ACCEPTED FOR PUBLICATION IN SAFETY SCIENCE

Asssessing and facilitating warehouse safety

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Abstract

Purpose – The purpose of this paper is to investigate how warehouse safety can be assessed and facilitated.
Methodology – Through a literature study, we build a theoretical framework to provide insights in how safety in Logistics Service Providers (LSPs) can be assessed and facilitated. We perform a case study at a large Dutch LSP using interviews and questionnaires to determine the relevance of the sub-dimensions to assess warehouse safety.
Findings – Using literature, we identify people, procedures and technology related sub-dimensions of safety culture and safety behavior and factors that may affect how safety culture translates to safety behavior. Using a case study our findings indicate which sub-dimensions and influencing factors LSP employees find important and why. We found differences in the importance assigned to safety, which may point to the existence of sub-cultures across warehouses.
Research limitations/implications – This paper contributes to the limited existing warehouse safety literature in which the factors that influence safety are not well explored. Although the case study investigates one LSP and as such does not generalize across LSPs, it provides valuable insights in important aspects of safety and how they can be influenced.
Practical implications – This paper offers safety managers insights in how to assess and facilitate safety within their warehouses.
Originality – Although warehouse safety is important, there is scarce academic research that explores this issue.

Keywords: Safety, Warehouse, Case study

1. Introduction

Workplace safety is important for both employees and firms. In this paper, safety is defined as the result of the whole of actions, measures, mental models, etc. in an organization that lead to increasing performance and lowering (operations-related) losses (definition based on ISO 31000:2009 (2009)). Globally, workplace accidents account for 960,000 injured workers and around 5,330 fatalities each day (Hämäläinen *et al.*, 2009). In monetary terms, US firms are estimated to spend almost $1 billion per week on direct costs (e.g. medical and legal costs) associated with injuries and fatalities (Cantor, 2008). A range of academic studies has investigated how to improve workplace safety (Cornelissen *et al*., 2014; DeJoy, 2005; Farina *et al*., 2015; Hale *et al*., 2010; Kines *et al*., 2013; Mearns *et al*., 2003; Morillas *et al*., 2013; Vredenburgh, 2002) and research on safety has covered a wide range of industries, including the energy and chemicals industries (Bragatto *et al*., 2015; Mearns *et al.*, 2003; Vinodkumar and Bhasi, 2009), various manufacturing industries (Hermann *et al*., 2010; Lo *et al*., 2014; Nenonen, 2013), construction (Choudhry et al., 2007a; Cigularov et al., 2010; Shen et al., 2015), aviation (Evans *et al*., 2007; Liao, 2015; O'Connor *et al*., 2011), and mining (He and Song, 2012; Paul and Maiti, 2007; Saleh and Cummings, 2011).

Safety is especially important in the logistics services industry. Data from 2014 indicates that in the United States the transportation and warehousing sector accounts for the second highest number of fatalities (U.S. Bureau of Labor Statistics, 2015). Additionally, its injury rate of 13.5 persons per 100,000 workers is around four times as high as the average injury rate across industries (U.S. Bureau of Labor Statistics, 2015). This can be explained by several factors: the logistics services industry is

labor intensive and requires a high level of materials handling (Cantor, 2008; Goode *et al*., 2014); heavy vehicles such as forklifts move around in close proximity to workers; and the workforce operates under time pressure (De Koster *et al*., 2011). Academic research on safety in logistics has mainly focused on transportation and in particular on safety in relation to motor carriers (Cantor, 2008). Surprisingly, literature on safety in warehousing is scarce (De Koster *et al*., 2011).

In this paper, we focus on safety culture and safety behavior in warehouses. We found that in this context several issues regarding warehouse safety remain unaddressed. It is unknown how an organization's safety culture and safety behavior can be measured within the logistics services industry. The term 'safety culture' was used for the first time in 1986 by the nuclear industry in a Summary Report on the Post-Accident Review Meeting on the Chernobyl Accident (Edwards *et al*., 2013; International Nuclear Safety Advisory Group, 1991). Since 1991 many definitions have been proposed based on a variety of studies undertaken by diverging disciplines. Despite widespread agreement about the importance of the concept, a single definition has yet to emerge and gain widespread acceptance within the scientific community (Edwards *et al*., 2013; Guldenmund, 2000; Strauch, 2015). Recent research by Vierendeels *et al*. (2016) conceptualizes a safety culture as consisting of observable, perceptual, and psychological elements.

For the purpose of this study, we focus on observable safety culture (hereafter referred to as safety culture). Safety culture can be seen as the integrated sum of certain observable factors that should be a proxy for the existence, quantity, and quality/adequacy of safety procedures, work instructions, a safety management system, safety-related technology, safety software, safety practices, safety training, safety behavior, safety knowledge, safety communication, etc It is assumed that the observable aspects of a safety culture strongly depend on available resources for safety within a firm (Reniers, 2010). Reniers (2010) and Reniers *et al*. (2011) argue that the aspects of a strong safety culture can be grouped under three dimensions: people, procedures, and technology (Reniers, 2010; Reniers *et al*., 2011). A majority of (near) accidents is caused by human error (Fuller and Vassie, 2004). Therefore people—who may, or may not, have e.g. safety knowledge and skills, be involved in safety issues, or place a high priority on safety—are an important dimension of a safety culture. The second important dimension of a safety culture, procedures, is interpreted broadly and includes, for instance, rules on how to work safely, how to handle emergencies, or how to operate equipment. The third dimension, technology, is important because it may, for instance, help to prevent or minimize hazardous situations. The interplay between these dimensions determines whether a safety culture is present (Reniers *et al*., 2011). While a safety culture is shared by members of an organization (Edwards *et al*., 2013), actual safety-related behavior, e.g. the (in)correct use of a forklift truck by a warehouse employee, takes place at the individual level. However, individuals are also members of the organization; thus, safety behavior is arguably shaped by the underlying safety culture (Myers *et al*., 2014). We therefore interpret safety behavior as related to the same three dimensions as safety culture (people, procedures, and technology). In the remainder of this paper we consider safety behavior as related to these three underlying dimensions.

It is unknown which factors influence the translation of safety culture into safety behavior in the logistics services industry (but also in other industries). What is known is that behavior is influenced by culture but also by contextual factors that interact with culture (Edwards *et al.*, 2013). Extrinsic factors such as rewards can be used to induce safe behavior (Zohar and Erev, 2007). This implies that there are contextual factors that can influence how safety culture shapes safety behavior which is in line with Schein (2010). In this study, we address the measurability of safety culture and safety behavior, as well as the factors influencing the translation from a safety culture to safety behavior (see Figure 1).

Through our study, we aim to make several theoretical and practical contributions. First, we aim to contribute to the safety literature by providing insights into how warehouse safety can be

assessed. In doing so, we are answering a call for safety research to be undertaken in operational settings (e.g. Das *et al*., 2008). Second, we aim to contribute to the identification of factors influencing the translation of safety culture into safety behavior. Not only would this effort complement existing safety literature in other industries, it also benefits warehouse managers struggling with safety issues on a daily basis (Goode *et al*., 2014; De Koster *et al*., 2011). Interventions to improve safety require an understanding of the factors that influence safe behavior (Fugas *et al*., 2012). By making these two contributions, we also aim to further clarify both safety culture and safety behavior from a theoretical standpoint. Although these are different concepts (Myers *et al*., 2014), the literature seems to implicitly assume that a safety culture automatically results in safe behavior (Guldenmund, 2000).

In order to investigate the issues mentioned, we present a literature study to explore the concepts under investigation and relate them to each other. We then refine and empirically assess the concepts and their relationships through a case study at a large Logistics Service Provider (LSP), considered to be a leader in its industry. Case research is considered appropriate given the exploratory nature of our study (Eisenhardt and Graebner, 2007; Voss *et al*., 2002; Yin, 2009). For the case study, we interviewed employees working at different hierarchical levels (i.e. managers, team leaders, and workers) at three different warehouses of the company (see also the Methodology section).

The remainder of the study is organized as follows. In section 2 we define, explore, and link together the key concepts. In section 3 we present our research method and instrument, as well as our data analysis procedure. In section 4 we present the outcomes of the case study and in section 5 we discuss results, acknowledge the limitations of our study, analyze the theoretical and practical implications, and reflect on directions for further research. Section 5 ends with summary conclusions.

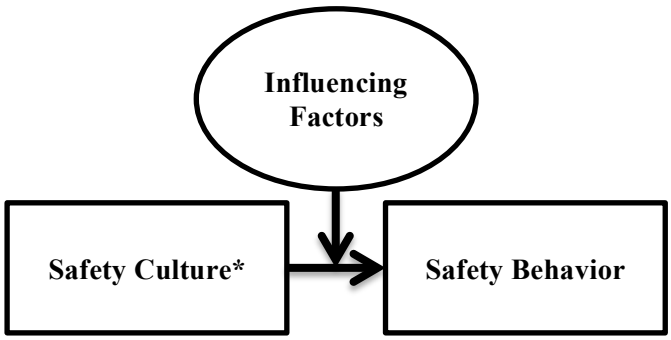

Figure 1. Conceptual model
* Measured via its observable factors

2. Literature study

2.1 Introduction

Academic research on safety in logistics has mainly focused on transportation, and in particular on safety in relation to motor carriers (Cantor, 2008). Among others, studies investigate characteristics of professional drivers (e.g. personality, health, attitude), stressors they face (time pressure, fatigue, stress) and how these relate to safety behavior and/or accidents (Douglas and Swartz, 2009, 2016; Grytnes *et al*., 2016; Kemp *et al.*, 2013; de Vries *et al.*, 2017). Recently, warehouse safety has started to gain attention. For instance, De Koster *et al.* (2011) analyze which factors impact warehouse safety. They find that hazard-reducing systems (HRS; safety processes and procedures such as safety markings, mirrors, personal protection like safety shoes) and safety-specific transformational leadership (SSTL; a leadership style motivating employees to 'go the extra mile') have a large influence on warehouse safety. Interestingly, they also find that safety consciousness (one's awareness

of safety) does not mediate the effect of SSTL on warehouse safety. Subsequently, de Vries *et al.* (2016) find that prevention focused leaders (who focus on rules, procedures, duties and responsibilities) are more likely to show SSTL, which in turn is associated with lower accident rates.

Regulations regarding the storage of products in warehouses are substantial particularly in the context of hazardous materials. Hazardous materials have their own well-defined standards of storage, which are set up by legislation to minimize the potential hazards pertaining to each specific material. Obviously, these standards of storage should be followed rigorously, and the list of potential hazards can serve as an input for the risk management process. However, as also indicated by Sörensen *et al*. (2013), additional hazards may stem from the storage of hazardous materials. For example those hazards arising from the combination of several chemical substances being present. One needs to manage the segregation and separation of hazards. Separation concerns the storage of substances in different storage areas by at least fire-resistant walls and ceilings. Outside a warehouse, hazardous products need to be stored at a distance of at least 5-10m depending on the combination of hazardous materials being stored. Segregation means storage in the same storage area, but the products of different classes are separated from each other by gaps or barriers, or in cabinets. Products of similar classes may, in principle, be stored together in the same storage area. Exceptions to this are cases where specific storage regulations such as the regulations for explosives, organic peroxides, and flammable substances, have to be observed. Segregated storage within a storage area may also be needed.

Furthermore, labeling of chemical substances is a critical issue since it is the most visible hazard communication tool. The label is often the first source of information alerting users to the inherent hazards of a chemical and any instructions for its safe storage, handling, and use. All containers that contain chemicals must be labeled, irrespective of the size of the container. It is worth mentioning that most dangerous goods are, and should be, clearly labeled, for example, by the ADR (European Agreement concerning the International Carriage of Dangerous Goods) regulatory regime.

Despite these regulations on particularly the storage of hazardous materials in warehouses the topic of safety culture has received little attention in warehouse safety studies. Safety culture can shape safety behavior (Clarke, 2000; DeJoy, 2005), which influences a firm's safety performance. Grytnes *et al.* (2016) study safety culture in truck drivers who transport heavy goods. They focus specifically on individual and collective understanding of safety because, during their work, both drivers and their company are physically at a distance from each other. The researchers study how these understandings impact the working environment, rather than the diverse aspects of which safety culture exists.

Fortunately, safety research has resulted in the development of a number of safety culture models. In the following, we first define safety culture and distinguish it from safety climate. Then, we review some of the existing models of safety culture. Based on one of these models, the P2T model of Reniers *et al.* (2011), we identify aspects of safety culture which are potentially relevant in warehousing. Thereafter, we discuss the concept of safety behavior and factors that may influence how safety culture shapes safety behavior.

2.2 Safety culture and its dimensions

There is ongoing debate about the definition of safety culture, particularly about the aspects it consists of (Edwards *et al.*, 2013) and which aspects of safety culture are important in which context (DeJoy, 2005). Nevertheless, there seems to be an agreement that safety culture is not self-contained but part of organizational culture (Clarke, 2000; Glendon and Stanton, 2000). For reviews on the concept of safety culture and its association with organizational culture, the interested reader is referred to e.g. Edwards *et al.* (2013), Glendon and Stanton (2000), Hopkins (2006), or Richter and Koch (2004). In

line with the general idea that safety culture is a structural aspect of safety and manifests itself at an organizational level (Guldenmund, 2000; Myers *et al*., 2014; Wiegmann *et al*., 2004), we define safety culture (i.e. observable safety culture) as the observable importance that is given to safety in an organization, as reflected in the resources which are made available for safety within the organization (adapted from Reniers, 2010).

Safety culture is also linked to a company's climate. Although both concepts are closely linked and the terms safety culture and safety climate are often used interchangeably (Fan *et al.*, 2014), it is imperative to make a clear distinction. Generally speaking, a company's climate can be thought of as the product of some of the underlying assumptions and hence, it is the way in which a company's culture is visible to and perceived by the outside world (Meyer and Reniers, 2016). Therefore, a company's climate can be seen as the outer layers of a company's culture and actually the perceived manifestation of the culture. As a result, a company's observable safety culture emphasizes continuity, while its climate is comparable to a perceived snapshot of its culture (Meyer and Reniers, 2016). An important difference between these two concepts is the way in which they are measured. A company's safety climate corresponds to the outer and more visible, perceived, layers of its observable safety culture and can therefore be measured with e.g., standardized questionnaires. A company's observable safety culture is more fundamental, and can for instance be measured by observations, in-depth interviews and document analyses.

One of the first models of safety culture was introduced by the National Safety Council (NSC) of the United States, which translated occupational safety into a three E's slogan. The three E's stand for: Engineering (mechanical safety devices are designed), Education (workers are trained to work safely), and Enforcement (safety is documented by the employer in rules and procedures, while compliance is monitored through supervision) (National Safety Council, 1978).

A second model is the Total Safety Culture model of Geller (1994), which encompasses three domains labeled person, behavior, and environment. In Geller's model, 'person' refers to people's attitudes, beliefs, and personalities; 'behavior' refers to (un)safe work practices (e.g. compliance, coaching, recognition, and communication); and 'environment' refers to factors present on the work floor (e.g. equipment, tools, machines, housekeeping, heat/cold, and engineering).

Geller's model closely resembles the reciprocal safety culture model of Cooper (2000). In Cooper's model, the 'people' domain is divided into two parts: an external (objective) observable factor, called 'behavior' and an internal (subjective) psychological factor, called 'person'. In addition to safety behavior, external observable factors include objective situational features, which Cooper calls 'situation'. Cooper (2000) asserts that the 'environment' domain of Geller translates into the 'engineering approach' from NSC's three E's slogan.

Both 'environment' and 'engineering' can be translated into 'technology' from the P2T model of Reniers *et al*. (2011). All four models—the P2T model (Reniers *et al*., 2011), the reciprocal safety culture model (Cooper, 2000), the Total Safety Culture model (Geller, 1994), and the 3E model (National Safety Council, 1978)—can be reduced into one integrated model of safety culture where the observable aspects (of the 'engineering approach') are distinguished from the non-observable psychological person-related aspects.

In this study, we build on the P2T model of Reniers *et al.* (2011) which asserts that safety culture consists of three dimensions: people, procedures, and technology and that current safety culture is determined by the interplay between these dimensions (Reniers *et al*., 2011). This model describes safety culture sub-dimensions for each of the dimensions. Based on this model and a literature review we identify sub-dimensions of safety culture that are potentially relevant in warehousing.

The first dimension is *People.* The involvement of both employees (Flin *et al.*, 2000; Reniers *et al*., 2011; Veltri *et al*., 2013) and external stakeholders in safety policy making (Cigularov *et al*.,

2010; Flin *et al*., 2000; Reniers *et al*., 2011) reflects the importance of safety in organizations, as well as the resources dedicated to it. Safety knowledge impacts the ability of employees (i.e. management, team leaders, workers) to adopt safe behaviors (Christian *et al*., 2009; Reniers *et al*., 2011). The safety culture in organizations is reflected by the general priority given to safety within an organization (Reniers *et al*., 2011) and the extent to which open communication regarding safety is possible between employees (Hale, 2000; Reniers *et al.*, 2011).

The second dimension is *Procedures*. The existence of safety policies and procedures (Guldenmund, 2000; Reniers *et al*., 2011; Wills *et al*., 2006) reflect the importance of safety, as do the placement of safety markings (Occupational Safety and Health Administration, 2004; Reniers *et al*., 2011).

Technology is the third observable dimension of an organization's safety culture. Technology can reduce risks and exposure to hazards (Brown, 1996). Equipment and facilities available to ensure/improve safety are therefore an important sub-dimension of a safety culture (Occupational Safety and Health Administration, 2004; Reniers *et al*., 2011).

Table 1 shows these dimensions of safety culture together with their sub-dimensions. In the next sections we investigate the extent to which the (sub-)dimensions derived from the literature apply to warehouses and whether there are other (sub-)dimensions that should be added to the list.

Safety culture dimension	Safety culture sub-dimensions	References
People	Employee involvement	(Flin *et al*., 2000; Reniers *et al*., 2011; Veltri *et al*., 2013)
	Involvement of external stakeholders	(Cigularov *et al*., 2010; Flin *et al*., 2000; Reniers *et al*., 2011)
	Knowledge about safety	(Reniers *et al*., 2011)
	Priority given to safety within the firm	(Reniers *et al*., 2011)
	Open communication	(Hale, 2000; Reniers *et al*., 2011)
Procedures	Safety markings	(Occupational Safety and Health Administration, 2004; Reniers *et al*., 2011)
	Safety policies	(Guldenmund, 2000; Reniers *et al*., 2011; Wills *et al*., 2006)
Technology	Equipment and facilities to ensure and improve safety	(Occupational Safety and Health Administration, 2004; Reniers *et al*., 2011)

Table 1. Safety culture and its sub-dimensions

2.3 Safety behavior and its dimensions

In contrast to safety culture, which forms a structural aspect of safety and is manifested at an organizational level (Edwards *et al*., 2013), safety behavior is more transient in nature and takes place at the level of individual employees. Safety culture is reflected in the resources that are made available for safety. Safety culture thus guides safety-related behavior of employees. For instance, procedures about handling of certain goods shape how employees handle these goods and can improve warehouse safety (De Koster *et al.*, 2011). It is typically assumed that safety culture influences safety-related behavior of employees (Choudhry *et al.*, 2007b; Clarke, 2000; Cooper, 2000; Myers *et al*., 2014; Zhang *et al.*, 2002). However, it is possible that the opposite happens as well: behavior shapes culture over time (Schein, 2010). However, the timespan involved in such relationships leading to cultural

change would require a different kind of study (longitudinal). Given the aims of this research (to explore how safety culture and safety behavior can be assessed and facilitated in warehouses), this paper is focused on how safety culture shapes safety behavior and the factors that influence this relationship (this is discussed in more detail in section 2.3).

Since the important aspects of a safety culture are captured by three dimensions in the P2T model (people, procedures and technology) it would stand to reason that aspects of safety behavior may also relate to these three dimensions. The P2T model by Reniers *et al*. (2011) defines the short-term operational sub-dimensions that encompass daily safety-related activities and are placed under one of the three dimensions. To study how safe behavior can be operationalized in warehouses, we identify sub-dimensions of safety behavior below, building on the P2T model and a literature review.

Regarding *People*, the extent to which employees (managers, team leaders, and workers) feel responsible for safety (Reniers *et al*., 2011) and communicate about safety on a daily basis (especially management; Cigularov *et al*., 2010); Hale, 2000)) may be a reflection of safe behavior in the workplace. Likewise, the extent to which employees apply their safety knowledge on a daily basis may reflect safe workplace behavior (Reniers *et al*., 2011).

Safety *Procedures* provide employees insight in how to deal with safety related issues. The degree to which employees know what is expected of them concerning safety can be a reflection of safe behavior (Reniers *et al*., 2011). Furthermore, safe workplace behavior is linked both to the degree to which employees adhere to safety policies and safety markings (Flin *et al.*, 2000; Fugas *et al*., 2012) and to the user friendliness of procedures in daily practice (Reniers *et al*., 2011).

Advances in *Technology* have reduced the risk of exposure to hazards or have in some cases eliminated the need for employees to execute dangerous tasks (i.e. behaving unsafe; Brown (1996)). Safety-related behavior in the workplace is also reflected by the frequency with which the safe functioning of equipment is checked and safety-related equipment and facilities are maintained and updated (Reniers *et al*., 2011).

The dimensions and sub-dimensions of safety behavior are shown in Table 2 below. Next, we investigate the extent to which the (sub-)dimensions found in literature apply to warehouses, and whether there are other dimensions which should be added to this list.

Safety behavior dimension	**Safety behavior sub-dimensions**	**References**
People	Employee feeling of responsibility	(Reniers *et al*., 2011)
	Employee communication about safety	(Cigularov *et al*., 2010; Hale, 2000; Reniers *et al*., 2011)
	Employee application of competence and expertise regarding safety	(Reniers *et al*., 2011)
Procedures	Degree to which employees know what is expected of them concerning safety	(Reniers *et al*., 2011)
	Employee adherence to safety procedures and markings	(Flin *et al*., 2000; Fugas *et al*., 2012; Reniers *et al*., 2011)
	User friendliness of safety procedures	(Reniers *et al*., 2011)
Technology	Checking equipment and facilities	(Reniers *et al.*, 2011)
	Maintenance on, and updating of, equipment and facilities	(Reniers *et al.*, 2011)

Table 2. Safety behavior and its sub-dimensions

2.4 The translation of a safety culture into safety behavior and its influencing factors

Although a range of safety culture models have been developed, little attention has been paid to what Cooper (2000) refers to as the 'product' of safety culture, i.e. safety behavior. It is known that not only culture but also contextual factors play a role in causing safety behavior (Edwards *et al*., 2013). Furthermore, in practice people do not always follow safety policies and procedures (which are part of safety culture) (Zohar and Erev, 2007), and put themselves at risk (Veltri *et al*., 2013). In other words, safety behavior may not be in line with the safety culture in place. Extrinsic motivational mechanisms such as rewards have been proposed to induce safe behavior. This suggests that there are factors that can influence how safety culture shapes safety behavior. Recall that this paper is concerned with *observable* safety behavior, as opposed to behavioral *intention*, which is another domain of study within the larger domain of cognitive psychology. Since safe behavior is demonstrated by the employee, i.e. safety behavior manifests at the individual level rather than at the organizational level, the factors influencing safe behavior also apply at the individual level.

First, perceived individual costs or benefits may influence the translation of a safety culture into safe behavior. Managers and other employees have the ability to steer the behavior of individuals in an organization (Edwards *et al*., 2013), for instance through punishments or rewards. Penalties or bonuses given to employees in response to their safety behavior can lead to behavioral improvements (Zohar and Erev, 2007). A similar logic may apply to the perceived effect of working safely on promotion and social status may influence behavior. Zohar (1980) found that companies with a low accident rate had distinctive ways of rewarding safety, for instance through individual praise and recognition for safe performance.

Another factor that may impact the translation of safety culture into safe behavior is the workload that employees face. Continuously increasing competition, pressure to reduce costs and increase efficiency and operations practices such as just-in-time delivery lead to workload increases, which can be detrimental to safety (Veltri *et al*., 2013). A high workload may compromise safety as employees may take shortcuts in order to perform their tasks faster and finish on time (Pagell, Dibrell, *et al.*, 2014; Pagell, Johnston, *et al.*, 2014). This factor is especially important for safety in warehouses as heavy equipment is used in close proximity of workers who are often working under time pressure (trucks/orders need to be fulfilled regardless of the volume to be handled; De Koster *et al*. (2011)).

The factors influencing the translation of a safety culture into safe behavior are shown in Table 3 below. We will investigate the extent to which these factors influence the translation of safety culture into safe behavior in warehouses, and whether there are other factors that should be added to this list.

Influencing factor	Based on
Penalties	(Zohar and Erev, 2007)
Bonus	(Zohar and Erev, 2007)
Promotion	(Zohar, 1980)
Social status	(Zohar, 1980)
Workload	(Veltri *et al.*, 2013)

Table 3. Factors which may influence the translation of safety culture into safety behavior

3. Methodology

3.1 Case study research

In order to study how safety can be assessed and facilitated in warehouses we apply an exploratory research design. We have selected case research because it is considered suitable in settings where

existing literature is limited and where explanatory 'how' questions are addressed (Meredith, 1998; Voss *et al*., 2002; Yin, 2009).

We use a multiple case study design including three different warehouses. This enables us to verify results across different cases and obtain more robust results (Eisenhardt and Graebner, 2007; Stuart *et al.*, 2002). We used theoretical (i.e. non-random) sampling to select our cases, which is considered appropriate given the nature of our study (Eisenhardt, 1989; Eisenhardt and Graebner, 2007; Meredith, 1998; Stuart *et al.*, 2002). We selected a Dutch LSP that is considered to be a leading firm in its industry. The firm operates a worldwide distribution network and performs a range of different logistics-related activities (e.g., transportation, warehousing, value-added services, and customs).

We selected three warehouses of the LSP (all of which are located in the Netherlands) which enables us to study a variety of warehouse activities and histories because they differ in the types of goods that they store—i.e., consumer goods in warehouse 3, hazardous materials in warehouse 2, and food (among other goods) in warehouse 1. The types of goods handled also makes safety an important issue for each warehouse. Warehouses 1 and 2 are self-established warehouses, while warehouse 3 is an acquisition through merger after establishment.

To explore how warehouse safety can be assessed, we used interviews to identify which factors are important with regards to safety and why. Interviews are considered an appropriate means to assess culture in a specific context (Schein, 2010). Given that safety culture manifests at an organizational level (Guldenmund, 2000; Myers *et al*., 2014; Wiegmann *et al*., 2004) but shapes the safety behavior of employees at the individual level (Myers *et al*., 2014), it is important to gain insight in these issues throughout the hierarchical layers of each warehouse. Thus, for each warehouse employees from multiple hierarchical levels are interviewed. Per hierarchical level, multiple employees are selected (as recommended by Yin (2009)); and per warehouse, managers, team leaders, and workers are randomly selected in order to limit bias in the selection of respondents (see Table 4 for an overview of the respondents and their function per warehouse). These selection methods increase the validity (Voss *et al*., 2002) of the study.

Warehouse	Manager	Team leader	Worker
1	4 and 9	1, 2 and 3	5, 6, 7 and 8
2	12, 18 and 20	10, 11 and 13	14, 15, 16 and 17
3	19 and 21	21 and 23	24 and 25

Table 4. Respondents per warehouse and function

3.2 Research instrument

We developed a detailed interview protocol that served as a framework for data collection and the replication thereof across cases, thereby improving reliability (Voss *et al.*, 2002; Yin, 2009). We used this protocol to conduct in-depth interviews. The first part of the interviews focused on how to assess safety culture. We first formulated open questions asking respondents which aspects of a safety culture they find important and why.

Furthermore, we wanted to obtain insight in the relative importance of the sub-dimensions of a safety culture. Therefore, next to the open questions in the interviews we also collected quantitative data by posing propositions related to the sub-dimensions identified in Section 2. The respondents were asked to indicate the extent to which they agreed with the propositions based on a five-point Likert scale, and then to explain their responses. The sole aim in collecting these descriptive statistics was to explore the relative importance of the sub-dimensions as it is beyond the scope of this study to test their objective importance. Given the scope and nature of the study, qualitative explanations in

combination with such descriptive statistics are sufficient and provide an empirical basis for future research (see also e.g. Belayutham *et al*. (2016)).

The second and third parts of the interviews were comparable to the first, except that they were focused respectively on how to assess safety behavior and on the factors that influence the translation of safety culture into safety behavior. In the second part, respondents were asked what they consider to be the important dimensions of safety in their daily work. In the third part, we asked them to what extent their safety behavior reflects the company safety culture, and why (or why not). Once again we posed propositions, which we asked the respondents to rate based on a five-point Likert scale.

As recommended, pilot tests took place prior to the actual interviews to improve the interview protocol (Voss *et al.*, 2002; Yin, 2009). Given the importance of using colloquial language terminology was adapted to the phrases used within the company (Hennink *et al.*, 2011). Interviews were conducted face-to-face and they were recorded. When additional interviews led to minimal additional insight (reasons why sub-dimensions or influencing factors are considered important or not), no additional interviews were done in the respective warehouse because saturation had been reached (Glaser and Strauss, 1967).

During the study, various site visits and informal conversations took place. This helped to develop understanding of the research context (e.g. kind of warehouses, daily operations, safety procedures). To improve reliability, the documentation of the data, i.e. transcription of the interviews, was done as soon as possible after the interviews (Voss *et al.*, 2002). Unclarities that came up after the interviews were verified. Moreover, study results were discussed with participants to verify insights and improve internal validity.

3.3 Data analysis

Similar to Grytnes *et al.* (2016), our analysis is primarily based on qualitative interview data and on quantitative data regarding the relative importance of sub-dimensions and influencing factors. Insights obtained during the informal conversations and site visits served as contextual information on e.g. working conditions of warehouse workers to better understand and interpret the interview data.

In order to analyze qualitative data, it is recommended to structure the data (Stuart *et al.*, 2002) and organize it into categories (Miles and Huberman, 1994; Voss *et al.*, 2002). This enables the identification of patterns and properties of categories. Thus, to analyze what sub-dimensions, influencing factors, and potential other safety aspects are important and why we grouped all respondent answers per question and then organized responses into different categories according to the type of answer given. The answer categories were formed based on the individual response that best represented answers given by all respondents. Thereafter, we grouped the answers per question based on the warehouse where the respondent is employed in order to discern differences between and commonalities across warehouses.

To analyze the quantitative data, we first calculated the mean score on each proposition. A higher mean score means that the sub-dimension or factor is considered more important. In addition to calculating the mean score we also calculated the Intra-class Correlation Coefficient (ICC) in order to show the spread in scores (which indicates the level of agreement between respondents). The ICC is considered to be a robust inter-rater reliability (IRR) measure (Hallgren, 2012). We calculated the 'two-way random absolute agreement' variant of the ICC statistic because our respondents were drawn from a larger sample, but all answered the same questions. When disagreements between respondents are large in magnitude, the resulting ICC values will be lower than when the disagreements are smaller in magnitude. An ICC value of zero signals random agreement among respondents (Hallgren, 2012). Cicchetti (1994) defines ICC values lower than 0.40 as poor, values between 0.40 and 0.59 as fair, values between 0.60 and 0.74 as good, and values between 0.75 and 1.0

as excellent. Negative ICC values indicate systematic disagreement between respondents (Hallgren, 2012).

4. Results

4.1 Introduction

In this section, we present the case study results. In the figures that follow the sub-dimensions of the three concepts are ranked (top to bottom) from most important to least important. In the bar graphs the proportion of respondents indicating the designated level of importance is shown in percentages. An average respondent score of 4 or higher is labelled as high importance, a score between 3 and 4 is labelled medium importance, and a score lower than 3 is labelled as low importance. In the analysis below we explain our results by indicating (direct) respondent quotes and providing the respondent number in (bold and) italics behind the quote.

4.2 Sub-dimensions of a safety culture

Figure 2 gives an overview of the extent to which the various sub-dimensions of a safety culture found in the literature reflect the safety culture in the warehouses examined for this study. All sub-dimensions received a medium or high score. The four sub-dimensions that are considered most important are 'team leader involvement in safety', 'equipment and facilities to ensure/improve safety', 'team leader knowledge about safety', and 'safety policies in place'. Overall, team leaders play a crucial role in a safety culture; moreover, it is considered important for management to involve team leaders in safety *(3)(7)*, especially since they are the link with workers *(7)*. Team leaders work on a daily basis with workers and they are often present in the warehouse. However, higher-level managers work at the office and are less often present at the warehouse. As such, warehouse workers can more easily and more often observe safety related behavior of team leaders than of higher-level managers. This may make team leaders more important role models in the context of warehouse safety. For instance, a warehouse worker indicated that he feels more connected with team leaders than with managers because he interacts more often with team leaders and therefore he attaches more value to safe behavior of team leaders than of managers.

Moreover, perhaps as a result of differing safety stances among managers or team leaders, the perception of the priority given to safety varies among respondents. Some respondents think that safety is considered more important than finishing tasks *(3)(9)(10)(11)(15)(16)(17)*; others think that getting their work done is considered more important than safety *(2)(21)(23)(24)*. One respondent expressed this disagreement as follows: *'one manager gives priority to safety and does not bother that it takes more time to get the job done. However, another manager indicates that safety is important, but that it is also important that the truck leaves on time.'* ***(4)***.

For most dimensions, the average scores on each sub-dimension were highest for warehouse 2. All sub-dimensions were found to be least important in warehouse 3. On average, the scores of warehouse 1 are between the values of the other two warehouses. The high value placed on safety culture sub-dimensions by warehouse 2 may result from the fact that this warehouse stores hazardous materials. Safety Fridays and Toolbox Sessions are regularly organized to discuss current safety issues. These sessions include both warehouse workers and employees from the office *(10)(12)(18)(20)*, whose presence underlines the importance of safety, and may improve awareness of it.

In contrast, respondents in warehouse 3 indicated that they think they '*should pay more active attention to safety'* ***(19)****(22)(24)(25)* and that '*safety is found important, but not important enough'* ***(22)****(23)(24)(25)*. The value attached to safety culture sub-dimensions by warehouse 3 is low

compared to warehouses 1 and 2. This lower value is illustrated by a worker explaining that he barely knows the meaning of safety symbols on products or packaging and that he does not consider this to be an issue. In warehouse 3 less attention may be given to safety, and thus there may be less awareness of it, because this warehouse stores mainly fast-moving consumer goods, which require fewer specific safety procedures for their handling and storage than the food and hazardous materials stored in warehouses 1 and 2, respectively.

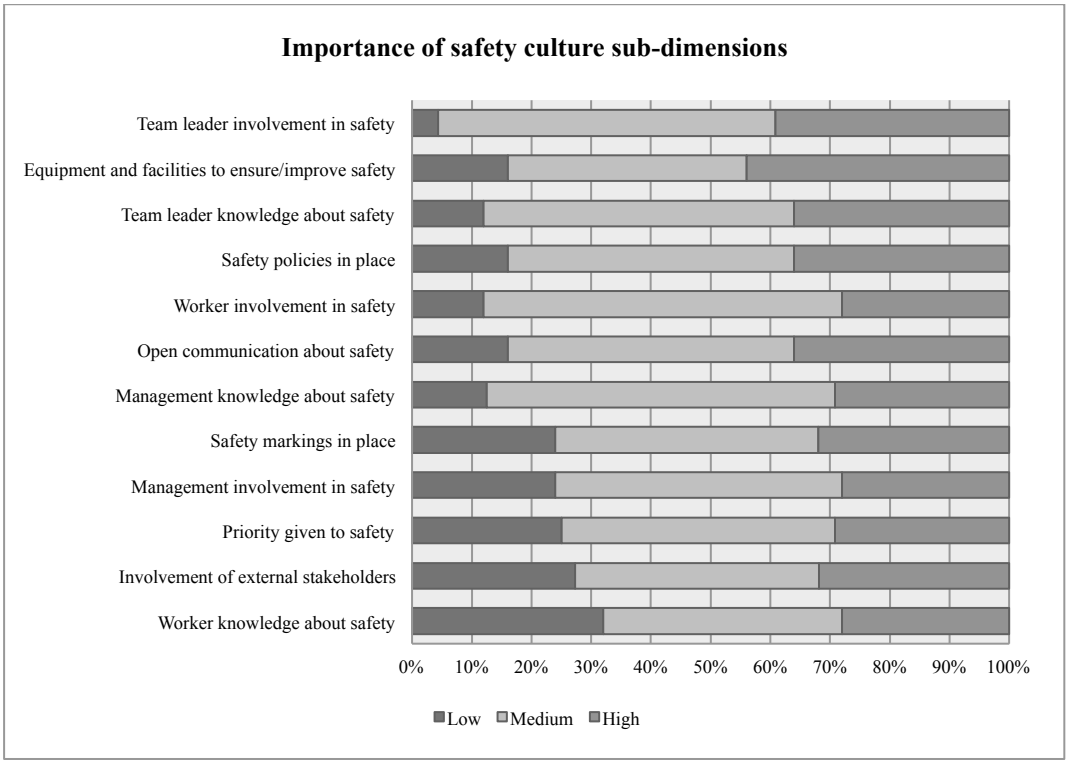

Figure 2. Scores of sub-dimensions of safety culture
* All sub-dimensions are ranked (top to bottom) from most important to least important

4.3 Sub-dimensions of safety behavior

Figure 3 shows the extent to which the safety behavior sub-dimensions found in the literature reflect the safety behavior in the warehouses under study. On average, all safety behavior sub-dimensions are indicated to be of medium or high importance. The 'degree to which employees know what is expected of them', the 'user-friendliness of safety procedures', and the 'monitoring of, and maintenance of equipment and facilities' are the four most important safety behavior dimensions.

User-friendliness is especially important in warehouses because of the customarily high workloads. Employees sometimes face a trade-off between safety and quickly finishing a task. To prevent the bypassing of safety rules and procedures, it is important that they are easy to understand and follow. Having access to proper equipment is frequently associated with safety in daily operations *(1)(4)(7)(18)(20)(23)*: *'the rolling stock must be well maintained because the most dreadful things can happen with these types of equipment'* ***(1)****(7)*.

The safety behavior sub-dimensions are considered most important in warehouse 2 and least important in warehouse 3. In warehouse 3 scores were low on both management communication about safety and management adherence to safety markings. Managers, team leaders, and workers in warehouse 3 gave a low score to communication about safety by managers *(22)(23)(24)*. These findings indicate that a lack of value placed on safety by management of warehouse 3 is reflected not

only in the safety culture of the warehouse (see section 4.1) but also in individual daily safety behavior of management.

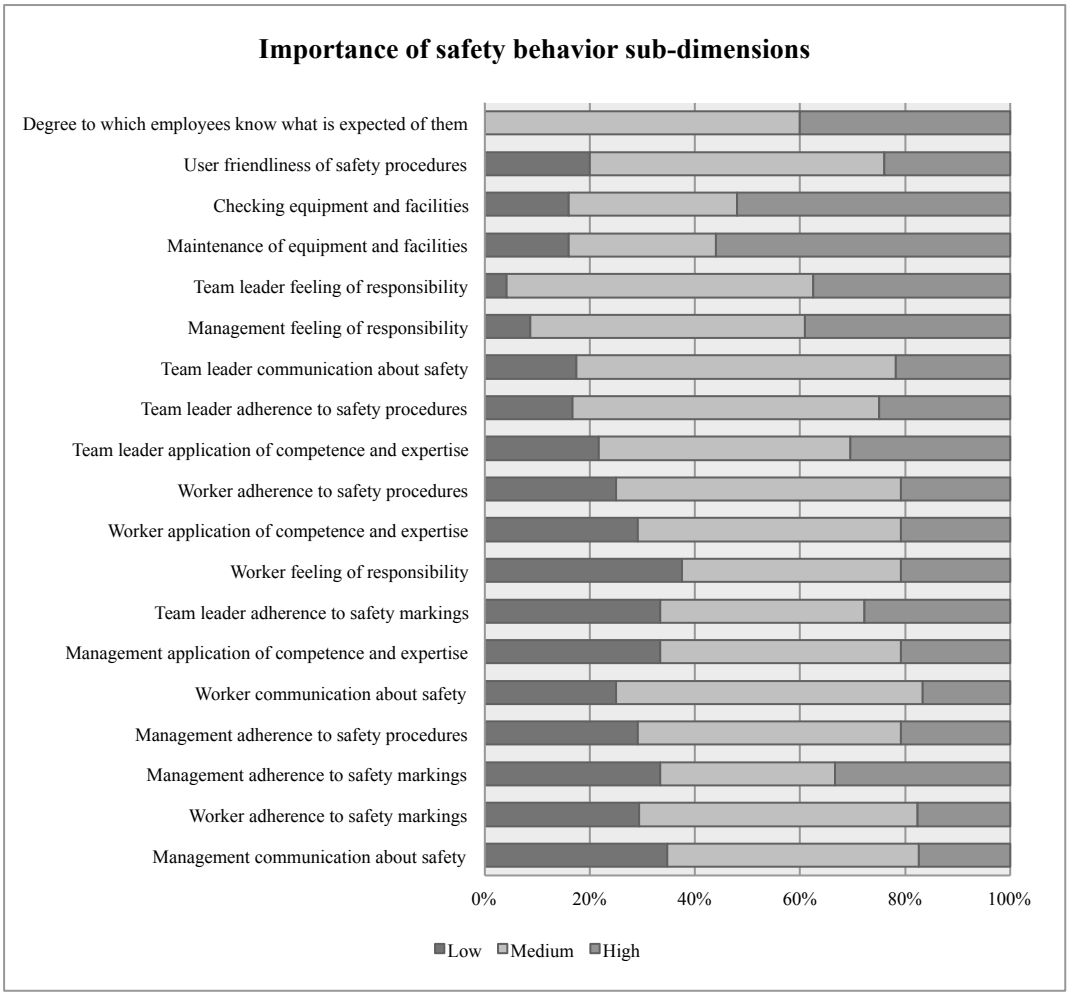

Figure 3. Scores of sub-dimensions of safety behavior
* All sub-dimensions are ranked (top to bottom) from most important to least important

4.4 Factors influencing the translation of safety culture into safety behavior

Figure 4 shows an overview of the factors influencing the translation of a safety culture into safety behavior. Managers and supervisors indicated that they think all of the following could have a medium effect on workers' translation of safety culture into safe behavior: workload, enhanced social status, receiving bonuses for safe behavior or penalties for unsafe behavior, and the opportunity to receive a promotion. Interestingly, respondents indicated that these extrinsic factors have a small influence. Most argued that these factors are not important because *'safety is always more important than work' (9)(13)**(16)**(18)(22)(24)* and that you should work safely *'because it concerns your own safety' (1)(2)(5)(11)(12)**(13)**(17)*. However, some argued that enhanced social status *(10)(11)*, a bonus *(6)(10)(23)*, penalties *(1)(4)(10),* or promotion *(10)(23)* would motivate them to behave in a safer manner. Although the overall average workload score indicates a low influence, various respondents mentioned that *'working under pressure is at the expense of safety' (2)(5)(6)(8)(21)(24)**(25)***. Thus, the influence of workload on the translation of safety culture into safe behavior should be taken into consideration.

The results indicate that respondents find safety important due to intrinsic reasons. Respondents argued that they behave safely because they *'want to come home safe and sound at the end of the day'* ***(2)****(7)(12)(13)(14)(17)(21)(23)* and want the same for their colleagues *(2)(6)(7)(12)(17)(23)*. This was especially visible in warehouse 2. Arguments against the influence of the factors were: *'I do not want to endanger myself' (7)****(8)****(24)*, *'you should perform your work in a safe manner'* ***(15)****(16), and 'what others do, is their own business'* ***(5)****(14)(17)*. When employees themselves find safety important, they are less influenced by extrinsic factors.

Besides intrinsic motivation, we identified three other additional factors that influence the translation of safety culture to safe behavior: customers, regulatory authorities, and habit. First, customers can have influence if they set specific requirements *(11)(12)(19)(21)*. One customer, for which the LSP stores and transports chemicals, begins every meeting with the LSP by showing a short movie in which safety is addressed in some way (e.g. someone walking a dog but failing to look both left and right before crossing the street). Employees indicated that movies about safety aspects improve their awareness of safety and motivate them to make the extra effort to behave safely when handling this customer's products, as compared to those of other customers. Safety concerns of customers motivate employees to behave safer than prescribed by the safety culture.

Second, respondents argued that regulatory authorities might also motivate them to behave safer than the norm (safety culture) because *'you have to comply with the law' (2)(11)****(12)***. Third, employees may not behave in line with the safety culture as a result of habituation *(19)(22)*. This is illustrated by the following quote from an employee in warehouse 3: *'I have enough experience so I know what is safe and what is not' (19)****(25)***. In sum, customers, regulatory authorities and habit should also be taken into account as factor influencing the translation of safety culture into safety behavior.

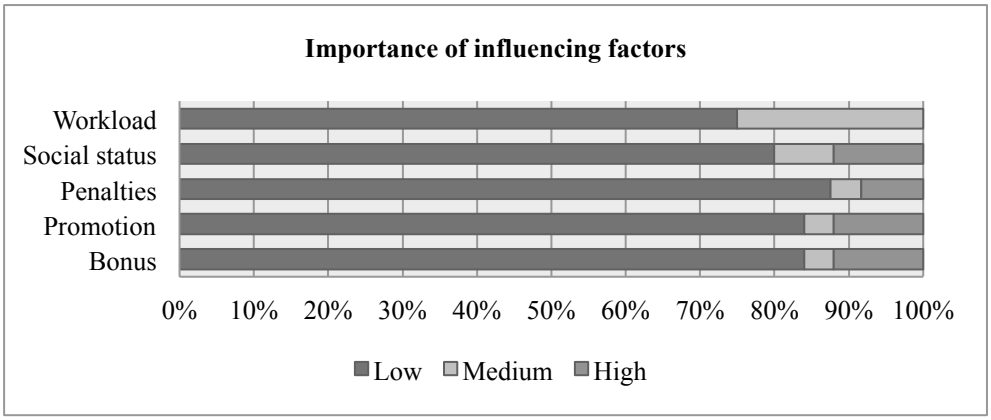

Figure 4. Scores of factors influencing the translation of safety culture into safety behavior
* All sub-dimensions are ranked (top to bottom) from most important to least important

4.5 Inter-rater reliability

There is only random agreement among respondents regarding safety culture (ICC = 0.021), fair agreement among respondents regarding safety behavior (ICC = 0.475) and random agreement regarding influencing factors (ICC = 0,105). Individual perception differences and scoring biases across respondents (e.g. some respondents score more towards the medium of a scale while others prefer the extremes of a scale) are acknowledged explanations for disagreement among respondents (Paulhus, 1991).

When examining the ICC values at the warehouse level, one notices that the ICC values for safety culture within each warehouse are lower than the average ICC across warehouses (i.e. -0.456 for warehouse 1; -0.013 for warehouse 2; and -0.462 for warehouse 3). As already indicated by the

qualitative data, these values suggest that there are differences in the importance that individual warehouses assign to safety. In warehouse 2 there is the least disagreement regarding the safety culture sub-dimensions.

In this study, we focus on how safety culture shapes safety behavior. Notably, the ICC values indicate that structural agreement on the importance of safety and available resources for safety (i.e. observable factors of safety culture) are not necessary to generate structural agreement on safety in daily practice (i.e. safety behavior). Interestingly, respondents from warehouse 3 indicate the most systematic disagreement on the sub-dimensions of safety culture, but the most systematic agreement on the sub-dimensions of safety behavior (ICC = 0,528 compared to 0,069 and 0,142 for warehouse 1 and 2 respectively). In other words, although employees in warehouse 3 do not agree on the importance of sub-dimensions of safety culture, they agree on safety behavior in daily practice.

5. Discussion and conclusion

5.1 Introduction

In this paper we performed a literature study that described two key aspects of safety (i.e. safety culture and safety behavior) and we identified factors that influence the translation of safety culture into safety behavior. We then assessed the extent to which these factors are relevant in assessing safety culture and behavior in the warehouses of a leading LSP. The results from the case study are summarized in Figure 5 below. In this study we particularly focused on how safety culture shapes safety behavior, rather than how behavior leads to cultural change. Before discussing the theoretical and practical implications of this study, we want to reflect on our study results.

First, comparing the different warehouses, we found differences in the importance assigned to safety, which may point to the existence of sub-cultures across warehouses. For one, employees from warehouse 3 attached the lowest values to the safety culture and safety behavior sub-dimensions. This could be explained by the fact that there are fewer safety specific issues that need to be dealt with in warehouse 3 as compared to the other warehouses, i.e. food and hazardous materials have more specific requirements in terms of product handling and storage. Fewer precautions that are required on a daily basis may result in less awareness of safety, and thus a lower value attached to it. Another explanation may be that warehouses 1 and 2 were founded by the owners of the LSP and are still highly influenced by the corporate values of the LSP; whereas warehouse 3 is an acquired warehouse that operates more independently. For example, a feeling of independence of their activities from the LSP company that owned the warehouse they worked in was noticed during informal conversations. In these conversations employees from warehouse 3 often talked about ‘we’ vs. ‘they’ when comparing their warehouse with the LSP.

Moreover, employees in warehouse 2 attached the highest values to safety culture sub-dimensions and they were the most in agreement on this. In warehouse 2, Safety Fridays and Toolbox Sessions are organized in which safety issues are discussed (e.g. examples of accidents, procedures). These initiatives may have resulted in improved awareness of the importance of safety and may have generated a more consistent understanding of safety across hierarchical levels. This active, open communication does not take place in warehouse 1 and 3 and may explain the lower values attached to safety culture sub-dimensions and lower levels of agreement regarding the importance of safety aspects within these warehouses.

Second, our results indicate that workers consider factors to stimulate safer behavior (i.e. social status, penalties, promotion, bonuses) to be of low importance. This implies that when engaging in efforts to improve safety behavior it is more worthwhile to invest in raising employee awareness of the importance of safety (so that individuals are intrinsically motivated to behave safely) rather than

trying to stimulate safe behavior through the use of extrinsic incentives. Such awareness can be created by for example organizing sessions in which safety issues are addressed (similar to the Toolbox sessions described above). The positive effects of such means of safety communication on safety behavior of employees have recently been confirmed in construction (Olson *et al*., 2016). In contrast, Zohar and Erev (2007) argue that in order to enhance safe behavior, it should be directly rewarded because employees often perceive higher direct benefits of unsafe behavior (such as being able to perform work faster or with less effort when safety procedures are not followed) compared to benefits of safe behavior (because of e.g. low risks of accidents/injuries, delayed impacts of behavior are discounted; (Vecchio-Sadus and Griffiths, 2004; Zohar and Erev, 2007)). In our study, the low value attached to stimulating factors can be attributed largely to the scores assigned by employees of warehouse 2, which were lower than the scores assigned by employees of warehouses 1 and 3. A strong existing safety culture in warehouse 2, in combination with a high value placed on safe behavior, may mean that warehouse 2 employees do not perceive high direct benefits from unsafe behavior. This could explain why there may be no need to directly reward them for safe behavior.

Third, technology sub-dimensions of both safety culture and safety behavior were among the most important sub-dimensions (in the top three for both aspects) by which to assess safety in the studied warehouses. Indeed, having safe equipment to work with and ensuring safety of equipment is especially important in warehouses as heavy equipment (e.g. forklift trucks, trucks) is often operated with workers standing nearby (De Koster *et al*., 2011).

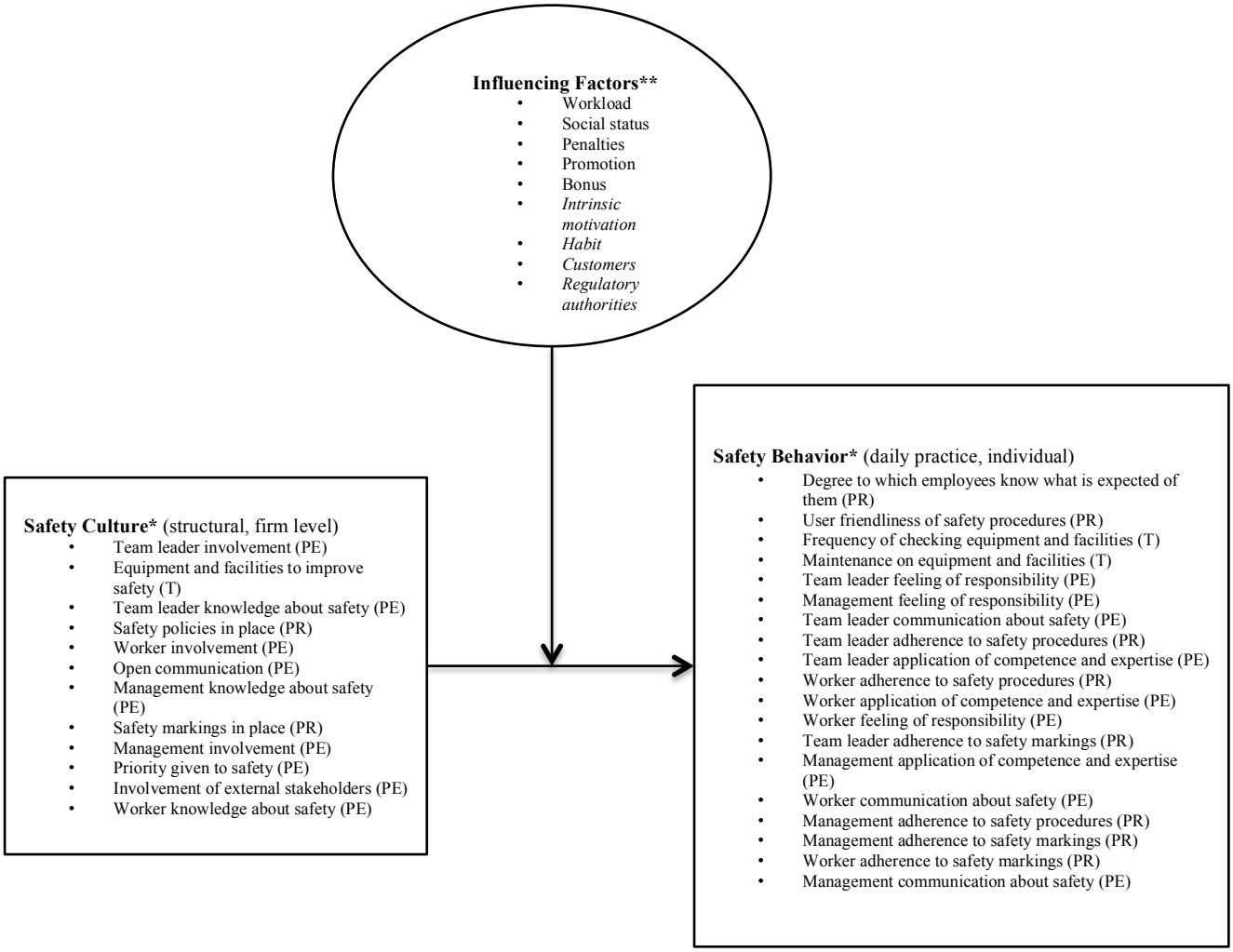

Figure 5. Safety framework based on literature study and case study
* PE = People dimension, PR = Procedures dimension, T = Technology dimension

** The additional influencing factors found, are shown in *italics*
*** All sub-dimensions are ranked (top to bottom) from most important to least important

5.2 Theoretical implications

The results of this study have several theoretical implications. First, while logistics research has focused on safety in transportation, research on safety in warehouses is scarce (De Koster *et al.*, 2011). Also, a literature review by Fan *et al.* (2014) on safety in Operations Management does not report on safety in warehousing. This paper contributes to this literature gap by exploring how to assess and facilitate safety in warehouses. The proposed conceptual model serves as an empirical basis for future research. Thereby, this study answers a call for more research on safety in operational settings (Das *et al.*, 2008).

Second, this research enriches safety literature in logistics by studying the observable part of safety culture, which reflects shared beliefs and values and emphasizes continuity and is enduring. This is different from safety climate, which can be seen as how a company's safety culture is visible to and perceived by the outside world, i.e. the perceived manifestation (snapshot) of the culture (Meyer and Reniers, 2016). Thereby, this study furthers understanding of two important concepts of safety (i.e. safety culture and safety behavior) that are not clearly distinguished in the literature (Myers *et al.*, 2014), which seems to assume that a safety culture automatically translates into safety behavior (Guldenmund, 2000). More specifically, we propose that there are factors, which influence how safety culture shapes safety behavior. In this regard, we explained the important influence of employees' intrinsic motivation to behave safely and the workloads they face.

Third, this study shows the importance of measuring safety across different locations/branches. The finding that safety is valued differently in different warehouses suggests there may be sub-cultures within the firm. These sub-cultures may vary, e.g. one being more developed than another (Parker *et al.*, 2006). Calculating an overall safety culture score may generate crude results (Parker *et al.*, 2006): differences between branches may be averaged out, hiding underperforming/'bad' safety sub-cultures. Thus, although it is often noted that one overarching safety culture can be identified, sub-cultures have to be taken into account.

5.3 Managerial implications

This study also has several implications for practice. This study shows warehouse safety managers how to assess safety, how to facilitate the development of a safety culture, and how to translate a safety culture into safety behavior. First, the safety culture and safety behavior dimensions posed will help them to assess the current state of safety in their warehouses. Our results suggest that if there is a lesser need to behave safely, awareness of and value placed on safety decreases. Our data showed the importance of a supportive role of management when efforts are taken to develop a safety culture. Also, our results revealed that the safe behavior of managers as well as team leaders is important when developing safety behaviors in employees.

Second, with an understanding of the factors influencing the translation of safety culture into safety behavior safety managers are better equipped to facilitate safety in their warehouses. Our findings suggest that managers should take into account the importance of employee intrinsic motivation on safety behavior. This intrinsic motivation is especially important in the logistics industry as managers in this industry have relatively little control over the daily behavior of their employees (Edwards *et al.*, 2013). Managers should also consider that a high employee workload could be an important barrier to positive safety behavior.

Third, this study offers the LSP under study specific insight into the overall level of safety and the differences in safety per warehouse. While safety has become an important issue for the top management of this LSP, we found a difference in the development of safety between warehouses 1 and 2 versus warehouse 3. This may be due to the fact that warehouse 3 (and its existing safety culture and practices) was acquired after establishment. When efforts are taken to improve safety within the LSP, specific attention should be paid to warehouse 3 as there may be inherited culture and climate related differences between acquired warehouses and self-established ones.

5.4 Limitations and directions for future research

This study has several limitations and offers directions for further research. A first limitation of our study design is that our case study research sample is limited. We interviewed a limited number of managers, team leaders, and workers from three warehouses owned by one LSP. While this was sufficient for our research purpose, which was exploratory in nature, more extensive research with a larger research sample is needed to strengthen conclusions.

A second limitation of our study design is that we observed a tendency for some respondents, especially those of the lowest hierarchical level, to indicate that everything regarding safety is fine. One possibility is that respondents were afraid of losing their jobs by giving a socially undesirable answer (i.e. by revealing that they or their superiors were not paying sufficient attention to safety), or that they did not have a sense of oversight on the situation and said that everything was fine by default (top management pointed out this possibility to us; they indicated that some workers follow procedures because they are told to do so but find it difficult to actively take charge of safety within their function). Future research could solve this issue by making the response process anonymous, e.g. by conducting a survey, and/or by performing an observation study.

Our research offers several other opportunities for further research. First, the conceptual model developed in this study serves as an empirical basis for future research to further develop the concepts of safety culture and safety behavior in warehouses. In this regard, one progression would be to develop and administer a survey instrument to provide insights in how to improve safety in warehouses and what the role is of leaders in this process. Regarding the sub-dimensions and their place in the conceptual model, factor analysis could provide insights in patterns underlying and correlations between sub-dimensions. This would contribute to the ongoing debate on the definition, and aspects, of safety culture (Edwards *et al.*, 2013). While such research opportunities are more often proposed in safety research, the next step would be to actually perform such a study.

Second, because our results show structural differences between acquired and self-established warehouses regarding the value that is placed on safety culture and safety behavior sub-dimensions, it would be interesting to investigate the difference between safety in an organization's self-established warehouses versus its acquired warehouses in more detail. Antonsen (2009), in this context, refers to a differentiation perspective, which holds that culture is something shared by a group but within subcultural boundaries (such as smaller groups within an organization as a whole). Future research could provide insights into why differences between warehouses (i.e. subcultures) exist and the possible safety implications. Studying the differences between sub-cultures in more detail is especially important since LSPs build their networks through acquisitions of other companies, which could include the acquisition of existing, and possibly different, safety cultures. Different subcultures could lead to significantly different safety outcomes across different warehouses (Edwards *et al*., 2013).

The low value attached to extrinsic factors to stimulate safe behavior may relate to the country in which this case study was conducted. The Netherlands has high standards for safe working, safe workplaces and ethics, and has relatively low corruption indices. As a result of the common value attached to safety employees in the Netherlands may perceive that extrinsic stimuli are not required to

work safely. In other countries (e.g. developing countries) the standards of safety and the value attached to safety throughout the society may not be as high. Because of this, employees in other countries may perceive extrinsic stimuli to work safely more important compared to employees in the Netherlands. The inclusion of other countries and backgrounds is required to explore potential differences in values attached to safety aspects identified in this study.

Moreover, based on our findings, we suggest additional research on safety culture and safety behavior. Overall we found a large spread in the respondents' answers. While this may be attributed (partly) to the research subject itself (as safety is by definition concerned with opinions and perceptions which can vary from person to person) and to differences between warehouses, we suggest more extensive research with a larger sample to gain insights into which factors contribute to this large spread. Such insights would be important for managers who aim to achieve a consensus and standard regarding safety within their organization. This complements Edwards *et al.* (2013) who argue that in industries where day-to-day behavior of employees is not tightly controlled and supervised, such as logistics, it may be of greater relevance to study employees' intrinsic commitment to safety rather than management practices, policies, and procedures.

5.5 Concluding remarks

In conclusion, our study contributes to existing literature by exploring how warehouse safety can be assessed and facilitated. Our findings especially show the importance of the involvement of team leaders to, and their knowledge about, safety and the importance of technology to prevent/minimize unsafe situations when efforts are taken to develop the safety culture. We also show that manager and team leader responsibility for safety and daily safety practices of especially team leaders are important aspects of safety behavior. The reason is that team leaders, as opposed to managers, are in daily contact with workers and are actively present in the warehouse; therefore, their safety behavior is considered more important by warehouse workers. Moreover, as our study explains, ensuring the safe working of equipment and facilities and monitoring and maintaining equipment and facilities are particularly important in warehouses where heavy equipment is used in close proximity of employees. Furthermore, we showed that intrinsic motivation of employees and employee workload are the main factors influencing the translation of a safety culture to safe behavior. We explained that extrinsic factors aimed at steering safety behavior are considered less important in contexts where a strong safety culture exists in combination with a high value placed on safety.

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Appendix A: Questionnaire

Since the questionnaire was held in Dutch, below we present the English translation (performed by the four authors). In this questionnaire, when we refer to safety, we specifically mean safety in the warehouse. A five point Likert scale is used to indicate the extent to which respondents agree with each proposition, where 1 means totally disagree, 2 means disagree, 3 means neutral (i.e. nor disagree nor agree), 4 means agree, and 5 means totally agree.

Safety Culture

1. What do you think safety in the warehouse is about? Can you give as many examples as possible?
2. Based on what do you notice that safety is found important in the warehouse?
3. Based on what do you notice that safety is not considered important, or not considered important enough?

Propositions (fill in a number from 1 to 5)

1. The degree to which management is involved in safety, reflects the importance of safety.	
2. The degree to which management has knowledge about safety and is trained on safety, reflects the importance of safety.	
3. The degree to which management involves team leaders in safety, reflects the importance of safety.	
4. The degree to which team leaders have knowledge about safety and are trained on safety, reflects the importance of safety.	
5. The degree to which managers and team leaders involve workers in safety, reflects the importance of safety.	
6. The degree to which workers have knowledge about safety and are trained on safety, reflects the importance of safety.	
7. The degree to which management involves external parties specialised in safety, in safety, reflects the importance of safety.	
8. The degree to which we can speak open and honest about safety, reflects the importance of safety.	
9. The degree to which there are safety procedures in the warehouse (for example the about the safe storage of materials, wearing safety clothing, safe working with a forklift truck or evacuation procedures) reflects the importance of safety.	
10. The degree to which priority is given to safety, reflects the importance of safety.	
11. The degree to which the forklift truck, the loading dock and the rest of the warehouse are provided with safety markings, reflects the importance of safety.	
12. The degree to which safety material is on hand to work safe (e.g. safety clothing, helmets, gloves), reflects the importance of safety.	

Safety Behavior

1. Based on which factors do you notice that working in the warehouse is safe? Can you give examples?
2. Based on which factors do you notice that working in the warehouse is not always safe? Can you give examples?

Propositions (fill in a number from 1 to 5)

1. The management feels responsible for safety.	
2. The management applies its knowledge on safety.	
3. The management communicates well about safety.	

4. The management adheres to the safety procedures. | |
5. The management adheres to the safety markings. | |
6. The team leaders feel responsible for safety. | |
7. The team leaders apply their knowledge on safety. | |
8. The team leaders communicate well about safety. | |
9. The team leaders adhere to the safety procedures. | |
10. The team leaders adhere to the safety markings. | |
11. The workers feel responsible for safety. | |
12. The workers apply their knowledge on safety. | |
13. The workers communicate well about safety. | |
14. The workers adhere to the safety procedures. | |
15. The workers adhere to the safety markings. | |
16. I know what is expected of me concerning safety. | |
17. Safety procedures are easy to apply in practice. | |
18. It is regularly being checked if the materials that we work with in the warehouse and the warehouse itself are safe. | |
19. Regularly maintenance is paid on the materials that we work with in the warehouse and the warehouse itself. | |

Factors Influencing The Translation Of Safety Culture Into Safety Behavior

Note: the first set of propositions was discussed to gain additional understanding on employees' perceptions about themselves. The second and third set of propositions were asked to gain additional understanding of the perception of employees higher in hierarchy on employees lower in hierarchy. Because the scores of these propositions are not visualised in a graph, no abbreviations are related to them.

1. What are reasons for you to exactly do what is required of you in terms of safety?
2. Can you give example where you to do more than is required of you in terms of safety? Why do you do this?
3. Can you give examples where you do less than is required of you in terms of safety? Why do you do this?

Propositions for managers, team leaders, and workers (about themselves; fill in a number from 1 to 5)

1. When I am busy, I find doing my job more important than safety. | |
2. If I would gain social status by behaving safely, I would behave safer than I do now. | |
3. If I would receive a bonus for safe behavior, I would behave safer than I do now. | |
4. If I would receive a penalty for not behaving safely, I would behave safer than I do now. | |
5. If I could make promotion by behaving safely, I would behave safer than I do now. | |

Propositions for managers (fill in a number from 1 to 5)

1. Team leaders would behave safer if they would have less work pressure. | |
2. Team leaders would behave safer if they would gain social status by behaving safe. | |
3. Team leaders would behave safer if they would receive a bonus for safe behavior. | |
4. Team leaders would behave safer if they would receive a penalty for unsafe behavior. | |
5. Team leaders would behave safer if they would be eligible for promotion by behaving safely. | |

Propositions for managers and team leaders (fill in a number from 1 to 5)

1. Workers would behave safer if they have less work pressure.	
2. Workers would behave safer if they gain social status by behaving safely.	
3. Workers would behave safer if they receive a bonus for safe behavior.	
4. Workers would behave safer if they receive a fine for unsafe behavior.	
5. Workers would behave safer if they could make promotion by behaving safely.	

Appendix B: Scores of sub-dimensions of safety culture

Importance	Sub-dimension of safety culture	Score*			
		Average	**Warehouse 1**	**Warehouse 2**	**Warehouse 3**
High	Team leader involvement	4.35	4.38	4.67	3.83
	Equipment and facilities to ensure and improve safety	4.28	4.22	4.60	3.83
	Team leader knowledge about safety	4.20	4.44	4.20	3.83
	Safety procedures in place	4.16	4.33	4.50	3.33
	Worker involvement	4.12	4.22	4.40	3.50
	Open communication	4.12	4.33	4.30	3.67
	Management knowledge about safety	4.08	4.38	4.20	3.83
	Safety markings in place	4.04	3.89	4.40	3.67
	Management involvement	4.00	3.89	4.30	3.67
Medium	Priority given to safety	3.96	4.25	4.20	3.17
	Involvement of external stakeholders	3.95	4.14	4.20	3.20
	Worker knowledge about safety	3.88	4.11	4.20	3.00

* High = Score $\geq$ 4, Medium = 3 $\leq$ Score < 4, Low = Score < 3

Appendix C: Scores of sub-dimensions of safety behavior

Importance	Safety behavior sub-dimension	Score*			
		Average	**Warehouse 1**	**Warehouse 2**	**Warehouse 3**
High	Degree to which employees know what is expected of them	4.40	4.44	4.60	4.00
	User friendliness of safety procedures	4.40	4.33	3.90	3.67
	Frequency of checking the functioning of equipment and facilities	4.36	3.89	4.80	4.33
	Maintenance on equipment and facilities	4.36	3.78	4.80	4.50
	Team leader feeling of responsibility	4.33	4.50	4.40	4.00
	Management feeling of responsibility	4.30	4.29	4.60	3.83
	Team leader communication about safety	4.17	4.13	4.11	3.67
	Team leader adherence to safety procedures	4.08	4.00	4.40	3.67
	Team leader application of competence and expertise to deal with safety issues	4.04	4.57	4.10	3.33
Medium	Worker adherence to safety procedures	3.96	3.63	4.40	3.67
	Worker application of competence and expertise to deal with safety issues	3.92	3.75	4.30	3.50
	Worker feeling of responsibility	3.83	3.63	4.00	3.83
	Team leader adherence to safety markings	3.83	3.50	4.50	3.17
	Management application of competence and expertise to deal with safety issues	3.79	3.50	4.30	3.33
	Worker communication about safety	3.79	3.88	4.10	3.17
	Management adherence to safety procedures	3.79	3.50	4.20	3.50
	Management adherence to safety markings	3.72	3.50	4.63	2.67
	Worker adherence to safety markings	3.71	3.33	4.38	3.00
	Management communication about safety	3.70	3.63	4.20	2.80

* High = Score ≥ 4, Medium = $3 \leq$ Score < 4, Low = Score < 3

Appendix D: Scores of factors influencing the translation of the safety culture into safety behavior

Importance	Factors influencing the translation of the safety culture into safety behavior	Score*			
		Average	Warehouse 1	Warehouse 2	Warehouse 3
Low	Workload	2.42	2.56	2.00	3.00
	Social status	2.28	2.00	2.50	2.33
	Bonus	1.88	2.00	1.60	2.17
	Penalties	2.24	2.56	2.00	2.17
	Promotion	2.16	2.44	1.90	2.17

* High = Score ≥ 4, Medium = 3 ≤ Score < 4, Low = Score < 3

Appendix E: Perception of factors influencing the translation of the safety culture into safety behavior per warehouse

Perception of influencing factor	Score*			
	Average	Warehouse 1	Warehouse 2	Warehouse 3
Management perception of factors influencing team leader safety behavior				
Work pressure	2.71	2.00	3.00	3.00
Social status	2.14	2.00	2.33	2.00
Bonus	2.43	2.00	2.67	2.50
Penalties	3.00	3.00	3.33	2.50
Promotion	2.43	2.00	2.67	2.50
Management and team leader perception of factors influencing worker safety behavior				
Work pressure	3.67	4.20	3.17	3.75
Social status	3.33	3.60	3.17	3.25
Bonus	3.36	3.75	3.00	3.50
Penalties	3.57	4.25	3.33	3.25
Promotion	3.36	4.25	3.17	2.75

* High = Score ≥ 4, Medium = 3 ≤ Score < 4, Low = Score < 3