THE INDIRECT COSTS ASSESSMENT OF RAILWAY INCIDENTS AND THEIR RELATIONSHIP TO HUMAN ERRORS: THE CASE OF SIGNALS PASSED AT DANGER

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INTRODUCTION

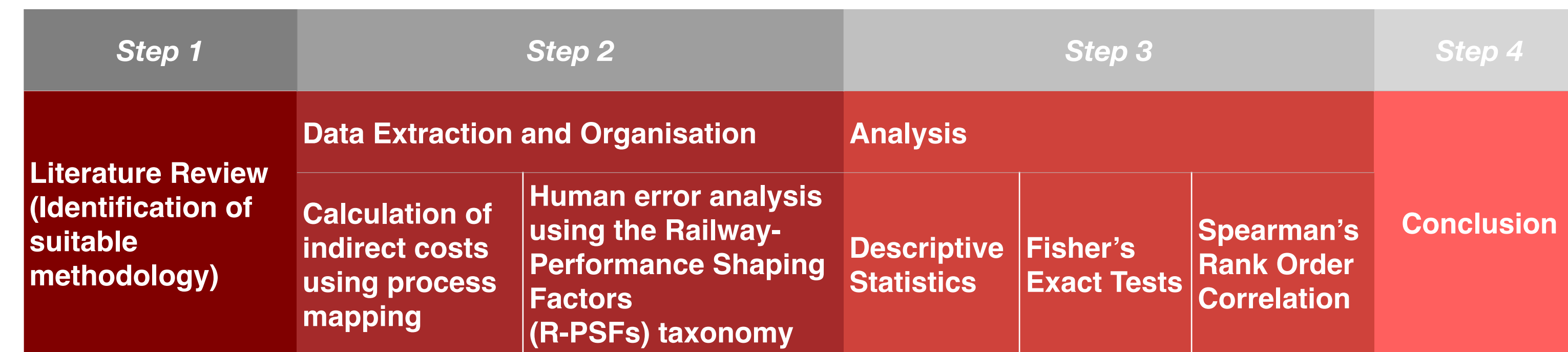In this work, Signals Passed at Danger (SPAD) are railway incidents where:

- train passes a stop signal without authority to do so
- there are no passengers hurt and no damage to rolling stock or rails

SPADs result in indirect costs that are difficult to isolate and quantify.

This project introduces **a novel framework to quantify the indirect costs of railway incidents** and assesses **the association between the costs and the associated human errors.**

This project aims to provide **a new dimension on the investigation of railway incidents** that could help to **allocate more efficiently investments in preventative systems**, which would in turn contribute to bringing a **safer railway to the society.**

Number of SPAD occurrences in the past 10 years

DATA & METHODOLOGY

Step 1	Step 2	Step 3	Step 4
Literature Review (Identification of suitable methodology)	Data Extraction and Organisation	Analysis	Conclusion
	Calculation of indirect costs using process mapping	Human error analysis using the Railway-Performance Shaping Factors (R-PSFs) taxonomy	Descriptive Statistics / Fisher's Exact Tests / Spearman's Rank Order Correlation	

Number of Cat-A1 SPAD incidents occurred

	2012	2013	2014
Greater Anglia	11	20	24
Northern Rail	14	24	29

Incident reports are reviewed to extract the following

Indirect Costs
- Response steps, with duration and employees involved
- Number of relief days
- One-off procedures undertaken (e.g. drugs and alcohol tests)
- Investigation outcomes and additional steps following them

R-PSFs
- Sequence of events
- Incident evidence
- Analysis of factors
- Immediate and underlying causes

REFERENCES

Department of Transport. (2014) *Signals passed at danger (SPADs) on Network Rail controlled infrastructure: annual from financial year ending 2002.* [Online] Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/385177/rai0504.xls [Accessed 28 May 2014].

Jallon, R., Imbeau, D. & de Marcellis-Warin, N. (2011b) *A process mapping model for calculating indirect costs of workplace accidents.* Journal of Safety Research. 42 (5), 333-344.

Kyriakidis, M. (2013) *Developing a Human Performance Railway Operational Index to enhance safety of railway operations.* Diploma of the Imperial College (DIC), PhD. Imperial College London.

RESULTS

- The two operators have different total costs, but they have **very similar average costs and standard deviations**
- Scenarios that end up with driver **dismissals and demotions cost much higher**
- Statistical tests confirm **association between cost and outcome of investigation** (*returned, dismissed, or demoted*)

Total Annual Indicent Cost
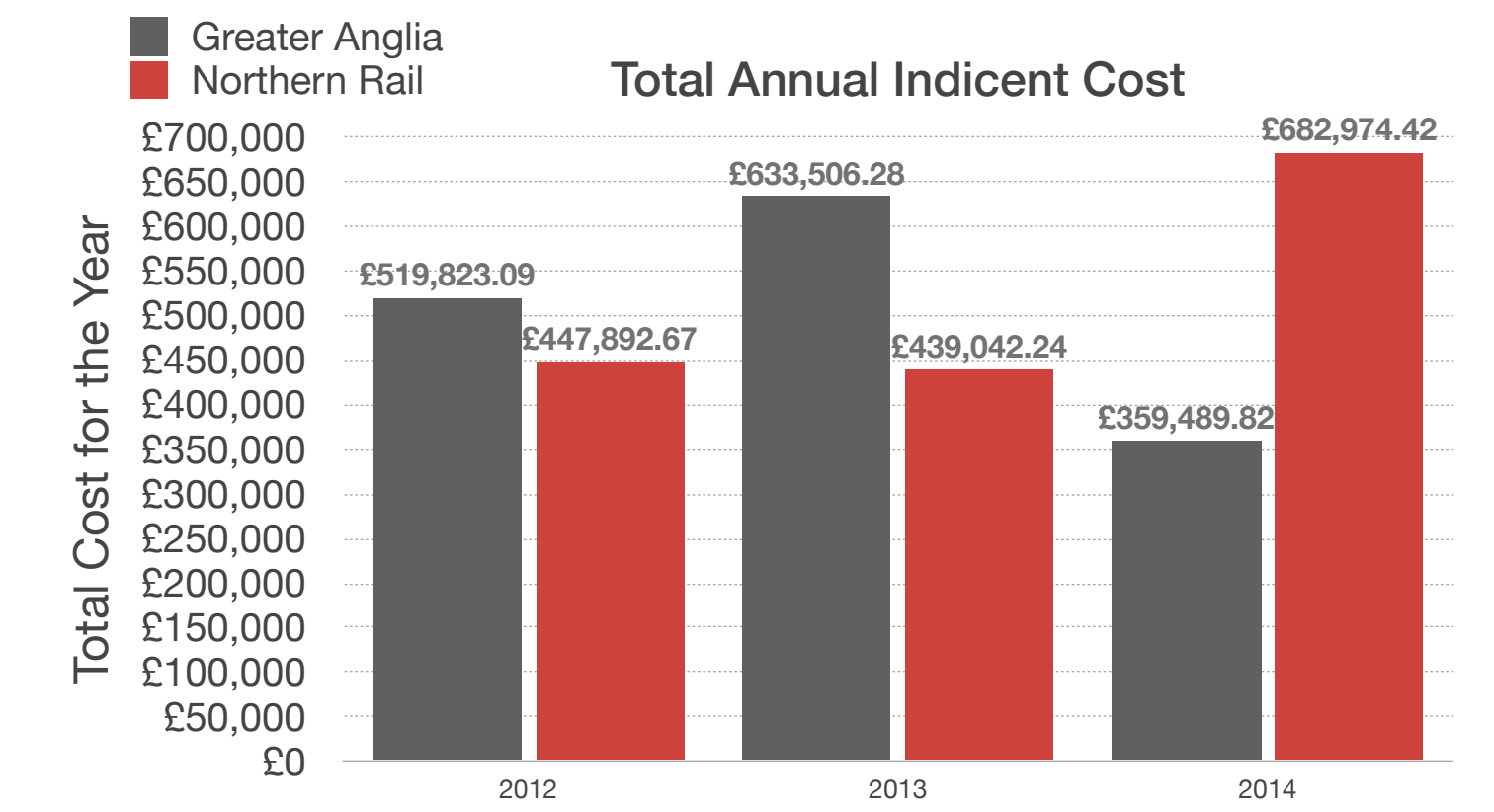
	All scenarios		Driver Returned		Dismissals		Demotions	
	Average Cost	Std. Deviation	Average Cost	Std. Deviation	Average Cost	Std. Deviation	Average Cost	Std. Deviation
Greater Anglia	£28,522.31	38645.56	£15,722.61	12636.94	£144,830.23	13084.61	£29,916.44	11269.04
Northern Rail	£29,620.93	40427.07	£18,459.35	18758.43	£141,948.10	1670.25	No cases in the past 3 years	

Average Cost Breakdown for Both Companies

Frequencies of R-PSFs
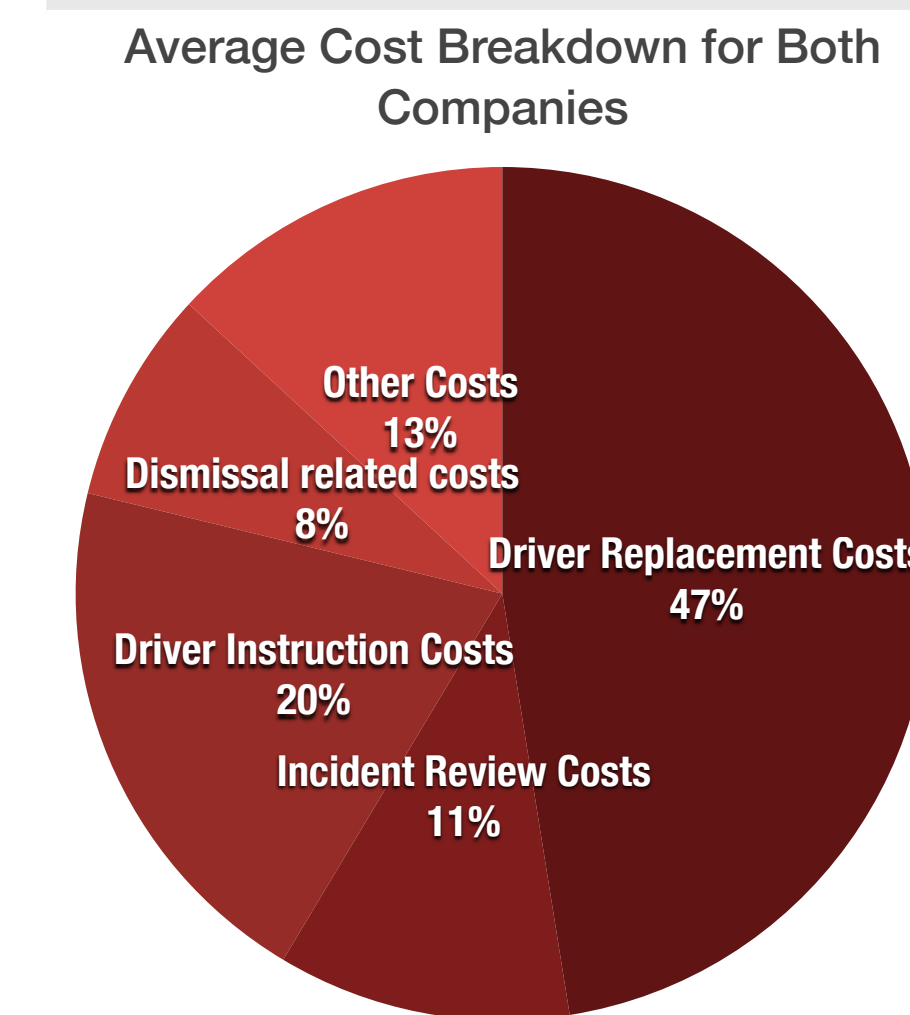
- **Driver replacement cost is the biggest cost component**
- **There is a very strong correlation between the cost and the number of relief days**
- *Distraction* and *safety culture* are **the most common R-PSFs**
- **There is a strong correlation between the costs and the R-PSFs, after taking into account their severity and significance.**
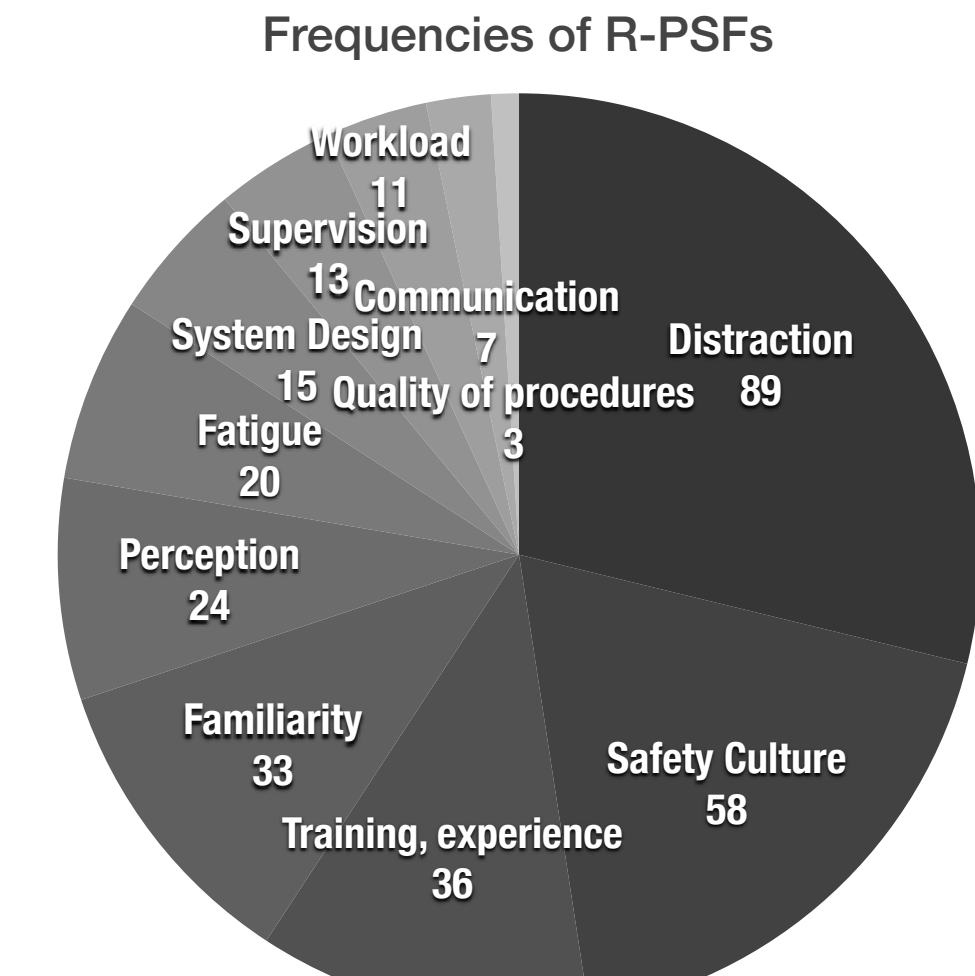
Two-Paired Associations	Association
Cost – number of days lost	Yes
Cost (categorised) – outcome of investigation	Yes
Cost – number of present R-PSFs per incident	No
Cost – presence of individual R-PSFs	No
Cost – R-PSFs with RSSB risk ranking multiplier	No
Cost – R-PSFs with investigation outcome multiplier	Yes
Cost – outcome of investigation (ordinal)	Yes

CONCLUSION

- Industry should invest in more efficient investigation processes, so the relief duration of train drivers is reduced
- Demotions and dismissals are to be avoided, and decision makers should invest more in improved Safety Management Systems that could prevent human errors that could lead to these outcomes
- Further research needs to be conducted to quantify the significance of R-PSFs on each incident in order to investigate this correlation further and in turn suggest the most effective preventative measures