Nowadays, lifeline systems provide the main utility or transportation services to a community. The scope of interdependency of the lifeline systems plays a crucial role on the vulnerability of a community as one or more systems begin to fail leading to a domino effect which could result in a major shut down. Linear infrastructure systems (roads, water/sewer/power lines) are often interdependent due to the similarities in their design purposes to provide the necessary services. Therefore, failure of one infrastructure can result in the disfunction of other infrastructures, which can cause severe economic disruption and loss of life or failure of services which hinder public health and well-being. The key impacts of bottlenecks in interdependent linear infrastructure systems (ILIS) are reduction of system reliability and oscillations in service delivery capacity. In order to minimize the effects of these events the development of solutions and approaches to support Critical Infrastructures Protection (CIP) are necessary.

The objective of this research is introducing a methodological framework of multi-criteria risk assessment technique was developed for integrated linear infrastructure systems (ILIS) to comprehensively analyze for finding critical area by overlaying critical points of each infrastructure points (Transportation and sewer networks critical point) and land use map. On the other hand, provides the system for hazardous modes rating and develop a smart and unified system for risk management analysis of interdependent linear infrastructure systems.

### General factors of interdependent infrastructure systems

#### I. Design Factors
- Components
- Age
- Pipe Materials
- Pipe Length
- Pipe capacity
- System redundancy
- Degree of Automation
- Pipe pressure
- Material being pipe

#### II. Operational Factors
- Number of people employed
- Quantification
- Qualification
- Periodic Training program
- Frequency of Inspections
- Work Hours
- Morale
- Work Ethics

#### III. Environmental Factors
- Geology
- Weather
- Ecology

#### IV. Urban Factors
- Pipeline Network
- Transportation network
- Land use

#### IV. Acts of God
- Earthquake
- Flood
- Hurricane

### Methodology

This research provides a hierarchy system for risk management. Urban factors divide to three GIS base factors including Pipeline Network, Transportation network and land use. Therefore critical points and areas can be identify and classify by Arcmap software. AHP method use in this research based on three main principals including dissection, comparison judgment and combination of priority steps. Four other factors, hazardous modes are identified base identification of causes of failure, identification of failure detection means and identification of effects of failure. After identification of each hazard mode, the each failure mode should be rated in a systematic manner. Failure frequency, Failure mode detection probability and the consequence of a failure are rated quantitatively on a scale of 1 to 10. An ILIS consequence number (ILIS-CN) will be developed using criteria based on frequency and severity of consequences and detectability rating.

ILIS-CN=(failure mode frequency rating)*(detectability rating)*(severity rating)

### Conclusion and Results

After classifications and identification critical points of each layer for urban factor. They will be overlay in Arcmap software and finally critical areas of integrated linear infrastructure system will be determined. On the other hand, an analysis of the ILIS-CN corresponding to hazard factors can provide information to identify areas which need to be addressed for risk reduction.

The results of this research can be used:

1. To develop strategies to minimize service interruptions in lifeline systems areas where agencies can coordinate maintenance schedules to maximize maintenance efficiencies to improve service quality and reduce cost.
2. Decision-making improve service quality under dynamics factors.
3. To improving service quality by smart maintenance planning water/sewer infrastructure.
4. Provide the unified system and tool to maintenance infrastructure systems by consideration most of related factors for failure.

### Acknowledgements

Funding for this research has been provided by Southeastern Transportation Research, Innovation, Development & Education Center STRIDE, University Transportation Center of University of Florida.