CROSS-BORDER THREAT SCREENING AND SUPPLY CHAIN DEFENSE
A Department of Homeland Security Center of Excellence

SGL Stochastic Geomechanics Laboratory

R13 - U.S.-Mexico Risk Taskforce to Support the Health Supply Chain Systems for Infrastructure and Workforce Threatened by the COVID19 Pandemic

Monthly Risk-Bulletin November 2020

The objective of the Monthly Risk-Bulletin is to provide an overview a) of lessons learned during the past month in the project, b) of a score-card-type system to communicate the state of risk of supply chains impacted by COVID-19 supporting health infrastructure and the workforce between the U.S. and Mexico, and c) of a communication system to facilitate the restoration of broken supply chains and the formation of new ones to reactivate trade between U.S. and Mexico. The report aims to offer valuable insights to the general public and decision-makers towards informed preventive actions to reduce the current pandemic's potential impact on critical supply chains and better strategize about feasible social, economic, and environmental risk-mitigating actions against COVID19 and converging threats. This bulletin is jointly produced by the project's PIs, the project's contractors, and the U.S.-Mexico binational task force serving as advisors to the project.

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I. Introduction

This risk bulletin report provides an overview of the project status, general objectives, and the most important initial lessons learned during the last period of covered performance. The main objectives of

this project are support all health supply chain systems for both infrastructure and workforce, and to do it accounting for the inherent cultural regional differences, and considering the current and emerging regional social, economic and environmental risks. As a reference for the publication of the Risk Bulletin, the three main milestones of the project are:

1. Integrate a triple-helix binational taskforce comprised of representatives from academia, industry, and government from the U.S. and Mexico. Address the public health impacts of the COVID-19 pandemic on the U.S. – Mexico health supply chain systems for health infrastructure and for the health of the workforce, considering current and emerging regional social, economic, and environmental Risks.
2. Develop a data-lake platform concentrating near real-time analytics following a risk system approach that can provide strategic information about the evolution of COVID19 and related current and emerging threats, the state of vulnerability of the health supply chain systems and the likely impacts a combination of these may cause to society, the economy and the environment.
3. Publish a monthly U.S.-Mexico COVID-19 Risk Bulletin to provide scientific, technological, and strategic cultural support to secure the operation of the U.S.-Mexico health supply chain systems.

II. Project Status & Lessons Learned

Milestone & Activity	Lesson Learned	Type
Milestone 3: Data-Lake		**Research**
Completed definition of the Taskforce members	Engagement and participation of key decision-makers was more difficult than anticipated due to the limited time availability and priorities of government officials.	
Started planning surveys and platform to be used in conjunction with R7 to acquire experts' inputs and opinions for validation of the preliminary risk-model and analytics.	The ongoing pandemic has reduced the frequency and quantity of in-person interactions; thus, an online-based survey system is being inspected to use Qualtrics (https://www.qualtrics.com/) as TAMU provides premium access to SGL faculty and staff.	
Completed a second draft (V1.0) of the risk assessment model being developed in coordination with R-7 which take into consideration multiple geographical locations.	The first draft of risk assessment model shows the degree of complexity for a single geographical location and all interactions that define the state of risk for a supply chain impacted by COVID-19. Naturally, its complexity increases when considering multiple locations interconnected by interactions.	
Used Risk-Model V0.0 to run several 'Test-Case Scenarios' with successful outcomes in terms of variables identification, dependencies, and flow of events	Proved the feasibility of the V0.0 risk model following our risk-framework Scenario 1: PPE and Customer Satisfaction Scenario 2: Medicines Scenario 3: COVID-19 Spread and Health Workers Deaths.	

Defined major sub-activities and responsibilities for each collaborator group and subcontractors to deliver their milestones	The organization of collaborators is shown in Figure 1 and Figure 2	
Started planning surveys and platform to be used in conjunction with R7 to acquire experts' inputs and opinions for validation of the preliminary risk-model and analytics.	The ongoing pandemic has reduced the frequency and quantity of in-person interactions; thus, it is expected to use Qualtrics (https://www.qualtrics.com/) as TAMU provides premium access to SGL faculty and staff.	

Identified US COVID-19 Case surveillance data	Identified patient level data availability. However, it requires sensitive security infrastructure
	
	Public data are only available at the national level, which updates monthly
	• Demographic
	  • Sex = 98 % cases and 99% of deaths
	  • Age = 99% of cases and deaths
	• Race and Ethnicity information is incomplete and not nationally representative
	  • 52% of the cases
	  • 80% of the deaths
	• Epidemiological, Disease exposure, Severity, Test information, Comorbidities	

Milestone 4: Risk-Bulletin		
Finalized preliminary risk model (in coordination with R7) to identify critical variables and processes associated to health infrastructure and the health of the workforce supporting trade supply chains between the U.S. and Mexico.	The Identification of variables and processes will facilitate the classification of available sources of evidence in the U.S. and Mexico	
Used Risk-Model V0.0 to run several 'Test-Case Scenarios'	The model successfully captures the main relationships and outcomes in terms of variables identification, dependencies, and flow of events	
Identified the main U.S. products imports by economic value (USD) from Mexico according to	Top 10 U.S. states based on imports from Mexico trade value (USD) Top 10 U.S. products imports from Mexico trade value (USD)	

the United States Census Bureau USA Trade data (August 2020).	Top 10 U.S. states based on medical instruments imports from Mexico trade value (USD)	
	Top 10 U.S. states based on imports from Mexico trade value (USD): o Texas = $7.80B o Michigan = $4.80B o California = $4.18B o Illinois = $1.15B o Tennessee = $983M o Georgia = $930M o Ohio = $864M o Kentucky = $673M o Arizona = $635M o North Carolina = $623M Top 10 U.S. products imports from Mexico trade value (USD): o Cars = 2.77B o Delivery trucks = 2.36B o Vehicle parts = 2.31B o Computers = 2.18B o Video Displays = 1.13B o Insulated wire = 959M o Crude oil = 821M o Telephones = 652M o **Medical instruments** = 596M o Seats (furniture) = 594M Top 10 U.S. states based on medical instruments imports from Mexico trade value (USD): ▪ California = $216M ▪ Texas = $108M ▪ Ohio = $43.9M ▪ Massachusetts = $37.6M ▪ New Mexico = $33.3M ▪ Arizona = $33.1M ▪ New Jersey = $24.2M ▪ Wisconsin = $18.8M ▪ Minnesota = $13.5M ▪ Delaware = $10.9M	
Generated first-order statistics for relevant U.S. Import codes relating to PPE, Medical Protective Clothing, N95 masks, and Medical Ventilators using	As expected, a significant demand increases during Q2 2020 e.g., ~980% increase YoY for PPE were observed due to the demand shock caused by the pandemic in the U.S.	

information from the Panjiva platform in coordination with R7.		
Designed, developed, and coded initial report for the Panjiva platform	Report generation to be based on Markdown for cross-platform compatibility. This will help us streamline the documentation and publication process of our results.	
Finished initial risk-communication systems review to follow and define our future development tasks	Learned about processes definition, and dashboard development cycles to accelerate the design, development, and publication of future versions of this bulletin.	
Applying for academic access to ProQuest TDM Studio, a web-based developer environment.	Resources available in the TAMU library system with much greater access to their science and databases aggregators for researchers.	
Defined the initial risk-based analytics for decision makers for development and delivery	1. Periodical Semantic Analysis 2. Automated Report and Interactive Dashboard Component 3. Moving Interactive Window of Semantic Evolution over Time 4. Geographical linkage and representation 5. Social & Supply Chain Vulnerability State of Vulnerability 6. US Imports/Exports Analysis from Panjiva for specific products The main hypothesis to test is	
Secured access to commercially available Panjiva platform for Imports and Exports Information	Project PIs should be aware of acquisitions processes to coordinate with the vendor while prospective talks are taking happening to accelerate procurement. Finalized contract and provided access to Graduate Students working on the project.	**Information Technology**
Identified IRB (Institutional Review Board) requirements	Using IRB-free methodologies to gather information from human subjects	**Management**

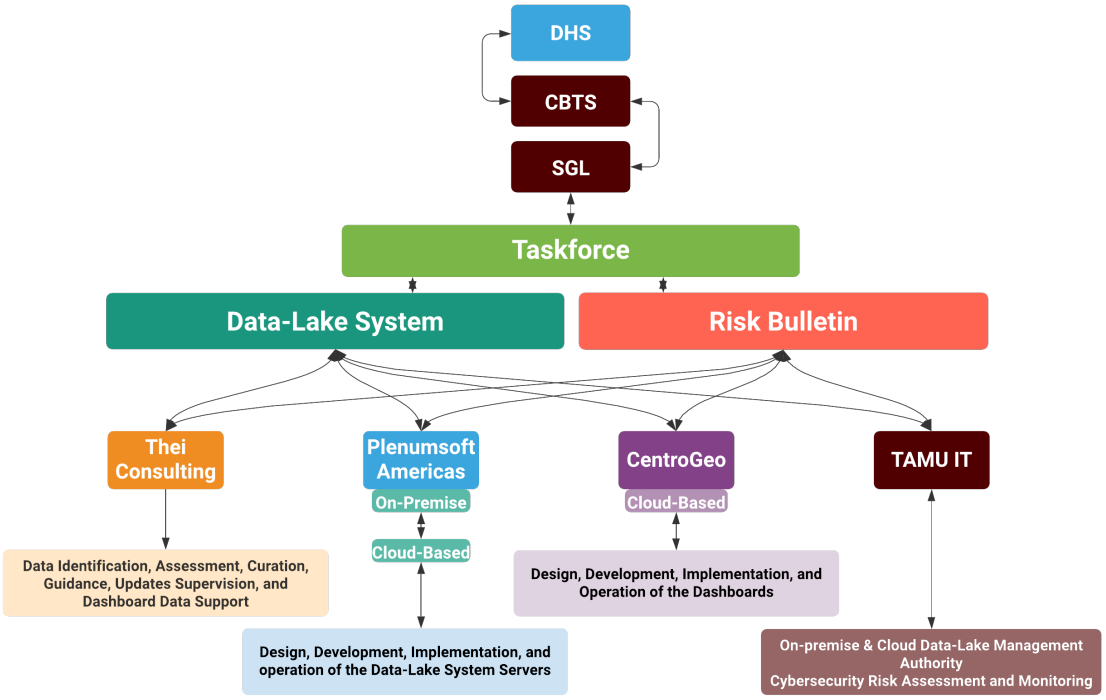

Figure 1. General project overview structure

Key Findings from Literature Review

Defining and creating a Data Management Matrix to aid on the identification of

A) Identification of same variables from Mexican Database in the US to define a plan for harmonization between Mexico & US.

B) Identification and characterization of variables available in the US that are not available in Mexico

C) Identification and characterization of variables available in the US (not available in Mexico)

The goal is to produce both a risk-based 1) analytics and 2) maps, focusing on data that is 'readily' available.

For this purpose, Plenumsoft Americas (R13 contractor) proposed the use of a cross-industry standard process for data mining (CRISP) approach, which started a discussion for data ingestion, processing, structuring and publication in the dashboard of the Data-Lake System. A schematic approach of this standard is presented in Figure 2.

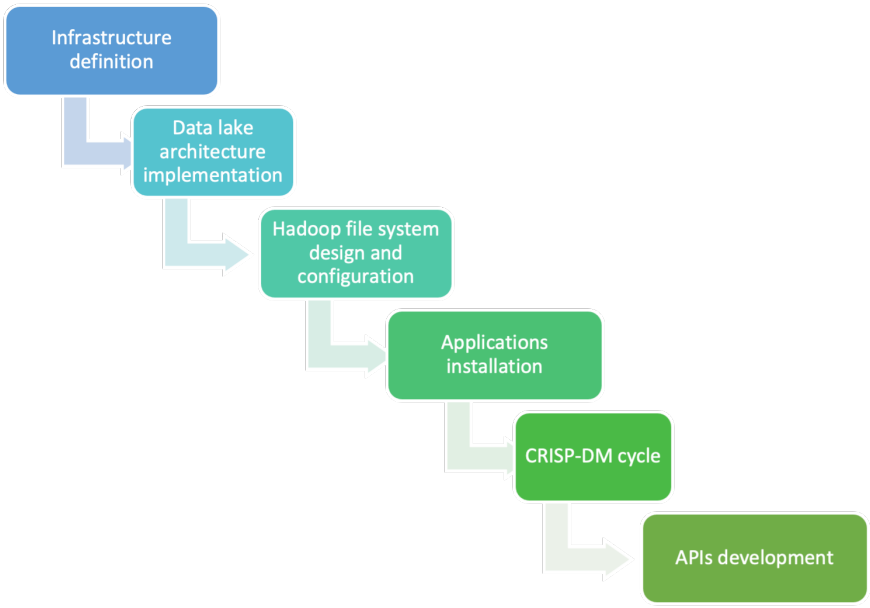

Figure 2. Plenumsoft Americas proposed Data-Lake System's major activities

Below some key risk-related findings during this month:

- Bayesian Network Risk Assessment model development.
  - Characterization of emerging zoonotic diseases:
    - "Emerging infectious diseases (EIDs) are a significant and **growing threat** to global health, global economy and global security" (Fauci & Morens, 2012; Moon et al., 2015; Morens & Fauci, 2013).
    - "Analyses of their trends suggest that their **frequency** and **economic impact** are on the **rise**" (Hufford, 2020; Jones et al., 2008; Pike et al., 2014).
    - "The majority of EIDs (and almost all recent pandemics) originate in **animals**, mostly **wildlife**, and their emergence often involves dynamic interactions among populations of **wildlife**, **livestock**, and **people** within rapidly changing environments" (Jones et al., 2013; Karesh et al., 2012; Wolfe et al., 2007).
    - (Allen et al., 2017) developed a weighted boosted regression tree model to predict the **probability of disease emergence**. The model incorporates spatial predictors such as proxies for human activity, environmental factors, and the zoonotic pathogen pool from which novel diseases could emerge. The model estimated a **high Risk** of emerging infectious disease at the central region of China where the city of **Wuhan** is located.
  - Model development:
    - A Bayesian Network conceptual model was constructed to represent pathways and barriers of zoonotic disease spillover. This model was inspired by a mathematical model developed by Plowright (Plowright et al., 2017)

    - Atmospheric, anthropogenic, oceanographic, hydrological, biological variables were also included in the Bayesian Network model to represent the cause-effect relationship between these variables and the pathways and barriers of zoonotic disease spillover.
- COVID-19 testing.
    - Number of tests per confirmed case:
        - The World Health Organization hosted a COVID-19 virtual press conference on March 30th, 2020. In this conference, Dr. Tedros Adhanom Ghebreyesus suggested a positive rate between **3 – 12%** as a general benchmark of adequate testing. This equals to **8 – 33** tests per confirmed case.
        - Ashish Jha and colleagues at the Harvard Global Health Institute published an article explaining why U.S. needs to have at least a positive rate between **5 – 6%** to open the economy and stay open. This equals to a minimum of **17 – 20** tests per confirmed case (Ashish K. Jha, 2020).
        - (Di Bari et al., 2020) studied the effects of different COVID-19 swab testing policies in in four regions of northern Italy. The author concluded that a **broader policy** for swab testing may contribute to containing COVID-19 threat.
        - (Liang et al., 2020) applied linear regression to a cross-sectional dataset comprising 169 countries. The author found that "**higher COVID-19 mortality** is associated with **lower test number**, lower government effectiveness, aging population, fewer beds, and better transport infrastructure. **Increasing** COVID-19 test number and improving government effectiveness have the potential to reduce Covid-19 related mortality.
        - U.S. is performing 16 tests per confirmed case at national level. Mexico is performing 2 tests per confirmed case at national level. These test numbers are dated from November 5th, 2020 (OWD, 2020).
- Excess mortality.
    - U.S. excess mortality from March 1st – August 16th (Max Roser, 2020):
        - 2020 cumulative confirmed COVID-19 deaths = 169,000.
        - Cumulative excess mortality in comparison with average 2015-2019 = **275,000**.
        - U.S. population = 331 million.
    - Mexico excess mortality from January – November 2020 (Health, 2020):
        - 2020 cumulative confirmed COVID-19 deaths = 97,056.
        - Cumulative excess mortality in comparison with average 2015-2018 = **203,231**.
        - Mexico population = 129 million

Used Risk-Model V0.0 to run three 'Test-Case Scenarios' with successful outcomes in terms of variables identification, dependencies, and flow of events within the risk-framework model. The following scenarios are based on "Understanding Mexican health worker COVID-19 deaths" report from The Lancet journal (September 2020). The purpose of this exercise was to attempt to represent the reported events in the R-7 & R-13 BN Model.

Scenario 1: PPE and Customer Satisfaction

- A shortage of Personal Protective Equipment (PPE) in Mexico's health system at the beginning of

the COVID-19 Pandemic has been reported in several news around the world. As a consequence of the shortage of PPE, "less than 3 weeks after Mexico recorded its first COVID-19 case, staff from a Mexican Social Security Institute (IMSS) hospital blocked a Mexico City road, demanding medical supplies and PPE" (Agren, 2020).

We learned from this case that precise PPE shortage causes are still **unknown**, but some causes can be hypothesized from the Bayesian network model, such as:

- A lack of a **contingency financial plan** supported by the **government** to promptly provide PPEs to the health workers. The Lancet journal (2020) reported an **absence** of **government's support** during the beginning of COVID-19 pandemic that contributed to the shortage.
- The global **demand** of PPEs **surpasses production capacity** of the supply chain. (WHO, 2020a) reported that the supply disruption is caused by rising **demand**, panic buying, hoarding and misuse.
- Failure to **satisfy** the client (health workers) with PPE supply can provoke **protests, unsafe workplaces**, and compromise health workers' **wellbeing**.

Scenario 2: COVID-19 Spread and Health Workers Deaths

- The Pan American Health Organization (WHO, 2020b) reported that **97,632** Mexican health-care workers were **infected** between Feb. 28 and Aug. 23, 2020.
- Amnesty International reported on Sep 3, 2020 that more **Mexican** health-care workers had **died** of COVID-19 (**1,320**) than in **any other country**. The **USA** ranked **second** with **1,077** deaths.
- **Obesity, diabetes, and hypertension** are **common** diseases between Mexican medical doctors, and contribute to these numbers (Agren, 2020).

The team discussed the hypothesis to potentially start the acquisition, extraction, of key components and analyses of periodic sources such as news, media press releases… and other readily available databases to provide valuable critical information to DHS, Taskforce, and other stakeholders about the evolution of the pandemic, and its potential risks, and impacts to key segments of the national supply chain by applying a lexicon, machine learning, probabilistic or hybrid-based methodologies once the data-lake is operational.

A preliminary case study was carried on datasets generated from ProQuest's news aggregators searching for specific keywords (Figure 3).

Figure 3.- Word cloud of the most common words found on the titles ProQuest's News Aggregator during October, 2020 (search keywords= 'supply chain + covid').

III. Risk Communication Mechanism

Risk Communication Literature review key takeaways:

According to (Ellis, 2018; Leiss, 2004), the most effective risk communication strategies are those customized to meet the target audiences' specific interests, concerns, and habits. It has been identified that the following main steps are needed to plan an effective risk communication effort (Bier, 2001):

1. Legal requirements
    1. Organizational policies that constrain the design of the risk communication message or format
2. Purpose of the risk communication
    1. E.g., raising awareness of a hazard, educating people, motivating people, etc.
3. Different risk communication strategies for different purposes
    1. Diagrams, outlines, and analogies
    2. Stakeholder participation processes to reach agreement, monitoring tools for hazardous situations.
4. Characteristics of the audience
    1. Level of knowledge and education
    2. Mental models, and beliefs
5. Sources of audience information
    1. Focus groups, surveys, public information officers, articles, books, etc.

In addition, at least six toolkits examples of previous risk communication strategies were identified.

1. CDC Crisis & Emergency Risk Communication (CERC) (CDC, 2020c)
2. The CDC Clear Communication Index (Index) (CDC, 2020a)
3. CDC Social Vulnerability Index (CDC, 2020b)
4. The *Primer on Health Risk Communication Principles and Practices (Lum & Tinker, 1994)*

5. *Communicating in a Crisis: Risk Communication Guidelines for Public Officials (HSA)(Health & Services, 2002)*
6. The *Crisis and Emergency Risk Communications Toolkit (Lundgren & McMakin, 2018)*
7. *Effective story telling with data ((*Knaflic, 2015)
8. *Census Business Builder (CBB)* (Census, 2020)

IV. Restoration and Creation of Supply Chains

There was no major advancement in this area of the project to report during this cycle.

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