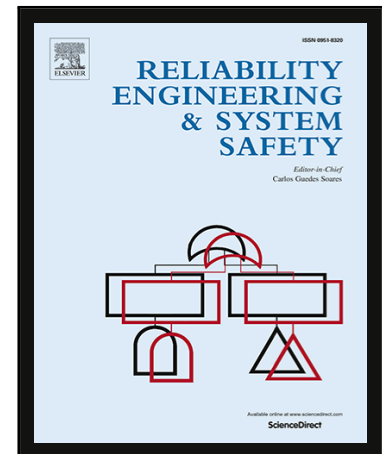


# Accepted Manuscript

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# Are too many safety measures crowding each other out?

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## ABSTRACT

It is well known that investments in new safety measures do not always give the intended effect, as new safety measures are sometimes offset by behavioural changes. In this article, we show that another cause for a reduced effect is that competition for resources can lead new safety measures to crowd out existing measures; to demonstrate this, we use a case related to the unloading of LPG (Liquefied Petroleum Gas) at a warehouse. If this aspect is not taken into consideration, the effects of a single measure might be considered too high. An overinvestment in new safety measures might then occur.

**Keywords:** Safety measure, investment optimization, scarce resources, behavioural adaptation, high risk industry, hazardous substance.

## 1. INTRODUCTION

Industrial operations imply risks for people, the environment and the business itself; this is particularly relevant in the context of high-risk industries (Grote, 2012). High-risk industries are those whose work process implies a considerable level of risk, regarding the large potential for major accidents occurring in the loss of control of chemical processes and/or the handling of substances (De Rademaeker et al., 2014; Fabiano et al., 2017). These activities can potentially lead to the release of hazardous materials and are regulated by the Seveso Directives, which address the control of major-accident hazards involving dangerous substances and aim to improve the safety within an establishment. According to this legislation, the plant manager is faced with the problem of finding risk-reduction solutions (Mancuso et al., 2017; Alkazimi and Grantham, 2015; Milazzo et al., 2013). It is well known that any safety improvements and risk-reduction interventions bring associated costs due to either an increase in redundant elements or the introduction of new items; therefore, it is necessary to manage the trade-off between risk reduction and the associated costs (HSE, 2001; Aven, 2016), or in an alternative language, risk provide an influence of scenarios to priorities (Connolly and Lambert, 2016; Thorisson et al, 2016). This implies that making decisions about whether or not to invest efforts and resources in reducing risks.

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