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# The Electric Revolution: Fully Electric Transportation System on an Urban College Campus

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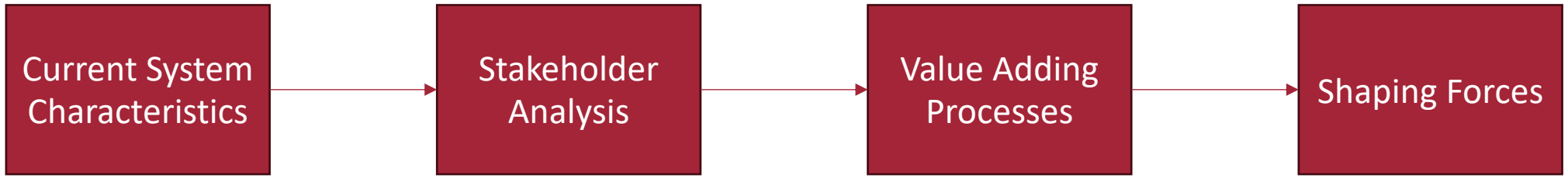
# Background

- Increase in Global Environmental Consciousness
- Study Focuses on College Universities
- Major University Environmental Impacts:
  - Congestion
  - Pollution
  - Limited Parking
- **Solution:** Implement a Fully Electric Transportation System
  - Use of Electric Vehicles (EVs)
  - Elimination of gas-powered vehicles

# Systems Thinking Methodology

- Systems Thinking Approach was Utilized
  - System is overly complex for traditional systems engineering approach
    - Involves many actors, interactions, and subprocesses
  - Provides a framework for solutions to be implemented
  - Better approach for holistically characterizing the system
- Methodology Process Flow:




- System Background
- New system benefits / challenges
- Driving Forces

- Stakeholder Involvement
- Stakeholder Needs

- Subprocesses that impact the system flow

- Processes that are interacting with the system (internal / external)

# Benefits

- Carbon-free transportation on a campus
  - Reduces local air and noise pollution
- Incentivizes local businesses to upgrade transportation systems
- Inspires new research opportunities
- Campus public relations are improved – sustainability leader

# Challenges

- EV Infrastructure
  - Availability of charging stations
  - Substantial cost to implement EV infrastructure
  - Maintenance plan for continued operations
- Campus Culture and Behavior
  - Large investment costs for off-campus commuters (purchasing EV)
  - Training required for operating and maintaining campus equipment
  - New systems may disrupt current transportation methods

# Driving Forces

- Institutional commitment to environmental sustainability
- EVs are becoming a more practical transportation method
  - Improved battery performance
  - Increased charging infrastructure nationally
  - More widespread adoption
- Community attitude shift towards sustainability

# Stakeholder Analysis

| Stakeholder | Description / Requirements | Active / Passive |
|---|---|---|
| Students | Attending the university for advanced degrees.<br>• Requires reliable & convenient transport between classes and extracurricular activities. | Active |
| Faculty | Teach and support students with academic studies.<br>• Requires efficient and available transportation to classes and research centers | Active |
| Campus Administration | Allocate university's financial resources toward strategic investments. | Active |
| Environmental Advocates | Advocate for projects that reduce carbon emissions and promote sustainability. Seek to ensure project meets sustainability and environmental goals. | Active |
| Local Community | Residents and local businesses who may be potentially impacted by the transportation network (ie. Traffic noise, traffic flow / management, quality of life) | Passive |
| Transportation Experts | Support the implementation of EV technology into new networks. | Active |
| Maintenance and Operations | Teams responsible for the upkeep and continued operation of the transportation network once implemented. | Active |
| Regulatory Authorities | Policy makers and legal bodies that dictate the requirements for EV and transportation networks. | Passive |
| Energy Providers | Supply power that will be used to charge the EVs via power stations. | Passive |
| Future Generations | Prospective students and staff who will be impacted by the implementation of the EV transportation network. | Passive |

# Value Adding Processes

| | |
|---|---|
| Sustainable Mobility Facilitation | • **Purpose:** Provides eco-friendly mode of transport for campus community.<br>• **Value:** Reduces air and noise pollution while contributing to healthier environment.<br>• **Process:** charging infrastructure, energy consumption, and vehicle utilized. |
| Energy Infrastructure Management | • **Purpose:** Provide reliable and efficient energy supply to transportation network.<br>• **Value:** Provides uninterrupted charging and minimizes down-time.<br>• **Process:** Design and maintenance of charging stations. Optimization of load distribution. |
| User Experience Enhancement | • **Purpose:** Create convenient transportation experience for system users.<br>• **Value:** Improves campus accessibility, reduces travel time, and enhances community satisfaction.<br>• **Process:** Use of mobile apps to make vehicle reservations, check charging stations, and track bus location. |
| Data-Driven Decision Making | • **Purpose:** Make informed decisions for future enhancements / optimization using data analysis methods.<br>• **Value:** Efficiency improvement, better maintenance prediction, and adaptation to shifting demands.<br>• **Process:** Implementation of data collection sensors and development of analytic tools for analysis. |
| Collaborative Stakeholder Engagement | • **Purpose:** Build and maintain communication among stakeholder groups within transport system.<br>• **Value:** Creates a supportive network to ensure issues are properly addressed and benefits all groups.<br>• **Process:** Consultation with various stakeholder groups to collect feedback and provide updates. |
| Technological Innovation and Adaptation | • **Purpose:** Remain at the forefront of electric transportation technology and advancements.<br>• **Value:** Staying relevant and efficient as well as being a good model for sustainability and innovation.<br>• **Process:** Continuous research and collaboration with sustainability and transportation experts. |

# Shaping Forces

## Integration with Multi-Modal Transportation

- **Rationale:** Other modes of transportation exist and must be accounted for (ie. Bicycles and scooters)
- **Shaping Force:** Individuals prefer multiple modes of transport and value seamless transfers.

## Long-Term System Scalability

- **Rationale:** Initial implementation may not address future needs with increased campus population growth.
- **Shaping Force:** System must accommodate expansion without significant disruptions or expensive overhauls.

## Dynamic Demand Management

- **Rationale:** Transportation services demand fluctuations may cause under- or over-utilization of services.
- **Shaping Force:** Adaptive approaches integrated in the network will be key to managing demand fluctuations.

## Sustainability and Long-Term Changes

- **Rationale:** All phases of the lifecycle for products used within the network is not accounted for in the system.
- **Shaping Force:** Increase emphasis on life cycle assessment for environmentally friendly component manufacturing and disposal will be important, especially to certain stakeholder groups.

# Conclusion

- A systems thinking framework was used to define EV transportation systems for college campuses.
  - Framework identified key stakeholders, value adding processes, and shaping forces.
- A key factor of this system is intent of creating and maintaining an environmentally friendly transportation network.

# Future Work

- Potential Research Projects and Emerging Technologies
  - Advanced EV technology
  - Emerging smart grid solutions
  - Sustainable urban planning
- Data analysis for system efficiency and effectiveness once transportation network has been established on campuses.
  - Comparative analysis based on historical efficiency data collected for existing transportation networks.
  - Identify future modification or upgrade plans to further enhance the system.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# Questions?