Interstate Highway

group 5: Junyao Liu
    Jacob Patterson
    Hanzhao Xiao
    Boyu Zhang
Background

Interstate highway is several highways connect all of the states of US, as of 2016, the total length is 48,181 miles. The interstate highway was firstly constructed on 1956 and as of 2016, the total cost is approximately 499 billion dollars.

Our mission is to analyze the potential problems of interstate highway from the internal perspective and external perspective and explore the solutions to prevent the failures and solve the problems by using quality analysis methods.
<table>
<thead>
<tr>
<th>interstate Highway users</th>
<th>Before</th>
<th>In Emergency</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>government</td>
<td>resting area</td>
<td>Above-average congestion</td>
<td>maintenance</td>
</tr>
<tr>
<td>truck drivers</td>
<td>emergency stop lane</td>
<td>evacuation</td>
<td>public report</td>
</tr>
<tr>
<td>travelers</td>
<td>manned and automatic</td>
<td>response on time</td>
<td>training</td>
</tr>
<tr>
<td>shipping companies</td>
<td>camera recording every</td>
<td>transportation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>vehicle enter and exit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>police officers</td>
<td>education</td>
<td>medical support</td>
<td></td>
</tr>
<tr>
<td>highway construction works</td>
<td>monitoring</td>
<td>emergency broadcast</td>
<td></td>
</tr>
<tr>
<td>military</td>
<td>training</td>
<td>block entrance</td>
<td></td>
</tr>
</tbody>
</table>
Process Flowchart (in progress)
Organizational Flowchart (in progress)
# Cost of Poor Quality

<table>
<thead>
<tr>
<th>COPQ</th>
<th>Internal</th>
<th>External</th>
<th>Appraisal</th>
<th>Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>evacuation</td>
<td>- traffic jamed</td>
<td>- people panic</td>
<td>- check the real-time traffic status of the road</td>
<td>- clear the traffic</td>
</tr>
<tr>
<td></td>
<td>- road destroyed</td>
<td>- lack of transportation</td>
<td></td>
<td>- emergency lanes separate from the highway</td>
</tr>
<tr>
<td>monitoring</td>
<td>- lack of technology</td>
<td>- weather</td>
<td>- check the hardware of monitor</td>
<td>- update the software and hardware for equipment</td>
</tr>
<tr>
<td></td>
<td>- lack of highway enforcement</td>
<td>- complex situations</td>
<td>- training</td>
<td>- assessment of law enforcement officer</td>
</tr>
<tr>
<td>Road Maintenance</td>
<td>- high cost on maintenance workers</td>
<td>- bad weather</td>
<td>- training the basic technical worker</td>
<td>- let experienced workers maintain the road on better weather</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- always check the weather forecast</td>
<td></td>
</tr>
<tr>
<td>Security</td>
<td>- pavement aging</td>
<td>- extreme weather like heavy snow</td>
<td>- check the real-time traffic status of the road</td>
<td>- broadcast and close the highway in danger</td>
</tr>
<tr>
<td></td>
<td>- metal structure rusting</td>
<td>- terrorism</td>
<td>- check the highway crime rate</td>
<td>- improve the ability of law enforcement officer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- overspeeding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>highway resting area</td>
<td>- high cost</td>
<td>- low consumer flow rate</td>
<td>- do the market survey on consumer satisfaction, worker induction intention.</td>
<td>- Base on the survey analysis results, decide the optimal location, design income and expense system.</td>
</tr>
<tr>
<td></td>
<td>- hard to hire workers</td>
<td></td>
<td>- do the cost analysis on construction</td>
<td></td>
</tr>
<tr>
<td>toll gate</td>
<td>- high cost</td>
<td>- some out-of-state vehicle</td>
<td>- check the rate of forced pass</td>
<td>- build the licence plate shared system</td>
</tr>
<tr>
<td></td>
<td>- hard to hire workers</td>
<td>forced pass the non-officer tollbooth</td>
<td>- evaluate the cost of construction and workers</td>
<td>- reduce the cost on unimportance aspects</td>
</tr>
</tbody>
</table>
## Affinity Diagram

<table>
<thead>
<tr>
<th>MEDICAL</th>
<th>ROAD</th>
<th>GOVERNMENT</th>
<th>MEDIA</th>
<th>RESCUE</th>
<th>MAINTAINCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>short in staff</td>
<td>jammed traffic</td>
<td>financial</td>
<td>response time</td>
<td>transportation</td>
<td>financial</td>
</tr>
<tr>
<td>equipment</td>
<td>damaged road</td>
<td>public training</td>
<td>inform</td>
<td>response time</td>
<td>time management</td>
</tr>
<tr>
<td>lack of training</td>
<td>weather condition</td>
<td>monitoring</td>
<td>advise on better route</td>
<td>equipment</td>
<td>quality</td>
</tr>
<tr>
<td>transportation</td>
<td>improvement</td>
<td></td>
<td>training</td>
<td></td>
<td></td>
</tr>
<tr>
<td>response time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
FISHBONE CHART

Cause-and-Effect Diagram

- RESCUE
  - TRANSPORTATION
  - RESPONSE TIME
  - EQUIPMENT
  - TRAINING
- GOVERNMENT
  - FINANCIAL
  - PUBLIC TRAINING
  - MONITORING
  - IMPROVEMENT
- MEDICAL
  - SHORT IN STAFF
  - EQUIPMENT
  - LACK OF TRAINING
  - TRANSPORTATION
  - RESPONSE TIME

FAIL TO IMPROVE

- QUALITY
- TIME MANAGEMENT
- FINANCIAL
- MAINTAIN
- MEDIA
- ROAD
- WEATHER CONDITION
- DAMAGED ROAD
- JAMMED TRAFFIC
- ADVISE ON BETTER ROUTE
- INFORM
- RESPONSE TIME
Quality Assessment: List of individuals to Interview

Head of Police Department

Head of Road and Transportation Department

Head of Medical Department

Head of Military

Head of Fire & Rescue Departments
Quality Assessment: Questions for individuals to Interview

Head of Police Department

Is there an officer on patrol around that area that reach the site of accident as soon as possible?

Is there enough local police able to secure the accidental area?

Head of Road and Transportation Department

Is the detour road already been assigned in order to keep the transportation available?

Is the road situation already been noticed on the Road sign screen or toll stations?
Quality Assessment: Questions for individuals to Interview

Head of Medical Department

  Are the ambulances ready for the long distance rescue?

  Are the doctors already been acknowledge the expected situations?

Head of Military

  If there are terrorists attack, does the armed level already been acknowledged?

  Is there a team ready for the emergency response?
Quality Assessment: Questions for individuals to Interview

Head of Fire & Rescue Departments

- Are there enough experts to salvage victim from the car accident or the ruins of the building?
- Are there enough fire truck ready for the accident?
Quality Assessment: Answers for individuals to Interview

Head of Police Department

No, we need to assign a group of officers go to the reach the accident area as soon as possible.

No, we don’t have enough officer work in this area we may need police department from other cities to have a combined action.

Head of Road and Transportation Department

Yes, but the officers are on the way to place the sign and do the vehicle detour guide.

Yes, but there still some road don’t have a traffic notification screen.
Quality Assessment: Answers for individuals to Interview

Head of Medical Department

The local hospital don’t have enough expert that can go on salvage. We may need other hospital’s help.

The Victim probably die of excessive loss of blood, but there is not enough blood in the storage.

Head of Military

We don’t have the armed level of the terrorist. we can only assigned a group first to investigate the situation.
Quality Assessment: Answers for individuals to Interview

Head of Fire & Rescue Departments

We need more technical tool in order to apply the salavage.
Quality Assessment: The Results

- Victims can't get the treatment timely
- Traffic congestion
- Rescue problem (tools, Technic)
- Unnecessary casualties (Unable fire down)
- Chaotic situations
Improvements to Current System (Suggestions)

● Many aspects to change that would work
● Toll booths for six pack analysis
● Automating a 5 laned toll from the more common 4 manned lanes and 1 automation lane
● Increasing automated toll speed from 5mph to 20mph
Assumptions in Process Capability Analysis

- A “manned” toll stop takes 12 seconds on average
- 5 mph automation takes ~2 sec
- 20 mph “ “ “ ~1 sec
- Variance in these times is unavoidable but setting a standard for theoretical analysis
- Counting how many vehicles go through a toll every half hour during a day
- Constant traffic flow
- Too many vehicles will cause traffic clogging at tolls (USL)
- Too few will provide lack of desired revenue for funding (LSL)
Process Capability (4 Manned 1 Auto)

- Random data with mean 780;
- and variance 20
- LSL= 760; USL=850
- $\bar{x} = 775.3; \sigma = 17.57$
- $C_p = 0.79; C_{pk} = 0.27$
Process Capability (5 Auto)

- Random data with mean 1800
- and variance 25
- $\text{LSL}=1700; \text{USL}=1900$
- $\bar{x}=1803; \sigma=31.82$
- $C_p=1.00; C_{pk}=0.98$