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To comparative Evaluation of currency notes of security Features India, Nepal, Malaysia, Singapore, America, United Arab Emirates

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Abstract:

Currency notes play an important role in the economic activities of any nation. These are essential components used in daily transactions by the citizens in the purchasing of goods, payment of bills, business deals, and even banking procedures. Each nation produces its currency notes, which have unique color combinations and distinct designs. The counterfeit currency, also known as the fake currency, is one of the major problems faced by economies. This can be harmful to the national economy in many ways; therefore, there is an ongoing improvement in the design and development of currency notes to avoid such issues. The study was done using observational and comparative approaches. Real money notes of the six selected countries were obtained through legitimate means such as banks, currency exchange offices, and learning institutions. Notes of different denominations were selected wherever possible since the security features vary depending on the denomination of the notes. The selected money notes were observed by use of natural light, microscope, UV light, and touch. It was found that all countries utilize more than one form of security feature within the notes of their currencies in order to safeguard themselves from counterfeiting and keep faith in the financial system among the citizens. Security features commonly used within currency notes during the course of research were watermark, security thread, micro printing, serial number, ultraviolet fluorescent properties, raised printing, latent image, and color shifting ink. Further, it is noted that the currency note is not only a monetary instrument but also represents an important cultural/national symbol. The Indian notes bear national historical places and a picture of Mahatma Gandhi while Nepalese notes have the image of Mount Everest and national symbols. The Malaysian and Singaporean notes represent their respective national identity. The US currency has portraits of its national heroes, including Benjamin Franklin. forensic science perspective, the comparative evaluation of international currency notes provides valuable knowledge for questioned document examination. Understanding the differences in printing methods, security threads, holograms, polymer substrates, and fluorescent patterns helps forensic experts detect counterfeit currency more accurately.

Introduction:

Currency notes are a part of a country's economy. People use them every day to buy things pay for services save money and do business. Currency notes also show the history, culture and identity of a nation. Every country makes sure their currency notes are hard to copy. That is why modern currency notes have advanced security features. Counterfeit currency is a problem all over the world. Fake notes can hurt the economy cause losses and make people not trust the banking system. They can even help bad people do things like terrorism and smuggling. To stop counterfeiting governments and central banks keep making their banknotes more secure. These security features help people, bankers and police tell notes from fake ones. Different countries use technologies to make their currency notes. Some security features can be seen with the eye while others need special light or instruments to see. This comparative evaluation analyzes the security architectures of banknotes from six distinct economies:

1) India (Reserve Bank of India)
2) Nepal (Nepal Rastra Bank)
3) Malaysia (Bank Negara Malaysia)
4)Singapore (Monetary Authority of Singapore)
5)The United States of America (Federal Reserve System)
6)The United Arab Emirates (Central Bank of the UAE)

Each of these nations faces unique socioeconomic realities, geographical counterfeiting threats, and climatic conditions. Consequently, their chosen security strategies vary. This ranges from the United States' cautious, tradition-bound reliance on unique cotton-crane paper and advanced 3D threads, to Singapore and Malaysia's extensive embrace of polymer substrates, to the United Arab Emirates' integration of advanced SPARK Flow dimensional inks. Common security features include watermarks, security threads and special images that can only be seen in light. India, Nepal, Malaysia, Singapore the United States of America and the United Arab Emirates are countries with economies and currency systems. Their banknotes show their identity and how good they are at keeping their currency secure. The currency of India is the Rupees. Indian banknotes have security features like the Mahatma Gandhi watermark and security thread, ink that changes color. India has made its currency more secure with the Mahatma Gandhi New Series notes. Nepal uses the Rupee and has security features like watermarks and fluorescent images. Malaysia uses the Malaysian Ringgit. Has advanced security features like polymer substrates and holographic strips. Singapore's currency is known for its security technologies and high-quality material. Singapore uses features like transparent windows and holograms to keep its currency secure. The United States Dollar is one of the widely used currencies in the world so it is a big target for counterfeiters. American banknotes have security features like color-shifting ink and 3D security ribbons. The United Arab Emirates uses the UAE Dirham. Has advanced security features like holographic foil strips and color-changing ink. Comparing the security features of currencies is important for forensic science and banking security. Experts examine banknotes to see if they are real or fake by looking at the paper quality printing methods and security features. Knowing about these features helps investigators catch counterfeiters and prevent crimes. One of the common security features is the watermark. A watermark is an image in the paper that can only be seen when held against light. Watermarks are hard to copy so they are a way to keep currency secure. Watermarks are also included in the currency notes of several nations, such as India, Nepal, Malaysia, the United States, and the United Arab Emirates. Security threads are also among the important security measures included in the notes. A security thread is the strip embedded in the banknote that includes any message or effect. The security thread cannot be identified unless the note is viewed under light. Another important characteristic is the use of microprinting in banknotes. It means the use of letters or digits printed on the currency but can be read by using magnifying equipment. Another important feature is the color-changing ink that changes colors with the movement of the note. This characteristic is used in the Indian, US, Malaysian, Singaporean, and UAE currencies. Other modern banknotes include fluorescent features that can only be detected in specific lighting conditions. The currency. By using these security features countries can keep their currency secure and prevent counterfeiting. Currency notes, like the Rupee, Nepalese Rupee, Malaysian Ringgit, Singapore Dollar United States Dollar and UAE Dirham all have their own unique security features to prevent counterfeiting. Ink colors are really cool because they glow in colors. These special marks that you cannot see help people who work in laboratories and banks figure out if a note is real or not. They use

things like fibers, serial numbers and patterns to make sure the money is real. Some countries are using plastic money that is stronger and safer than the old paper money. This plastic money has see-through parts and complicated pictures that are hard to copy. Singapore and the UAE are using this kind of money for many of their notes and Malaysia is using it for some of their notes too. There are also features on the money that help people who cannot see. These features are like bumps and special textures that help blind people know what the money is. It is also harder for bad people to make money because they need special machines to make these bumps and textures. Some money has cool pictures that look different when you turn the money around. These pictures are like magic. These designs assist in ensuring the safety of money. Singapore, Malaysia, and the UAE incorporate these images in their currencies. Every single currency also features a serial number for traceability purposes to prevent criminals from reproducing fake money. The serial number acts as a form of code used for the purposes of money security. In analyzing money from different nations, one realizes that each nation employs different mechanisms of securing its currency. While some nations employ complex technologies such as polymer currency and security features, others opt for traditional mechanisms of money protection. The Indian money is made up of a unique paper material and security features. Nepal money is very similar to India money since Nepal enjoys a good relationship with India and engages in trade. Malaysia and Singapore money are complex with polymer currency and security features. America has safe currency due to its wide application throughout the globe. Currency of the UAE features Arab-style designs with advanced technology to increase safety of the money. During the counterfeiting process, there are very vital steps to be taken by the experts in detecting if the bills are genuine or not. The experts use equipment such as microscopes and ultraviolet lights to examine the genuineness of the bill. There are certain aspects of the bill which experts consider in determining whether or not the bill is genuine such as the pattern, the material of the paper and the threads and numbers on the currency bill. The counterfeit currency detection is vital for the law enforcement authorities and the individuals like you and me. It is necessary for individuals such as yourself to know that there are ways through which one may know if the bill is genuine or not through checking if there is watermark in the bill, feeling the raised printings and examining the color-changing property when you tilt the bill. This is what the central bank advises. The problem is that due to modern technology in printing it is easy to create notes nowadays. So central banks have to keep making their notes better with security features. Countries also work together to stop notes from being used. They share information about how to detect notes and how to stop them from being made. This helps to keep our money safe. The design of currency notes is also a way for countries to show their pride and culture. For example, Indian notes have a picture of Mahatm Gandhi and important historical sites. Nepalese notes have a picture of Mount Everest. Malaysian notes have pictures of their family and cultural symbols. Singapore notes show how different cultures live together in harmony. American notes have pictures of leaders like Benjamin Franklin. UAE notes have writing and pictures of important buildings. All countries want to keep their money safe from notes. They want to make sure that people can trust their money. So, they have to make security features what're easy for people to recognize but hard for bad people to copy. This is a challenge. Studying how different countries keep their money safe can help us learn more about how to stop notes. It can also help us understand how important it is to have security features in our money. By looking at currencies we can find ways to make our money safer. In the end currency notes are not pieces of paper. They are documents that are made to be safe and secure. Countries like India, Nepal, Malaysia, Singapore, America and the United Arab Emirates all use ways to keep their money safe. By studying these ways, we can learn more about how to keep our money safe. Currency is the foundation of the world economy. It is what we use to buy things. It is a symbol of a country's independence. If people do not trust their money the whole economy can be, in trouble. Central banks are always trying to stay one step of bad people who try to make fake notes. They use technology to make our money safer and to stop fake notes from being used.

Objective:

Studying the security features of currency notes is really important for our economy and society. Since we still use money to buy things we need to know how to keep it safe from people who want to make fake money. The main goals of studying currency note security features include:

1. Stopping People from Making Money and Protecting Our Money

To tackle the issue of counterfeit money, we need to understand how to prevent people from creating fake currency. When fake money is made, it can lead to economic problems and erode trust in our financial

system. By examining the security features of real money, such as the color-shifting ink and holograms that are visible when you tilt the note, we can stay ahead of those trying to create counterfeit money. These security features, like the ones found in currency notes, play a crucial role in detecting fake money and keeping our financial system secure. For instance, the unique colors and holograms make it difficult for counterfeiters to replicate the exact same features, allowing us to identify genuine money. By utilizing these features, we can protect our economy and maintain trust in our currency.

2. Making it Easy for People to Check if a Note is Real

Another goal is to make it easy for anyone to check if a note is real or not. We can do this by using the "Feel, Look Tilt" method:

Feel: We can feel the texture of the paper or plastic that real money is made of. Currency note security features include raised textures that we can feel.

When we want to make sure a note is real, we can do a simple check. Hold the note up to the light and look for the watermarks and other special features that are built into it. These security features, like watermarks, are there to help us verify that the note is authentic.

Checking Money: If you want to make sure your money is real, you can do a simple trick. Just tilt the note and look at it from different angles. You'll see the colors change or special threads inside the paper. This is a great way for anyone to check their money and make sure it's genuine. By taking a closer look at these security features, we can all be sure that our cash is authentic.

3. Making Machines that Can Check Money Faster

In places where a lot of money is handled, like stores and banks we need machines that can check the money quickly. So, another goal is to develop features that machines can detect, like:

Special Lights: Some money has ink that glows under certain lights. These currencies note security features help machines detect money.

Magnetic Ink: Some money has ink that machines can detect with magnets. By studying this currency note security features we can make machines that can check money faster and more accurately.

4. Making Money that Lasts Longer

The kind of material used to make money is really important. We should look at how different materials can withstand being used a lot, like when you fold them or they get hot. The security features of currency notes also depend on the material they're made of. If we study these features, we can create money that lasts longer and is cheaper to produce. This way, we can make money that is more durable and saves us money in the long run. By doing this, we can also prevent money from getting damaged easily, which can help prevent counterfeit money from being made.

5. Making Money that Everyone Can Use

We need to make sure our money is usable by everyone, including those who are blind or have trouble seeing. To do this, we can add features like raised lines and Braille codes to our currency. By looking at the security features of currency notes and how to make them accessible, we can ensure that everyone can use our money and be independent. This way, our money will be accessible to everyone, regardless of their abilities. We can learn from the security features of currency notes and use this knowledge to make our money more accessible. This is important because it will allow everyone to use our money, even those who have trouble seeing.

1. The Battle of the Bases: Paper vs. Polymer

The basic thing a country decides is what to print the money on. This divides the world into two groups

with some countries using a mix of both.The countries that use Polymer, like Singapore, UAE and Malaysia use a kind of plastic. This plastic is completely waterproof does not get dirty and is very hard to tear. For countries with humid weather like Singapore and Malaysia or countries with a lot of dust and heat like the UAE polymer keeps the money clean and nice for a long time. The countries that use Paper, like India and Nepal use a kind of paper made from cotton. This paper is not as good with water and dirt. It looks and feels like traditional money, which people trust. The United States uses a mix of 75% cotton and 25% linen to make its money. This mix has red and blue threads that make the money hard to copy and give it a special feel.

2. Advanced Optical Illusions

To stop people from copying money using scanners modern money has special features that change when you tilt it. The US $100 bill has a blue ribbon with tiny lenses that make the images on the bill move when you tilt it. The UAE uses ink that changes when you tilt the money making a bright bar appear to move across a color-shifting picture. Some countries, like Singapore, Malaysia and the UAE use patches that show national symbols and number when you tilt the money.

3. Light-Dependent Security

When you hold money up to light you can see special details that are hidden inside the paper. Some countries, like India and Nepal use watermarks with pictures of people or symbols. These watermarks are not printed on the surface. Are made by varying the thickness of the paper. Some countries, like India, Nepal, Malaysia and Singapore use a trick where a shape is split in half and printed on both sides of the money. When you hold the money up to light the two halves fit together perfectly.

4. Accessibility and Inclusivity

Different countries design their money in ways to help blind and visually impaired people. Some countries, like the UAE, India, Singapore and Malaysia use raised bars and Braille codes on their money to help people recognize the denomination by touch. Most countries make their money in sizes based on the value but the United States is one of the few countries where all the money is the same size. The US uses numerals on the back of the bills to help people, with low vision.

1. Cotton-Rag Paper (The Classic Foundation)

Most of the worlds paper banknotes such as the Rupee, Nepalese Rupee and Euro are made from 100% cotton rags or cotton linter. These are the fibers left over from processing cotton. The reason for using cotton rags is that they give the money a texture. Cotton fibers fit together tightly unlike wood fibers. It the money gives a fresh you snap it; it makes a sharp noise. There's something satisfying feel. When about the sound it it's so distinct. People know this feel instinctively. Some other reasons for using cotton rags are:

Cotton paper absorbs ink well.

It is good for a type of printing called intaglio printing. In this printing ink is pressed deep into the paper. When you run your thumb over the surface, you can actually feel a raised texture, it's pretty noticeable. Cotton paper does not react with light. Some papers glow under ultraviolet (UV) light. Pure cotton paper stays dark. This helps inks and security threads glow.

2. The Cotton-Linen Blend (The US Dollar Strategy)

The United States uses a type of paper for its dollars. This fabric is made up of a combination of materials, with 75% of it being cotton and the remaining 25% being linen. The reason for using this mix is: It is very strong. Linen fibers are tough. Do not break easily. This helps keep the dollar safe from getting torn or damaged. It can have security features These features are put into the paper when it is made. The pretty cool security feature - US $100 bill has an its ribbon woven right into it got a blue. Some other features of this paper are: It has red and blue fibers. These fibers are mixed into the paper

when it is made. If you take a really close look at a dollar bill, there are some tiny details that are easy to miss.

3. Polymer Substrate (The High-Tech Plastic)

Some countries, like Australia, Singapore and Malaysia use a type of plastic for their money. It is called Biaxially Oriented Polypropylene (BOPP). The reason for using this plastic is: It is waterproof and dirt-resistant. It does not get wet or dirty easily. This makes it last longer than paper money. Some other features of this plastic are: It has windows. Those parts in the center are the transparent of the bill that allow through them. you to see right Making fake versions of these windows is a tough task for counterfeiters. It can have holograms. These are images that change color and shape when you tilt the bill. It can be recycled.

When the plastic money gets old it can be. Made into new things, like bins or benches.

Literature Review

Currency notes are very important for buying and selling things and show who a country is. Because more and more people are making money banks all over the world keep improving the safety features on notes. These safety features include things you can see things you can't see and special details like Watermarks, Security threads, tiny writing, Special printing, Inks that change color, Holograms, Hidden images, features that machines can read. The goal of these features is to make sure notes are real stop people from making fake money and keep people trusting the money system. A study by Mann, Shukla and Gupta in 2015 compared the safety features of currencies. They found that modern notes have layers of protection against fake money. They also saw that features like watermarks, security threads, tiny letters marks showing the value and detailed pictures are common in currencies. The study, by Mann, Shukla and Gupta showed currency notes have safety features. The people who wrote the study found out that Indian money has a lot of security features. This includes technology that makes it hard to make fake copies of Indian money. When we look at money, we see that the Reserve Bank of India has made the money safer over time. They have added features like secret images that you can only see when you tilt the money, special ink that changes color, tiny writing and special printing that you can feel. They have also added fibers that glow and security elements that machines can read. After they started using the Mahatma Gandhi New Series, they made Indian money even safer. They did this to make it easier for people to check if the money is real and to stop money from being used. The people who study money say that it is designed so that anyone can check if it is real and also so that experts can examine it closely. When we look at the money, from Nepal we see that the Nepal Rastra Bank uses different methods to stop people from making fake money. Nepalese currency has things like watermarks and special threads to stop people from making money. It also has text and pictures that you can only see under special light. Even though the money in Nepal is similar to the money in India it does not have many advanced security features... These features do help make sure that the real money is used in the country. Malaysian money is known for having good security features. The Malaysian Ringgit has things like watermarks and threads that shine under light. It also has colors that change when you look at it from angles and special printing that you can feel. All these things help people and machines check if the money is real. Researchers think that using technology like special lights makes the Malaysian money safer from people who try to make fake money. Singapore’s money system is one of the best in the world when it comes to technology. Singapore banknotes are made of plastic and have see-through parts and holograms. They also have letters and special marks that you can feel. Using this plastic has made the Singapore money stronger and safer. It is also much harder to make money now. The see-through part and the special security devices are some of the things that make the Singapore money very safe from counterfeiters. The Singapore money is very good, at stopping people from making money. The United States dollar is a

currency and needs strong security measures. The US dollar has security features. These include: Watermarks, Security threads, Color-shifting ink, Microprinting, 3D security ribbons, Special optical features. Adding ribbons and motion effects to higher denomination US dollar notes makes it hard to create notes. These features help make sure the US dollar is real for people and machines. The US dollars security features make it hard to fake. Some countries, like the United Arab Emirates use polymer banknotes with security technologies. The UAEs banknotes have: Windows, Holographic strips, Microprinting, Color-shifting elements, Tactile symbols, features that machines can read Using polymer substrates makes banknotes last longer and harder to fake. Polymer banknotes have security devices inside them. Many countries use security features like: Watermarks, Security threads. There are big differences, in how complex and advanced their banknotes are. Some countries like Singapore and the UAE use polymer technology and advanced optical security features. India and the United States use a mix of security mechanisms to keep their currency safe. Nepal relies more on security measures. Malaysia uses a mix of hidden security elements. The United Arab Emirates and other countries are moving towards advanced banknote technologies.

The United States and other countries are also improving their banknote security.

Methodology: -

In this comparative evaluation of security features of currency notes of India, Nepal, Malaysia, Singapore, America, and the United Arab Emirates, a systematic and scientific method was followed to study, compare, and analyze the different anti-counterfeit features present in the banknotes of these countries. The methodology included collection of currency samples, visual examination, physical examination, ultraviolet light analysis, magnification study, comparative analysis, documentation, and interpretation of findings. The purpose of the methodology was to identify the visible and hidden security features of the selected currency notes and compare their effectiveness in preventing counterfeiting

1) Research design: -

The present study was designed as a comparative observational study. The main objective was to compare the security features of currency notes from six different countries:

- India
- Nepal
- Malaysia
- Singapore
- America (United States Dollar)
- United Arab Emirates

The research focused on identifying both visible and invisible security features used in modern banknotes. The study also aimed to understand the technological differences between paper-based and polymer-based currencies.

2) Selection of Currency Samples: -

The first step in the methodology was the collection and selection of currency notes. Genuine currency notes from the six selected countries were collected for examination.

- Indian Rupee
- Nepalese Rupee
- Malaysian Ringgit

- Singapore Dollar
- United States Dollar
- UAE Dirham

3) Materials and Instruments Used: -

Several basic and advanced instruments were used during the examination of the currency notes. These instruments helped in observing visible, hidden, and microscopic security features

Instrument used

a) magnificent lens: -

A magnificent lens was used to examine

Microprinting, Fine- line pattern, small symbol, Printing quality

b) Ultraviolet (UV) Lamp: -

An ultraviolet lamp was one of the most important instruments (254nm short UV,365nm long UV)

Fluorescent fibers, Glowing serial numbers, Invisible markings, Hidden patterns, Security threads

c) White Light Source: -

A strong white light source (Sunlight)was used to examine:

Watermarks, Security threads, Transparent windows

d) Measuring Scale: -

Size of notes, Alignment of printing, Width of security strips

e) Digital Camera / Mobile Camera: -

Photographs of notes were taken for documentation and comparison purposes. Images under normal light and UV light were recorded whenever possible

4) Physical Examination of Currency Notes: -

The notes were touched gently to feel the texture and raised printing. Intaglio printing creates a slightly rough surface, especially on portraits, denomination numerals, and national symbols.

Size and dimensions, Color combination, Texture of note, Printing quality, Thickness of paper/polymer, Raised printing, Serial numbers, General condition

5) pencil rubbing or trace: -

When you place a currency note under a piece of white paper and then rub it over it with a pencil, the embossed design and handwriting of the note is imprinted on the paper

i. Raised Details: The Ashoka Pillar, Mahatma Gandhi's portrait, denomination (₹100, ₹200, ₹500), and security thread, upper side Devnagari word भारतीय ररज़र्व बैंक (RESERVE BANK OF INDIA) lines are slightly raised on currency notes.

The United States of America Security thread, Alexander Hamilton portrait (10 Doller)

ii. 2. Pencil Effect: When you tilt the tip of the pencil and rub it over the paper, the pencil touches only that part of the paper which is in contact with the raised parts of the note.

iii. 3.Result: The depressions of the note are left blank, and the raised areas are blackened. This creates a 3D

print of the exact shape and texture of the note. It comes out on paper

Observation: -

The comparative evaluation of currency notes of India, Nepal, Malaysia, Singapore, America and United Arab Emirates was made and many important observations were made in terms of the security features, printing quality and anti-counterfeit technologies. It was found that all the countries had a number of security features in their currency notes to prevent forgery and also to keep up the confidence of the public in the monetary system. Almost all the currency notes had common security features like watermarks, security threads, serial numbers, bleed line, micro printing, micro text, ultraviolet fluorescent features and raised printing.

Observation of Indian Currency Notes (500,200Rs):

Indian currency notes issued by the Reserve Bank of India were found to contain multiple security features that help in identifying genuine notes. The Indian Rupee notes mainly use 75% cotton and 25% linen, which gives the note a special texture and durability. When touched, the note feels slightly rough because of intaglio printing used for important areas such as the portrait and denomination numeral. The most noticeable feature in Indian notes was the watermark of Mahatma Gandhi. When the note was held against light, the watermark became clearly visible. Along with the portrait watermark, an electrotype denomination watermark was also observed. This feature helps common people identify genuine notes easily. Another important observation was the security thread embedded inside the paper. In higher denomination notes, the thread was partially visible on the surface and appeared as a continuous line when viewed against light. The thread contained inscriptions such as “भारत”, “RBI”, and the denomination value. Under ultraviolet light, the thread showed fluorescent properties green color. Micro-lettering was observed near the portrait area. Very small text such as “RBI”India (भारत) and the denomination numeral could only be read using a magnifying lens. The color-changing ink feature was also clearly visible in Indian ₹100, ₹200 and ₹500 notes. The denomination numeral changed from green to blue when the note was tilted at different 45degree angle. This optically variable ink is one of the advanced security features used in modern Indian currency. Raised printing was observed on the portrait, Ashoka Pillar emblem, signature of the Governor of the Reserve Bank of India (RBI). and identification marks for visually impaired persons. By touching the note, these raised areas could be felt easily. Different geometric shapes were used on various denominations to help blind individuals identify notes. Under ultraviolet light, fluorescent fibers and serial numbers glowed brightly. Hidden patterns and invisible security elements became visible under UV examination. This observation proved the importance of forensic instruments in currency examination. "All Indian banknotes feature two languages on the front Hindi and English and a panel of fifteen languages on the back Assamese, Bengali, Gujarati, Kannada, Kashmiri, Konkani, Malayalam, Marathi, Nepali, Odia, Punjabi, Sanskrit, Tamil, Telugu, and Urdu. Indian banknotes actually feature 17 languages in total across the entire note.

Figure 1: Security features on the Front side of the ₹500

1) Bleed lines both sides left and right
2) Micro text RBI 500
3) See-through register in denominational of ₹500 in numeral.
4) Latent Image of Denomination ₹ 500.
5) Devanagari number ₹५००
6) Anti-Coping Feature8.
7) Micro lettering RBI
8) Micro letters भारत and India
9) Security thread भारत and RBI colour of the thread changes from green to blue
10) Government signature
11) RBI logo
12) Mahatma Gandhi's watermarks
13) Electrotype 500 watermarks
14) The small circle with ₹500 printed inside
15) Ashoka pillar emblem
16) ₹500
17) RBI Increasing order numeral Series

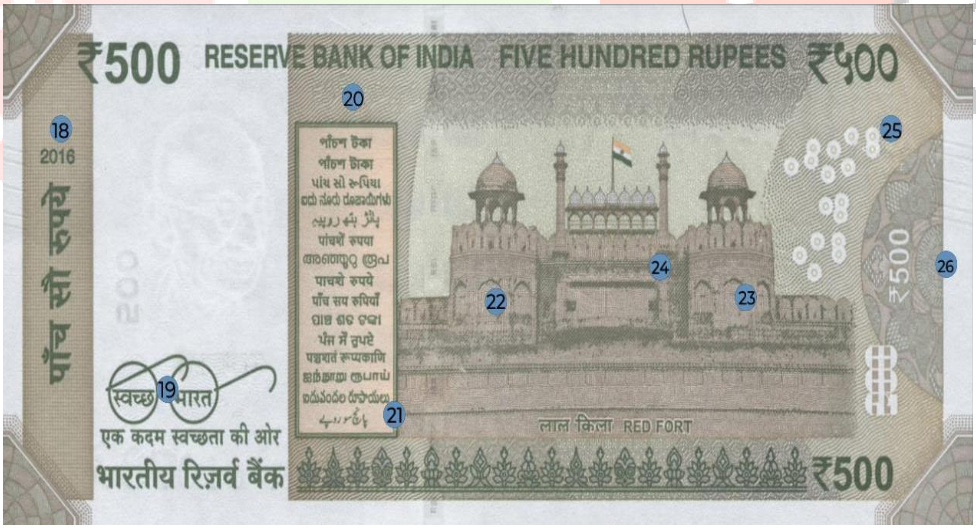

Figure 2: Security features on the back side of the ₹500

18) Year printing 2016
19) Swachh Bharat logo with slogan
20) Micro text 500
21) Language panel (15 language)
22) Micro lettering INDIA BHARAT
23) Micro lettering INDIA BHARAT

24) Micro lettering INDIA BHARAT

25) Anti-Coping 18

26) ₹500 and micro lettering RBI 500

Figure 1: Security features on the Front side of the ₹200

1) Bleed lines both side left and right

2) Micro lettering RBI 200

3) Micro lettering RBI 200 India

4) Devanagari number ₹२००

5) Latent Image of denomination ₹200

6) See-through register in denomination of ₹200 in number

7) ₹200

8) Anti-Coping

9) Micro lettering RBI

10) Micro letters भारत and India

11) Security thread भारत and RBI colour of the thread change from green to blue

12) RBI logo

13) Government signature

14) Mahatma Gandhi's watermarks

15) Electrotype 500 watermarks

16) Micro lettering RBI 200

17) Ashoka pillar emblem

18) Micro lettering INDIA 200

Figure 2: Security features on the back side of the ₹200

18) Year printing 2026 (INDIA) Watermarks

19) Swachh Bharat logo with slogan

20) Micro Number 200

21) Language panel (15 language)

22) Micro lettering INDIA 200 RBI

23) Micro lettering INDIA 200 RBI

24) Anti-Coping

25) Micro lettering RBI 200

Observation of Nepalese Currency Notes (₹50):

Nepalese currency notes issued by the Nepal Rastra Bank showed similarities with Indian currency in many aspects. Nepalese notes are also paper-based and contain traditional as well as modern security features. One of the most prominent observations was the watermark. The watermark became visible when the note was held against light. Nepalese notes commonly include the portrait of national symbols and images related to Mount Everest. The watermark quality was clear and difficult to reproduce. The security thread with 'NRB 'embedded in Nepalese notes was also observed clearly. Microprinting was present in selected areas of the note. Small letters and numbers could only be read using magnification. This feature increases note security because counterfeiters cannot easily duplicate such fine details. The texture of Nepalese notes felt softer due to paper composition. Under ultraviolet light examination, fluorescent fibers and serial numbers glowed in different colors. Some hidden markings also became visible. This indicated the use of invisible fluorescent ink technology. One important observation was that Nepalese currency notes use fewer advanced optical features such as holograms and transparent windows. However, the combination of watermark, security thread, fluorescent features, and fine printing still provides effective protection against counterfeiting. “On the current Nepalese banknote series, two languages are primarily utilized."

Figure 1: Security features on the Front side of the ₹50

1) Denomination numeral "50" in the upper left corner
2) Image of Mount Everest
3) Latent image, see-through register near the denomination text
4) Intricate guilloche and line patterns and security thread NRB
5) Year of issue and fine-line security printing at the bottom center
6) Governor's signature
7) Micro lettering NEPAL RASTRA BANK
8) Watermarks Nepal national flower (Rhododendron)
9) Circular emblem containing the Nepali zodiac design
10) Denomination numeral "50" in the upper right corner

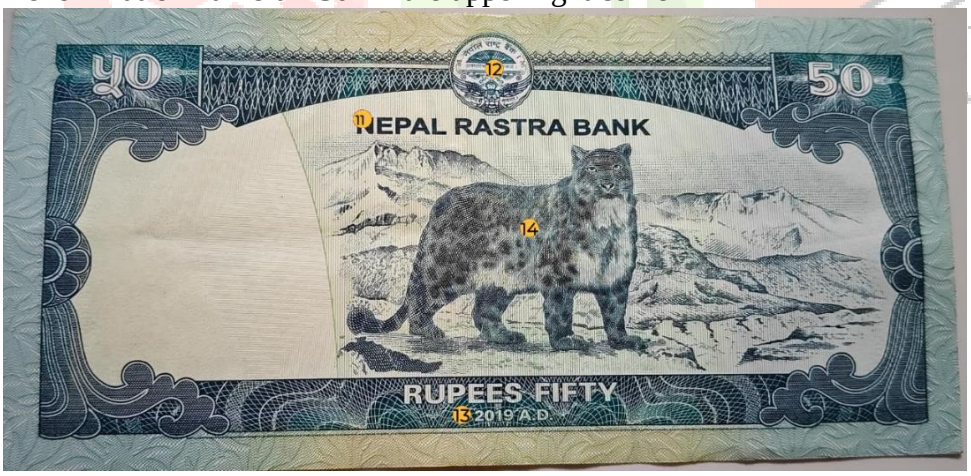

Figure 2: Security features on the back side of the ₹50

11) "NEPAL RASTRA BANK" inscription
12) National emblem of Nepal at the top center
13) Year of issue (2019 A.D.) and fine-line security printing
14) Snow Leopard image principal reverse design

Observation of Singapore Currency Notes (10 dollars):

Singapore currency notes issued by the Monetary Authority of Singapore were among the most technologically advanced notes observed during the study. Singapore notes displayed a combination of sophisticated security features and excellent material quality. Most Singapore notes are made from polymer material. The polymer substrate made the notes highly durable, flexible, and resistant to dirt and moisture. The notes felt smooth but strong when handled. The transparent window was one of the most noticeable features. It contained detailed patterns, symbols, and optical effects that were difficult to duplicate gold patch (Kine gram) A metallic holographic patch in the shape of the Singapore lion symbol. Main Portrait and lettering, features a portrait of Yusof bin Ishak, along with official lettering and the denomination number. UV Fluorescent Elements: Specific elements glow under UV (ultraviolet) light, which are completely invisible to the naked eye. Small text, such as the Singapore national anthem on some editions. Signature of chairman Monetary Authority of Singapore.

The five Most five popular sports:

1) land sports: - Jogging, Tennis, and Soccer

2) Water Sports: - swimming, Sailing

Geometric Symbol: A geometric symbol is located directly below the word "SPORTS". Under ultraviolet light examination, hidden fluorescent patterns became visible. Different colors appeared on serial numbers, security threads, and decorative elements. Microprinting was observed in many parts of the note

Figure 1: Security features on the Front side of the 10$

1) Singapore Coat of Arms watermark visible through transmitted light

2) Watermarks Encik Yusof bin Ishak

3) Serial Number Horizontal

4) Gold patch (Kinegram) A metallic holograms patch in the shap of the Singapore Lion symbol

5) Country name and micro-printing

6) Large denomination numeral "10" with intaglio printing

7) Monetary Authority of Singapore security mark

8) Lettering SINGAPORE

9) Portrait of President Yusof bin Ishak

10) Transparent polymer window with micro-text

11) Braille pattern

12) Asymmetrical serials number

13) Transparent window with latent image and micro-printing (10)

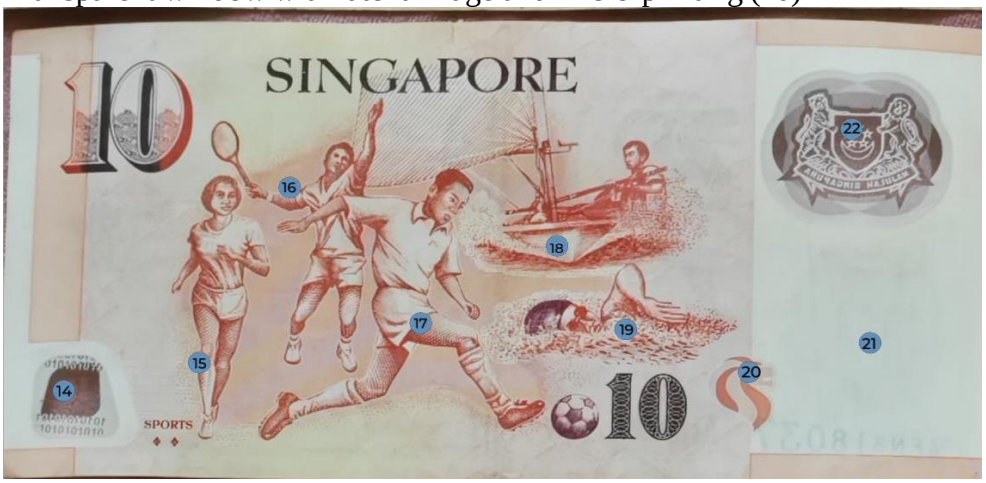

Figure 2: Security features on the back side of the 10$

14) Transparent window with latent image and micro-printing (10)

15) Athletics (running) sports illustration

16) Badminton player illustration

17) Football (soccer) player illustration

18) Sailing sport illustration

19) Swimming sport illustration

20) Singapore Sports Council sports theme logo

21) Watermark shadow image area on polymer substrate

22) Singapore Coat of Arms watermark visible through transmitted light

Observation of Malaysian Currency Notes (5RM):

Malaysian money notes, issued by the Bank Negara Malaysia have some advanced security features. The Malaysian Ringgit notes look great with good printing quality, bright colors and complex security systems. One of the notable things is that some notes are made from a special polymer material. These polymer notes feel smoother stronger and more durable than paper notes. They can withstand water, folding and tearing. The transparent part of the note changes appearance when you look at it from angles. The color-shifting ink is another feature. The denomination number changes color when you tilt the note under light. This optical effect is easy to see. Helps people quickly verify the note. Malaysian notes also have strips and metallic patches. These holograms show images and colors when you view them at different angles. The symbol RM and the words `RM5' are visible under magnification. When you look closely you can see small letters and patterns. The watermark is clear and sharp when you view it against light. The security thread is embedded inside the note. Has readable text. Under light the thread and serial numbers glow brightly. The Malaysian Ringgit notes have security features, such, as the RM symbol, that make them secure.

Figure 1: Security features on the Front side of the 5 BNM

1) Registration mark small raised marks that can be felt by touch.

2) Transparent window with portrait and mosque design a clear see-through security window in the polymer substrate.

3) Security strip Lettering BNM

4) Governor signature

5) Colour-shifting feature appears or changes when viewed at different angles.

6) Portrait of the first colonel seri paduka and very small text printed around the design, visible under magnification (BNM M5RM)

7) See-through feature

8) Lettering LIMA RINGGIT

Figure 2: Security features on the back side of the 5 MYR

9) Serial number unique identification number printed on the note.

10) Portrait building design feels slightly raised when touched

11) Raised printing on the denomination ("RM5")

12) Part of a design that aligns with the matching part on the reverse when held to light

13) Micro lettering RM5

14) A hibiscus flower

15) Clear polymer window containing a hidden image visible when held against light.

Observation of UAE Currency Notes (Ten Dirhams):

Currency notes of the United Arab Emirates issued by the Central Bank of the United Arab Emirates displayed a mixture of traditional Arabic artistic designs and modern security technology. Recently introduced UAE polymer notes showed high durability and smooth texture. The notes were resistant to water and physical damage. Holographic foil strips were clearly visible. The holograms reflected different colors and images when tilted. This feature added both security and beauty to the note. The signature odd His Highness sheikh Mansour Bin Zayed AI Nahyan, chairman of the board of Directors of the central bank. The Hijri Year of Printing (1443). Right Side logo sheikh Zayed bin sultan AI Nahyan (Transparent) Micro print small letters Central Bank of the United Arab in English EMIRATES is printed in very small letters at the bottom of the banknotes, Micro text (ENTRAL BANK OF THE UNITED ARAB EMIRATES). Serials number Arabic serial number are printed 002839130 Under ultraviolet light, hidden fluorescent features and glowing serial numbers became visible. UV examination revealed invisible security patterns. “There are four main language groups represented on UAE banknotes or used by its population: Arabic, English, and South Asian languages."

Figure 1: Security features on the Front side of the 10 Dirham

1) UAE Nation Brand Logo
2) Partial design that forms a complete image when viewed against light and scanner
3) Security Thread visible when held to light.
4) Micro lettering CENTRAL BANK OF THE UNITED ARAB EMIRATES
5) Micro lettering
6) Fineline engraving of the mosque, difficult to reproduce accurately.
7) Micro lettering
8) Year Marking (1443 AH)
9) Color-Shifting Feature Security emblem that changes appearance when tilted
10) Governor's Signature
11) Transparent Portrait Watermark Sheikh zayed bin sultan al nahyan

Figure 2: Security features on the back side of the 10 Dirham

12) Tactile raised printing near the denomination

13) Year printing (2022)

14) Micro lettering

15 Colour shifting features security emblem

16) Intricate line patterns and micro lettering within the building illustration

17) Micro lettering

18) Denomination number with optically variable ink effects

Observation of American Currency Notes (Ten dollars):

American currency notes issued by the Federal Reserve System were found to contain some of the most sophisticated security features in the world because the US Dollar is widely circulated internationally. The color-shifting ink on denomination numerals changed from copper to green when viewed at different angles. This optical feature provided easy public authentication. Watermarks were visible when the note was held against light. Portrait watermarks matched the printed portrait on the note and appeared clear and detailed. Microprinting was observed around portraits, borders, and security threads. Tiny letters were sharp and readable only under magnification. The embedded security thread glowed under ultraviolet light in different colors depending on denomination.

Figure 1: Security features on the Front side of the 10$

1) F6
2) Micro text 10
3) G1
4) Denomination number 10 and series 2017
5) United States logo
6) Portrait of Alexander Hamilton printed with high resolution intaglio engraving
7) Micro lettering G56
8) Green treasury serials number PF33353347B
9) US Department of the treasury seal
10) Embedded security thread
11) Color shifting number 10

Figure 2: Security features on the back side of the 10$

12) Watermarks
13) US Treasury Building
14) Denomination number 10
15) Micro text 10

Observation table: -

Country name	Currency Note Under UV light observation (365nm)	Currency Note Observation Front Side	Currency Note Observation Back Side
India Currency Note 500Rs	Figure: 1   Figure:2	Fluorescent Fibers tiny is, bright, multi-colored specks or hair-like structures (primarily glowing in shades of green, yellow, or blue). Color-Shifting Ink. The denominational numeral. Some printed portions of "₹500" and RBI markings fluoresce. Embedded security thread appears as a glowing vertical strip. The serial numbers glow brightly under UV light. Mahatma Gandhi watermark region becomes more distinguishable.	The thread is visible from back sid under UV illumination. Hidde fluorescent patterns become visibl Some alignment features appear cleare under UV light. Genuine note pape shows scattered fluorescent fibers.

India Currency note 200Rs	 Figure:3  Figure:4	Serial numbers glow brightly under ultraviolet light. A vertical fluorescent security thread becomes clearly visible. Small fluorescent fibers embedded in the paper appear under UV light. The "₹200" denomination and some RBI markings fluoresce. Mahatma Gandhi watermark region becomes more distinct.	The embedded thread glows strongly o the reverse side. ₹200 denomination markings exhibit U fluorescence. Micro-patterns and design elements become visible. Genuine cotton-paper fibers fluoresc under UV exposure. Fine securit printing appears clearer unde ultraviolet illumination. The colo changes to yellow under UV light.
Nepal currency notes 50 Rs	 Figure:5  Figure:6	The serial numbers become bright and clearly visible under UV light. Embedded vertical security thread glows under ultraviolet illumination. Watermark region becomes more prominent under UV exposure. "50" denomination markings exhibit UV-reactive fluorescence. Fine security designs and hidden UV patterns become visible. Glow the mountain and Nepal Rastra bank	The security thread remains visible an fluorescent from the reverse side. Som printed areas glow brightly under U light. Glowing Snow leopard

Nepal currency notes 20 Rs	 Figure:7  Figure:8	The serial numbers glow brightly under ultraviolet light. Small fluorescent fibers inside the currency paper appear under UV light. The denomination "20" shows UV-reactive fluorescence. Watermark region becomes clearer under ultraviolet illumination. Fine micro-patterns and hidden printing become visible. Some printed portions emit different fluorescence intensity.	Background designs and securit markings become clearer. Deer images become more distinct under U light. Denomination numerals fluoresc under ultraviolet illumination.
UAE currency notes 10 dirhams	 Figure:9  Figure:10	The denomination "10" fluoresces clearly under ultraviolet radiation. Watermark area becomes more distinct during UV examination. Certain printed areas emit different fluorescence intensity. Tiny fluorescent fibers embedded in the paper appear under UV light. Serial numbers glow brightly under ultraviolet light.	Background designs and securit motifs become clearer. Fine printin and micro-patterns appear more visible. Denomination numerals glo under ultraviolet illumination. Th security thread remains visible on th reverse side under UV light. Glowin the year printing.

US currency notes 10 dollars	 Figure:11  Figure:12	A glowing, golden-colored security thread under ultraviolet light. Under normal light, the thread contains the repeating text "USA TEN" and a small flag pattern The glowing thread appears vertically just to the right of Alexander Hamilton's portrait	The same embedded security thread visible and continues through the not Under UV light, the thread should sti glow Golden in the correspondin position. The Treasury Building imag itself should not have strong fluorescer features.
Malaysia currency notes 5	 Figure:13  Figure:14	Bright fluorescent elements in the hibiscus and decorative patterns. Fluorescent geometric squares and blocks that become more visible under UV. Portions of the security features near the portrait fluoresce in yellow-green colors. Some serial number elements may react under UV depending on the series.	Fluorescent patterns integrated into th background design. UV-reactiv features around the hibiscus moti Selected security-printing elemen glow yellow-green under UV ligh Additional fluorescent registratio features may appear that are no obvious under normal light.
Singapore currency notes 10 dollars	 Figure:15  Figure:16	The serial number 4FN318037 glows bright yellow under UV light. This is a key security feature on genuine notes. The large yellow-green glowing "10" is visible. Genuine Singapore polymer notes contain UV-reactive denomination elements. Portions of the note show fluorescent geometric and decorative patterns not prominent in normal light. Some UV response is visible around the Singapore coat of arms.	Large areas of the sports-themed desig show bright yellow-green fluorescenc Decorative motifs become visible under UV and sprea across the background. Elemen surrounding the "$10" denominatio exhibit fluorescence.

Discussion:

The comparative evaluation of currency notes of India, Nepal, Malaysia, Singapore, America, and the United Arab Emirates showed that modern banknotes contain multiple security features designed to prevent counterfeiting and maintain financial security. The study demonstrated that every country uses a combination of visible and hidden security elements according to its technological development, economic requirements, and counterfeit risks. During my research I noticed that all the countries I looked at have some common security features, on their currency. These features include watermarks, security threads, serial numbers, fluorescent features, microprinting and raised printing. These features help

regular people and experts tell if a note is real or counterfeiting. The watermarks and security threads are the commonly used and reliable features because they are hard to copy accurately. Watermarks are really hard to counterfeiting which makes them a great security feature. Security threads are also difficult to reproduce that's why they are so reliable. This is why these features are used by all the selected countries. The study found that Indian and Nepalese currency notes mainly use paper-based security systems with printing. Indian currency notes from the Reserve Bank of India have key features. These include the Mahatma Gandhi watermark, ink that changes colour, a hidden image, tiny writing and raised marks for the visually impaired. The Nepal Rastra Banks currency notes also have a watermark, a security thread. Features that glow under UV light. Compared to countries, with more advanced technology these currencies have fewer complex optical devices and modern polymer tech. Indian currency notes have these features to prevent counterfeiting. Similarly Nepalese currency notes also have security features. The Reserve Bank of India and Nepal Rastra Bank are working to improve currency security. They are updating their notes with security features. This will help prevent counterfeiting and make their currencies more secure. The study suggests that Indian and Nepalese currencies can learn from countries. They can adopt advanced security features. This will make their currencies more secure and trusted. The use of printing technologies is helping. It is making Indian and Nepalese currency notes more secure. Malaysia, Singapore and the UAE use systems to protect their currencies. These countries have made their currency notes more secure. They use polymer currency which're more durable. They are also water-resistant. It is hard to make ones. The Monetary Authority of Singapore issues currency notes with features. These features include: Transparent windows, Holograms Security elements that machines can read, Devices that change colour when viewed from angles Malaysian and UAE currency also have strong security features. They use: strips, Transparent windows, fluorescent patterns, for security. American currency notes, issued by the Federal Reserve System have advanced -counterfeit technologies. This is because the US Dollar is used around the world. The 3D security ribbon is one of these features. Colour-shifting ink is another. Microprinting and fine-line printing are also used. These features help prevent counterfeiting. The US Dollar is widely circulated globally. It needs strong protection. The Federal Reserve System includes these features to make American currency notes secure. The study also discussed the role of forensic science in counterfeit currency detection. Forensic experts use techniques such as magnification, UV examination, microscopy, and document analysis to identify counterfeiting currency. Microprinting, holograms, and colour-changing inks were found to be highly effective because they are difficult to copy using ordinary printers or scanners. Mostly, it’s clear that as technology gets better, the systems keeping our currency safe are getting better. Old features like watermarks and security threads are still very relevant. It’s hard to copy our currency with modern technology because of holograms and other special materials. We need to keep working on how to secure money, educate the public and monitor currency, so that we can prevent financial crime and verify our currency.

Result:

The comparative evaluation of currency notes from India, Nepal, Malaysia, Singapore, the United States of America, and the United Arab Emirates revealed that all selected countries the successfully observation all country currency note all most same the security feature like security thread, watermark, microprinting, serial numbers, ultraviolet fluorescent properties, raised printing, and colour-shifting ink. These security features assist both the general public and forensic experts in identifying genuine notes and detecting counterfeit currency. The study revealed that paper-based currency notes such as Indian, Nepalese, and American notes mainly depend on cotton or cotton-linen material combined with advanced printing technologies, while Singaporean, Malaysian, and UAE notes widely use polymer substrate technology, which increases durability and security. Microprinting was observed in several areas of the currency notes and could only be read with the help of magnification. This feature was highly effective because counterfeiters cannot easily reproduce extremely small letters and fine-line designs. Raised printing created by intaglio printing techniques was also observed on important portions such as portraits,

denomination numerals, national emblems, and identification marks for visually impaired individuals. Color-shifting ink was another important security feature observed in many notes where denomination numerals changed colour when the note was tilted under light. The study also found that polymer-based notes had additional advanced optical security features such as transparent windows, holographic strips, metallic patches, kinegrams, and motion effects. These optical devices reflected different colors and images when viewed from different angles and were highly resistant to duplication. Singapore, Malaysia, and UAE currency notes especially demonstrated excellent durability, water resistance, flexibility, and sophisticated optical technologies compared to traditional paper notes American currency notes contained highly advanced anti-counterfeit technologies such as fine-line printing, machine-readable security devices, and 3D security ribbons because the US Dollar is widely circulated internationally. Overall, the results demonstrated that all countries use a combination of traditional and modern security technologies to protect their currency systems. The comparative analysis showed clear differences in the complexity and advancement of security features among different countries, but every nation continuously upgrades its currency design to prevent counterfeiting and maintain public confidence.

Conclusion:

The study on the comparative evaluation of security features of currency notes India, Nepal, Malaysia, Singapore, America, and the United Arab Emirates successfully examined and capered the different ani-counterfeit technologies used in modern bank-notes. The study revealed that all selected countries use multiple of security features to protect their currency from counterfeiting and maintain public trust in the financial system. The research showed that common security features such as watermarks, security threads, microprinting, serial numbers, and raised printing are widely used in all the examined currencies. These features help banks; forensic experts and the general public identify genuine notes and detect counterfeit currency effectively. Indian, Nepal currency notes mainly use paper-based security system combined with traditional and modern anti-counterfeit features. In comparison Malaysia, Singapore, and the United Arab Emirates use advanced polymer technology, transparent windows, holograms, and optically variable devices that provide greater durability and stronger protection against counterfeiting. American currency notes were found to contain highly sophisticated features such as the 3D security ribbon, fine-line printing, colour -shifting ink, and advanced microprinting because the US dollar is one the most widely circulated currencies in the world. Overall, the research demonstrated that continuous technological advancement is essential for maintaining currency security and preventing financial crimes. Central banks must regularly upgrade banknote security features to stay ahead of counterfeiters. Public awareness, forensic examination, and advanced printing technology play an important role in protecting the authenticity and reliability of currency notes worldwide.

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