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# Locational priority of fixed automated spray technology (FAST) using analytic hierarchy process

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# Presentation Outline

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- Background
- FAST description
- Producing a locational priority
- AHP structure
- Final priority results
- Summary

# Background

- Freezing rain and black ice on road would be very dangerous for drivers.
- As for winter maintenance, proactive actions should be performed to reduce traffic accidents originated from skidding.
  - bridges, overpasses, around the tunnels, fog frequency of road, and shady road sections



Freezing rain and black ice on road



Skidding accident

# Fixed Automated Spray Technology (FAST)

- FAST is a proactive solution for anti-icing that distributes chemicals preventing formation of bonded snow and ice.
- FAST entails installation of spray units fully embedded in the road surface to anticipate the surface freezing point.
- A complete system includes a pump, tank, spray nozzles, and a controller.



U.S. DOT



Korea Expressway Corp.



# Gathering fundamental data

- Priority was produced by integrating the Analytical Hierarchy Process (AHP) method with scoring table provided by the Ministry of Land, Infrastructure and Transport (MOLIT).
- For this, fundamental data was gathered from 18 regional offices of MOLIT.



Locations of 18 Regional Offices in Korea

Division	# Regional Office	Division	# Regional Office
Geometry	Route Number, Specific Location	Weather	Number of Snowfall Days (Average 3-year)
	Number of Lanes		The entry into force of a special weather report number
	Vertical Grade (%)	Etc.	Traffic Accident (Average 3-year)
	Starting Point, Ending Point		Traffic Volume (AADT)
	Expected Length		Preferred Type of FAST System
	Vulnerable Roadway Section for Snow (Yes, No)		Civil Complaint (Sum of 3-year)

Survey list to Collect Basic Information for the Analysis

# Gathering fundamental data

Example of Survey Results of “A” Regional office

Office	Route	Expected Length	Num. of Lanes	Preferred Type of FAST System	Num. of Snowfall Days	The entry into force of a special weather report number	Traffic Accident	Traffic Volume	Civil Complaint	Vertical Grade (%)	Vulnerable Roadway Section for Snow (Yes, No)
A	a	400m	2	Shoulder (up&down)	22	5	2	21,275	3	5	Yes
	b	400m	2	Shoulder (up&down)	22	5	2	16,844	2	5	Yes
	c	400m	2	Shoulder (up&down)	22	5	2	10,136	3	5	Yes
	d	400m	2	Shoulder (up&down)	22	5	2	2,683	1	5	Yes

# Scoring classification by MOLIT

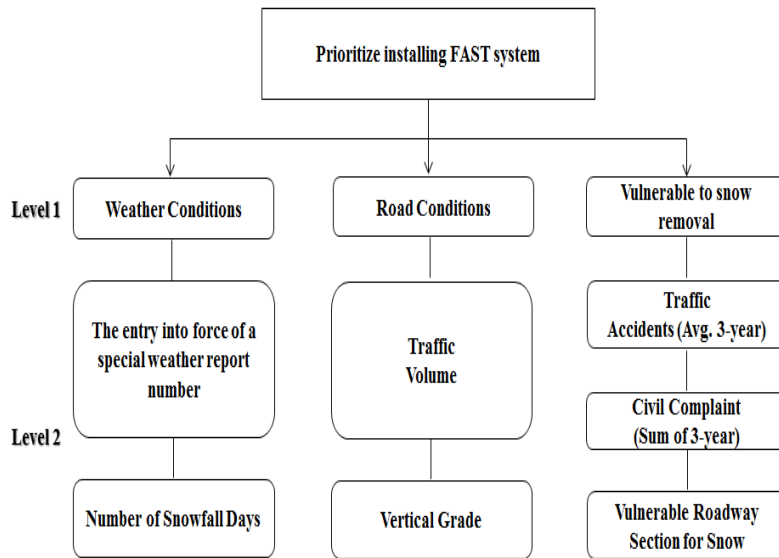
- MOLIT uses their own scoring table to determine roadway section that need to install FAST systems.
- In this study, three additional criteria such as civil complaint, vertical grade, and vulnerable roadway section for snow were considered to reflect current significant issues for winter maintenance.

Scoring Table used by MOLIT

Division	Scoring Classification			
	4-point	3-point	2-point	1-point
Number of Snowfall Days	over 20 days	19~15 days	14~10 days	Less than 9 days
The Entry into Force of a Special Weather Report Number	over 11 days	10~9 days	8~5 days	Less than 4 days
Traffic Accidents (Average 3-year)	over 10 cases	9~5 cases	4~3 cases	Less than 2 cases
Traffic Volume (AADT)	over 20,000	20,000~10,000	10,000~5,000	Less than 5,000
Civil Complaint (Sum of 3-year)	over 4 cases	3 cases	2 cases	Less than 1 case
Vertical Grade (%)	over 6%	5%	5~3%	Less than 3%
Vulnerable Roadway Section for Snow (Yes, No)	-	-	-	If considered

# AHP Structure

- Based on survey results and an arbitrary rating scale developed by Saaty, a pair-wise comparison matrix was developed.
- The highest weight was assigned to “*vulnerable to snow removal*” in the level 1, and “*traffic volume*” has the highest weight in the level 2.
- Consistency index and consistency ratio were less than 0.1, and thus all were considered as consistent.



AHP Structure

Level	Criteria	Estimated Weights	Consistency Index	Consistency Ratio
1	Vulnerable to Snow Removal	0.669	0.0035	0.006
	Weather Condition	0.243		
	Road Condition	0.088		
2	Number of snowfall Days	0.208	0.051	0.0085
	The entry into force of a special weather report number	0.004		
	Traffic Accident (Average 3-year)	0.039		
	Traffic Volume(AADT)	0.433		
	Civil Complaint(Sum of 3-year)	0.104		
	Vertical Grade (%)	0.004		
	Vulnerable Roadway Section for Snow (Yes, No)	0.208		

Estimated Weights



# Final Priority Results

- Honam and Metropolitan areas have high priority for installation of the FAST systems.
- The AHP and MOLIT scoring table produced similar ranking .
- The combined AHP with MOLIT scoring table can reflect more detailed preferences of potential users in its priority.

Region	Route	Rank		Region	Route	Rank	
		Integrate AHP with MOLIT	MOLIT Scoring Table			Integrate AHP with MOLIT	MOLIT Scoring Table
Honam	26	1	1	Metro	42	20	28
Metro	17	2	31	Chung	32	21	9
Metro	43	3	31	Metro	3	22	28
Metro	6	4	21	Gangwon	7	23	9
Metro	6	4	21	Chung	36	24	9
Honam	17	6	9	Honam	1	25	1
Honam	23	7	1	Chung	38	26	21
Youngnam	20	8	17	Honam	17	27	17
Honam	26	9	5	Chung	38	28	25
Honam	19	10	5	Honam	2	29	5
Honam	21	11	9	Chung	38	30	25
Honam	15	12	1	Honam	19	31	9
Honam	30	13	21	Honam	30	32	17
Honam	27	14	9	Metro	3	33	37
Honam	2	15	9	Chung	38	34	31
Honam	2	16	17	Honam	24	35	31
Metro	39	17	28	Honam	30	36	25
Metro	39	18	31	Gangwon	46	37	36
Chung	32	19	5	-	-	-	-

\* Metro = Metropolitan, Chung = Chungcheong Area, Youngnam = Youngnam Area, Honam = Honam Area, Gangwon = Gangwon Area

# Summary

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- Priorities for installing FAST systems were suggested by integrating AHP with existing MOLIT scoring table.
- Our study added three of new criteria that would affect priority for snow removal works which are *Vulnerable to Snow Removal*, *Weather Condition* and *Road Condition*.
- The result can be used to allocate available budget and resources for winter maintenance.
- It is expected that this study could contribute to determining priority for installing necessary equipment or facilities/system for road management.

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# Questions



Thank you !