, BILL_AMT_AUG, and AMT_PAID_SEP, AMT_PAID_AUG.

In correlation matrix analysis, we noticed strong correlations exist between repayment amounts across successive months, like REPAYMENT_JUN and REPAYMENT_MAY (0.82), suggesting a pattern in repayment behavior. Likewise, high positive correlations among consecutive monthly bill amounts, such as BILL_AMT_SEP and BILL_AMT_AUG (0.95), advocate a consistent billing pattern across months. But correlations between billing amounts and repayments were generally weaker, with most below 0.3, highlighting limited direct relationships. Some repayment and bill amounts showed modest negative correlations with the DEFAULT_PAYMENT_NEXT_MONTH variable, such as REPAYMENT_AUG (-0.06) and LIMIT_BAL (-0.15), suggesting that lower repayment amounts or credit limits might be associated with a higher likelihood of default. Figure 01 shows the correlation matrix among the features of the dataset.

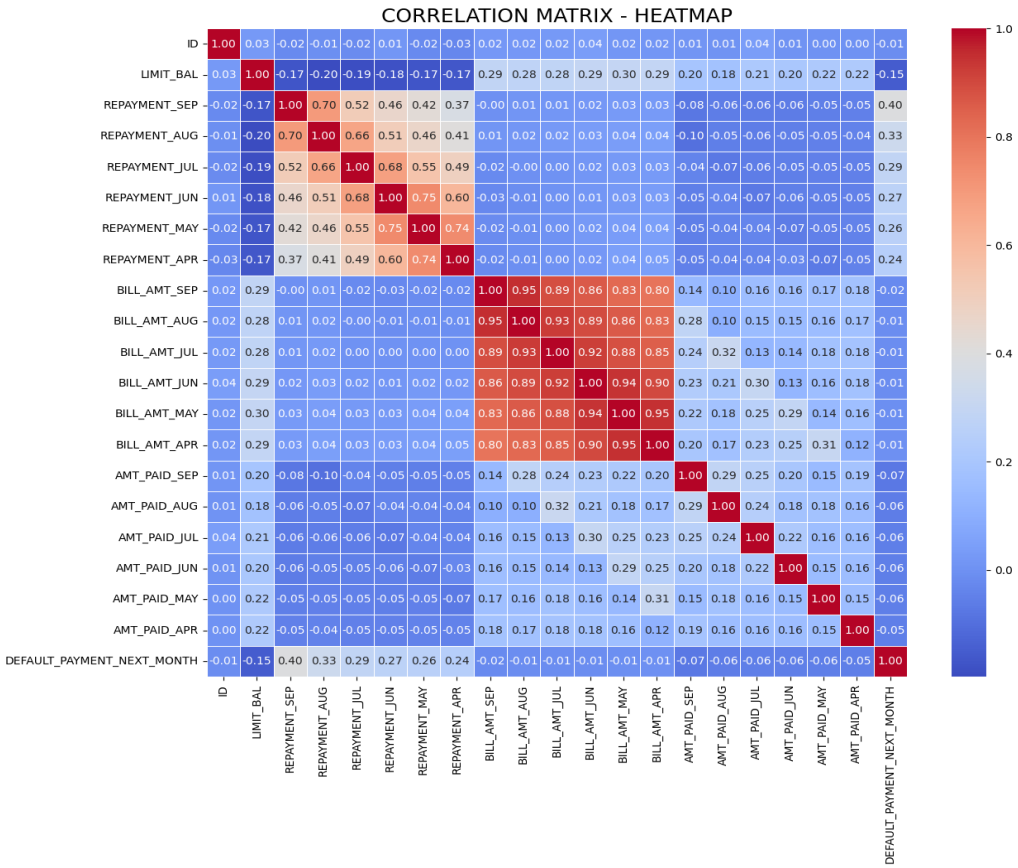


Figure 01: Correlation matrix

4 Findings

This section outlines the key findings from both the qualitative and quantitative analyses, exploring the underlying factors and trends related to credit access and repayment behavior.

4.1 Qualitative Overview

The overall theme of this study is encompassed by the credibility of the women entrepreneurs and the limiting as well as discriminating standings of the financial institutions for loan or credit consent; Credibility is the ultimate determinant of clients' worthiness determined by the financial institutions. On the other hand, the limiting conditions of the institutions evolves the current tainted practices that restrict the process with multiple clauses and thus declining the country's divination.

4.1.1 Elementary Attributes Under Consideration

The basic imperative elements, their consequences, limitations, and affinity between the financial systems and women entrepreneurships are featured here. The practitioners from all the financial institutions along with NGOs have disclosed that the clients are required to be verified with their creditworthiness, valid assets and physical existence of business organizations including size, employees, and the evenness of the information provided by them. This is to get loans either for launching or supporting or expanding their businesses. Table 2 shows a comparative overview of the documentation required in each type of financial institution. The concern about the physical existence of business in getting loans has been foregrounded supremely by the female entrepreneurs; the confinement of the banking institutions on approving loans to online business proprietors has been clung up with the statement of one of our female entrepreneurs. She succinctly put the dilemma that the entrepreneurs with online business face as follows.

> *"They did not give me the loan just because I didn't have a dedicated store, I had a flowing business and I could set up the shop if I got the loan, could not do that with my money because you need a lot of one time money for that. I could not hamper cash flow. I showed them my revenue and everything, but they got stuck there."* - P17, Entrepreneur, Tangail.

Bank officials' voices agreed that they are starving for specific provisions to serve online business entrepreneurs with particular schemes. Since the online business mode nowadays has significantly been chosen by women, they cannot be accommodated in online businesses through banking loans due to their lack of physical embodiment, inventory and other dignitaries. While the loans could facilitate the businesses prolonging it up to the establishment of the physical form, the impaired banking systems thus dim the growth of the female entrepreneurships and affect our emerging economy. These regulations, which are in place to ensure fair and reliable credit access to creditworthy entrepreneurs to increase their business growth, slow down the process significantly which puts off the good potential borrowers as shared by a bank official with years of experience working in the Credit Risk Management (CRM) team. He quoted as follows.

> *"People don't want to come to the banks for SME loans because the process here is too slow. A lot of protocols and everything that we go through makes it impossible to disburse quick*

loans but for most businesses, it is like 10 taka in time worth 100 taka after the time has passed. So, running businesses don't always come here." - P9, Govt. Bank Official, Mid Level

Although the loan or credit facility aims to serve the entrepreneurs in establishing their business to a broader extent, the lack of associating guided particulars hinder the online business exploration in this age of technology and slandering our global position.

Table 2: Basic Perspectives of Loan Processing

Attribute	**Private bank**	**Government Bank**	**NBFI**	**NGO**
Formal Documents Requirement	NID, Birth certificate, Photo, Trade license (companies), e-TIN, Regional character Certificate	NID, Birth certificate, Photo, Trade license (companies), e-TIN, Regional character Certificate	NID, Birth certificate, Photo, Trade license (companies), e-TIN, Regional character Certificate	NID, Birth Certificate, Photo ID
Survey	Marketing and individual customer outreach	Marketing and individual customer outreach	Marketing and individual customer outreach	In-person, physical data collection
Application Submission	Official and/or online	Official and Limited online facility	Official and/or Online application	On Spot submission
Authenticity verification	Higher authority verification	Higher authority verification	Higher authority verification	Officer query

4.1.2 Sequential Processes of Continuation

According to the common implications of financial institutions, the subsequent phases of determining the credit score and the contribution of risk assessment in female entrepreneurship have been unveiled in this section. Upon initial evaluation, banks move onwards following different models with diverse considerations. Plans of EMI, different time-bounded schemes are usually offered to the clients scrutinizing borrower's repayment records, loan history that introduce their financial behaviors. Afterward, the process incorporates a credit information bureau (CIB) report to assess "risks with loan defaulters". The individual consideration criteria of each organization type has been illustrated in table 3. The general scenario revealed that the most popular resolution of assessing a client's credibility of loan repayment is conspicuously related to the guarantor's status including solvency, social positions and the firmness of relationship between the guarantors and clients. The role of the guarantor is well emphasized by the bank officials and one of them presented a poetic narration about the guarantor's role as follows.

"The role of guarantor is like a river, if there is a flowing river, the area would flourish spontaneously. There is provision to auction the property of the guarantor also in case of loan defaults, so a good guarantor gives a great margin of safety and the rest of the things get easy (for us). But if not then the opposite." - P9, Govt Bank, High level.

However, female entrepreneurs are found dealing with multi-faced challenges in managing as well as longing for the committed guarantors. The superfluous press and justifications of the financial institutions articulated the ultimate storyline; they are seeking for the guarantor's confidential credentials such as trade license, bank statements or legal documents of their fixed assets granted as

their safeguards. Thus, the guarantors become apathetic to be promising and thus the expansion of the female-led businesses drops off. Another story from the women entrepreneurs validated the extravagant requisition of the financial institutions along with their discriminating approaches of interventions. Banks' justification is satisfied with the compulsory supporting documents of the male counterparts of female entrepreneurs; however, male clients are not obligated to keep their female counterparts as their guarantors by the financial institutions.

> *"They (bank officials) ask to provide a selfie with my husband and family. It needs to be a casual family photo. Now, you say, why should I provide that? They don't ask men to do so. I'll have to go through a whole lot of process in that case and if I do it like this then I can get money directly (from him). But then it's not the same."* - P11, Entrepreneur, Dhaka.

These gender biased financial systems are leading our economic escalation downwards and dominating our socio-economic context with a contaminated norm. Female entrepreneurs are losing their grounds in enlightening their empowerment with their own compatibility and competence.

Table 3: Risk assessment across financial institutions

Attribute	Private bank	Government Bank	NBFI	NGO
Small Loan Risk Analysis	Trade license, e-tin, credit rating, guarantor	Trade license, e-tin credit rating, guarantor	Trade license, e-tin, credit rating, guarantor	Inventory, location, guarantor
Big Loan Risk Analysis	Trade license, e-tin, credit rating, audited sheet, balance sheet, ICRS	Trade license, e-tin credit rating, audited sheet, balance sheet, ICRS, guarantors' financial statement	Trade license, e-tin, credit rating, audited sheet, balance sheet, ICRS, guarantors' financial statement	Inventory, location, guarantor

4.1.3 Facultative Approaches of the Institutions

The encountering exposure of technological interventions and the readiness of the client community in operating the financial systems have been pictured in this section. The overall findings suggest that in the case of reaching clients and expanding the range of the clients, institutions are nowadays dependent on digital media platforms, emails, and phone calls whereas, NGOs are carrying on along with their gray approaches of physical outreach to hold and to expand their client community. Since the age of automation leads to faster processes with the least errors in the maintenance of documents, the process is now running with different in-house software to manage the primary data submission, verification, and surveillance.

> *"Day by day we are using technology a lot more. They (applicants) actually apply through the app, the online banking app that we have. They submit most things online primarily. In fact, for most loans up to 50 lakh taka, they use the app. It has made our branch work much more convenient."* - P4, NBFI, High Level.

However, the technological advancement of the organizations is found incapable of complementing the female entrepreneurs with their disclosures. Although the familiar technological interfaces have already been introduced through multiple options of Mobile Financial Services, they are not grounded with the information about using, maintaining and disseminating the features of digital transactions. The

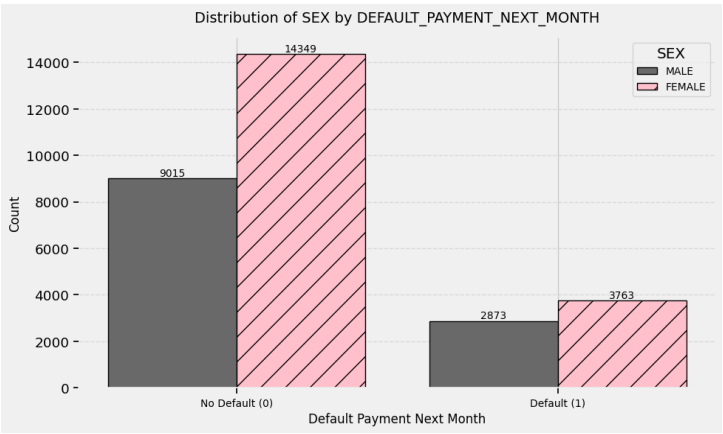
community of female entrepreneurs has commonly voiced that they are mostly hesitant to reaping its benefits due to the inaccessibility [50] of the modern devices and being concerned of securing their privacy [49] over their confidential information available into the devices. The diffident voice of the female entrepreneurs has firmly stated that the excessive cautions are required to be addressed dealing with these digital platforms; the wrong interpretation or misjudgments of the digital terms may lead to huge financial loss, or it may intervene and disrupt their individual and social privacy, are believed by them.

The lack of proper acknowledgment of the relevant technical information, device access and a secured form of financial system are obstructing the amplification of the overall economic growth dipping the female entrepreneurs into indigence.

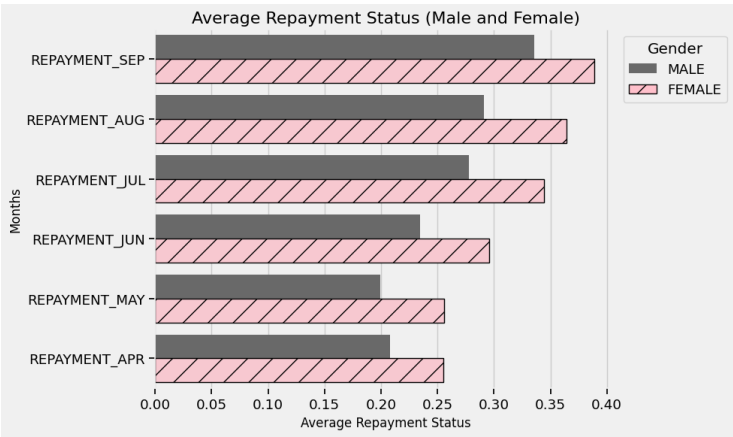
4.2. Quantitative Visualization

4.2.1 Exploratory data analysis (EDA)

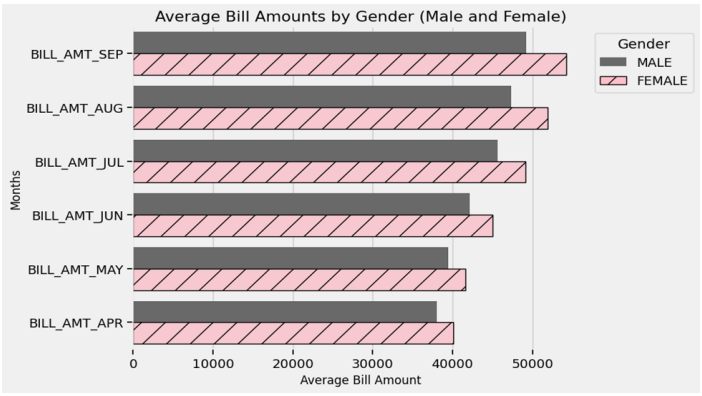
Several EDA are conducted to understand the data patterns and their relationship among all features. In the DCC dataset overall, about 22.1% of the sample defaulted on their payment, and the rest of the people are non-defaulters. We have analyzed the ratio of defaulters and non-defaulters across different genders, educational levels, marital statuses, and age groups. Figures 2 (a), (b), (c), (d), and (e) illustrate the following: the ratio of defaulters and non-defaulters among different genders, the average repayment status by gender, the average bill amounts by gender, the default rate by gender and age group, and the default rate by gender and educational level.



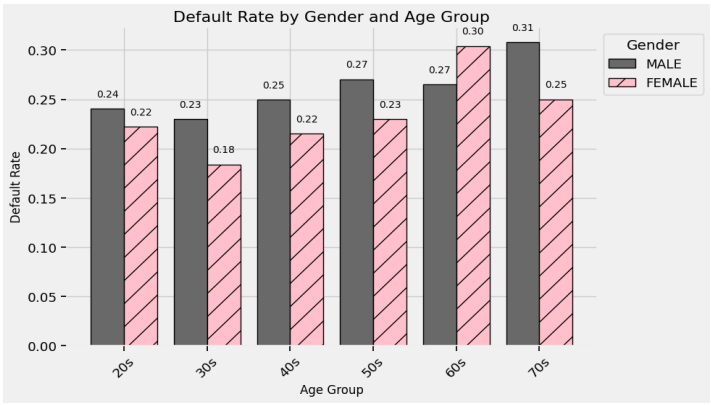
(a)



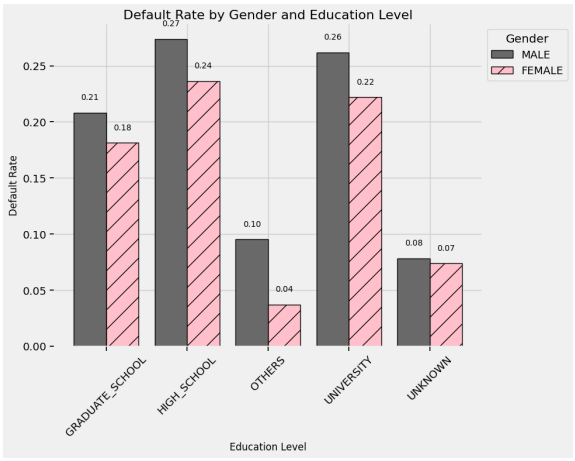
(b)



(c)



(d)

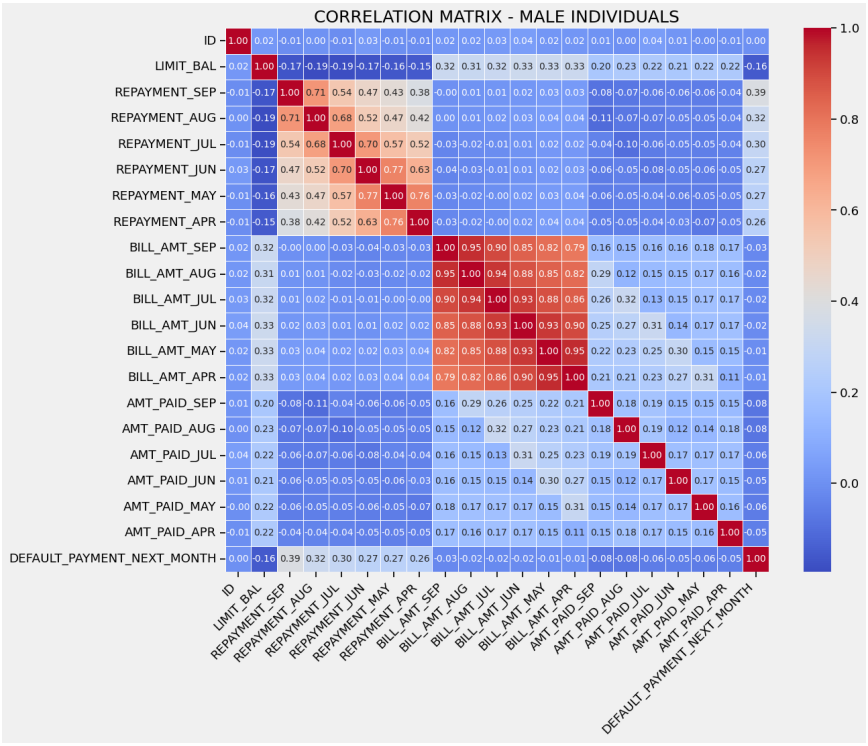


(e)

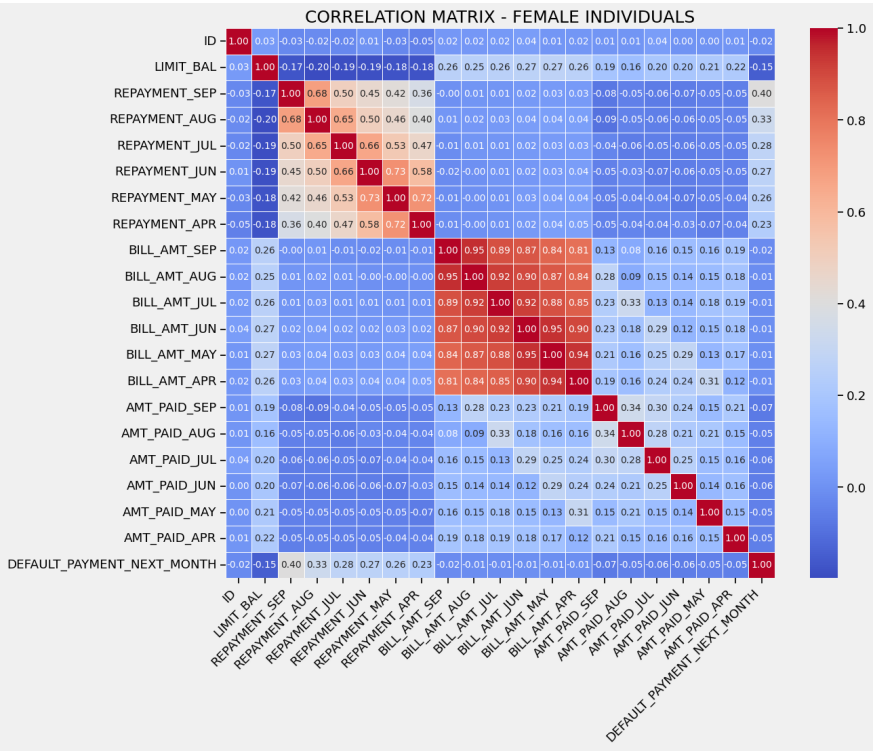
Figure 02: Subfigures 2(a)–2(e) depict defaulter ratios, repayment status, bill amounts, and default rates by gender, age group, and education level.

Females are more likely to be both defaulters and non-defaulters. On average, men tend to default at a slightly higher rate than the general population. The analysis of repayment behavior indicates that women consistently exhibit a stable and smooth repayment tendency, a trend that holds across all months. It implies that women may have a higher tendency toward financial prudence and careful management of credit, while men seem to demonstrate more inconsistent repayment behavior, highlighting potentially different methods for handling debt and financial risk. The average bill amounts for males and females also remained similar throughout the examination. Bill amounts rose consistently from April to September, and since this time series trend seemed axiomatic, rising bills do not imply a unique spending behavior of either sex; it is likely driven by seasonal or macroeconomic factors. These results speak to the impact of context on financial responsibilities while highlighting gender differences in repayment reliability. By both age group and gender in terms of default rates, females have consistently higher rates than males across the different categories. The increase in default rates with age among both sexes peaks during the 60s and 70s, where the disparity between genders is most pronounced. Such a trend is indicative that older females are more at financial risk, which may stem from socio-economic or health effects. The findings underline the necessity of age- and gender-specific credit risk predictions and specific financial support measures, especially for older women. Males have lower default rates than females at every education level, with the largest differences seen in the high school and university levels. High school graduates, regardless of gender, record the highest default rates, while the "Others" category has the lowest. Default Rates among Females Surpass Males Slightly

in Categories Show Modest Default Rates Graduate School & Unknowns. The default rate for these two groups (graduate school and unknown) is moderate. These findings emphasize the significance of knowledge to monetary stability, being that low levels of education are one more vital factor in figuring out dangers for default and maximal for males.



(a)



(b)

Figure 03: Gender-specific correlation matrices for males (a) and females (b).

To investigate the dissimilarities of correlations between all involved variables based on gender, males and females were distinguished separately, and the corresponding correlation matrices are visualized in Figures 3(a) and (b), respectively. While both groups have high billing and repayment consistency month-to-month, males show stronger correlations (which are also more stable), while females show some variation between months, indicating less rigidity. For credit limits, males show moderate correlations between LIMIT_BAL and other variables, suggesting weak associations with financial behaviors. Females, however, display a negative correlation between LIMIT_BAL and amounts paid, indicating that higher credit limits correspond to distinct financial behaviors. Regarding default prediction, there are weak correlations between repayment behavior and default for each group, so it follows that amounts repaid are poor predictors of default. Even females show a weaker correlation, which may imply that the default risk is due to some unobserved factor. In general, males show less variation in the way they engage financially over time compared with females; females have significantly more variability than males, especially for billing amounts and suggest periodicity rather than engaging with an ideal of financial behavior.

The results identify that the concerns of repayment and defaults are eminently influenced by gender and level of education of the borrowers. Women are genuinely found stable in repayment than men throughout the visualization of the whole dataset. The consistency is observed in the case of the male clients preventing their status from being a loan defaulter when their education level lifts upward regardless of the financial compatibility. The relevant research studies [26] have also resonated with the similar illustration of data that uncovered the dominant number of women clients as successful and sincere in repayment despite enduring diverse challenges around accessing credit, especially in their early years of entrepreneurship.

5 Conclusion and Way Forward

Credit Scoring is one of the most significant aspects of obtaining loans from financial institutions and thus supporting businesses and ensuring the growth of the country's economy. In the current age of globalization, technologies have intervened in the financial sectors intensifying the credit-related aspects so that transparency can be maintained, and the customer community can be enriched with the trustworthiness of performance. However, extending the banking opportunities to facilitate the online business owners, eliminating gender-based financial discriminations, expanding the access to the digital devices, ensuring comprehensive understanding on 'privacy' of using the digital mediums of transactions have already been highlighted to amplify the economic growth of the country. Female entrepreneurship is an emerging concept in Bangladesh's economy. Accelerating the financial accessibility to female entrepreneurs has increased; however, the discrimination, contradictory assumptions circulated by the banking institutions along with their superfluous documentation and formalities led them towards informal loans and thus depriving both banks and entrepreneurs from contributing to the country's economy.

In this study, both the qualitative and quantitative study have accumulated significant attributes in the context of female entrepreneurship in Bangladesh. Qualitative analysis retrieves the modes of business execution (physical or online), additional pressure with guarantor's documentation and privacy concerns along with the inaccessibility to the smart devices have become underlined; whereas, quantitative section interlinked their educational qualification and propensity to repay the loans in such a way that the common insight indicating the cautious nature of the female entrepreneurs in loan

repayment as well as in bill repayments. The education level fortifies this capability of them; the higher the education level, the higher chances to repay the loans or bills. The socioeconomic contents of Bangladesh have been suppressing women's empowerment in many ways from the ancient ages; however, with the excursion of time, the configuration of crushing women entrepreneurs in Bangladesh has been transformed into unique kinds of exposure. Although the responsible approaches are higher for women entrepreneurs toward loan and bill repayment, the quantitative section has reinforced this showing women's steady repayment behavior. Despite this, women entrepreneurs face significant challenges, particularly in online business, due to implicit biases in credit access and systemic barriers. Both studies emphasize the need for a more inclusive financial environment to support women's success in entrepreneurship. The women entrepreneurs fail to retrieve their businesses securing formal bank loans despite having and presenting their social-media pages, number of sales, and transaction history altogether. As a result, the incited demotivation and frustration lead their traits either to compress their business size or to the alternative options along with insecurity and indistinction. The economic growth of the country is hindered by the artistic norms of cultivating gray superstitions.

Although many government and private training schemes have been incorporated to enlighten the women entrepreneurs in Bangladesh, females are either not familiar with these or resist themselves due to the abounding considerations of the banking institutions. After COVID-19, the exposure of E-businesses has significantly increased throughout the country and female entrepreneurs have shielded their standings with it enhancing their own financial stability and contributing to the country's growth. However, the requirement of their male counterparts, the demand for private credentials of the clients as well as of the guarantors, etc. are impeding the whole system from flourishing. Moreover, the lack of legal leap in this regard plays a vital role in daunting the systematic and progressive growth leveraging the potential of the women entrepreneurs of our country. The need-based initial training on smart financial transactions, document maintenance, and networking should be prioritized and prescribed to the governmental body so that technological interference may not halt their prosperity. Also, the accessibility of the smart devices and awareness of the privacy related issues with the financial attributes can frontier them. The institutions are sluggishly adopting the technological benefits; systems need to be introduced as a one-stop solution for the institutions as well as to the clients regardless of gender and age so that the authentication can be done with a single click. However, banks and other financial institutions need to be compassionate to the women entrepreneurs of Bangladesh with the minimal required documents ensuring transparency. The overall association of the banking institutions and female entrepreneurs can uplift our economic growth, securing the state's law, and functioning the banking special schemes for female entrepreneurs.

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Appendix (1): Original Feature name after renaming (DCC Dataset)

Original Column Name	Renamed Column Name
PAY_0	REPAYMENT_SEP
PAY_2	REPAYMENT_AUG
PAY_3	REPAYMENT_JUL
PAY_4	REPAYMENT_JUN
PAY_5	REPAYMENT_MAY
PAY_6	REPAYMENT_APR
BILL_AMT1	BILL_AMT_SEP
BILL_AMT2	BILL_AMT_AUG

BILL_AMT3	BILL_AMT_JUL
BILL_AMT4	BILL_AMT_JUN
BILL_AMT5	BILL_AMT_MAY
BILL_AMT6	BILL_AMT_APR
PAY_AMT1	AMT_PAID_SEP
PAY_AMT2	AMT_PAID_AUG
PAY_AMT3	AMT_PAID_JUL
PAY_AMT4	AMT_PAID_JUN
PAY_AMT5	AMT_PAID_MAY
PAY_AMT6	AMT_PAID_APR