In the present world, the rapid growth of technology-enabled public communication for various purposes like cloud computing, social networks, automated processes, and online transactions, etc. Though technological evolution leads to good deeds, still allowed the existence of intruders and cybercrimes seemingly without any interruption which further leads to the evolution of new attack types, techniques, and tools. All those immoral signs of progress allow attackers to get through more complicated or well-governed infrastructures, and develop enhanced impairment and even persist as an untraceable source. There is plenty of techniques that don't demand prior cognition of hacking. These immoral approaches can be executed by any exploiter if there exists an opening for some defenseless code in the system or websites. This research article intent to traverse through the brief summarization on the cybercrime domain that mostly includes cyber-attack, hacking as it is outlined and exposed by specialized existing work, international statute law, and historical realities. Eventually, the work is focused on analyzing various major attacks accounted throughout the world over the past three years to find out trends and patterns in the sector of cyber-crime. Later on, different experiments are carried out on several aspects to find out or trace some possible attacks, and to examine countermeasures. Based on the outcomes of the experimental analysis, this research article exhibits valid countermeasure strategies that any organization may undertake to ensure improved protection that would affirm in guarding their enterprise against the attackers. Moreover, the core part of the article aids thesecurity experts, incursion testers, and developers to acquire prior knowledge about countermeasures based on an information security perspective.

Keyword: Cybersecurity, Attacks, Security Countermeasures, Security Assurance

1. INTRODUCTION

In the present era, the world is increasingly moving onto social networks, cloud, big data, web servers, and online transactions. Nowadays valuable data is being stored and managed
online via the internet. Most of the automated procedures that are followed and executed through
the utilization of standard IT systems, data privacy, and information security are continuously
dealing with higher risks. With the unstable and unsaturation of new security systems, cyber-
crimes are systematically raising in terms of the number of vulnerabilities to its victims.

About the recent research, it is found that 229,000 attacks against online web systems
happened every day and out of these 229,000, it’s been evident that around 76% of website
attacks [1] are occurring due to vulnerabilities. To evolve some novel modes to attain
unauthorized admittance into the secured networks, confidential data, and precise programs,
most of the attackers intend to compromise the integrity, availability, and confidentiality of
information. Further, they aim to build up their objectives from individuals to the minor or mid-
sized organization and sometimes larger enterprises. Thus the overall immoral activities lead to
the business discontinuity and ultimately losing the customers’ faith. The raising course of action
has attained new elevations in 2014, cosmically recognized as “the year of cyber-attacks”, but the
real fact is believed that this would be a non-culmination factor unless fixed with suitable
countermeasures at a global reference standard. The overall advancement and evaluation led to a
much easier way of dealing with security concerns but on the other aspects, it is getting vast
dispute in ensuring the security standards for any online systems.

1.1. Overview of Web Systems

Penetrations testing of web systems has huge grandness since it implies base-level user data
and log-in credentials. Testing acts as a critical part in ensuring the quality of whatever web system.
Software examiner makes various test suit on which they execute testing on all developed web
system to further catch up with encountering bugs. This work iterates until every bug is eliminated
[2]. Normally, it has been found that the software examiners are not cyberpunks so they can’t
breach the database and credentials as hackers do. Thus, the prerequisite of basic knowledge on
hacking techniques can act as a critical part in maintaining the quality sureness of any software.

In this research work, the few most recent proficiencies or techniques of hacking for web-
based applications with sign-up and sign-in pages are discussed [3]. In such applications, user
data plays a key role, therein, various techniques are utilized by the attackers to disfigure
these security of entire web systems. Few major techniques include R2L, DoS, Probing, U2R, etc.,
[4].
Remote to User (R2L): On the utilization of this technique, hackers use to sends a good deal of packets to the machine to determine vulnerability and to make headway for local access.

Denial of Service (DoS): Through these techniques, the perpetrator attempts to make the system or available resource of the network into an unavailable mode to the users, thus disrupts the service indefinitely or temporarily.

Probing: On the utilization of this survey type of proficiency, the hackers obtain control over the entire network through the scan and determines the vulnerabilities that further destabilize the network.

User to Root (U2R): To attain control over the root of the server, cyberpunksemploymereg user credentials then broadcast packets to detect vulnerabilities to arrive at the root.

All the aforementioned techniques demand a lot of prerequisite knowledge to execute attacks. Though the attacker has multiple choices to opt for a suitable technique, few simple techniques can be utilized to deface the web systems.

1.2. Types of Vulnerabilities

Vulnerability is of various types but for the objective of this research article very few vital types of vulnerabilities are considered and they are stated as:

SQL INJECTION: One of the most popularly known vulnerabilities is “SQL Injection” which is based on Input parameters. In SQL Injection malicious exploiters can falsify any SQL Command by injecting their SQL command to access the desired database [5].

Cross-Site Scripting (XXS): It is a well-known kind of vulnerability that is usually detected across web systems. In this type, the attacker mainly induces more or less malicious scripts into the web to attain accessibility over the main server [6].

Cryptography: From the perspective of cryptanalyst, this technique is known to be the separate domain for secure communication. Here, the sender is an authorized person to encrypt the data before sending and the receiver is responsible to decrypt the received data. But most occasions, this form of secure communication is breached by an intruder or middle man who can attain control and possess enough capabilities to deceive the sender (act like receiver) [7].

Cross-Site Request Forgery: It is a special kind of technique through which a hacker or malicious user could send and perform an unneeded request to user side web application during the login duration [8].
This article has the aim of exposing the elaborated analysis based on existing attack models, trends, patterns, and results observed in the last three years. Further, through the overall obtained reports, the research work tends to confront justifiable countermeasures for aiding the system betterment especially in security build-ups and to reduce worldwide crimes. This article is integrated with three primary constituents: it commences by exhibiting the most generalized perspective of cyber-crime in terms of specialized existing work, international statute law, and historical realities. Later on, continues to disclose major attacks with their principal resolutions and interpreting the short study that has prevailed for the past three years. Afterward, a methodology is proposed in which an attack is executed on the selective webpage to detect and examine the vulnerabilities and their following countermeasure strategy. Finally, it concludes by depicting some of the primary countermeasures strategies that any enterprises may set about to assure the betterment of controls addressing the data confidentiality, availability, and integrity concerning the reduction of several security breaches.

2. RELATED WORK

In daily reality, cyber-attacks turn nightmare for both giants as well as small scale organizations; but still only a few are aware of this cybercrime. The article from [9], delineate the lack of understanding and gaining knowledge regarding various attacks and their characteristics. Thus, this sense of unawareness possesses some real obstacles in defending the network, and information security.

Respective resolutions on cyber-crime, cyber-attack, etc. can be found amongst the world-wide literature, all bearing in common the intention to compromise the integrity, availability, and confidentiality of information. The technological advancements also contributed to the progress of cybercrime, thus novel modes to execute attacks, accomplish even more difficult to penetrate objectives or targets, and to stay in untraceable mode are aroused endlessly. Nevertheless, conventional cyber menaces persist as the origin of the majority of the common attacks. Several types of approaches or attacks have been outlined and examined across the standard literature:

*Man-in-the-middle:* Whenever some communicative messages are sent from source to destination, is interrupted and reaches the attackers which are commonly referred to as a man-in-the-middle attack. The consequences of this type of attack compromises by admitted
unauthorized access to a sensible set of information or allows the attackers to modify the information/data before reaching the destination.

**Brute force attack:** This type of attack comprises recurrent attacks to benefit accession on the highly protected data/information (e.g. encryption data/ciphertext, passwords, etc.) until the required data is breached, and obtained.

**Distributed Denial of Service (DDoS):** This is a kind of approach that compromises the accessibility of data, decisively that the attacker plans to flood out the host (e.g. server) with necessary commands, thus going unserviceable;

**Malware:** Malware is a collective term describing numerous malicious software variants, often preferred by the attacker to compromise the availability, integrity, and confidentiality of data. The most common types of malware are Ransomware, Viruses, Trojans, Worms, Adware, Rogware /Scareware, and Spyware.

**Phishing:** It is a kind of technique targeted to attain some private information without prior authorization from users via masquerading as a faithful resource (e.g. website).

**Social Engineering:** It is the generic name that delineates the proficiencies used to attain unauthorized accessibilities to secured information via human interaction.

In [13] the author demonstrated a research tool called “VulScan” which is used to create automatic test cases to find vulnerabilities from the web system. These vulnerabilities could be in the form of SQL injection and Cross-Site Scripting (XXS). But the author fails to elaborate on the countermeasure strategies which are highly complex to understanding by the developers.

In [14], the authors provided an in-depth survey and also exhibited lots of mechanisms to find Vulnerabilities caused due to SQL Injection. They also delivered a few techniques and mechanisms to preclude the occurrence of these vulnerabilities while launching the websites. Prerequisite knowledge on Vulnerabilities supports the developer in developing an efficient secure code.

The work from [15] delivers extremely practicable methodologies to detect the various form of vulnerabilities and they also delineate the categorization of SQL Injection attacks. Here, the prevention strategies or countermeasures are described only in the statement formulation.

The article from [16] demonstrated the idea to preclude CSRF (Cross-Site Request Forgery) which exhibits the additional authentication technique along with browser-based resolution. This technique is found to be huge utilitarian from the perspective of...
architectural aspects but this is a kind of proficiencies which is not much practicable for the developer’s side but it could be a very facilitator segments especially for software quality assurers and testers.

The research paper from [17] provided a required and complete study on the open issue of penetration testing which is very critical for Cyber Security. Here, the authors delineated these associated technical issues in a narrower form but fail to elaborate standard countermeasure and solutions for the same issue.

The researchers from [18] described the state of the art review of various types of hacking approaches on the web system. They also delivered a relative study of detection tools in a comparable mode and suggested several tools for countermeasures as a prevention strategy from these attacks.

From [19], the author presented a various testing methodological analysis for penetration testing of web systems. They also exhibited the conception of abuse cases, which was notable for penetration testing, however, such test cases fail to aid the developers to create an accurate system as per the desired outcomes.

3. **GENERALIZED PERSPECTIVE OF CYBER-CRIME**

The analysis set out with a thoughtful follow-up regarding cyber-crimes current status, through this critical review of specialized existing work, international statute law (legal aspects), and historical realities of the last three years. The goal was to attain a worldwide overview of the cyber-attacks across the world, to realize the significances of functioning and possible impact upon business enterprise or individuals, besides the countermeasures to be taken as for dealing with the jeopardizes. This research was based on attacks keyed out and tracked among the last three years. With the vast count of cyber-attacks set about on a day-to-day basis across the world, besides the bounded selective information companies mostly exhibit whenever they found to be the victim of cyber-crime and the conception that some approaches are difficult to be tracked, and it was inconceivable for the authors to attain a perfect data set for analysis intents. Nevertheless, the analysis was based on the data ensued from combining information concerning detected attacks and tracked from the last complete three years. Commonly the data are gathered from the news and attacks account, as well as from previous reports and surveys published by globally major market
participants on anti-malware overhauls and security consulting, thus attaining a targeted round sum of around 15 million attacks or approaches.

3.1. Primary Factors

On concerning the real facts about this study which tends to expose the root cause of the security breaches. To a lesser extent, 50% of the illegal approaches are purported to intentional criminal attacks. The causes constituting three primary factors: Man-made errors, deliberate attacks, and the overall organization system vulnerabilities. Here, the outcomes delineate the fact that whenever an attack or intentional approaches succeed, it is only due to the partial proficiency skills of the attacker and prior cognition, and also on account of vulnerabilities at the victim’s position – such as Man-made errors, defective programs, and deficient level of controls to assure some standard information security guidelines. In the year 2013, Cenzic organization has observed numerous security vulnerabilities in 96% of the analyzed applications coverage. Accordant to the 2014 Application Vulnerability Trends Report, it’s been stated that with an average of 14 vulnerabilities for any single application.

3.2. Generalized Review on Attacks

All around the analysis, it was difficult to decide the precise count or vital component of the various attack type. However, the majority of these kinds of attacks are:

- Malicious Codes
- Worms
- Trojans
- Malware
- Denial of Service
- Viruses
- Web-Based Attacks
- Stolen Devices, And
- Phishing
- Social Engineering, And
- Malicious Business/Corporate Executive,
The final resolutions could easily be segregated into four classes, which are based on the targeted plan/ultimate goal of the attack, they are;

- Cyber Espionage
- Hacktivism
- Cyber-Crime, And
- Cyber Warfare.

3.3. Cyber Espionage

Cyber espionage [11] is a type of cyber-attack that grabs the most restricted, sensible information or IP (Intellectual Property) to benefit some vantage over a competitor Organization.

3.2.1 Hacktivism

Hacktivism portrays the act of maltreating a network system for a politically or socially prompted intellect. The person who executes hacktivism is referred to as hacktivists.

3.2.2 Cyber-Crime

Cybercrime [10], sometimes referred to as e-crime which necessitates a web-connected system and a network. The particular system or network will be utilized to equip for crime service into other targeted subjects.

3.2.3 Cyber Warfare [12]

On the utilization of digitalization across the world, the attackers tend to attack an enemy’s network infrastructure, leading to destruction, thus disables the entire or partial communication system of the targeted nation.

3.4. Dissipation across various sectors

This study disclosed the realism about the organization of versatile sizes and how the business spheres have been influenced and became the primary victims of cyberattacks for the last three years. Irrespective of the entity’s business sector and size, all the fields, right from the public sectors (Government, Education, Enforcement, Healthcare, and Law), and some non-profit
organizations still to the private sectors (like media, finance, Tourism, online services, retail, internal security, telco, automotive, food & beverage, and energy & utilities) are targeted by cyberpunks for major attacks. In connection with the geographical split oriented attacks, this cogitation is prominently focused on two linear perspectives: the geographic origin of the attacks, and their destination. As per the study’s outcomes, it’s been revealed that the few countries are targeted as the source of the attack, are:

- Canada,
- France,
- Germany,
- Romania and others.
- Russia,
- Netherlands,
- UK,
- Ukraine,
- USA,
- Vietnam,

Concurrently, it is found that the regular frequent victims are located in Russia, the USA, and the UK.

3.5. Cyber-attacks Impacts

Concerning the impact that cyber-attacks deliver upon their victims, it is difficult, and sometimes not possible enough to quantitates the precise costs of the organizations which always expect for recovery process for their regular business, customers’ faith, and reputation, especially considering that victimized organization do not perpetuallyexpose all the security concerned information to the populace. However, the outcomes depict the impact of cyber-hackings which normally leads to the loss of selective information, business commotion, and revenue loss, and device or instrumentation damages. Such kind of attacks allows for unauthorized admittance of intruders, especially to profile information (meta-source) that comprises data sets like personal IDs, full names, surname, Date-of-birth, official and residential addresses, financial and medical
records, mobile numbers, and official mail-ids addresses, important credentials, and insurance policy details.

3.6. Cybersecurity Correlations, Trends and Patterns

This study discloses concerning results, trends, and patterns. Foremost, the consequences delineate a proportional correlation among the business sector and the different types of attacks; thus, cyber espionage is majorly targeting Media, Law Enforcement sectors, Government, and also unconvincing targeting other commercial sectors (Online Services, Telco, Retail, etc.). The resultants for the past three years delineate a relatively firm correlation among the types of attacks and manufacturing sectors. The correlation demonstrates the cases of targeting the public sector (government, law enforcement, education, etc.) likely by cyber espionage, wherein all business sectors are targeted by hacktivism, cyber-crime, and cyberwar techniques.

The analysis results exhibit that the attacks are not only from external hackers but fragmentation among them and organization associated factors (current or former employees, partners, management, etc.). These consequences draw a few more trends, attaining the source's trust regarding unauthorized forcible accession endlessly loses base against unauthorized legitimate accession to secured information. Likewise, it’s been illustrious that there is an uninterrupted incremental issue through the mobile attacks, from which the sources believed to be instinctive deliberation on the dissipation of smartphones that may evident to be a leisure target. All these effects are illustrated as the forcible forerunner to the unrecognized actions due to the permanent establishment through the internet, utilization of a social network and other public-oriented applications, besides the realities that they are hardly switched off and comprise/hold back a lot of personal data (from the first name, mobile number and locating to the device to the recently connected network, etc.).

3.7. Generalized Outcomes

The cogitation was based on a targeted round sum of around 15 million attacks or approaches, that were compiled across past news and events, as well as accounted records set by key players in the industry sectors concerning security. Some primary key players are the Federal Bureau of Investigations (FBI), Kaspersky Cenzic, CISCO, Mandiant, Sophos, Verizon,
The “Threats Predictions 2015” reported by McAfee Labs expose the estimate that cyber-attack will engage a raising trend, sketching the anticipation of heightened espionage and cyber-warfare, also toughened by cyberpunks/hackers’ improved schemes and tools for concealing their individuality/emplacement and finally, receives sensible information. As per the report, ‘Attacks on IoT (Internet of Things) devices and its peripherals will enhance speedily because of overactive growth in the count of associated objects, hapless security hygiene, and the high-pitched measure of information on the devices associated with IoT domain, also estimating an approximated count of 50 billion devices to be linked to the cyberspace by 2019. The outcomes delineate the reality that attackers seemingly without any interruption evolve new modes to exploit the secured programs, Information, and networks. On the other hand, on yearly basis, a trend that has been observed is the uninterrupted increment of hand-held device based attacks or approaches.

4. **VULNERABILITY DETECTION METHODOLOGY**

In this research article, a novel vulnerability detection methodology has been proposed, in which well-framed attacking scenarios are performed on a sample webpage. This page has a vulnerable code to test out the proposed attacking scheme. On the detection of vulnerabilities, a standard and suitable countermeasure have been suggested. The entire process has been depicted in Figure 1.
In this article, two major types of vulnerabilities have opted for experiments analysis, which is already discussed in section 2. They are

- SQL injection-based experiment
- Cryptography

Based on the aforementioned experimental results, suitable countermeasures are suggested to tackle different types of vulnerabilities in section V.

4.1. SQL injection-based experiment

Normally SQL statements are text-only statements, which makes it the hackers easy to alter the Statement. Here come the concepts of “tautology”. Tautology-based SQL injection is a process of bypassing the authentication and derives partial or complete information/data through the WHERE clause of any query. Example: Valid data to be entered in the field of username & password is given as which is based on "or"=" string. Figure 1 and 2 depicts an HTML login page and a relevant PHP code in which data is given through the user and standard authentication procedures are followed.
4.2.1 Unsecure Code

Here, the tautology process of casting an erroneousness to make the application to certify the string that is not encapsulating quotes correctly. This way of attacking the SQL query statement, where it constantly conceived to be true on account of "has row" logic in the codification part as illustrated in Figure. This SQL injection attack is primarily employed by the hackers into the query part of the "WHERE" clause. Since the statement is made as a tautology (i.e.: 1=1); query affirmation consequence will always be true. In this way, the hacker obtains all the tuples/records of the table in this case hacker get all rows from the table as depicted in Figure 3.

Figure 2. Unsafe and safe PHP code

Figure 3: Outcomes of the SQL Injection Attack

4.2.2 Secure Code: Countermeasure
To tackle the vulnerability caused by SQL injection, code developers are supposed to validate credential data as “mysqli_real_escape_String”, where v1 and v2 are escaping special characters required to be utilized for constructing the SQL statements for security reasons. Normally, in the secure PHP code depicted in the figure, the credential data are validated and filtered before stored in the database. Whenever a user feeds string data like "or" "=" into fields of username and password respectively, the coded function automatically creates a legal query statement by escaping the special character from the input, later then, which are usually converted as "\or\" and "\=\". Thus, a suitable countermeasure has been suggested.

4.2.3 Cryptography

Cryptography is a special domain in the field of computer science in which original data is encrypted (ciphered) and as of requirement of the user, the ciphered data is decrypted. Both the encryption and decryption are handled through Mathematics logic to enable secure communication. To transfer and receive the most sensitive information across the network (internet), cryptography techniques play a vital role. Figure 4 depicts the basic working mechanism of the cryptography technique.

![Figure 4. Simple Cryptography Process](image)

All sensitive information should be stored and transmitted securely on the internet. The cryptography technique ensures that the data transferred between source and destinations are highly secured and prevents any intrusion by hackers to the maximum extent. Suppose a string like "WELCOME" is needed to be encrypted. Then a specified schema is framed as per the user choice, Example:

\[ABCDEF\ GHIJK\ LMN\ OPQR\ STUV\ WXYZ\]

A schema for encryption and decryption.

\[efghijklmnopqrstuvwxyzabcd\]
Where W=a, E=i, L=p, and so on. On utilizing this, plain text "WELL" encrypt as "aipp".

5. **CYBERSECURITY COUNTERMEASURES**

Most of the unauthorized accession is seemly growing in a sophisticated and broader way, with even many organization secure schemes that were once conceived secure enough versus various menaces now being opened to dangerous cyber-attacks. Thus, this study exposes the suitable countermeasures against various cyber-attacks in association with different sectors like the secure status of industrial bodies, Certification (authentication).

Relying upon the risks to be dealt with, various control conditions and periodic checks may be enforced to assure the integrity, confidentiality, and availability of primary information. Controls may vary from one organization to another, and maybe classified as:

5.1 **Secure Status of Industrial Bodies**

Organizations are supposed to ensure that all their deployed instrumentation (hardware and software), including security software like antivirus, is unremittingly updated as per the current requirement, the most recent set of commands (patches) are installed with the total exclusion of errors. Also, industries need to guarantee the upgrade services and maintenance coverage through third party agreement provided software.

5.2 **Certification**

Relying upon the endangerment assessment, admittance to the company’s schematic codes and data must be always saved solely by an encrypted instruction or password. Nevertheless, particularly for web-based applications or remote access, to ensure the safeness, it is encouraged to employ more complex authentication entails like in leastways, aggregating any two of the following: “something you generate” (e.g. known password), “something you have chosen” (e.g. stochastic PIN generating device), and “something you provide” (e.g. biological identity verification).

5.3 **Grant to Access Information**

Top stakeholders of any organization should frame the regulation which assures the automated accessibility conditions through appropriate restrictions and timely terminations for
departers, declarers, comptroller and all third parties those who have the previous association to the business network. A wide range of verification may deal with these risks, from manual verification (e.g. occasional follow-up upon all exploiter access rights) to automated verification will assure tight security enhancements. (e.g. automated removal of inactive domain records that have no relation to the network).

5.4 Enhancing the level of information retentiveness

Removing all information is considered to be of no use for routine business activities. But retrieval and storage of vital and primal information in advanced back-up servers always assures safer environs. Limiting the control of vital data minimizes the risk factors associated with unauthorized access. (Particularly 20% data stored on the network server of any organization to which most of the victims have no prior knowledge).

5.5 Additional security checks

Detective checks – this kind of checks driven to detect any menace to the data security (e.g. even if the unauthorized approach was contacted, IDS (Intrusion Detection System) supervises the network traffic and distinguishes the defendant access from the right one);

Preventive checks – Those security check are commonly utilized to forestall the rise of any threat (e.g. constraining the illegal access to the organization information, programs, and network systems which autonomously restricts any unauthorized access).

Corrective Checks – Here, the security checks deal to counterbalance the keyed out irregularities (e.g. recovery of regular business routine to the Subsequent of any attack).

6. CONCLUSIONS

There is a broad space for advancement in the global combat against cyber-crime activities. This article aids to enhance the cybersecurity of network systems at the organization level (small, mid, or large), and also created better awareness against the keyed out vulnerabilities in various sectors. This composition theory also presents various countermeasures and it is also found that after choosing the suitable countermeasures, the selected web page was secured and the preferred set of instructions fails to accomplish the vulnerable input strings.
Besides this, the study comprises the evolution and trends of cyber-crime along with their suitable countermeasures especially concentrating on the global awareness concerning cyber-crime and regulative determinations. Finally, all these facts entailed defending the cyber-security domain. For future enhancement diversified approaches to the rise of novel vulnerabilities cases are considered to have experimented for the advanced build-up of the security system (at the domain level and organization level).

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