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A systemic modelling of ground handling services using the functional resonance analysis method

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ABSTRACT

In contrast to air transport safety, safety in ground handling is not concerned only with aircraft accidents but also the Occupational Health and Safety of the employees who work at airport aprons. Ground handling safety costs the aviation industry tens of billions USD every year which raises the questions about the effectiveness of linear safety risk management of Ground Handling Services (GHS). This paper uses the state-of-the-art safety theory to justify and highlight the need for a systemic approach to safety risk management of GHS on the apron. A hybrid Total Apron Safety Management (TASM) framework, based on the combination of Functional Resonance Analysis Method (FRAM), Grounded Theory, Template Analysis and Goals-Means Task Analysis (GMTA) was developed to support systemic safety modelling of GHS. The data that underpins the TASM framework includes extensive literature review, 15 observations, 43 interviews and expert judgement across five international airports. While the TASM framework can be applied in retrospective, prospective and system design analysis to improve both the safety management and the efficiency of apron operations, this paper showcases only one of its application on a case study of a historical safety occurrence. The results of the investigation carried out in this paper clearly demonstrate the benefits of the systemic as opposed to the existing linear approaches to retrospective safety analyses and the suitability of the TASM framework for occurrence analysis and prevention.

1. Introduction

Ground Handling Services (GHS) represent a key component of the air transport system essential for a safe, efficient and cost-effective handling of air traffic at airports and such services are undertaken on the surface of the airport called the apron (or ramp in the US English). Whilst numerous definitions exist of the GHS (also referred to as the turnaround process) (ICAO, 2010; IATA, 2008, 2013; European Parliament and Council of the EU, 1996), in this paper it is defined as a sum of all the processes required for servicing the aircraft, its passengers and baggage/cargo/mail from the moment an aircraft taxis into its stand upon arrival to the moment it starts taxiing out on departure. When taken together, GHS and the apron form the apron system.

The importance of safety in GHS has been stressed in the literature. Research conducted by the Health and Safety Executive (HSE) in the United Kingdom and the Bureau of Labour Statistics (BLS) in the U.S., indicates that the Ground Handling

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(GH) workforce has higher accident rates than the workforce employed in either the construction or the agricultural sectors (UK HSE, 2000; BLS, 2013). Furthermore, in 2005 the Flight Safety Foundation's (FSF) detailed, data-driven, ground handling damage cost model estimated that: one ground handling occurrence resulted in a property damage and nine personal injuries per 1000 flights (Lacagnina, 2007), cost the aviation industry over $10 billion annually in direct and indirect costs (Flight International, 2005). Lastly, International Air Transport Association's (IATA's) decade old estimates attributed a $4 billion direct cost to ground damages. The indirect cost is, however, estimated to be between four and ten times the direct cost (IATA, 2014a), in line with the FSF estimate.

In the past decade, safety on the apron has been consistently ranked as amongst the top five safety risks for commercial aviation accidents (EASA, 2015). With a view to improving this situation, this paper analyses the current approach to apron safety management in terms of both the practice and the research. This indicates that the apron system is a complex socio-technical system and it is managed too often in a simple, linear and piece-meal manner. To overcome these limitations, this paper proposes a Total Apron Safety Management (TASM) framework for a holistic and systemic safety risk management of the apron system. After demonstrating the need to model the apron system through a systemic modelling approach and identifying the research gaps in the apron safety domain in terms of the systemic modelling, this paper for the first time proposes a methodology for systemic modelling of GHS through the development of a TASM framework. The methodology is described in the following Section followed by a case study dedicated to a retrospective analysis of an occurrence and a discussion about the TASM framework respectively.

2. Theoretical foundations of systems tractability and safety models

A pre-requisite for an efficient and effective Safety Management System (SMS) of the apron system is the derivation of the best theoretical match between the apron system characteristics and the required safety analysis methodology (Hollnagel, 2014b).

To assess system characteristics, Hollnagel (2008) proposed an assessment based on the tractability associated with the principles of the functioning of a system. He distinguished two extreme types of systems: tractable (i.e. a production line in a factory) and intractable (i.e. an emergency room at a hospital). The theoretical difference between the two types of system is summarised in Table 1 under (a).

Regardless of whether safety analysis is concerned with the analysis of the past occurrences (retrospective analysis), or with the prediction and prevention of the future occurrences (prospective analysis), three distinct types of safety analysis models are found in the literature (Hollnagel, 2004; Hollnagel et al., 2007): (i) simple linear, (ii) complex linear, and (iii) systemic. Depending on system tractability, all of the three analysis models can be used. However, not all the models are equally effective for each type of system tractability. Simple and complex linear models are considered to be appropriate (Hollnagel, 2008, 2012a, 2014b; Hollnagel et al., 2007) for the safety analyses of tractable systems, whereas systemic models are deemed necessary to model intractable systems due to their ability to account for the following (Hollnagel, 2014b): emergent system behaviours, functional interdependence, performance variability and non-linearity. Table 1 under (b) provides an overview and the limitations of the three safety analysis models.

Given the description of system tractability and safety models categories, the best theoretical match between the apron system characteristics and the required approach for its safety risk management is determined next.

3. Characterisation of the apron system in terms of its tractability

A precondition for the TASM modelling is a detailed understanding of the system in which the ground handling (turnaround) process takes place. The apron system belongs to the category of socio-technical systems where the '*objects of system design*' (Goode and Machol, 1957) are founded on the interaction of technical, human and institutional system components (Ottens et al., 2005). The section starts by providing the relevant background information on the apron system description and the existing research previously conducted in the domain, prior to proceeding to the process of elicitation and validation of the safety methodology required for a complex socio-technical system such as the apron.

3.1. Background

In terms of the organisational safety management practices, operations on the apron represent a 'grey' area in the wider Air Traffic Management (ATM) system. For instance, since no specific Ground Service Provider (GSP) international and national requirements are established, GSPs define their safety policy and objectives in a way that meets aircraft operator (i.e. Ground Operations Manual) and airport expectations (i.e. Airside safety requirements) in terms of both safety and quality performance standards. Based on the occurrences that a GSP requires to be collected within its policies and objectives, safety hazards are identified and reported. However, in addition to the differences in the type of occurrences that need to be reported, GSPs adopt different definitions of severity categories in the process of risk management within the organisation. Furthermore, GSPs vary in their approach to the reporting culture based on the organisational safety culture that is specific to each GSP. Continued improvements in GSP operations are achieved through the combination of internal and external audits. Internal audits are typically performed on an annual/bi-annual-basis within each GSP department. However,