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Katina, P.F., Pinto, C.A, Bradley, J.M, and Hester, P.T. (2014). Interdependency Induce Risk with Applications to Healthcare. *The International Journal of Critical Infrastructure Protection*, Vol 7.

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Develop effective protection, mitigation recovery measures for critical infrastructures is paramount in reducing natural and human-initiated hazards, risks and threats. Consequently, the nature of understanding systems interdependencies can play an essential role in minimizing the probabilities and consequences. The paper discusses the need for policy makers, infrastructure operators, and researchers to consider alternative approaches in formulating risk and enabling solutions to challenge the 21st-century issues related to interdependent infrastructures. The health care sector is used as an example. Thus, this article review explores the risks associated with managing public sectors and goes beyond the risk formulation to the structural complexity brought by infrastructure interdependencies (Katina, Pinto, Bradly & Hester, 2014).

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Risk refers to the probability of occurrence of an event and the magnitude of the resulting consequences. Some of the different articulations of risk depending on the context includes, in an industrial setting; the risk is associated with the determination of event sequences and the evaluation of event frequencies and probabilities. The notion of risk in modern society is the nature of critical infrastructures whose destruction can have a debilitating impact on public wellbeing. Modern society at high levels depends on the goods and services provided by essential foundations (Katina, et al, 2014). In contrast, critical infrastructures do not operate as isolated systems. Instead, they function as interconnected systems whose state relies on the state of other systems. Due to the technological advancement and ubiquitous computing, managing risk in the context of critical infrastructures may require a reformulation of the notion of uncertainty to deal with the interdependent nature of critical infrastructures.

The idea of critical infrastructures used explains the increase in the importance of the realization that information warfare could leverage the increasing dependence on information warfare. However, this could leverage the rising dependence on information and computerized control systems. As a result, there was the creation of a path for legislation aimed at protecting infrastructures and their users in the United States of America. For example, Europe and other parts of the world embraced the European program for critical infrastructure in 2004 providing security for critical infrastructures in the European Union. The United States national monuments, icons, demand critical manufacturing were identified as vital under Presidential Policy Directive 21 issued by the Obama administration (Katina, et al, 2014).

In the context of essential infrastructures, a consideration of how infrastructure operate is required. Traditional risk formulation offers a breakthrough for developing protection measures against natural and human initiated events by addressing two variables which include probabilities and consequences (Katina, et al, 2014). There is a change in the infrastructure landscape in the 21st century due to increased dependence in services provided which include communication, manufacturing, and technology in general. The effect of such changes is not necessarily affected by geographical location. This risk requires consideration of how infrastructure operates concerning their transboundary and cross border effect.

Infrastructure, on the other hand, has also emerged as an area concern because it may resist tremendous agents because it helps to minimize the normal operation. Another emerging area of interest is fragility of the ability to have breakdowns as a result of outside influences. Also, to note the number the number corresponding to a dependency denotes the level of cascading risk from one infrastructure to another. There remains the need to formulate the risk in interdependent critical infrastructures based on the availability of bidirectional pathways among

infrastructures. To illustrate this, the need to understand the interconnected nature of foundations is significant. Dependency is a unifying concept that enables the consideration of infrastructure risks beyond a system of interest and unidirectional risk (Katina, et al, 2014).

Infrastructural interdependencies relate to the bidirectional relationship between the two infrastructures. By the state of each infrastructure influences the state of each other. Similarly, this suggest that the operability of one infrastructure can be contingent on the operability of one another. It has also been recommended that infrastructure interdependencies increase the overall structure, contribute to system complexity and could be a basis for systems of systems

According to recent research, the risk formulation in the field of critical infrastructures might require a better understanding of the interdependencies existing between infrastructures. A good example is the European Commission suggests that there is a need to understand the dependencies of technological advances such as the internet space-based radio navigation, communication systems among others. The recognition that infrastructures do not operate in isolation suggests the need to develop infrastructure protection measures for example detection, mitigation, and recovery that capture the intricate relationships existing between infrastructures. Gibson, Scherer & Gibson, argues that the notion of infrastructure interdependence requires infrastructure owners, operators, users, and policy makers to have an expansive view of infrastructure systems.

In the process of identifying types of interdependencies the performance of several interdependent factors should be considered for instance hazards, threats, and risk. Similarly, we can categorize infrastructure interdependencies as physical, cyber, geographical and logical interdependencies. Researchers at Idaho National Laboratory proposed the use of the critical

infrastructure Modeling System which engages an agent based approach to model infrastructure elements, relationships between elements and individual component behavior (Katina, et al, 2014). A health care system refers to a collection of related institutions charged with providing direct care. A healthcare system includes hospitals, ambulatory healthcare facilities, nursing, and residential care facilities, individual or group medical practices, health insurance companies, pharmacies, pharmaceutical manufacturers, medical device. In the critical healthcare sector, it is examined how policymakers and infrastructure owners expand their views of risk interdependent infrastructures.

The risk in health care operations relates to the probability of occurrence of an event that would disrupt the expected performance of activities. It also includes the consequences of such an appearance of such an event. Healthcare is indeed not unique; for example, the patient portal technologies patient-focused health by cutting down time-consuming tasks. The technologies introduce new areas of concern such as technical problems, computer experience, computer access, and inaccurate and disorganized information (Wood, et.al.2006, pp.109). Therefore, these areas of concern are essential in a healthcare system because of the potential lives of patient's critical infrastructure. The risk formulation approach in a healthcare setting enables management to consider risk from significant themes. The themes include dependence, exposure, fragility, susceptibility, and reliability among others.

The article relates more broadly to the criminal justice components. Briefly considering the three elements which include law enforcement, court, and corrections critical interdependencies may apply to minimize risk. Thus, risk formulation is crucial, consequently, the critical infrastructures are of considerable interest to the 21st-century society because the destruction of essential assets of infrastructure assets could result in massive financial losses and

causalities (Katina, et al, 2014). To illustrate on the same, we find that law enforcement is crucial in a healthcare system. Thus, risk formulation must account for bidirectional relationships among health care components. In the case of the workforce for instance doctors, nurses, law enforcement must be undertaken to ensure quality patient treatment.

Infrastructure relates to one of the most critical parts of the development. This includes general health transport economic vitality and also security. It is essential to develop it, especially in the 21st century. It is helpfully in easy access to material resources that are used by the country to export and earn income. Failure to take its development will lead to casualties and overuse of financial resources. For this to be enhanced policymakers have to design systems that provide better social facilities especially health facilities. By doing this, it will help you endure the interdependency amongst the countries (Wood, et.al.2006, pp.106). This will ensure the country become dependent on itself thereby reducing the exploitation by other countries. To enhance this facility, they have to put into consideration the opinions from the public concerning the challenges facing them and also the development that they may require to be done to them.

Development in technology is a consideration and also advancement in an institution because these two are interconnected. This primarily reduces the risk that might result from poor infrastructure. Also, these two are interlinked to infrastructure as one is required to know to develop new and advanced technology (Katina, et al, 2014). Interdependency dependency is a risk that should be put into consideration in future as they are the core for the development. Technological advancement dependencies and rapid institutional changes have and will continue creating a web of interconnected infrastructure to maintain public wellbeing since those are a concern for the development. Institution and technology are the core emphasis should be put to reduce the risk of interdependent.

Health care is a critical field that should be considered. Poor health care is caused by the policy that exists due to interdependence and changes in the systems. These policies include regional international examples are the new laws and procedures. The shift in technology will also cause a decline in health facilities. This is because more people will be reluctant to accept the adopted medical facilities. A country should be able to influence its citizen on the adoption of the new technology on health facilities to ensure infrastructure development. The standard tool for identifying interdependent in the infrastructure sector is hospital, this helps to determine the level of the interconnected system for a country (Katina, et al, 2014).. There are several questions that the article raises. For instance, what can be done in the future to the risk of interdependencies in infrastructures and what can be done to improve infrastructures.

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