Proceedings of the 2023 International Conference on Machine Learning and Automation
DOI: 10.54254/2755-2721/43/20230800

Investigation related to database design for letter of credit

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Abstract. The "Letter of Credit" is a fundamental payment mechanism in global trade, and its efficiency has significantly declined due to the impact of the COVID-19 pandemic. This document delves deeply into the development and execution of a comprehensive database for managing Letters of Credit (L/Cs). It is designed with a real-world case study derived from the International Settlement Department of the Bank of China. The central goal of this database is to enhance the efficient management and simplification of the complex procedures inherent in L/C transactions. The development process follows a systematic approach, commencing with the establishment of three fundamental assumptions to delineate the scope of the study. Subsequently, the database design progresses through stages involving Entity-Relationship Diagram (ERD) development, relational model construction, and normalization procedures. These steps collectively culminate in the creation of an intelligently structured database comprising thirteen distinct tables. In conclusion, this paper not only delves into the design and implementation of the L/C database but also showcases its practicality through real-world scenarios. The database, fueled by meticulous design and thoughtful implementation, is poised to revolutionize the management of L/C operations, offering enhanced efficiency and accuracy in international trade transactions.

Keywords: Letter of Credit, Database Design, SQL.

1. Introduction

Letter of Credit(L/C) is a major international payment and settlement method in international trade. A L/C refers to a written document issued by a bank to provide a guarantee of payment responsibility on behalf of the importer (buyer) to the exporter (seller) upon the importer's request. According to data from the international trade payment platform, L/C account for approximately 38% of the international trade payment methods in 2015, especially in transactions involving large equipment and raw materials, where their usage is more prevalent [1]. Therefore, the L/C remains one of the principal methods for international settlements and a significant component of intermediary banking operations.

As illustrated in Figure 1 below, the entire process of a letter of credit transaction can be summarized into 14 steps. It begins with the importers and exporters signing a contract, followed by the importers applying for a L/C. Once the exporters receive the L/C, they will ship the goods, and the documents related to the shipment will be handed over to the bank. Finally, the importers will take delivery of the goods upon presenting the required documents. Throughout these processes, six different functions within the banks are involved, responsible for tasks such as issuing the letter of credit, verifying documents, and making payments.

DOI: 10.54254/2755-2721/43/20230800

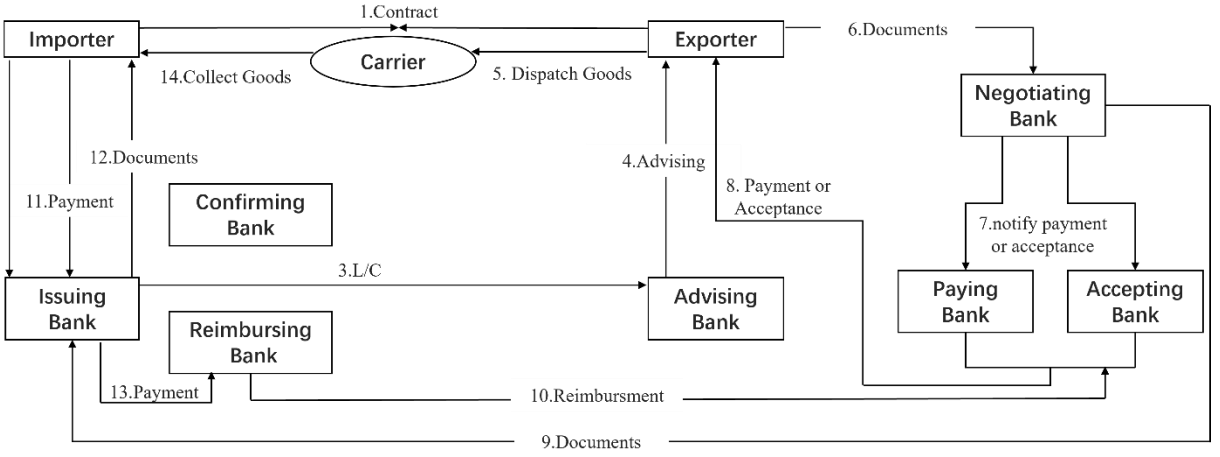

Figure 1. The process of L/C (Photo/Picture credit: Original).

In today's highly digitized landscape, the transformation of letters of credit towards online, automated, and digital processes is underway, with documents representing a crucial element within the context of letters of credit [2]. However, the traditional practice of using paper-based document submission in letters of credit is not only impeded by factors such as the prior impact of the COVID-19 pandemic on physical deliveries but also suffers from relatively low efficiency [3]. Therefore, the shift towards electronic document submission is a prevailing trend within the industry. The design of a letter of credit database encompasses the electronic transformation of documents and the storage of document-related data, contributing to the enhancement of letter of credit efficiency.

In this paper, this author chooses Bank of China's International Settlement Department as an example. Bank of China, being a large corporation, possesses a highly comprehensive Letter of Credit system [4].

2. Methodology

2.1. Assumptions

Due to the wide variety of L/C involving multiple parties [5], for the sake of simplicity, this paper make the following three assumptions: 1) The types of the L/C support the specification of these businesses and processes. 2) There already exists a cooperative relationship among the banks involved in the L/C. 3) The terms of the L/C have clearly stipulated the designated banks involved and their respective responsibilities and obligations, and different responsibilities are borne by different banks.

Most of the L/C transactions can meet these assumptions, while only a few exceptional cases require separate consideration. Therefore, this paper's current analysis focuses on the general scenarios.

2.2. Data requirements and user demands

The data requirements and user demand for the constructed database are presented in Table 1 and Table 2, respectively.

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Table 1. Data Requirements.

Data Requirement	Data Details
L/C Information	L/C Number, IssuanceDate, ExpiryDate, Amount, Currency, Beneficiary, Applicant, LatestShipmentDate
Issuing Bank Information	Name, Address, Email
Beneficiary Information	Name, Address, Email
Advising Bank Information	Name, Address, Email
Confirming Bank Information	Name, Address, Email
Paying Bank Information	Name, Address, Email
Accepting Bank Information	Name, Address, Email
Negotiating Bank Information	Name, Address, Email
Shipping Requirements	ModeOfTransport, PortOfDestination, PortOfShipment
Documentary Requirements	Types, Quantity, TradeTerm
Freight and Insurance Charges	Terms, Amount
Payment Details	PaymentDeadline, PaymentMethod

Table 2. User Demands.

User Demand	Description
Importer Requirement	The importer needs a user-friendly database for easy credit letter applications, status checks, and timely updates on negotiations.
Bank Staff Requirement	Bank staff need an efficient database to manage and process credit letter applications and transactions.
Exporter Requirement	Exporters seek quick access to credit letter terms, timely notifications, and prompt settlements.
Confirming Bank Requirement	Confirming banks require timely information for verifying and providing confirmations.
Paying Bank Requirements	Paying banks need prompt payment instructions compliance.

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Table 2. (continued).

Accepting Bank Requirements	Accepting banks must swiftly accept drafts and ensure timely payment.
Negotiating Bank Requirements	Negotiating banks review and notify payment instructions or draft acceptance.
Regulatory Authorities Requirements	Regulatory authorities may supervise transactions, requiring accurate reports and data export capabilities.

2.3. Processes

In order to construct the Letter of Credit (L/C) database, as depicted in Figure 2, a series of steps need to be undertaken.

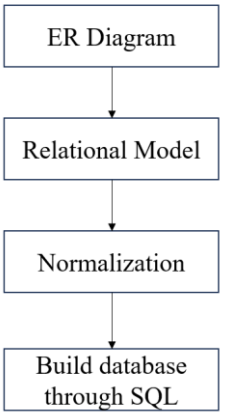

Figure 2. The process diagram for establishing the database (Photo/Picture credit: Original).

Firstly, Based on the literature by Yizhu Wang [6], the entities, their attributes, and the relationships between entities within the L/C process must be identified, resulting in the creation of an Entity-Relationship (ER) diagram, wherein primary keys are discerned. Subsequently, the ER diagram must be translated into a relational model, establishing individual tables for each entity [7]. To mitigate data redundancy and enhance data consistency, normalization of the database is necessary. Based on the functional dependencies between attributes, the normalization process involves adhering to the First Normal Form, Second Normal Form, and Third Normal Form [8]. Ultimately, upon completing the normalization process, the database is implemented using the SQL language based on MySQL database.

3. Results

Based on the methodology employed for the establishment and implementation of the database, this study has obtained the outcomes of each respective step.

3.1. Entity-relationship diagram (ERD)

In order to derive the ERD for the Letter of Credit (L/C) database, this author have identified the entities and their corresponding attributes within the L/C process, as illustrated in Figure 3.

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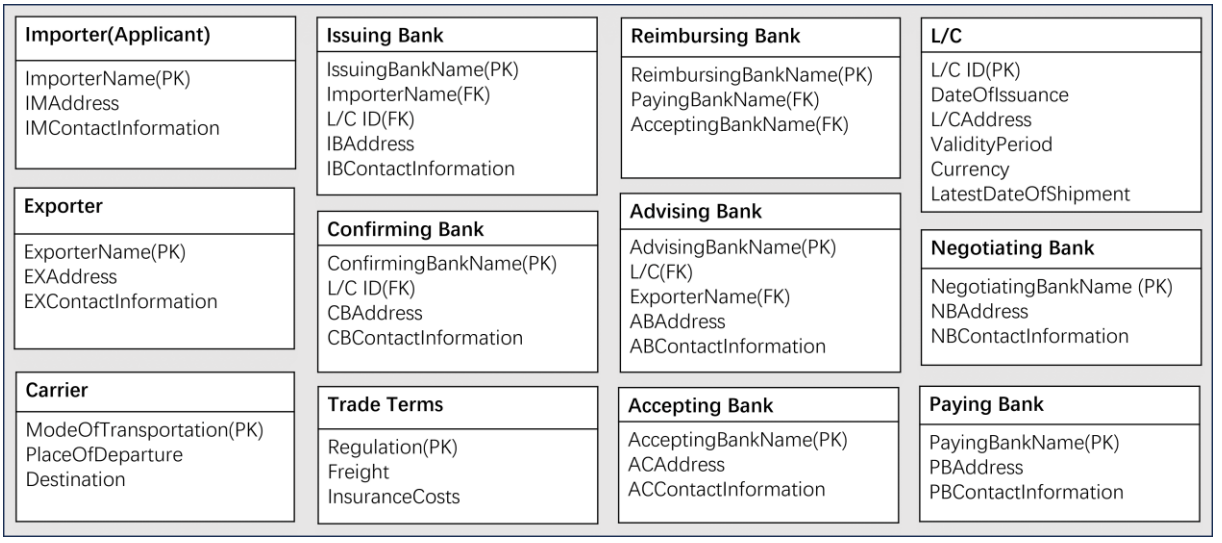

Figure 3. All entities in L/C database (Photo/Picture credit: Original).

Upon acquiring a comprehensive list of all entities involved, the Entity-Relationship Diagram (ERD) is constructed by discerning and defining the various relationships that exist between these entities. These relationships are categorized into distinct types, including one-to-one, one-to-many, and many-to-many, as visually represented in Figure 4. This graphical representation serves as a vital tool for depicting the intricate web of connections and dependencies among entities within the database structure.

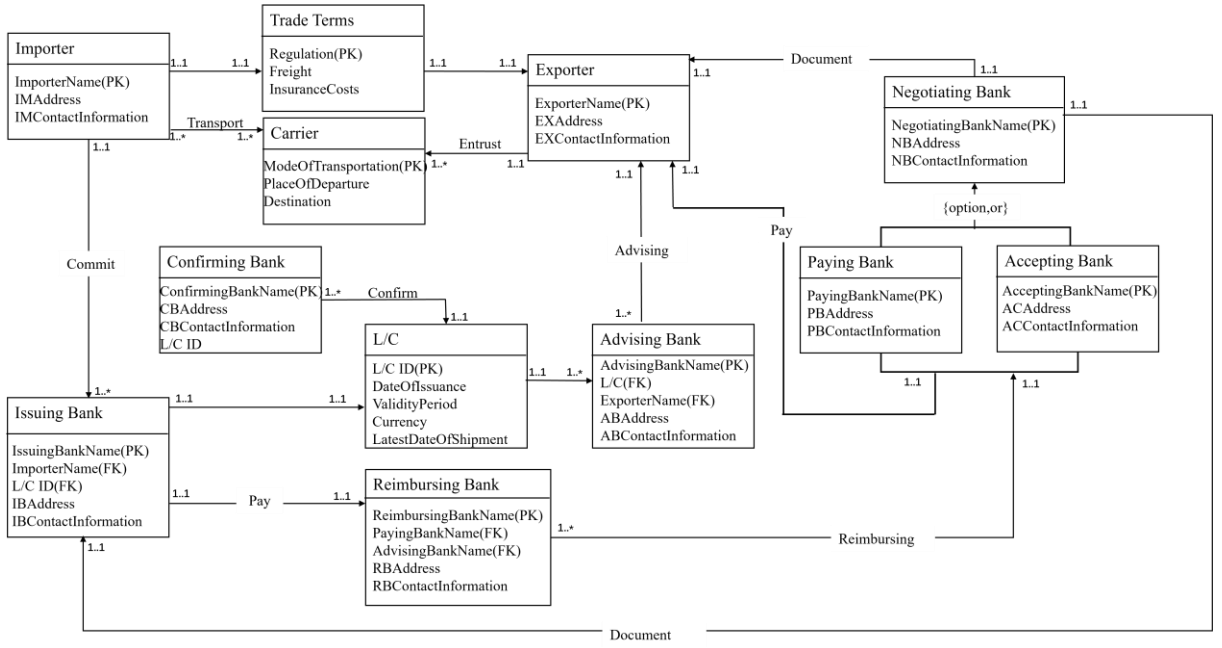

Figure 4. The ERD of L/C database (Photo/Picture credit: Original).

3.2. Relational model

Following the acquisition of the ERD, the relational model naturally emerges, as exemplified in Figure 5.

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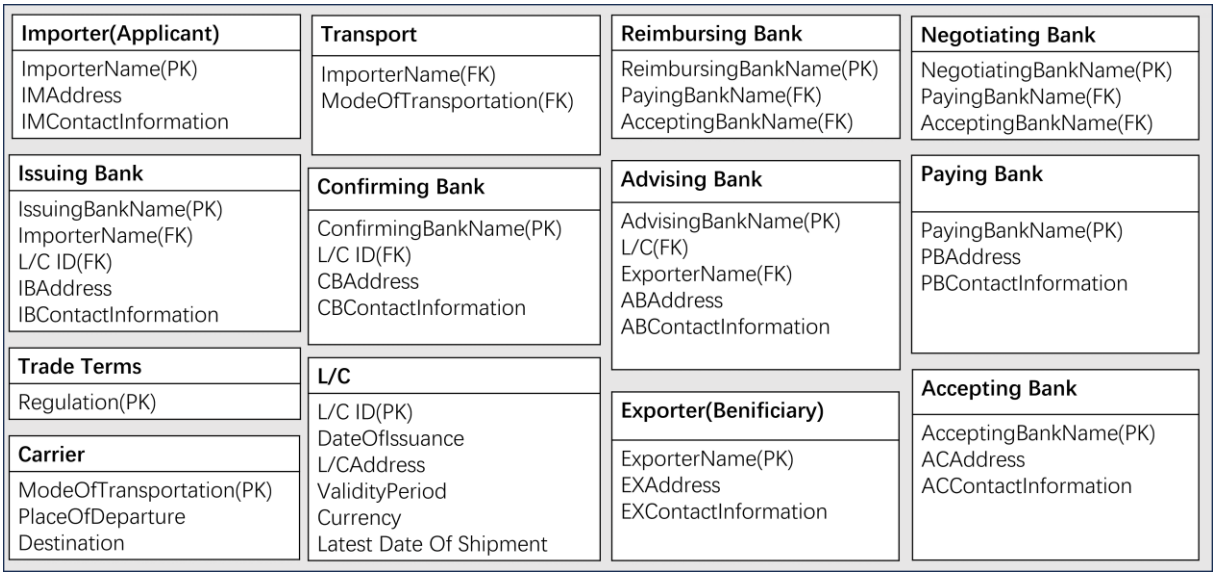

Figure 5. The Relational Model of L/C database (Photo/Picture credit: Original).

3.3. Normalization

Prior to formal normalization, it is imperative to discern the functional dependencies (FDs) and candidate keys pertinent to each table within the relational model. This involves scrutinizing the data relationships within the database and ascertaining the interdependencies among individual attributes. The resultant FDs are illustrated in Figure 6.

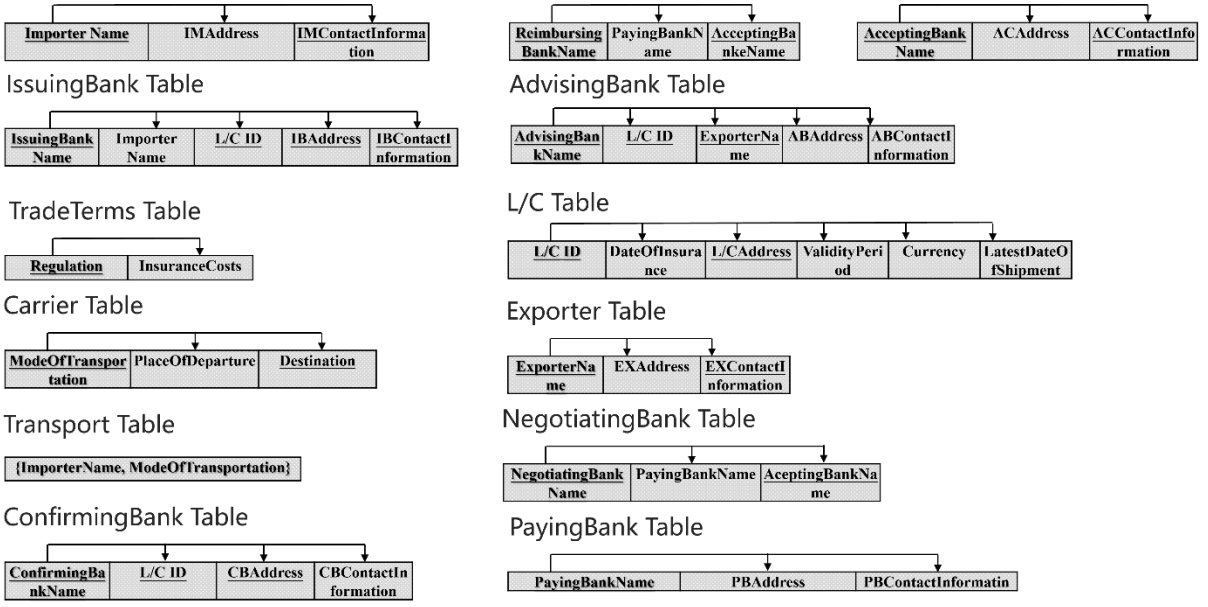

Figure 6. The FDs in each table (Photo/Picture credit: Original).

In accordance with the FDs across all tables, it becomes requisite to perform individual normalizations for each respective table. As delineated by the workflow diagram depicted in Figure 7, the pursuit of achieving first, second, and third normal forms (1NF, 2NF, and 3NF) for each table ensues as part of the normalization process.

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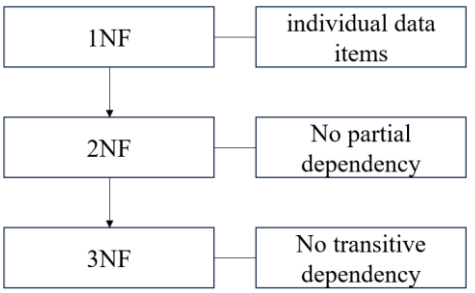

Figure 7. The process diagram for normalization (Photo/Picture credit: Original).

Notably, given the context that all tables have already achieved the state of the first normal form (1NF) and are devoid of partial dependencies and transitive dependencies, it becomes evident that all tables have already achieved a normalized state.

3.4. Building database through SQL

In this study, the realization of the database was achieved using WampServer and SQL. WampServer is a cost-free application that facilitates the development of websites while considering the integration of a database [9]. All tables within the Letter of Credit (L/C) database are delineated in Figure 8, totaling 13 tables, mirroring the number of normalized tables.

Table	Number of Lines	Type	Collation	size
Acceptigbank	4	MyISAM	Utf8mb4_0900_ai_ci	2.2 KB
Advisingbank	4	MyISAM	Utf8mb4_0900_ai_ci	4.3 KB
Carrier	4	MyISAM	Utf8mb4_0900_ai_ci	2.2 KB
Confirmingbank	4	MyISAM	Utf8mb4_0900_ai_ci	3.2 KB
Exporter	4	MyISAM	Utf8mb4_0900_ai_ci	2.2 KB
Importer	4	MyISAM	Utf8mb4_0900_ai_ci	2.3 KB
Issuingbank	4	MyISAM	Utf8mb4_0900_ai_ci	4.3 KB
L/C	4	MyISAM	Utf8mb4_0900_ai_ci	2.1 KB
Negotiatingbank	4	MyISAM	Utf8mb4_0900_ai_ci	4.2 KB
Payingbank	4	MyISAM	Utf8mb4_0900_ai_ci	2.2 KB
Reimbursingbank	4	MyISAM	Utf8mb4_0900_ai_ci	4.2 KB
Tradeterms	4	MyISAM	Utf8mb4_0900_ai_ci	2.1 KB
Transport	4	MyISAM	Utf8mb4_0900_ai_ci	5.1 KB
13 tables in total	**52**	**MyISAM**	**Utf8mb4_0900_ai_ci**	**40.9 KB**

Figure 8. All tables in L/C database (Photo/Picture credit: Original).

To verify the accuracy of the constructed database, a series of 15 query statements were formulated and executed. For illustrative purposes, consider one of these queries. This query is aim to retrieving all carriers and the importers they are associated with, and Figure 9 is the result of that query.

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ModeOfTransportation	ImporterName	IMAddress	IMContactInformation
Truck Freight	Asia Imports Co.	789 Market Road, Tokyo	info@asiaimports.co
Rail Freight	EU Trading Ltd.	321 Trade Lane, Paris	contact@eutrading.eu
Air Freight	Global Traders Inc.	456 Park Avenue, London	info@globaltraders.com
Sea Freight	John Doe Importers	123 Main Street, New York	John.doe@example.com

Figure 9. Result of one query (Photo/Picture credit: Original).

4. Discussion

4.1. Implications of L/C database implementation

The successful deployment of the L/C database bears significant implications for both the banking sector and international trade operations. The streamlined L/C processes facilitated by the database can substantially enhance the efficiency of cross-border transactions, reducing the time required for document verification and fund transfers. This enhancement has the potential to foster a more conducive environment for international trade by cultivating trust between importers, exporters, and banking institutions.

4.2. Limitations and future directions

It is imperative to acknowledge the limitations inherent in this study's approach and implementation. The database design and implementation are contingent upon the accuracy and completeness of the data sources used. Incomplete or inaccurate data could compromise the reliability of the database outputs. Additionally, while the current focus has been on the Letter of Credit process, future iterations could encompass more diverse international trade operations, expanding the database's scope.

Future research could also explore the integration of advanced technologies such as blockchain and artificial intelligence to further enhance the security and efficiency of L/C processes [10]. Additionally, collaborating with regulatory bodies and industry stakeholders could refine the database's design and align it more closely with evolving industry standards.

5. Conclusion

This study has undertaken a comprehensive exploration of the design and implementation of a robust letter of credit (L/C) database, employing a practical case derived from the International Settlement Department of Bank of China. The primary goal of this database is to efficiently manage and optimize the intricate processes inherent in L/C operations. The developmental approach adheres to a systematic methodology, initiated by the establishment of three fundamental assumptions that define the scope of investigation. Sequentially, the database design advances through stages encompassing the creation of an Entity-Relationship Diagram (ERD), construction of a relational model, and the execution of normalization procedures. These systematic steps collectively culminate in the construction of an intelligently structured database, comprised of thirteen distinct tables.

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