









Another key threat confronting the oil and gas firms is the disruption of precarious physical operations by cybercriminals in the cyberspace. With the advancement of information technology and its application in different phases of oil and gas making i.e. beginning at oil and gas exploration and production to their processing and distribution, the vulnerability of these industry operations also increases especially to the cyber-attacks.

A cybercriminal with advanced tools, access rights, and with the right knowledge may, for instance, ascertain critical supervisory control and data acquisition systems together with the industrial control systems that are used to run critical oil and gas infrastructure which may be connected to the Internet [5].

Once these attackers get into the system, could be theory likely to start the flow of natural gas or oil over a pipeline to stop then possibly activate an explosion at petrochemical facilities (terrorism) or damage offshore drilling rigs which may lead to oil spills which becomes dangerous in case of fire or cause environmental destruction, outages of energy-supply and even the loss of life [8].

### **2.1.3. Social Engineering**

This is the form of threat that aims at compromising the company's cybersecurity using the employees who are the weakest point of any security. The attacker relies on human interaction to trick users into breaking security procedures in order to gain sensitive information that is typically protected [4]. Systems controls and employees need to learn to be suspicious and recognize such attacks as they are happening. Oil and Gas Company's management should ask basic questions to get a sense of the company's vulnerability [13]. Can anyone gain unauthorized physical access to the company's office or to the executives' e-mail or pretend to be sending messages from their e-mail accounts? Retrieve and modify the source code that runs the company's key products? Access the company's data centre? Employee security education is one of the major ways to prevent cyber threats which should be embraced by the oil and gas companies' management [18].

Therefore, social engineering is seen as the cornerstone and initial point for just about every other targeted attack in the oil and gas industry and indeed any other industry that is susceptible to cyber-attacks. Hackers scrutinize social media sites of the associated companies' staff as well as different online forums including company directories and other sources of intelligence obtainable to them as they look for an advantage that will help them get past the initial security such as firewalls, or at least get past the network perimeter [19].

## **3. Methodology**

This paper uses exploratory research design with an objective to review existing literature and secondary data based on the latest publications and technologies available on the effects of cyber-attacks on oil and gas industries. This research design was guided by the following research questions:

- i. What are the types and forms of cyber-attacks that oil and gas industry face?
- ii. Why these cyber-attacks are targeted to the companies operating in the oil and gas industry?
- iii. What ways through which these cyber-attacks can be mitigated or eliminated?

The researcher conducted the advanced search for the relevant publications from the electronic libraries and databases using the query string(s) defined below:

(Cyber-attacks OR "Cyber threat" OR "Cybersecurity") AND (Oil OR Gas OR Oil\* OR \*Gas\*)

Some of the electronic databases and electronic libraries that were searched by the authors include: Google Scholar, IEEE-Xplore, Elsevier Science Direct, Mendeley, Springer link and ACM Digital Library.

## **4. Results and Discussions**

### **4.1. Top Cyber Security Vulnerabilities for the Oil and Gas Industry and their Mitigation**

While organizations continue to prioritize cybersecurity - and are making good progress in identifying and resolving vulnerabilities - they are more worried than ever about the breadth and complexity of the threat landscape.

To a larger extent, especially in large scale oil and gas producers, Industrial computerization including the implementation of control and safety systems is a phenomenon that is witnessed in the oil and gas industry. The firms in this industry are largely digitized and fairly dependent on digital equipment [20]. Previously, these systems were exclusive but now, to a large extent, they are based on commercially available components such as computers with Microsoft Windows operating system. This implies that commonly well-known vulnerabilities of such standard products will also be visible in the industry.

Equally, in the previous days, the interconnection between process apparatus and control systems were isolated and proprietary unlike nowadays where they are based on Internet technology. Industrial computerization and control systems were previously kept physically separate from typical information systems and the associated open networks. The desire to transmit data from production stage to the information systems coupled with the desire for provision of remote maintenance drives organizations away from such separation because it will be practically impossible. Equally, there is a rise in the use of remote control from an onshore location which usually demands the use and application of common computer networks. Ultimately, this implies **exposure of the production equipment to network and internet related vulnerabilities.**

According to [6] report which is one of the Global Information Security Survey that investigates the most important cybersecurity issues facing organizations today. It captures the responses of nearly 1,200 participants around the globe from over 20 industries. This paper bases the findings and conclusions on those insights and the extensive global experience of working with clients to help them improve their cybersecurity programs in various sectors.

The following findings are from the 40 participants from the oil and gas (O&G) sector as indicated by the Microsoft report [6].

- a. Employee awareness remains important
  - 78% of the respondents consider a careless member of staff as the most likely source of a cyber- attack.
  - 43% of the respondents stated that significant cyber breaches are from a lack of end user awareness, exploited via phishing.
- b. Information security needs board-level attention
  - 87% have not fully considered the information security implications of their current strategy and plans.
  - 46% feel the whole board is knowledgeable about information security.
- c. The risk to reputation is rising
  - 60% have had a recent significant cybersecurity incident.
  - 15% have a robust incident response program and regularly conduct table-top exercises.
- d. A skilled cyber workforce is essential to keep pace with evolving threats
  - 50% say the lack of skilled resources is challenging information security's contribution and value to the organization.
  - 95% say their cybersecurity function does not fully meet their organization's needs.
- e. Challenges are on the rise with the Internet of Things (IoT)
  - 17% feel it is very likely that they would detect a sophisticated cyber-attack.
  - 48% say it will be challenging to ensure that the implemented security controls are meeting the requirements of today.
- f. The financial impact of breaches is not fully examined
  - 97% of the organizations' information security reports do not evaluate financial impact of every significant breach.

- 63% would not increase their cybersecurity spending after experiencing a breach that did

In summary, the following are some of the vulnerabilities facing the oil and gas industry across the globe according to [6]:

- i. Lack of or limited cyber security awareness and training among oil and gas stakeholders. This has mainly been compounded by a long term thinking that cyber security is a preserve of Information Technology and computer science individuals. Whereas these are the individuals that would protect these spaces, they are not monopolies to the ideas and knowhow related to computer security.
- ii. Rampant remote connection and operations and maintenance especially of the oil and gas equipment. As pointed out earlier, this is likely to expose the equipment to the attackers. There is therefore reason to insist on onsite access and maintenance of these systems.
- iii. Tendency to use standard Information Technology products. These products and software have already known weaknesses and so makes it possible for attackers to take advantage of the vulnerabilities to gain access to the oil and gas systems. Instead of standard information systems, oil and gas industry should invest in proprietary and customised systems which will have limited exposure to the cyber-attackers mainly because their vulnerabilities are not so common. There is also reason to conduct frequent penetration tests to ascertain the points of weakness in their systems and provide necessary patches frequently to seal the weaknesses.
- iv. Staying pretty with inadequate cyber security culture within the whole supply chain of oil and gas industry including producers, vendors, suppliers, and contractors etc. Most of the associated individuals have a culture of trusting and so fail to frequently update themselves against cyber-attacks.
- v. Insufficient separation networks. This means, the more organizations want to make their information technology systems interlinked with industrial systems, the more the oil and gas control systems are likely to be exposed to the cybercriminals. There is therefore need to separate industry control and production systems from the usual information systems. Data can be imported from the production systems to the information systems where necessary without interlinking the two.
- vi. The increasing use of mobile devices and mobile storage units including PDAs, IPADS, smartphones etc. There is need to restrict the devices used to access industrial systems and networks. The Bring Your Own Device (BYOD) policy by many other organizations is dangerous especially in managing access control.
- vii. Data networks between offshore and onshore facilities, unless proper security like offering secure channels, data transmission between onshore and offshore sites will remain dangerous. The need for this data is so crucial that it somehow must be shared between the different sites.
- viii. There is also claims of these firms in this industry possessing insufficient physical security of data rooms, cabinets, among others. This makes it a little easy for attackers to physically break into the facilities hosting some critical systems. There is therefore reason to ensure proper and comprehensive physical security in all areas of oil and gas firms.
- ix. Overreliance in vulnerable software is also another challenge. Most of these firms do not want to invest in proprietary and domesticated software. The vulnerable software and components being used will keep on exposing the industry to attacks.
- x. Consistent use of out-dated and ageing control systems in oil and gas facilities. These systems are regarded as legacy systems. Changing them has been resisted over time. Therefore, attackers keep on learning their points of weakness for a long time which increases their chances of penetration.

#### **4.2. Mitigating Cyber Threats and Cyber attacks**

- i. Understand the sources of the threats. The beginning of cybercrime saw stand-alone cybercriminals working on their own personal aims. However, gone are those days and different countries have “wised up” to reap the perceived benefits of cyber espionage and oil and gas industry is a big catch. If different corporations understand the sources of their attacks, they are most likely going to understand how to defend themselves.
- ii. Discover the attacker’s motive. By understanding the threat sources can provide guidance towards discovering the motive

of the espionage hackers. These motives are likely to range from attempt to gaining corporate competitive advantage to system disrupting in an organization or region. The motives of such attacks often indicate the method used to hack. Therefore, when the hacking methods are identified, there is a likely greater understanding of the target system hence leading to an enhanced understanding of the method that will most likely be used to penetrate organizational systems.

- iii. Employ thoughts like those of a hacker. To get hold of cybercriminals accidentally happen. Therefore, thinking like a hacker is likely to offer the organization indication of what the hackers' movements are. Thinking like this should be a norm in an endeavour to protect an organization as opposed to doing it as an aftermath of a breach. Should the company's cyber security squad get into the mind-set of the hacker(s), they will be able to actively look for their own vulnerabilities and comprehend necessary tactics to be used to gain entry and what data/information can be accessed using the discovered methods.
- iv. Develop a proactive approach. Proactive approach to cyber security is usually an effective way of cyber protection. There is a saying that "best defense is implementing good offense" which really makes a lot of sense now and someone once said, "it is now time to start thinking like a bad guy and fight back."
- v. Implement data security frameworks and techniques such as data encryption, intrusion detection and intrusion prevention techniques etc.

### **4.3. An Integrated Approach to Combat Cyber Risk and Securing Operations in Oil and Gas**

The oil and gas industry are advancing towards digitization, robotics, and the Internet of Things (IoT) among other technological evolution. These concepts are speedily being incorporated into the operative atmosphere of oil and gas industry. Equally, the interest of cyber criminals in the industrial operations of oil and gas industry has increased over time subsequently leading to cyber-attacks that have largely compromised both production and safety of this sector. To implement an integrated approach, there is need to:

#### **i. Building a unified program**

For a long time now, the primary motivation behind designing and deploying security controls for physical production processes especially in oil and gas industry has been done to ensure safety. With all these efforts, the scenery of potential attacks now is around the cyber space. These therefore require a unified program to address oil and gas cyber security in a systematic manner across all industry operations by ensuring security, resiliency, and vigilant industrial systems

#### **a. Secure Industrial Systems**

This is about preventing system penetrations or compromises by implementing effective and automated controls and monitoring. It is however not possible to fully secure an information system. But even then, critical assets and infrastructure, and their associated industrial Control Systems, should be in the top of the list. The whole supply chains and its processes should be secured, and its weaknesses mitigated from end-to-end.

#### **b. Vigilant Industrial Systems**

Continuous monitoring of the industrial control systems in the oil and gas industry in addition to security will determine their system's security. Valuable efforts towards vigilance begin with knowing what needs to be defended against. There are numerous evident threat trends in the oil and gas industry, which can provide a decent starting point for understanding the types of attacks targeting industrial control systems. These trends supplemented by a good understanding of the industry's risks will help predict what might occur and so be able to design detection and prevention systems accordingly.

#### **c. Resilient Industrial Systems**

A resilient system should identify potential cyber-attacks, neutralize them, and rapidly restore normal organizational processes. This generally involves detection, response, and recovery. At any specific point of the oil and gas value chain, whether upstream operations, midstream processing plants and pipelines, or downstream refining and delivery logistics, continuous monitoring of equipment should allow real-time detection of any anomalies. This comprises of continually understanding the status of oil and gas pumps, compressors, valves, and process units, including rates of flow and fluid and gas patterns. Continuous visibility and resilience will facilitate rapid reaction to any attacks to eradicate environmental hazards.

#### **ii. Implement key controls**



To be able to implement controls that are necessary to cyber security, there are several pillars necessary to transform cyber security in an information security systems environment of Oil and Gas Companies. By implementing these controls, the companies will be able to provide basic security that will aid in achieving security, vigilance, and resiliency. These basic controls include:

- a. Awareness training: there is need to enforce mechanisms that will ensure cyber security awareness in these companies together with thorough training meant to offer all employees and management the essential skills for interacting with systems in a safe, secure, and responsible manner.
  - b. Access control: Information security system components which include hardware, software applications, and computer networks, should be physically and logically secured by enforcing access control mechanism that will ensure that access is only granted to an individual after strict authentication and authorization has been established.
  - c. Network security: Access to cable and wireless computer networks within the information security system environment of Oil and Gas industry should be restricted and secured in accordance with top notch identity and access management tenets which could include dynamic provisioning and authentication of users, all time monitoring, and end point security.
  - d. Portable media: Use of portable media (the Bring Your Own Device (BYOD)) into the information security systems environment of Oil and Gas industry should restricted and thoroughly scanned for malicious software.
  - e. Incident response: Incident management policies should be developed by implementing such mechanisms such as intrusion detection and carry out penetration tests periodically. This will help detect points of weakness hence be able to provide holistic defense.
- iii. Embrace good governance

The management of the oil and gas companies can consider including cybersecurity in the policies and procedures that govern the day to day operations and business processes of the companies

## Conclusion

Sustained low oil prices are driving the adoption of digitization across the oil and gas industry, ramping up the stakes for cybersecurity. Responses to cyber-attacks must be multi-layered, repelling the most common attacks, with a nuanced approach for advanced and emerging threat vectors in the oil and gas sector. To protect critical information, an oil and gas organization must not only address the security of the traditional ICT environments, it must also deal with the added complexities from the innovative digital business process disruptors, such as robotic process automation, IoTs, blockchain and artificial intelligence. Never before, has it been so important to ensure that security efforts are integrated into every facet of an oil and gas organizations operations, which we call "cyber fusion."

Defending against common attack methods means point solutions remain a key element of cybersecurity resilience, with tools including antivirus software, intruder detection and protection systems (IDS and IPS), consistent patch management and encryption technologies to protect the integrity of data, even if an attacker does gain access to it. Employee awareness is also a crucial frontline defense, building cybersecurity consciousness and password discipline to protect against the relentless malware and phishing campaigns.

Defending against advanced attacks means accepting that attackers will get in and being able to identify intrusions quickly. A Security Operations Center (SOC) that sits at the heart of the organization's cyber threat detection and response capability is an excellent starting point, providing a centralized, structured, and coordinating hub for all cybersecurity activities. SOCs are increasingly moving beyond passive cybersecurity practices into active defense - a deliberately planned and continuously executed campaign that aims to identify and remove hidden attackers and defeat likely threat scenarios targeting the organization's most critical assets.

Defending against emerging attacks, such as the rise in cyber-physical threats, means recognizing that some threats will be unknown, especially in the oil and gas sector, where many are still in the early stages of their digital transformation journeys. Organizations need to build agility into their cybersecurity practices and approaches so that they can react quickly when the time comes. Organizations with good governance processes underlying their operational cyber fusion approach can practice security-by-design - building systems and processes able to respond to unexpected risks and emerging dangers.

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