DC Streetcar Expansion Project
Risks Faced by D.C. Residents

The George Washington University

DNSC 6254 Risk Management (RM)

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1. Introduction and Background

In the first half of the twentieth century, the District of Columbia had a robust streetcar network with more than 200 miles of track and multiple companies providing service. But, like many US cities, the District began favoring buses and cars, and the last day of streetcar service in the city was January 28, 1962 (DCstreetcar.com). In response to the growing transportation issues within the region, the District of Columbia Transit Improvements Alternatives Analysis recommended the re-establishment of the DC Streetcar. Although the Regional Transportation Priorities Plan was not officially published until 2014, the streetcar project was first studied in 2002 under Mayor Anthony Williams and prevailed through four mayoral administrations, finally taking passengers on February 27, 2016. It is evident that the streetcar project was priority through several administrations because it directly addressed critical transportation and development issues. The project's main goals were as follows:

- Provide a comprehensive range of transportation options. The streetcar could provide additional transportation options where passengers don't have to find parking or worry about road congestion.
- Promote a strong regional economy, including a healthy regional core and dynamic activity centers. The streetcar creates neighborhood connections where they do not currently exist. At the moment, one route across H street from Union Station to Oklahoma Ave NE and Benning Rd NE is actively connecting more than 100 businesses across the area *(DCstreetcar.com).*
- Ensure adequate system maintenance, preservation, and safety. The streetcar would be built with the intent of providing reliable, predictable, and high-quality transportation services and transportation alternatives.
- Maximize operational effectiveness and safety of the transportation system, enhance environmental quality, and protect natural and cultural resources. One of the main functions of the District Department of Transportation (DDOT) is to provide safe transportation, whether someone is walking, driving, or taking public transportation *(DCstreetcar.com)*. Another main function is to ensure compliance with the National Environmental Policy of 1969. This policy was critical in defining the design of this project. The streetcar's role in both safety and the environment lies again in providing transportation alternatives that in theory reduce the number of pedestrians and drivers on the street, hence reducing the possibilities for accidents and making transportation overall more efficient towards the environment.
- Support inter-regional travel and commerce. One of the primary goals of the streetcar is to facilitate travel for DC residents, workers, and visitors. Service is intended to be low-cost and will serve critical parts of the District that would not be connected otherwise.

As aspiring project managers, we will assess the potential risks of expanding the DC streetcar system to other areas of the city (currently envisioned between Union Station and Georgetown, as well as connecting Anacostia to the rest of DC). Accessible information and lessons learned from the initial development of the H Street Corridor streetcar project will be instrumental in identifying future risks and analyzing its implications.

2. Project Structure

2.1 Identifying Risk Events

Using the Expert Choice Riskion software to structure our risk model, we identified ten (10) risk events that could impact the expansion of the streetcar line. These ten events were brainstormed and prioritized based on potential impact and cause of loss to the overall project.

Unique ID		Events
[1]		Businesses not interested in relocating near the line
[2]		Streets more congested than before
[3]		Dissatisfaction with quality of the completed project
[4]		High numbers of injuries or deaths related to streetcar operations
[5]		System does not open when promised
[6]		High occurence of property damage
[7]		Completed system only covers a limited area (reduced scope)
[8]		Underutilization of streetcar system
[9]		Streetcar inefficient / slow / unreliable
[10]		Visual clutter / poor aesthetics

Figure 1: Risk Events

2.2 Identifying Sources

The figure below depicts the sources (or threats) to the risk events. We identified four main sources (hierarchies, or groups) that could cause an event to result in a loss. We also identified sub-sources to further elaborate on the assumable threats.

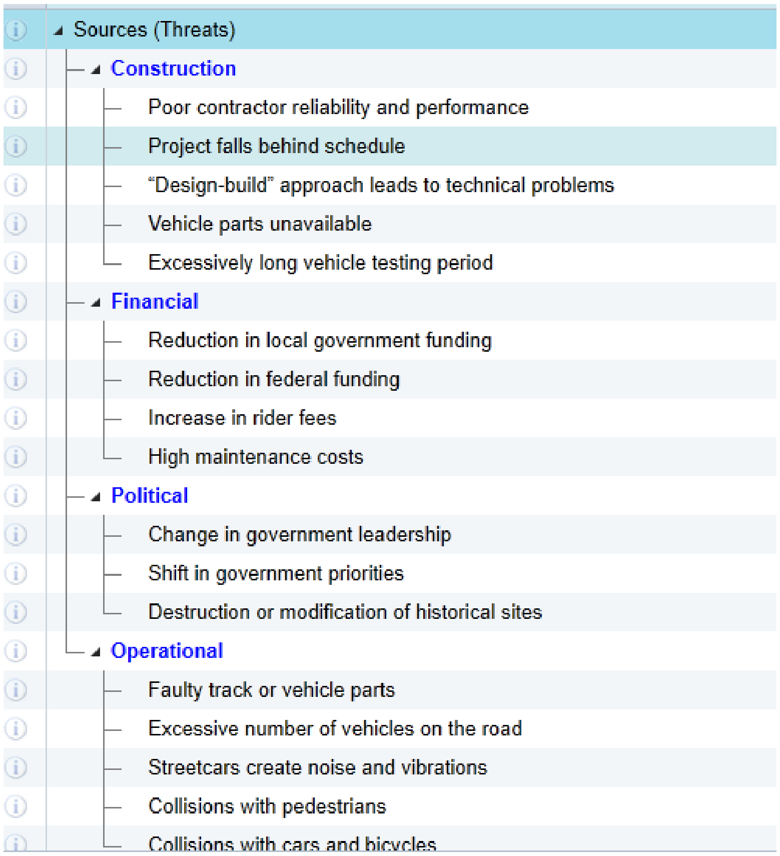

Figure 2: Hierarchy of Sources

2.3 Identifying Objectives

In collaboration with DC Mayor, Muriel Bowser, we assigned a list of objectives based on the purpose and goals of expanding the DC Streetcar. These objectives are listed in a hierarchical format in the figure below.

- Objectives
  - City Development
    - Promote business growth
    - Revitalize struggling neighborhoods
    - Increase property values
    - Modernize the image of the city
    - Enhance the quality of life
  - Transportation Improvement
    - Connect areas of the city lacking public transit
    - Decrease commute times
    - Reduce the number of vehicles on the streets
    - Provide residents and visitors with enjoyable transportation

Figure 3: Hierarchy of Objectives

2.4 Participants and Roles

There are several people with critical roles within the DC government who oversee the expansion project. We identified these key players to assist us with evaluating all possible risks. It was imperative to assign evaluating roles of the sources and events based on the participant's position and level of involvement in the project. The participants are displayed in the figure below.

Email Address	Participant Name	Permission
EmileS@gwu.edu	Emile Smith (Chief Safety & Secu	Evaluator
mmankowski@gwu.edu	Michael Mankowski (Risk Manag	Project Manager
MurielB@gwu.edu	Muriel Bowser (DC Mayor)	Evaluator
natashaagard@gwu.edu	Natasha Lester (Risk Manageme	Project Manager
PhilM@gwu.edu	Phil Mendelson (City Council Cha	Evaluator
SamZ@gwu.edu	Sam Zimbabwe (DDOT Director)	Evaluator

Figure 4: List of Participants

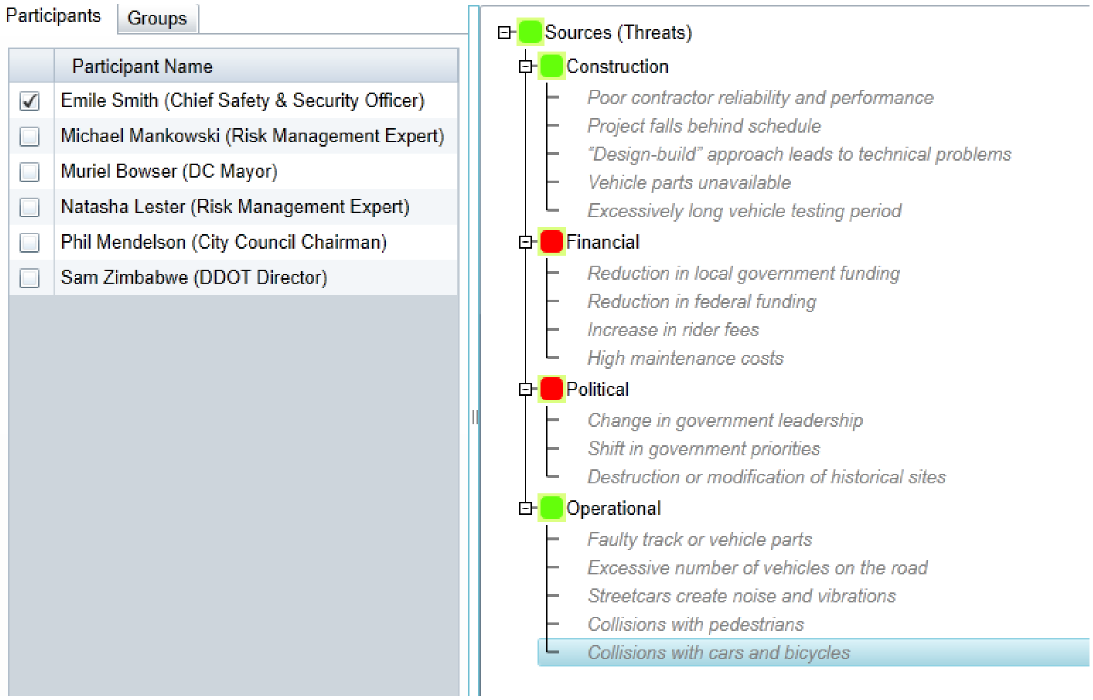

Figure 5: Sample of Participant Roles for Sources

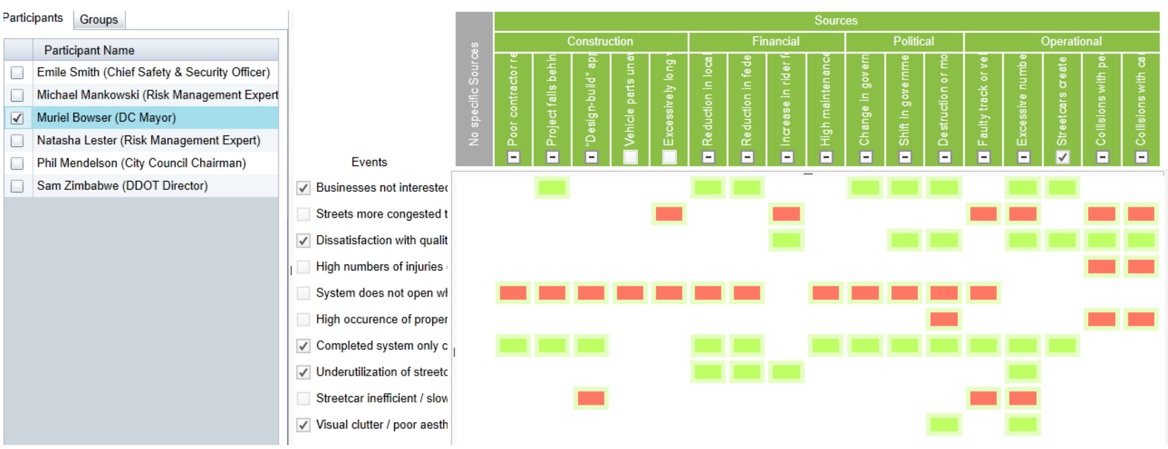

Figure 6: Sample of Participant Roles for Events

3. Events and Source Mapping

3.1 Likelihood of Events

The below grid shows the likelihood of the events based on the sources. Some sources were linked to one or more events on the likelihood of occurrence.

	Attributes			Sources (Threats)																
				Construction					Financial				Political			Operational				
Events	Cost	Risk	Map Key	Poor contract	Project falls t	"Design-build	Vehicle parts	Excessively l	Reduction in	Reduction in	Increase in ri	High mainten	Change in go	Shift in gover	Destruction o	Faulty track c	Excessive nu	Streetcars cr	Collisions wit	Collisions wit
Businesses not interested in relocating near the line				□	■	□	□	□	■	■	□	□	■	■	■	□	■	■	□	□
Streets more congested than before				□	□	□	□	■	□	□	■	□	□	□	□	■	■	□	■	■
Dissatisfaction with quality of the completed project				□	□	□	□	□	□	□	■	□	□	■	■	□	■	■	■	■
High numbers of injuries or deaths related to streetcar operations				□	□	□	□	□	□	□	□	□	□	□	□	□	□	□	■	■
System does not open when promised				■	■	■	■	■	■	■	□	■	■	■	■	■	□	□	□	□
High occurence of property damage				□	□	□	□	□	□	□	□	□	□	□	■	□	□	□	■	■
Completed system only covers a limited area (reduced scope)				■	■	■	□	□	■	■	□	■	■	■	■	■	■	■	□	□
Underutilization of streetcar system				□	□	□	□	□	■	■	■	□	□	□	□	□	■	□	□	□
Streetcar inefficient / slow / unreliable				□	□	■	□	□	□	□	□	□	□	□	□	■	■	□	□	□
Visual clutter / poor aesthetics				□	□	□	□	□	□	□	□	□	□	□	■	□	■	□	□	□

Figure 7: Vulnerabilities Gird

3.2 Impact of Events

Once the objectives were developed and agreed upon, we completed an impacts grid to illustrate the impact of the events on each of the project objectives. This is an important step in the mapping process because we needed to identify the events that had a direct impact on the objectives. The events are risks that are likely to happen, which result in a loss. If this takes place the project objectives (one or more) are affected and cannot be accomplished.

	Attributes			Objectives								
				City Development					Transportation Improvement			
Events	Cost	Risk	Map Key	Promote business growth	Revitalize struggling neighborhoo	Increase property values	Modernize the image of the city	Enhance the quality of life	Connect areas of the city lacking public transit	Decrease commute times	Reduce the number of vehicles on the streets	Provide residents and visitors with enjoyable transportatio
Businesses not interested in relocating near the line				■	□	■	□	□	□	□	□	□
Streets more congested than before				□	□	□	■	■	□	■	■	■
Dissatisfaction with quality of the completed project				■	□	□	■	■	□	□	□	■
High numbers of injuries or deaths related to streetcar operations				□	□	□	■	■	□	□	□	■
System does not open when promised				□	□	□	■	■	□	□	■	□
High occurence of property damage				□	□	□	■	■	□	□	□	□
Completed system only covers a limited area (reduced scope)				■	■	□	□	□	■	■	■	□
Underutilization of streetcar system				□	□	□	□	□	□	■	■	□
Streetcar inefficient / slow / unreliable				□	□	□	■	■	□	■	■	■
Visual clutter / poor aesthetics				□	□	□	■	■	□	□	□	■

Figure 8: Impacts Gird

4. Risk Measurement Methods/Scales

Using the Expert Choice Riskion software, we determined the appropriate measurement to utilize for the project's objectives. The methods in Riskion provide relative and absolute measurements. This is based on the integrated AHP model. The AHP tool is mathematically meaningful, in that it uses a ratio scale/weight method to weigh all possibilities or priorities of events and objectives. We decided to use two types of measurements: rating scale (absolute measurement) and pairwise comparison (relative measurement). Each participant was then asked to take a detailed survey with questions related to their expertise. Example of such questions are shown below.

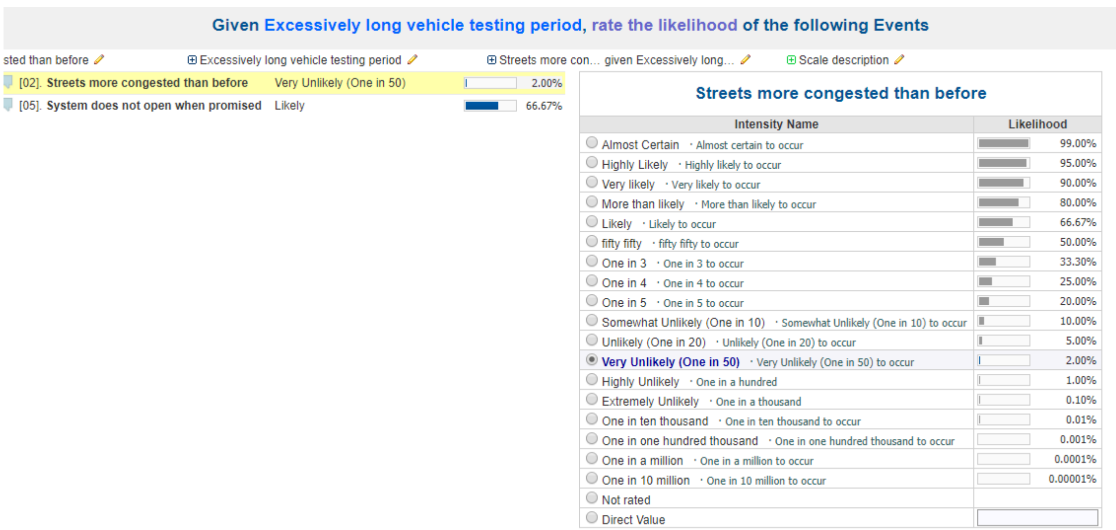

Figure 9: Rating Scale Measurement

Figure 10: Pairwise Comparison Measurement

4.1 Methods for Events

4.1.1 Likelihood of Events for Events

Measure Event Likelihoods	Measurement Type Default: Rating Scale	Measurement Scale or Given Likelihood	Action	# of Events, # of Probabiliti	# of Judgm Clust
Sources (Threats)					
Construction					
Poor contractor reliability and performan	Rating Scale	WIDE LIKELIHOOD RATING SCALE	Copy Edit	2	2
Project falls behind schedule	Rating Scale	WIDE LIKELIHOOD RATING SCALE	Copy Edit	3	3
"Design-build" approach leads to technic	Rating Scale	WIDE LIKELIHOOD RATING SCALE	Copy Edit	3	3
Vehicle parts unavailable	Rating Scale	WIDE LIKELIHOOD RATING SCALE	Copy Edit	1	1
Excessively long vehicle testing period	Rating Scale	WIDE LIKELIHOOD RATING SCALE	Copy Edit	2	2
Financial					
Reduction in local government funding	Rating Scale	WIDE LIKELIHOOD RATING SCALE	Copy Edit	4	4
Reduction in federal funding	Rating Scale	WIDE LIKELIHOOD RATING SCALE	Copy Edit	4	4
Increase in rider fees	Rating Scale	WIDE LIKELIHOOD RATING SCALE	Copy Edit	3	3
High maintenance costs	Rating Scale	WIDE LIKELIHOOD RATING SCALE	Copy Edit	2	2
Political					
Change in government leadership	Rating Scale	WIDE LIKELIHOOD RATING SCALE	Copy Edit	3	3
Shift in government priorities	Rating Scale	WIDE LIKELIHOOD RATING SCALE	Copy Edit	4	4
Destruction or modification of historical s	Rating Scale	WIDE LIKELIHOOD RATING SCALE	Copy Edit	6	6
Operational					
Faulty track or vehicle parts	Rating Scale	WIDE LIKELIHOOD RATING SCALE	Copy Edit	4	4
Excessive number of vehicles on the roa	Rating Scale	WIDE LIKELIHOOD RATING SCALE	Copy Edit	7	7
Streetcars create noise and vibrations	Rating Scale	WIDE LIKELIHOOD RATING SCALE	Copy Edit	3	3
					Total

Figure 11: Events Measurement (Likelihood)

4.1.2 Impact of Events for Events

Measure Events With Respect To	Measurement Type Default: Rating Scale	Measurement Scale
Objectives		
City Development		
Promote business growth	Rating Scale	Default Impact Scale
Revitalize struggling neighborhoods	Rating Scale	Default Impact Scale
Increase property values	Rating Scale	Default Impact Scale
Modernize the image of the city	Rating Scale	Default Impact Scale
Enhance the quality of life	Rating Scale	Default Impact Scale
Transportation Improvement		
Connect areas of the city lacking public t	Rating Scale	Default Impact Scale
Decrease commute times	Rating Scale	Default Impact Scale
Reduce the number of vehicles on the st	Rating Scale	Default Impact Scale
Provide residents and visitors with enjoy	Rating Scale	Default Impact Scale

Figure 12: Events Measurement (Impact)

4.2 Methods for Sources and Objectives

4.2.1 Likelihood of Events for Sources

Measure Likelihood	Measurement Type	Measurement Scale or Given Likelihooc	Action	Elements, # of Probabiliti
Sources (Threats)				
Construction	Rating Scale	WIDE LIKELIHOOD RATING SCALE	Copy Edit	5
Poor contractor reliability and performan				
Project falls behind schedule				
"Design-build" approach leads to technic				
Vehicle parts unavailable				
Excessively long vehicle testing period				
Financial	Rating Scale	WIDE LIKELIHOOD RATING SCALE	Copy Edit	4
Reduction in local government funding				
Reduction in federal funding				
Increase in rider fees				
High maintenance costs				
Political	Rating Scale	WIDE LIKELIHOOD RATING SCALE	Copy Edit	3
Change in government leadership				
Shift in government priorities				
Destruction or modification of historical s				
Operational	Rating Scale	WIDE LIKELIHOOD RATING SCALE	Copy Edit	5
Faulty track or vehicle parts				
Excessive number of vehicles on the roa				
Streetcars create noise and vibrations				

Figure 13: Source Measurement (Likelihood)

4.2.2 Impact of Events for Objectives

We decided to use the pairwise comparison measurement function to measure the impact of events on the project objectives. The pairwise comparison function allows the participants to compare an objective or an event with one another to determine the probability of likelihood. The verbal methods of pairwise comparison were utilized (*see figure 14 below).*

leasure Importance With Respect To	Measurement Type
Objectives	Pairwise Comparis
City Development	Pairwise Comparis
Promote business growth	
Revitalize struggling neighborhoods	
Increase property values	
Modernize the image of the city	
Enhance the quality of life	
Transportation Improvement	Pairwise Comparis
Connect areas of the city lacking public t	
Decrease commute times	
Reduce the number of vehicles on the st	
Provide residents and visitors with enjoya	

Figure 14: Measurement Method for Objectives

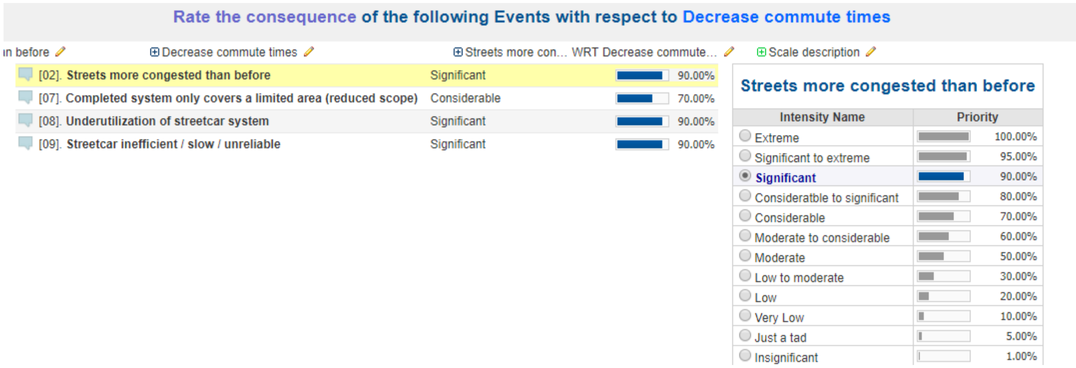

Figure 15: Pairwise Comparisons Model (Verbal)

5. Synthesis/Sensitivity Analysis

Project synthesis is simply the computation of the likelihood and impact of the events. This computation is done in the Riskion software, where we can make meaningful conclusions of the likelihood of the events on a percentage scale. The figures below represent the sensitivities of the hierarchy of sources and objectives and analysis of the events.

5.1 Synthesis: Likelihood of Events and Sources

Figure 16 below shows the computation of the likelihood of all events. It depicts that the Political source, *shift in government priorities* has a 37.51% chance of occurring. Three other sources have almost identical percentages: *reduction in federal funding*, *change in government leadership, and destruction or modification of historical sites*. These measurements all came from data collected in the surveys.

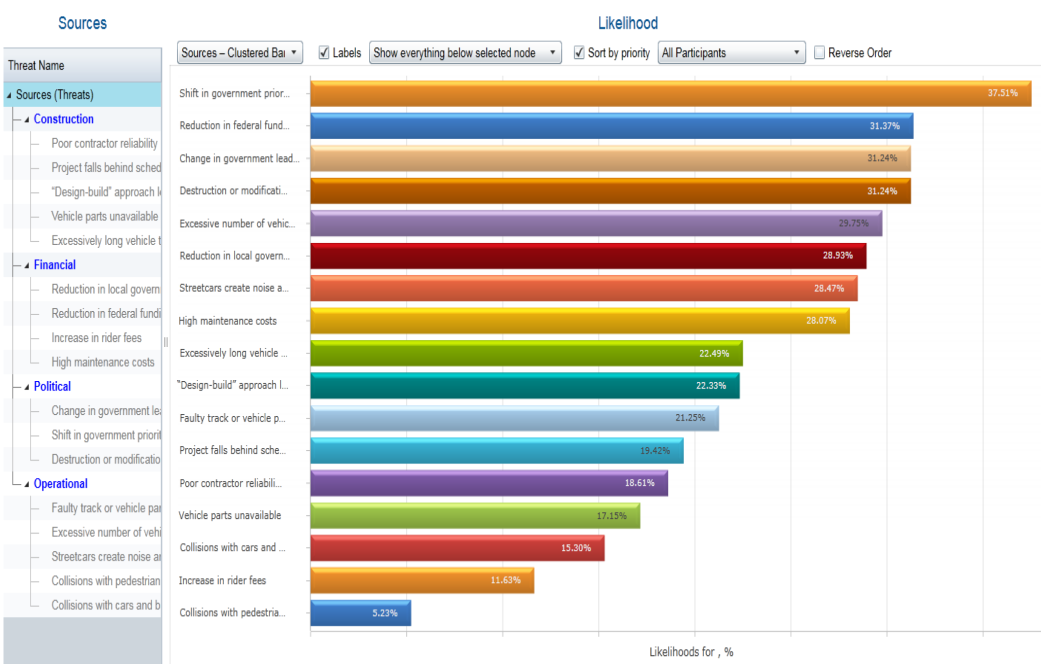

Figure 16: Likelihood of Threats

In figure 17, the risk event *completed system only covers a limited area (reduced scope)* yields the highest likelihood of 24.36%, followed by *system does not open when promised* at 23.54%, and the third, *businesses not interested in relocating near the line* at 14.29%.

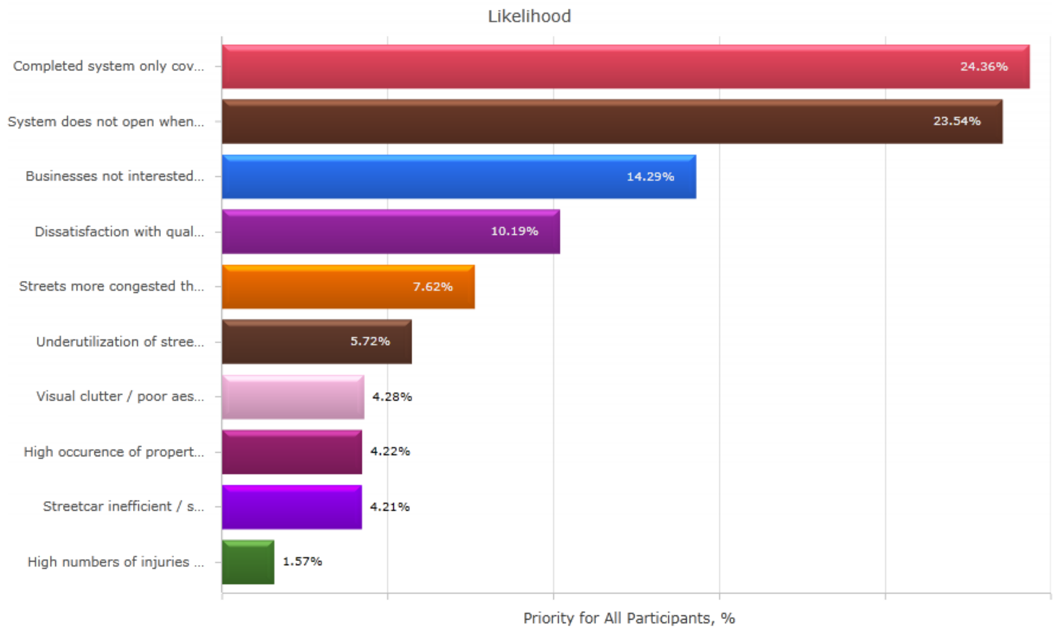

Figure 17: Likelihood of Events

5.2 Synthesis: Impact of Events and Objectives

In the following illustrations, we depict the computations of the overall impact of the risk events to the objectives. Figure 19 shows the performance sensitivity of the objectives—the performance of each objectives on the overall impact of the events. Figure 20 depicts the results of the dynamic sensitivity of the objectives and the event impacts.

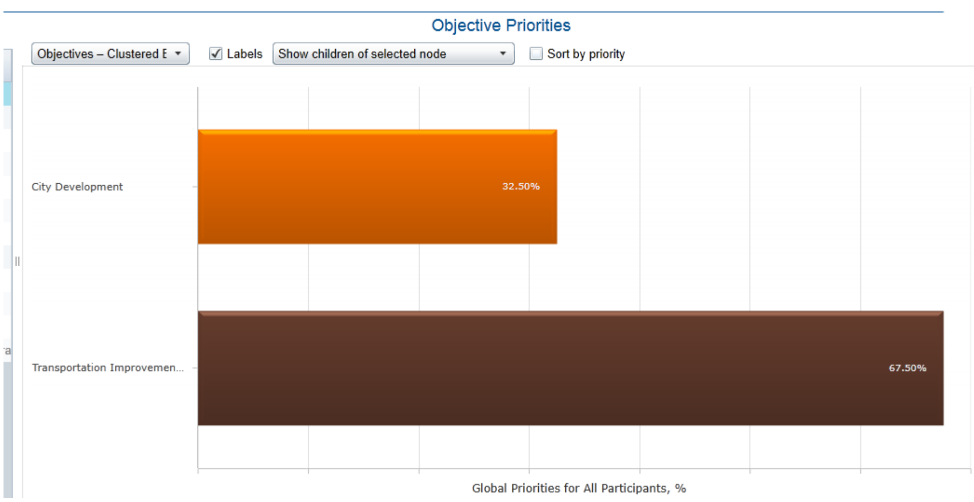

Figure 18: Impact of Events on Objectives

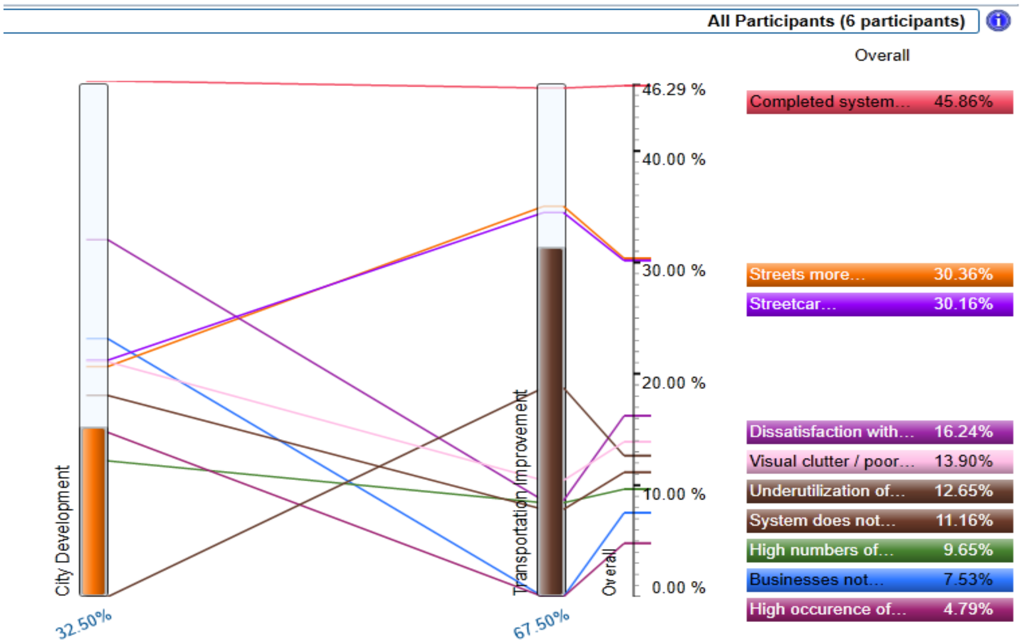

Figure 19: Sensitivity of Objectives (Performance)

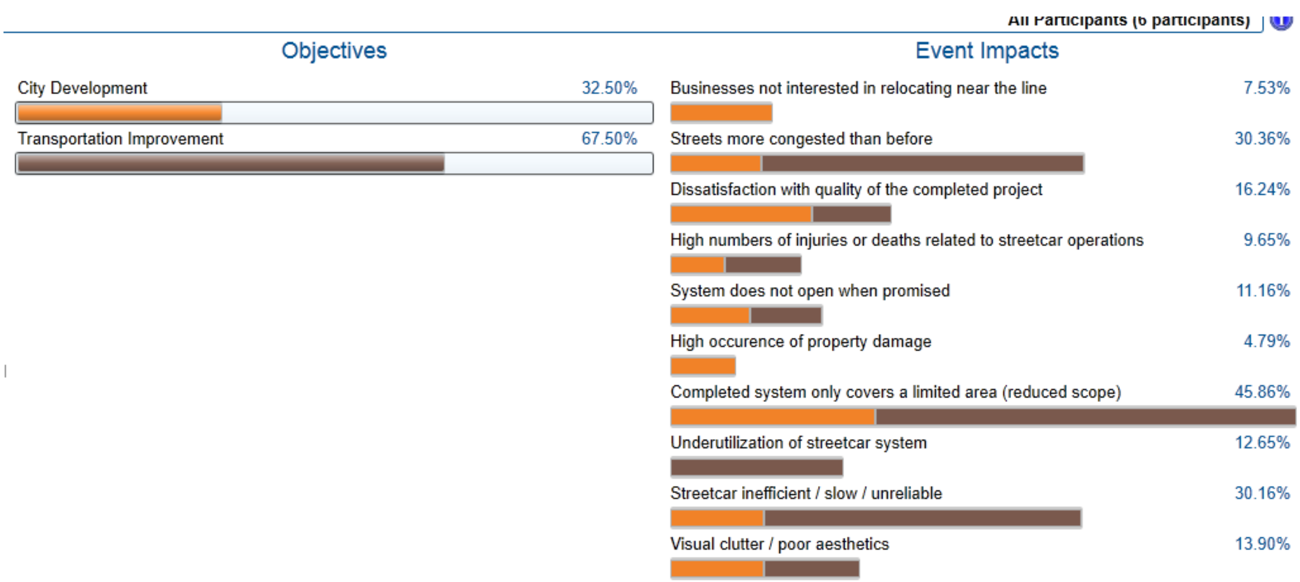

Figure 20: Sensitivity of Objectives (Dynamic)

6. Risk Review

6.1 Overall Risk (without Controls)

We define risk as "an unexpected event or uncertainty that results in a loss." Since we have identified and measured the likelihood of the events as well as the impact of these events, we can now determine what the greatest risks facing the streetcar project are. For the purposes of measurement, we valued the project at $200 million (which is the hypothetical total budget of the project). Based on this valuation the overall likelihood, impact, and risk are shown in Figure 21 (simulated and computed). A monetary value can be attributed to the impact and risk for each event. In Figure 22, the line on the graph represents the probability that the loss will exceed the corresponding value. For example, there appears to be an 80% probability that the loss will exceed $120 million!

Overall Likelihoods, Impacts, and Risks for «*Project: Expanding the DC Streetcar System (Natasha Lester and Michael Mankowski)»

		All Participants					
		Likelihood		Impact, $		Risk, $	
No. ▲	Event	Computed	Simulated	Computed	Simulated	Computed	Simulated
[01]	Businesses not interested in relocating near the line	14.3%	71.5%	15,051,819	9,869,921	2,076,254	7,054,033
[02]	Streets more congested than before	7.6%	51.4%	60,716,563	30,312,143	4,764,691	15,589,535
[03]	Dissatisfaction with quality of the completed project	10.2%	59.8%	32,473,087	17,142,846	3,091,778	10,258,279
[04]	High numbers of injuries or deaths related to streetcar operations	1.6%	27.8%	19,307,300	9,604,207	340,211	2,666,128
[05]	System does not open when promised	23.5%	82.0%	22,320,789	11,351,409	6,209,171	9,305,885
[06]	High occurence of property damage	4.2%	61.4%	9,586,416	3,688,919	318,403	2,265,734
[07]	Completed system only covers a limited area (reduced scope)	24.4%	82.0%	91,718,870	81,372,816	23,372,263	66,758,258
[08]	Underutilization of streetcar system	5.7%	48.0%	25,307,509	13,667,986	1,024,415	6,560,633
[09]	Streetcar inefficient / slow / unreliable	4.2%	28.4%	60,327,345	27,462,248	2,279,310	7,796,532
[10]	Visual clutter / poor aesthetics	4.3%	62.7%	27,798,932	13,885,619	730,415	8,704,894
	Total Risk (Computed)					$44,206,916	
	Total Loss (Simulated)						$136,959,915

Figure 21: Overall Likelihood, Impact, and Risk

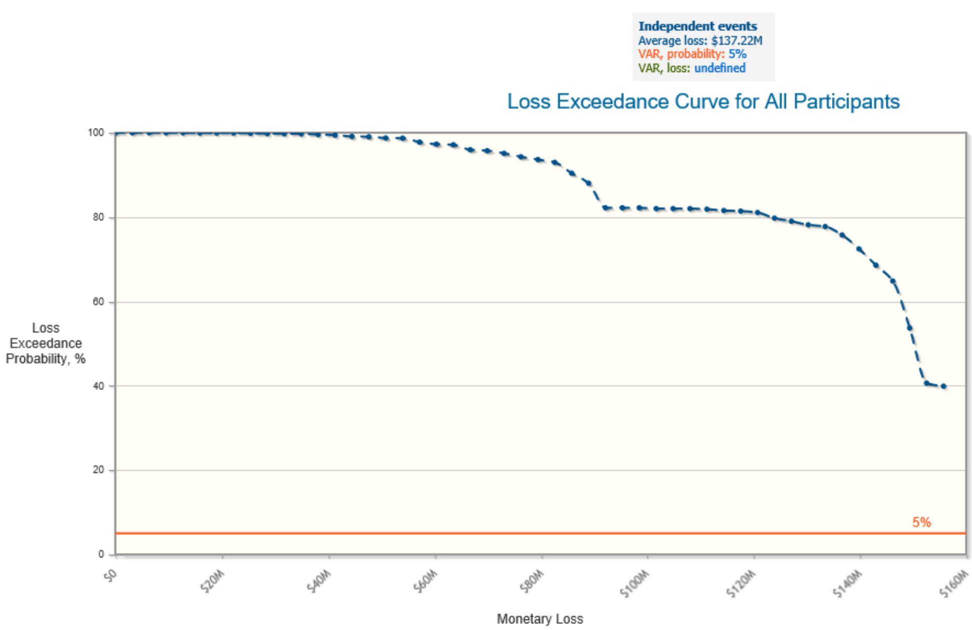

Figure 22: Loss Exceedance Curve

6.2 Risk Map (without Controls)

The risk map in Figure 23 below represents the likelihood and impact of risk events. If the bubble is relatively large compared to others, it represents both a higher likelihood and greater impact on the project. We set different risk regions to highlight different levels of risk appetite. This is an effective way to visualize and prioritize events that should to be controlled. From the graph, it's clear that "completed system only covers a limited area (reduced scope)" poses the greatest risk to the project. This makes sense because if construction is halted or government officials decide to cut funding for the project while it's being constructed, the very purpose of the project is in question. This is what happened with the first segment on H Street. What value is a streetcar system that is only halfway finished and doesn't go where it was originally intended to go? Figure 21 above shows the simulated risk of this event alone at nearly $67 million.

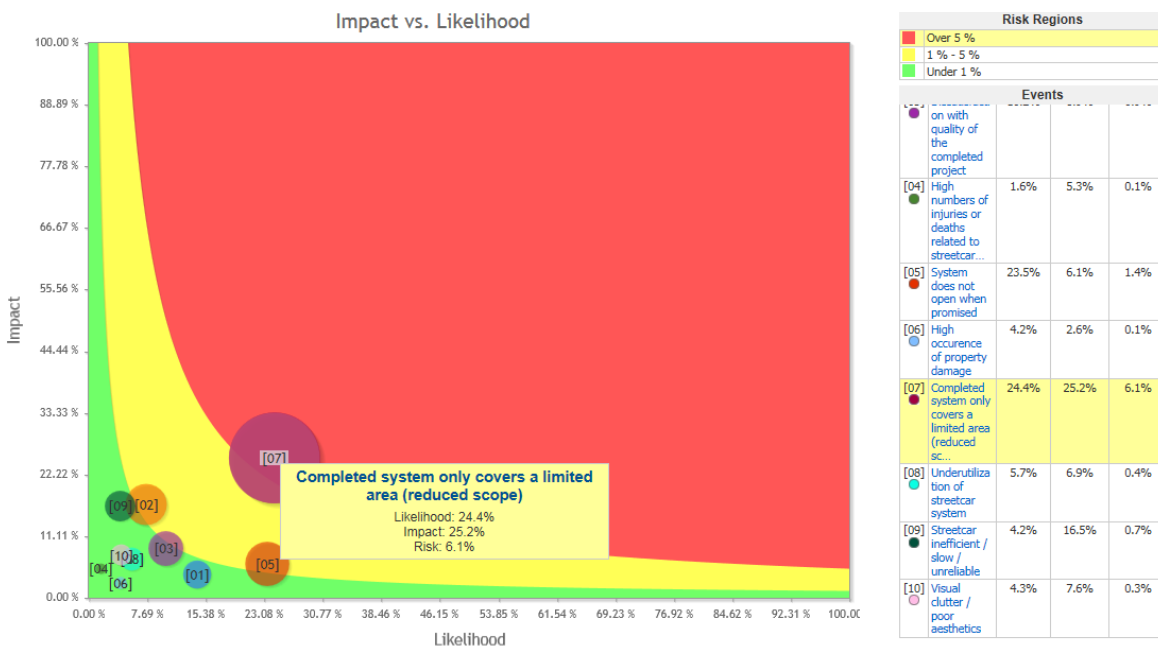

Figure 23: Risk Map and Risk Priority Matrix

6.3 Identifying and Selecting Controls

As discussed above, there appears to be a great deal of risk involved with this project, especially after analyzing the loss exceedance curve. Before deciding whether to scrap the project or blindly give it the green light, we should identify possible controls. Controls can help mitigate risk events and the likelihood of their occurrence. Controls can be applied to sources, events, or objectives. We identified 17 controls with a total cost of approximately $23 million, shown in Figure 24 below.

Control register for "*Project: Expanding the DC Streetcar System (Natasha Lester and Michael Mankowski)"

Selected controls: 0
Cost Of Selected Controls: $0 (unfunded: $22,620,000)
Total Cost Of All Controls: $22,620,000

Search:

Index	☐	Control Name	Control for	Selected	Cost	Applications	Categories
01	☐	Promote positive impact of streetcar project to attract private investment if goverment funding is reduced	Threat		100000	4	
02	☐	Hire a senior project manager to oversee the entire project (three years)	Threat		450000	4	
03	☐	Implement a change control process to enforce approval of all changes to the project plan	Threat		10000	4	
04	☐	Hire outside consulting firm to provide analysis/feedback on project completion timeline	Threat		50000	4	
05	☐	Conduct highly competitive bidding process to ensure that the best contractors are selected	Threat		10000	8	
06	☐	Construct streetcar-only passageway in high-traffic areas to reduce collisions	Threat		8000000	4	
07	☐	Implement regular vehicle safety testing	Threat		100000	2	
08	☐	Schedule meetings with historical committees to understand impact on historical landmarks	Threat		50000	2	
09	☐	Eliminate rider fees during the first three years of operations	Vulnerability		4000000	2	
10	☐	Schedule town hall forums to provide planning and construction status updates to the public	Vulnerability		50000	7	
11	☐	Provide tax incentives for businesses along the streetcar line during the first three years of operation	Vulnerability		5000000	3	
12	☐	Reduce the number of streetcars operating in late evenings	Vulnerability		1000000	2	
13	☐	Run public service announcements (television, billboards) to promote streetcar safety	Vulnerability		200000	4	
14	☐	Create advanced traffic control system that limits the numbers of cars on the streets when a streetcar is in the vicinity	Vulnerability		2000000	3	
15	☐	Survey area business leaders to determine ideal location of route	Consequence		50000	1	
16	☐	Conduct referendum vote to determine residents' interest in the streetcar	Consequence		50000	3	
17	☐	Purchase additional trolleys for use during peak hours	Consequence		1500000	2	

Figure 24: Identifying Controls

After identifying controls, we mapped them to their sources, vulnerabilities, and consequences. We did this by examining at the grid and asking if the control would have a positive impact on its corresponding threat. If "yes", we checked the box. Effectiveness of each application is measured in the next step.

Controls for Threat Likelihoods

Control Name	Construction					
	Poor contractor reliability and performance	Project falls behind schedule	"Design-build" approach leads to technical problems	Vehicle parts unavailable	Excessively long vehicle testing period	Reduction in local government funding
1. Promote positive impact of streetcar project to attract private investment if goverment funding is reduced	☐	☐	☐	☐	☐	☑
2. Hire a senior project manager to oversee the entire project (three years)	☑	☑	☑	☐	☐	☐
3. Implement a change control process to enforce approval of all changes to the project plan	☑	☑	☑	☐	☐	☐

Figure 25: Mapping Controls to Threats

Based on their area expertise, participants were asked to rate the effectiveness of controls. For each measurement, we asked them to input a number between 0 and 1, which represents the percent effectiveness.

Figure 26: Measuring Effectiveness of Controls

6.4 Overall Risk (with Controls)

After the judgments were collected, we analyzed the impact of controls. In the first scenario, we were curious to see the impact of implementing *all* controls. Average loss is reduced by almost $43 million. However, we incurred $23 million in additional costs by implementing all 17 of the controls.

No. ▲	Event	All Participants Likelihood		Impact, $		Risk, $	
		Computed	Simulated	Computed	Simulated	Computed	Simulated
[01]	Businesses not interested in relocating near the line	15.3%	48.6%	6,327,237	6,222,732	4,692,826	3,022,381
[02]	Streets more congested than before	6.5%	29.7%	60,716,563	44,799,983	22,077,822	13,323,514
[03]	Dissatisfaction with quality of the completed project	9.0%	36.9%	24,762,222	20,243,089	11,817,128	7,475,772
[04]	High numbers of injuries or deaths related to streetcar operations	0.3%	0.2%	19,307,300	14,618,933	74,619	35,085
[05]	System does not open when promised	22.1%	49.1%	22,320,789	17,944,815	18,096,645	8,801,932
[06]	High occurence of property damage	3.6%	1.0%	9,586,416	5,071,435	73,597	48,685
[07]	Completed system only covers a limited area (reduced scope)	30.7%	63.7%	91,718,870	89,136,291	101,678,437	56,788,731
[08]	Underutilization of streetcar system	4.5%	20.5%	10,859,294	8,784,159	2,889,779	1,797,238
[09]	Streetcar inefficient / slow / unreliable	2.6%	3.9%	39,121,985	25,169,391	1,462,777	986,640
[10]	Visual clutter / poor aesthetics	5.4%	9.7%	27,798,932	20,171,578	2,851,722	1,950,591
	Total Risk Reduction (Computed)					$-121,508,440	
	Total Residual Risk (Computed)					$165,715,356	
	Total Loss Reduction (Simulated)						$42,729,341
	Total Residual Loss (Simulated)						**$94,230,574**
	Cost of Selected Controls						$22,620,000

Figure 27: Overall Likelihood, Impact, and Risk with Controls

Figure 28 shows the risk map with controls. We can see that the bubbles shift slightly compared to Figure 23 on page 16. Interestingly, the event "completed system only covers a limited area" was not reduced when we applied the controls. In fact, likelihood, impact, and risk all increased for this event! This is probably because it is a risk that is difficult to mitigate.

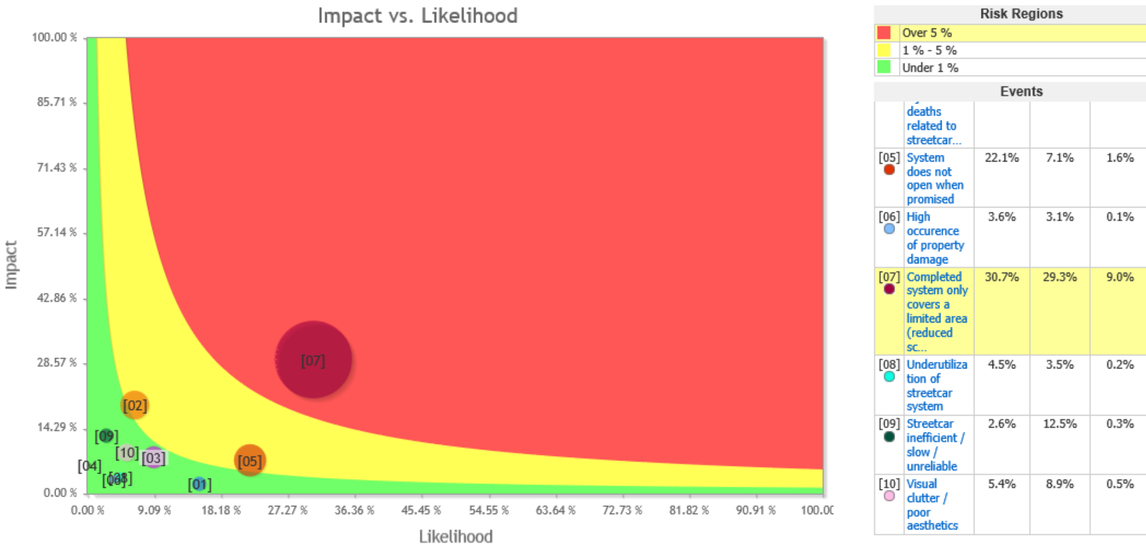

Figure 28: Risk Map with All Controls

Earlier, we noted that there was a nearly 80% probability that losses would exceed $120 million (without controls). It is therefore useful to analyze the change in the loss exceedance curve (Figure 29) after adding controls. It appears the probability dropped to about 40% with the controls in place!

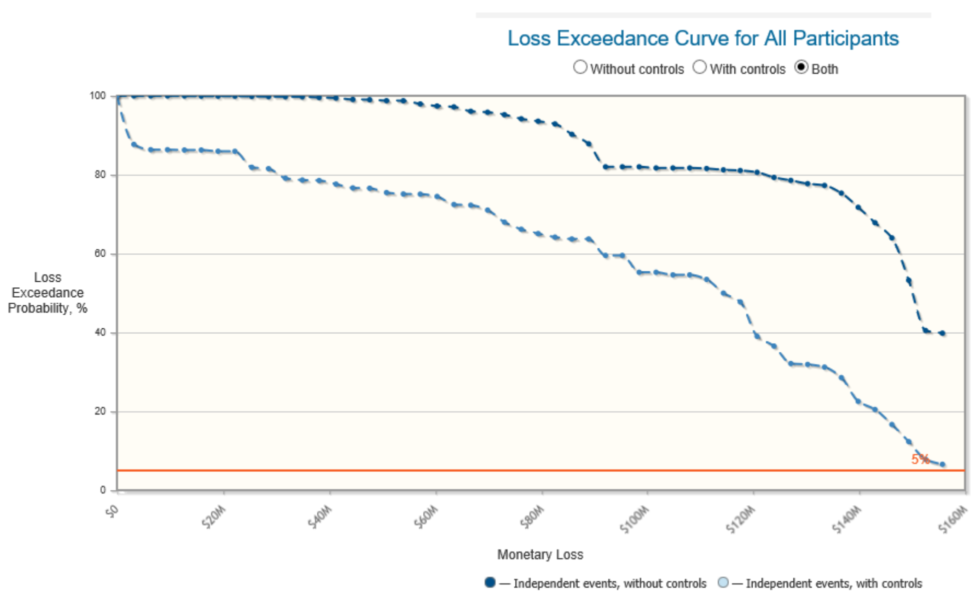

Figure 29: Loss Exceedance Curve with and without Controls

6.5 Optimizing Controls

Unfortunately, not all controls can be selected, as projects operate within a fixed budget. However, even though resources are limited, it's also possible that adding additional controls is not cost effective.

Let's assume we are given a budget of $10 million (5% of a project valued at $200 million) for controls. Riskion allows us to input our budget for controls into the software and then optimize the most valuable controls (i.e. controls that have the most positive impact) simply by clicking the optimize button.

Select Controls

◉ Budget ○ Risk ○ Risk Reduction
Budget Limit: $ 10,000,000

Total Risk: $968,571,405
Risk With Selected Controls: $187,998,642 (Δ: $780,572,762)
Risk With All Controls: $165,715,356 (Δ: $802,856,048)
Total Risk Reduction: $161,180,220

Selected controls: 12
Cost Of Selected Controls: $9,920,000 (unfunded: $12,700,000)
Total Cost Of All Controls: $22,620,000

Ignore: ☐ Musts ☐ Must Nots ☑ Dependencies ☑ Groups

Search:

Index	Selected	Control Name	Control for	Cost	Applications	Categories	Must	Must Not
01	☑	Promote positive impact of streetcar project to attract private investment if goverment funding is reduced	Threat	100000	4		☐	☐
02	☑	Hire a senior project manager to oversee the entire project (three years)	Threat	450000	4		☐	☐
03	☑	Implement a change control process to enforce approval of all changes to the project plan	Threat	10000	4		☐	☐
04	☑	Hire outside consulting firm to provide analysis/feedback on project completion timeline	Threat	50000	4		☐	☐
05	☑	Conduct highly competitive bidding process to ensure that the best contractors are selected	Threat	10000	8		☐	☐
06	☑	Construct streetcar-only passageway in high-traffic areas to reduce collisions	Threat	8000000	4		☐	☐
07	☑	Implement regular vehicle safety testing	Threat	100000	2		☐	☐
08	☑	Schedule meetings with historical committees to understand impact on historical landmarks	Threat	50000	2		☐	☐
09	☐	Eliminate rider fees during the first three years of operations	Vulnerability	4000000	2		☐	☐
10	☑	Schedule town hall forums to provide planning and construction status updates to the public	Vulnerability	50000	7		☐	☐
11	☐	Provide tax incentives for businesses along the streetcar line during the first three years of operation	Vulnerability	5000000	3		☐	☐
12	☑	Reduce the number of streetcars operating in late evenings	Vulnerability	1000000	2		☐	☐
13	☐	Run public service announcements (television, billboards) to promote streetcar safety	Vulnerability	200000	4		☐	☐
14	☐	Create advanced traffic control system that limits the numbers of cars on the streets when a streetcar is in the vicinity	Vulnerability	2000000	3		☐	☐
15	☑	Survey area business leaders to determine ideal location of route	Consequence	50000	1		☐	☐
16	☑	Conduct referendum vote to determine residents' interest in the streetcar	Consequence	50000	3		☐	☐
17	☐	Purchase additional trolleys for use during peak hours	Consequence	1500000	2		☐	☐

Figure 30: Controls Selected with a Budget Scenario of $10 Million for Controls

No. ▲	Event	Likelihood Computed	Likelihood Simulated	All Participants Impact, $ Computed	All Participants Impact, $ Simulated	Risk, $ Computed	Risk, $ Simulated
[01]	Businesses not interested in relocating near the line	15.5%	50.3%	6,327,237	6,220,341	5,189,180	3,130,076
[02]	Streets more congested than before	8.3%	37.1%	60,716,563	38,674,969	30,481,063	14,336,811
[03]	Dissatisfaction with quality of the completed project	8.4%	38.3%	24,762,222	19,132,739	12,715,114	7,331,665
[04]	High numbers of injuries or deaths related to streetcar operations	1.7%	2.1%	19,307,300	11,984,162	470,190	256,461
[05]	System does not open when promised	19.7%	49.1%	22,320,789	16,667,008	18,097,779	8,176,834
[06]	High occurence of property damage	4.6%	2.4%	9,586,416	4,619,622	232,034	112,256
[07]	Completed system only covers a limited area (reduced scope)	26.4%	63.7%	91,718,870	87,655,764	101,678,437	55,845,487
[08]	Underutilization of streetcar system	6.2%	39.4%	10,859,294	7,841,059	6,641,480	3,087,025
[09]	Streetcar inefficient / slow / unreliable	4.6%	15.3%	60,327,345	30,620,632	9,641,640	4,691,080
[10]	Visual clutter / poor aesthetics	4.6%	9.7%	27,798,932	12,859,802	2,851,722	1,243,542
	Total Risk Reduction (Computed)					$-143,791,726	
	Total Residual Risk (Computed)					$187,998,642	
	Total Loss Reduction (Simulated)						$38,748,673
	Total Residual Loss (Simulated)						**$98,211,242**
	Cost of Selected Controls						$9,920,000

Figure 31: Overall Risk with a Budget Scenario of $10 Million for Controls

Interestingly, we spent $13 million less on controls compared to the first scenario, and risk was reduced by $39 million instead of $43 million. That $13 million in controls led to an additional risk reduction of only $4 million. It makes no sense to add these controls, unless they are a "must" (e.g. for political reasons, legal reasons, etc.)

Riskion's efficient frontier feature can help us visualize when diminishing returns kick in. Figure 30 shows that somewhere between $7.5 million and $10 million, it's no longer efficient to add additional controls.

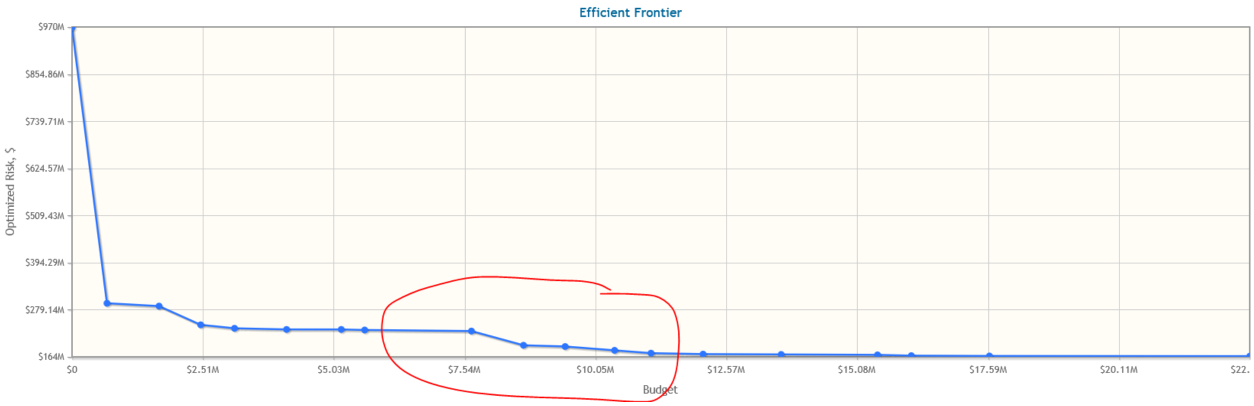

Figure 32: Efficient Frontier

7. Recommendation and Conclusion

Streetcar projects are a recent phenomenon in the United States. Some cities, like Portland, have had great success in using streetcars for development and improving transportation. Other cities, such as Atlanta, have been a failure; the system ends up being underutilized and constant breakdowns lead people to distrust public transportation in general. The results from our hypothetical assessment demonstrate the high amount of risk involved in these projects, so it's no surprise that people have strong opinions on whether public funds should be used when losses could be so great.

It's clear that when developing a plan for a massive and expensive project such as this one, risk management is key. Those who favor expanding the streetcar in DC need to carefully think through the risks, threats, objectives, and controls, as well as understand how these elements all interact with each other. Having highly-qualified experts provide judgements is also crucial.

8. References

1. "History." DCStreetcar.com. DDOT. Web. Accessed 5 September 2017.

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3. *Project: Expanding the D.C. Streetcar System* Model. Retrieved October 2017. https://gwcomparion.expertchoice.com/?passcode=2846-2628