A Systems Approach to Transportation Infrastructure Development using a Concept Map

by

Sam Owusu-Ababio, Ph.D., P.E.
University of Wisconsin-Platteville, USA

Kofi Acheampong, Ph.D., P.E., ENV SP
KCI Technologies, Inc. Sparks, Maryland USA
Presentation Outline

• Background/Context
• Objectives
• Concept Map Basics
• Concept Map Application to Transportation Infrastructure
• Summary and Conclusions
• Recommendations
Recent Disasters Reveal Significant Vulnerabilities in Ghana’s Infrastructure
2015 Accra Floods and Goil Station Explosion

- 256 fatalities

Impacted Infrastructure Sectors

- Drainage system
- Roadway
- Emergency Response Services
- Health Care
- Waste Management
- Water Supply
- Energy sector
- Public Health
- Pharmaceutical
- Commercial Facilities
- Communications
- Financial Services
2017 Kintampo Waterfalls Tragedy

20 Fatalities, 20 Injuries

Impacted Infrastructure Sectors

• Emergency Response Services
• Roadways
• Health Care
• Waste management
• Public Health
2001 Accra Sports Stadium Stampede

127 fatalities

Impacted Infrastructure Sectors

- Emergency Response Services
- Roadway
- Health Care
- Waste Management
- Public Health
Other Disasters

2016 Meningitis outbreak in Ghana (Brong Ahafo): >153 cases >33 fatalities

February 18, 2016 Bus & Truck collision near Kintampo: ≥71 fatalities, 13 injuries

2014 Cholera outbreak: 17,000 cases, >150 fatalities

June 2, 2012 Allied Air Flight 111 cargo plane runway overran: 12 fatalities, multiple ground injuries

Nov 12, 2009 Dompoase mine collapse: >18 fatalities
Earthquake or Seismic Risk Zones of Southern Ghana

How will current infrastructure systems react if....?
Why such Vulnerabilities?

Inadequate planning and disjointed nature of infrastructure systems development in Ghana

- Infrastructure in Ghana occur as *isolated systems* rather than an *integrated system of systems*

Minimal risk assessment performed

Less resilient infrastructure systems
Consequences of having Non-Integrated Infrastructure Systems

High social, environmental, and economic costs from any disaster

Failure in one sector triggers a domino effect on other sectors

Little to zero consideration for infrastructure resiliency
Any relationships between the infrastructure components seen in this picture?
Benefits of a well-planned and integrated Infrastructure

**Risks** to systems can be properly assessed and mitigation measures implemented

**Resiliency** can be built into systems and components

**Restorative** - Less negative consequences on the environment from both man-made and natural disasters (capacity to restore the environment)

**Life-cycle** - Longer life of infrastructure coupled with better levels of service

**ROI** - Preservation of capital investment and resources made in infrastructure
Objectives

Use a concept map approach to depict the **functional and spatial organization** (network of system inter-relationships) within transportation infrastructure systems.

Apply concept map to depict relationships between the transportation system and other infrastructure systems.
What is a Concept Map?

A visual representation of how to organize and structure knowledge-base regarding a subject of interest

Uses boxes/or circles with connected arrows and a word or phrase to illustrate the relationship between concepts
Facilitates lateral thinking, brainstorm and generate new ideas

Integration of ideas and concepts

Gain enhanced knowledge about a subject for evaluation and proper decision-making
Disasters can create widespread impacts across multiple sectors of infrastructure and society

Most of Ghana’s infrastructure systems are fragmented and unorganized

Recent disasters have exposed severe vulnerabilities in Ghana’s infrastructure, which has failed to keep pace with population growth after years of rapid economic expansion
Recommendations

Approach infrastructure planning and development from a systems standpoint

Incorporate risk analysis and resiliency in infrastructure project delivery to minimize social, environmental, and economic costs that can result from disasters.
Thank You!!

Questions?