CHAPTER I

INTRODUCTION

1.1 Background

Digitalization and automation are currently pursued to be implemented in many sectors, including in trade finance banking. Letter of Credit (L/C) is a trade finance instrument that is mainly used worldwide [1]. This L/C contains a guarantee to pay from Issuing Bank to Exporter which is referred as Beneficiary. This guarantee could only be realized after receiving a complying document as required by L/C terms and conditions [2]. The required documents may vary such as, invoice, packing list, Bill of Lading, Certificate of Origin, Certificate of Insurance etc.

Due to its worldwide usage of L/C, International Chambers of Commerce issued a set of rules to govern the uniformity in L/C practices. This rule known as Uniform Customs and Practices for Documentary Credit (UCP 600), and its supplementary rule known as International Standard Banking Practices (ISBP 745) [3]. Though these rules are not automatically bound to every L/C transaction, most of parties implement these rules as a governing rule in their L/C [3].

This also means that document(s) required by L/C not only have to comply with L/C terms and conditions, but also have to comply with these rules governing the L/C. Considering that the compliance of these documents is the main condition for payment in L/C, then the examination of these documents become a crucial process to be done.

In current practices, despite its large transaction volume that is processed daily, these documents mostly presented in printed forms or hard copy. This made

the examination of these documents still using manual eyeballing of examiner that depends on individual precision of each examiner [4]. Other than precision of checking, manual examination of documents can also be time consuming. Therefore, a need to digitalize and automate this process become more crucial as the times goes by.

Digitization of paper-based document is not an easy task considering how many parties involved in the process. Not only Exporter, Importer and Bank but also other parties such as Shipping Company and its agents, Insurance Company, Customs Regulator or External Appraiser are involved in processing of these documents. Every company have different format of document which gives many variations of document form, even between the same document type. Every Bank also have their own wording in issuance of L/C. Other than that, UCP 600 as governing rule consists of 39 article and ISBP 745 consist of 298 paragraphs. That means there is at least that much parameters to examine the compliance of these documents. These conditions are some of the causes that make it difficult to implement digitalization and automation in examination process of documents under L/C.

In order to digitize the process as mentioned above, it is needed to extract data from L/C and documents to text format, then compare them to determine compliance of those documents. L/C can be obtained in text format directly from bank's system called SWIFT [5]. L/C content will be structured with certain field specific for certain information. However, different wording of every bank may cause this content to vary. Hence, come the need to normalize the L/C content. Natural Language Processing (NLP) can be applied for this purpose. Named Entity

Recognition (NER) is a part of NLP that capable of recognizing an entity from text. This entity can be a company name, country name, organization, place etc. Most NER model for English Language make use of first letter capitalization to determine whether a word is an entity or not (ex: “apple” is not recognized as an entity but “Apple” is recognized) [6]. This is unapplicable in L/C since most Bank issued the L/C with full capital letter. Therefore, there is a need to customize and train the suitable NER model so it is possible to recognize and separate data which appear simultaneously in one field of L/C such as company name and company address, goods name and quantity etc.

Obtaining data from documents on the other hand needs further pre-process. Document that is still in paper form needs to be scanned to image format which then Optical Character Recognition (OCR) will be used to extract text data from these document images. OCR processes in general are divided into image pre-processing, text segmentation, feature extraction, text recognition and post-processing step. Image pre-processing is initial process to improve quality of the image, text segmentation is a process to recognize text area in the image, feature extraction is a process to extract the feature that will be used for learner on text recognition step, Text recognition is a process to recognize text in the image to be classified as any alphabet, numerical or symbols, Post-processing step is a process to improve the accuracy of text recognition after the text recognition step is done.

There are already many researches done in these fields. For image pre-processing; Resizing, Sharpening, Blurring and K-Means clustering to minimize noise in image was researched by Brissinello *et al.* in [7]. These processes aim to improve the accuracy of text recognition. Resizing is done for character that is less

than 100 pixels, Sharpening is done to enhance contrast between edges in image, blurring is done to remove background noise that often misclassified as diacritical character and K-means clustering to segment text better on colorful background. This method resulting improvement of up to 33.3% of OCR Accuracy using Tesseract OCR engine. Another research on image pre-processing is by Kumar S. *et al.* [8]. This research was using Hough Transform to de-skew the image. Hough Transform is a method to detect lines in image by using parametric space of linear function.

For text segmentation which separate text and non-text area in an image; Adaptive Thresholding and Region Labeling are used by Lukas *et al.* [9] to identify Vehicle Registration Plate (VRP) area in images. Adaptive threshold is done to binarize the image based on grayscale value in segmented area of image. This method is useful for an image with unbalanced illumination. From binarized image, region labelling then used to detect VRP area in the image. Other research on text segmentation is by Aladhadh *et al.* [10]. This research used Maximally Stable Extremal Region (MSER) and stroke width analysis to segment text in the image. MSER is blob detection method based on stability in region after repeated thresholding using every grayscale value in the image. These blobs can also be a non-text object. Hence, stroke width analysis is utilized to eliminate a non-text object.

For feature extraction step that extract features which will be processed through classifier in text recognition step; Zoning, Projection Profile, Histogram of Oriented Gradient (HOG) and combinations of them were researched by Reynaldo P *et al.* [11]. This research test those feature extraction for the best result. Zoning is

feature extraction from divided image into many zones. Projection profile is feature extraction from foreground pixels in rows and columns of the image. HOG is feature extraction from the occurrences of gradient orientations in localized parts of an image. This research result shows that projection profile feature extraction and combination of projection and HOG produce the best result for 94.43% of accuracy.

For text recognition step as classifier; Many machine learning models have been researched for text classifier. Support Vector Machine (SVM) and Neural Network as text classifier were compared by Reynaldo P *et al.* in [11], resulting SVM produce better accuracy up to 94.43% compared to Neural Network with best accuracy up to 93.48%. K-Nearest Neighbour (KNN) were compared to Neural Network as text classifier for handwritten Pashto Letter by Khan S *et al.* in [12]. Results are 70.07% accuracy for KNN and 72% for Neural Network. Long-Short Term Memory (LSTM) as text classifier also researched by Aladhadh in [10]. LSTM is an updated version of Recurrent Neural Network to deal with vanishing gradient problem. This experiment resulted in 95% accuracy without lexicon and 99% accuracy with lexicon on 20,000 images tested.

For post-processing steps; Lexicon-based was researched in [10],[13]. This method basically checks the OCR output with words in dictionary of utilized languages. Some of those methods above applied in this research based on results of referenced research adjusted for Document checking under L/C. For example, LSTM with lexicon-based post processing produce 99% recognition accuracy for 20.000 images of payable documents [10]. However, lexicon-based post processing must not be applied when examine description of goods in invoice under L/C. Since

as per UCP 600 article 18.c typing error of description of goods in invoice will determine Invoice to be not comply with L/C terms. Therefore, lexicon-based post processing may not be used and other methods and their combination will be tested to find the best result for extracting text data from document under L/C.

1.2 Problem Identification

L/C as a product of a Bank comes with several risks, like every other product of a Bank. Examination of documents under L/C is one out of several process involved in L/C transaction. This process is the determining process in L/C payability. Therefore, the accuracy of this process must be ensured to mitigate risks involved. Examination of document under L/C involving several risks such as Operational Risk and Reputational Risk. Operational risk is a risk that associated with procedural problem within an organization such as human error [14]. The inaccuracy on examination of document under L/C may cause an L/C to become unpayable, thus a financial loss occurs. Because inaccuracy of examination is a procedural error, it is an operational risk in itself. Reputational Risk is a risk that associated with negative publicity regarding organization's cultural alignments, quality commitments and operational focus [15]. L/C is a transaction that involves many parties, therefore the inaccuracy of examination will damage Bank's reputation which possibly affect future transactions.

Examination of documents under L/C until this day mostly relies on manual examination of human checker. This is due to automation and digitalization of this process still have its difficulties, such as:

a. Document examination process that still relies on paper-based document
b. Variations on document format

c. Many parameters to determine compliance of documents (UCP 600 consist of 39 article and ISBP 745 consist of 298 paragraphs)
d. Many documents related to the L/C
e. Variations on L/C wording from every Bank

While there are many promising advantages offered by automatic examination of document under L/C, above difficulties are what hinders improvement in this process. One of contribution from successful automation on this process is additional Artificial Intelligence (AI) resource that can complements a deficit in human resources. The London Intitute of Banking and Finance (LIBF) is an institution that is authorized and acknowledged to provide an international certification for L/C Specialist known as Certified Documentary Credit Specialist (CDCS). From LIBF official webpage it is known that only 163 persons qualified as L/C specialist in Indonesia as per March 2022 [16]. This proves that tools for automation of document examination under L/C will be helpful to complement the deficit in human resource for this process.

1.3 Problem Limitation

This research will assume that the document has been obtained in image format such as .png, .jpg or .jpeg and L/C has been obtained in text format. The reasoning behind this is documents mostly presented in paper-based copy. Therefore, scanning them into image format is common practices. On the other hand, L/C mostly issued in SWIFT message format which enables L/C to be obtained in (digital) text format directly. SWIFT stands for Society for World

Interbank Financial Telecommunication which is a service providing a means to exchange interbank financial information [5].

In order to determine the performance of proposed tool, examination of invoice is sufficient to build a ground base tool for its complete version that is capable to examine other type of documents. This is due to examination of other type of document can be repeated with similiar method but using different parameters. Other than that, invoice is one of document type that mostly required in L/C [17]. Therefore, from all articles and paragraphs of UCP 600 and ISBP 745 this research will be limited to examination of invoice with the following parameters:

1. Invoice must appear to have been issued by Beneficiary/Exporter (UCP 600 article 18.a.i)
2. Invoice must be made out in the name of Applicant/Importer (UCP 600 article 18.a.ii)
3. Address of Beneficiary and Applicant, if mentioned, should be in the same country (UCP 600 article 14.j)
4. Invoice should be issued in the same currency of L/C (UCP 600 article 18.a.iii)

1.4 Problem Definition

To build an automated model for document examination as explained above, it is needed to solve the following problems accordingly:

a. How to extract Data from L/C in text format and from invoice in image format?

b. How to compare data to examine the compliance between L/C, invoice and default parameters as per UCP 600 article 14.j, 18.a.i, 18.a.ii, and 18.a.iii?

1.5 Research Purpose

This research will aim to build a tool that is capable of AN AUTOMATION OF INVOICE EXAMINATION under L/C based on UCP.

To achieve this purpose, there are 3 processes that will be done. First, data extraction from L/C that is; Beneficiary name, Beneficiary country, Applicant name, Applicant country, Currency and Description of Goods. L/C will already be in text format with certain field number for every data needed. However, some natural language processing is still needed to extract Beneficiary and Applicant's Country from their addresses and to segment text in description of goods semantically since it may contain multiple information in one sentence such as quantity of goods, name of goods, trade terms, type of goods, country of origin etc. Second, converting invoice image to text format. This process will be further divided into three steps that is image pre-processing, text segmentation/localization and text recognition. Last process will be rule-based text matching between extracted data from L/C and invoice that has been converted into text format. This final step will determine the compliance of invoice.

1.6 Outline of the Thesis

This research consists of 5 chapters. Every chapter elaborate its content each with specific purpose. Herewith the systematics of every chapter:

Chapter I Introduction. This chapter contain brief introduction to L/C and its documents, challenges in L/C and Document examination process, the needs to digitize and automate the examination process, proposed method to digitize and automate the examination process along with research limitation and past research that related to the proposed method.

Chapter II Theoretical Background. This chapter explain theories that are used in this research or past research related to problem defined in chapter 1. Theories covered are Named Entity Recognition, Image Processing Method, Optical Character Recognition and Rule-Based matching for invoice examination under L/C based on UCP 600 and ISBP 745. Named Entity Recognition category like Rule-based NER, Machine Learning-Based NER and Hybrid NER are explained in this chapter. Image pre-processing technique such as Grayscaling and Binarization, De-skewing, Sharpening and Blurring also explained in this chapter. Further, Optical Character Recognition and general infrastructure of Tesseract OCR as OCR tools are explained. This chapter is the key to determine methodology of research in the next chapter

Chapter III Research Methodology. This chapter contains research planning and research experiments. Block Diagram of experiment process is displayed in this chapter. In general experiment processes are data extraction from L/C in .txt file using Named Entity Recognition, data extraction from invoice image using OCR with pre-processed image and Rule-Based Matching of extracted data. Image pre-processing done are image binarization, de-skewing, blurring and some morphological operation such as border removal, box lines removal and Connected Component Analysis for signature detection.

Chapter IV Result and Discussion. This chapter will explain and discuss results of experiments with commentary of what have been achieved while attaching related published paper

Chapter V Conslusion and Suggestion. This chapter will summarize the research according to the result achieved also constructive suggestions that is potentially used for next research to achieve an even better results.