A framework for handling digital forensic evidence and evaluation on cyber resilience

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***Abstract*— Handling cybercrime investigations by identifying digital forensic evidence that intent to analyze and preserve it in well terms and conditions. Most research materials did implement frameworks on handling digital forensic evidence based on their source, format, and type of classification without understanding the process of digital evidence accordingly. As a forensic investigator is a MUST to understand the concept of handling digital evidence by studying each stage of the process with law facts. To this end, we have designed a use case framework on how to handle digital forensic evidence along the process with an explanation in detail. Therefore, evaluating the cyber resilience at this pandemic crisis to highlight the influence of advanced technologies on people. Cyber resilience has been planted in all aspects such as medical fields, business, or industrial areas, or even through cyber threat intelligence with advanced technologies like Artificial Intelligence (AI). Based on cyber resilience studies, the developer had analyzed and identified the evidence collected to conclude a cybercrime investigation works in the corporate world currently.**

Keywords*— *Digital evidence, cyber resilience, cybercrime investigation, evidence framework.

I. Introduction

In this study, we have discovered the definition of digital forensic and its process to handle digital evidence accurately. Moreover, another study evaluates the cyber resilience in cybersecurity to analyzed and predict the intents of the future generation that depend fully on smart things such as, smartphones, smart TV, smartwatch, smart furniture, etc.

Based on that, the developer has designed a framework for handling digital forensic evidence start with the Identification, Collection, Acquisition, and Preservation phase to be followed for analyzing the correct path of that evidence in a criminal investigation. [1]. Below figure 1 describe a sample flow of cybercrime scene that handle digital evidence adequately whereas the evidence gathered to submit in court for committing that this crime has been occurred by the suspect.

An attack that occurs risk to a person or an organization, is a common routine to erase sensitive data through smart devices or even in a cloud environment where the main motives of a hacker. As incident becomes persistent and sophisticated to an organization floor, they need to be twice secure on cyber resilience that may lead them to damage their internal and external services eventually. [2]

To keep an effective cyber resilience, we bear in mind 3P's concepts which are, Predict, Prioritize, and Practice. This concept will be helpful to prevent or alert employees if any event occurs to identify the cyber risks and vulnerabilities that have been attacked before. Furthermore, the organization itself being lack of intelligence threat to discover any potential cyber-attack. [2]

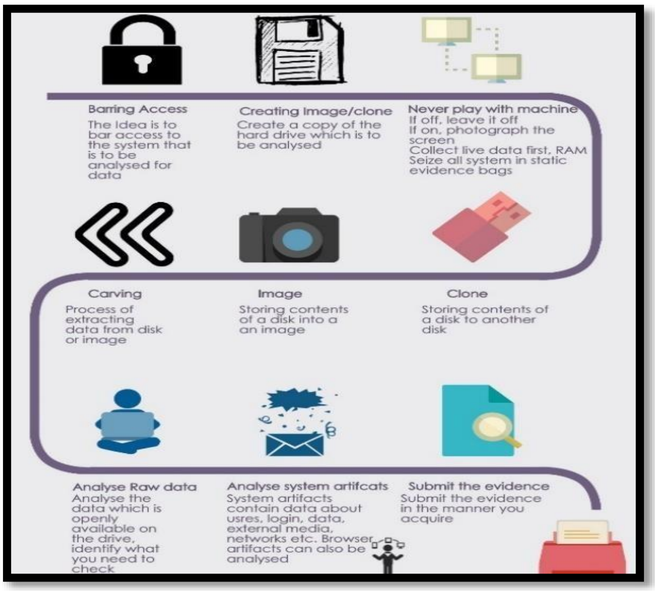

Barring Access
The Idea is to bar access to the system that is to be analysed for data
Creating Image/clone
Create a copy of the hard drive which is to be analysed
Never play with machine
If off, leave it off
If on, photograph the screen
Collect live data first, RAM
Seize all system in static evidence bags
Carving
Process of extracting data from disk or image
Image
Storing contents of a disk into a an image
Clone
Storing contents of a disk to another disk
Analyse Raw data
Analyse the data which is openly available on the drive, identify what you need to check
Analyse system artifcats
System artifacts contain data about usres, login, data, external media, networks etc. Browser artifacts can also be analysed
Submit the evidence
Submit the evidence in the manner you acquire

Fig. 1. Flow of digital forensic process

The best way to prevent these potential threats in organizations then, employees should attend regular training based on CISRT (computer incident response team) or understanding the incident response policies and to be tested frequently before or after any attack occur which stabilizes the cyber resilience rate. [2]. Where in figure 2 shows the extensions of cyber resilience from ISO 27001 to ISO 27014.

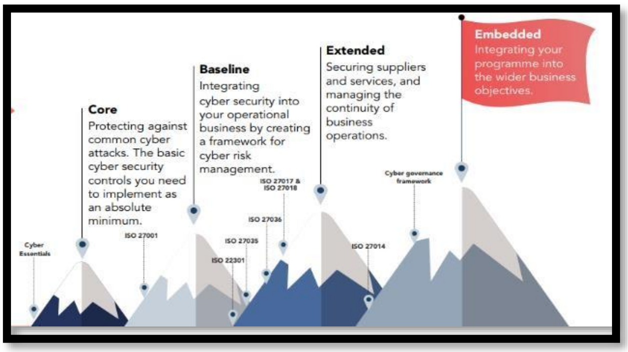

Embedded
Integrating your programme into the wider business objectives.
Extended
Securing suppliers and services, and managing the continuity of business operations.
Baseline
Integrating cyber security into your operational business by creating a framework for cyber risk management.
Core
Protecting against common cyber attacks. The basic cyber security controls you need to implement as an absolute minimum.
Cyber governance framework
ISO 27017 & ISO 27018
ISO 27036
ISO 27001
ISO 27035
ISO 27014
Cyber Essentials
ISO 22301

Fig. 2. Cyber resilience framework in general

Usually, the targeted will be forensic investigator, forensic examiner, forensic analyst, and expert witness who able to capture the intent and motive of the preserve evidence. Besides, CSIRT or Incident Respond team can be a part of researching or even analyzing the gathered evidence such as, in an organization that occurred malicious attack or security breaches in SOC lab. The targeted user will undergo investigation stages with a proper procedure under law enforcement in legal action taken. The scope of this study:

- Analyzing and designing a framework for handling digital forensic evidence based on past studies.
- Justification of the proposed framework on digital forensic evidence that could be related to cyber resilience.
- Determining the past facts from the author's reviews with a conclusion statement.
- Identifying the effectiveness of cyber resilience towards everyone in the technology era.

II. RESEARCH METHODOLOGY

This section explains the past studies of the existing framework for handling digital forensic evidence in various aspects of the technology field along with cyber resilience research done by authors. Hence, those research materials had evaluated and clarified the proposed framework with a hypothesis from the developer reviews. Therefore, knowing about cyber resilience and the impact on the technology era.

Handling the digital forensic evidence process has been designed and implemented in past studies to overcome cybercrime investigation by preserving its digital evidence accurately and securely to proceed in court. Most forensic analysts fail in progressing the evidence stages. In an overall investigation, the investigator will only rely on evidence analyzed and examined by forensic examiners in the lab to make sure the jury reliable the evidence under law enforcement to make a legal judgment for that particular suspect of the crime.

The author [3], has implemented VODE (verification of digital evidence) framework in figure 3 below that encounters undocumented digital artifacts and data of an investigation. Therefore, an interpretative methodology was helpful for a practitioner to complete the process accurately to identify the digital data.

As a result, the author's VODE has been supportive to the practitioner for analyzing the digital evidence along with an interpretative methodology that founded a digital trace term on the suspect system which captured the testing and verification data. [3]

For a live forensic analysis, three authors [4] has designed a visual decision-support system as a methodology to analyze the inflected system even devices turn off. Which able to erase evidence that is known as "Fileless Malware". The authors made defined and identified the domain issue by analyzing the visualization system to abstract available evidence during a live investigation. Figure 4 has a layout of four timeline version of visualization-support system in detail.

In conclusion, the authors contributed a tailor-made visualization approach that enables to gather data during the forensic investigation to archive the domain issue faced on how visual security analytics generated. [4]

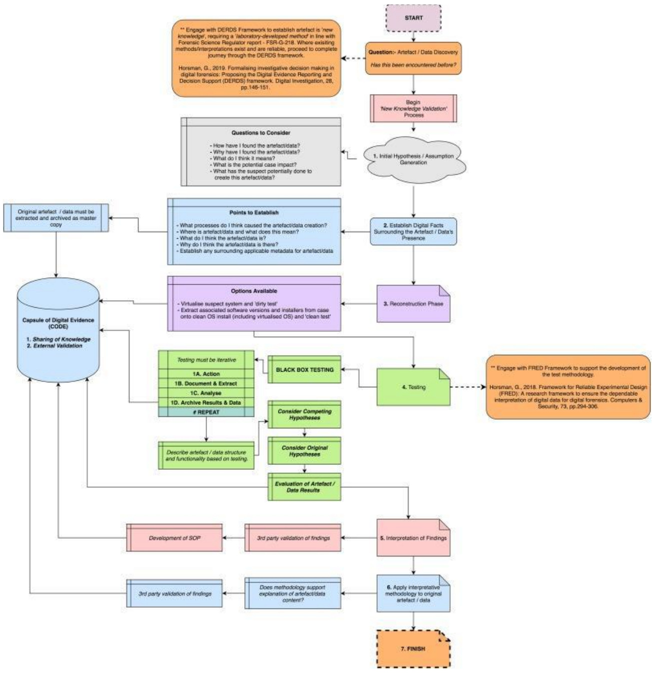

START
Question:- Artefact / Data Discovery
Has this been encountered before?
** Engage with DERDS Framework to establish artefact is 'new knowledge', requiring a 'laboratory-developed method' in line with Forensic Science Regulator report - FSR-G-218. Where existing methods/interpretations exist and are reliable, proceed to complete journey through the DERDS framework.
Horsman, G., 2019. Formalising investigative decision making in digital forensics: Proposing the Digital Evidence Reporting and Decision Support (DERDS) framework. Digital Investigation, 28, pp.146-151.
Begin 'New Knowledge Validation' Process
Questions to Consider
- How have I found the artefact/data?
- Why have I found the artefact/data?
- What do I think it means?
- What is the potential case impact?
- What has the suspect potentially done to create this artefact/data?
1. Initial Hypothesis / Assumption Generation
Original artefact / data must be extracted and archived as master copy
Points to Establish
- What processes do I think caused the artefact/data creation?
- Where is artefact/data and what does this mean?
- What do I think the artefact/data is?
- Why do I think the artefact/data is there?
- Establish any surrounding applicable metadata for artefact/data
2. Establish Digital Facts Surrounding the Artefact / Data's Presence
Capsule of Digital Evidence (CODE)
1. Sharing of Knowledge
2. External Validation
Options Available
- Virtualise suspect system and 'dirty test'
- Extract associated software versions and installers from case onto clean OS install (including virtualised OS) and 'clean test'
3. Reconstruction Phase
Testing must be iterative
1A. Action
1B. Document & Extract
1C. Analyse
1D. Archive Results & Data
# REPEAT
BLACK BOX TESTING
4. Testing
** Engage with FRED Framework to support the development of the test methodology.
Horsman, G., 2018. Framework for Reliable Experimental Design (FRED): A research framework to ensure the dependable interpretation of digital data for digital forensics. Computers & Security, 73, pp.294-306.
Consider Competing Hypotheses
Consider Original Hypotheses
Describe artefact / data structure and functionality based on testing.
Evaluation of Artefact / Data Results
Development of SOP
3rd party validation of findings
5. Interpretation of Findings
3rd party validation of findings
Does methodology support explanation of artefact/data content?
6. Apply interpretative methodology to original artefact / data
7. FINISH

Fig. 3. VODE framework

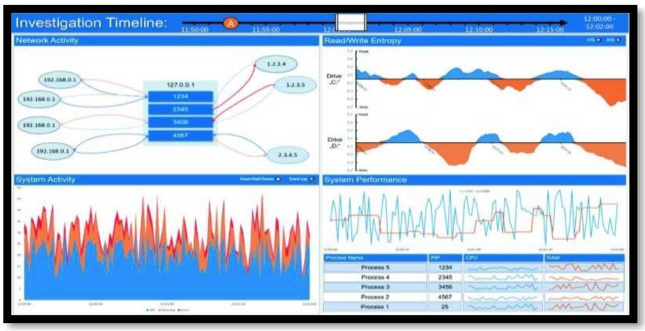


Fig. 4. Visual security analytic timeline [4]

Both authors [5] have done auto-triage B-CoC an automatic collecting and uploading blockchain in figure 5 during a live crime scene investigation. During the on-scene, the forensic examiner identified data of case ID and evidence ID through four stages of the B-CoC framework which are, Triage, Documentation, Blockchain, and Report that had preserved the evidence. [5]

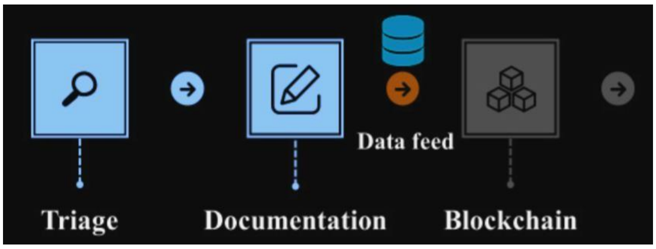


Fig. 5. Auto triage B-COC framework

More precisely, DEC (digital evidence bag) framework was designed to utilize data storage backup with a blockchain prototype on Ethereum. Based on the CoC concept the DEC framework accomplished data storage integrity to manage the digital evidence which is shown in figure 6 below. [6]

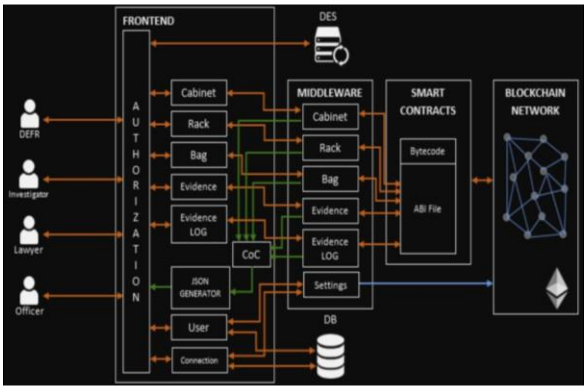


Fig. 6. Architecture B-DEC

The author made a statement of forensic investigation process was not processing accordingly. Due to that, the author analyzed and evaluate the observation on how to preserve and gather evidence securely by following each step of handling digital forensic evidence. Also, the author highlighted law enforcement of digital evidence of an investigation to the jury for leading to inadmissibility at court. [7]

The author summarised of cybercrimes involves cloud computing threats to the industrial world. Based on the law enforcement agencies they discovered many digital crime cases that attacked through cloud computing platform. [8]. At the final stage, the author evaluates the difference between modern and traditional digital forensic and examiner process to identify the fastest way of gathering evidence. [8]

Nowadays, technology changes due to advanced AI and electronic devices that make it easier to discover any tiny data from a bulk storage space. Based on that, the author [9] differentiates the traditional digital forensic process in a cloud computing environment to conduct an acquisition phase as a methodology that able to teaches the limitation of cloud environment due to complexity.

From the result, a classroom of Delphi study applied this methodology by analyzing a 20 forensic acquisition process that categorized by SMEs (subject matter experts). Where these experts have skills and knowledge about conducting a forensic process in a cloud computing environment. [9]

Thusly, the author [10] has proposed a proactive mechanized quantity of procedures to discovered the condition and challenges of an electronic logical method. By developing it, in the end, the author registered the circulated condition usage of current logical systems during that period. On that approach, the system has been utilized as an IaaS model to apply on other sensible logic mechanical assemblies' structure before an organization process initialized. [10]

OSINT (open-source intelligence forensic) used in criminal intelligence to discover link analysis and data mining for tracking espionage or cyber terrorism activities. Based on this situation, the author [11] has investigated the incident from the employee who has been suspected. The aim of this investigation to identify the potential evidence by collecting with the selected tools.

Based on intelligence development their benefits of data link in digital forensic by analyzing it can be gathered irrelevant databases. In conclusion, the author's proposed tool was evaluated in a virtual lab to be designed and verified made under control environment shown in figure 7 below. [11]

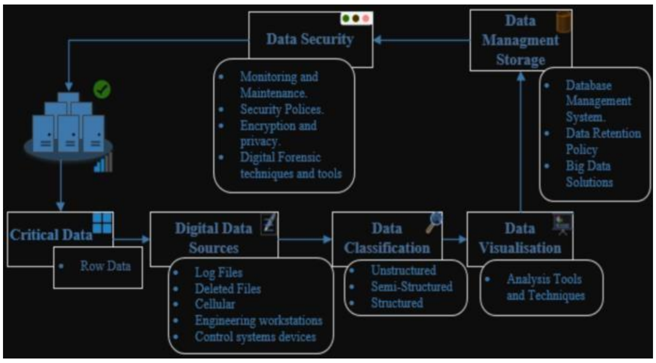
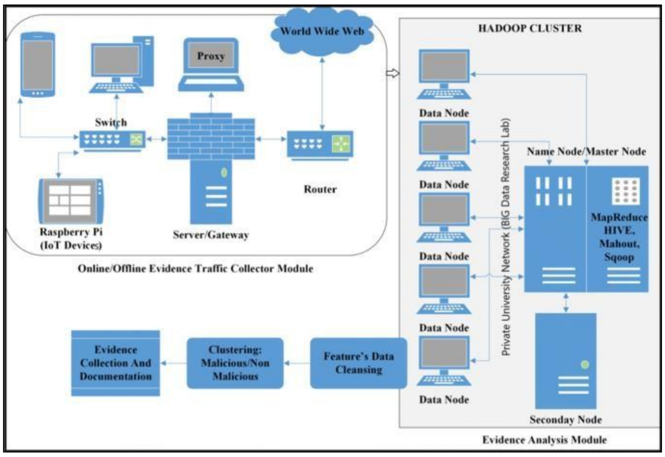


Fig. 7. DatalLife cycle

The last journal about the forensic framework that was proposed in MapReduce as a Google's programming model to analyze traffic features, extraction, and traffic translation along with techniques such as, Mahout, R. Apart, Hive, and Hadoop to help the process parallel mode. [12].

Based on that, the author executed the dataset from CAIDA to validate the parallel proposed model which finally result in forensic metrics of the performance with 99% of sensitive connection in figure 8 below by using Gain Ranking algorithm to analyzed the forensic evidence. [12]

Fig. 8. Model of Forensic Performance


World Wide Web
Proxy
Switch
Router
Raspberry Pi (IoT Devices)
Server/Gateway
Online/Offline Evidence Traffic Collector Module
HADOOP CLUSTER
Data Node
Data Node
Data Node
Data Node
Data Node
Data Node
Private University Network (BIG Data Research Lab)
Name Node/Master Node
MapReduce HIVE, Mahout, Sqoop
Seconday Node
Evidence Collection And Documentation
Clustering: Malicious/Non Malicious
Feature's Data Cleansing
Evidence Analysis Module

From Fig. 8, the forensic analysis phases were divided into four stages of architecture: [12]

1. Collection of data and generator of information.
2. Analytics and extraction module of future.
3. ML (machine learning) models.
4. Types of metrics in models of analysis.

III. Cyber Resilience Reviews

The article has concluded the difficulty of handling the cyber resilience policies of an organization structure. The cyber resilience policies prevent risk from cyber threats or espionage terms which may lead to human error or company reputation. The author succeeds by designing a model and defined an effective cyber resilience strategy to maintain the methodology of system dynamics for the perfect investment in cyber resilience. [13]

Based on the system dynamics of developing the cyber resilience strategy, the author has analyzed several experts by interviewing them into behavior culture to this issue faced. Whereby, the model highlights importance of personnel training and technology for building the cyber resilience process rather than overlooking investment strategy. It might decrease the cyberattack threats as a strategy of the corporate whole. [13]

Overall, the author's model used for the decision-making stage for IT organization to be aware of cyber resilience with a proper policy, systematic investment strategy, and IoT devices been structured in a good manner. [13]

Therefore, the author [14] has analyzed and identified existing CRF (Cyber Resilience Framework) as an instance of 25 research areas with 36 types of industries. Based on the survey it determined the strategic or operational consist of CRF as a decision influence by the methods used to does CRF research as a result.

It concluded the CRF research had identified certain gaps and similarities to proposes an opportunity for interdisciplinary research to label as a guideline for future research path in the field to analyze the intention of cyber resilience. [14]

Conversely, airports being advanced technology in their infrastructure that tracks the number of travelers every year has increased continuously. The author [15], identified challenges for aviation to integrate with IoT (Internet of Things) such as communication between smart devices with smart airports facilities developed by programmers. This smart layout enables a key to cyber resilience security and safety for users. The article emphasizes tracing malicious threats due to IoT and smart devices that are installed with mitigation actions to countermeasure the rate of cybersecurity in airports. [15]

By monitoring and securing smart airports may have high risks that involve cyber threats for aviation stakeholders, employees, airline operators, and regulators. The authors also collaborated on a cyber resilience model that defined the airport's cybersecurity prevention structure that highly prioritizes the safety and security of passengers and airline operators. [15]

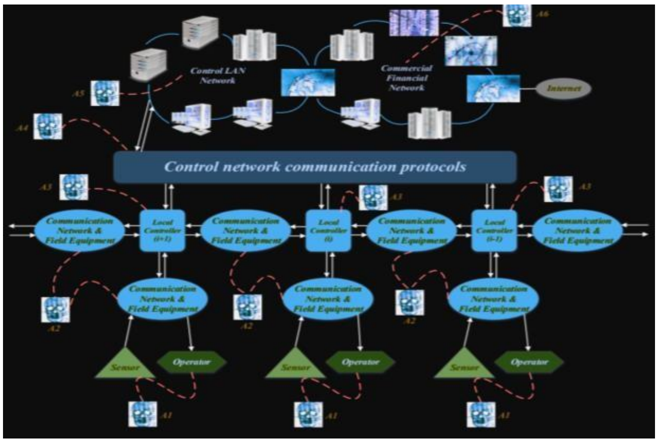

A6
Control LAN Network
Commercial Financial Network
Internet
A5
A4
Control network communication protocols
A3
A3
A3
Communication Network & Field Equipment
Local Controller (i+1)
Communication Network & Field Equipment
Local Controller (i)
Communication Network & Field Equipment
Local Controller (i-1)
Communication Network & Field Equipment
A2
Communication Network & Field Equipment
A2
Communication Network & Field Equipment
A2
Communication Network & Field Equipment
Sensor
Operator
Sensor
Operator
Sensor
Operator
A1
A1
A1

Fig. 9. SG Control System Vulnerabilities [16]

SG (smart grids) brought threats to computer-based software that enhanced the use of communication and information technologies. Which intent to lead cyber-attack in an organization. [16]. In figure 9, a model was designed by the author to address the vulnerabilities of the SG control system to monitor any cyber-attacks.

As result, the author analyzed the SG control system with identified various vulnerabilities that might occur event without security protection. Understanding the IT security strategies helps to maintain and monitor the system without hacker's threat to be destroy and reduces its impact to control systems. [16]

Besides, the author has simulated and identified advanced communication technologies network known as VANET (Ad Hoc Network) that receive possible outcome to coordinate action for ITS (Information Transportation System). [17]. Based on the top 10 cyber threats surveyed, the author approached cyber resistance access on VANET/ITS model have identified the threats pattern of vulnerability and centralization management. [17]

Moreover, the proposed steps had delayed issues of vulnerabilities exploits from neutralization to prevent the model of forecasting and designed cyber system of VANET/ITS within the level of cyber resistance. [17]

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