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A study on developing index for the railway safety investment

Korea Railroad Research Institute

22th Oct. 2018

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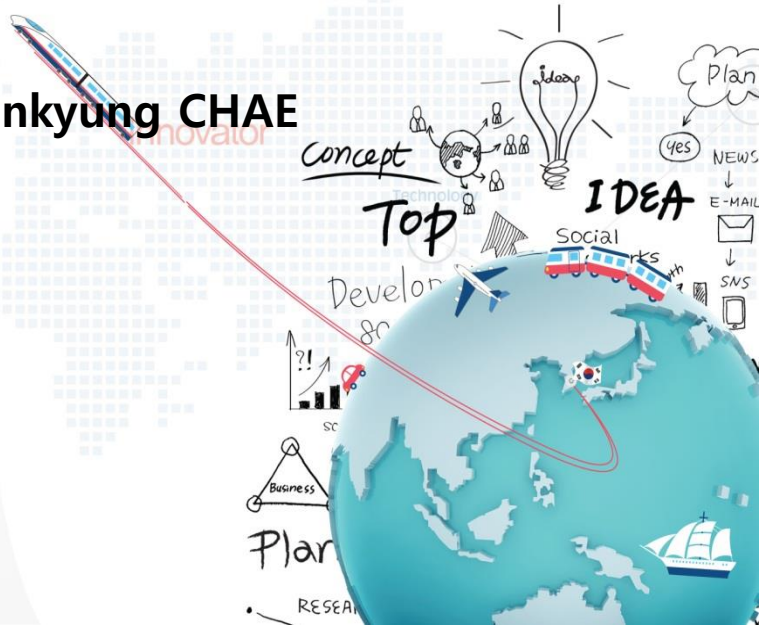
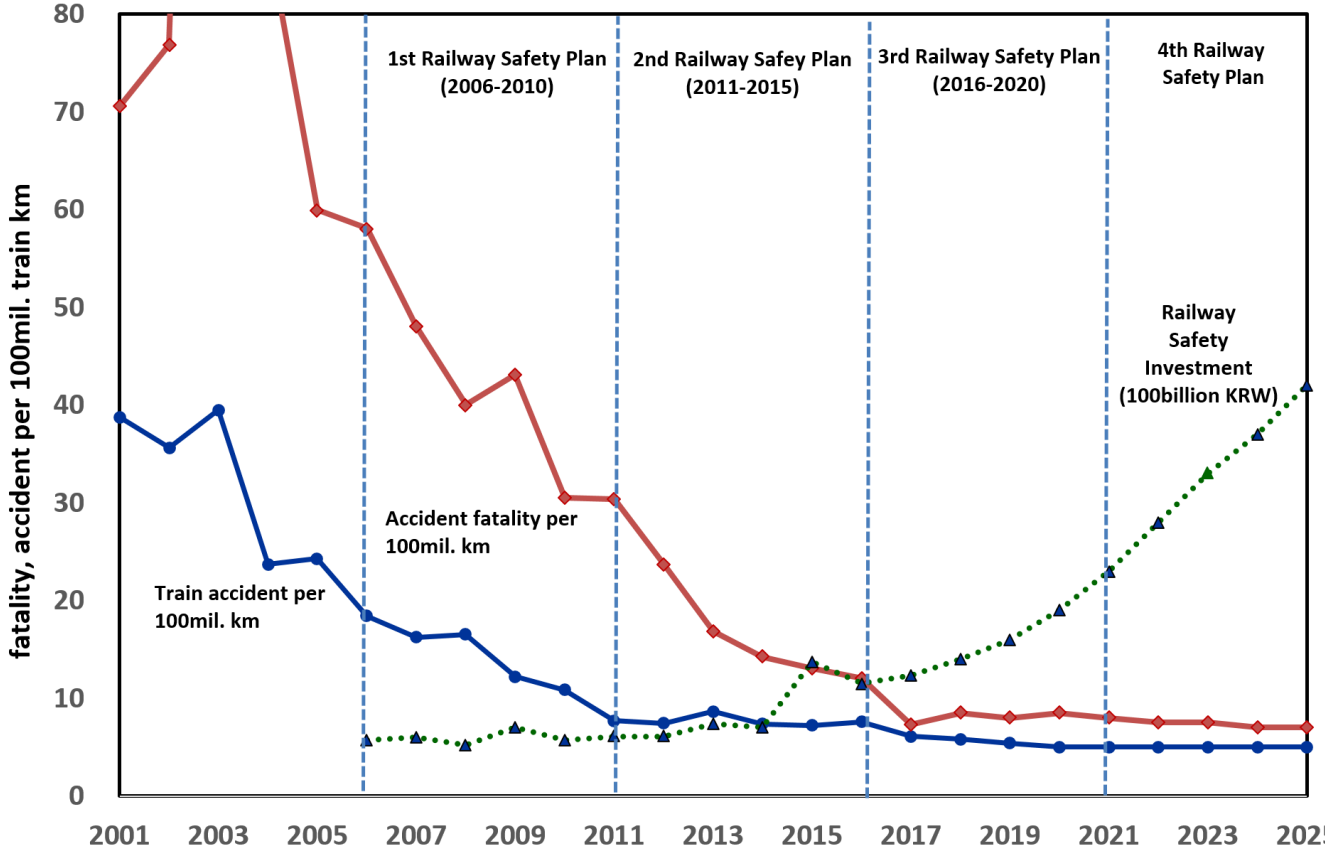


21st-26th October, 2018
Royal Marine Hotel, Dun Laoghaire,
Dublin, Ireland

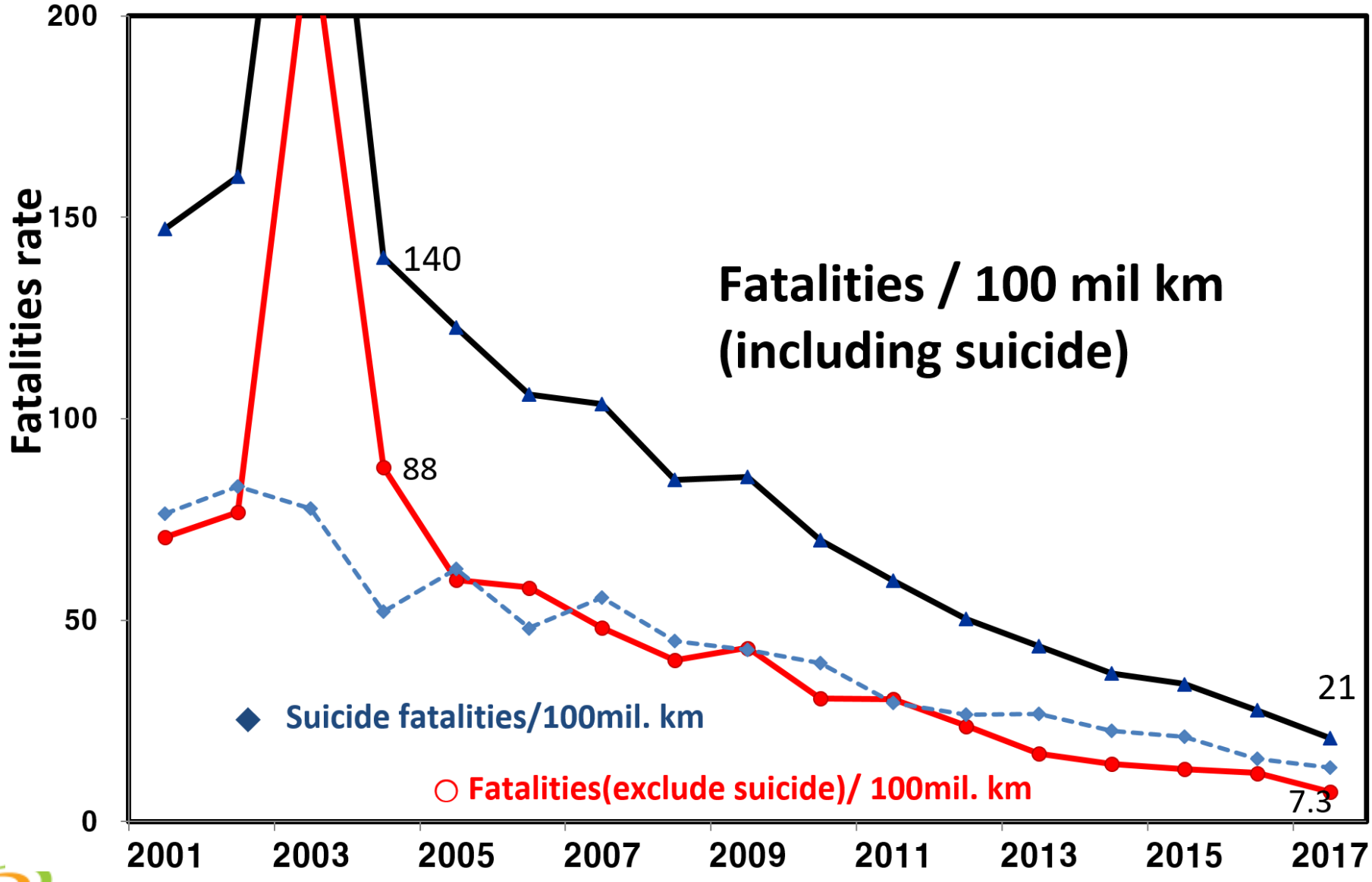
1. Background : environmental changes

Environmental Change in Safety Investment

- Previous : accident result based target & index
  - ➔ Focus on frequently occurring accident safety measures, neglect train accident safety measures
  - ➔ Change of accident causes and accident pattern, trial error for train accident safety measures
- Increase of private railway operators(80% of operators owned by Central or Regional Governments)



1. Background : Safety index



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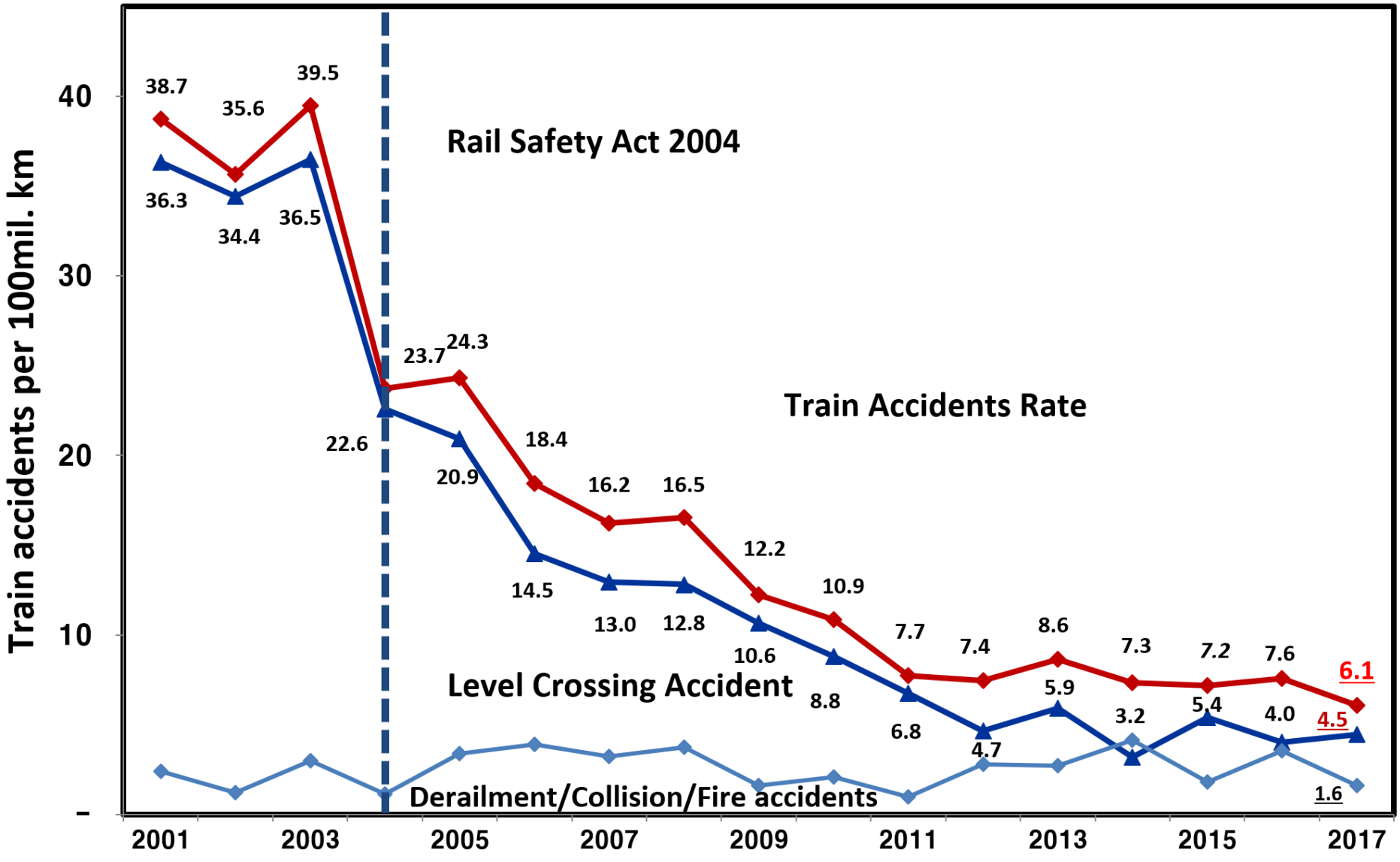
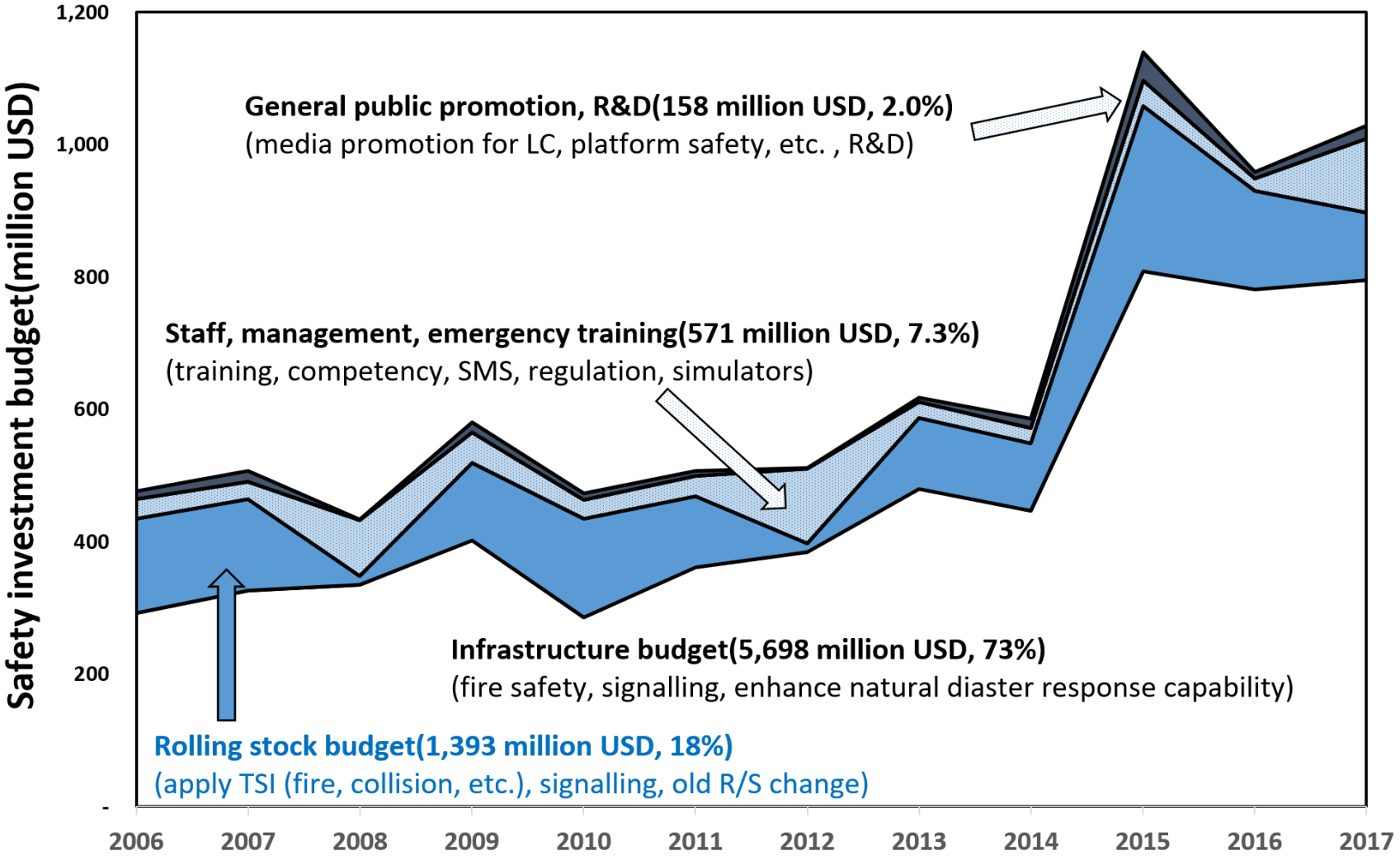
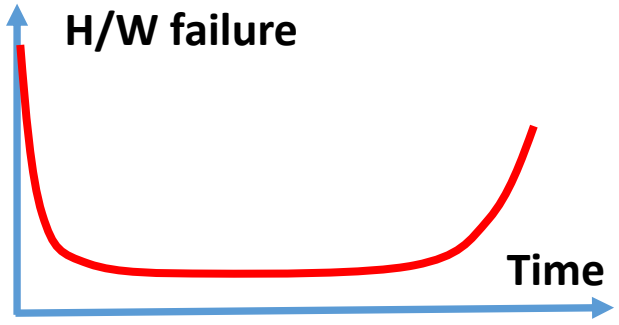
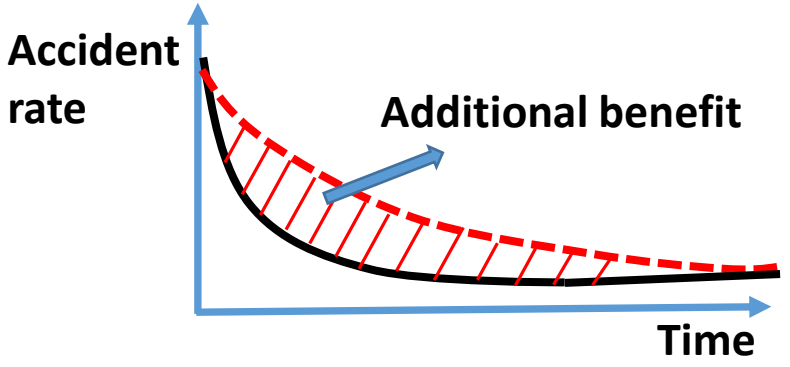


1. Background : safety investment



2. Basic idea of safety investment

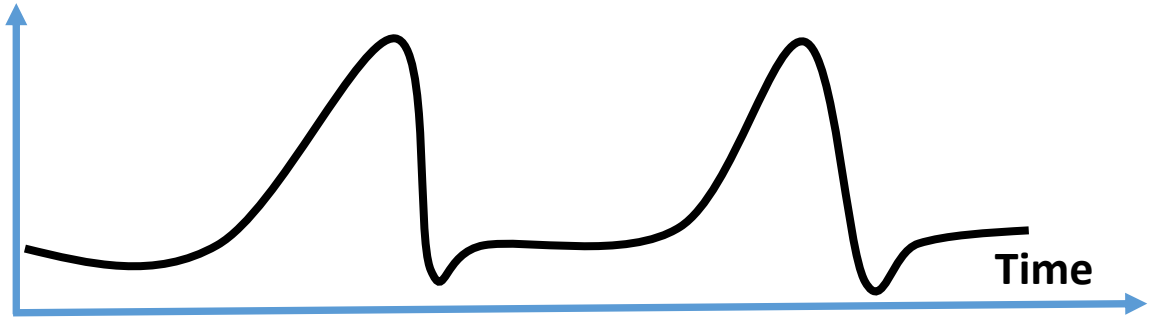


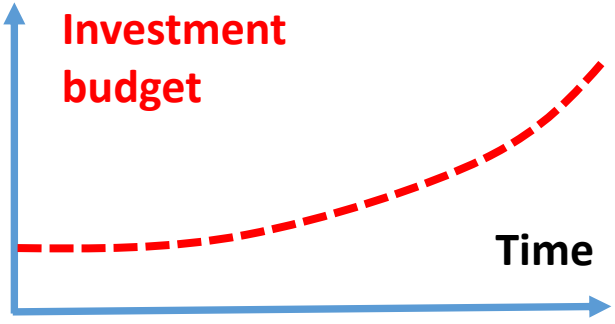


Same budget, different effects

Intensive investment

Current investment





2. Time leg for safety investment

❖ Accident result based safety index
- Based on safety target, investment
- Penalty for fail to achieve safety target

❖ Focus on safety target related safety measures
- Frequently occurring accidents(accident to person, LC) : 80% decrease
- Rarely occurring accidents(derailment, collision, fire) : tie-up

❖ Effectiveness of safety measures
- Life cycle cost
- Short-time leg
- Minimize trial error(side effect, redundant investment)

2. Time leg for PSD(Platform Screen Door)

Year	budget (mil. USD)	Installed station	Installation ratio	Urban Train km (mil. km)	Accident fatalities at station	Change rate (%)
2006	38.1	45	8%	90.26	92	-
2007	105.3	102	16%	91.22	98	+7%
2008	101.7	156	25%	93.17	74	-20%
2009	197.2	371	53%	97.19	77	-16%
2010	106.7	419	59%	100.90	62	-32%
2011	**61.4**	**457**	**60%**	**107.91**	**43**	**-53%**
2012	**38.7**	**519**	**64%**	**111.97**	**56**	**-39%**
2013	**54.7**	**534**	**65%**	**117.13**	**31**	**-66%**
2014	**62.4**	**592**	**70%**	**118.31**	**25**	**-73%**
2015	**226.8**	**592**	**70%**	**121.65**	**26**	**-72%**
2016	**174.1**	**598**	**72%**	**125.92**	**30**	**-67%**
2017	**249.7**	**649**	**77%**	**131.92**	**23**	**-75%**

Measure for accident to person at platform

- Intensive safety investment in 2007
- Effective from 2011
- 4 year time difference
  (reduce 53% of accident fatalities)
- Cost-effective measure for long-term
- Plan to install PSD for all urban platform by 2020

➔ **Effective measure for safety target**

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2. Time leg for track fence

Year	Track length (km)	Installed track fence length	Train km (million km)	Safety budget for fence on track (mil. USD)	No. of accident (conventional train)	Change rate (%)
2006	3,140	662	68.51	13.3	44	-
2007	3,158	667	72.98	9.2	32	-27%
2008	3,141	685	72.74	0.2	29	-34%
2009	3,145	692	69.15	1.7	14	-68%
2010	3,219	713	69.68	2.5	13	-71%
2011	3,185	722	72.60	4.8	17	-61%
2012	3,203	752	73.28	4.0	31	-30%
2013	**3,222**	**771**	**70.11**	**7.6**	**11**	**-75%**
2014	**3,269**	**807**	**66.68**	**7.6**	**5**	**-89%**
2015	**3,285**	**820**	**68.14**	**4.0**	**8**	**-82%**

Measure for trespass at track

- Intensive safety investment in 2006
- Effective from 2013
- 7 year time difference
  (reduce 75% of accident fatalities)
- High maintenance cost measure for long-term

➔ Related with other factors
(train density, population density along track, nursing(dementia) facility(near track)),…

2. Time leg for Level Crossing

Year	No. of LC accident	Fatalities at Level Crossing	Number of Level crossing	Safety budget for LC (mil. USD)
2003	61	9	1657	6.8
2004	39	6	1577	8.0
2005	37	7	1537	3.6
2006	26	3	1510	35.8
2007	24	4	1455	43.8
2008	24	4	1369	43.9
2009	20	4	1313	44.0
2010	**17**	**4**	**1262**	**12.5**
2011	**14**	**5**	**1219**	**14.9**
2012	**10**	**4**	**1149**	**14.0**
2013	**13**	**3**	**1075**	**13.1**
2014	**7**	**0**	**1058**	**18.2**
2015	**12**	**5**	**1054**	**15.4**
2016	**9**	**0**	**1001**	**24.5**
2017	**11**	**0**	**965**	**18.8**

Measure for Level Crossing

- 3D construction for road & pedestrain
- Intensive investment since 2006
- Effective from 2010
- 4 year time difference
  (reduce 46% of LC accident)
- Cost-effective measure for long-term

➔ **Effective measure for safety target,**
Focus on LC measure,
neglect other train accident measures

3. Coverage of safety measures for train accidents

- New line(Planning, Designing, Manufacturing, Commissioning)
  - Rolling stock & Infrastructure : Type approval(TSI), reinforced regulation
- Operating line
  - Upgrade Signaling system(ATP, ATO, ATC) for all network
  - Straighten the track(speed up & derailment measure)
  - Upgrade to double track or install side track for turnout
  - Natural disaster measures

- Emergency planning, staff training, confidential reporting

3. New Safety Index

❖Index can measure both frequent accident and train accidents

➢Relatively easy for frequent accident

- Many data for analysis, simple pattern, simple hazards, simple measures

➢Difficult for rarely occurring train accidents (derailment, collision, fire, explosion, dangerous goods)

- Hard to verify PRA(too many assumption, low reliability), too much hazards, complicated measure(many trial error in safety investment)
- Accident patterns are changing(H/W problem → Human Factors)

➢Time leg from safety investment to improvement

3. Safety investment for train accident

Tie-up train accident rate

- ✓ Investment were focus on high train density line : accident occurs low density line or side track(plan to install but delayed lack of safety budget)




Trial error for train accident measures(redundant investment)

- ✓ Additional investment for remove redundant measures
- ✓ Too much false alarm ➔ increase task load for Driver & controllers, ignore real alarm

➔ Safety index for investment needed

4. Conclusions

❖ Current index for safety investment

- Find easy way to achieve the safety target & index(avoid penalty)
- Focus on short term measures

➔ Train accident measures were not main issue for investment

➔ Train accident rate were tie-up

➔ Reinforced regulations were difficult to apply on operating line

❖ New index for safety investment must include

- Life cycle cost verification for train accident measures
- A safety investment budget is accumulated for a certain period of time
- As hazard change, investment must change

➔ Increase intensity & coverage of safety measures

➔ Emergency planning, staff training, advertisement to public,…