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Analysis of Selected Methods Used in Forensic Paper-Based Document Examination

Njabulo Bruce Khumalo
National University of Science and Technology

Sandile Sibusiso Bhebhe
Ministry of Home Affairs, Department of Forensic Science

Abstract
The examination of questioned documents is a very key part of forensics and the justice systems. This is because fraudsters and other criminals may temper with documents in their criminal activities. A number of forensic document examination methods and techniques have been developed to examine the authenticity of documents. These methods and techniques have advantages and disadvantages. This study thus sought to identify and analyse some of the methods used in forensic document examination. A literature review was applied in this study. This study concluded that forensic document examination had advanced as it had a number of methods which could be used to determine the authenticity of documents. However, forensic document examination still needed to develop further as some methods being used were destructive and could lead to information loss or the deterioration of documents.

Introduction

Records and or documents hold evidential value and thus have to be authentic in order to be admissible in a court of law. The evidential value of records and documents has seen people trying to manipulate and alter them in order to have access to wealth and other benefits which they might not be entitled to. Saini and Kaur (2015) cited in their study that the recent exponential growth in the use of image processing software applications has been accompanied by a parallel increase in their use in criminal activities. Furthermore, a number of people have forged records and documents for different political, religious, economic and social benefits. Forgeries were rife in medieval and classical times, requiring vigilance with respect to their authenticity at the time and their authentication subsequently by historical scholars (Rogers and John, nd) Questioned documents therefore, have to be subjected to forensic examinations in order to authenticate them. Breuel (nd) opined that paper is a desirable medium from a forensic point of view as modern forensics has made it possible to detect even sophisticated forgeries and alterations of paper documents. Furthermore, Rogers and John (nd) highlighted that there has been a longstanding interest in the identification of forgeries specifically and in ascertaining the origin of all documents generally. The need to authenticate records and documents is high especially given technological developments which have made the manipulation of documents easier. The Texas Education Agency (2011) stated that crimes such as forgeries and counterfeiting are on the rise, and thus increase the need for document examination.

The purpose of forensic document examination, according to Dogaroiu (nd), is to provide information about the history of a document to either a court of law or investigating police officer seeking evidence present in the document. Ellen (1997) noted that the document to be examined is termed the questioned document where 'questioned' indicates that not everything about the document is accepted for what it appears to be. Reyden (1996) warned that taking objects at face value can lead people to misunderstand or misrepresent the true value of objects. A case of forgery also included documents pertaining to the alleged attempted purchase of uranium by the Sadam Hussain regime in Iraq from Niger in which an obsolete letterhead was used which included the wrong symbol for the Niger presidency (Dogaroiu, nd). Furthermore, history has it that manuscript such as: "Howard Hughes' Autobiography," "Hitler's Diary," and the Mormon Church's "Salamander Letter" had the power to greatly influence issues of legal, historical or religious significance, but as it turned out, each was actually proven to be fake (Reyden, 1996:1). Rendell (1978) further noted that the truth however, exacted a costly toll, including the loss of human lives. Forensic document examination is thus, critical in authenticating documents and thus, supporting the justice system. Fraudsters and other criminals know the value of producing documents when seeking to prove their claims and therefore, the justice system has to have means of examining these documents.

Statement of the Problem

A number of methods are used in forensic document examination. However, not all of these methods produce the best results as they may fail to produce the required results or even damage documents.

Purpose of the Study

This study sought to highlight and also analyse methods used in forensic document examination. The specific objectives of the study were to:

i. Determine methods used in forensic document examination; and
ii. Analyse methods used in forensic document examination

Methodology

This study applied a literature review. An online search was conducted using the terms forensic document examination, methods used in forensic document examination and document forgeries.

Literature Review

Forensic document examination grew out of the courts' need for assistance in interpreting evidence relating to the preparation and subsequent treatment of documents (Lindblom, 2006: 10). The field of document examination has become more diverse and requires authenticity or validation in many areas of examination which involves determination of authorship, fraud detection and personal identification (Saini and Kapoor, 2015:1). Crime involving documents, ranging from fraud and anonymous letters to armed robbery and murder, is dealt with by Questioned, or Forensic Document Examiners (Srihari and Leedham, 2003:1). The National Forensic Science Technology Centre (nd) highlights that questioned material may consist of identification cards, contracts, wills, titles and deeds, seals, stamps, bank checks, handwritten correspondence, machine-generated documents, such as those from photocopiers, fax machines, and printers), currency and electronic documents.

Forensic document examination makes use of methods to examine inks and toners. Kumar et al (2016) pointed out that in modern offices photocopiers and printers occupy an important part of routine work and they are also vulnerable tool in document forgeries. Many of the questioned documents require examination of printed toners and printers in different aspects of document frauds (Kriel, 2011). Most printed questioned documents are printed in black ink and the method to be used for examination has to differentiate between cartridges through their absorption spectra.

Kriel (2011) pointed out that forensic document examiners examine various types of documents through infrared, ultra violet and spectroscopic analysis in order to determine whether a document has been altered in any way or not. Examinations can include deciphering the original or altered entries (Kriel, 2011). Imaging techniques and devices (non- destructive) together with chromatographic techniques (destructive) are used for the examinations of these questioned documents. Songer (2014) highlighted that comprehensive digital imaging systems can provide the questioned document examiner with an extensive range of facilities for detecting irregularities on altered and counterfeit documents. Destructive methods are used for quantitative analysis. They base mainly on the analysis of the composition of inks. The non- destructive methods reveal these alterations by exploiting the way different inks respond to different wavelengths of light (Wanderson et al, 2012).

Findings of the Study

The literature review led to a number of findings which are presented in the following sub-sections. The forensic document examination methods which emerged in this study include non-destructive methods such as hyper-spectral images in the near infrared range (HIS-NIR) and the Video Spectral Comparator, iN10 Fourier Transform Infrared Microscope (In FT-IR). Furthermore, there are destructive or physicochemical methods which include chromatographic techniques.

Non- Destructive Methods (Imaging devices and techniques)

These researchers analysed some non-destructive forensic document examination methods which included hyper-spectral images in the near infrared range (HIS-NIR), the Video Spectral Comparator and iN10 Fourier Transform Infrared Microscope (In FT-IR). These methods are discussed in subsequent sections. Non-destructive methods give more accurate results as they allow for other confirmatory tests. Results are not dependant on one test and the sample is still in the state it was when it was first submitted. Polak et al (2017) noted that Imaging techniques are non-destructive giving the possibility to use complementary techniques and obtain more information from the same sample and the analysis requires little or no sample preparation, therefore decreasing the chances of possible contamination. Kumar et al (2016) posited that they are simple, faster and easy to understand and the non-destructive nature protects the evidential value of a document and scope for re-examination.

Hyper-spectral Images in the Near Infrared Range (HSI-NIR)

According to Eldeman et al (2012) Hyper-spectral Images in the Near Infrared Range (HSI-NIR) is used for the examination of alterations, obliterations and erasures. In document analysis, it improves visualisation and gives an analysis which establishes a sample's formulation. ChemImage (2011) highlighted that with HSI-NIR, a

hyper-spectral image is generated by collecting digital images as a function of wavelength through the use of an electro-optic tuneable imaging filter. Furthermore, following data acquisition, image processing software may be used to generate single wavelength images characteristic of absorbance, reflectance or fluorescence exhibited by inks of interest (ChemImage, 2011). Alternatively, through the use of multivariate statistical tools, the software draws from the variability present at a range of wavelengths to enhance image contrast and reveal minor differences between different inks (Chem Image, 2011).

The Advantages of Hyper-spectral Images in the Near Infrared Range (HSI-NIR)

Polak et al (2017) noted that HSI-NIR has undergone significant development and that there is an increase in camera technologies that with different configurations provide many ways to obtain a hyper-spectral image at several spectral ranges. Another advantage of HSI-NIR, according to ChemImage (2011), is that it combines standard digital imaging techniques with common spectroscopic methods to provide increased sensitivity and discrimination capabilities over traditional methods of questioned document analysis. The rapid, non-destructive and non-contact features of HSI-NIR make it suitable in forensic analysis (Elderman et al, 2012). Furthermore, HSI-NIR is the most preferred imaging technique because it allows for better visualization and discrimination of a wider range of documents (Chem Image, 2011; Kumar et al (2016). Kumar et al (2016) also highlighted that with HSI-NIR a large number of printed content can be analysed at once making comparisons of different specimens easier and reducing the analysis time.

Kumar et al (2016) further noted that this technique is a simple and effective method for large volume of samples whose printing source is unknown, and that it is very useful in detection of alterations and forgeries at very minute level by printing. Furthermore, ChemImage (2011) noted that results obtained from this method are accurate, reliable, validated and courtroom friendly. This, according to ChemImage (2011), is because HSI-NIR allows for a wider range of evidence to be examined. With HSI-NIR there is the examination of information embedded within an image. Because the images are a series of snapshots collected as a function of wavelength, each pixel within the image has a fully resolved spectrum associated with it. It allows a wider range of evidence to be examined (ChemImage, 2011). Furthermore, HSI-NIR integrates conventional imaging and spectroscopy to obtain both spatial and spectral information (Eldeman et al, 2012).

Video Spectral Comparator

Another non- destructive method used in forensic document examination is the Video Spectral Comparator (VSC). Kriel (2011) noted that the VSC is used to examine documents for alterations, forgeries, and counterfeit items and it can create a variety of lighting conditions and in the process making it possible for document examiners to identify features necessary for accurate results. The VSC also uses an integrated spectrometer utilised for non-destructive ink analysis to determine if different writing instruments were used on various documents (Kriel, 2011). According to Songer (2014) VSC is used for the detection of alternations which include, but are not limited to: surface features, watermarks, alterations, use of different inks, embedded invisible information, latent images, ink stamps and tampering and photo-substitution. Furthermore, Chourasiya et al (2017) stated that the VSC machine can be utilised to check for inks and deterioration in documents, and as a comparator, it works by enhancing a document from different angles and in different light at the same time taking spectral measurements.

Advantages of Video Spectral Comparator

There are a number of advantages attached to using VSC. This method is a convenient and comprehensive method for the non-destructive analysis of inks and papers Foster and Freeman (nd). Another outstanding feature about VSC is that it can help detect differences between inks in terms of chemical formulation and it reveals writing that has been added using a different ink (National Forensic Science Technology Centre, 2013). Furthermore, the VSC method also reveals writing that has been altered or removed using the variations in the way different inks respond to different wavelengths of light (Khaikar et al, 2016). It visualises the security features printed into papers and allow quick examination of the questioned document. Foster and Freeman (nd) noted that non-destructive VSC examination makes it possible to establish the authenticity of an item, detect changes that have been made and to see beneath the surface of an artefact revealing its history.

Limitations of Video Spectral Comparator (VSC)

Chourasiya et al (2017) highlighted that the results obtained by using the VSC are only indicative and not definite because the machine only compares one set of data to another. Furthermore, when using the VSC for examination, comparison can only be done only when the specimen comparison is available (Kriel, 2011; Songer, 2014). This technique has been used only for differentiating purposes and not for identification purposes (Songer, 2014).

iN10 Fourier Transform Infrared Microscope (In FT-IR)

One other method used in forensic document examination is the Fourier Transform infrared (FT-IR) microscope. According to the Thermo-scientific (2013) the FT-IR microscope is well suited for study of the inks, toners, and papers of fraudulent documents because it combines standard visible light microscopy with non-destructive molecular spectroscopy analysis Thermo-scientific (2013) also noted that Nicolet iN10 microscope combines standard colour video inspection, polarized light, infrared transmission and reflection spectroscopy, and micro contact-mode sampling using attenuated total reflectance (ATR).

Advantages of iN10 Fourier Transform Infrared Microscope (In FT-IR)

In their study of the forensic analysis of paper currency using this FT-IR, the Thermo-scientific (2013) noted that the use of these various modes of chemical imaging inspection can lead to advances in paper currency researches. They stated that FT-IR allows for fast chemical imaging of both ink and the paper material producing clear information that is used to compare to original documents.

Impressions/ Indentations Examination

Forensic document examination also examines impressions or indentations made on a document by machines. Kriel (2011) highlighted that technical impressions are impressions placed on a piece of paper by a machine or simple tool such as typewriters, check writers, rubber stamps and seals. Kriel (2011) further pointed out that it is often possible to identify the impression left on a document as produced by one particular machine or tool and to determine whether two documents have a common source, typewriter make and model determinations and identification of photocopy machines.

Electrostatic Detection Apparatus

The field of forensic document examination uses Electrostatic Detection Apparatus (ESDA) to examine impressions or indentations. Kriel (2011) pointed out that the text of indentations may be deciphered, and it can be determined whether a certain document was written while in contact with a certain pad, notebook and paper among other things. ESDA works by creating an electrostatic image of the indented writing and charge sensitive toners are then used to visualise the image (Songer, 2014). This sensitive imaging process reacts to sites of microscopic damages to fibres at the surface of a document, which have been created by abrasive interactions with overlying surfaces during the act of handwriting. According to the National Forensic Science Technology Centre (NFSTC), 2013, the ESDA uses the principle that indented areas of the document carry less negative charge than surrounding areas. This causes the toner used in the EDD to be attracted to these areas, revealing indentations that are present. The NFSTC (2013) also highlighted that using this technique, indented impressions have been recovered from up to seven layers of paper beneath the original writings and that research has demonstrated that impressions can be successfully visualized from documents up to 60 years old, provided the papers are not mishandled or stored improperly.

Limitations of Using Electrostatic Detection Apparatus

According to the Indiana State Police Document (2016) the limitations of using Electrostatic Detection Apparatus are that;

i. Documents submitted for examination may have inherent limitations that can interfere with the procedures in this test method.
ii. Certain documents submitted for an indented impression examination may have inherent limitations due to their size, shape, thickness, or condition, which may render the documents less suitable for examination.
iii. The amount and the depth of the indented impressions depend upon several factors. These factors include, but are not limited to, the pressure exerted on the writing instrument or typewriter keys; the sharpness of the writing instrument; the writing surface; the thickness and type of paper; and the number of stacked sheets of material present under the original document.
iv. Not all indented impressions can be deciphered. The reasons for this may also be due to overlapping indented impressions, interfering folds and creases, as well as the interference of the original writing on the document.
v. Indented impressions may degrade due to environmental conditions, prior forensic testing, improper storage, and excessive handling (e.g., rubbing the documents surface and taking the document(s) in and out of the evidence container multiple times)

Disadvantages of Using the EDD Machine

The Indiana State Police Forensic Document Unit (2016) in their document of the test methods they highlighted that the disadvantage of using the EDD machine are that;

i. The EDD process may lift particles of pencil, carbon-film ribbon, and toner off the document being processed.
ii. The EDD may develop secondary impressions as well as primary impressions. Caution should be taken when attempting to determine whether indented impressions are primary or secondary.
iii. Extreme levels of humidity may limit or be detrimental to the indented impression examination.
iv. Repeated processing of a document using the EDD may result in the development of indented impressions that are degraded.
v. Documents have to be handled as little as possible prior to EDD examination to prevent contamination or alteration of the document(s) such as the addition of latent prints, biological materials, and additional indented impressions.

Destructive or Physicochemical Methods

Forensic document examination also uses destructive or physicochemical methods in examining documents. According to Goc and Miron (2014) the examination of the age of writing can be performed using graphical and physicochemical analyses methods. Goc and Miron (2014:1) highlighted that examining the age of a document is based on measuring the decay of a strong volatile solvent (2-phenoxyethanol) commonly occurring as a constituent of ballpoint inks (Physicochemical methods require specialized equipment (GC/MS). These methods are also used for analysing the composition of inks in document examination (Goc and Miron, 2014:1). Some destructive document examination methods include high pressure liquid chromatography which will be discussed in the subsequent section.

High Pressure Liquid Chromatography

Liquid Chromatography is used for the determination of chemical composition of individual dye components. Wanderson et al (2012) mentioned that this technique is one of the few destructive methods that are still being used by forensic examiners. Furthermore, United Nations Office on Drugs and Crime UNODC (2010) stressed that this method is used to separate, identify and quantify compounds based on their idiosyncratic polarities and interactions with the column's stationary phase.

GC-MS (Gas Chromatography –Mass Spectrocopy)

One technique used to separate compounds is the GC-MS which uses a stationary phase and a gas mobile phase (United Nations Office on Drugs and Crime(UNODC), 2010). Moreover, according to Calcerrada (2015) GC-MS has been applied to determine, quantify and study the drying process of solvents contained in the ink. UNODC (2010) also pointed out that GC requires sample preparation which can be done by extraction, thermal desorption or pyrolysis and the components of the sample are then separated in the column. Furthermore, the GC system is coupled with a detector in this case the MS, allowing reliable identification and quantification of components, and the equipment is used to examine photocopy toners and inkjet inks. (UNODC, 2010).

Limitations of Destructive or Physicochemical Methods

Goc and Miron (2014:2) noted that the disadvantage of destructive methods is that of its inability to indicate a precise time of writing as it can only determine whether the traces of ink on the questioned document are fresh, that is, deposited over 18 or more years from the date of the examination. Goc and Miron (2014:2) pointed out that, in practice, this dividing line is too fuzzy and in most cases extends over several months. Furthermore, destructive methods require removing small samples of the writing substrate from the questioned document, in the place where the ink was deposited and such action violates the integrity of the questioned document, this method is destructive in character (Goc and Miron, 2014:2). Furthermore, the received results generally are not of a conclusive nature (Goc and Miron, 2014:2)

Scientific Working Group for Forensic Document Examination(SWGDOC) (2013) also noted that the methods require sample preparation hence time consuming. Moreover, SWGDOC (2013) pointed out that this technique damages the document and present a high risk of contamination of the sample during the extraction stage and the original questioned document cannot be obtained for other confirmatory tests. Furthermore, Bugler et al (2005) highlighted that solvent extraction followed by analysis with GC-MS exhibits disadvantages because of its concomitant effects of dilution and contamination by the extraction step.

Graphical Methods

Forensic document examination also uses graphical methods which seek to determine the likely time of creation of the examined writing, most often signatures, on the basis of their graphical features, based on the assumption that the writing, in addition to its durable features, with a high level of stability, also includes certain features affected by modifications over the years (Goc and Miron, 2014:1).

Challenges of Graphical Methods

Graphical methods ignore other variables which may be critical to examining the document. This, according to Goc and Miron (2014:1), is because graphical methods require extensive research material prepared under different conditions that would allow the exclusion of other factors such as mental and physical condition of the writer, circumstances in which the examined writing was prepared, the type of writing tools, and the substrate inter alia, as a source of possible graphical fluctuation. Furthermore, often, the level of stability of graphic forms, particularly of signatures, is so significant that it does not give rise to inference of the time of creation, or vice versa, the studied writing is characterized by these options of graphical solutions which do not allow them to be linked to the time of creation of the writing being examined (Goc and Miron, 2014:1). Goc and Miron (2014:1) also stressed that the results of graphical analyses are generally highly hypothetical because it does not consider other factors dramatically affecting the appearance of the writing and the psycho motor performance of the writer such as trauma and illness.

Ways of Examining Document Authenticity

There are further methods used to determine the authenticity of documents by examining handwritings. These methods will be discussed in subsequent sections.

Forensic Handwriting Examination

Srihari and Leedham (2003:1) noted that much of forensic work involves the comparison of handwriting and handwritten signatures. According to Saini and Kapoor (2015:1) a number of techniques have been developed to identify the individual through their handwriting pattern, to detect whether the handwriting is forged and to determine the origin and history of documents. According to the European Network of Forensic Science Institutes (ENFSI)(2015:26) the purpose of such an examination is to determine whether or not there is evidence of that two or more pieces of handwriting have a common authorship. The ENFSI (2015:26) also stressed that the approach relies on a visual examination of the characteristics of the handwriting and an assessment of the similarities and differences found between pieces of handwriting. ENFSI (2015:26) highlighted that there are five main principles applied when examining handwritings and they are;

i. No two people write exactly alike
ii. No one person writes exactly the same way twice, and no two naturally written signatures are exactly the same (assuming that a signature machine has not been used)
iii. The significance of any feature, as evidence of identity or non-identity, and the problem of comparison becomes one of considering its rarity, complexity, the relative speed and naturalness with which it is written, and its agreement or disagreement with comparable features.
iv. No one is able to imitate all the features of another person's handwriting and simultaneously write at the same relative speed and skill as the writer that he/she is seeking to imitate; and
v. In those cases where the writer disguises their normal handwriting or imitates the handwriting of another person, it is not always possible to identify the author of the handwriting.

Psycho-motor Aspects of Handwriting.

A number of models have been established to study and analyse handwriting. Plamondon and Srihari (2000) postulated that these models are generally divided into two major classes: top-down and bottom-up models. Franke and Rose (2004) further highlighted that top-down models refer to approaches that focus on high-level information processing, from semantics to basic motor control problems. Franke and Rose (2004) posited that bottom-up models are concerned with the analysis and synthesis of low-level neuromuscular processes involved in the production of a single stroke, going upward to the generation of graphs, allographs and words inter alia. An ink-deposition model in the formation of signatures and can also be thought of a bottom-up model.

Computational Forensic Handwriting Examination Systems

Technological development, especially in the field of computer software, combined with possibilities offered by modern microscopy, optics, 3D technique and Raman spectroscopy, allow for significant progress in this field of document examination and make possible to give opinions on matters which have so far remained outside the sphere of procedural knowledge (Goc and Miron, 2014:4**).** A number of systems meant to assist in the examination of handwritings include: the FISH system, WANDA Architecture and CEDAR-FOX System, FLASH-ID (Srihari and Leedham, 2003).

Hecker (1993) posits that the Forensic Information System Handwriting (FISH) was developed by German law enforcement. This system enabled interactive work with the document examiner to enable the retrieval of the closest match from a large database of examples of handwriting (Srihari and Leedham, 2003:3).

WANDA is an open software and system architecture based on the following considerations: (i) allow integration of computer-based methods and facilities currently in use in forensic laboratories, (ii) allow future

updates with state-of the-art technology, and (iii) have an open plug-in concept to promote newer computer-aided examination and identification procedures to be developed by independent research groups and industrial entities (Srihari and Leedham, 2003:4).

CEDAR-FOX. This system contains several tools for interactive handwriting examination as well as methods for autonomous operation. In the autonomous mode it can perform several operations including writer verification, writer identification and signature matching (Srihari and Leedham, 2003:6). (Srihari and Leedham, 2003:6) The goal of identification is to identify the writer of a questioned document given a repository of writing exemplars of several known writers. The goal of verification is to provide a level of confidence as whether a questioned document and a known document are from the same writer. Central to both identification and verification is the need for associating a quantitative measure of similarity between two samples (Srihari and Leedham, 2003:6).

The Forensic Language Independent Analysis System for Handwriting Identification (FLASH-ID) contains proprietary software which automatically segments writing and assigns an isomorphism class and a shape class to each graph (Gantz and Walch, 2013). Gantz and Walch, 2013) indicated that the FLASH-ID method combines a method for segmenting writing into graphs with an isomorphic classification for graphs and a meaningful shape definition for graphs. This analysis system contains proprietary software which automatically segments writing and assigns an isomorphism class and a shape class to each graph (Gantz and Walch, 2013).

Forensic Handwriting Examination Challenges

Challenges faced in forensic handwriting examination entail the availability of scientific validation of the handwriting's individuality (Srihari and Leedham, 2003). Their observation was that forensic document examination employs many reasonable but scientifically unproven techniques and thus they concluded that the acceptability of expert opinion is strongly based on the credibility and standing of the document examiner rather than on the scientific evidence supporting their opinion. Saini and Kapoor (2015) lamented the fact that conventional methods of handwriting examination employ many reasonable but scientifically unproven techniques and these methods are not very effective in measuring the minor peculiarities of handwriting in terms of pressure and character recognition. Furthermore, Saini and Kapoor (2015) noted that visual examination (quantitative features) of handwriting features are subjected to human error because of non-availability of tools to measure these features efficiently and quantitative conventional features are also based on uncertainty for evaluating handwriting comparison.

According to Srihari et al (2002) computational approaches of the handwriting examination overcome these problems with a scientific basis and formalize human expert-based approaches. The computational theory also has the advantage of repeatability as the same results are obtained when applied to the same documents as opposed to expert human document examiners who are using conventional methods (Srihari et al, 2002). Saini and Kapoor (2015) posited that computational methods of document examination offer the promise of validating conventional methods but these computational methods are still at an initial stage. The limitation of the computational theory is that any of the conventional features, for example, line quality, rhythm are too subjective to be validated through algorithms. Therefore, computer assisted document examination needs to be more strengthened for complete validation of handwriting examination and general acceptance by forensic document examination community (Saini and Kapoor, 2015).

General Challenges Faced in Forensic Document Examination

Forensic document examination generally faces a plethora of limitations which are presented in this section. The US National Forensic Science Technology Centre (nd: 11-12) highlighted that the examination of questioned documents may be hampered or limited by the following factors:

i. **Non-original evidence** (such as photocopies or faxes) - submitted for examination. Every time a document is subjected to a copying process, a small amount of information is lost. Original documents may bear defects, flaws or characteristics that are not reproduced in a copy. Multigenerational copies which are copies of copies, may be of insufficient quality for examination and comparison. It may even result in the examiner being unable to render a conclusion.
ii. **Insufficient quantity of questioned material**. If there is not enough material for an adequate examination, the examiner will most likely be unable to render a definitive conclusion.
iii. **Insufficient quality**. If the quality of either the questioned document or the known samples is not sufficient for proper examination, the examiner will likely be unable to render a definitive conclusion. Examples include documents that have been burned to ashes or cross-cut shredded, documents that are multi-generation copies or faxes, or documents containing writing that is too distorted or disguised (as discussed below).
iv. **Insufficient known specimens submitted for comparison**. This refers to situations where there is not enough known writing, or the samples are inadequate, poor-quality or machine-printed and not suitable

for comparison.

v. **Lack of comparability between the questioned documents and the known samples.** The examiner must be able to compare "apples to apples" as the saying goes. For instance, the specimen material must be of the same type of writing as the questioned material; uppercase entries can only be compared to uppercase, and cursive writing can only be compared to cursive writing. An examiner cannot determine the counterfeiting process by looking at only a photocopy of the suspected counterfeit. Likewise, the examiner cannot determine if an identification card is fraudulent unless a known standard is also submitted for comparison.

vi. **Lack of contemporaneous writings submitted for comparison.** It is important to obtain known writing that is prepared around the same time frame as the questioned writing.

vii. **Distortion or disguised writing**. The writing on the questioned document or the known sample may be too distorted or disguised. For example, graffiti on a wall may be considered distorted and cannot be compared to a suspect's normal handwriting.

Conclusion

This study concluded that forensic document examination had advanced as it had a number of methods which could be used to determine the authenticity of documents. However, forensic document examination still needed to develop further as some methods being used were destructive and could lead to information loss or the deterioration of documents. More non-destructive techniques are to be advanced and improved.

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