Cost-benefit Analysis of runway occurrences

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Safe-Runway GmbH
The Issue

Prevention successful
Riyadh: A Royal Jordanian plane veered off the runway early this morning as it was landing at Sulaimaniyah International Airport in Iraqi Kurdistan. The Embraer 175 jet was heading from Amman, Jordan to Iraqi Kurdistan with 30 passengers and crew members aboard, reported Jazirah. In a statement, the Royal Jordanian Company said no casualties were reported.  
SOURCE: GDN Gulf Digital News, 04-03. 2017

RIGA, Feb 17 (LETA) — "A Vim Airlines charter flight from the Russian city of Ufa got into an accident at Riga International Airport today when the aircraft started skidding on the runway before takeoff. There were 43 passengers and seven crew members on board the plane, but none of them was injured in the accident. The plane has been taxied to the apron. The runway has been closed and examined for technical issues. According to information on the airport's website, there have been no arrivals at Riga airport since 11.54 a.m., while the last departure took place at 11.32 a.m." 
SOURCE: LETA, Latvian information agency, 17.02.2017

KALININGRAD, Jan 17 — "Aeroflot flight SU1008 suffered a runway excursion and nose landing gear collapse after landing at Kaliningrad-Khrabrovo Airport (KGD) in Russia. The aircraft, an Airbus A321, took off from Moscow's Sheremetyevo Airport at 19:18 UTC on a domestic service to Kaliningrad. It landed on runway 24, a 2400 m long runway, but was not able to stop on the runway and veered off by 15-20 meters, coming to rest in the snow with a collapsed nose landing gear."
SOURCE: TASS, Russian News agency 03-01-2017
The challenge

- Runway Safety has priority
- The ROI of additional prevention measures might become negative
- CHALLENGE: Find cost effective solutions for runway safety risks
INSPIRATION: Two runway excursions

NO grooving and, NO standard RESA · · · · · · · · · · · · · · · · · · WHY NOT?

- AF 358; 2 aug 2005, A 340, CYYZ, runway excursion into Etobicoke creek, 12 injuries, fully destroyed.

- TAM3054; 17 July 2007, A 320, SBSP, runway excursion into road fuel station, 199 fatalities (187 SOB + 12 others)
Runway End Safety Area (RESA)

ICAO standard RESA ↔ Inadequate RESA → Risks

RESA inadequate

Graph Source: ATSB, Runway excursions, Part C: Minimising the likelihood and consequences of runway excursions, An Australian perspective, 2009.
EASA Safety Risk Management defines ALARP:

“Showing that the safety risk is ALARP means that any further risk reduction is either **impracticable** or grossly outweighed by the cost”.

- Impracticable?
  - No

- Grossly outweighed by the costs?

Let’s find out. → Model
Model Principle

Costs of runway overruns

Accident data
Open Source and Accident reports

Assumptions
• Human costs
• Direct Safety Costs
• Indirect Safety Costs

Calculation

Accident costs

Source: Safe-Runway GmbH
Who Pays?

- **Aerodrome operator**
  - Opportunity costs
  - Damage (too limited data)

- **Aircraft Operator**
  - Aircraft damage costs
  - Delay and Diversion costs
  - Passengers compensation

- **Human**
  - Injury and casualty costs

- **ISC**
  - Source: Safe-Runway GmbH
Major results 2016

- 643 Identified runway accidents
- 52% General Aviation
- 18% CAT

- $ 6.5 Billion total costs
  - averaging $ 0.5B per month.

![chart showing runway accident costs and percentages]
![chart displaying monthly runway accident costs]

www.Safe-Runway.com
Major results 2016

- 643 Identified runway accidents.
- Cost distribution per Type of operation:
  - CAT (67%)
  - GEN (11%)
  - NCC (13%)
  - MIL (7%)
643 Identified runway accidents.

Cost distribution Type of aerodrome.
- Hubs: (36%)
- Regional aerodromes (49%)
- Military and Municipal airports each (8%).
Major results 2016

- 643 Identified runway accidents.
- Cost distribution Type of accident.
  - On runway accidents (34%)
  - Veer-offs (35%)
  - Overruns (23%)
  - Incursions (<2%)
  - Underruns (4%)
Major results 2016

- 643 Identified runway accidents.
- Cost distribution per type of operator.
  - Aerodrome operators (4%)
  - Aircraft operators (60%).
  - Fatalities in injuries (7%).
  - ISC (30%)
Results 2016

- 52% of Number of occurrences with GENeral aviation
- 65% of Costs by CAT & MCTOM >5700kg & MCPSC>20.
- 49% of Costs occur at Regional Aerodromes.
- 62% of Costs are due to Runway excursions
- 56% of Runway excursion costs are due to veer-offs.
- Costs for Aircraft operators 15 x higher than for aerodrome operators
- Number of injuries and fatalities in General aviation supersede those in CAT
Results Jan-Feb 2017 (provisional)

Conclusion:
No Significant differences
Opportunities

**Most Productive**
Here, your input leads to productive returns. It pays to invest more time, effort.

**Diminishing Returns**
Each added input leads to a decreasing rate of output. It’s best to stop somewhere within this phase.

**Negative Returns**
Never get here. Not only do you not get a return for your effort, you decrease your overall output!

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Reducing runway events RISK

Risk = f [Probability, Severity]

<table>
<thead>
<tr>
<th>Probability</th>
<th>Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almost certain (5)</td>
<td>Negligible (4)</td>
</tr>
<tr>
<td>Likely (4)</td>
<td>Low (4)</td>
</tr>
<tr>
<td>Possible (3)</td>
<td>Low (3)</td>
</tr>
<tr>
<td>Unlikely (2)</td>
<td>Low (2)</td>
</tr>
<tr>
<td>Rare (1)</td>
<td>Low (1)</td>
</tr>
</tbody>
</table>

Probability → Aircraft operator
Crew
SOP’s
Equipment
SMS
Oversight

Point of Maximum Yield
Point of Diminishing Returns
Most Productive
Here, your input leads to productive returns. It pays to invest more time, effort.

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Total Output
(Overall quality of work, total yield)

Total Input
(Time, effort, resources invested)

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Reducing runway events RISK

Risk = f [Probability, Severity]

<table>
<thead>
<tr>
<th>Probability</th>
<th>Severity</th>
<th>Hardware</th>
<th>Aircraft &amp; Interior</th>
<th>Aerodrome</th>
<th>RESA</th>
<th>Strip</th>
<th>Oversight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Possible (3)</td>
<td>Low (3)</td>
<td>Low (3)</td>
<td>Low (3)</td>
<td>Low (3)</td>
<td>Low (3)</td>
<td>Low (3)</td>
<td>Low (3)</td>
</tr>
<tr>
<td>Unlikely (2)</td>
<td>Low (2)</td>
<td>Medium (6)</td>
<td>Medium (8)</td>
<td>Medium (10)</td>
<td>Medium (10)</td>
<td>Medium (10)</td>
<td>Medium (10)</td>
</tr>
<tr>
<td>Rare (1)</td>
<td>Low (1)</td>
<td>Low (2)</td>
<td>Low (3)</td>
<td>Low (4)</td>
<td>Medium (5)</td>
<td>Medium (5)</td>
<td>Medium (5)</td>
</tr>
</tbody>
</table>

Risk = f (Probability, Severity)

- **Law of Diminishing Returns**
  - Here, your input leads to productive returns. It pays to invest more time, effort.
  - Each added input leads to a decreasing rate of output. It's best to stop somewhere within this phase.

- **Most Productive**
  - Point of Diminishing Returns

- **Negative Returns**
  - Maximum Yield
  - Never get here. Not only do you not get a return for your effort, you decrease your overall output.
Severity reduction costs effective?

Analysis study (2016 Safe-Runway GmbH):

- Was it Cost effective to bring a non-ICAO standard RESA to an equivalent level of safety by EMAS?
- Total Installation costs
- Total costs of overruns in EMAS
- Total hypothetical accident costs without EMAS

METHOD

• 117 world wide installations
• 12 actual overruns into an EMAS
• Each overrun analyzed and associated overrun costs estimated
• Two scenario’s estimated:
  • Actual overrun costs (AOC)
  • Hypothetical overrun costs if EMAS would not have been installed (HOC)
• Difference between hypothetical accident cost estimate and actual arrestments costs estimate
• ALL world wide installations costs (WIC)
• NET COSTS SAVED= HOC-AOC-WIC= one billion $
On 26 October 2016 at 19:40 eastern daylight time, a Boeing 737 N278EA, carrying 37 passengers and 11 crew, including the republican vice presidential candidate Pence experienced a runway overrun upon landing at LaGuardia Airport in New York City. Sources state that “it was a rough landing, the pilot jammed the brakes and that the aircraft was suddenly stopped.”

- Estimated position NO EMAS
- Central parkway rush hour traffic: 300 vehicles per minute
- Estimate a certain nr of Human Injuries distribution
- Estimate level of damage, associated costs (Aircraft and third party) and ISC
- Estimate installation costs, bed repair costs
The key issue: Right Priority?

- Total world-wide runway accidents costs of 6.5 Billion $
- Costs of runway excursions 25 x Higher than runway incursions
- Investment in adequate / improved RESA’s and runway strips could possibly be a cost efficient method to reduce the runway excursion costs
Conclusion & Problem

- Conclusion
  - Further likelihood reduction faces future limits due to law of diminishing returns
  - As an alternative could the excursion costs be reduced by addressing the severity of excursions
  - Adequate / Improved RESA and runway strip reduce these cost effectively

- Problem
  - Aerodromes are not all to ICAO RESA or Strip standard,
  - Situation is accepted by a number of CAA’s.
  - Aircraft operators operate in these aerodromes
  - resulting is an increased runway excursion risk and thus costs.
Conclusion Runway accidents

- Policy on Runway Risk reduction for CAT is justified.
- **Risk** reduction of runway excursions through reducing the severity of an runway excursion could likely cost-effectively be realized.
- Financial incentive for aerodromes to reduce the overall runway risk costs is lacking.

Disproportional costs distribution blocks cost-effective solutions, potentially saving up to 1 Billion $ on runway excursion costs.
Recommendations

① Prioritize i.a.w. Follow the Money concept

② Special attention to:
   a) Regional aerodromes (also outside Basic regulation)
   b) Reduction # Injuries General aviation.
   c) Veer-Offs

③ Include Severity reduction in runway risk reduction policies
   a) Solve disproportional problem
   b) Align CAA’s
Questions / Discussion

A safe runway is THE core business

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