Prioritization of Future Freight Infrastructure Projects within the Anchorage Metropolitan Area Transportation Solutions (AMATS)

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Abstract

The purpose of this project is to lay a foundation for the Anchorage Metro Area Transportation Solutions (AMATS) Freight Advisory Committee's (FAC) long-term vision of identifying the freight infrastructure projects in Anchorage.

This phase of the study consisted of three components, which progressively fed into one another. The first deliverable was creation of a database which was constructed based on a) Subjective criteria obtained via a survey of local freight drivers, and b) Objective criteria such as freight traffic volumes and freight accident data. The second component was the database information analysis, used modeling to establish a relative weighting, for comparison at pre-determined intersections. Both database construction and its subsequent analysis resulted in the final deliverable a comprehensive prioritization list of freight infrastructure projects in Anchorage.

Introduction

Background

Anchorage's transportation system is critical for the movement of people and goods throughout our state, region, and city; support our economy; and helps shape our community (AMATS, 2004). Daily, over 24,000 tons of essential freight moves on Alaska roads, carrying medical supplies, food, clothing, and household necessities. Over 94% of all Alaskan communities depend exclusively on trucking to supply their goods; this overwhelming reliance on freight needs to be acknowledged when infrastructure decisions are made (AMATS Committee, 2005, revised 2007).

Needs

Given the importance of freight mobility, the motivation for this project is to identify and rank the freight movement problem areas in the Anchorage region. As the Freight Advisory Committee (FAC) is an advisory group to the AMATS Policy Committee, it is vital that the FAC send firm and well researched project suggestions to the Policy Committee for approval. By understanding the local freight mobility issues along with having a systematic method to prioritize projects, future FAC recommendations will be increasingly appreciated and will have an improved opportunity to be included in long-term planning documents. Transportation decision making experts Kumares Sinha and Samuel Labi simplify this by saying "Transportation programming is typically accomplished using tools such as ranking prioritization and optimization: the goal typically is to select the project types, locations, and timings such that some network-level utility is maximized within a given budget." (Sinha & Labi, 2007, p. 2)

Solution Approach

This study will consist of multiple deliverable modules which progressively feed into one another.

The first deliverable is a database which will be constructed based on:

- Subjective criteria obtained in a survey to local freight drivers, and
- Objective criteria such as freight traffic volumes and freight accident data.

The database information will then be analyzed, weighted, and compared to predetermined intersections in town using the preferred modeling technique. This will result in a comprehensive prioritization list of freight infrastructure projects in Anchorage. Future projects will take this study and develop it into an automated mapping application.

Report Structure

This report will demonstrate an extensive literature search and then discuss how the research associates incorporated previously published work to create stakeholder surveys. The report will then detail different types of decision making techniques along with their inputs and then explain how the model development for this project was prepared. Given the approved model, future research associates will develop a formal prioritization list for the FAC and continue the discussion on the interactive automated mapping application.

Data and Model

Statement of Problem

The FAC does not currently have an objective process to prioritize the preferred freight projects within Anchorage. As Keeney (1992) asserts, the process by which the decision is made will likely be just as important as the decision itself if there are multiple competing interests. Given the broad range of potential stakeholders and categories of impact, there are numerous items to consider when making the prioritization list. The following table was developed by Sinha and Labi (2007) as an illustration to aid in understanding of those complexities.

Exhibit 1: Impact Categories and Types (Sinha &Labi, 2007, p.7)

Categories of Impact	Impact Types
Technical	Facility condition
	Travel time
	Vehicle operating cost
	Accessibility, mobility, and congestion
	Safety
	Intermodal movement efficiency
	Land-use patterns
	Risk and vulnerability
Environmental	Air quality
	Water resources
	Noise
	Wetlands and ecology
	Aesthetics
Economic efficiency	Initial costs
	Life-cycle costs and benefits
	Benefit-cost ratio
	Net present value
Economic development	Employment
	Number of business establishments
	Gross domestic product
	Regional economy
	International trade
Legal	Tort liability exposure
Sociocultural	Quality of life

Due to so many possible impacts into the prioritization list, it should be noted this paper will deal with travel time, congestion, and safety as inputs into the model. If the other impact types were included into this research, the scope would grow to an unmanageable size and magnitude. In order to find appropriate solutions for each of these inputs both subjective and objective criteria were analyzed.

Subjective Inputs Analyzed

Stakeholders

According to the Project Management Institute (PMI), stakeholders may have a positive or negative influence on a project. The PMI PMBOK Guide goes on to explain that "stakeholders have varying levels of responsibility and authority when participating on a project. This level of responsibility and authority can change over the course of the project's life cycle." (Project Management Institute, 2004, p. 25) While there are numerous ways to define stakeholders, Mersino has the most complete picture when he states "Project stakeholders are individuals and organizations that are actively involved in the project, or whose interest may be affected as a result of project execution or project completion." (Mersino, 2007, p. 117)

For the Freight Movement Project, it was determined that the key stakeholders would be Anchorage freight companies and their truck drivers along with the FAC. It is assumed that both these groups would benefit from the prioritization list deliverable.

Given that, these stakeholders were viewed as positive stakeholders. "Positive stakeholders feel they benefit by the success of your project, or at least have the potential to benefit from it." (Dobson, 2003, p. 107) Stakeholders that have been identified include Alaska Trucking Association, Private Freight companies, Alaska Railroad, Anchorage International Airport, Port of Anchorage, AMATS Policy Committee, AMATS FAC Committee, Alaska Department of Transportation & Public Facilities, Federal Highway Administration, and UAA Research Associates .

Stakeholder Analysis: Power Influence Matrix

The following matrix shows the power level and influence of each of the previously identified stakeholder groups.

Exhibit 2: Stakeholder Matrix

	Low Interest	High Interest
High Power	Key Influencers Freight Truck Drivers	Decision Supporters AMATS Policy Committee Freight Advisory Committee
Low Power	Low Threats Local Community Councils Anchorage Railroad Anchorage International Airport	Keep Informed UAA Research Associates Port of Anchorage Alaska Trucking Association

Stakeholder Survey

The following questions were asked during the stakeholder survey. The reasoning is explained as to why those questions were developed.

What type of firm do you work for?

The goal of any survey is to have the appropriate group of stakeholders answering the questions. By asking the type of firm the stakeholder is involved with, it gives the research associates a reassurance that the majority of the survey results from the freight industry. The primary stakeholder group for this survey is freight truck drivers within the Municipality of Anchorage.

What kinds of transportation services does your company provide?

This question will assist the research associates with making sure the answers are coming from ground freight transportation companies, primarily those that are common carrier.

What kinds of transportation services does your company provide?

This question was designed to specify the type of vehicle the company is utilizing. This information will help the research associates when the accident data is analyzed. If there are numerous companies using one particular type of vehicle and having increased issues at one intersection, then the FAC could instigate detailed conversations with that company in order to identify the root cause.

Are you a Freight Driver in Your Company?

This question was asked in order to go to a yes/no node in the survey. If the answer was "yes" then stakeholders were asked questions relating to length of driving service and vehicle size. If the survey answer was "no" then the stakeholder was taken directly to the intersection questions of the survey.

Please rate the following Anchorage intersections on the level of importance to your daily freight driving.

Given a random order of pre-identified intersections in Anchorage, all stakeholders were asked if these pre-determined intersections were:

- Problem Area
- Not A Problem Area
- Not Sure

Which of the following conditions present problems at the above listed intersections?

The stakeholders were then asked to rate the top three conditions for problem areas they identified. These problem areas and problem conditions were not correlated on a one-to-one basis; the research associates thought that would be out of scope. However the data from the problem condition question will be used as background information in the prioritization list background.

Summary of Survey Results

We've received 52 responses by March 24, 2010. 42.3% of responders said that their company provides the transportation service of truckload. 52.2% of responders are not a freight driver. And, 29.5% of responders drive single-trailer tractor. The key results from the survey are summarized in the following table:

Table 1: Survey Summary Results

Area	Problem?	Type of problem
Ocean Dock Road and Terminal Road intersection	34.1%	road congestion (54.2%)
Industrial Area circulation and access area	34.2%	turning radius (36.8%)
School Bus storage area	13.9%	road congestion (36.8%)
3rd Avenue and Ingra/Gambell area	**54.3%**	road congestion (50.0%)
Ocean Dock alignment near the Port entrance	31.4%	road congestion (84.6%)
3rd Avenue: Post Road and Reeve Blvd	45.5%	road congestion (50.0%
Dowling Road: New Seward Hwy to Lake Otis Pkwy	**51.6%**	turning radius (77.8%)
International Airport Road and Postmark Drive	3.2%	merge lanes (50.0%
Ocean Dock Railroad Crossings	43.3%	road congestion and poor signage (43.8%)
C Street and 5th/6th Avenue Intersection	43.3%	road congestion (72.2%)
Lake Otis Parkway: Debarr Road to Northern Lights Blvd	40.0%	road congestion (53.3%)
West Northern Lights Blvd and Wisconsin Street intersection	16.7%	road congestion (37.5%)
C Street/Potter/64th Ave intersections	33.3%	road congestion (50.0%)

North C Street and Ocean Dock road Intersection (i.e. Multiple RR Crossings)	40.0%	road congestion (41.7%)
Ocean Dock road access and crossing from Port to Terminal Road	26.7%	road congestion (55.6%)
C Street and International Airport Road intersection	17.2%	road congestion (50.0%)
New Seward Hwy and O'Malley Interchange	41.4%	turning radius (53.3%)
C Street: Tudor Road to 36th Avenue Northbound	31.0%	road congestion and turning radius (50.0%)
Postmark Drive and Point Woronzof/West Northern Lights Blvd Intersection	10.3%	road congestion (40.0%)

The result shows that most problem types are road congestion and turning radius. Some of the candidate areas, e.g. 3rd Avenue and Ingra/Gambell area, need more attention than other areas. We expected that most respondents to be truck drivers but the results show that is not the case. The respondents are not necessarily truck drivers.

The survey provides much different information but our ranking model uses one of them, which is the percentage of the stakeholders who think the area is a problem as the subjective input.

Objective Inputs Analyzed

In any type of analysis, an objective approach is needed. For the freight movement study, the objective criteria entered into the analysis model are related to safety and vehicle capacity.

Crash Data

This study uses the crash data obtained from Matthew M Matta, Research Analyst II of Alaska DOT on Oct. 23, 2009. The data include truck-related crash records in Anchorage from 2005 to 2009. 2009 data is incomplete due to the timing of the data collection. All the data for these years are used for the analysis.

For each candidate area, crashes are counted. Each count is divided by the maximum number of crash count among the candidate areas to make the scale comparable to the subjective inputs.

Traffic Volumes

This study uses the traffic volume data from Annual Traffic Volume Report 2006-2007-2008 by Alaska State DOT & PF. Only 2008 data is used to reflect the latest status of each traffic area.

For each candidate area, traffic volume data is collected. Each traffic volume is divided by the maximum traffic volume among the candidate areas to make the scale comparable to the subjective inputs.

Model Analysis

Given so many potential decision making models that were discovered in the literature search, our analysis to choose the best fit was refined to those that transportation experts Sinah and Labi suggest as the most appropriate for systematic evaluations. Once the analysis was complete, the research associates came to the unanimous decision that AHP would be the most logical and best suited model for developing future freight mobility prioritization lists. "A decision-making mechanism based on multiple criteria can:

1) Help structure an agency's decision making process in a clear, rational, well-defined, documentable, comprehensive, and defensible manner; and

2) Help the agency to carry out "what-if" analyses and to investigate trade-offs between performance criteria." (Sinha & Labi, 2007, p. 449)

The following excerpts discuss the specific models that were analyzed.

<u>Delphi Technique</u>

"Delphi technique is a widely used group decision-making tool that aggregated the perspectives from individual experts for consensus building and ultimately for a holistic final assessment. In this technique, the results from the first set of questionnaire surveys are analyzed and summarized, and the summary statistics are presented to the respondents. The respondents review their original individual responses relative to the summary statistics and make any needed adjustments to the weights they assigned originally. This cycle of iterations continues until there is no change in the scores. The final scores are then averaged to yield the relative weights. In most cases, a consensus emerges after two iterations." (Sinha & Labi, 2007, p. 451)

<u>Direct Weighting Method</u>

"In the direct weighting method, decision makers assign numerical weight values directly to performance criteria. Two approaches are: 1) Point allocation (a number of points are allocated among the performance criteria in proportion to their important.) 2) Ranking (involves a simple ordering of performance criteria by decreasing importance as perceived by the decision makers.) Of these two methods, point allocation is typically preferred because it yields a cardinal rather than an ordinal scale of importance. The point allocation approach is particularly useful when there are a large number of criteria. Both of these methods are generally easy to implement and are useful for initial estimation of relative weights." (Sinha & Labi, 2007, p. 450)

<u>Equal Weighting Approach</u>

"The equal weighing approach, which assigns the same weight to all performance criteria, is simple and easy to implement. It has been the common practice at many agencies to simply sum up agency and user cost to obtain a single cost value upon which a decision is made." (Sinha & Labi, 2007, p. 450)

Gamble Method

"The gamble method assigns a weight for one performance criterion at a time by asking survey respondents to compare their preference for a guaranteed outcome against an outcome that is not guaranteed. This method involves the following steps: Carry out an initial and tentative ranking of performance criteria in order of decreasing importance. Set the first criterion at its most desirable level and all other criteria at their least desirable levels. Compare between the following two outcomes:

- Sure thing
- Gamble

Step 2 is repeated for all other criteria until the weights have been determined for all criteria. The gamble method is particularly useful for determining relative weights of performance criteria in the outcome risk scenario. A disadvantage of this method is that it may be difficult to comprehend or administer." (Sinha & Labi, 2007, p. 452)

Multicriteria Decision Making

"A key step in multicriteria decision making is the explicit assignment of relative weights to each performance criterion to reflect its importance compared to other criteria. The first task in multiple criteria evaluation is to assess how decision makers attach relative levels of importance to criteria. The next task in multicriteria evaluation is scaling where each criterion is converted from its original dimension to one that is uniform and commensurate across all performance criteria." (Sinha & Labi, 2007, p. 449)

Regression-Based Observer-Derived Weighting

"Regression-based Observer-Derived Weighting is based on unaided subjective evaluations of alternative actions and their overall impact, followed by analysis of the results using statistical regression to identify the implicit relative weights. For each transportation alternative, survey respondents, such as agency decision-making personnel or facility users, are requested to assign scores of overall "benefit" or "desirability" for a given combination of performance criteria that is accrued by a given transportation alternative. Using statistical regression, a functional relationship is then established on the basis of each respondent's overall desirability for each alternative and the scores assigned to individual criteria." (Sinha & Labi, 2007, p. 450)

Value Swinging Method

"The value swinging method involved the following steps:

- Consider a hypothetical situation where performance criteria are all at their worst values.
- Determine the criterion for which it is most preferred to "swing" from its worst value to its best value, all other criteria remaining at the worst values. Repeat steps 1 and 2 for all criteria. Assign to the most important criterion, the highest weight in a selected weighting range, and then assign weights to the remaining criteria in proportion to their rank of importance." (Sinha & Labi, 2007, p. 455)

Anchorage Freight Mobility Study Model Development

This study adopted the Direct Weighting Method to handle multi-criteria in a simple and easy but flexible way. The study use both subjective and objective data for the prioritization. For subjective data, the percentage the respondents perceive it is a problem area was used as a subjective rating for each candidate problem area. For objective data, crash data and traffic volume were used. The study used relative frequency of truck crash at each candidate problem area as compared with the highest frequency among them as an objective data. The study also used relative volume of traffic at each candidate problem area as compared with the highest traffic volume among them. The combination of weights assigned to the three types of rating can differ by stakeholders. So, our model allows stakeholders to control the weight assignment. The model refers to the weight for the crash data as *wA*, the weight for the survey result as *wB*, and the weight for the traffic volume as *wC*.

We developed an interactive spreadsheet model for the prioritization. If the crash data is updated, it is reflected to the 'count of truck crash' and the ranking is updated automatically. The weights for the three inputs for ranking are controlled using scroll bars and the ranking is updated immediately in the spreadsheet model.

Figure 1: Snapshot of Ranking Model

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			weight (wA)		weight (wB)		weight (wC		
			0.39		0.31		0.3		
Area code	Area	count of truck crash	relative frequency of crash (A)		% respondents say "problem area" (B)	2008 Annual Average Daily Traffic (AADT)	relative AADT (C)	wA*A+wB*B+wC*C	Ranking
1	Ocean Dock Road and Terminal Road Intersection	5	71.4%		34.1%	2790	11.6%	41.9%	8
2	Industrial Area circulation and access area	1	14.3%		34.2%	2068	8.6%	18.8%	14
3	School Bus storage area	0	0.0%		13.9%	9979	41.6%	16.8%	15
4	3rd Avenue and Ingra/Gambell area	2	28.6%		54.3%	8099.5	33.8%	38.1%	9
5	Ocean Dock alignment near the Port entrance	0	0.0%		31.4%	2790	11.6%	13.2%	17
6	3rd Avenue: Post Road and Reeve Blvd	0	0.0%		45.5%	10770.5	44.9%	27.6%	10
8	Dowling Road: New Seward Hwy to Lake Otis Pkwy	7	100.0%		51.6%	16302.5	68.0%	75.4%	1
9	International Airport Road and Postmark Drive	2	28.6%		3.2%	10300	43.0%	25.0%	12
10	Ocean Dock Railroad Crossings	0	0.0%		43.3%	2176	9.1%	16.1%	16
11	C Street and 5th/6th Avenue Intersections	7	100.0%		43.3%	15043.5	62.7%	71.2%	2
12	Lake Otis Parkway: Debarr Road to Northern Lights Blvd	2	28.6%		40.0%	17859	74.5%	45.9%	7
13	West Northern Lights Blvd and Wisconsin Street intersection	0	0.0%		16.7%	17750	74.0%	27.4%	11
14	C Street/Potter/64th Ave intersections	5	71.4%		33.3%	21714	90.6%	65.4%	4
15	North C Street and Ocean Dock Road Intersection i.e. Multiple RR Crossing	1	14.3%		40.0%	2176	9.1%	20.7%	13
16	Ocean Dock Road access and crossing from Port to Terminal Road	0	0.0%		26.7%	2790	11.6%	11.8%	18
17	C Street and International Airport Road intersection	3	42.9%		17.2%	21940	91.5%	49.5%	6
18	New Seward Hwy and O'Malley Interchange	4	57.1%		41.4%	15551	64.9%	54.6%	5
19	C Street: Tudor Road to 36th Avenue Northbound	5	71.4%		31.0%	23975.5	100.0%	67.5%	3
20	Postmark Drive and Point Woronzof/West Northern Lights Blvd Intersectic	0	0.0%		10.3%	5110	21.3%	9.6%	19
	sum =	44		sum =		209184.5			
	max =	7		max =		23975.5			

Areas sorted by ranking

Ranking	area code	area
1	8	Dowling Road: New Seward Hwy to Lake Otis Pkwy
2	11	C Street and 5th/6th Avenue Intersections
3	19	C Street: Tudor Road to 36th Avenue Northbound
4	14	C Street/Potter/64th Ave intersections
5	18	New Seward Hwy and O'Malley Interchange
6	17	C Street and International Airport Road intersection
7	12	Lake Otis Parkway: Debarr Road to Northern Lights Blvd
8	1	Ocean Dock Road and Terminal Road Intersection
9	4	3rd Avenue and Ingra/Gambell area
10	6	3rd Avenue: Post Road and Reeve Blvd
11	13	West Northern Lights Blvd and Wisconsin Street intersection
12	9	International Airport Road and Postmark Drive
13	15	North C Street and Ocean Dock Road Intersection i.e. Multiple RR Crossings
14	2	Industrial Area circulation and access area
15	3	School Bus storage area
16	10	Ocean Dock Railroad Crossings
17	5	Ocean Dock alignment near the Port entrance
18	16	Ocean Dock Road access and crossing from Port to Terminal Road
19	20	Postmark Drive and Point Woronzof/West Northern Lights Blvd Intersection

If the stakeholder thinks that three ratings are equally important, the weights can be assigned as

$$wA = 1/3,\ wB = 1/3,\ wC = 1/3.$$

Then, the list of problem areas sorted by the ranking is generated as

Ranking	Area
1	Dowling Road: New Seward Hwy to Lake Otis Pkwy
2	C Street and 5th/6th Avenue Intersections
3	C Street: Tudor Road to 36th Avenue Northbound
4	C Street/Potter/64th Ave intersections
5	New Seward Hwy and O'Malley Interchange
6	C Street and International Airport Road intersection
7	Lake Otis Parkway: Debarr Road to Northern Lights Blvd
8	Ocean Dock Road and Terminal Road Intersection

9	3rd Avenue and Ingra/Gambell area
10	3rd Avenue: Post Road and Reeve Blvd
11	West Northern Lights Blvd and Wisconsin Street intersection
12	North C Street and Ocean Dock Road Intersection i.e. Multiple RR Crossings
13	International Airport Road and Postmark Drive
14	Industrial Area circulation and access area
15	Ocean Dock Railroad Crossings
16	Ocean Dock alignment near the Port entrance
17	School Bus storage area
18	Ocean Dock Road access and crossing from Port to Terminal Road
19	Postmark Drive and Point Woronzof/West Northern Lights Blvd Intersection

Different weighting gives different ranking. This feature gives the flexibility when dealing with different perspectives of stakeholders on the future infrastructure project.

Conclusion

With the limited inputs, we developed the ranking model for future freight infrastructure projects. The website shows some examples of the prioritization using the model. With more improvement, the website will give much more valuable information to the stakeholders.

REFERENCES

AMATS Committee. (2005, revised 2007). Anchorage Bowl 2025 Long-Range Transportation Plan. Anchorage: Anchorage Metropolitan Area Transportation Solutions.

Dobson, M. S. (2003). Streetwise Project Management. Avon: Adams Media.

Freight Advisory Committee, A. (2009, 10 6). Anchorage Intersection Tour. (K. Brown, Interviewer)

Keeney, R. L. (1992). Value-Focused Thinking; A Path to Creative Decisionmaking. Cambridge: Harvard University Press.

Mersino, A. (2007). Emotional Intelligence for Project Managers. New York: AMACOM.

Project Management Institute. (2004). A Guide to the Project Managment Body of Knowledge, Third Edition. Newtown Square: Project Management Institute, Inc.

Sinha, K. C., & Labi, S. (2007). Transportation Decision Making; Principles of Project Evaluation and Programming. New Jersey: John Wiley & Sons, Inc.