KENEXIS

Bowtie Analysis

Theory and Fundamentals

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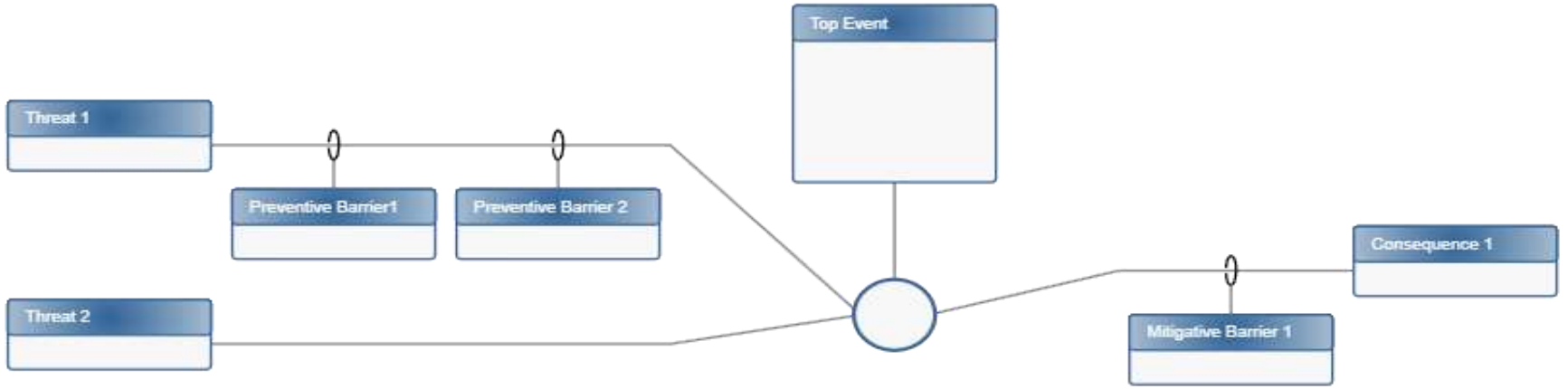
Agenda

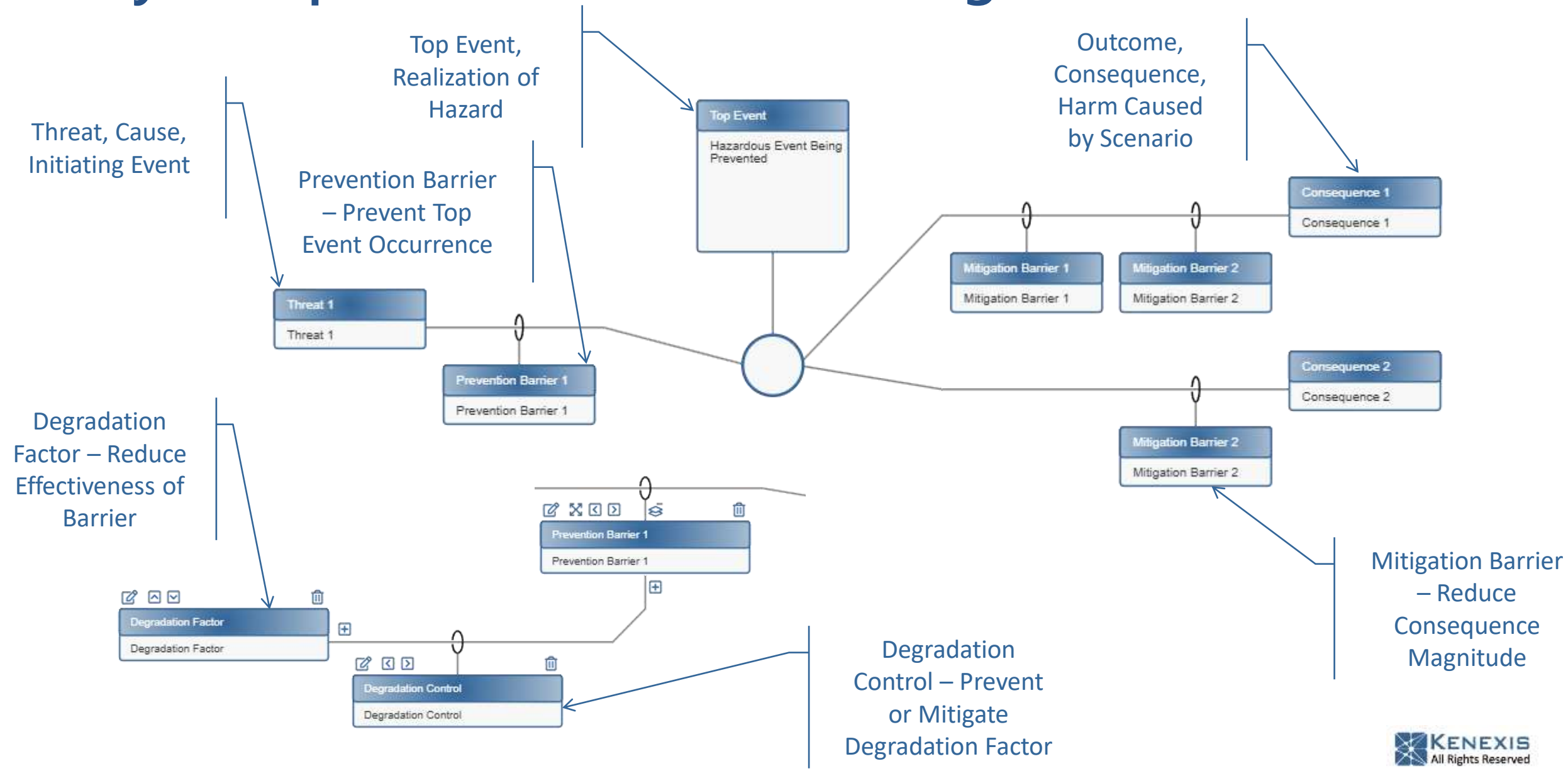
- Introduction
- Overview of Bowtie Diagram Components
- Key Terminology for Hazards, Threats, Top Events, Consequences, and Barriers
- Understanding Preventive and Mitigative Barriers
- Data Center Example



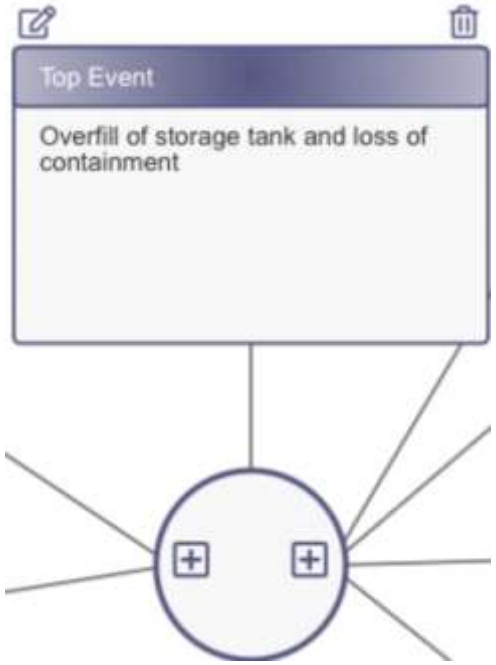
Bowtie Diagrams – Visualizing Risk

- Visualizing Risk Pathways:
  - Bowtie diagrams provide a clear, visual representation of the relationship between causes (threats) and effects (consequences) of hazardous events
  - Bridging the Gap Between Qualitative Visualization and Quantitative Analysis
  - Industry Applications: Used across various sectors (e.g., Chemical, Oil & Gas, Aerospace, Pharmaceuticals) to identify gaps in risk controls and improve safety management

Key Components of a Bowtie Diagram



Understanding Hazards and Top Events



- Hazards
  - The source of potential harm or risk
  - Can be physical, chemical, environmental, operational, or human-related
- Top Events
  - The critical point where control over the hazard is lost
  - The incident that occurs when threats materialize and barriers fail
  - Represents the moment when control over hazard is lost
- Relationship Between Hazards and Top Events
  - Hazards always exist
  - Top event marks the transition to potential consequences
  - Top event connects the threats and consequences

Understanding Threats (Causes)

- Definition of Threats
  - Events, actions, or conditions that could cause the top event
  - Direct causes that initiate the loss of control over a hazard
- Types of Threats
  - Operational (e.g., equipment failure, human error)
  - Environmental (e.g., extreme weather conditions, earthquakes)
  - Procedural (e.g., poor maintenance, inadequate safety protocols)
- Role of Threats in a Bowtie Diagram
  - Identified on the left side, connected to the top event
  - Threats are the factors that barriers aim to prevent or control

Understanding Consequences

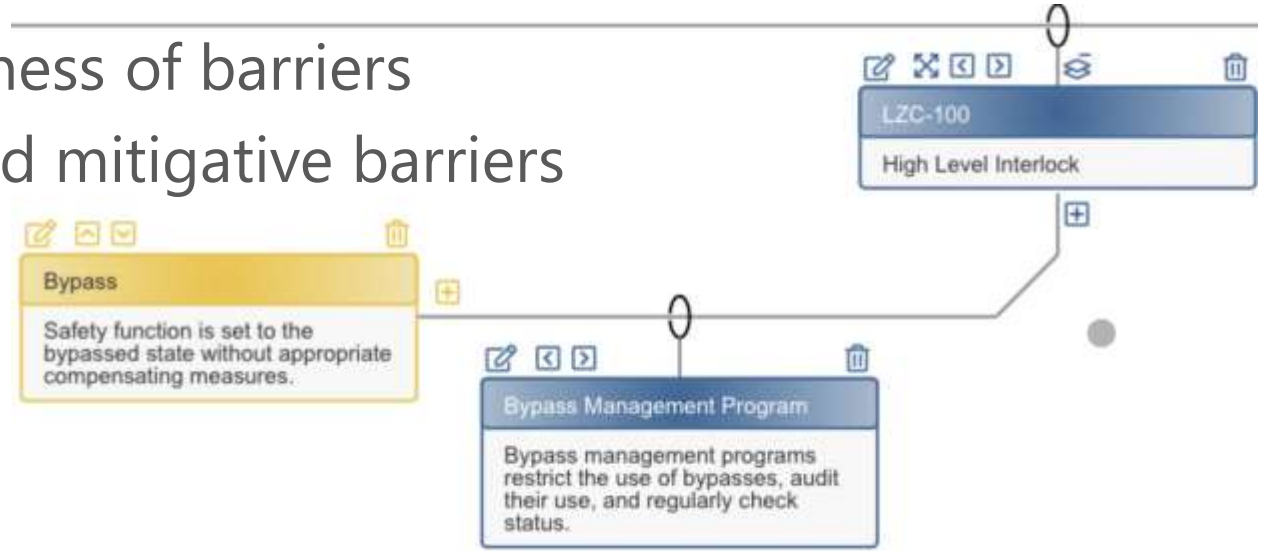
- Definition of Consequences
  - The outcomes or impacts if the top event occurs
  - Potential damage to people, property, environment, or business operations
  - Degree of harm from loss of control of hazard
- Types of Consequences
  - Safety, Environmental, Asset (Financial), Reputation, Community
  - Other – based on application
- Role of Consequences in a Bowtie Diagram
  - Located on the right side, stemming from the top event
  - Loss of control can result in many different consequences
  - Help prioritize risk mitigation strategies based on severity

Understanding Barriers – Preventive and Mitigative

- Definition of Barriers
  - Controls implemented to either prevent the top event or reduce the impact of its consequences
- Preventive Barriers
  - Designed to stop the top event from occurring
  - Positioned between threats and the top event
  - Examples: Alarm systems, maintenance, emergency shutdown
- Mitigative Barriers
  - Minimize the consequences if the top event occurs
  - Positioned between the top event and consequences
  - Examples: Fire suppression systems, evacuation procedures
- Role of Barriers in Risk Management
  - Barriers act as safeguards to protect against risks
  - Effectiveness of barriers depends on their design, implementation, and maintenance

Understanding Degradation Factors and Controls

- Definition of Degradation Factors
  - Conditions that reduce the effectiveness of barriers
  - Can compromise both preventive and mitigative barriers
- Types of Degradation Factors
  - Human Factors
  - Environmental Factors
  - Operational Factors
- Degradation Controls
  - Measures put in place to maintain the effectiveness of barriers despite degradation factors
  - Regular inspections, maintenance, training, and testing of equipment or processes



Common Pitfalls in Bowtie Diagram Construction

- Incomplete Threat or Consequence Identification
- Over-Simplification of Barriers
- Failure to Account for Degradation Factors
- Misplacing or Mislabeling Barriers
- Lack of Quantification
- Failure to Validate Bowtie Diagrams

Step-By-Step Guide to Building a Bowtie Diagram

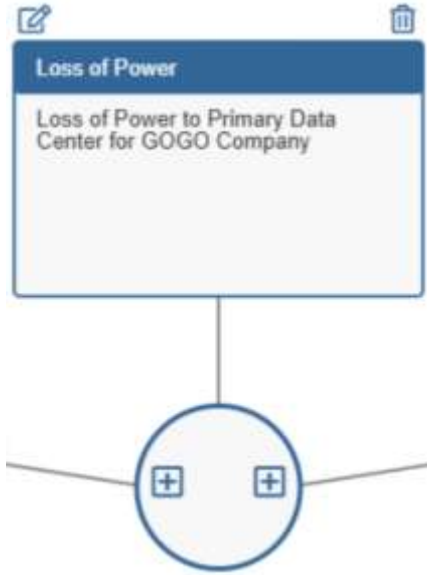
1. Identify the hazard
2. Determine the top event
3. Identify threats
4. Identify consequences
5. Add preventive barriers
6. Add mitigative barriers
7. Incorporate degradation factors
8. Assign degradation controls
9. Validate the diagram

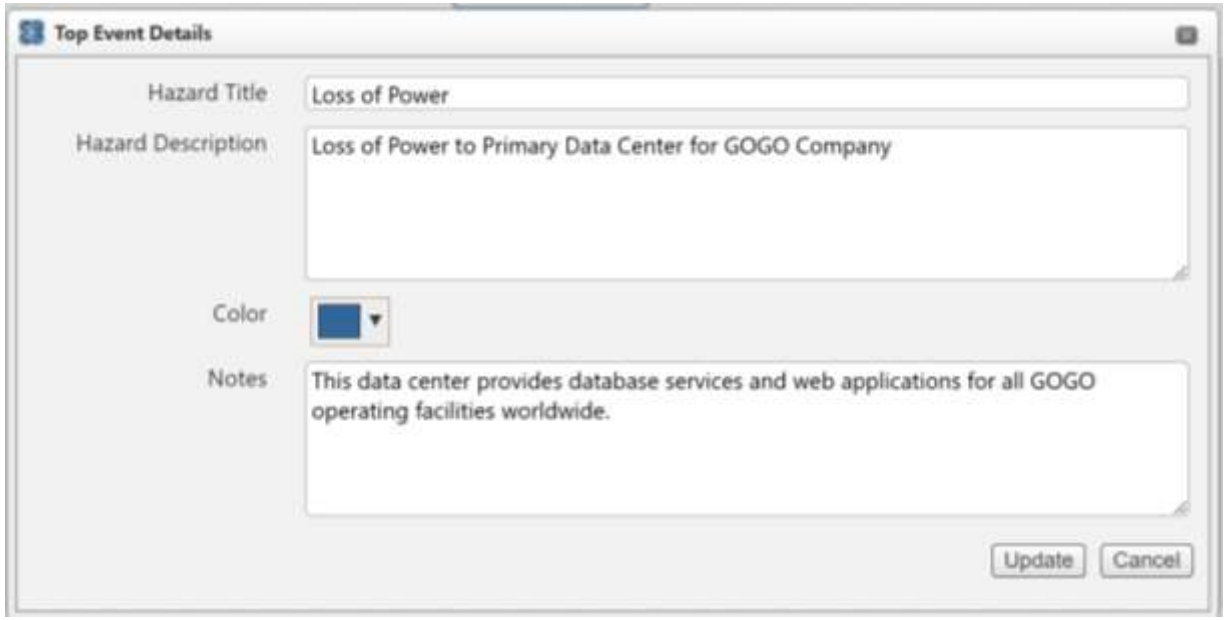
Practical Example – Building Loss of Power

- Consider a data center building that is used to house your company's databases and cloud computing infrastructure

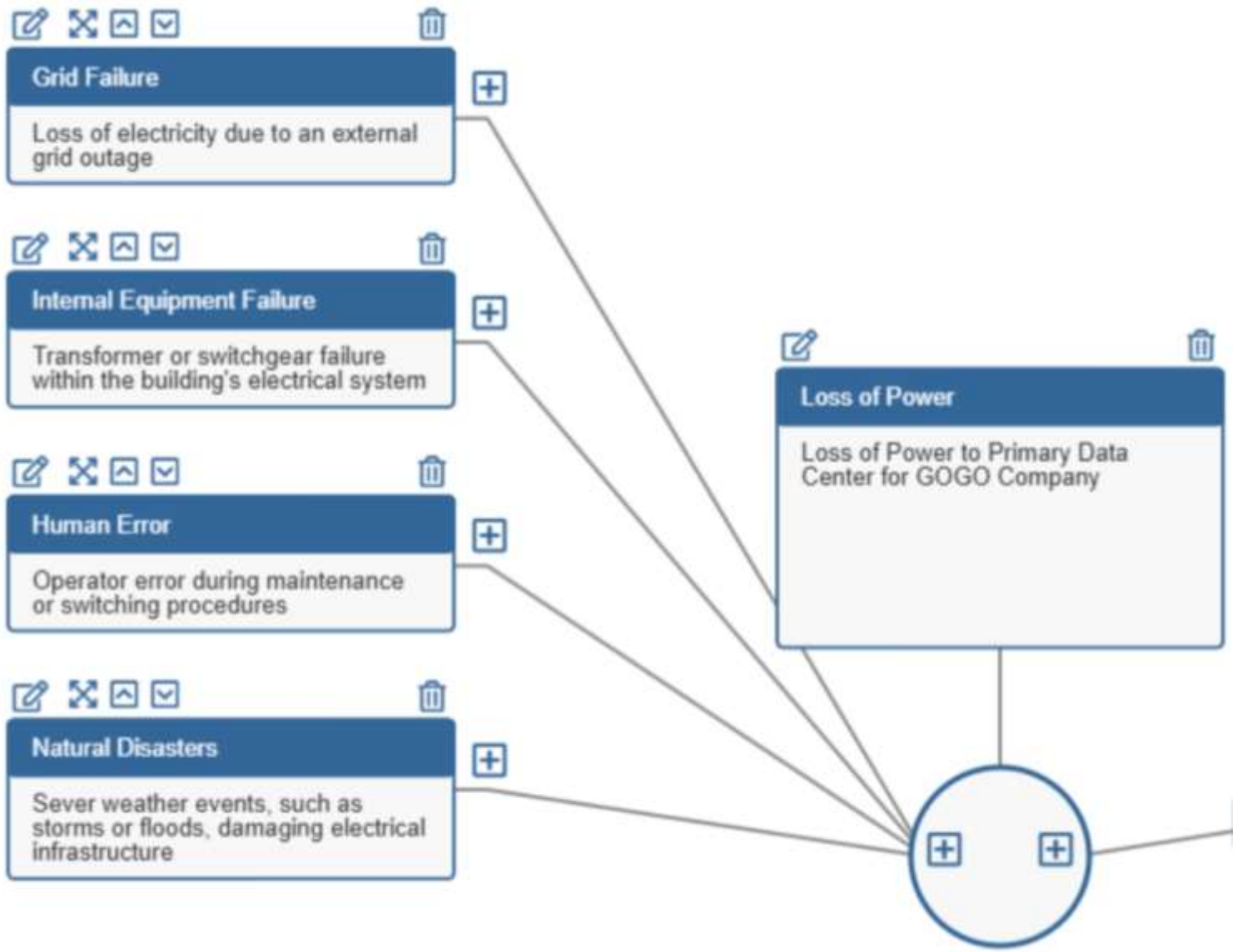
Data Center Example – Hazard and Top Event

- **Hazard:**
  - Electrical power supply to a critical building or facility (e.g., hospital, data center, office building).
- **Top Event:**
  - Complete loss of electrical supply to the building.

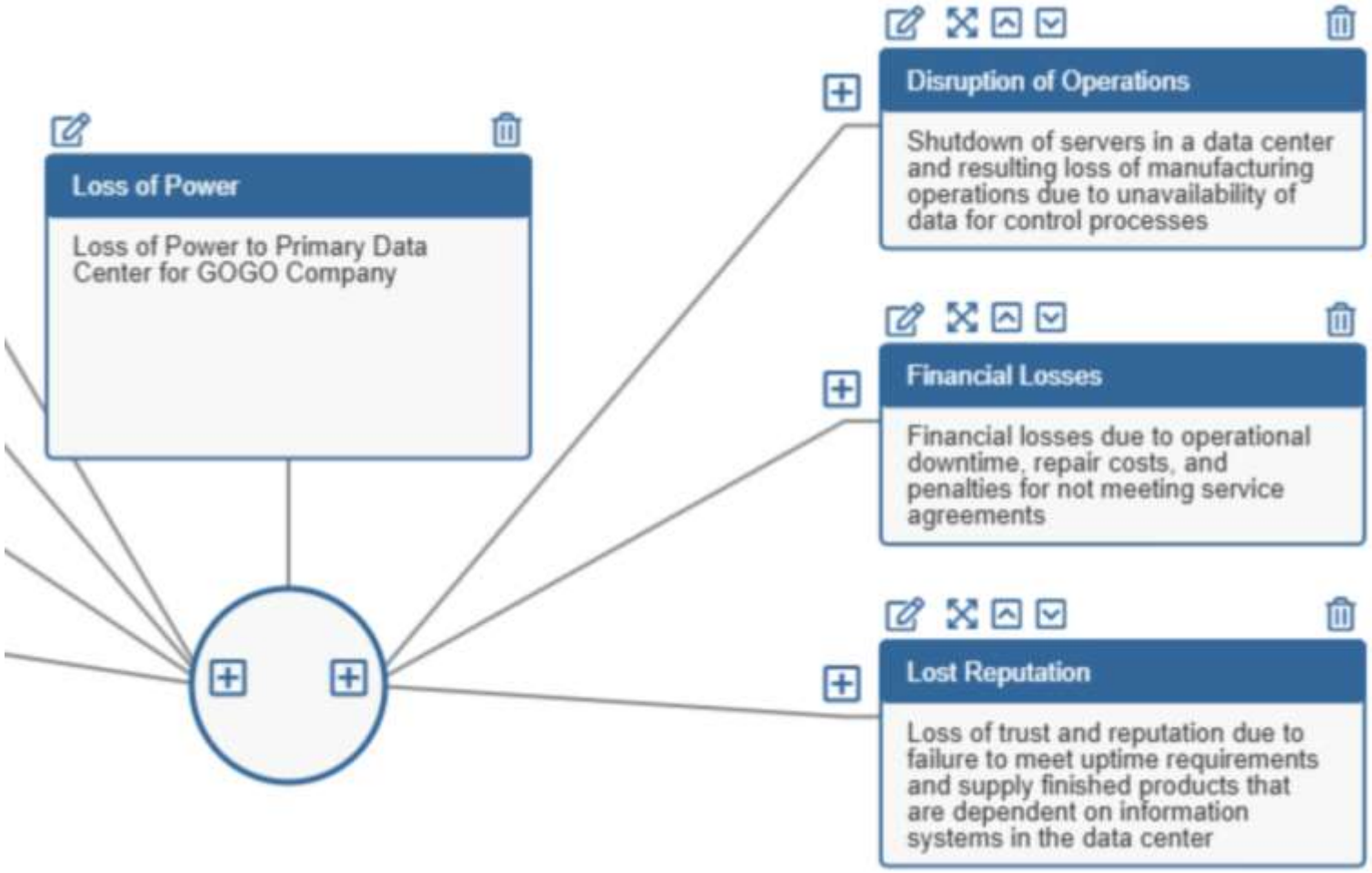




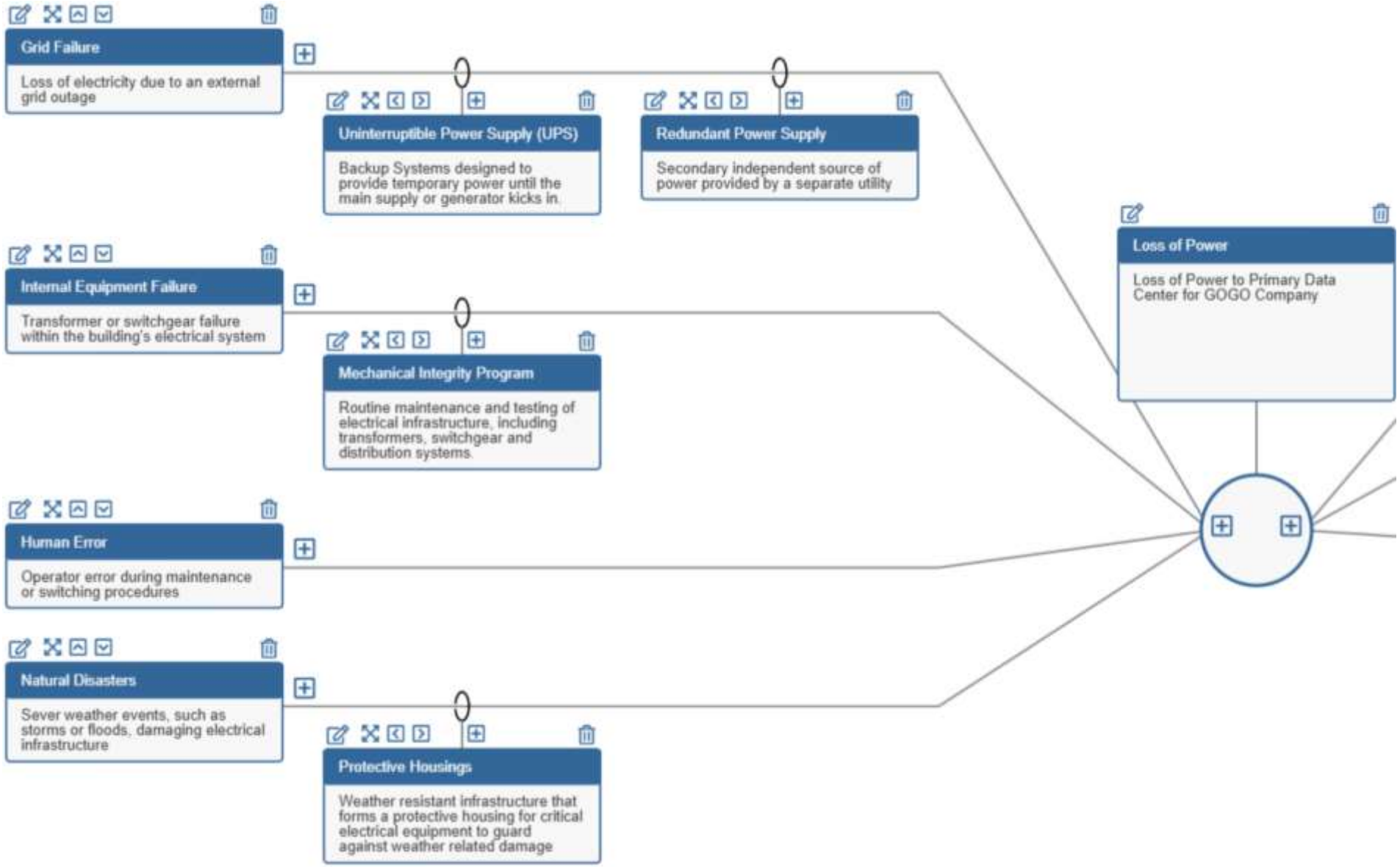
Data Center Example - Threats



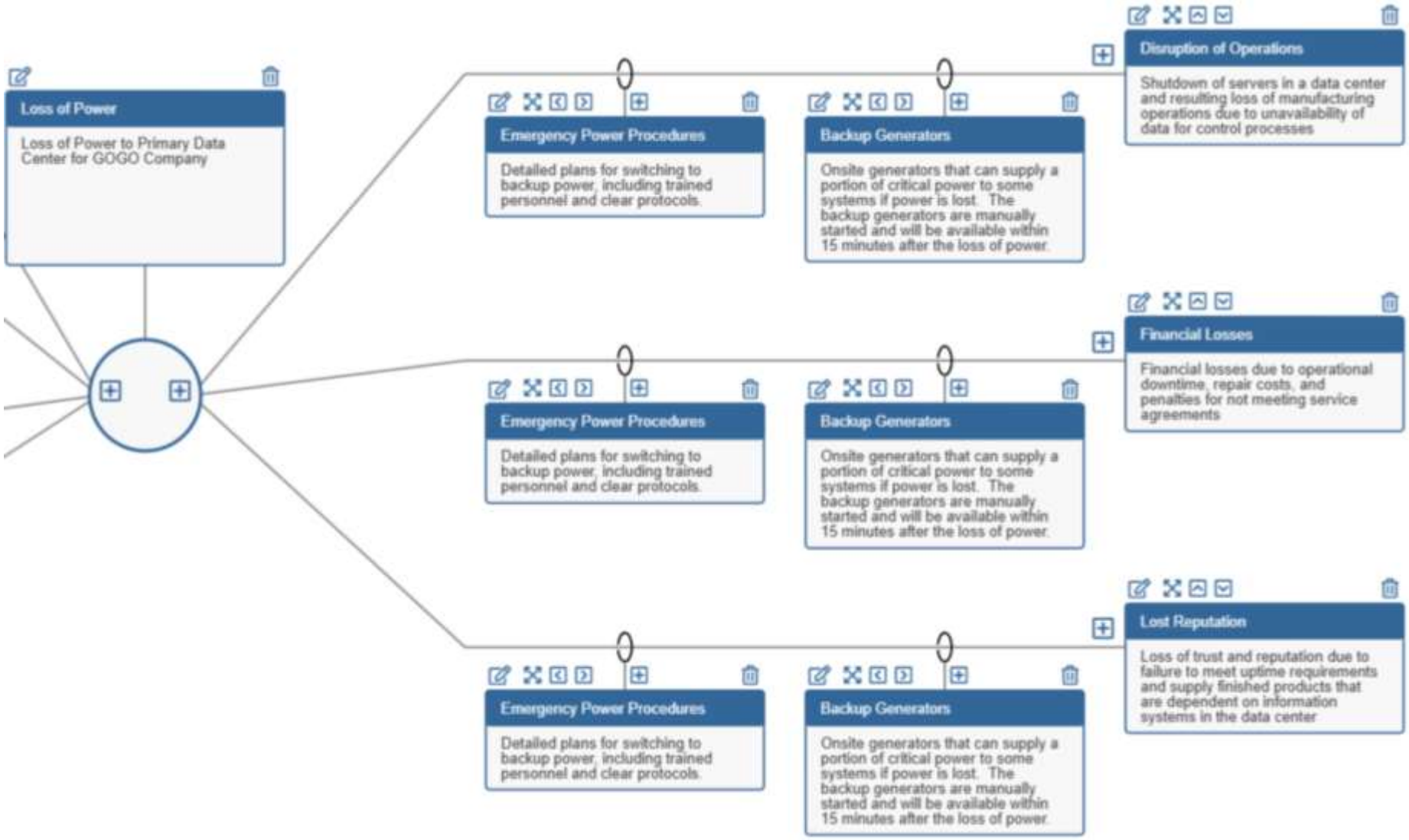
Data Center Example - Consequences



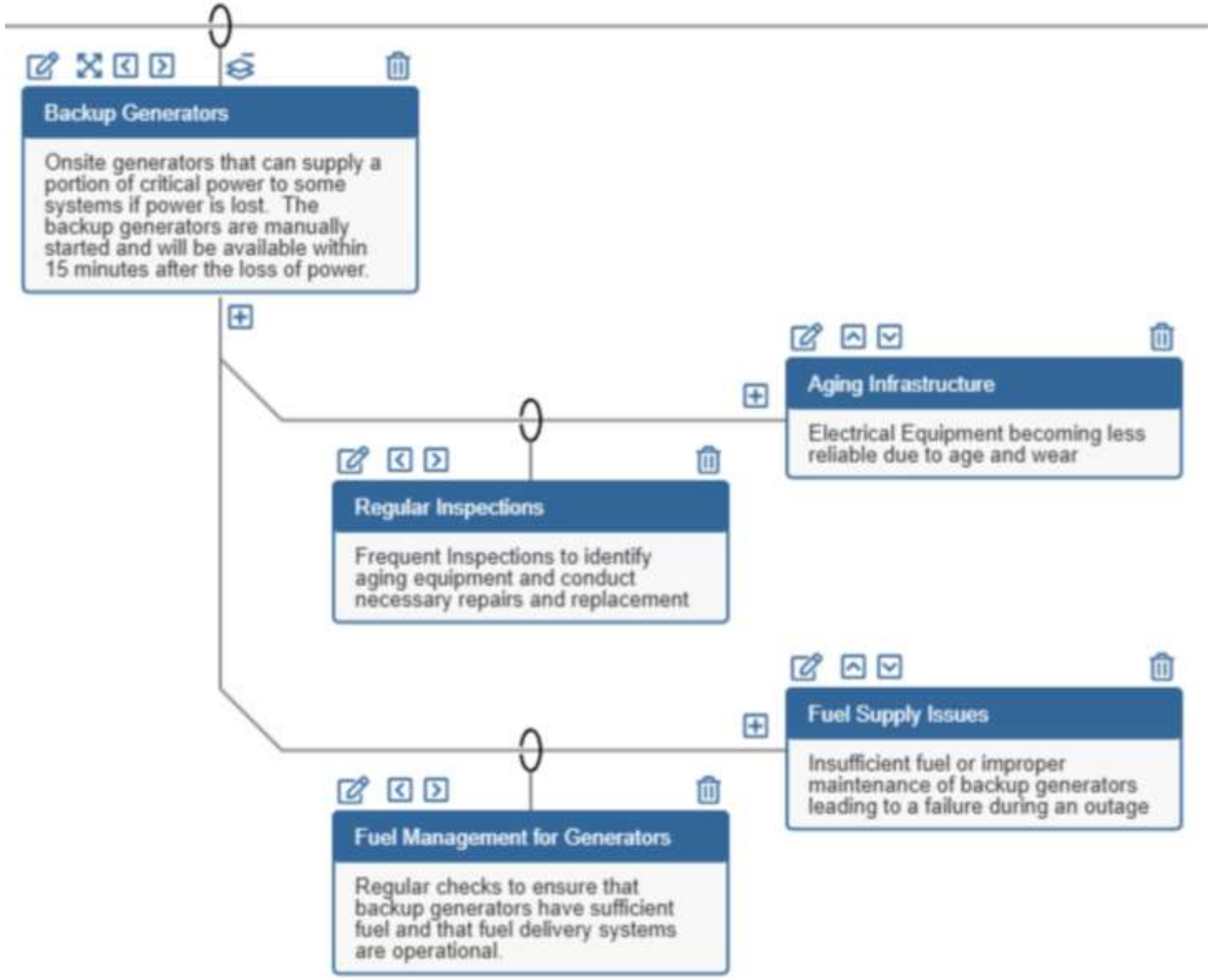
Data Center Example – Barriers (Preventive)



Data Center Example – Barriers (Mitigative)



Data Center – Degradation Factors and Controls



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