

Consumer and Business Owner Rights and Legal Access: An HCI Based Approach

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Declaration

It is hereby declared that

1. The thesis submitted is our own original work while completing degree at Brac University.
2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The thesis does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. We have acknowledged all main sources of help.

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Ethics Statement

This research was conducted in accordance with the ethical guidelines and standards prescribed by the Department of Computer Science and Engineering and the university. All ethical considerations relevant to the study were carefully observed throughout the research process. The study involved the use of human participants only in a non-invasive and minimal-risk manner, such as surveys or indirect data collection, where applicable. Participation was entirely voluntary, and informed consent was obtained from all participants prior to their involvement. Participants were clearly informed about the purpose of the research, the nature of their participation, and their right to withdraw at any stage without any negative consequences. All data collected during the research were used solely for academic purposes. Confidentiality and anonymity of the participants were strictly maintained, and no personally identifiable information was disclosed or stored. The collected data were securely handled and analyzed to ensure privacy and data protection. This research did not involve any form of physical, psychological, or social harm to participants. Furthermore, no unethical practices, fabrication, falsification, or plagiarism were involved at any stage of the study. The authors confirm that the work presented in this thesis is original and that all sources of information and data have been properly cited and acknowledged.

Abstract

Nowadays, people are being cheated every day while buying groceries. The sad thing is that even if people take measures to avoid awareness, the results are revealed very late. Another issue is that people still do not fully know what laws apply and what steps should be taken if they are deceived while buying a product. And because of this, the syndicate system in the market is increasing day by day. The main goal of our research is that if people are victims of fraud when buying a product in the current market, they can easily access the laws that exist for that case which are included in consumer act. The types of cases that fall under this category are expired products, products sold at a price higher than the original price, adulterated and counterfeit products, etc. We train the models of this earning model including Naïve Bayes, Decision Tree, K-Nearest Neighbors (KNN), Support Vector Machine (SVM), LDA, Linear Regression, Logistic Regression, Decision Stump with data collected through the survey (n=1500) according to the type of fraud. After analyzing the models, it was seen that SVM gives the most effective results which showed accuracy of 98%, recall (97%), F1-score (97%), precision (97%). This study will help the people of Bangladesh to easily know which law is applicable for that fraud and what measures need to be taken if they are a victim of fraud when buying any product in the local market. By doing this, it will ultimately create awareness among the businessmen in the country, protect the public health of the common people, and eliminate the syndicate system in the local market. This will improve the economic system of Bangladesh on the one hand as well as the development of the country.

Keywords: Machine Learning, Legal Rights, HCI, Consumer Rights, Bangladesh

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Chapter 1

Introduction

1.1 Background

In the current world, like other countries, the rate of fraud is high in Bangladesh. It has become a big social and national problem. People still do not fully know what law applies if they are faced with fraud when buying any product. If a person is cheated, if he has knowledge about his law, then confidence will grow in him and he will be able to know what legal action needs to be taken for fraud. Although, there is a consumer rights law on the internet in the country, many people do not know how and where to find out about those issues. Also, if the Department of Consumer Rights sees any kind of problem, they go to the market and raid it. By doing this, after imposing some fines, the traders are aware for a few days. But after a few days, the common people are cheated again due to syndicates. So we researched and created an app through which people can easily know about their consumer rights. And as soon as they know the law, they can decide what action to take.

1.2 Motivation

There is increasing consumer fraud in Bangladesh, and many consumers are unaware of their rights under the Consumer Rights Protection Act of 2009. The Consumer Rights Protection Act prohibits fraudulent advertising (false marketing), overpricing, and selling tainted or defective goods to consumers, but most consumers do not know how to enforce their consumer rights and protections. According to a study conducted by Hassan et al. (2016), only 53.3% of Bangladeshi consumers are aware of their consumer rights or how to address an issue regarding fraud [1]. Ignorance of the law enables fraudsters to take advantage of consumers, and to make restitution and/or a claim very difficult.

The Internet marketplace is growing at a faster pace than the legislative framework has established protection for consumers; therefore, the problems outlined have become worse over time. Consumers who use technology frequently are subjected to misleading or deceptive marketing and the selling of unsafe goods, and they usually have a hard time figuring out how to get their money back [2]. The level of consumer exploitation continues to increase due to the influence of a syndicate system in the marketplace. Due to the complexity of legal language, length of time for procedures, and lack of clear sources of information, several issues arise.

The HCI (human-computer interaction) principles will be utilized to determine and create a mobile application that will address the above-stated issues. The application will provide an overview of legal rights and guarantee consumer claims of Internet fraud based on machine-learning techniques, specifically using support vector machine (SVM) model, to provide classification of consumer fraud claims and recommend actions. The application will make the legal rights and protections provided by the Consumer Rights Protection Act easily accessible and allow consumers to file legal action against Internet fraud quickly. The use of this application will ultimately reduce instances of Internet fraud, improve the public health and economic systems of Bangladesh, and eliminate the syndicate system within the marketplace.

1.3 Problem Statement

Bangladesh has consumer laws that protect consumers; however, there is no consistent way to navigate these laws [2]. The average consumer is caught in an unfamiliar legal system without knowing the appropriate laws for their circumstances, enabling continuous exploitation of consumers by companies and neglecting consumer rights and protections [3].

The lack of understanding about consumer rights puts Bangladeshi Consumers at risk from fraud, overcharging, selling fake/low-quality products, and dishonest business practices. In Bangladesh, there are Consumer Protection Laws; however, it is extremely difficult for consumers to understand or access the information that consumers need due to how complicated the legalese used by lawyers makes consumer rights difficult for most to understand. Due to the rapid growth of the internet, companies now have the capability to falsely label products as being "safe" or "of good quality", or to use confusing terms when discussing returns and refunds.

This research will explore how to use the power of modern technology through Machine Learning to create an easier way for consumers to categorize their complaints and provide them quicker access to attorneys. This research will investigate both the opportunity and challenges involved in developing a Machine Learning Support System for Consumers that helps them better understand their rights and use the appropriate methods for pursuing a legal remedy, allowing consumers access to, and to enforce, their legal protections in an easier way.

1.4 Objective

In order to accomplish the research objectives, the study employs various machine learning classifiers, including Support Naive Bias, Decision Tree, K-Nearest Neighbors (KNN), Support Vector Machine (SVM), Linear Discriminant Analysis (LDA), Linear Regression, Logistic Regression, Decision Stump and Random forest. After analyzing the models, it was seen that the SVM model gives the most effective results for our consumer rights. However, it is essential to admit that until awareness increases among people and traders, the harassment that people are subjected to while buying products will continue to occur. However, the main goal of our research is to make them easily accessible to the laws contained in the Consumer Act

2009. If people know about the consumer rights laws, they will be able to deal with all the frauds they face from traders while buying products. And they will be able to take immediate legal action. Through this, public health of the people will be protected, the economic system will improve and the bad syndicate system will be stopped. For this purpose, this study will:

- Consider how HCI can enhance consumer awareness and access to legal rights, with specific reference to issues like refunds, warranties, fraud, and consumer protection.
- Recognize and document the challenges faced by consumers to understand their rights and undertake an overall assessment of how such impediments hamper their efforts to enforce their rights and seek relief.
- Create and promote human-computer interaction (HCI) based systems, such as chatbots, mobile apps, and voice assistants, to enable easy access to and utilisation of pertinent legal information regarding consumer rights.
- Evaluate the efficiency of online platforms—such as websites, voice-enabled devices, and mobile applications—to make legal rights and relevant information accessible to users in a simple and convenient way. This is particularly pertinent within consumer affairs, complaints against services, and claim-related processes.
- Create an overarching framework combining both legal and technical aspects delivered within an understandable interface so as to make complicated legal terminology and consumer protection policies accessible to non-legal specialists.

1.5 Methodology in Brief

The project utilizes machine learning, to quantitatively categorise Fraud Allegations based on Consumer Rights Protection Act (CRPA) Statutes that exist from 2009. The research team has ascertained how to make the Legal Knowledge accessible to Bangladeshi Consumers using survey studies, Machine Learning Models, and Usability Tests on Machines.

The survey asked 1500 people 15 yes/no scenario questions regarding the types of fraud seen in the consumer community including expired products, counterfeits, misleading advertising, and price discrepancies. The responses produced the target "ground truth" variable based on identifying how respondents classify the most common types of fraud attempts. The proprietary variable referenced 20 CRPA statutes for each fraud identified.

The conducted study evaluated several machine learning approaches, including Naïve Bayes, Decision Tree, K-Nearest Neighbors, Support Vector Machines (SVM), and Logistic Regression, ultimately establishing that SVM provided the highest scores for Accuracy, Precision, Recall, and F1 score, with an accuracy of 98%. Moreover, the SVM approach produced three probabilities in predicting the best cause of action.

HCI methodologies were used here for creating User-Friendly and Accessible machine learning procedures, applications, and data collection tools for the honourable consumers with varying levels of digital literacy. The smartphone application is designed to allow consumers to collect complaints, assistance with legal interpretation, and advice on preventing fraudulent practices. Consumer and business feedback during testing supported the design of the application interface to accommodate both business and consumer needs.

In conducting this research, participant rights to privacy and data security were maintained. All survey participants provided informed consent upon approval from their own legal counsel regarding the collection of their data.

1.6 Scopes and Challenges

This research focuses on the use of machine-learning techniques for analysing consumer complaint data with reference to the Consumer Rights Protection Act of 2009. The app provides users with information and advice on how to protect themselves, including their rights in relation to expired goods or items; excessive prices; counterfeit goods; false or misleading advertising; and other issues related to unfair trading practices. Support Vector Machine (SVM) classification and Human-Computer Interaction (HCI)-based usability testing reduces the complexity of the relationship between consumers and businesses.

Inadequate education and knowledge regarding consumer law creates barriers to enforcing consumer rights, which has direct negative impacts on the results of this research. Hassan et al. (2016) found a significant number of consumers know nothing about their rights and find it extremely stressful and burdensome to go through the legal process to assert them. The lack of law data for Laws 3, 17, 18, and 19 resulted in fewer instances for which to generate training data. Support Vector Machines (SVMs) perform better when trained using the largest amount of data possible; therefore, the next phase of the study will involve training scenarios regarding the laws.

The SVM model performed well despite the challenges of scaling and class imbalance. Unfortunately, the algorithm failed to match consumer complaints with the correct types of fraud reported. Thus, in future studies, we will need to collect additional data and provide better SVM algorithm training for classification. Low-digital-literacy users of the mobile app wanted quick access to legal assistance and requested improvements to the app's UI to enhance HCI usability; therefore, the authors of Mia et al. (2021) are working to improve the app UI and working towards making their designs more accessible.

The existence of regulations that protect consumers does not ensure that consumers will find it easy to access the protection provided by those regulations. There are barriers that make it difficult for the general public to reach the legal resources they need as a result of enforcement difficulties in accessing the legal system. Barriers include limited access to the courts for consumers; long delays before consumers can file complaints in court; and inadequate support mechanisms for obtaining assistance in securing legal counsel.

Chapter 2

Literature Review

2.1 Preliminaries

The introductory of consumer-rights protection systems give the background knowledge upon which it is possible to assess how digital tools can enhance legal awareness and access to justice. Basic notions like the rights of consumers, fair-trade, digital legal support, and Human-Computer Interaction (HCI) models define the premises of examining modern technological interventions. Existing literature states that consumer protection depends on transparency, proper product information, and responsible business practices to provide fair practices in the market [4].

The principles are used in the formulation of the regulations and in developing information systems that are to be used by the people. The other priority area to be made beforehand is the structure of the Consumers Right protection act that stipulates actions to be taken against fraudulence, deceptive advertisement, misrepresentation of adulterants, expired goods, and unfair discrimination. According to the scholars, legal texts are usually hard to be interpreted by an average consumer because they are complicated and use a specialized language [5]. This brings about the necessity of plain and simple platforms that are able to provide translation of legal specifications into user-friendly instructions.

2.2 Review of Existing Research

(Santos, et al, 2025) [6] consider how the issues under "dark patterns" are described in Human-Computer Interaction as well as in law, particularly under EU data protection, consumer, and competition laws. It seeks to link empirical studies of sly interface design with means of holding people legally accountable. The authors review the HCI literature on dark-pattern harms (individual, collective, material, non-material) and propose a means for classifying such harms. They then relate these categories of harm to applicable laws (GDPR, Consumer Protection, Competition law, the Digital Services Act, etc.). Their approach involves collecting information, examining legal questions, and relating legal remedies to harm allegations. The outcomes: The paper unifies debates from HCI and legal perspectives, demonstrating where laws currently can (or cannot) do something about particular harms. It asserts that legal instruments frequently lie scattered and that more precise definitions

and more logical organization must be had if dark-pattern designers are to be held accountable. It facilitates an understanding of what harms can be litigated and enables a call for more unambiguous regulatory norms.

(Purdue DIAL Ventures, 2023) [7] This white paper explores transparency and traceability in food value chains’ implications on consumer confidence, quality assurance, as well as supply chain integrity. It identifies labels (such as lists of ingredients, expiry dates, as well as nutrition facts) and traceability systems (food tracking from farmgate to plate) as significant forces shaping consumer perception. The authors show survey data (Consumer Food Insights) and examples from supply chains. They look at what consumers want, the challenges of making traceability work (like sharing data, building infrastructure, and following regulations), and new chances for clear systems in the market. Results: The paper finds that more than 70% of consumers rely on labels (like nutritional facts, ingredients, and expiration dates) for important information. It says that better traceability systems (both technology and rules) are very important to meet this need, build trust, reduce fraud, and improve food safety. It mentions obstacles like costs, digital infrastructure, and the need for common standards.

(Wageningen, 2023) [8] This paper investigates how strengthening on-pack date marking (use-by versus best-before) can facilitate consumer disposal behavior and thus help mitigate household food wastage. It hypothesizes that expiry semantic ambiguity causes edible food wastage due to its early disposal. The research utilizes experiments or real-world labeling modifications: introducing useful phrases (such as "Often good after date: look, smell taste") or explanatory "Do not use after date." It observes people’s response in terms of what they choose to discard and how they behave. Consequences: The intervention brings about substantial changes in consumers’ decision-making behavior — fewer foodstuffs get wasted unnecessarily when labels offer more unambiguous communication. That is, labeling enhancement can help reduce wastage by bringing consumers’ knowledge closer in alignment with real food safety.

(Zaheer) [9] This paper thoroughly discusses the crucial problem of how UX design decisions can slip towards the dark side, often defined as dark patterns, or instead maintain ethical standards that foster trust, augment user autonomy, and facilitate long-term use of digital goods and services. It truly captures the underlying tension that exists between legitimate persuasion as a kind of influence that is desired and acceptable versus manipulation as an unwanted coercion that users might feel. In particular, the paper finds and discusses particular patterns that are categorized as manipulative—like forced persistence, hidden advertisements, default opt-in, and misleading menus—and conducts an in-depth exploration of their detrimental effects, such as diminished trust, further digital fatigue, as well as the overall feeling of deceit that they can instill in users. Later on, it posits these manipulative patterns against UX principles that focus on transparency, notice, voluntariness, as well as accessibility for every kind of user. The authors’ approach is both descriptive as well as normative in kind: it incorporates definitions for significant terms, a typology for the patterns found, as well as an argument concerning their effects on trusting users. This paper’s outcomes show a compelling case for the need to instill UX practice

with ethical norms as a way towards preventing the development of manipulative interfaces that can eventually undermine as well as endanger trusting users. Additionally, it gives practicable guidelines for designers in marking, recognizing, as well as sidestepping these dark patterns that discuss the important as well as vulnerable role that trust plays in the use that people make with digital interfaces. In that sense, the approach that they advocate is less legalistic or formal yet incorporates real heuristics that may be built into use of design as a way towards a more ethical as well as usable digital experience.

(Nah et al, 2002) [10] This paper discusses the principal Human-Computer Interaction (HCI) issues that underlie consumer experience in e-commerce: web usability, interface design, and trust. We make a case that these HCI issues fundamentally influence users' perceptions regarding fraud risk as well as the success of support/help-seeking apparatuses. Methodologically, the research integrates prevailing HCI as well as e-commerce literature and offers a conceptual framework. Central research questions pertain to navigation simplicity, information lucidity, customization versus confidentiality, as well as trust-boosting cues such as security indicators/certifications. Designing for usability assumes central importance in mitigating consumer vulnerability. Results: Usability, trust, and interface quality emerge as the highest-prioritized HCI research questions for e-commerce. These facets not only establish users' satisfaction but they directly influence consumer protection as well as dispute-settling potential.

(Baymard Institute, 2023) [11] This e-commerce industry research explores the usability of online return/refund flows on leading e-commerce platforms. It points out that although returns form the heart of customer retainability, more than a half of the testing platforms had serious UX flaws that irked customers and hampered service delivery. The approach encompassed mass UX benchmarking, heuristic review, as well as usability testing on return flows. Findings outline issues such as unclear policy on returns, confusing forms, obscured returns options, as well as inadequate feedback upon processing. Results: Poorly designed returning interfaces not only erode credibility but also hurt brand loyalty. Improved HCI design in returns flows can directly lower customer churn as well as complaints, highlighting the UX design-effectiveness on consumer redress linkages.

(Madhavi, 2021) [12] This paper discusses the role of Consumer Dispute Resolution (CDR) in virtual marketplaces, emphasizing the need for efficiency, convenience, and affordability in conflict resolution. It positions the challenge against the backdrop of asymmetries in information where consumers lack negotiating power and access routes for redress. Methodology integrates legal critique with commentary on conflict resolution trends. It addresses consumer grievance routes, arbitration, and redressal routes. Results demonstrate that poorly managed complaints not just exacerbate consumer disenchantment but also damage marketplace reputation and long-term confidence. Conclusion: The study recommends bolstering online conflict resolution tools, underscoring the benefit of swift, transparent, and cheap redress in safeguarding consumers and ensuring the sustainability of e-commerce. This research introduces a Dispute System Design (DSD) framework custom-built for consumer versus business disputes that links procedural design to fairness percep-

tion directly. It maintains that dispute resolution needs to be designed proactively instead of reacting by patching up. The approach is theoretical and prescriptive, based on DSD principles (diagnosis, design, implementation, evaluation) that it applies to consumer e-commerce settings. The framework incorporates a systematic structure that blends mediation, arbitration, and complaints handling. Results: The introduced DSD model provides a structured system of consumer dispute resolution that strikes a balance between efficiency and fairness as well as incorporates an element of trust. Embedding fairness principles in system design enhances consumer protection where reputational risk for firms is diminished.

(Poitras et al, 2016) [13] This guidance articulates the requirements for advertising health products by the FTC that such advertising must be truthful, supported by evidence, and not deceptive. Though health product-oriented, these principles apply to the digital interface as a product and online advertising. The text details the legal framework: substantiation standards, competent and reliable scientific evidence, and prohibitions against deceptive or exaggerated claims. It is a regulatory and doctrinal resource, not an empirical study. Outcomes: The guidance reinforces that UX/UI choices (e.g., how claims are displayed) fall under truth-in-advertising obligations. It highlights the broader principle that misleading design harms consumer autonomy and violates compliance standards.

(FasterCapital) [14] This paper outlines best practices for clearly and accurately presenting product information emphasizing simplicity, evidence-based statements, and clear labeling. It nicely frames good UX/HCI design as a compliance device for minimizing deceptive representation. The approach is descriptive and prescriptive, presenting guidelines for companies. It discusses presenting nutritional facts, lists of ingredients, directions, and disclaimers in easy-reading and consumer-oriented manners. Outcomes: The blog enumerates that product transparency is not only a legal matter but also a builder of trust. It frames labeling and disclosures as UX central disciplines with compliance implications.

(Federal Trade Commission, 2023) [15] This business advice describes the INFORM Consumers Act, an American law that obliges online marketplaces to collect, authenticate, and provide publicly available truth about high-volume third-party sellers. It aims to boost transparency, discourage fraud, and enhance consumer safeguarding. Regulatory and legal interpretation approach: describing requirements, "high-volume sellers" definition, and implications for enforcement. It positions the law against a trend towards growing digital marketplace fraud. Impact: The Act is a major regulatory step for e-commerce with implications for HCI/UX since marketplace interfaces will now need to integrate identity verification and transparency tools. This aligns legal compliance with interface design.

(Indah, et al, 2025) [16] The main themes of this paper are the "dark patterns" in digital platforms and the problems they pose to the existing Indonesian consumer protection laws. User behavior-controlling deceptive design patterns are featured in the discussion of their rights impact through the Indonesian legal system. The writers analyze the range of consumer decisions prone to the influence of these patterns and the extent of consumer autonomy, thus leading to a risk of their annoyance.

Moreover, the paper points out that the current legal framework in Indonesia is inadequate to resolve such issues, thus making the case for stronger laws in this area to combat dark patterns efficiently. One of the proposed solutions by the authors is to change the consumer protection law and set up more detailed regulations that would hold companies liable for the use of manipulative designs. Ultimately, it is about the incorporation of the principles derived from global best practices in digital consumer protection to enhance the legal response of Indonesia.

(Gray et al, 2021) [17] This paper investigates the legal consequences of consent banners on digital platforms, giving attention to the dark patterns used in the banners that contribute to the conflict between legal requirements and GDPR. The authors apply the interaction criticism viewpoint and to see the whole process of consent banners creation as well as their support (or no support) for the regulations of the European privacy laws. The authors critically assess a variety of real-life consent banners and assign a score to each one according to its compliance with the legal requirements for user consent. They also mention that certain design choices influence user behavior in such a way that it becomes unclear whether or not the user has given consent. The issue of dark patterns in consent banners is further examined in the paper, and a new set of guiding principles is even suggested to be established, which would enable the interfaces to meet both the legal and moral standards.

(Ipsos, 2021) [18] This report is about consumer attitudes to the use of food after the 'use by' date (UBD) which turned out to be an important aspect of usability problems in food labeling. Some of the participants even after correctly identifying the UBDs still mixed them up with BBDs which led to them not following the safety rules consistently. The research paper shows that UBDs were often treated as soft rules and consumers based their decisions about food safety on their sense of smell and sight. The main factors influencing consumer decision-making were affordability, social, and physical environments. The results highlight the necessity for improved labeling, and design changes to assist consumer understanding and compliance with food safety standards.

(Andikatama et al, 2024) [19] The article discusses how the consumer protection law in Indonesia is adapting to the digital age, particularly focusing on e-commerce law. The authors carried out a legal research which was mostly normative in nature to analyze the present-day regulations governing the Consumer Protection Law of Indonesia together with ITE Law to assess their adequacy in safeguarding internet consumers. Consumer ignorance about their rights in the digital realm and the need for the legal reforms to keep up with the technology are the main issues identified. The study emphasizes the importance of consumer education investment and legal framework updates to be done frequently in order to effectively protect the consumer rights in the increasingly complicated e-commerce environment.

(Chinomona et al, 2013) [20] The present study analyses customer complaints and their impact on service policies in online retail. It is argued that criticism, if handled well, could even set the business direction and lead to service improvements. By studying the techniques and tactics employed by e-commerce firms to handle complaints, the paper highlights the significant role of responsive customer service and

open rules in creating customer satisfaction and loyalty. It emphasizes that proper management of customer complaints brings about long-time customer acquisition and service quality enhancement.

(Stimmel et al) [21] This article provides an overview of the legal implications surrounding false advertising and labeling, and the significant civil and criminal liabilities that may be encountered by the parties involved in the sale or distribution of such products that misrepresent their content, origin, or utility. It counts the federal and state rules, including the Lanham Act and California Business and Professions Code § 17500, that prohibit untrue or misleading claims in commercial advertising. For instance, the article further cites possible third-party responsibility based on fraud and negligent misrepresentation, thus underlining the significance of conducting proper checks in the distribution network to steer clear of deceptive practices.

(UNCTAD, 2017) [22] This policy note outlines the United Nations Conference on Trade and Development's (UNCTAD) recommendations for improving consumer protection in electronic commerce. It points out the difficulties created by information asymmetry, unfair commercial practices, and data privacy issues. The paper highlights the following requirements: information disclosure should be transparent, online payment systems should be secure, contract terms should be clear, and dispute resolution mechanisms should be accessible. These guidelines represent a thorough framework for policy-makers to gain consumer confidence and maintain good practices in digital market-places. They also serve as a basic reference for Human-Computer Interaction (HCI) professionals who want to develop user-centered digital interfaces that conform with international consumer protection standards.

(Santos et al, 2023) [23] introduce a series of heuristics that are proposed to help the development of computer-mediated human interactions that acknowledge and respect consumer rights. It is pointed out by the authors that the conventional usability standards do not take into account the ethical and legal aspects of user interactions, especially in the case of digital environment. Their suggested heuristics are mainly concerned with user interfaces which are to be transparent, accountable, and fair, paying particular attention to informed consent, data protection, and the ease of upholding one's right in dispute resolution. By bringing in all these consumer rights elements into the HCI design phase, the paper is calling for a more responsible and user-friendly practice in the digital product development process.

(Manwaring et al, 2018) [24] This paper examines the possibility of new technologies to move faster than legislation for consumer protection, mainly on the issue of digital consumer manipulation. The writer highlights that the technology for data collection and processing, which is integrated into daily use objects, allows firms to take advantage of the customers' cognitive biases and weaknesses. The paper outlines the difficulties that such techniques create for the current legal systems and insists on the urgent requirement for new laws to be made that would ensure customer empowerment and privacy protection.

(Braun et al, 2019) [25] This paper explores the remarkable potential of the user-focused LegalTech to be a game changer in consumer protection during the digital

age. The authors showcase the development of software that will be able to interpret and break down the terms and conditions from German e-commerce sites for the specific purpose of giving consumers a better grip on and clearer views about digital contracts. The paper encourages the application of legaltech devices in the consumers' favor and that of the merchants' advocates so that the digital market gets more and more open and just.

(Hassan et al., 2016) [26] reveal that only 53.3% of individuals in Bangladesh do not know their rights and that 46.7% know about some of their rights. Lack of awareness gaps, illiteracy, weak enforcement of the law, and shortages of complaint options make consumer protection less effective. Adulteration of food, misleading information, and after-sales service problems are major issues. Campaigns, legal reform, infrastructure improvement, and e-complaining systems are measures that the authors propose for empowering consumers.

(Alam et al., 2024) [27] discusses the influence of self-efficacy, social influence, and perceived benefits on Bangladesh's digital consumerism using an extended Technology Acceptance Model (TAM). "Digital accountability" as a moderating element including organizational capacity, data privacy, legal protection, and ethical marketing is presented. While commenting on the contributions of Bangladesh's online platforms, the authors discuss such issues as scams, fraud, and privacy concerns amidst rising online and cell-phone use. They believe that in the absence of appropriate regulation, increasing digital accountability will become crucial for establishing the trust of consumers, fostering ethical activities, and enhancing performance of the market. Relying on the use of secondary data (e.g., BTRC) and literature review, the paper establishes that responsibility needs to become the priority for businesses and policymakers for the betterment of emerging economies' digital marketplaces. Future research will confirm and develop the model.

(Hossain et al., 2021) [5] stated that The Bangladesh Consumer Rights Protection Act (CRPA) of 2009 is regarded as weak that Consumers do not have the facility for filing cases, limiting access to justice. The complaint period of 30 days is short because of poor awareness. Omission of adulterated medicines makes the Act weak. The Directorate of Consumer Rights does not have powers, and the district committees are not well-coordinated. Suggested recommendations are an extension of the time period for complaint, the facility for consumer-initiated proceedings, empowerment of the Directorate, and the mobilization of the local committees. This paper will provide direction for Bangladesh for future legislative reforms.

(Hasan et al., 2025) [28] discusses consumer protection in the digital world. The Consumer Rights Protection Act of 2009 is challenged by online scams, data privacy, and algorithmic domination. Reforms to provide secure transactions, transparency, and responsibility online are urged for by the authors. Effective grievance redressal, e-commerce regulation reform, and data safeguarding are stressed by the authors. Suggested recommendations include the training of regulators and enhancing digital consumer literacy. The research holds importance for policymakers, the industry, and HCI researchers for emerging economies.

(Islam et al., 2024) [2] investigate the present-day scenario of online shopping in Bangladesh. Irritating features like product mismatches, trust issues, payment method limitations, and time delays reduce the satisfaction of consumers. The study also highlights the adverse effects of personalized product recommendations among which user reactions persistently vary, while emphasizing the importance of UI/UX design in establishing trust and satisfaction. The paper further explains how cultural and socio-economic dynamics engender online shopping behaviors in Bangladesh. They recommend that personalized recommendation algorithms, site interfaces optimized for mobile users, culturally conscious platform designs, and consumer education programs be improved to develop consumer trust and inclusivity in cyberspace.

(Mia et al, 2021) [29] undertake a critical exposition of the divergence between consumer legal provisions and on-the-ground enforcement in Bangladesh. Although the Consumers' Rights Protection Act, 2009 was introduced, many problems have lingered on-the-ground, such as lack of awareness, inefficiency of institutions, and restricted recourse through law. There are many structural defects that the authors insist upon, such as obsolete legislation, limited jurisdictional ambit of authorities, and inadequate punishments. Some of the major problems are adulteration, misleading advertisements, and a lack of access to justice. The authors opine on increasing consumer awareness, reforms in the legal sphere, mainstreaming stronger institutional frameworks, and really putting in the enforcement machinery to bear upon protecting consumer rights in the country.

(Nishat, 2024) [30] discusses the subject of interest is the rise in consumer protection in the emerging e-commerce environment in Bangladesh. The author mentions major problems such as lack of privacy rights, fraudulent transactions, and inadequate legal safeguards that must be in place. Basic laws like Consumer Rights Protection Act 2009, Contract Act 1872, and Penal Code 1860 were found to be inadequate in regulating the new digital marketplaces. Some biggies include outdated legislation, weak enforcement, absent frameworks for digital evidence, and exclusion of virtual goods and services from traditional legal provisions. The study suggests amendments to laws, the upholding of digital accountability, consumer awareness, and building up greater infrastructure in support of facilitating justice in e-commerce transactions.

(Hamid et al., 2013) [31] In Sylhet, Bangladesh, a need for consumer rights awareness is felt due to a severe gap between the written law and knowledge of rights. Consumer rights have been heard by some 70% of respondents, yet only a handful could describe them or name organizations like the CAB. An immense amount of illiteracy, zero government initiatives, very little media input, and societal apathy all contribute as hindrances. Despite passing the Consumer Rights Protection Act, 2009, instances of food adulteration, cheating on weights, and supply of bad-quality products are still common, the study reveals. They recommend changes in the education system, introduction of a much stronger law, active media participation, and efficient legal enforcement to strengthen and empower the consumers.

HCI and Societal Issues: A Framework for Engagement (Hochheiser et al, 2007)

[32] address HCI’s contribution to social concerns such as voting, privacy, and access. It proposes a new model with social necessity, technology creation, and impact at an organizational level, in contrast to predictive datasets. Participatory design, evaluation, and political advocacy represent key strategies in its view. Active, multi-dimensional interventions can maximize social values, according to them, and ethics in usability is critical in HCI interventions and in future program structures.

(Delgado et al, 2022) [33] deal with participatory design for AI in Law, with a concern for AI system development in collaboration with legal professionals and policymakers. It aims towards developing legally compliant, user-centred AI tools for legal practice and decision-making. Paper employs machine learning models specific to legal case analysis and decision-making, working with model and dataset specific such as legal cases, contracts, or legislative documents. Model and dataset specifically rely on a legal issue getting resolved. Participatory discussion involves, with a concern for AI tools’ compliance with both legal requirements and requirements of use through iterative integration of feedback with legal professionals. Qualitative methodologies such as feedback with stakeholders through workshop and interviews, and AI development methodologies such as natural language processing and data annotation, are part of its application. Outcomes: Participatory design, in terms of study, aids usability and legal compliance of AI, and trust with legal professionals, with a boost in system effectiveness.

(Iachello et al, 2007) [34] in their paper treat privacy in Human-Computer Interaction (HCI) a significant consideration in a range of areas including communications, medical care, and e-business. It treats both information protection (processing individual information by companies) and individual privacy (the upkeep of interpersonal information borders) both in its consideration. There is no predictive model and no single corpus referenced. It takes academic and commercial activity over three decades and employs surveys (e.g., Westin segmentation), scenario experiments, and ethnography to inform its collection of observations about observations about user privacy. It advocates a three-step lifecycle for privacy-related design: inquiry, build, and evaluate. It advocates employing HCI tools to inform about preferred behavior, enhancing privacy interactive tools, and iteratively building them. Qualitative methodologies (e.g., interviews, focus groups) and quantitative methodologies (e.g., survey, experimental studies) both feature in it. It aggregates these observations and identifies gaps and formulates actionable recommendations for developing privacy-focussed systems. Outcomes: Central observations report contextual and social and technological factors have an impact on concerns regarding privacy. It identifies a ”privacy paradox” in that both behavior and attitude vary and advocates balancing usability with strong security for privacy and identifies obstacles such as standardising tools for privacy and improving evaluation measures.

(Chan, 2023) [35] compares legal peril in Macao with regard to HCI design with significant jurisdictions such as the US, EU, and China. It addresses two significant forms of peril—intellectual property (IP) and privacy/personal information safeguard—and acknowledges discrepancies in respective environments of laws. The paper doesn’t depend on predictive frameworks and datasets but leans towards academic sources, laws, and international laws such as GDPR, PIPL, and the US CCPA.

Comparative analysis is utilized in an attempt to assess provisions in laws in jurisdictions. The paper brings out compliance with global standards for information safeguard (e.g., GDPR’s ”data protection by design and default”) and incorporation of legal safeguard for IP and privacy into HCI design in an effective manner to counter peril. Qualitative comparative analysis between laws in Macao and in the US, EU, and China is embraced in the work. Applicable laws, interpretations in laws, and pragmatic recommendations for HCI designers is analyzed. Findings: Laws in Macao comply with global standards but less complete and less specific for HCI design in comparison with significant jurisdictions. For example, GDPR necessitates ”data protection by design,” but laws in Macao don’t. Similarly, laws in Macao regarding IP are general, in contrast with tailor-made approaches in the US and EU.

(Hagan, 2020) [36] diagnoses weaknesses in web-based legal information for citizens and proposes improvements. It employs literature review, analysis of consumer feedback, and survey work in lieu of predictive models. It aims at improving web-based accessible legal services with a view towards citizen requirements, usability, and dependable information. The study looks at present-day services, identifies consumer dissatisfaction, and considers non-professionals in search of legal information. It concludes that most web offerings infuriate citizens with irrelevant and untrustworthy information. Reliable, jurisdiction-specific sources must be accessible in order for web-based legal services to work effectively.

(Carrera et al, 2023) [37] introduce a significant dataset for behavior analysis and adaptable interfaces for optimizing human-machine interfaces in order to maximize experiences through behavior analysis and adaptable interfaces. There are over 10,608 entries in the manuscript, collected through a custom app for an industrial mixer. Finite state machines (FSM) model behavior actions, and Markov Chains forecast future behavior. Performance and learning, according to the study, are maximized with adaptable interfaces. Rule-based, configurable interfaces increased completion times by over 40%, and personalized HMIs have proven effective. User behavior was captured through a mobile app, and algorithms determined key trends. Sequence analysis and clustering delivered useful insights. Productivity overall is maximized through personalized designs, increased efficiency, and tools for customizability derived from the dataset.

(Urquhart et al, 2016) [38] connect IT legislation and Human-Computer Interaction (HCI) to frame emerging technology such as the Internet of Things (IoT). User orientation is one of the most dominant themes in connecting HCI with legal frameworks. Benford et al.’s (2009) theory of trajectories unites consent in IoT through harmonizing legal requirements and user experiences. It utilizes Cavoukian (2011) and Mayer-Schonberger (2009)’s observations to tackle regulatory concerns through such theories as trajectories, affordances, and provenance. IoT consent designs prioritize dynamic interfaces with trajectories. User experiences form a focal point in uniting HCI approaches with legal examination for consent and legislation for and about users. There is a necessity for increased collaboration between legal and HCI professionals in creating legislation tools for and about users.

(Muoma, 2024) [39] analyzes the role of technology in human rights focusing on access to information, privacy, and equality. It delves into the responsibilities of governments, corporations, and civil society in safeguarding and advancing human rights in the face of threats like surveillance, harassment, and algorithmic bias. There are no computational models or datasets presented within the article. It is a policy-oriented and analytical piece that uses secondary sources such as the Universal Declaration of Human Rights and international covenants to lay down the context for its argument. The authors propose multi stakeholder responses that involve the joint engagement of governments, corporations, civil society, and individual actors. The focal points of work include transparency, ethical conduct, and incorporation in technology innovation, along with robust legal frameworks that guard against human rights vulnerabilities. The article adopts qualitative methods by looking at existing law and international human rights frameworks in the context of real-life examples to look at the intersecting area of technology and human rights. The article concludes that technology could stand as a rejuvenating force for human rights, whereas it can also be a great challenge with issues such as surveillance and inequality. To alleviate the problems, it proposes that priority should be given to education, legal reforms, ethical design, and international cooperation to create a balanced digital environment. Ethical and Legal Gaps, Algorithms, and AI Making Unfair Decisions: Algorithmic bias is where a computer program or an AI system acts in ways that cause harm or unfairness.

(Burk et al, 2001) [40] describe how frequently the user finds himself in a situation where he cannot utilize copyright content because of legitimate Digital Rights Management (DRM) issues. The balance seems to be between user rights such as fair use and copyright protection in better-designed DRM systems and legal frameworks. A fair use infrastructure comprising technical designs supporting user access and external mediation by trusted third parties (e.g., key escrow systems). The paper does not rely upon empirical datasets but makes its argument by way of legal analysis, case studies, and examples drawn from the implementation of DRM systems. Designing DRM systems with inbuilt allowances for fair use access, creating key escrow systems where a trusted third party gives keys to users for legitimate access under conditions that ensure privacy and public policy. Reviewing laws like the DMCA, which serves to critique current DRM practices about their influence on user rights. Proposing changes in relation to DRM systems and creating a procedure for third-party oversight to achieve open access-based on fair use privileges without any handled restriction.

(Wen, 2023) [41] focuses on human-computer interaction (HCI) and its impact on the protection of minor persons' rights in China, specifically regarding privacy, the risks of cyberbullying, online consumer disputes and legislative (as well as judicial) measures to protect minor persons' rights. The paper does not mention any technical model or dataset. It proposes, Policy and legislative frameworks as conceptual models for HCI issues and the protection of minors online. A wide-ranging law with regulations on online guardianship, protection of minors' personal data, and proper technology use. Minors with technology: social networks, digital choices and feedback loops. Safeguarding minors' personal information and addressing potential harms, including addiction and online abuse, through youth protection software and

privacy-focused practices.

(Urquhart et al, 2021) [42] consider implications for compliance with "trustworthy AI" principles under an HCI background in relation to the EU AI Act. It covers legal analysis such as transparency, government, administration, and accountability in perilous AI systems. In contrast to a dataset's orientation, it contemplates legal substructures such as GDPR and AIA. In addition, it combines HCI with AI consent in risk management systems (RMS) and post-market supervision (PMS). Analysis expresses a theoretical confluence between compliance requirements and values embodied in HCI for a harmonious integration in both AI and compliance development. Human-machine interfaces boost supervision, minimize algorithm bias, and comply with quality requirements. A study reveals that incorporation of HCI in AI promotes social trust, reduces danger, and promotes compliance with laws. Reengineering AI with HCI yields systems with a view to human requirements and compliance.

(Gerber et al, 2023) [43] explore and promote human factors in terms of security and usability, and deals with PETs development, GDPR compliance, and usability and security of data. IUIPC-8 approaches evaluate behavior in relation to privacy frameworks. PreView development raises IoT awareness, and "Data Cart" protects information for companies. HCD, expert interviews, and behavior analysis inform awareness studies. Nudges, personalized messages, and usability testing enhance compliance and trust through behavior integration in privacy design, enhancing compliance and satisfaction.

(Lazar et al, 2019) [44] identify legal concerns in Human-Computer Interaction (HCI) in terms of access, privacy, intellectual property, telecommunications, and ethics in research. It mentions concerns in laws such as GDPR and Americans with Disabilities Act in HCI professionals. Accessibility is addressed through the UN Convention for the Rights of Persons with Disabilities and Marrakesh Treaty. User-centered design seeks compliance with worldwide access and privacy legislation. Stakeholder and dramaturgical analysis present theoretical approaches. Trust in technology integration, usability, and access for the users is increased through this.

2.3 Summary of Key Findings

The literature review of the extant studies yields some significant findings that directly guide the objectives and design of this thesis. To begin with, the literature on the subject shows that the existing gap between the consumer and the law is confirmed, as the majority of people are unable to see how the violation has been made or declare the law applicable [45]. This proves the need to have technologies that can make the interpretation of the law easier and offer structured guidelines. Second, the current systems, be it mobile applications or web or automated legal-advice systems prove that digital solutions can be applied to raise user awareness. Nonetheless, studies indicate severe constraints as well. Most of the systems are just giving their information in statical form and are not interactive which includes questionnaires, OCR-based product scanning, and dynamic law-matching algorithms [5].

This is where the more intelligent, scenario-based systems with an imitation of solving the problem in the real world are necessary.

Third, experiments on AI-based legal assistance indicate that the machine-learning models can effectively classify legal problems and provide laws related to them highly accurately when properly trained [4]. Nevertheless, the majority of the current models are oriented on general areas of law and not on consumer rights context. This implies a chance to have specific models, e.g. the SVM classifiers specialized to consumer-rights context.

Lastly, studies of the HCI community point out that it is advantageous to users when the systems provide multi-modal interaction (e.g. text input, guided questions, document generation, visual scanning). Such systems simplify cognitive processing and enhance the level of engagement [46]. The results are all in line with the orientation of this thesis, and prove the feasibility of creating a combined platform that will integrate interactive questionnaires, problem-description analysis, and legal document generation and the product scanning in the future that will be achieved through OCR.

Chapter 3

Requirements, Impacts and Constraints

3.1 Final Specifications and Requirements

3.1.1 Technical Requirements

The work on the Legal Rights Advisor platform, is based on a specific set of technical requirements that are properly aimed at the accuracy, accessibility, and the fluidity of the platform. The system is developed fully on the basis of the modern web technologies, which make it lighter and allow it to perform all functions on the client side as well as with the necessity to use the backend server fastAPI.[47] is selected as the frontend since it provides a quick rendering and a component-based structure well-developed system. The styling is done using vanilla CSS [48] to ensure the interface remains clean, responsive, and mobile-first, JavaScript (ES6+) [49] is used as the main programming language, which can easily integrate with external libraries and machine learning tools [50].

The platform incorporates robust multi-lingual Natural Language Processing (NLP) for the analysis of complaints and/or description of user submitted complaints written in User Created Complaint Definitions. Based on keyword-based logic classification, the NLP classifies violations into categories and associates them with relevant consumer protection laws. The interface includes a 15-step binary question-answer flow based on a predefined logical path based on the user's responses; this flow predicts the potential legal violation(s) based on the answer(s) to the question(s). The interface is entirely in line with WCAG.

2.1 Level A requirements for accessibility and lets users choose between English and Bangla as their main language, for an optimal user experience. The Vercel framework serves to host the client-side of the platform, which allows for the codebase fast-loading, globally accessible and version-controlled (source-controlled). All of these technological components work together to create a Digital, Private, Secure, and Fast Legal Support System.

3.1.2 Data Requirements

To train, test, and validate this project’s ability to recognize and describe violations of consumer rights, it must contain both structured and unstructured datasets. In this project’s research phase, data was obtained from 1500 individuals via a Google Form survey. The purpose of the questionnaire was to collect information on how everyday Bangladeshis experienced fraud/cheating when purchasing items. In particular, participants responded to many survey items based on their actual experiences in various types of markets (e.g. grocery stores, drug stores, retail stores). Participants were asked open-ended questions that specifically addressed the following situations: receiving expired products, being overcharged, receiving items with false labelling, receiving damaged/low-quality products.

The data that was entered via Google Form is a very useful resource for analysing the different types of consumer exploitation that individuals commonly experience in Bangladesh. Each participant entered personal accounts explaining the nature of their violation and how it impacted their purchase; these accounts allow researchers to understand how consumers typically express problems when they explain them. Thus, this dataset will be used by the Natural Language Processing (NLP) system as a source to determine standard patterns to apply in various algorithms [51]. Additionally, the research dataset also allows researchers to rank the most frequently reported violations. Consequently, the project’s NLP system is able to develop priority lists of rules and increase the accuracy of prediction in both QA and text-analysis modes.

Additionally, the data acquired serves as a basis for identifying which legislation relates most specifically to consumer concerns, enhancing the understanding of 19 consumer protection laws built into the software [52]. Because of the program’s capability to discern language in common use and that of legal terms, the dataset will provide the language model with a frame of reference as to what the general public refers to when talking about fraud or deception. The dataset, that has 1500 answers, will be the basis of the system’s reasoning engine. This will result in more accurate and better legal advice tailored to users perfectly.

3.2 Societal Impact

In Bangladesh, this project has a huge significant impact on establishing a transparent and equitable market. Through the use of this platform, consumers will have access to information regarding their legal rights and can quickly identify applicable laws when they have been victims of fraud. Consumers will thus be able to make better-informed decisions regarding purchases, and business owners will be encouraged to engage in ethical business practices. Along with increasing public awareness, it is hoped that this will lead to a decrease in fraud and an increase in trust between consumers and sellers, which will help create a more ethical market environment[52].

3.2.1 Health Impact

One of the most serious implications of grocery and food-related consumer fraud is its impact on the health and safety of consumers as a result of exposing consumers to the potential risk of being seriously ill with potential long-term consequences from consuming an expired, altered or fake product. If the consumer fraud detection and reporting system enables consumers to be aware of these fraudulent activities and the legal remedies available for them, consumers will be better able to protect their health and safety as well as to be aware of what constitutes a legal remedy for the particular type of consumer fraud identified. In addition, the increase in law enforcement against consumer fraud will create a greater incentive for producers and retailers to meet quality standards as consumers will have less opportunity to purchase dangerous products [53].

3.2.2 Safety Impact

By assisting consumers in identifying high-risk items or products that do not follow regulations, this project raises awareness about consumer protection, enabling consumers to easily determine instances of law-breaking or unsafe items and report them. When consumers are able to identify and notify authorities, this provides a preventative measure against dangerous and unsafe products. This approach ensures that products are sold in the market before any damage occurs, thereby increasing the overall safety of the marketplace [54].

3.2.3 The Legal Impact

The system connects to the citizens to the justice process by making it more easier to understand and access consumer protection laws. There are many people, where they do not know what their rights are under current law, and this project helps to make those rights more understandable and accessible for those people. The project also crystal clearly provides a means of enforcing the Consumer Rights Protection Act (CRPA)—2009 [52], thereby fostering the greater legal accountability among businesses. The project will also provide significant information to the regulators, which can be used to identify the consumer fraud trends, thereby helping them to more effectively enforce policies as well as implement legal reforms in the future.

3.2.4 Cultural Impact

This initiative culturally shifts expectations about the valuable consumer knowledge and as well as responsible business behavior. Many regions of Bangladesh do not use formal recourse when encountering fraudulent activity because either people do not understand how to report it or are afraid to confront those responsible. The Technology-based tool will assist in embedding an expectation of responsibility, education, and fairness. Ultimately, with time, the promotion of ethical business practices and responsible consumerism will build trust between the providers of

goods and services and consumers and create a sense of collective civic responsibility between buyers and sellers [55].

3.3 Environmental Impact

3.3.1 Project Sustainability

The machine learning technology provides the opportunity to create a secure, accessible and trusted marketplace for consumers in Bangladesh from all sectors of the country. Consumers can now better make smart choices and hold sellers accountable for their commitments to provide high-quality products. Increasing consumer awareness about what they are entitled to leads to increased confidence, which benefits the marketplace by enhancing buyer/seller relationships and reducing instances of fraud. Most of the machine learning technology is comprised of digital data and software applications that do not require a large amount of physical infrastructure or resources to be successful. The machine learning technology will continue to be effective and efficient as long as you continue to update the machine learning methods with fresh data. This will reduce the need for major redesigns and save your business money. Lastly, this feature clearly allows for system flexibility to promote your economic and as well as societal stability [56].

3.3.2 Environmental Impact

The primary and basic focus of this significant project is technology, but through the development of a way for the honorable consumers to easily identify and report counterfeit products and expired items, it has also been crystal clearly shown to have an indirect impact on reducing pollution through reducing the volume of potentially hazardous, expired, or contaminated items entering our landfills as well. Providing consumers with a means to report counterfeit items allows them to make informed decisions to avoid purchasing items that are likely to end up in a landfill. Any item whose source cannot be verified, such as an item manufactured outside of a retailer's supply chain, may contain toxic chemicals; and therefore, when they are no longer usable, they pose the same risk of contaminating soil, groundwater, and the environment for many years. Through limiting the sale of counterfeit items, the TNDS contributes to the continued reduction of pollution in Bangladesh. The recent increase in enforcement of consumer protection laws encourages companies to adhere to proper storage and handling procedures to ensure that the goods they produce do not become damaged or otherwise unsellable prior to being sold. As the TNDS continues to advocate for responsible consumption and continues to discourage the production of counterfeit products that might damage the environment, it is expected that the TNDS will help to promote cleaner products and practices within the market and the long-term sustainability of the overall environment of Bangladesh.[57]

3.4 Ethical Issues

The ethical responsibilities related to this project include the safeguarding of people’s personal information and the confidentiality of their responses, as the model will be built on surveys and public records that contain personally identifiable data. It is critical to protect the anonymity of all individuals who respond to surveys and to protect the privacy of the information collected from public records through secure storage to eliminate unauthorized access. The use of people’s personal information without consent would violate the ethical standards of conducting research and damage the reputation of the model [58].

Additionally, algorithmic bias is an important ethical issue [59]. If the training set has an uneven distribution of fraud types, the ML models could produce biased predictions about what type of fraud occurred or failed to identify genuine frauds and would provide the incorrect legal advice to the user. To fix this issue, the project team needs to make sure that everyone has an equal chance to collect data, clean the data thoroughly before training the model, and come up with algorithms that aren’t based on biased data or pre-processed with biased information. To ensure the model is effective, it needs to be rechecked.

Due to its reliance on the Consumer Rights Protection Act 2009 [52], it is ethically obligated to promote correct information and avoid misinformation through the System. If it were to make a misleading recommendation or create an incorrect law mapping, this could lead to confusion for Consumers or would result in improper reporting of cases to the legal system. As such, all legal references should be reviewed by Subject Matter Experts (SMEs) and periodically reviewed to ensure updates are made to avoid the risk of unintentional harm.

3.4.1 Professional Responsibilities

Designers of this technology item should have a professional obligation to design a model (algorithm), and report it accurately. Additionally, designers must make sure their model has undergone thorough review and validation prior to use. Designers also need to be transparent in how their model functions, the data that was used to develop the model, and the limitations of the model so that end users can comprehend the scope of the model.

Furthermore, designers should be aware of another responsibility, namely that of ensuring neutrality/fairness of the technology item. Specifically, designers should ensure that the algorithm does not show a bias towards any one particular brand/business. For there to be trust in the public’s perception of the system, it is vital to establish no excess benefit or targeting has been applied to one consumer or vendor over any other. Lastly, throughout the design and development of the model, designers should follow approved engineering standards, document the work appropriately, and adhere to ethical principles as outlined in the Mediation Group 2024 Mediation Ethics document.[60]

In addition to these areas of focus, the team must also ensure that the system is both secure and accessible to end users. In addition, they must provide clear and simple output and tools – they should take care when they develop these; for example, to develop tools that are easily understood by individuals with no IT background. Finally, companies developing this type of system need to consider potential ways in which users might misuse the system, as well as how the system can protect individuals from any harm that may arise from this misuse of the system. Finally, reviewing the system on a regular basis can assist maintain the number of people who like the product high and its functionality and professional standards substantial [61].

3.5 Project Management Plan

The Project Management Plan contains a timeline for completion and provides anticipated cost estimates and a method of managing resources required to complete the project successfully. When the project is well planned; it enables the project team to continue working to meet its deadlines with the resources available to them. This structured plan also defines the nature of the tasks to be accomplished, their associated costs, and the number of personnel and tools needed for successful implementation.

3.5.1 Schedule

Months 1–4: For the initial four months, the team focused on learning about the problem domain, examining the applicable consumer legislation as per the Consumer Rights Protection Act (2009) and investigating how to close current public knowledge deficits in this area via survey development, administration and data collection from participants (approximately 1,500). In addition to the survey, this phase included preprocessing, filtering and classifying fraud types, researching existing literature, and providing insights into the appropriate use of machine learning algorithms.

Months 5–9: The second phase included creating and training significant types of machine learning algorithms (Naive Bayes[62], Decision Trees[63], KNN[64], SVM[65], LDA[66], Linear Regression[67], Logistic Regression[68], Decision Stump[69]) using the dataset which was collected . This dataset was divided into both training and test datasets. All machine learning algorithms were evaluated according to multiple metrics for evaluation including Accuracy, Precision, Recall, and F1 score, with the Decision Tree Algorithm yielding the highest accuracy rating (97 percent). The second part of this phase is consisted of designing the Law Suggestion Application Architecture that openly depicted how the output generated from the selected model would be integrated within the application UI as well.

Months 9–12: The last step was there to add the selected design to the application prototype and evaluate it properly and thoroughly to make sure it was accurate as well as easy for users to use, and so properly matched the type of scam to the law.

At this time of point, the framework was also properly tested, fixed the unwanted bugs, and made better as well. There was also the final submission step along with presentation, as well as the thesis paperwork and reporting.

3.5.2 Budget

The cost estimate for the development of this project in the table 3.1, includes the purchase of tools, software, data collection, collection of operational costs. Development costs are mainly software based, which will result in lower total development costs.

Table 3.1: Items and Estimated costs

Item	Description	Estimated Cost (BDT)
Data Collection	Survey printing, online forms, participant incentives	10,000
Software & Tools	Python libraries, Google Colab, cloud storage, Google Scholar (mostly free)	500
Computer & Internet Usage	Electricity, maintenance, and internet charges	2,000
Report Printing & Binding	Hardcopy of thesis, binding materials	1,500
Miscellaneous Costs	Unexpected costs (transport, stationery, etc.)	3,000
Lawyer	Data verification by one lawyer	8,000
Total Estimated Budget	—	16,000 BDT

3.6 Risk Management

Table 3.2: Risk Impact and Mitigation Workflow

Risk	Impact	The mitigation work process
Delay in development	High	Plan extra time for tasks, have a set of planned milestones each week, and keep teams updated on their performance to ensure they stay on schedule.
Hardware or software failure	High	Have a backup of all systems, keep files saved in the cloud (Google Drive/GitHub), and ensure that the data is backed up. Introduce version control as well as updating system software.
Data quality issues	Medium	Review your data carefully to make sure that it will not be biased. Use a variety of data sources and validate all data from surveys with the respondent or information so that it is thoroughly captured.
Model underperformance	Medium	Try several different methods of predicting outcomes (for example, complementing with hyper-parameters), carefully review all selected models and collect more data until the model can generate reasonable and replicable data.
Legal interpretation issues	High	Consult with a lawyer or legal expert to confirm that you are aware of and your system follows the Consumer Rights Protection Act of 2000.
Privacy Risk	High	Ensure that you have strong data protection policies and secure user data when processing it. Provide users with transparent information about the applicable privacy policies.

3.6.1 Delay in Development

Software based research projects commonly experience delays as a risk. For this project, delays could occur due to long periods of collecting data, an unforeseen amount of complexity in training the model or unforeseen challenges as the team integrates the developed model into the system. Reducing the likelihood of this type of risk, the team developed a well structured timeline for the entire project including weekly reviews of each team member's progress as well as monitoring the milestones. Within the schedule, buffer time was planned between tasks to accommodate small delays without the potential for throwing off the entire project timeline. Also, regular communication among the members of the team, coupled with the ability to identify potential problems early in the process, has reduced the potential

for long-term delays in the project completion [70].

3.6.2 Hardware or Software Failure

In addition to the risk posed by both software and hardware failure, there are a number of other impacts that training machine learning models and processing the data needed to train them may have on the stability of systems and computational resources. Crashing systems, failing components, and software malfunctions, may lead to a detrimental effect on project advancement. To mitigate the risk of these events occurring, all files associated with a project and electronic datasets were regularly saved through backup services, such as Google Drive and GitHub. Version control also provided assurance that the previously completed coding efforts would not be lost. Software updates were performed regularly to ensure system compatibility and stability. Backup devices, as well as additional computers, were also set up to ensure continuity of workflow in the event of hardware failures [71].

3.6.3 Data quality issue

A frequent risk in research projects that are intensive on survey-based or user provided datasets is the problem of data quality. Such problems can occur in this project due to incomplete responses, inconsistent formatting, or inaccurate information given by the participants. These issues may severely diminish the efficiency of the machine learning model because the quality of the data may become low, and therefore, misclassification will occur and lower the overall reliability of the system. To reduce this risk, the team adopted comprehensive data cleaning, normalization of data, and validation of survey data. Response cross-checking and elimination of anomalous entries also enhanced the integrity of data sets. Besides, the team also had explicit data collection policies and tracking measures that could identify and correct defects in the quality at an early stage of the process to ensure the strength of the training data.

3.6.4 Model underperformance

The other possible risk is model underperformance, particularly in a machine learning-based system where the quality of output is determined by the accuracy and generalizability of the trained model. This can be attributed to underperformance because of lack of training data, ineffective feature selection or lack of balance classes in the data. In case the model fails to achieve the anticipated accuracy level, the system would generate unreliable fraud classifications, which adversely impacts on user confidence.

In order to prevent this threat, the team experimented with various machine learning algorithms and undertook a lot of hyperparameter optimization. Frequent testing using validation datasets was used to make sure that the performance weaknesses would be detected early. In particular cases, retraining was done on refined datasets and feature engineering procedures in order to increase accuracy. All these measures

minimized the chances of long term model failure in the implementation.

3.6.5 Legal interpretation issues

The fact that legal interpretation is highly susceptible to errors is a major threat in systems that involve the mapping of user inputs to applicable laws or regulation. In this project, errors may happen when the system misapplies the relevant part of the Consumer Rights Protection Act 2009 on the types of frauds that have been identified. This could be a wrong perception of what the consumers are entitled to, and it can be quite confusing.

To minimize this risk, the team coordinated with the legal experts to confirm all mappings between fraud categories and legal provisions. Legal knowledge base was thoroughly recorded and revisited severally to be checked. In addition, updates would be made periodically to ensure that the system is in tandem with any subsequent changes to laws that protect consumers and therefore avoids obsolete or misleading legal advice.

3.6.6 Privacy Risk

The privacy risk occurs when the sensitive information gathered by users or the participants of the survey is not adequately secured, which may lead to the personal data exposure to unauthorized access or misuse. As in this project we will be collecting actual consumer experiences, it is important to have confidentiality to retain the confidence of people and the standards of ethical research.

In order to control this risk, the members of the team made sure that all of the data collected was anonymized prior to processing such that no correlation could be formed between the answers and personal identity. Access permissions and encrypted drives were used as secure storage solutions to protect the dataset. Moreover, ethical data management protocols, informed consent, and proper disposal of the raw data were adhered to so as to reduce the chances of privacy violations during the lifecycle of the research.

3.7 Economic Analysis

In evaluating the overall cost of the proposed project as well as the potential economic benefits to users (consumers, regulators, and government), the analysis focuses mainly on cost. Since the majority of the system's components will be delivered via software, initial costs of development are relatively low compared to large-scale commercial projects. The total cost of the project is estimated to be about 16,000 (approx \$200) and includes data collection/capture/development, technical support, report preparation, and any other operational operational costs associated with the system. Additionally, the majority of development related tools are open source and free to use and significantly decreasing the amount of financial investment required to develop the proposed system as well. Therefore, this project can be really

affordable to implement in both a research and commercial environment as well.

The benefit of this system to consumers, regulators, and the entire economy will be tremendous. The proposed system will provide significant economic value to consumers by allowing them to avoid massive amounts of losses associated with frauds (overpricing, selling expired/contaminated goods, selling counterfeit copies, etc.) [72]. When a consumer has the ability to find out about fraudulent transactions quickly and identify what laws protect them against said frauds, the likelihood of deception decreases significantly. This will lead to decreased incidences of fraud and increased levels of transparency in the marketplace. Additionally, the proposed system will promote honest business practices and help to reduce the impact of syndicates on manipulation of price, thereby creating a more equitable marketplace for all consumers.

The use of the classification tool by government agencies and regulatory bodies decreases the time they spend conducting investigations because the tool allows members of the public to report their issues in a way that is most accurate and to make legal complaints. This increases the level of efficiency with which government agencies administer their programs; therefore, reducing the administrative costs associated with enforcement. The ongoing, long-term financial benefit of this tool is significantly greater than the initial development cost, as it fosters better consumer protection practices, healthier market behaviours and improved levels of confidence, all of which contribute to sustained economic growth. Thus, the overall cost-benefit ratio crystal clearly indicates that this project is both financially viable and has a very positive impact on the economy of Bangladesh book [73].

Chapter 4

Proposed Methodology

4.1 Design Process

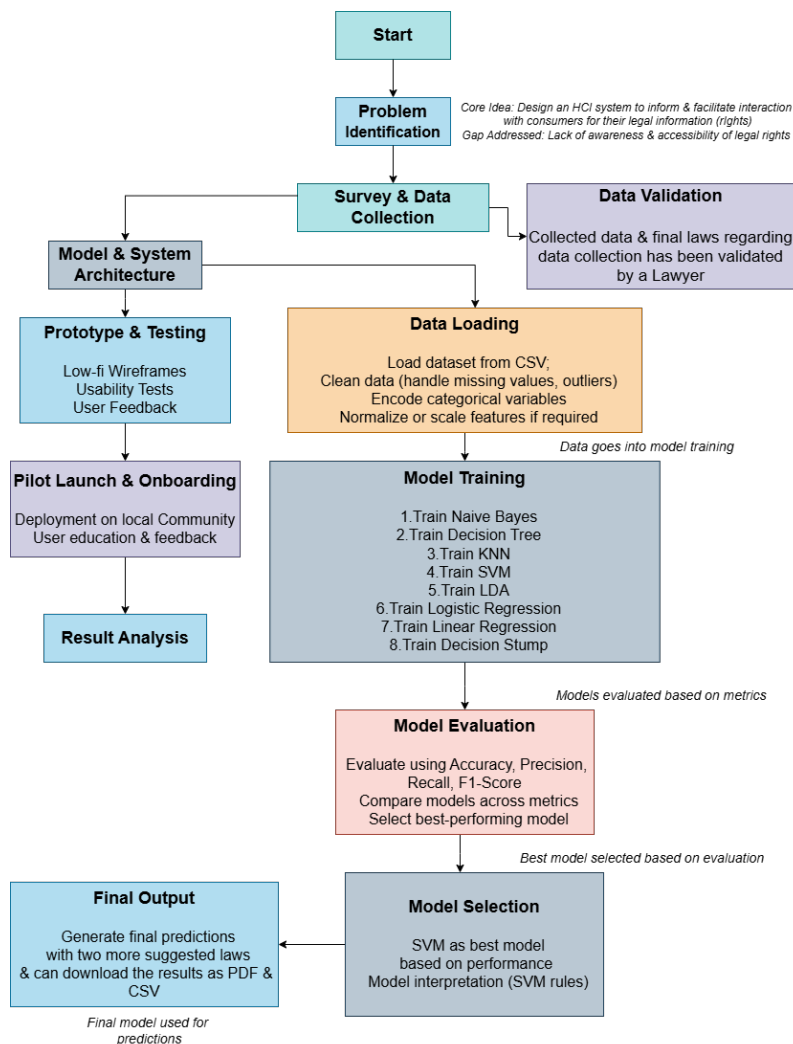


Figure 4.1: Pipeline of the Proposed Consumer and Business Owner Rights and Legal Access framework

In this study, the issue of consumer fraud has been identified as an important area of increasing concern in Bangladesh, largely due to the lack of knowledge of the rights enjoyed by the public under the Consumer Rights Protection Act of 2009 [52]. It has been observed that, in spite of the comprehensive legal provisions protecting the rights of consumers, the issues of fraudulent advertisements, overcharging, and the supply of counterfeit products continue to affect consumers to a concerning extent. To measure the level of awareness, the survey method has been chosen, in which 1,500 respondents above the age of 18 were selected to answer 15 questions, specifically designed to measure the level of awareness pertaining to the rights enjoyed by consumers, the practice of fraud, and the legal recourse available to consumers. Data validation was performed with the utmost rigor and expertise of a certified lawyer with regard to its conformity with legal standards and its appropriateness with regard to the context of the Consumer Rights Protection Act, 2009 [52]. After validation of the data, pre-processing of the data was performed with regard to its quality and usability. The cleaned data was then utilized for training the model and constructing the architecture of the low-fidelity prototype of the proposed system with regard to Human-Computer Interaction principles.

Eight machine learning algorithms have been trained and evaluated, and from the comparative evaluation, the Support Vector Machine (SVM) selected, which makes it the most efficient model to be used for the classification of consumer fraud data. In addition, the finalized SVM model incorporated all applicable feature columns, providing predictions and generating two additional insights, which were useful in providing precise fraud detection and recommendations to consumers.

4.2 Preliminary Design

This section includes the development and evaluation of eight machine learning models. Each model was evaluated according to its accuracy, performance, and fit for the dataset. The model with the best accuracy and precision was chosen to be implemented on the basis of the comparison evaluation, and then an application was created using the chosen model.

4.2.1 Machine Learning Model Specifications

We use a Gaussian Naïve Bayes classifier as a simple starting point. Its assumption of conditional independence fits our mostly yes-or-no survey questions and shows clear effects for each class. Even though it is simple, it gives a trustworthy standard for later comparisons and helps identify possible feature overlap or label errors [67]. Building on this baseline, the Decision Tree (stump; depth = 1), a one-split tree is a very simple model that shows the value of the most important question. This “stump” helps us understand which features are important right away and sets a basic limit on how well we can perform[74]. In contrast, K-Nearest Neighbors (KNN) is a technique not based on a preconceived model, and it compares examples by their similarity, rather than a distinct generalization rule, by examining how similar individuals’ votes are to determine whether local regions of the data are informative. It offers a substitute for relying solely on straight-line decisions [64]. Linear Discriminant Analysis (LDA) generates a low-variance linear classifier with

a maximum between-class scatter regarding within-class scatter. On our structured Survey responses show that LDA is a good basic method. It provides a clear view where we can directly see how different classes are separated [66].

Moreover, Multinomial logistic regression, also known as one-vs-rest, is our main linear model for making distinctions. It uses L2 regularization and adjusts probabilities to keep things clear and strong, providing a good standard for models that add complexity [68]. To explore bias-variance behavior, Linear Regression model used to number codes of the target to check how well it fits and to look at bias-variance behavior using learning curves. Although it is not a probabilistic classifier, rounding or argmax on outputs gives a basic check and a way to see if it's underfitting or overfitting [75]. To explore deeper non-linear relationships, the depth-8 tree shows some relationships between labeling, pricing, and safety indicators while staying easy to check using rules. In tests, it had the highest cross-validated accuracy with consistent results, and its rule paths fit well with legal reasoning. [74].

Finally, the linear-kernel SVM achieves a large margin optimization in a high-dimensional sparse space and, more often than not, beats other linear models when classes are almost separable. It accompanies logistic regression by imposing a bigger margin and usually returns competitive generalization. The SVM model considers all feature columns to generate its predictions. After running the test, it produces output in a probability format. The model then selects the data with the highest probability as the final prediction. However, the other predicted data also indicate a partial similarity with the data. In the testing phase, we extracted two additional data that were closely related to the predicted one, showing how the model captures multiple possible outcomes. [65].

4.2.2 Application Specifications

This part outlines the system architecture and the development methodology of the consumer rights protection assistance system. The app offers a convenient online platform that assists customers in discovering the breach of the law and creating the formal complaint paper based on the Consumer Rights Protection Act of Bangladesh of 2009 [52]. The system combats typical consumer problems such as false advertising, contamination of the product, overpricing, and poor product packaging by the means of machine learning, rule-based processing, and current web technologies.

Project Overview

The project will establish an automated system to help the consumers in the process of complaint handling. The first target is to use a SVM model to anticipate pertinent laws of consumer protection by employing user feedback to a scenario-based questionnaire and to reduce complex groups of law into simple Yes/No responses. The second goal deals with designing a text-processing system that converts free-form problems fronting to professional summary forms, so that untrained users are able to formulate complaints in a manner that is understandable. The third goal focuses on automation of the creation of structured discharge letters in order to save on the reliance of legal professionals and to do away with hand-formatting mistakes. It has features that can assist in the future upgrades such as OCR product scanning to detect fraudulent tags and a chat robot that will provide real-time legal counsel

using AI. Lastly, Fast API, Vanilla JavaScript and cloud deployment technologies are used in the project as they enable scalability and modularity so that the project is easily maintained and extended in the future [76, 77, 78].

System Architecture

There is a client-server architecture of the application. The frontend will be created with HTML, CSS and JavaScript to offer a lightweight and responsive user experience. This backend is built on FastAPI, which provides high-performance REST APIs to be able to process the data effectively [76]. The machine learning features are achieved by using a trained SVM classifier, which identifies consumer law violations using the inputs of the users [79]. NumPy and Pandas are used to process the data and pickle files are used to store trained models and encoders [80, 81, 82]. The whole system is implemented on Render to allow smooth continuous integration and accessibility by people [78].

Core Features

The system in figure 4.2 consists of a number of features which are interconnected. The guided questionnaire module is a machine learning-delivered questionnaire module to assist the users in finding relevant laws by answering Yes/No. The problem description feature converts free-text entries into structured summaries of complaints to be documented formally. The document generator gathers all the information and compiles the complaint letters in proper format and can submit. Two improvements are intended in the future, namely a product scanner that can be used through OCR technology to automatically read the content of the labels on the products and ensure the accuracy of the information and an AI chatbot to explain the rights and the legal process to the consumer in an interactive way.

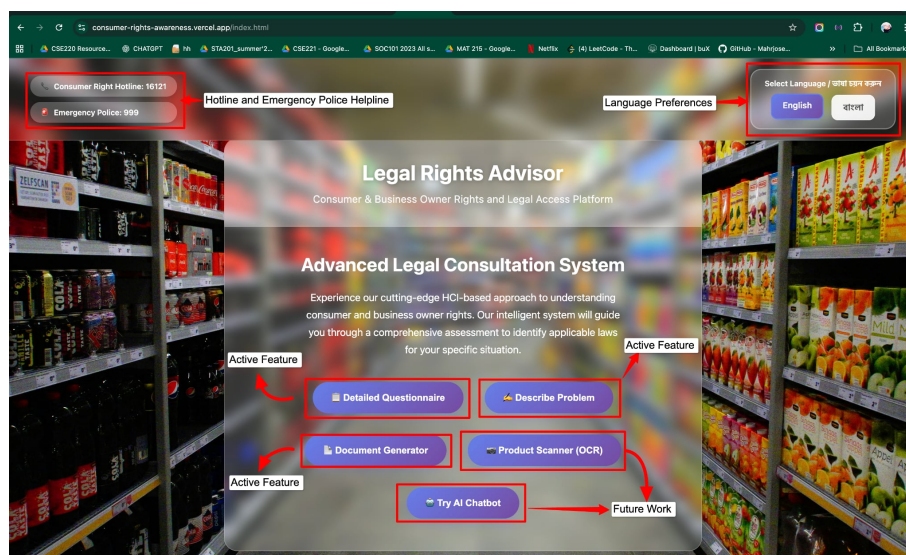


Figure 4.2: Homepage of Legal Rights Advisor Application

Detailed Questionnaire Module

This module 4.3 helps the user identify the applicable laws on consumer protection by using non technical queries. The user provides responses to a set of questions which are predefined, and each of the questions relates to an encoded feature that is taken during the training of the SVM. JavaScript on the client-side standardizes the responses by transforming Bangla input to English and arranging the responses as a structured array. The array is sent to the prediction API of the backend in the form of JSON. An encoder (encoder.pkl) decodes the data with the help of a saved label encoder, and passes it to the trained SVM model, which scores the probability under each and every law via Platt scaling [82]. The three most applicable laws are chosen by applying NumPy function, argsort, which ranks the confidence levels and the results are returned to the frontend to be displayed dynamically. This strategy is quite successful due to the inability of the users to establish what kinds of laws are applicable in their cases, and the case-based questions with the structure of SVM classification are rather intelligent.

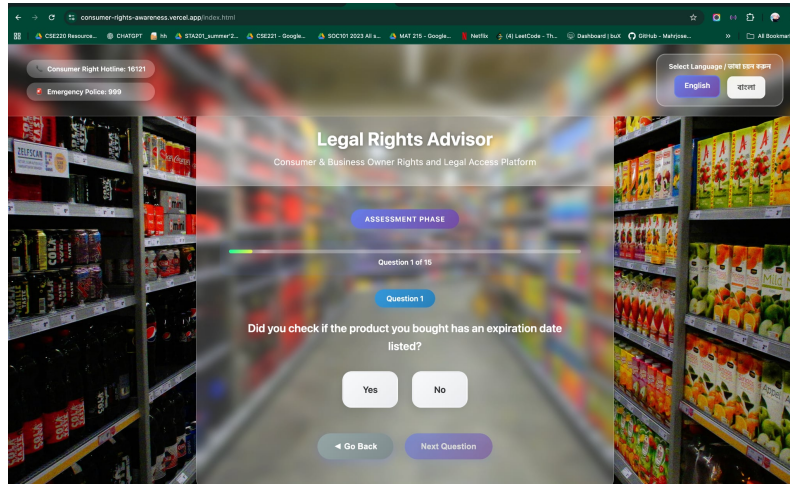


Figure 4.3: Detailed Questionnaire Feature to identify the Applicable Law

Description of Problems Feature

The feature in 4.4 offers an alternative method to the user who might want to write in a free-form text as opposed to responding to structured questions about their consumer issues. The user enters the description of the problem in natural language, and the system determines the text and finds the applicable consumer protection laws. The backend is fed with the description of the user and subject to text analysis algorithms that find essential information and compare it to a set of recognized patterns of violations. The system uses the process of extraction of key words and pattern matching to extract the relevant categories of laws including expired products, false advertising, weight variation, counterfeited goods, and overcharging. As soon as the analysis is done, the system provides the most applicable part of the law besides the other related laws that could also concern the user. The feature is especially convenient to the users who might not be aware of the structured questions or those who wish to present their concerns using their own vocabulary. The system is available in both English and Bangla languages thus making it available to a wider

group of users. Upon getting the analysis results, the users are able to examine the laws that are identified and go ahead to create formal complaint forms or go to the detailed questionnaire whereby more specific laws are identified.

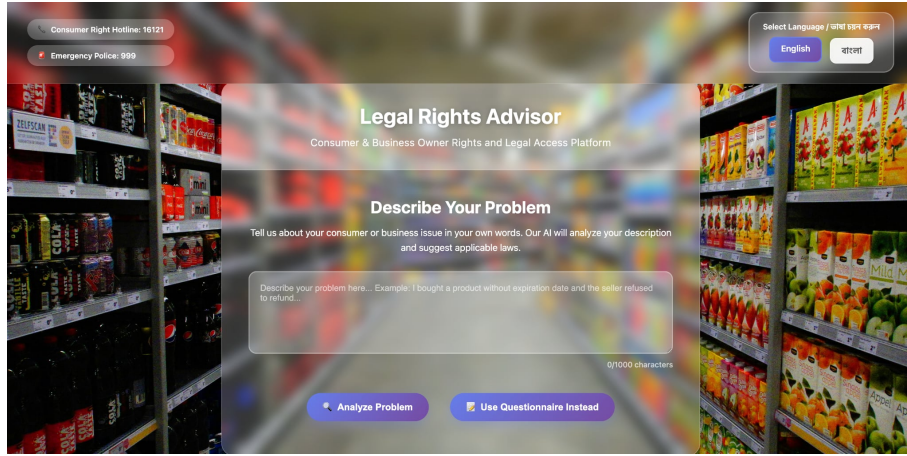


Figure 4.4: Description of Problem Feature to identify the Applicable Law

Document Generation Module

It 4.5 automatically creates formal complaint letters that are in legal battle. The system gathers data related to various sources such as the response of the questionnaire, the processed problem description, the prediction of the laws given by the ML model, and details given by the user such as name, contact, and product. All the information that is collected is entered into a pre-designed template which is replaced with the replacement tags that are the real user inputs by a template engine. The system uses uniform formatting such as the appropriate alignment, sectioning, and professional formatting to give out a downloaded document in either PDF or text format. Such automation is necessary since official complaints must have a particular format and formal language and by automating the process of drafting documents, the system also does not need legal knowledge and provides the professional standard.

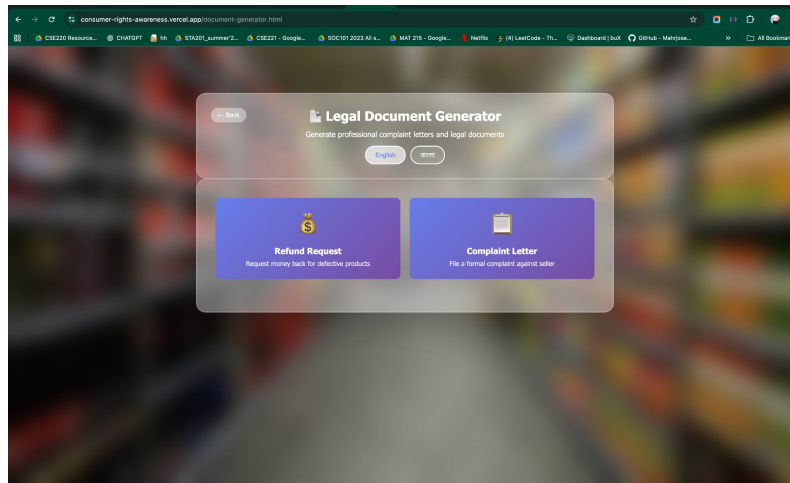


Figure 4.5: Document Generate Feature to File Complaint Letter

Future Enhancement: Product Scanner

The intended product scanner will enable a user to scan the product labels automatically to be verified. The text printed on the product, the expiry date, price, and weight will be extracted with the help of the OCR technology of Tesseract or PaddleOCR [83, 84]. This system will then run rule based logic whereby it will verify products that have expired, those lacking required information, discrepancies in the price or weight declared and labels that have been altered or spotted. The format consistency checks apply in this validation process to indicate the deviation of the regulatory standards.

Future Enhancement: AI Chatbot

The intended AI chatbot shall offer real-time interactive legal advice depending on conversations queries. It will enable users to query their rights, the process of reporting complaints, or particular laws, and the chatbot will access the curated knowledge base to find an answer to simple and practical advice. It will be implemented with the help of retrieval-based natural language processing or lightweight Retrieval-Augmented Generation (RAG) pipelines [85], where semantic search is applied to find the relevant legal information matching user queries.

Technology Stack

The high speed, asynchronous nature, and machine learning API suitability of FastAPI are utilized in the backend 4.1. The scikit-learn Support Vector Machine is used to implement the ML model since it is highly precise on small sample sizes. The frontend is written in HTML, CSS and JavaScript because it is simple and easy to implement [86, 87, 88]. Render offers an automated deployment and service to the hosting platform. NumPy and Pandas are used to process the data features and pickle module in the Python language is used to persist the model [82, 80, 81]. Future OCR will also use Tesseract or PaddleOCR to be able to do reliable text recognition in terms of images 4.1 [89, 83].

Table 4.1: Tech Stack and Rationale

Category	Technology	Rationale
Backend	FastAPI	High speed, asynchronous, perfect for ML API
ML Model	SVM using <i>scikit-learn</i>	High precision on a small set of data.
Frontend	HTML, CSS, JavaScript	Easy and amateurish.
Deployment	Render	Unproblematic automatic deployment, reliable hosting.
Data Handling	NumPy, Pandas	Efficient feature handling
Storage	Pickle	Simple model persistence
OCR	Tesseract/PaddleOCR (future)	Reliable recognition

4.3 Data Collection

We conducted our survey on 1500 people of ages 18 to 65 and it was found that most of them are residents of the urban and suburban areas of Dhaka. There are many diverse people among them who shop regularly in the markets. Most of the respondents who filled our survey form have HSC or graduation degrees. It is understood that they have the ability to understand the information and consumer rights laws about the products they are buying. Another thing that becomes clear that, what middle-income consumers can access and what will be determined by price sensitivity. The survey form had 15 questions which had to be answered mainly through “Yes” and “No”. This shows that a consumers face any kind of problem with the traders in the market and while shopping.

We have conducted surveys to assess barriers and requirements in accessing legal information through in-person and electronic platforms such as Google form. The purpose of the survey was to reveal retrieval-related obstacles in accessing legal rights; quantitative information has been collected on user experiences.

4.3.1 Participants

Here, the general public participants were asked about their awareness, inexperience and facing problems like fraud, defective goods and alternative arrangements for returns and services of the sold goods. Many consumers also expressed the difficulties they face in interpreting legal language, the fear of approaching legal institutions, and the lack of accessible information on how to file complaints or seek redress. Through surveys and interviews, this group has revealed how socio-economic factors, education levels, and geographical locations influence a consumer’s ability to defend their rights. Their responses have been instrumental in highlighting the ground-level challenges faced by ordinary citizens and the urgent need for consumer education programs, legal awareness campaigns, and simplified complaint mechanisms.

4.3.2 Purpose of the Questionnaire

The 15 questions 4.2 that were asked in our survey were basically given to understand the daily shopping experience of the consumers. And the questions were asked in such a way that it was possible to directly access the consumer rights laws through it. We have 20 consumer rights laws but it didn’t need separate questions per law as those 15 questions covered all those 20 Sections of laws.

Table 4.2: Questionnaire covering Law Sections

Survey Question	Legal Sections	Interpretation
Q1. Checking product expiration date	37–39	Addresses labeling and packaging accuracy
Q2. Asking for product replacement	33–34	Relates to consumer rights to remedy and refund
Q3. Requesting refund or replace	30–33	Covers complaint and redress mechanisms
Q4. Correct product or description	40–45	Deals with false/misleading representations
Q5. Clarity of product label	42–47	Relates to product and disclosure requirements
Q6. Misleading advertisement	47–51	Directly checks laws against false advertisement
Q7. Discrepancies in verbal promises	35–40	Reviews dishonest bargaining or assurance
Q8. Overcharging or wrong pricing	49–50	Covers pricing violations and excess charges
Q9. Harmful or unsafe product	48–52	Notes safety, standards, and consumer risks
Q10. Seller taking responsibility	33–35	Involves accountability and redress efforts
Q11. Taking consumer returns	35–38	Reflects return and confirmation of refunds
Q12. Issue resolved satisfactorily	25–30	Evaluates practical enforcement of consumer rights
Q13. Clear labeling and details	37–39	Relates to legal labeling and disclosure
Q14. Information on measuring weights	27–33	Complies with measurement and fair trade practices
Q15. Harmful materials or safety issues	46–50	Aligns with consumer health and safety protection

4.3.3 Data Cleaning

In our survey, 1470 out of 1500 people were accepted as valid because there were some out of 1500 that gave unbalanced data. A Python-based process was applied to remove duplicate data [90]. The level column was defined as a final rule as the target variable that all matches were identified and removed based on all feature columns.

4.3.4 Data Transformation

We take the answer process as valid in the model and take 1176 records for training as in 80% of the records and 20% of the records as in 294 records for testing. As a result, the model has been evaluated in a representative manner. Encoding was done by only with the training data set. In addition, categorical variables handled

as ordinal encoders to handle the conversion to numeric index representation.

4.3.5 Data Reduction

A demographic questionnaire on participants' age, occupation, residence, income range, and monthly grocery costs was included of the research. These variables aided in the analysis of how consumer awareness and fraudulent susceptibility are influenced by socioeconomic characteristics. There were disparities in respondents' legal knowledge in socioeconomic levels, indicating important areas for raising awareness. The demographic data only included characteristics with high predictive value for model training. To lessen noise and overfitting, irrelevant or duplicate characteristics were eliminated by feature selection. Because of the increased model accuracy and generalization, the Support Vector Machine (SVM) can now produce more dependable and comprehensible results for a variety from consumer demographics.

4.3.6 Data Validation

The dataset is validated by Mohammad Jamal Hossain, Senior Lawyer, Legal Advisor, and Ex Public Prosecutor, ensuring "One final Law" accuracy and reliability for analysis.

Chapter 5

Result Analysis

5.1 Performance Evaluation

The performance analysis phase is important to assuring that the machine learning models developed for this research are not only precise and correct but also reliable and applicable to unseen data. As our research utilizes a dataset (survey-based) with an imbalanced distribution of multiple classes (One Final Law - target variable), a complete evaluation strategy exceeding basic accuracy was applied. To precisely evaluate the models, the dataset was separated using a standard Train-Test Split approach. It was divided into a training subset (80%), used for parameter tuning and model learning, and a distinct testing subset (20%) in table 5.1. It assures that the evaluation shows how the model will perform on real-world, indistinct, and unseen data/responses.

Due to the unevenness of the survey outcome, we depended on a multi-metric evaluation approach to get various aspects of model performance. For each model, the following metrics were derived from the confusion matrix.

Precision: It measures how reliable the model is for everything the model flagged as positive.

Recall: It evaluates the model's capability to find all related samples within a class. In this research, the high recall confirms that the defined legal figures are not neglected by the system.

F1-score: This is the harmonic mean of Recall and Precision. This acts as the primary metric for our uneven data because it equalizes the interchange between precision and recall, delivering a single score that represents model strength and robustness.

Accuracy: This shows the overall ratio of accurate predictions by the model to the total samples of the dataset. Due to the class distribution, the accuracy was considered secondary to the F1 weighted averages.

A comprehensive testing matrix was introduced for every algorithm, including SVM, which showed a high performance result, including F1-scores around 0.97.

Class-wise Analysis: Metrics were evaluated for each unique value in the (One Final Law) category, where the classes are defined as the section numbers of the laws to ensure the specific models perform appropriately through different legal categories, not only the majorities.

Weighted Averaging vs Macro: Macro Averages, which treat all classes equally, and Weighted Averages, which justify class frequency, were both calculated. This

approach examines whether the models are biased by more constant survey results. To ensure mathematical objectivity, the classification report and confusion matrix functions have been utilized. This method was handled by the Scikit-Learn testing suite. The test data were strictly isolated throughout the Label encoding and every model training phase. In this way, the integrity of the testing process was maintained. For this multi-layered assessment framework process the high performance of the model, which achieved around 96% accuracy.

Table 5.1: Single hold-out test(protocol)

Item	Description
Split Strategy	One time hold out
Train/Test Proportion	80%/20%
Reporting	One number per metric on the held-out test set

5.2 Analysis of Design Solutions

The following models were tested for our dataset to finalize one model to implement. All these models were tested on the balanced dataset, and our final model, SVM was tested on both balanced and imbalanced datasets. Class-wise accuracy and the final accuracy of every model have been generated for every model.

5.2.1 Accuracy of each Models

With classwise accuracy, we can understand whether our model is testing correctly against each class (classes holds every unique law’s section number) in our dataset. Naive Bayes - Accuracy (0.8843537415) and KNN - Accuracy (0.887755102) in table 5.2, LDA - Accuracy (0.506802721) and SVM - Accuracy (0.965986) in table 5.3, Linear Regression - Accuracy (0.9455782313) and Logistic Regression - Accuracy (0.9455782313) in table 5.4, Decision Stump - Accuracy (0.5102040816) and Decision Tree - Accuracy (0.9591836735) in table 5.5.

Table 5.2: Naïve Bayes and KNN metrics

Class	Naïve Bayes				KNN			
	P	R	F1	Sup	P	R	F1	Sup
1	0.9688	0.5167	0.6739	60	0.7917	0.9500	0.8636	60
4	0.7778	1.0000	0.8750	7	1.0000	0.4286	0.6000	7
5	0.6000	0.7500	0.6667	4	0.0000	0.0000	0.0000	4
6	1.0000	1.0000	1.0000	67	0.8533	0.9552	0.9014	67
8	0.0938	0.5000	0.1579	6	1.0000	0.5000	0.6667	6
10	1.0000	1.0000	1.0000	65	0.9508	0.8923	0.9206	65
13	1.0000	1.0000	1.0000	83	0.9500	0.9157	0.9325	83
17	1.0000	1.0000	1.0000	1	0.0000	0.0000	0.0000	1
Accuracy	0.8844	-	-	294	0.8878	-	-	294
Macro Avg	0.7156	0.7519	0.7082	294	0.6162	0.5158	0.5428	294
Weighted Avg	0.9610	0.8844	0.9054	294	0.8787	0.8878	0.8764	294

Table 5.3: LDA and SVM metrics

Class	LDA				SVM			
	P	R	F1	Sup	P	R	F1	Sup
1	0.5676	0.3500	0.4330	60	0.9661	0.9500	0.9580	60
4	0.0000	0.0000	0.0000	7	0.8750	1.0000	0.9333	7
5	0.0000	0.0000	0.0000	4	0.8000	1.0000	0.8889	4
6	0.4681	0.3284	0.3860	67	1.0000	1.0000	1.0000	67
8	0.5000	0.3333	0.4000	6	0.5714	0.6667	0.6154	6
10	0.5333	0.6154	0.5714	65	1.0000	1.0000	1.0000	65
13	0.4923	0.7711	0.6009	83	1.0000	1.0000	1.0000	83
17	0.0000	0.0000	0.0000	1	0.0000	0.0000	0.0000	1
Accuracy	0.5068	-	-	294	0.9660	-	-	147
Macro Avg	0.2846	0.2665	0.2657	294	0.7745	0.8204	0.7922	147
Weighted Avg	0.4896	0.5068	0.4805	294	0.9680	0.9660	0.9658	147

Table 5.4: Linear Regression and Logistic Regression metrics

Class	Linear Reg.				Logistic Reg.			
	P	R	F1	Sup	P	R	F1	Sup
1	0.8169	0.9667	0.8855	60	0.8169	0.9667	0.8855	60
4	0.6667	0.2857	0.4000	7	0.6667	0.2857	0.4000	7
5	0.0000	0.0000	0.0000	4	0.0000	0.0000	0.0000	4
6	1.0000	1.0000	1.0000	67	1.0000	1.0000	1.0000	67
8	0.6000	0.5000	0.5455	6	0.6000	0.5000	0.5455	6
10	1.0000	1.0000	1.0000	65	1.0000	1.0000	1.0000	65
13	1.0000	1.0000	1.0000	83	1.0000	1.0000	1.0000	83
17	0.0000	0.0000	0.0000	1	0.0000	0.0000	0.0000	1
Accuracy	0.9456	-	-	294	0.9456	-	-	294
Macro Avg	0.5648	0.5280	0.5368	294	0.5648	0.5280	0.5368	294
Weighted Avg	0.9261	0.9456	0.9327	294	0.9261	0.9456	0.9327	294

Table 5.5: Decision Tree and Decision Stump metrics

Class	Decision Tree				Decision Stump			
	P	R	F1	Sup	P	R	F1	Sup
1	0.9375	1.0000	0.9677	60	0.0000	0.0000	0.0000	60
4	0.4667	1.0000	0.6364	7	0.0000	0.0000	0.0000	7
5	0.0000	0.0000	0.0000	4	0.0000	0.0000	0.0000	4
6	1.0000	1.0000	1.0000	67	0.4589	1.0000	0.6291	67
8	0.0000	0.0000	0.0000	6	0.0000	0.0000	0.0000	6
10	1.0000	1.0000	1.0000	65	0.0000	0.0000	0.0000	65
13	1.0000	1.0000	1.0000	83	0.5608	1.0000	0.7186	83
17	0.0000	0.0000	0.0000	1	0.0000	0.0000	0.0000	1
Accuracy	0.9592	-	-	294	0.5102	-	-	294
Macro Avg	0.4894	0.5556	0.5116	294	0.1133	0.2222	0.1497	294
Weighted Avg	0.9337	0.9592	0.9439	294	0.2629	0.5102	0.3462	294

The learning curve of every model in table 5.1 also been generated to interpret the distinct behaviors of the eight models in terms of stability of training. Cross-validation score defines how our models react to unseen data. Scaling and resampling were applied within Cross-Validation folds. It is an approach used in machine learning to estimate a model's performance by splitting the dataset used for training. It involves multiple training and testing sets. By K-fold cross-validation, we can estimate the model's performance by testing it multiple times by dividing the data set into small subsets. ((gfg cross validation ml)) K-fold cross-validation allows our model to run the data set (K=5) times by splitting the data set into sub-sets. The model is trained on encoded Q1-Q15 features, where Cross-Validation was implemented only in reliable classes (laws) to ensure a valid cross-validation process.

The whole dataset was split into 5 folds; validation and training are prorated (K=5) times, and the metric values were averaged to get the mean. Cross-validation was implemented only for the classes (laws) with appropriate support. Precisely, any class

(law) depicted by only one observation was omitted from K-fold Cross-validation because those classes cannot be split across the folds.

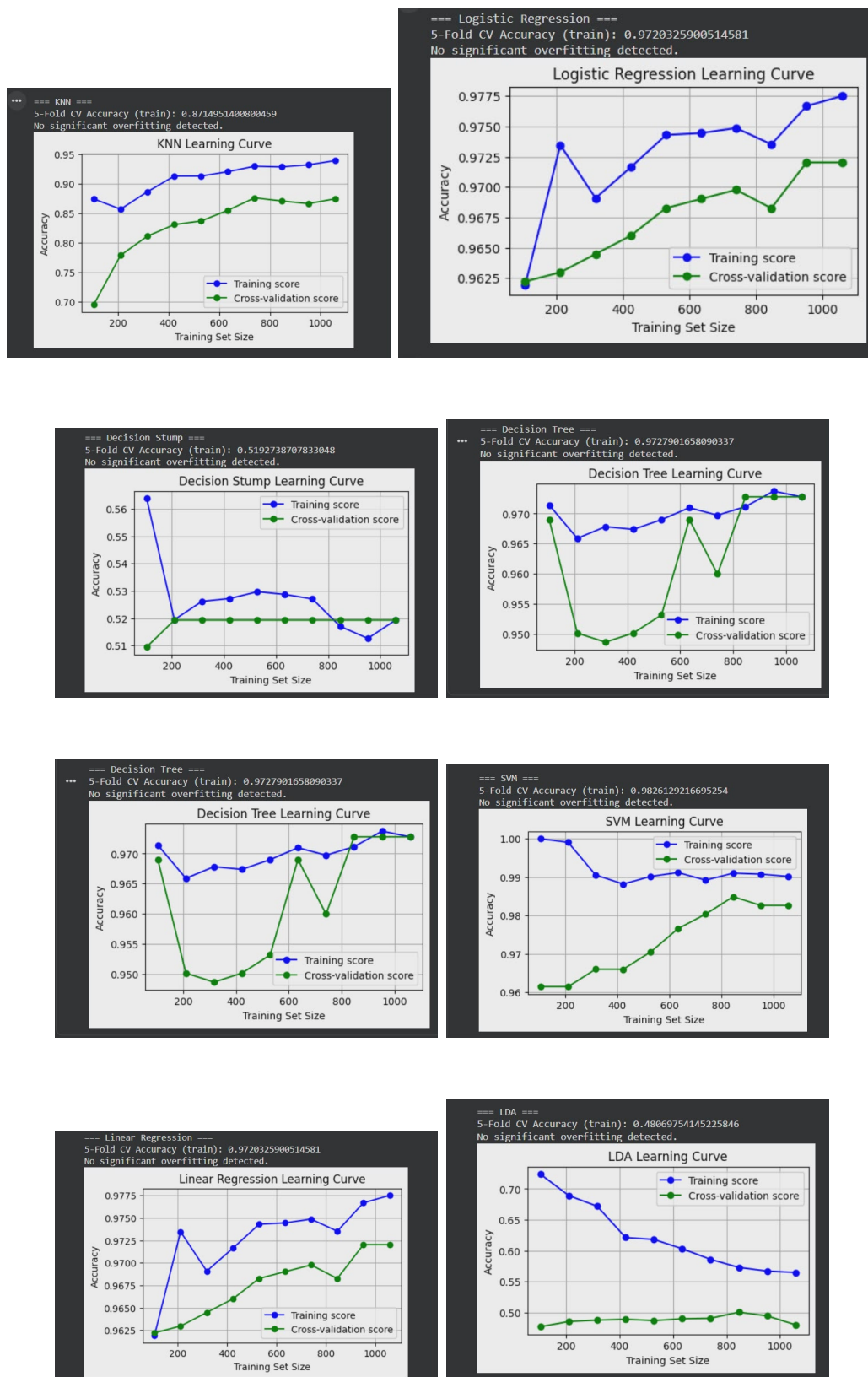


Figure 5.1: Learning Curve of each Models

5.2.2 Imbalanced Dataset

Initially, the dataset exhibited a notable class imbalance in table 5.6. The main constraint occurs from the absence of data for some specific legal laws. In cases where a specific law category had only three samples (Section:17), it was not practical to perform a proper training/testing split. As a consequence, the model lacked sufficient data on those laws/classes during training. Thereby retaining its ability to apply broadly and make reliable predictions for such categories or scenarios in practical applications.

Table 5.6: Class-wise accuracy and final accuracy of SVM on Imbalanced Dataset

class	precision	recall	f1-score	support	model
1-(Sec 37)	0.966102	0.950000	0.957983	60.000000	SVM
4-(Sec 40)	0.875000	1.000000	0.933333	7.000000	SVM
6-(Sec 42)	0.800000	1.000000	0.888889	4.000000	SVM
7-(Sec 43)	1.000000	1.000000	1.000000	60.000000	SVM
8-(Sec 44)	0.571429	0.666667	0.615385	9.000000	SVM
9-(Sec 45)	0.000000	0.000000	0.000000	1.000000	SVM
10-(Sec 46)	1.000000	1.000000	1.000000	65.000000	SVM
13-(Sec 50)	1.000000	1.000000	1.000000	83.000000	SVM
17-(Sec 55)	1.000000	1.000000	1.000000	5.000000	SVM
accuracy	0.976190	0.976190	0.976190	0.976190	SVM
macro avg	0.690281	0.751385	0.710621	294.000000	SVM
weighted avg	0.971836	0.976190	0.973647	294.000000	SVM

5.2.3 Balanced Dataset

Here, several laws were either absent or severely minimally represented in the dataset. Specifically, “The Consumers’ Right Protection Act, 2009” (Act No. 26 of 2009), Chapter IV, section no. : 39, 43, 47, 49, 51, 52, 53, 55, 56. had no samples present in the dataset, while Laws No. 45 and 42 had very few [52]. Due to this huge scarcity, these law sections were excluded from the model testing in table 5.7. Thus, from a total of 19 laws, 11 were omitted, and the model evaluation was conducted using data from the remaining 8 laws or legal sections.

Before the final model training on the balanced dataset, several pre-processing steps were used. These included data refining, cleaning, encoding, and the removal of duplicate entries. Duplicate data mainly arose by human error during data collection, where the same user responses are being linked with different class labels/laws. The legal experts verify the correct labels, and this problem of duplicate entries is resolved and thus removed. In this way, the final dataset had a total of 1470 valid instances. Finally, categorical responses (“Yes/No”) were converted into binary numerical values (0/1), and the dataset was divided into an 80:20 split ratio of training and testing subsets.

Table 5.7: Class-wise accuracy and final accuracy of SVM on Balanced Dataset

class	precision	recall	f1-score	support	model
1- (Sec 37)	0.962963	0.896552	0.928571	29.000000	SVM
4- (Sec 40)	0.833333	1.000000	0.909091	5.000000	SVM
5- (Sec 41)	1.000000	1.000000	1.000000	2.000000	SVM
6- (Sec 42)	1.000000	1.000000	1.000000	28.000000	SVM
8- (Sec 44)	1.000000	0.666667	0.800000	3.000000	SVM
10- (Sec 46)	1.000000	1.000000	1.000000	38.000000	SVM
13- (Sec 50)	1.000000	1.000000	1.000000	41.000000	SVM
17- (Sec 55)	0.000000	0.000000	0.000000	1.000000	SVM
accuracy	0.965986	0.965986	0.965986	0.965986	SVM
macro avg	0.774537	0.824002	0.792208	147.000000	SVM
weighted avg	0.967707	0.969806	0.968510	147.000000	SVM

5.3 Final Design Adjustments

Although, a preliminary test was conducted on this imbalanced dataset, it achieved an accuracy of approximately 97%. As this performance was obtained on an imbalanced dataset, it was not considered reliable for real-world deployment. To improve the reliability of the results, we took steps to handle the class imbalance and to put impact on real-world problems. Classes with a very small number of samples were used only for training, not for testing. Thus, it didn't have an effect on the evaluation metrics. This approach made the report accuracy more realistic and less affected by the uneven class distribution.

The accuracy dropped from 0.976190 (on the imbalanced dataset) in the table 5.6, to 0.965986 (on the balanced dataset) in the table 5.7, which makes a difference of 0.010204. But even though the results of the imbalance dataset were slightly better, we ignored them because the results of the imbalance dataset were not reliable for real-world deployment. Also, we chose SVM for final deployment because our finalized model gains better performance in cross-validation than all other models.

5.4 Statistical Analysis

In this section, the data was evaluated to identify patterns, trends, and correlations among the survey responses. And a correlation heatmap, which shows possible dependencies, consumer behavior clusters, where seller practices or consumer awareness may overlap, is used to show how answers to one question connect to others in order to enable deeper insights.

5.4.1 Analysis over the Collected Data

Table 5.8: Percentage Distribution of Consumer Responses by Question

Question	Yes (%)	No (%)
Q1. Checking product expiration date	54.7	45.3
Q2. Asking for product replacement if expired	60.7	39.3
Q3. Reporting issues if not replaced or refunded	50.7	49.3
Q4. Correct product given as advertised	58.7	41.3
Q5. Clarity of product(ingredients, weight, instructions)	62.7	37.3
Q6. Seller misleading advertisement	59.3	40.7
Q7. Discrepancies in weight or measurements during the transaction	54.0	46.0
Q8. Overcharging or wrong pricing	60.3	39.7
Q9. Harmful or unsafe material in the product	57.3	42.7
Q10. Seller taking responsibility and resolve	62.0	38.0
Q11. Taking action for returns or refund	58.3	41.7
Q12. Issue resolved satisfactorily	56.3	43.7
Q13. Clear labeling and details	61.0	39.0
Q14. Counterfeit product or misleading measurements	60.0	40.0
Q15. Harmful materials or safety issues	51.0	49.0

Consumer Awareness and Pre-Purchase Behavior

The assessment of consumer awareness and their first response to product problems occurs through these individual questions. The survey data shows in the table 5.8, that users check product expiration date is 54.7% and request replacement products is 60.7% but their requests decrease to 50.7% when they want to get authorized product replacements or money back. The decreasing number of complaints shows that consumer awareness does not automatically result in better market protection for consumers. People in the public domain understand current problems yet they do not file official complaints because they lack faith in consumer protection systems' ability to work effectively.

Seller Honesty and Market Practices

This group evaluates seller transparency and honesty. The survey results demonstrated in table 5.8, that participants obtained 58.7% correct product details but

they faced 59.3% deceptive advertisements and 54% contradictory verbal statements from more than half of the participants. The Yes and No responses show a close distribution which indicates that sellers maintain inconsistent practices because their customers cannot depend on the information sellers provide.

Product Information, Labeling, and Pricing Issues

Questions related to information transparency and fair pricing practices include Clarity of product label in table 5.8, (Q5: 62.7% Yes), Overcharging or wrong pricing (Q8: 60.3% Yes), Clear labeling and details (Q13: 61.0% Yes), and Information on measuring weights (Q14: 60.0% Yes). The survey results indicate that a majority of respondents were able to identify product labels, pricing information, and measurement details at the time of purchase. This pattern suggests that although labeling and pricing standards are generally present in the marketplace, their application and enforcement lack consistency. As a result, consumers continue to face misleading or deceptive business practices, particularly in relation to unclear labels, inaccurate pricing, and insufficient weight or measurement information, which ultimately undermine consumer trust and protection.

Post-Purchase Responsibility and Complaint Handling

Questions related to post-purchase responsibility and issue resolution include Seller taking responsibility in table 5.8, (Q10: 62.0% Yes), Taking consumer returns (Q11: 58.3% Yes), and Satisfactory resolution of the issue (Q12: 56.3% Yes). These findings indicate that although a majority of sellers accept responsibility and allow product returns, the proportion of respondents reporting satisfactory resolution decreases at each subsequent stage. Notably, in table 5.8, 43.7% of participants expressed dissatisfaction with the final outcome, highlighting significant weaknesses in dispute resolution mechanisms and follow-up processes. This declining trend suggests that procedural compliance by sellers does not consistently translate into effective or satisfactory consumer outcomes, underscoring gaps in post-purchase consumer protection.

Health and Safety Concerns

The research revealed health and safety problems which turned out to be its most important finding. The survey results showed that in table 5.8, 57.3% people encountered dangerous products which endangered safety occurred in more than half of the participant experiences. The Q15 results show minimal variation between answers because consumers remain uncertain about product safety because modern products face various risks which current safety standards fail to protect against.

The assessment of related questions shows that people understand how markets function but business owners continue to use different methods which produce dangerous products and poor customer service after sales. The system fails to protect consumers effectively because consumers continue to express high levels of dissatisfaction regarding multiple related aspects.

5.4.2 Survey Findings

The interview process required participants to explain their failure in reporting consumer rights violations which they encountered when their rights became problematic. The analysis of their answers shows that three main qualitative patterns emerged from their responses which included their distrust toward legal enforcement and their belief that reporting systems operate slowly and their insufficient understanding of legal matters.

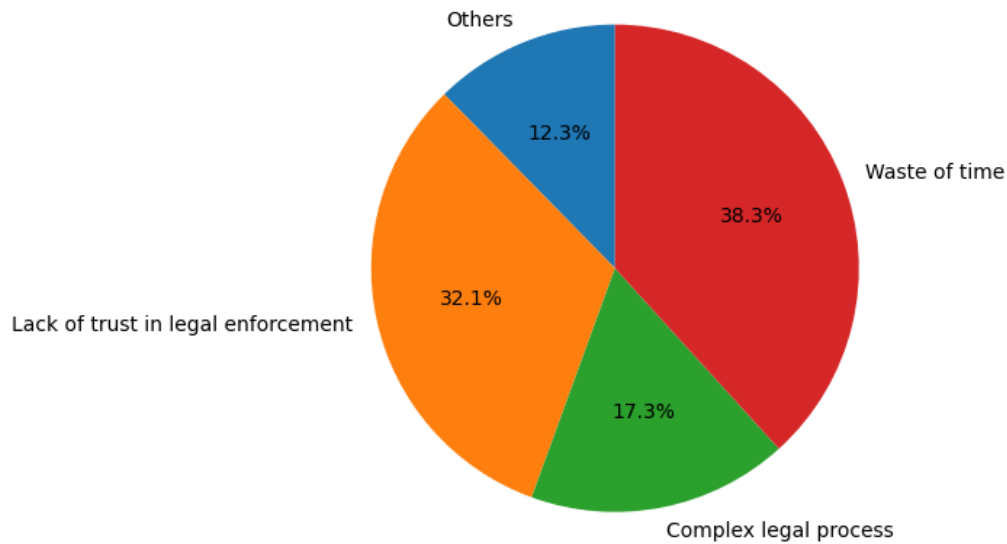


Figure 5.2: Percentage of Participants' response of Reason for not reporting issue

Lack of Trust in Legal Enforcement

The legal enforcement system received distrust from multiple participants who took part in the interviews. The participants about 32.1% in the figure 5.2, believed that submitting consumer complaints would result in no substantial response or legal resolution. The public doubts official complaint systems because they either ignore consumer complaints or reject all feedback from consumers. The absence of institutional trust indicates that consumer protection laws by themselves do not suffice because people need to trust that these laws will be properly enforced to participate in consumer protection.

Perception of Reporting as a Waste of Time

The practice of reporting consumer problems kept appearing as a useless activity. The reporting process according to numerous respondents of 38.3%, in the figure 5.2, takes a long time while being complex and slow to deliver results. People select to handle their losses and problems by themselves instead of using the established complaint system. People evaluate costs against benefits to decide if reporting requirements outweigh expected benefits which leads them to report incidents only rarely.

The public lacks understanding about legal matters

The legal system contains intricate laws which most members of the public find difficult to comprehend. In survey, 17.3%, in the figure 5.2, participants reported they did not understand legal terms because consumer protection laws used complex terminology which created reading difficulties. The absence of legal knowledge acts as a mental obstacle which stops people from using official legal systems. The public shows no interest in legal matters because complex legal terminology exists alongside insufficient educational programs which most people cannot understand. The interview data reveals why survey participants took few formal steps yet expressed strong dissatisfaction according to the survey results. Consumers understand when businesses engage in unfair practices yet they tend to avoid filing complaints because they do not trust institutions and find the reporting process too difficult and legally complicated.

Positive Attitudes Toward Technology-Enhanced Legal Support

The interest shown in the potential for using a mobile application for easier access to consumer law, legal information, and reporting was expressed through the majority of 94.8% participants' responses in the figure 5.3, to the related inquiries. The participants expressed the view that the application would be useful if the information is presented in simple terms without the use of complex legal terminology.

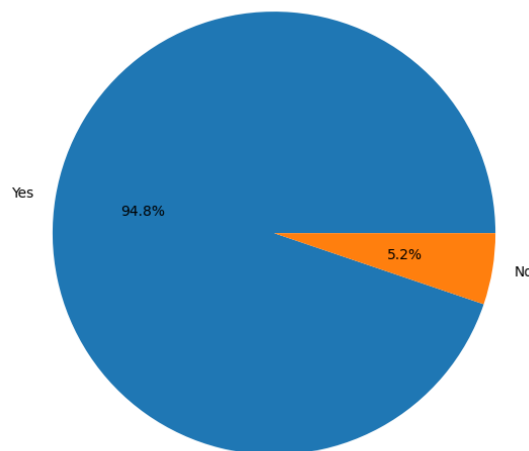


Figure 5.3: Percentage of Participants' response of wanting to use Mobile App for easier Legal Access

The results suggest that there is a positive attitude towards technology-assisted legal support. At the same time, the expressed eagerness of the participants to use the proposed mobile legal application suggests that technology might serve as the bridge between awareness and action, potentially helping to overcome the current barriers for reporting. The qualitative results revealed that the disengagement of consumers from formal reporting is caused by distrust of legal enforcement, time inefficiencies, and low levels of legal literacy. However, the expressed willingness to

use the proposed mobile-based legal support application suggests that technology might greatly contribute to the improvement of legal processes, thus empowering consumers.

5.4.3 Feature Analysis

The color gradient in the heatmap in the figure 5.4, reflects the strength of these correlations; red areas denote strong positive relationships, while blue areas represent weak or negative ones. Every cell in this heatmap shows the Pairwise Pearson correlation Coefficient between two variables. Here, the values range from Negative one (-1) to Positive one (+1). Any value close to Positive one (+1) shows that the two variables maintain a strongly linear relationship, where they increase together; any value near Negative one (-1) shows an inverse linear correlation, and values close to Zero (0) imply that there is very small or no direct correlation between the two variables. As we know, the correlation estimates linear dependency. A correlation close to Zero (0) does not necessarily mean no relationship between them, preferably it suggests there is no strong linear correlation between the two variables [91].

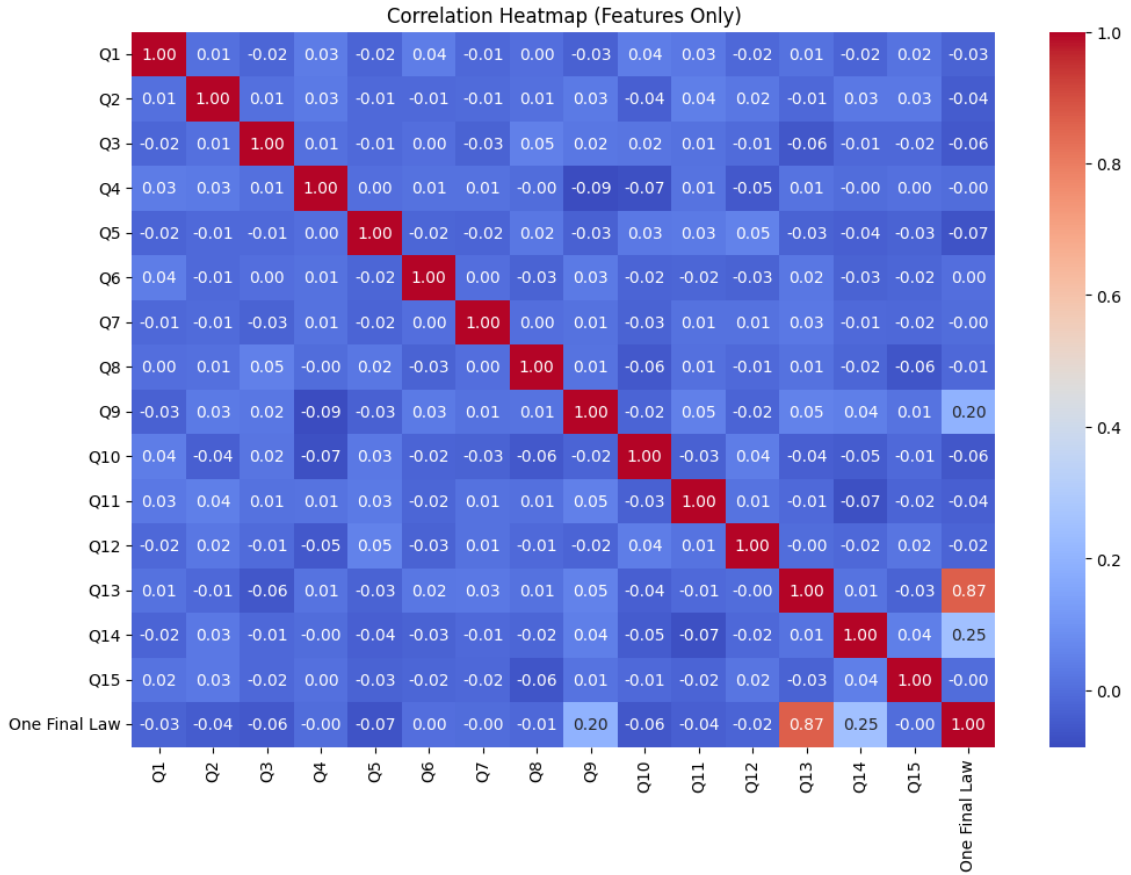


Figure 5.4: Correlation Heatmap

The heatmap is mirrored over the main diagonal, defining that the correlation between (Q_i, Q_j) is equivalent to (Q_j, Q_i) . The diagonal line in the heatmap (from top-left to bottom-right) holds value One (1.00), which occurs because every variable is ideally correlated with itself, for example, $(Q_8 \text{ with } Q_8)$. Consequently, this

diagonal operates as a standard and reference line and validates that the correlation matrix is accurately constructed.

Another significant observation is the nonexistence of strong correlations among the input variables themselves, which are (Question 1 to Question 15). In several datasets, peak inter-feature relationship (for example, where $(-r-)$ is greater than or equal to 0.7 or 0) may signify duplication and covariation, where a few variables convey almost the same information. Here, the maximum off-diagonal feature-to-feature relationships are minimal, suggesting that the questionnaire features represent different attributes rather than often measuring the same factor.

Concerning the target correlation, the heatmap indicates that the Question: 13 - "Did the product have a clear expiration date, ingredients list, and proper labeling?" has the most linear correlation with the "One Final Law" target column, where ($r = 0.87$), which can be explained as a strong predictive value/signal in contrast to other features. While Question: 14 - "Was the product counterfeit or did it have misleading weight/measurement?" and Question: 9 - "Did you find any harm in the product (e.g., unsafe ingredients, counterfeit materials, etc.)?" indicate a compact but observable Positive correlation with the "One Final Law" target column where ($r = 0.25$ and $r = 0.20$). In effect, these correlations mean any changes in Question:13 are highly correlated with changes in the target outcome, which refers to the final laws/sections being predicted, in contrast to Question:14, which contributes more fairly. The rest of the features which are Questions (1,2,3,4,5,6,7,8,10,11,12,15) include almost Zero (0) correlation with the target variables, suggesting the limited individual linear contributions, even though a few of them may still be in use in combination through non-linear decision boundaries, such as non-linear kernels in SVM, or through interactions which the correlation can not capture alone.

It is necessary to observe that the correlation does not reflect causation but rather association. Consequently, even though Q13 and Q14 seem to be the most essential in the correlation-based view, confirmatory research through model-based methods reflects necessity; ablation analysis, which refers to component removal test, or cross-validation performance comparisons, can eventually explain the reasons why they matter most for prediction in the final results section.

5.5 Comparisons and Relationships

In this section, we discuss the comparison and relationships in the table 5.9, between other research work on consumer protection and their solution to the problem.

Table 5.9: Comparison of Studies on Consumer Protection

Aspect	Our Thesis	Gray et al.	Santos et al.	Zaheer	Yi & Li
Problem	Consumers in Bangladesh suffer from fraud and lack of awareness. 46.7% are unaware of their rights under the Consumer Rights Protection Act 2009 due to complex legal language and absence of an empirical system to access consumer protection laws.	Users are manipulated by dark patterns in cookie consent banners, resulting in invalid or coerced consent under GDPR requirements.	Dark patterns cause diverse individual and collective harms, but these harms are insufficiently conceptualized, measured, and enforced under EU data protection, consumer, and competition laws.	Digital interfaces increasingly use manipulative design patterns (dark patterns) that undermine user trust, autonomy, and informed consent, violating ethical design principles and regulatory requirements like GDPR.	Legal and HCI scholarship on dark patterns regulation remains fragmented, with unclear conceptual boundaries, inconsistent harm theories, and lack of comprehensive regulatory frameworks across jurisdictions.
Methodology	Quantitative, empirical methodology involving survey-based data collection, supervised machine learning model training, and HCI-driven system design and evaluation.	Qualitative methodology using interaction criticism to analyze consent interfaces from designer, legal, ethical, and user-centered perspectives.	Doctrinal and analytical legal research combined with systematic review of HCI studies to construct a taxonomy of harms.	Qualitative thematic literature review examining ethical responsibilities of UX designers, analyzing dark patterns, regulatory frameworks (GDPR), and psychological models of user interaction.	Systematic literature review following PRISMA guidelines, analyzing 65 studies from Law and HCI disciplines using content and thematic analysis to map regulatory landscape of dark patterns.
Dataset	Primary dataset of approximately 1500 survey responses (1470 valid) structured according to fraud types and violations of the Consumer Rights Protection Act 2009, using 15 binary questions and an 80/20 train-test split.	Observational dataset consisting of consent banner recordings collected from hundreds of websites (non-ML, non-labeled).	Secondary dataset consisting of 59 sources (academic HCI studies and policy reports) systematically analyzing dark pattern harms.	Literature review dataset of over 40 academic sources covering dark patterns, HCI ethics, GDPR, behavioral economics, and consumer protection frameworks.	Systematic review corpus of 65 papers (50 law papers: 40 theoretical, 10 empirical; 15 HCI papers: 3 theoretical, 12 empirical) from interdisciplinary databases covering dark pattern regulation.
Solution	Machine-learning based decision-support system that classifies consumer complaints and maps them to specific CRPA provisions with actionable guidance.	A conceptual analytical framework exposing how interface designs undermine consent and conflict with legal requirements.	A multi-layer taxonomy of dark pattern harms aligned with EU legal standards to support enforcement, regulation, and redress mechanisms.	Comprehensive ethical design framework advocating for transparency, user autonomy, regulatory compliance (GDPR), elimination of dark patterns, and establishment of accountability mechanisms.	Comprehensive regulatory mapping identifying doctrinal challenges, proposed solutions (paradigmatic changes, technical design-embedded solutions, accountability frameworks), and advocacy for a proactive “diligent design” regulatory paradigm.

Continued on next page

Table 5.9 – continued from previous page

Aspect	Our Thesis	Gray et al.	Santos et al.	Zaheer	Yi & Li
App Development	A complete HCI-based mobile application enabling complaint registration, fraud detection, and legal document generation. Built with FastAPI backend, HTML/CSS/JS frontend, deployed on Render cloud platform.	No application developed; focuses on analysis of existing interfaces.	No application developed; focuses on legal and regulatory frameworks rather than implementation.	No application developed; focuses on ethical design principles, regulatory analysis, and theoretical frameworks for responsible UX design rather than technical implementation.	No application developed; systematic review and policy-oriented research focused on mapping scholarship and proposing regulatory paradigms rather than technical implementation.

5.6 Discussions

From a statistical point of view, the dataset has low correlation among its features, implying that the input variables are largely independent and do not redundantly convey information. This is desirable for the SVM model, which is likely to perform optimally with each feature playing its part differently in the prediction process. During training, the SVM model is able to separate legal classes by finding an optimal boundary based on the input variables. It then predicts the score for each potential law based on the concurrence between the input variables and the learned patterns. This is then translated into a probability-like value, with values closer to one indicating better concurrence. Variables that are more frequently and better correlated with particular laws are more influential in the prediction process. Therefore, the model predicts multiple laws but selects the one with the highest probability as the output.

All laws are represented in the dataset used for training, but not all legal sections are represented in the dataset used for testing. This is likely to limit the evaluation of the model’s performance with regard to these laws. It is clear that legal classes are not equally represented in the dataset; some legal classes are underrepresented compared to others. This limit the model’s ability to learn optimal boundaries for these legal classes and limit the model’s ability to make accurate predictions for these laws. Future work will ensure that all legal sections are adequately represented in the dataset for both training and testing phases.

Chapter 6

Conclusion

6.1 Summary of Findings

Through the use of Human-Computer Interaction (HCI), the study improved access to legal information for Bangladeshi consumers. Alongside these tools, the core structure of the platform is built using standard web technologies—HTML and CSS—to ensure compatibility and performance across all devices. Identifying initially, through survey work, the consumer’s greatest obstacles in understanding legal/text comprehension and accessing their legal rights, the researchers then developed a digital platform to simplify important legal protections for consumers (i.e., ability to prevent fraud; obtain refunds; warranties; online shopping rights) through the use of “easy to read”; Visuals; and analyst/collaborative features[32].

Research shows that by employing HCI tools to present legal information in a more understandable and engaging format, HCI tools effectively reduce the barriers of understanding and accessing legal rights. In addition to a supporting role for consumers, the tools are also designed to assist new attorneys in providing their clients accurate and reliable information related to their legal rights and the legal process[52].

Future enhancements include a broadening of the legal protections for consumers; multiple language support; and integrating the digital HCI platform with government legal document repositories. The study illustrates how HCI-based technology can lead to the creation of a better informed and empowered legal consumer base in Bangladesh.

6.2 Contributions to the Field

At this point in our overall contribution to the entire research is that we are creating applications that will allow for easy access to consumer rights law for the general public. We know that a national consumer rights protection agency has produced a mobile phone application allowing individuals to view the price of imported and exported goods in the country of Bangladesh.

However, this application does not inform consumers about what legal recourse they have available to them if they experience fraud or commit a different type of offence against a seller. Therefore our primary objective is to provide consumers with the ability to access consumer rights law information easily. When shopping every day,

consumers often experience a variety of different types of offences committed by Sellers. Once a consumer experiences an offence, they will probably not be able to consider what legal actions to take (or how to pursue those actions) until the end of the day when their daily purchases have been completed. The application we are developing will provide consumers with the ability to immediately initiate any necessary legal actions against the seller who committed the offence(s). In addition, our application will also help to provide information on how to prevent market syndicates from taking advantage of consumers and producing counterfeit products by selling fraudulent products that were incorrectly manufactured or processed and have already been sold on the market as a result of being sold to consumers at or above the normal price point by unscrupulous sellers. Through the above, we can protect the health of the public as well as improve the economy of a nation.

6.3 Recommendations for Future Work

In future, we are planning to develop this mobile application into a more user-friendly solution for both business owners and the consumers as well. The public will get used to the same sources of information as it relates to the laws pertaining to them. Many times, consumer fraud is committed against business owners, so consumers should know what to do in these type of situations. Our goal is to create an intuitive mobile application that allows business owners to have easy access to information regarding the HCI process. Many times, we have seen that consumers, when they purchase an item, may purchase an item for the wrong amount of money. Consumers can also go into a store, pull an item off the shelf, and leave without paying for it. Though there are existing laws that protect consumers and allow businesses to be held accountable for their actions under those laws, many business owners do not know the consumer protection laws that apply to their specific business[92].

Our application currently provides consumers with easy access to the laws protecting them, but in the future, it will also provide business owners with an easy way of knowing which laws apply to their businesses and how to submit complaints about product pricing through the app, in turn providing business owners and the government with a way to identify where the syndicate is operating. This will help improve both the economic system of the country as well as benefit both the businesses and the government[93]. Optical Character Recognition (OCR) is carried out by Tesseract.js [89] on the platform. This helps to make clear that the English and Bengali text on product labels, bills, and receipts are read properly by the platform, which clearly lets it do advanced things like text extraction and object detection as well.. Also, the TensorFlow.js [94] with the COCO-SSD model [95] can be used to detect objects in real-time in images and thus the system can identify product packaging and other important objects in an AI scan. The complete pipeline, which is image upload, object detection, OCR reading, text analysis, and the final law matching is fully done in the browsers of the user to guarantee user privacy and speed.

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Dataset

This is the dataset of our survey. In the following link the dataset is available.

https://drive.google.com/file/d/1L_aJ1gwplZEj00cDj8cuENmVMwOlxgoJ/view?usp=drive_link Google Drive